NUREG-0002,VOL. 5

Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Cooled Reactors

HEALTH, SAFETY & ENVIRONMENT

Public Comments
and
Nuclear Regulatory Commission Responses

August 1976

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Date: 01/17/2006

Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

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INTRODUCTION

Volume 5 contains copies of 69 letters commenting on the Draft Generic Environmental Statement (GESMO) WASH-1327 and the NRC's responses to the comments received from Federal, State and local agencies; environmental and public interest groups, members of the academic and industrial communities, and individual citizens. An index to these letters indicating the number assigned to each letter, the author, and organization represented, is provided in the Table of Contents for Volume 5.

These letters were analyzed to identify major issues for the preparation of the final GESMO. Twenty principal topics appearing in the various public comment letters are listed on page 3 with the assigned letter number wherein the listed topic appears. In Volume 5, after each comment letter, specific comments are repeated, a number assigned and a direct NRC response supplied. The comment responses generally cite responsible opposing or supporting views, or both, and arrive at a conclusion based on the best available information. Where views other than those of the NRC are cited, the name of the author or organization is identified. The objective of this procedure was to provide an efficient means of handling the various viewpoints presented, and to be responsive to all issues raised. Public comments have been taken into consideration in the preparation of final GESMO. Most of the responses to specific comments include references to portions of the revised text of final GESMO.

Many comments were directed to the safeguards issues relating to the separation of plutonium from the spent fuel. These issues are not assessed in this health, safety, and environmental portion of the final statement. Responses to public comments on safeguards issues will be included in the safeguards supplement.

Aside from the safeguards considerations, the principal issues put forth by commenters on the health, safety, and environmental issues of the draft GESMO were:

- Plutonium is toxic and plutonium recycle will introduce unacceptable risks to public health and safety.

- The Waste Management Program should be clarified as the handling of high level waste, transuranic waste, and other than high level waste.

- Projected growth of electric utilization has been overstated and will not materialize if practical energy conservation measures are taken, thus obviating the need for Pu recycle as a viable alternative for meeting the realistic energy growth requirements.

The costs for recovered materials and services and the cost estimates for supporting fuel cycle facilities were not realistic. Realistic cost-benefit analysis may indicate that Pu recycle is not a viable option.

The draft GESMO, WASH-1327, was issued in August 1974. The public and government agencies were requested to submit comments within 60 days. On December 10, 1974, the AEC issued proposed amendments to the Commission's rules and regulations relating to the health, safety and environmental aspects of mixed oxide fuels in LWR's (Federal Register, Volume 39 FR 30186). The proposed amendments were sent to all persons who submitted comments on GESMO, and all others who requested copies. Thirty-four comment letters commenting on the proposed amendment were received. Those comment letters which included comments on draft GESMO health, safety and environmental issues are included herein with appropriate NRC responses. On May 8, 1975, the NRC issued its provisional views on safeguards and the deferral of licenses of plutonium-related facilities (Federal Register, Volume 40 FR 20142). Approximately 240 comment letters were received. Few comments addressed the health, safety and environmental aspects of draft GESMO.

In summary, the various actions taken by the former AEC and present NRC to solicit and address public participation in the preparation of final GESMO, have resulted in three categories of input. These are:

1. Comment Letters on Draft GESMO
2. Comment Letters on the Amendments to the Commission Rules
3. Comment Letters on the NRC Provisional Views

The records of all these items are maintained in the NRC Public Document Room, 1717 H Street, NW, Washington, D.C. 20555. All of the letters of Item 1 and those of Items 2 and 3 which include specific comments on the health, safety and environmental and cost-benefits issues related to plutonium recycle, are reproduced in this Volume 5 of final GESMO.

INDEX FOR PRINCIPAL TOPICS APPEARING IN COMMENT LETTERS

	Topic	Comment Letter Numbers
1.	Pu toxicity Pu recycle will introduce unacceptable risks to the public	5, 15, 20, 25, 36, 48, 53, 54, 55, 68
2.	Safety concerns with MOX fuels in existing LWR's	25, 34, 36, 37, 46, 55
3.	The projected nuclear industry growth was overestimated	25, 54
4.	Costs used in evaluations were too low; benefits were overestimated in terms of Pu and U values	15, 18, 21, 24, 29, 30, 31, 34, 35, 36, 37, 42, 43, 49, 54, 61, 69
5.	Present radiation standards for handling Pu are not adequate	5, 20, 63
6.	Pu recycle is a viable method of utilizing an energy sourcea way of burning up Pubetter than Pu storage	3, 7, 17, 30
7.	Economics of utilization of Pu are favorable	3, 17, 18, 22, 29, 30, 31
8.	Occupational exposure assessments are incorrect	15, 17, 20, 21, 25, 48, 54
9.	Selection of alternatives and "basecase" are unrealistic on account of delays in reprocessing spent fuel	15, 18, 22, 25, 58, 64, 65
10.	Practicability of recycle of uranium is questioned with indicated high reprocessing costs	15, 25, 54
11.	Concern with the release of noble gases (^{85}Kr)	15, 21, 25, 36, 54, 62
12.	Dissolution of MOX (solubility of PuO_2 portion of fuel) was questioned	15, 24
13.	Do not limit Pu in MOX fuels to 1.15 self generation in LWR's	18, 21, 24, 29, 30, 34, 42, 46
14.	Overconservatism has been used to bridge uncertainties and tend to result in unrealistic values dose commitments	18, 21, 44, 50
15.	Present and future Pu plants should be subjected to Commission's upgraded regulations pertaining to workers' training; maintenance of equipment; operation, including security; an increased NRC inspection is needed	20, 21
16.	Lower risk alternatives to Pu recycle exist	15, 25
17.	Buildup of ^{242}Pu and ^{236}Pu after several recycles can be detrimental to effective operations	25, 30, 46, 53, 54
18.	Hot particle contention	25, 44, 46, 48, 62, 63

INDEX FOR PRINCIPAL TOPICS APPEARING IN COMMENT LETTERS (Continued)

	Topic	Comment Letter Numbers
19.	The waste management program for the LWR cycle must be defined	25, 27, 29, 30, 37, 40, 42, 49, 54, 55, 61, 62
20.	Concerns with the risks associated with the transportation of plutonium, PuO_2, and MOX fuels	20, 25, 27, 31, 37, 42 45, 54, 59, 62

Comment Letter No. 1

STATE OF LOUISIANA
COMMISSION ON INTERGOVERNMENTAL RELATIONS

EDWIN EDWARDS
GOVERNOR
SENATOR MICHAEL H. O'KEEFE
CHAIRMAN
LEON TARVER
EXECUTIVE DIRECTOR

P. O. BOX 44455
BATON ROUGE, LOUISIANA 70804
389-5664

August 26, 1974

Mr. S. H. Smiley, Deputy Director
Fuels and Materials
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

The State Clearinghouse has reviewed your Draft Environmental Statement on the "Generic Environmental Statement Mixed Oxide Fuel," in respect to agency impact and responsibility.

Therefore, we are forwarding your draft environmental statement to the Division of Radiation Control, Board of Nuclear Energy.

Comments will be forwarded directly to you with a copy to our office.

If any further assistance is necessary, please contact this office.

Sincerely,

Regis Allison

Regis Allison
State Clearinghouse Director

cc: Mr. Jim Porter

RA:se

HOUSE COMMITTEE
J. RICHARD BREAUX
ROBERT FREEMAN
T. W. HUMPHRIES
ALPHONSE JACKSON, JR
RICHARD THOMPSON

GOVERNOR'S COMMITTEE
KENNETH BOWI
JOHN A. COA
GORDON FLOR
J. K HAYNES
EDWARD STAG

SENATE COMMITTEE
WILLIAM D. BROWN
FREDERICK EAGAN
K. D. KILPATRICK
EDGAR G. MOUTON
DONALD W. WILLIAMSON

Comment Letter No. 2

STATE OF MISSISSIPPI

OFFICE OF THE GOVERNOR

WILLIAM L. WALLER
GOVERNOR

WM. M. HEADRICK
COORDINATOR OF FEDERAL-STATE PROGRAMS

STATE CLEARINGHOUSE FOR FEDERAL PROGRAMS

TO: Mr. S. H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing - Regulation
United States Atomic Energy Commission
Washington, D.C. 20545

State Clearinghouse Number
74082601
Date: August 26, 1974

PROJECT DESCRIPTION: Generic Environmental Statement Mixed Oxide Fuel (Recycle Plutonium in Light Water - Cooled Reactors)

(X) 1. The State Clearinghouse has received notification of intent to apply for Federal assistance as described above.

(--) 2. The State Clearinghouse has reviewed the application(s) for Federal assistance described above.

(--) 3. After proper notification, no State agency has expressed an interest in conferring with the applicant(s) or commenting on the proposed project.

(--) 4. The proposed project is: ( ) consistent ( ) inconsistent with an applicable State plan for Mississippi.

(--) 5. Although there is no applicable State plan for Mississippi, the proposed project appears to be: ( ) consistent ( ) inconsistent with present State goals and policies.

COMMENTS: Final State Clearinghouse review and comment will await indication of State agency interest in this project.

Edward A. May, Jr.
Assistant to the Coordinator

SUITE 400, WATKINS BLDG. • 510 GEORGE STREET • JACKSON 39201 • (601) 354-7570

Comment Letter No. 3

DOCKET NUMBER
PROPOSED RULE PR - Misc Notice (39 FR 30186)
GESMO

MISSISSIPPI
STATE BOARD OF HEALTH
2423 NORTH STATE STREET, P. O. BOX 1700
JACKSON, MISSISSIPPI 39205

ALTON B. COBB, M.D., M.P.H.
STATE HEALTH OFFICER

September 6, 1974

U. S. Atomic Energy Commission
Fuels and Materials
Directorate of Licensing
Washington, D. C. 20545

Re:- Comments on the generic environmental impact statement on the use of recycle plutonium in mixed oxide fuels in light water reactors, WASH-1327.

Gentlemen:

The State of Mississippi, through its Division of Radiological Health, Mississippi State Board of Health, has reviewed the draft GESMO, WASH-1327, August, 1974, and would submit its comments briefly.

Summarily, our review of WASH-1327 leads to the same conclusions, more or less, as those stated by the AEC Staff on page S-62 of Volume 1 of the document. Our conclusions are based on the radiological and, to a lesser extent, the economic implications of incorporating plutonium oxide into the fuel of light water reactors.

As uranium is a precious and rapidly depleting resource, the incorporation of a spent fuel product - plutonium - (with all due respect to and awareness of both the radiotoxicity and chemical toxicity of the element) as cited by the Staff in their Alternatives 3 and 4 seemingly forms a viable alternative to dispose of the highly noxious plutonium while deriving maximum benefit from the utilization of uranium.

With regard to our ultimate objective of protection of public health and safety, the utilization of plutonium as a constituent of the mixed oxide fuel of light water reactors serves to reduce the population dose commitment, according to the Staff's radiological health impact evaluation. This factor, as it is our major concern, meets with our approval and would receive our support.

The reduction of plutonium stockpiles via MOX fabrication would appear outwardly to at least reduce, if not eliminate, the possibility of plutonium release and contamination from internal subersive activities. This would appear to be an environmentally sound alternative to that of storage of the material for an indefinite amount of time.

From an economic standpoint, we can support, with no hesitancy, the recycle plutonium effort. We have all seen and felt the effects of rising fossil fuel costs on the electric power producing industry. Additionally, as it is known fact that the fossil fuel reserves, as well as the uranium reserves, are being depleted at a frightening rate, alternative means of energy production from our natural resources and artifically produced (plutonium) resources need to be introduced into our way of life as expediently as possible, without the sacrifice of caution. The Staff's Alternative 4 "prompt reprocessing of spent fuels and re-cycle of uranium and plutonium providing for significantly upgraded materials and plant production measures as might be judged to be consistent with AEC objectives" seemingly provides a viable means of partially meeting our energy needs at a reduced cost.

We would like to extend our appreciation to the Staff for giving us the opportunity to voice our comments on WASH-1327.

Sincerely,

Ronald J. Forsythe

Ronald J. Forsythe
Health Physicist
Division of Radiological Health

RJF/rmp

cc: P. T. Bankston, D.Sc., Director
Office of Science and Technology
State of Mississippi

Comment Letter No. 4

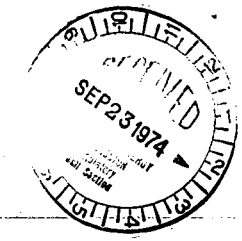
PROPOSED RULE FR-Misc Notice (39 FR 30186) GESMO

STATE OF KANSAS

AREA CODE 913
296-2436

Department of Administration

DIVISION OF THE BUDGET
STATEHOUSE - TOPEKA 66612



September 19, 1974

Mr. S. H. Smiley, Deputy Director
for Fuels and Materiels
Directorate of Licensing
Atomic Energy Commission
Washington, D.C. 20545

RE: Environmental Statement on the Use of Mixed Oxide Fuel
in Light Water Reactors
Clearinghouse Number 1389-24.998(ES)

Dear Mr. Smiley:

The referenced environmental statement has been processed by the Division of the Budget under its clearinghouse responsibilities described in Circular A-95.

After review by interested state agencies, it has been found that the proposed project does not adversely affect state plans. We are enclosing comments received from the Office of Comprehensive Health Planning concerning this project for your information and referral.

Sincerely yours,

James W. Bibb

James W. Bibb
Director of the Budget

JWB:REK:rw

Enclosure

State Clearinghouse
State of Kansas

REQUEST FOR ACTION ON PROPOSAL (UNDER OFFICE OF MANAGEMENT AND BUDGET CIRCULAR A-95)

Agency Name	
Raymond Solee - Office of Comprehensive Health Planning	
Clearinghouse Number 1389-24.998(ES)	Applicant's Name Atomic Energy Commission
Expected Filing Date	Project Title Environmental Statement on the use of Mixed Oxide Fuel in Light Water Reactors
RETURN NO LATER THAN September 13, 1974	Return to Division of the Budget, Department of Administration, 1st Floor, Statehouse, Topeka, Kansas 66612

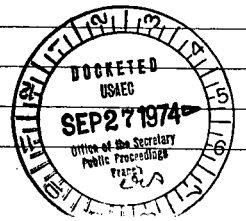
• ADDITIONAL INFORMATION AVAILABLE

The enclosed proposal has been submitted to the Division of the Budget under its clearinghouse responsibilities described in Office of Management and Budget Circular A-95. Your review of this proposal as it affects the interest of the state will be appreciated. Your appropriate comments concerning the proposal should be submitted to the Division of the Budget no later than the date specified above.

Comments filed on a proposal may include: (1) the extent to which the project is consistent with or contributes to the fulfillment of comprehensive planning within the state; (2) how the proposal relates to state objectives; and (3) the effect of the proposal on your agency's activities.

__X__ No Objections "at this time"
_____ Objections (discuss below)
_____ Request for Additional Information (discuss below)
_____ Request for a Conference

COMMENTS:



Raymond R. Solee, Director
Signature

FR-Misc Notice
GESMO (39 FR 30186)

United States Senate
COMMITTEE ON FINANCE
WASHINGTON, D.C. 20510

September 26, 1974

OCT 30 1974

The Honorable Dixy Lee Ray
Chairman
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Ray:

We are writing to express our grave reservations regarding the Atomic Energy Commission's proposal to proceed in the next few months to authorize the use of plutonium as fuel in present-day nuclear power plants around the country. In our judgment, a decision to authorize "plutonium recycle" is a momentous one which should only be made after its risks and implications have been thoroughly explored and debated by the public and the Congress.

As you know well, plutonium is one of the most virulent carcinogens known. Many scientists believe it to be as toxic as the most lethal biological warfare agents. Even more significant, plutonium is a material from which atomic bombs are made. Several pounds are enough for a nuclear weapon capable of tremendous destruction. It is now widely recognized that the design and manufacture of a crude atomic bomb is not difficult technically and that the only effective obstacle in making such a weapon is the availability of plutonium itself.

A Commission decision to authorize the commercial use of plutonium here and abroad would dramatically increase the risk that plutonium might be stolen by determined groups of terrorists, blackmailers, or other criminals. Such a decision would result in the creation of a large private plutonium industry with the sum of its activity being to process hundreds of tons of plutonium annually. The theft of a tiny fraction of this plutonium -- less than one half of one percent -- would be enough to make hundreds of nuclear weapons.

Many reputable scientists informed about the risks of plutonium have warned that its use will pose unprecedented problems. For example, Dr. Bernard T. Feld of M.I.T. wrote recently in the Bulletin of the Atomic Scientists that "within the coming decade or two, the major security problem that the world will face is how to prevent the widespread dissemination of nuclear weapons, not only to governments or semi-governmental bodies, but to groups of unauthorized, even anti-social, elements as well."

We have been particularly impressed by the analysis of the problem prepared by two scientists and an attorney on the staff of the Natural Resources Defense Council. The NRDC report, entitled The Plutonium Decision: A Report on the Risks of Plutonium Recycle, will be published in the November, 1974 issue of the Bulletin. This report expresses great skepticism that safeguards can be implemented which will reduce the risk of plutonium theft to the vanishingly small possibility that is essential. It notes that present safeguard measures are admittedly inadequate and points out the numerous obstacles to upgrading these safeguards to the virtually foolproof system that would be needed. These obstacles include: (1) the sheer difficulty of the task of maintaining perpetual security over immense quantities of this material in a world where law enforcement officials have difficulty securing confiscated heroin and where terrorist activities and sophisticated crime are increasing, (2) the strenuous opposition of the nuclear industry to more strict safeguards, (3) the lax, inadequate enforcement of even present safeguards as described in the recent report of the General Accounting Office, Improvements Needed in the Program for the Protection of Special Nuclear Material (1973), and (4) the fact that the most effective safeguards would exact a tremendous price in terms of civil liberties and privacy and would require social and economic changes that are probably unacceptable to our society.

This last point is of particular concern to us, for we fear that the commercial introduction of plutonium may force choices between personal safety and civil rights -- trade-offs that our country should not have to make. The draft environmental impact statement which the Commission's staff has prepared for its proposal to authorize the commercial use of plutonium fuel expressly mentions as possible new safeguards the creation

of a large federal plutonium police force and the extension of the military security clearance and surveillance system into the rapidly growing private nuclear power industry. The Congress will want to carefully study the implications of these far-reaching proposals and others of similar nature that might follow.

Another problem raised on the NRDC report is the public health risk associated with using a material of plutonium's toxicity as a principal commercial fuel. The adequacy of the Commission's present radiation protection standards applicable to plutonium are under serious challenge, with some qualified experts arguing that those standards are perhaps 100,000 times too lax to protect the public. Until this controversy is resolved, it is impossible to predict the health effects of using plutonium and impossible to know what standards should govern its handling and release to the environment. Moreover, even if the present standards were undisputed, the fact that plutonium is one of the most carcinogenic substances known raises the question of whether we want a material of unprecedented toxicity involved in countless shipments around the country.

Because of the importance of the issues raised in the NRDC report, we are forwarding a copy to you and request the Commission's response to it. In addition to the points raised in the letter, we have attached a list of specific questions we would like you to answer regarding safeguards with respect to plutonium.

In our judgment, it is encumbent upon the Commission to state with clarity and detail the safeguard measures it believes are necessary and to defer any action authorizing plutonium recycle until the public and the Congress have had an opportunity to publicly review the adequacy and the economic and social costs of the Commission's proposals and to take appropriate action. We believe it would be a grave mistake for the Commission to proceed now to authorize plutonium recycle prior to that review. Too many questions, both technical and social, are unanswered today, and arriving at those answers will not be easy. We cannot simply assume, for example, that adequate safeguards are possible or, if they are, that their costs in terms of human freedom and privacy will be acceptable.

These are obviously issues that deserve the most searching public scrutiny while it is still possible to make a decision unencumbered by premature commitments. We look forward to your cooperation in this endeavor.

Sincerely,

Walter F. Mondale

Walter F. Mondale, U.S.S.

Philip A. Hart, U.S.S.

The Hon. Dixy Lee Ray
Chairman
U.S. Atomic Energy Commission
Washington, D.C.

Questions on Plutonium Recycle

1) Does the Commission plan to proceed with plutonium recycle with less than a zero risk safeguard system? If greater than zero, what level of risk does the Commission consider acceptable in terms of nuclear theft, terrorist incidents, unauthorized nuclear explosions or plutonium dispersal devices?

2) Does the Commission believe the creation of a federal security or police force is a necessary or desirable safeguard measure? How large would such a force be? What would its functions be? For example, would it merely guard plutonium shipments and facilities, or would it also be responsible for uncovering and preventing possible theft attempts and recovering plutonium after it is stolen? If a plutonium black market does develop, as at least one former A.E.C. Commissioner believes is "likely", would this security force be prepared to carry out sustained operations against such an underworld market? What standards would govern and restrain the operations of this security force? Will the uniquely grave threat posed by nuclear terrorism justify uniquely drastic police action to protect the public safety? If a federal plutonium security force is not created, will it not be necessary to develop an equivalent police capability within the framework of existing institutions such as state and local law enforcement groups and private security and surveillance forces?

3) In its draft environmental impact statement for plutonium recycle the A.E.C. states:

> "Security problems are much simplified when it can be established with high probability that the persons who are responsible for the handling of plutonium or implementing of related safeguards programs are trustworthy. Various court rulings in recent years have been favorable to the protection of individual privacy and of individual right-to-work. These rulings have made it difficult to make a personnel background check of an individual in commercial activities to assure with high probability that he is trustworthy and, hence, potentially acceptable as a steward for the protection of plutonium. [illegible] which would allow background checks of individuals with access to plutonium and related material accountability records."

We would appreciate receiving copies of the requested legislation referred to in this passage and also an identification of the recent court rulings at which the legislation is aimed. Has the Commission considered the effects of such a security system on the individual rights and privacy of nuclear industry employees, their families, and friends, and how these effects might compare with those of the military and nuclear weapons security systems?

4) Given that police have been unable to spot the underworld market in heroin or even maintain security over confiscated drugs and that the black market price of plutonium is likely to be even higher than that of heroin, what basis does the Commission have for believeng that plutonium security force, whether public or private, will perform with the requisite perfection both today and into the indefinite future when the enthusiasm of the new security enterprise will have dimmed but the quantity of plutonium in commerce will have swollen dramatically?

5) Does the Commission believe that Integrated Fuel Cycle Facilities, where plutonium fuel cycle plants are located at one site, thereby reducing the transport of plutonium, are a necessary safeguard measure? Do present industry plans call for Integrated Fuel Cycle Facilities? Why did the draft environmental statement for plutonium recycle not discuss the more significant Nuclear Power Park concept, where reactors as well as fuel cycle facilities are located at the same site, thus eliminating the transportation link altogether?

6) Does the Commission agree with the view expressed by former Oak Ridge National Laboratory Director Alvin Weinberg and, more recently, by the editors of The Economist (September 7, 1974) that the nuclear fuel cycle should be brought under international control to prevent nuclear theft and ensure effective, long-term regulations? In the Commission's judgment, what is the near-term feasibility of such a proposal?

Attachment to
G-8

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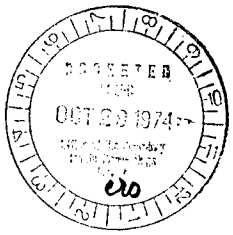
THE PLUTONIUM DECISION

A Report on the Risks of Plutonium Recycle



J. Gustave Speth
Arthur R. Tamplin
Thomas B. Cochran

Natural Resources Defense Council
1710 N Street, N.W.
Washington, D.C. 20036

September, 1974

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Natural Resources Defense Council, Inc.
1710 N STREET, N.W.
WASHINGTON, D.C. 20036
202 783-5710

New York Office
15 WEST 44th STREET
NEW YORK, N.Y. 10036
212 869-0150

Palo Alto Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

The Plutonium Decision

A Report on the Risks of Plutonium Recycle

By

J. Gustave Speth
Arthur R. Tamplin
Thomas B. Cochran

September, 1974

"I fear that when the history of this century is written, that the greatest debacle of our nation will be seen not to be our tragic involvement in Southeast Asia but our creation of vast armadas of plutonium, whose safe containment will represent a major precondition for human survival, not for a few decades or hundreds of years, but for thousands of years more than human civilization has so far existed."

James D. Watson
Nobel Laureate,
Medicine

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I. Introduction

The Atomic Energy Commission, if unchecked, is about to sow the seeds of a national crisis. The Commission now proposes to authorize the nuclear power industry to proceed to use plutonium as fuel in commercial nuclear reactors around the country. The result of a decision approving this commercial use of plutonium will be the creation of a large civilian plutonium industry and a dramatic escalation in the risks posed by nuclear power.

This decision to launch what the AEC calls the "plutonium economy"[1] is the conclusion of the AEC's recently released draft environmental impact statement for plutonium recycle -- the recycling of plutonium as fuel in the present generation of light water reactors.[2] The final version of the impact statement, which is expected to confirm the decision to authorize plutonium recycle, is due in six to nine months.

Plutonium is not native to Earth: the entire present-day inventory is man-made, produced in nuclear reactors. Plutonium-239, the principal isotope of this element, has a half-life of 24,000 years, hence its radioactivity is undiminished within human time scales. It is perhaps the most toxic substance known. One millionth of a gram (there are 28 grams in an ounce) has been shown capable of producing cancer in animals. Plutonium is also the material from which nuclear weapons are made. An amount the size of a softball is enough for a nuclear explosive capable of mass destruction. Scientists now widely recognize that the design and manufacture of a crude nuclear explosive is no longer a difficult task technically, the only real obstacle being the availability of the plutonium itself.

Thus, former AEC physicist Donald Geesaman observes that "plutonium is a fuel that is toxic beyond human experience." Its use, he states, "will inextricably involve our society in the large-scale commercial production of a substance that is a suitable nuclear explosive."[3] The successful theft of this material, as Mason Willrich and Theodore Taylor note, "could enable a small group to threaten the lives of many people, the social order within a nation, and the security of the international community of nations."[4]

It is the burden of this report that the commercialization of plutonium will place an intolerable strain on our society and its institutions. Our unrelenting nuclear technology has presented us with a possible new fuel which we are asked to accept because of its potential commercial value. But our technology has again outstripped our institutions, which are not prepared or suited to deal with plutonium. And those who have asked what changes in our institutions will be necessary to accomodate plutonium have come away from that enquiry profoundly concerned.[5]

The AEC's impact statement assessment of plutonium recycle reinforces, and does not allay, these concerns. It concedes that the problems of plutonium toxicity and nuclear theft are far from solved and indicates that they may not be for some years. Yet it concludes, inexplicably, that we should proceed. Whether stemming from blind faith in the beneficience of the technology it has fostered or from a callous promotion of the bureaucratic and industrial interests of the nuclear power complex, the AEC decision

cannot be justified in light of what we know and, just as important, what we do not know.

II. Dimensions of a Commercial Plutonium Industry

The fuel now used in present-day reactors, the light water reactors or LWR's, is uranium which has been enriched so that the uranium-235 content is increased from the 0.7 percent present in natural uranium to about 3 or 4 percent. Uranium-235 is a fissionable isotope of uranium, the remainder of the fuel being non-fissile uranium-238. Unlike plutonium, this uranium fuel is not extremely toxic, and it is not sufficiently rich in uranium-235 to be fashioned into nuclear weapons.*

While present-day reactors are operating, however, they are also producing as a by-product moderate amounts of plutonium, principally plutonium-239. A typical large reactor produces about 200-250 kilograms of plutonium each year.** Since this plutonium is easily fissioned, it can be used as reactor fuel. "Plutonium recycle" is the nuclear industry-AEC proposal to recover this plutonium produced in LWR's, process it and recycle it as fuel back into LWR's.

Several critical steps are involved in recycling this plutonium. First, the used or "spent" fuel from the reactor must be shipped to a fuel reprocessing plant. The spent fuel contains

*/ Only with extremely sophisticated technology not available to the public, notably gaseous diffusion plants, can uranium be enriched to weapons grade.

**/ LWR's capable of producing 1000 megawatts (1 million kilowatts) of power are being built today. The plutonium is produced when the uranium-238 in the LWR fuel captures neutrons.

plutonium, uranium and extremely toxic fission products or "high-level wastes" (strontium-90, cesium-137, etc.). The function of the reprocessing plant is to separate these three constituents and prepare them for their next destinations. For example, reprocessing plants are supposed to solidify the high-level wastes and ship them to a permanent AEC repository for perpetual management. As yet, however, the AEC has no such repository. Nor does the agency know whether the technology and social institutions for isolating high-level wastes for geologic periods can be made available.

The principal purpose of a reprocessing plant, however, is to recover plutonium, to convert it to oxide form, and to ship it to the next fuel cycle stages -- the fuel fabricating and assembly plants. At a fuel fabricating plant the plutonium oxide will be mixed with uranium oxide into what is called "mixed oxide" fuel. This mixed oxide fuel will be fabricated into fuel pellets, the pellets will be placed in fuel rods, and these rods will be collected into fuel assemblies. These assemblies will then be sent to the reactors for use, thus completing the fuel cycle.

The only privately owned fuel reprocessing plant which has operated in the United States is the Nuclear Fuel Services (NFS) plant at West Valley, New York. Until recently the AEC purchased the plutonium output of this facility for weapons and research purposes. Recently, however, the AEC stopped purchasing recovered plutonium, and in June, 1972, the NFS plant closed for renovation and enlargement. Since mid-1972, then, all spent fuel from LWR's has been simply stored and not reprocessed, a favorable development in terms of nuclear theft since the penetrating radiation of the high-level wastes virtually insures that plutonium will not be

stolen as long as it is still mixed with these wastes in the spent fuel rods.

Two additional fuel reprocessing plants are now being constructed, a General Electric plant at Morris, Illinois, and an Allied-Gulf plant at Barnwell, South Carolina. GE recently announced however, that its Morris plant might never operate and that most of its investment would be lost due to faulty design and construction.[6] Operating license proceedings are scheduled to begin shortly for the Barnwell plant.

There are at present no major commercial plutonium fuel fabricating plants operating or under construction.* The first such plant is planned by Westinghouse for Anderson, South Carolina. Nor has there yet been any non-experimental use of plutonium as fuel in light-water reactors, although the AEC attempted such a recycle until stopped by a lawsuit.[7]

In sum, plutonium recycle has not yet begun, and there is no major industrial commitment of resources to it at this point. The reprocessing plants that have been built do not represent a substantial investment in national terms, and reprocessing plants may be needed in any case to prepare spent fuel for long-term storage.

On the other hand, if the plans of the AEC and the nuclear industry are permitted, a major plutonium industry will develop quickly. Some 140 tons of plutonium could be recovered from commercial reactors by 1985 and some 1700 tons by the year 2000.[8] This figure for the year 2000 includes the plutonium that will be

*/ There are currently several small commercial facilities that process plutonium for research and development purposes.

produced in the fast breeder reactor, which the AEC plans to introduce in the mid-1980's. This is a new type of reactor designed to produce more plutonium than it consumes. A plutonium industry by the turn of the century could involve hundreds of LWR's fueled with plutonium, perhaps a score of fuel reprocessing and fabricating plants, and thousands of interstate and international shipments containing hundreds of tons of plutonium.

III. The Toxicity of Plutonium

The most pernicious product of the nuclear industry is plutonium. Microgram quantities in skin wounds cause cancer, and in the body plutonium is a bone seeker where, once deposited, it can cause bone cancer. But plutonium is most dangerous when inhaled. Donald Geesaman explains this hazard:

> "Under a number of probable conditions plutonium forms aerosols of micron-sized particulates. When lost into uncontrolled air these particulates can remain suspended for a significant time, and if inhaled they are preferentially deposited in the deep lung tissue, where their long residence time and high alpha activity can result in a locally intense tissue exposure. The lung cancer risk associated with these radiologically unique aerosols is unknown to orders of magnitude. Present plutonium standards are certainly irrelevant and probably not conservative. Even so, the fact that under present standards, the permissible air concentrations are about one part per million billion is a commentary on plutonium's potential as a pollutant. Its insolubility and long half-life make the continuing resuspension of particulate contamination another unresolved concern of serious proportions."[9]

To determine whether the AEC's radiation protection standards for plutonium are inadequate, as Geesaman suggests, Arthur Tamplin and Thomas Cochran undertook a major review of the biological evidence for the Natural Resources Defense Council. Their conclusions, found in their report "Radiation Standards for Hot Particles,"

are that plutonium particulates or "hot particles" are uniquely virulent carcinogens and that the current AEC radiation protection standards governing the amount of plutonium to which members of the public can be exposed are roughly 100,000 times too lax.[10] The lung cancer risk associated with hot particles of plutonium as estimated by Tamplin and Cochran is comparable to the lethal dose of botulin toxin, a biological warfare agent. Certainly one would hope that this nation would give careful consideration, and pursue all alternatives before implementing an energy policy based on such toxic materials.

As a result of the Tamplin-Cochran report, NRDC formally petitioned the AEC and the Environmental Protection Agency to reduce the present maximum permissible exposure levels by 100,000. Neither AEC nor EPA have responded finally to the NRDC petition, but the petition is now being considered by the National Commission on Radiation Protection, the National Academy of Sciences, the Biophysical Society and several of the AEC national laboratories. Moreover, EPA will shortly commence a series of hearings and other initiatives on plutonium-related issues, including the hot particle controversy.

Although the adequacy of the AEC's plutonium standards is thus a matter of considerable doubt and great controversy, the AEC's draft impact statement for plutonium recycle simply assumes that the present standards are adequate. The entire risk analysis of the statement, as well as the ultimate decision to proceed with plutonium recycle, are based upon a premature and unexplained rejection of the hot particle hypothesis. Yet, the AEC is forced to concede that this hypothesis "is being given careful considera-

We submit that the AEC has no basis whatever to conclude that plutonium recycle will not cause undue risk to the public health and safety until it has either satisfactorily resolved the hot particle issue or calculated the impacts of plutonium recycle using the assumption that hot particles are uniquely carcinogenic. The draft environmental impact statement for plutonium recycle does neither.

It should be remembered that there is clear experimental evidence that plutonium is one of the most carcinogenic substances known regardless of one's views about the hot particle risk: one millionth of a gram has caused cancer in experimental animals. Thus, the more basic question is whether we want our energy system based on a material of unprecedented toxicity.

Some plutonium contamination of the environment has already occurred due principally to the atomic weapons program. Aside from the worldwide plutonium contamination associated with the fallout from atmospheric weapons tests, there is significant ground contamination at the Nevada Test Site and the Bikini and Eniwetok Atolls. The AEC's plutonium weapons plant at Rocky Flats, 10 miles west of Denver, Colorado, was the site of one of the most costly industrial fires in history. The leakage of plutonium from contaminated oil at this site led to an uncontrolled source of plutonium which was some orders of magnitude larger than the integrated effluent loss during the 17 years of plant operation. As a result of this source, tens to hundreds of grams of plutonium went off site, 10 miles upwind from Denver. The loss was internally unnoticed, the ultimate deposition is now speculative, as is its human significance.[12]

One can derive little comfort in the current operation of the small commercial plutonium fuel fabrication facilities. The Nuclear Materials and Equipment Corporation (NUMEC) of Apollo, Pennsylvania was recently fined $13,720 for a sixteen count violation of AEC regulations ranging from failure to follow radiation monitoring procedures to failure to comply with certain safeguards requirements.[13] Production workers from the Nuclear Fuel Services facility in Erwin, Tennessee met with AEC inspectors on August 13, 1974 to complain about the absence of even the rudiments of accepted health physics practices at that plant.

Occurrences such as these can reasonably be expected to multiply greatly if plutonium is made a major article of commerce.

IV. Nuclear Theft and Safeguards

A. The Problem Defined

On May 18 of this year the world was made dramatically aware of the relationship between nuclear power and nuclear weapons when India exploded a nuclear device made from plutonium taken from a "peaceful" reactor built with Canadian assistance. The threat posed by the availability of plutonium from power reactors is set out by Willrich and Taylor in their book Nuclear Theft: Risks and Safeguards

> "As fuel for power reactors, nuclear weapon material will range in commercial value from $3,000 to $15,000 per kilogram - roughly comparable to the value of black market heroin. The same material might be hundreds of times more valuable to some group wanting a powerful means of destruction. Furthermore, the costs to society per kilogram of nuclear material used for destructive purposes would be immense. The dispersal of very small amounts of finely divided plutonium could necessitate evacuation and decontamination operations covering several square kilometers for long periods of time and costing tens or hundreds of millions of dollars. The damage could run to many millions of dollars per gram of plutonium used. A nuclear explosion with a yield of one kiloton could destroy a major industrial installation or several large office buildings costing hundreds of millions to billions of dollars. The hundreds or thousands of people whose health might be severely damaged by dispersal of plutonium, or the tens of thousands of people who might be killed by a low-yield nuclear explosion in a densely populated area represent incalculable but immense costs to society."[14]

In our troubled world, terrorist activity and other forms of anti-social violence is an almost daily occurrence. A recent AEC study identified more than 400 incidents of international terrorism carried out by small groups during the past six years.[15] In an age of bombs and bomb threats, of aircraft hijacking, of the ransom of diplomats and the murder of Olympic athletes, the risks of nuclear theft, blackmail and terrorism are not minimized even by some of the most ardent supporters of nuclear energy. Thus former Atomic Energy Commissioner Clarence Larson recently described the evolution of a plutonium black market:

> "Once special nuclear material is successfully stolen in small and possibly economically acceptable quantities, a supply-stimulated market for such illicit material is bound to develop. And such a market can surely be expected to grow once the source of supply has been identified. As the market grows, the number and size of thefts can be expected to grow with it, and I fear such growth would be extremely rapid once it begins . . . . Such theft would quickly lead to serious economic burdens to the industry, and a threat to the national security."[16]

The critical point here is that these tremendous risks will become real with the advent of plutonium recycle. Unless plutonium is reprocessed and recycled, the possibility that it will be stolen is small, for if the plutonium has not been "detoxified" by separating it from the high-level wastes in the spent fuel, it is very

effectively protected from theft, at least for hundreds of years.

Willrich and Taylor explain the important relationships:

> "In the light-water reactor (LWR) fuel cycle without plutonium recycle, plutonium which is produced in a power reactor, if reprocessed, might be stolen at the output end of a reprocessing plant, during transit from the reprocessing plant to any separate storage facility used, and from a long-term plutonium storage facility. Until irradiated fuel is reprocessed, the theft possibilities in the LWR fuel cycle are minimal.
>
> "In the LWR fuel cycle with plutonium recycle, in addition to possibilities without recycle, plutonium might be stolen during transit from any separate long-term storage facility, and from a fuel fabrication plant. Complete LWR fuel assemblies, each containing a significant quantity of plutonium might also be stolen during transit from a fuel fabrication plant to a power reactor, and at a power plant prior to loading into the reactor, although the weight of each assembly makes this difficult." (Emphasis added.)[17]

In sum, plutonium recycle will bring with it all the risks associated with nuclear theft that numerous authors have described.[18] Reasonable prudence dictates, therefore, that we have adequate answers to the problem of nuclear theft well in hand before we begin plutonium recycle.

B. Safeguards and the Impact Statement

In the language of the nuclear industry, the various programs and techniques to prevent nuclear theft and recover stolen nuclear material are called "safeguards." There is now widespread agreement, at least among those outside the nuclear industry, that present safeguards are woefully inadequate. The AEC's own Rosenbaum Report concluded:

> "In recent years the factors which make safeguards a real, imminent and vital issue have changed rapidly for the worse. Terrorists groups have increased their pro-

> fessional skills, intelligence networks, finances and level of armaments throughout the world . . . . Not only do illicit nuclear weapons present a greater potential public hazard than the radiological dangers associated with power plant accidents, but . . . the relevant regulations are much less stringent."[19]

It is not that the AEC has not implemented the necessary safeguards programs; rather it has not even developed an adequate program on paper.

On the subject of safeguards, the AEC's draft impact statement for plutonium recycle is a marvel of clouded reasoning and breezy optimism. The statement concedes that the objective of keeping the risk of nuclear theft small "will not be fully met for the recycle of Pu by current safeguards measures."[20] Steps which might be taken to correct current inadequacies are summarized in the statement as follows:

> "1. Minimization or elimination of the transportation of plutonium from reprocessing plants to mixed oxide fuel fabrication facilities which is the operation most vulnerable to an attempted act of theft or sabotage. To the extent that such shipments are minimized or eliminated, the safeguarding of plutonium would be enhanced. This objective can be accomplished by locating mixed oxide fuel fabrication plants in close proximity to or adjacent to reprocessing plants in Integrated Fuel Cycle Facilities . . . .
>
> "2. Further protection of transportation functions by use of massive shipping containers, special escort or convoying measures, vehicle hardening against attack, improved communications and response capabilities.
>
> "3. Additional hardening of facilities through new barrier requirements, new surveillance instrumentation, new delaying capabilities (e.g., incapacitating gases).
>
> "4. Upgrading of operating and guard functions through the use of personnel security clearance procedures, a Federally operated nuclear security system, more advanced

systems for monitoring and searching of personnel, and closer liaison with law enforcement authorities.

"5. Improving the timeliness and sensitivity of the system of internal control and accountability of plutonium.

"6. Use of 'spiked' plutonium which would be less susceptible to theft and would be more difficult to manufacture into a nuclear explosive because of the required elaborate handling procedures."[21]

Despite the facts (1) that these proposals are preliminary and their content not well-defined, (2) that they are still being studied, some for the first time, (3) that several would require Congressional action, (4) that several would necessitate substantial changes in the structure of the U.S. utility industry, and (5) that a sophisticated safeguards program would pose a major threat to civil liberties and personal privacy, the draft impact statement nevertheless recommends that we proceed now with plutonium recycle because "The Commission has a high degree of confidence that through implementation of some combination of the above concepts the safeguards general objective set forth earlier can be met for Pu recycle."[22] The Commission's faith, unfortunately, is hardly reassuring.

The issues of a federal plutonium police force and personnel security and surveillance measures will be discussed in the following section,[23] for they are the entering wedge of what promises to be more pervasive and continuing undermining of our civil rights. Two other potential safeguards should be mentioned here, however, in order to highlight the degree to which the issues remain unresolved. First, the draft statement refers to the possible use of "spiked" plutonium, i.e. plutonium combined with radioactive

material emitting high levels of penetrating radiation. The type of radiation emitted by plutonium -- an alpha particle -- while extremely carcinogenic in soft tissue, is not very penetrating and can be shielded against without heavy concrete or lead structures. The spiking of plutonium with more penetrating radiation would substantially increase the hazards of handling it and thus decrease the theft incentive. This step would appear to be an essential part of any safeguards program, yet it could substantially increase the costs of plutonium recycle, making it much less attractive to the industry.

Second, the AEC's lead safeguards suggestion -- the Integrated Fuel Cycle Facility concept -- actually represents a major watering down of a far more significant concept, that of nuclear power parks where reactors as well as fuel reprocessing and fabricating plants are all located at one site.[24] In our judgment, a safeguards system which does not require nuclear parks is not addressing the problem of theft during transportation in a serious and responsible way. Moreover, the nuclear industry's current plans, already well advanced, do not call for the implementation of even the Integrated Fuel Cycle Facilities concept.

C. Are Adequate Safeguards Possible?

While it may be possible to devise an adequate safeguard system in theory, there is little reason to believe that such a system would be acceptable in practice.[25] This is true for several reasons.

First, the problem is immense. The illegal diversion of weapons material is only one type of anti-social behavior a

safeguards program must protect against. Terrorist acts against the reactors, shipments of radioactive wastes, fuel reprocessing facilities and waste repositories can result in catastrophic releases of radioactivity. Such threats against nuclear facilities have already occurred.[26] Moreover, a safeguards system would have to exist on a vast, worldwide basis. Some 1000 nuclear reactors are projected for the United States in the year 2000, with hundreds of shipments of radioactive materials daily. Hundreds of tons of plutonium will be in the commercial sector of our economy by that date.[27] Abroad, American firms are constructing nuclear reactors in countries that have little political stability and in countries, such as Japan, who have not signed the non-proliferation treaty. Safeguarding nuclear bomb material would ultimately require a restructuring of the socio-political institutions on a worldwide scale. The United Nations unfortunately gives us little reason to believe that this is a practical reality.

Second, safeguards measures are strongly opposed by the nuclear industry. Some indication of the degree to which the industry is sensitive to the diversion hazards, and the degree with which the industry is likely to be an effective partner in the enforcement and implementation of safeguards programs can be gleaned from published accounts of the industry's response to the modest strengthening of the AEC safeguards rules which were first published in the February 1, 1973, Federal Register.

Some of the comments received on these proposed regulations were:

> ". . . it is clear that the severity of the proposed [physical security] procedures greatly exceeds any reasonable relationship to the public need intended to be served. We are unaware, and we believe the industry as a whole is unaware, of occurrences of industrial sabotage which would tend to justify the imposition of requirements as strict as those proposed. The Commission has not demonstrated the need . . . or offered any justification or explanation . . . . Certainly the public interest will not be served by adoption of burdensome requirements disproportionate to the end sought."
>
> ---from comment of Kerr-McGee;

and,

> ". . . a move backward to the types of security practices in the Manhattan District era."
>
> ---from comment of Westinghouse;

and,

> "One principal objection is to the emphasis placed on the use of armed personnel . . . and the seeming reliance on such personnel to protect against threats to the common defense and security . . . . To the extent that the proposed regulations . . . require an armed confrontation between a licensee's security force and potential diverters, the proposed regulations should be amended. The surest and most proper method of protection . . . is prompt detection and reporting . . . ."
>
> ---from comment of United Nuclear.

Third, experience with present safeguards is hardly reassuring. The NUMEC, over several years of operation, was unable to account for six percent (100 kilograms) of the weapons grade material that it handled, and as noted previously was recently fined by the AEC, in part because of safeguards violations. At a recent safeguards symposium the director of the AEC's Office of Safeguards and Materials Management observed that "we have a long way to go to get into that happy land where one can measure scrap effluents, products, inputs and discards to a one percent accuracy."[28] This

statement takes on particular significance when it is realized that only one half of one percent of the plutonium utilized by the commercial sector in the year 2000 is enough to make hundreds of atomic bombs. The editors of Bulletin of the Atomic Scientists have noted that the frequent "misrouting" of nuclear shipments highlights a key safeguards problem -- hijacking. They cite instances where theft of weapons grade materials would have been relatively easy: a shipment bound for Missouri ended up in Boston; another shipment between two California cities was eventually located in Tijuana, Mexico.[29] Finally, a spot check by General Accounting Office investigators at three AEC licensed contractors showed that in some cases access to easily portable quantities of special nuclear material could be gained in less than a minute using the simplest of tools. At two of the three plants checked, GAO found weak physical barriers, ineffective guard patrols ineffective alarm systems, lack of automatic detection devices, and the absence of an "action plan" should material be stolen or diverted. In contrast, the AEC's inspectors were giving the same facilities good marks on virtually every security category.[30]

Fourth, and perhaps most basically, there is little reason to believe that safeguards will work when little else does. For example, the AEC supports the creation of a federal police force which might provide an immediate federal presence whenever the use of force may be needed to protect these incredibly dangerous materials from falling into the hands of would-be saboteurs and blackmailers. But is there anyone who believes that police are effective at a level commensurate with the potential nuclear hazard? The New York City police department was proven incapable of maintaining security over confiscated heroin. Are similar losses of plutonium acceptible? The general point here is that our safeguards system must be essentially infallible; it must maintain what Alvin Weinberg former Director of the Oak Ridge National Laboratory, has called "unaccustomed vigilance" and "a continuing tradition of meticulous attention to detail."[31] Yet our human institutions are far from infallible. Our experience indicates that rather than sustaining a high degree of esprit, vigilance and meticulous attention to detail, our governmental bureaucracies instead become careless, rigid, defensive and, less frequently, corrupt. A basic question, then, is whether we want to entrust so demanding and unrelenting a technology as plutonium recycle to institutions which are negligent of their own responsibilities and insensitive to the rights of others and to technical fixes which are untried and unproven.

V. The Threat to Civil Liberties

One principal reason for our believing that an adequate safeguards system would not be acceptable in practice is the tremendous social cost of such a system in terms of human freedom and privacy. Safeguards necessarily involve a large expansion of police powers. Some one million persons have been trained in the handling, moving and operation of nuclear weapons. The projected growth of the nuclear industry will give rise to a parallel and an ultimately much larger group of persons, in this case civilians, who will be

subjected to security clearance and other security procedures now commonplace in the military weapons program. Indeed, the AEC makes the following disturbing statement in its draft impact assessment of plutonium recycle:

> "Security problems are much simplified when it can be established with high probability that the persons who are responsible for the handling of plutonium or implementing of related safeguards programs are trustworthy. Various court rulings in recent years have been favorable to the protection of individual privacy and of individual right-to-work. These rulings have made it difficult to make a personnel background check of an individual in commercial activities to assure with high probability that he is trustworthy and, hence, potentially acceptable as a steward for the protection of plutonium. The AEC has requested legislation which would allow background checks of individuals with access to plutonium and related material accountability records. We believe that enabling legislation such as this is necessary to the further improvement of personnel selection practices."[32]

The keeping of police dossiers will not be limited to nuclear industry personnel. The New York Times reported August 11 that Texas state police maintain files on nuclear power plant opponents.[33] The police stated that they had information that some nuclear opponents might attempt to sabotage transmission lines, though they declined to disclose their information or its source. How much more government investigation into the private lives of individuals can be tolerated by a free society? Security and surveillance procedures at best infringe upon the privacy of families and their friends. At worst, they are the instruments of repression and reprisal.

A second AEC safeguards proposal is the creation of a federal police force for the protection of plutonium plants and shipments. The draft impact statement for plutonium recycle justifies such a federal force in the following terms:

> "A federal security system would be less apt to have the variations in staff and capability that would be encountered in use of private security guards. In addition, it should be noted that the consequences of a successful theft or diversion of plutonium would undoubtedly have nationwide impacts and could best be handled by Federal authorities; certainly, with Federal participation, there is the potential for a larger force, more effective weapons, and better communications."[34]

But what standards should govern and restrain the operations of such a force? The AEC has already issued shoot-to-kill orders once to personnel directing the production, shipment and storage of atomic weapons, at the height of the Yom Kippur War.[35] Once a significant theft of plutonium or other weapons material has occurred, how will it be recovered? To prevent traffic in heroin, police have asked for no-knock search laws. This infringes upon one of our most cherished freedoms. To live with plutonium we may have to abandon this freedom along with others. In the presence of nuclear blackmail threats, the institution of martial law seems inevitable. It has been said that the widespread availability of weapons material and terrorists' targets in the nuclear fuel cycle will radically alter the power balance between large and small social units.[36] It should be added that the threatened society will undoubtedly attempt to redress that balance through sophisticated and drastic police action.

In sum, to accommodate plutonium we shall have to move towards a more intimidated society with greatly reduced freedoms. In this respect the following passage from the Report of the distinguished international group of scientists attending the 23rd Pugwash Conference on Science and World Affairs is instructive:

> "The problem of theft of nuclear material by internal groups or individuals intent on sabotage, terrorism or

> blackmail was agreed to be a very serious one, although there was some skepticism that the possibility of such activity was much smaller in socialist states."

We believe that sentiment to be true. It is also apparent that that is the direction in which we must move to accommodate the nuclear industry. After having spent billions of dollars for our nuclear deterrent, our civilian nuclear industry might well accomplish that which our defense system is trying to prevent.

Dr. Alvin Weinberg, former Director of the Oak Ridge National Laboratory, is one of the few persons closely associated with the nuclear power complex who has looked carefully at the political and regulatory institutions that will be necessary to support a plutonium-based nuclear power economy. Dr. Weinberg's views on this subject merit close attention.

Weinberg's basic premise is stated in his article "Social Institutions and Nuclear Energy" which appeared in the July 7, 1972, issue of Science:

> "We nuclear people have made a Faustian bargain with society. On the one hand, we offer - in the catalytic nuclear burner - an inexhaustible source of energy . . . .
>
> "But the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to . . . . In a sense, we have established a military priesthood which guards against inadvertent use of nuclear weapons, which maintains what a priori seems to be a precarious balance between readiness to go to war and vigilance against human errors that would precipitate war. Moreover, this is not something that will go away, at least not soon. The discovery of the bomb has imposed an additional demand on our social institutions. It has called forth this military priesthood upon which in a way we all depend for our survival.
>
> "It seems to me (and in this I repeat some views expressed very well by Atomic Energy Commissioner Wilfrid Johnson) that peaceful nuclear energy probably will make demands of the same sort on our society, and possibly of even longer duration."37

Here Dr. Weinberg observes that nuclear power will place unprecedented strains on our institutions. He correctly states that the nuclear power industry will pose problems for society that eclipse those posed by nuclear weapons.

In an unpublished paper circulated prior to a conference at the Woodrow Wilson International Center for Scholars in Washington, D.C., on June 18, 1973, Dr. Weinberg elaborated his views on the type of institutions required to cope with the plutonium economy:

> "One suggestion (proposed by Sidney Siegal) that is relevant to the situation in the United States would be to establish a national corporation patterned after COMSAT to take charge of the generation of nuclear electricity. Such an organization would have technical resources that must exceed those available to even a large utility: and a high order of technical expertise in operating reactors and their sub-systems is essential to ensuring the continued integrity of these devices. [Here Dr. Weinberg suggests nationalization of the industry.]
>
> "Each country now has its own AEC that sets standards or, in some cases, actually monitors or operates reactors. Perhaps this will be sufficient forever. Yet no government has lasted continuously for 1000 years: only the Catholic Church has survived more or less continuously for 2000 years or so. Our commitment to nuclear energy is assumed to last in perpetuity -- can we think of a national entity that possesses the resiliency to remain alive for even a single half-life of plutonium-239? A permanent cadre of experts that will retain its continuity over immensely long times hardly seems feasible if the cadre is a national body.
>
> "It may be that an International Authority, operating as an agent of the United Nations, could become the focus for this cadre of expertise. The experts themselves would remain under national auspices, but they would be part of a worldwide community of experts who are held together, are monitored, and are in an long-term stability by the International Authority. The Catholic Church is the best example of what I have in mind: a central authority that proclaims and to a degree enforces doctrine, maintains its own long-term social stability, and has connections to every country's own Catholic Church." (Emphasis added.)

These are far-reaching concepts presented by Dr. Weinberg. The basic question they pose is: Will the plutonium economy raise socio-political problems of such magnitude that their resolution will be unacceptable to society? In attempting to do the impossible -- live with plutonium -- we may create the intolerable.

VI. The Super-Human Requirements

The commercialization of plutonium will bring with it a major escalation of the risks and problems already associated with nuclear power. Plutonium will further strain the already weakened regulatory fabric of the nuclear industry.

Dr. Hannes Alfven, Nobel Laureate in Physics, has described the regulatory imperatives applicable to the nuclear industry:

> "Fission energy is safe only if a number of critical devices work as they should, if a number of people in key positions follow all their instructions, if there is no sabotage, no hijacking of the transports, if no reactor fuel processing plant or reprocessing plant or repository anywhere in the world is situated in a region of riots or guerilla activity, and no revolution of war -- even a 'conventional one' -- takes place in these regions. The enormous quantities of extremely dangerous material must not get into the hands of ignorant people or desperados. No acts of God can be permitted."[38]

In his article in Science, Dr. Weinberg similarly stresses the need, ". . . of creating a continuing tradition of meticulous attention to detail." It is important to recognize that such a tradition would have to be "created." There are no historical precedents to suggest that this is possible on the scale demanded by the nuclear industry. Dr. Weinberg has also observed that:

> "What is required is a cadre that, from now on, can be counted upon to understand nuclear technology, to control it, to prevent accidents, prevent diversion. Moreover, in this ultimate world, nuclear reactors will be in Uganda as well as the U.S.A., in Ethiopia as well as England. And one must ensure the same high degree of expertise in the underdeveloped country as in the developed country."[39]

We quote Dr. Weinberg because he is one, if not the only, proponent of nuclear power who has given serious thought to its requirements. But the public and its decisionmakers must seriously question whether it will be possible to attract, train and motivate the personnel required for these functions. These must be highly qualified persons who will maintain a tradition of "meticulous attention to detail" even when the glamorous aspects of a new technology become the commonplace operations of an established industry. What are the qualifications of these people? How does the AEC and the nuclear industry plan to attract and continuously motivate them? We suggest that it is beyond human capability to develop a cadre of sufficient size with expertise of "very" high order that can be counted upon to understand nuclear technology, to control it, to prevent accidents and diversion over many generations, or even over the present generation.

There is considerable evidence at the present time to suggest that the fledgling nuclear industry is already unmanageable. For example, in testimony presented to the Congressional Joint Committee on Atomic Energy, Ralph Nader and the Union of Concerned Scientists on January 29, 1974, made public a heretofore secret report by an AEC Task Force dated October, 1973. That report stated the following:

> "Review of the operating history associated with 30 operating nuclear reactors indicated that during the period 1/1 72 - 3/30/73 [illegible] approximately 850 abnormal occurrences were reported to the AEC. Many of the occurrences were significant and of a generic nature requiring followup investigations at other plants. Forty percent of the occurrences were traceable to some extent to design and/or fabrication related deficiencies. The remaining incidents were caused by operator error, improper maintenance, inadequate erection control, administrative deficiencies, random failure and combinations thereof."

Regarding these incidents, on page 16, the Task Force stated:

> "The large number of reactor incidents, coupled with the fact that many of them had real safety significance, were generic in nature, and were not identified during the normal design, fabrication, erection, and preoperational testing phases, raises a serious question regarding the current review and inspection practices both on the part of the nuclear industry and the AEC."

In addition to these 850 abnormal occurrences, consider the tritium that recently appeared in the drinking water of Broomfield, Colorado. Consider the 115,000 gallons of high level radioactive wastes that leaked from the tank at Hanford over a period of 51 days while no one monitored the tank. Consider that the radioactive releases from the famed Shippingport reactor were higher than recorded. Consider that the executives of the Consumers Power Corporation failed to notify the AEC that their radioactive gas holdup system was not functioning. Consider that two reactors were half completed before the AEC was informed that they were being constructed over an earthquake fault. Consider that the GAO found the security at plutonium storage areas totally inadequate after the AEC inspectors had [illegible] the facilities.

Considering all this, there is good reason to suggest, because of the meticulous attention to detail that will be required at every stage of plutonium recycle, that a decision to proceed with plutonium recycle will precipitate an already unmanageable situation into a national crisis.

VII. Options: Alternatives to Plutonium Recycle

Given that the risks of plutonium recycle are unacceptably high, particularly in light of the present uncertainties, a key question is what are our options -- what are the alternatives to the AEC's proposal to proceed now with plutonium recycle? We believe that there are essentially three options, each of which is preferable to the AEC's announced plan.

First, we could phase out nuclear power reactors. There is mounting apprehension within the scientific community concerning the human and societal hazards of fission reactors which would only be compounded by plutonium recycle. As evidence of this apprehension among scientists, a statement of concern over the environment and world peace (The Menton Statement) which was signed by 2,200 scientists, included a call for an end to the proliferation of nuclear reactors. It was presented to U.N. Secretary U. Thant, and published in the U.N. Courier, July, 1971. Similarly, scientists from all nations at the 23rd Pugwash Conference on Science and World Affairs in September, 1973, concluded:

> "1. Owing to potentially grave and as yet unresolved problems related to waste management, diversion of fissionable material, and major radioactivity releases arising from accidents, natural disasters, sabotage, or acts of war, the wisdom of a commitment to nuclear fission as a principal energy source for mankind must be seriously questioned at the present time.

"2. Accordingly, research and development on alternative energy sources - particularly solar, geothermal and fusion energy, and cleaner technologies for fossil fuels - should be greatly accelerated.

"3. Broadly based studies aimed at the assessment of the relation between genuine and sustainable energy needs, as opposed to projected demands, are required."

This third recommendation implies the implementation of energy conservation measures. It is important to recognize that energy conservation can be our major energy source between now and the year 2000. Conservation means using our present energy more efficiently; it need not mean a change in life styles. Coupled with the use of solar and geothermal energy, energy conservation could eliminate the need for new nuclear power stations.

Second, we could continue with the present generation of light-water reactors but strictly prohibit plutonium recycle for the foreseeable future. Such a decision would be premised upon a judgment that plutonium is too dangerous because of its toxicity and explosive potential to be allowed to become an article of commerce. Of course, we would still have plutonium to cope with, because it is produced in present-day reactors. But without plutonium recycle there is little incentive to reprocess the plutonium out of the spent fuel, so the plutonium could remain in the spent fuel where it is effectively protected from theft and, hopefully, confined and contained.

The benefits of plutonium recycle are small. Plutonium recycle would reduce the annual uranium requirements by about 10 to 15 percent and reduce the light water reactor fuel cycle cost by about the same amount. But the nuclear fuel cycle cost represents

less than 20 percent of the total cost of power from nuclear plants, and nuclear plants by 1985 will represent less than 40 percent of the electric, or about 15 percent of the total, domestic energy supplied. In other words, plutonium recycle involves an economic savings of less than one-half of one percent.

Plutonium differs from the high-level wastes in the spent fuel in one critical respect: whereas the radioactivity of high-level wastes will continue for thousands of years, that of plutonium will continue for hundreds of thousands. Thus, while the problem of effectively storing both these materials and preventing their entering the environment are unprecedented in human history, plutonium must be contained for eons longer. For this reason, an argument can be made that, ultimately, the safest thing that can be done with plutonium is to burn or fission it in reactors, thus making it into high-level wastes rather than plutonium. But that is an activity that is best left for decades or even centuries hence -- for a society more capable and less violent than today's.

Third -- and we believe that this is an option that must command general support -- a decision regarding plutonium recycle, and of course plutonium recycle itself, could be deferred several years until present uncertainties regarding safeguards and plutonium toxicity are satisfactorily resolved and a basis has been laid for a more intelligent judgment regarding the risks and benefits of the commercialization of plutonium. Too many questions, both technical and social, are unanswered today, and until these questions are answered it would be a grave error, we believe, to rush into the AEC's plutonium economy.

The basic question which must be answered is whether the public is willing to accept the risks of plutonium in exchange for the promised benefits. The national debate which must occur on this basic question has hardly begun.

Footnotes

1. "The Plutonium Economy of the Future," Speech by AEC Chairman Glenn T. Seaborg, AEC Release No. S-33-70, dated October 5, 1970.

2. AEC, Draft Generic Environmental Statement On The Use Of Mixed Oxide Fuel, WASH-1327, July, 1974 [hereinafter cited as WASH-1327].

3. Donald P. Geesaman, "Plutonium and the Energy Decision," in The Energy Crisis, (ed. R.S. Lewis and B.I. Spinrad, 1972), pages 56-59.

4. Mason Willrich and Theodore B. Taylor, Nuclear Theft: Risks and Safeguards (1974), page 1.

5. See the discussion at pages 17-23, infra.

6. "GE Fuel Recovery Plant Inoperable," Weekly Energy Report, Vol. II, July 15, 1974, page 1.

7. West Michigan Environmental Action Council v. AEC (W. D. Mich. Dkt. No. G-58-73).

8. AEC, Nuclear Power Growth: 1974-2000, WASH-1139 (1974), page 34 (Case D projection).

9. Geesaman, op. cit., pages 58-59.

10. Arthur Tamplin and Thomas Cochran, Radiation Standards for Hot Particles, February 14, 1974. Copies of this report are available from NRDC for $3.00 per copy.

11. WASH-1327, Chapt. IV, Section J, page 7.

12. Geesaman, op. cit., page 59.

13. AEC News Releases, Vol. V, August 14, 1974, page 4.

14. Willrich and Taylor, op. cit., pages 107-108.

15. Paper by W.C. Bartels and S.C.T. McDowell of the AEC's Division of Safeguards and Security, reprinted in Nuclear News, Vol. 17, (Aug., 1974), page 46.

16. "Nuclear Materials Safeguards: A Joint Industry-Government Mission," Speech by AEC Commissioner Clarence E. Larson, published in [illegible] Atomic Power Development, October 27-29, 1969. See also Deborah Shapley, "Plutonium: Reactor Proliferation Threatens a Nuclear Black Market," Science, 9 April 1971, page 143.

17. Willrich and Taylor, op. cit., page 168.

18. See, e.g., Bernard T. Feld, "The Menace of a Fission Power Economy," Bulletin of the Atomic Scientists, April, 1974, pages 32-34; Lawrence Scheinman, "Safeguarding Nuclear Materials," Bulletin of the Atomic Scientists, April, 1974, pages 34-36; David [illegible], "Nuclear Electric Power," Science, 19 April 1974, pages 351-359. See also Robert L. Heilbroner, An Inquiry Into The Human Prospect (1974), pages 40-43.

19. See, e.g., "A Special Safeguards Study," a report to the AEC on the Adequacy of Current Safeguards (the "Rosenbaum Report"), reprinted at 120 Cong. Rec. S6623 (April 30, 1974); U.S. General Accounting Office, Improvements Needed in the Program for the Protection of Special Nuclear Material, (GPO: November 7, 1973), reviewed by Robert Gillette in Science, December 14, 1973, pages 1112-1114.

20. WASH-1327, page S-6.

21. WASH-1327, page S-7.

22. WASH-1327, page S-7.

23. See pages 18-24, infra.

24. See Dean E. Abrahamson, "Energy: Nuclear Theft and Nuclear Parks," Environment, July/August, 1974, page 5.

25. Taylor and Willrich believe that "a system of safeguards can be developed that will keep the risks of theft of nuclear weapon materials from the nuclear power industry at very low levels." Op. cit., page 171. Yet they also emphasize that "regardless of its effectiveness, a nuclear safeguards system applicable to the nuclear power industry in this country cannot provide complete assurance that unannounced fission explosions will not occur in the United States in the future." They point out that "no future safeguards system that will be practical can offer 100% assurance against theft." Op. cit., page 123. They never say what level of nuclear theft, or what size plutonium black market or how many unauthorized nuclear explosions is in fact acceptable.

26. See L. Douglas DeNike, "Radioactive Malevolence," Bulletin of the Atomic Scientists, February, 1974, page 16.

27. See text accompanying note [illegible] supra.

28. Quoted in Goesaman, op. cit., page 59.

29. The Energy Crisis, op. cit., page 59.

30. GAO, Improvements Needed in the Program for the Protection of Special Nuclear Materials, op. cit.

31. Alvin Weinberg, "Social Institutions and Nuclear Energy," Science, 7 July 1972, pages 33-34.

32. WASH-1327, Chapter V, page 42.

33. New York Times, "News of the Week in Review," August 11, 1974, ("Texas Police Have A List For Dissenters").

34. WASH-1327, Chapter V, page 42.

35. The Washington Post, October 12, 1973, page A-3.

36. DeNike, op. cit.

37. Weinberg, op. cit., pages 33-34.

38. Hannes Alfven, "Energy and Environment," Bulletin of the Atomic Scientists, May, 1972.

39. Weinberg, op. cit.

The Authors

[illegible] has been a biophysicist at the Lawrence Radiation [illegible] in Livermore, California since 1963. During the period June, 1967 to January, 1969 he was a member of the AEC's Division of Biology and Medicine Committee on Space Nuclear Systems Radiological Safety. The primary interest of this committee was the hazard of plutonium. Dr. Tamplin holds a Ph.D. degree in Biophysics from the University of California at Berkeley. He has published and lectured extensively on the problems of nuclear power. His books include Poisoned Power: The Case Against Nuclear Power Plants (with Gofman). For the past year he has been working on the staff of NRDC while on a one-year leave of absence from the Laboratory.

J. Gustave Speth has been an attorney on the staff of NRDC since 1970, specializing on nuclear power problems. He was the attorney for the Scientists' Institute for Public Information in Scientists' Institute v. AEC, 481 F.2d (D.C. Cir. 1973), which required the AEC to prepare an environmental impact statement for its fast breeder reactor development program. He is a former Rhodes Scholar and law clerk to Supreme Court Justice Hugo L. Black and is the author of "The Federal Role in Technology Assessment" in Federal Environmental Law (Environmental Law Institute, 1974).

Thomas B. Cochran is a nuclear physicist on the staff of NRDC. Before joining NRDC, Dr. Cochran was a Senior Research Associate at Resources for the Future. He is the author of The Liquid Metal Fast Breeder Reactor: An Environmental and Economic Critique (1974), which was published by Resources for the Future. He is a member of the Federal Power Commission's Task Force on Energy Conversion Research and Development, part of the National Power Survey. Dr. Cochran holds a Ph.D. degree in physics from Vanderbilt University and is a former AEC Health Physics Fellow.

NRC Staff Response to Specific Health, Safety and Environmental Impact Comments by Senators W. F. Mondale and P. A. Hart

1. Comment:

"In our judgment, a decision to authorize 'plutonium recycle' is a momentous one which should only be made after its risks and implications have been thoroughly explored and debated by the public and the Congress."

Response:

The NRC agrees that a decision to authorize plutonium recycle use in light water reactors (LWR's) is an important one. A final decision on this important issue will be forthcoming only after the findings of the draft GESMO have been thoroughly reviewed in light of public comments received and any new technical developments since the draft preparation. These detailed assessments of all health, safety and environmental factors have been considered in the preparation of this final statement. In addition, prior to the final decision on the widescale use of Pu recycle in the LWR industry, a supplement draft and final statement on the safeguards considerations related to plutonium will have been issued, economic evaluation of the related overall cost-benefits completed, amendments to applicable rules and regulations made, and public hearings held on all issues. The planned course of action does not foreclose any options of independent action by Congress, if Congress desires to become involved.

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2. Comment:

"As you well know, plutonium is one of the most virulent carcinogens known. Many scientists believe it to be as toxic as the most lethal biological warfare agents."

Response:

While it is true that plutonium is potentially a hazardous material, experience in both government and commercial plants has shown that large quantities can be safely handled as detailed in this final statement in CHAPTER II, Background and Experience with Plutonium, and in CHAPTER IV, Environmental Impacts. The filtration systems for reducing the release of Pu, which are used in the MOX fabrication components and spent fuel reprocessing and Pu nitrate solidification to PuO_2 of the fuel cycle are described in detail in CHAPTER IV, Sections D and E, respectively. CHAPTER IV, Section J, includes a comprehensive radiological health assessment of the impacts of the Pu recycle industry for the period 1975 through 2000, comparing it to a no recycle option and a uranium only reycle option.

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3. Comment:

"Another problem raised in the NRDC report is the public health risk associated with using a material of plutonium's toxicity as a principal commercial fuel. The adequacy of the Commission's present radiation protection standards applicable to plutonium are under serious challenge, with some qualified experts arguing that those standards are perhaps 100,000 times too lax to protect the public. Until this controversy is resolved, it is impossible to predict the health effects of using plutonium and impossible to know what standards should govern its handling and release to the environment. Moreover, even if the present standards were undisputed, the fact that plutonium is one of the most carcinogenic substances known raises the question of whether we want a material of unprecedented toxicity involved in countless shipments around the country."

Response:

With regard to the NRDC contention concerning the health risk associated with plutonium, the "hot particle" petition which challenges present plutonium protection standards has been studied by the National Council on Radiation Protection and Measurements (NCRPM Report No. 46). "Alpha Emitting Particles in Lungs," and the National Academy of Science. These organizations have been leaders in the setting of radiological safety recommendations in this country over the years. Predominant evidence to date, including an AEC report, "A Radiological Assessment of the Spatial Distribution of Radiation Dose from Inhaled Plutonium," by W. J. Bair and C. R. Richmond and B. W. Wachholz, does not support the NRDC contention.

The Federal Register Notice on the Denial of Petition for Rule Making, Volume 41, Number 71, Monday, April 12, 1976, National Resources Defense Council, is included in Chapter IV, Section J, Appendix D.

For the bases of this denial, reference is made to the Federal Register Notice, Volume 41, 15371, Monday, April 12, 1976, sections marked: (A) background information concerning the question at issue; (B) a discussion of the formulation of the NRDC hypothesis and its corollary; (C) a critical analysis of the hypothesis and its corollary; (D) the conclusions of the NRC; (E) a discussion of the basis for existing standards for insoluble plutonium, and (F) a summary of ongoing work which will be important to the NRC in its future considerations of radiological protection standards for insoluble plutonium.

The Commission has consistently dealt with plutonium as a toxicant capable of inducing cancer and has imposed protective measures, for working with or transporting the material, that are commensurate with its radiotoxicity.

Comment Letter No. 6

COVER SHEET for FEDERAL GRANT APPLICATION/AWARD NOTIFICATION

ARIZONA

3. APPLICANT Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS Street or P. O. Box: NONE
5. CITY: WASHINGTON
6. COUNTY:
7. STATE: DC
8. ZIP CODE: 20545
9. PROG NO FEDERAL AGENCY: 24999 Atomic Energy C

10. TYPE OF ACTION: [X] a New [ ] c Modification [ ] b Continuation

TYPE OF CHANGE (Complete if 10b or 10c was checked)
11. [ ] a Increased Dollars [ ] b Decreased Dollars
12. [ ] a Increased Duration [ ] b Decreased Duration
13. [ ] a Other Scope Change [ ] b Cancellation

14a. EXISTI
14b. EXISTI

15. REQUESTED FUND START: 19__ __ __
16. FUNDS DURATION: ____(Months)
17. EST. PROJECT START: 19__ __
18. EST. PROJECT DURATION: ____(Months)

19. APPLICANT TYPE — Enter Letter [J]
A. State F. School District
B. Interstate G. Community Action Agency
C. COG H. Sponsored Organization
D. County I. Indian
E. City J. Other

FUNDS REQUESTED (If Change Show Only Amt)
20a. FEDERAL GRANT $
20b. FEDERAL LOAN $
21. STATE $
22. LOCAL $
23. OTHER $
24. TOTAL (20,21,22,23) $

25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXID (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS

26. PROJECT ABSTRACT (60 Characters Per Line - 5 Lines). Attach 1-2 Page Project Summary For Review
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.)
STATEWIDE, ARIZONA

28. CONGRESSIONAL DISTRICT
Of Applicant [ ] Districts Impacted By Project [ ]

29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No
If Yes, Attach.

30. CLEARINGHOUSE(S) TO WHICH SUB
a [X] State b [X] Area Wide

31. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c TELE

BALANCE OF FORM TO BE COMPLETED BY RESPONDING AGENCY

Mr. Lloyd Clark, Reg. Adm.
Southeastern Az. Govts. Org.
P.O. Box 204
Bisbee, AZ 85603

SEP 20 A.M.

State Application Identifier (SAI)
State AZ Number 74-

(39 FR 30186)

From: Constance LaMonica

PROPOSED RULE PR-Wise Notice GESMO

DOCKETED USAEC OCT 8 1974

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you n information or additional time for review.

[ ] Respond to Applicant

5-6.1

Comment Letter No. 7

Misc Notice
GESMO (39 FR 30186)

OFFICE OF PLANNING AND PROGRAMMING

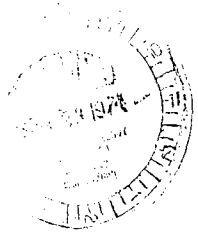
STATE OF NEBRASKA

BOX 94601 · STATE CAPITOL · LINCOLN, NEBRASKA · 68509 · (402) 471

Governor J. James Exon
State Planning Officer

W. Don Nelson
Director

September 20, 1974



Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

ATTN: Deputy Director for Fuels and Materials

Gentlemen:

Project 74 08 26 99
GESMO

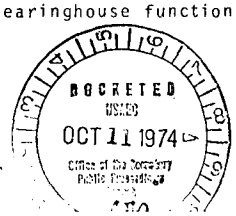
Under the provisions of OMB Circular A-95, this office has conducted a state level review of The Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors.

The enclosed comments were received from the Nebraska Department of Environmental Control and the Department of Water Resources for use in the final planning process.

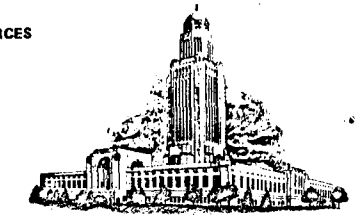
This letter completes the state clearinghouse function on this project.

Sincerely,

Robert D. Kuzelka
Comprehensive Planning Coordinator



DEPARTMENT OF WATER RESOURCES
M. E. Ball
Director

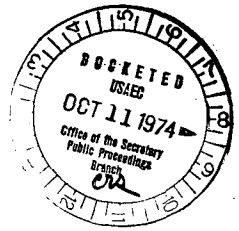


State of Nebraska
J. JAMES EXON, Governor

MAILING ADDRESS
P. O. Box 94607
Lincoln, NE. 68509
LOCATION
1420 "P" Street
TELEPHONE
402-471-2383

September 9, 1974

IN REPLY REFER TO



Ms. Neoma Parks, Project Review Coordinator
Office of Planning and Programming
Room 1319, State Capitol
P. O. Box 94601
Lincoln, Nebraska 68509

Subject: SAI No. 74 08 26 99
Recycle Plutonium in Light Water - Cooled Reactors

Dear Ms. Parks:

My comments regarding the attached report are very brief. I do not consider myself to be an expert on atomic energy, but I approve the report and the principle stated therein, as the report indicates that the implementation of the program will bring about a saving of all types of fuel including atomic energy.

Very truly yours,

DEPARTMENT OF WATER RESOURCES

M. E. Ball

M. E. Ball, Director

MEB:ejm
Attachment

State of Nebraska
Department of
Environmental Control

J. James Exon
Governor
Dan T. Drain
Director

Mail Box 94653 State House Station Office, 1424 'P' Street Lincoln, Nebraska 68509 (402) 471-2186

September 13, 1974

State Office of Planning
and Programming
State Capitol
Lincoln, Nebraska

Attention: Neoma Parks

RE: Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in LWR's - A95 Review

Dear Sir:

We have reviewed the information submitted on the above-referenced project.

Our only comment is that we are concerned that proper safeguards should be taken in transportation, transfer, storage, and disposal to preclude any pollution to land, air, or water and to protect public health and safety to the maximum possible.

We appreciate the opportunity to review such projects and offer our comments.

Yours very truly,

Dan T. Drain

Dan T. Drain
Director

DTD/DL/jem
Enclosure

Comment Letter No. 8

K-Misc Notice
GESMO (39 FR 30186)

STONE & WEBSTER ENGINEERING CORPORATION
7315 WISCONSIN AVENUE, WASHINGTON, D. C. 20014

NEW YORK
BOSTON
CHICAGO
HOUSTON
LOS ANGELES
SAN FRANCISCO

DOCKETED
OCT 11 1974
Office of the Secretary
Public Commission
ERS

September 30, 1974

Dear Sy,

Thanks very much for sending me a copy of your GESMO environmental statement. I scanned the summary, but haven't had an opportunity yet to go into the detail of it. I agree with Ralph Lapp that it was a good job.

I enjoyed running into you the other day and hope we can have lunch together in the next few weeks.

Best regards,

Jim

James T. Ramey

RECEIVED
OCT 7 1974
U.S. Atomic Energy Commission

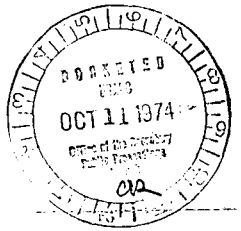
Mr. S. H. Smiley
Deputy Director for
Fuels and Materials
U.S. Atomic Energy Commission
Washington, D.C. 20545

Comment Letter No. 9

-Misc Notice
GESMO (39 FR 30186)

EPRI

Electric Power Research Institute
3412 Hillview Avenue
P.O. Box 10412
Palo Alto, California 94304
(415) 493-4800



October 3, 1974

Dr. Seymour H. Smiley
U.S. Atomic Energy Commission
Office of Regulatory Standards
Washington, D. C.

Dear Dr. Smiley:

Subject: GESMO -- General Comments

In the course of conducting our own plutonium recycle programs, several Institute members have had the opportunity to review the Generic Environmental Statement Mixed Oxide (GESMO) recently issued by your office.

I thought you might be interested in some general reactions even while recognizing that they represent opinions of some knowledgeable individuals and are not necessarily those of "The Industry" or the Electric Power Research Institute.

One common comment is that the GESMO appears to be the most thorough and comprehensive environmental impact assessment of its type which we have reviewed.

Identification of issues, trade-offs and baseline data appear to be essentially complete and contemporary. Obviously, there are areas where 'things might have been presented differently' -- or where projections of currently unresolved issues may differ. But, in the main, these are areas of ambiguity or uncertainty that would normally be expected when one attempts to apply a generic statement to the specific installations and specific data which are the concern of the individual utilities.

It is also interesting to note that we feel our efforts closely complement the GESMO. Our work, which is integrated by Plutonium Utilization Workshop activities, focuses on development, testing and analysis of the options which a utility has available -- and an economic and operational evaluation of these options.

I enjoyed discussing our possible mutual interests in this technology, and I hope that this preliminary GESMO comment is of interest to you.

Sincerely yours,

Ed Zebroski

E. L. Zebroski
Department Director
Nuclear Systems & Materials

ELZ/sr

Comment Letter No. 10

JAMES O. EASTLAND, MISS., CHAIRMAN
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ROMAN L. HRUSKA, NEBR.
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LAWRENCE M. BASKIR
CHIEF COUNSEL AND STAFF DIRECTOR

United States Senate

COMMITTEE ON THE JUDICIARY
SUBCOMMITTEE ON CONSTITUTIONAL RIGHTS
(PURSUANT TO SEC. 5, S. RES. 51, 91ST CONGRESS)
WASHINGTON, D.C. 20510

DR-Miscellaneous
GESMO (39 FR 30186)

September 25, 1974

Dr. Dixie Lee Ray
Chairperson
Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Ray:

My attention has been directed at certain proposals apparently under consideration by the Atomic Energy Commission which appear to have a potential impact on civil liberties and the guarantees of the Bill of Rights. While the Constitutional Rights Subcommittee, of course, does not have jurisdiction over atomic energy policy, any proposal of the Commission which has implications in the area of the Subcommittee's jurisdiction over individual rights is of concern to me.

In particular, I should like to inquire about proposals now under discussion for security measures that might be necessary in conjunction with the possible commercial use of plutonium as a source of atomic energy. I gather that the use of plutonium will present new problems of security to ensure that the highly dangerous substance does not cause radiation injury, and that it is not diverted to unauthorized persons for use in atomic weapons.

In response to this concern, I am aware of a draft impact statement prepared by the AEC which refers generally to the need for improved security procedures, to changes in security clearance rules, to reversal of certain court decisions respecting personal privacy, to a possible federal atomic security police force, as well as other innovations. I understand, further, that observers outside the Commission have expressed great concern over what they regard as the immense new security problems that would be presented, and the need, as a consequence,

9/30 To DR for reply for chairman's signature

Copy of incoming to each Commissioner, Exec. Dir. for Operations, Secretary
Coordinate reply with EDO

10/2/74

Dr. Dixie Lee Ray
September 25, 1974
Page two

for stringent new security precautions.

While I have no personal opinion about the overall merits of the use of plutonium for commercial power, I am concerned about any security requirements that might affect individual rights and liberties. May I request, therefore, that you supply the Subcommittee with information about the security aspects of commercial plutonium power, and in particular any reports, draft impact statements, studies or the like that describe the alternative means available to satisfy the security question. I would also like to receive a copy of the draft bill or any other legislative proposals which are alluded to in the draft impact statement.

Let me thank you for your attention to this request.

With kindest wishes,

Sincerely yours,

Sam J. Ervin, Jr.

Sam J. Ervin, Jr.
Chairman

SJE/lbh

Comment Letter No. 11

PR-Misc Notice (39 FR 30186)
GESMD
TWX INCOMING

F

USAEC-NRG-CTWN

910 338 0116 SAN JOSE CALIF 10/8/74 OCT 8 1974 PM 1 30

SH SHILEY DEPUTY DIRECTOR FUELS AND MATERIALS LICENSING U.S. ATOMIC ENERGY COMM.
DIRECJORATE OF LICENSING USAEC WASHINGTON DC TWX UNIT

DEAR MR. SHILEY:

ON AUGUST 21, 1974, THE COMMISSION PUBLISHED NOTICE IN THE FEDERAL REGISTER /39 FR 30103/ THAT THE DRAFT GENERIC ENVIRONMENTAL STATEMENT - MIXED OXIDE FUEL /GESMO/ IS AVAILABLE FOR INSPECTION AND THAT COMMENTS ON GESMO ARE DUE ON OCTOBER 30, 1974. THE NUCLEAR ENERGY DIVISION OF THE GENERAL ELECTRIC COMPANY HAS COMPLETED PRELIMINARY REVIEW OF THAT DRAFT AND FINDS, IN GENERAL, A WELL ORDERED DISCUSSION OF A VERY COMPLEX SUBJECT. IN LIGHT OF THE COMPLEXITY AND BECAUSE THE NUCLEAR ENERGY DIVISION IS A DIVERSE AND LARGE ORGANIZATION DESIROUS OF SUBMITTING COMPREHENSIVE AND DETAILED COMMENTS, WE HEREBY REQUEST AN EXTENSION OF THE DUE DATE FOR COMMENTS TO NOVEMBER 15, 1974.

VERY TRULY YOURS,

AN TSCHAECHE GENERAL ELECTRIC [illegible]

DOCKETED USAEC OCT 16 1974 Office of the Secretary Public Document Room

OCT 9 1974

5-11.1

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

STATE OF IOWA

Office for Planning and Programming

523 East 12th Street, Des Moines, Iowa 50319 Telephone 515/281-3711

STATE CLEARINGHOUSE

ROBERT D. RAY
Governor

ROBERT F. TYSON
Director

PROJECT NOTIFICATION AND REVIEW SIGNOFF

Date Received: August 23, 1974 State Identification No: 750101

Review Completed: October 2, 1974

APPLICANT PROJECT TITLE:
Draft Environmental Impact Statement of Mixed Oxide Fuel

APPLICANT AGENCY: U. S. Atomic Energy Commission
Address Washington, D. C. 20545
Attention: Deputy Director for Fuels and Materials, Directorate of Licensing

FEDERAL PROGRAM TITLE, AGENCY AND CATALOG NUMBER: Directorate of Licensing
Atomic Energy Commission

AMOUNT OF FUNDS REQUESTED:
NA

PROJECT DESCRIPTION:
Atomic Energy Commission draft generic environmental statement for mixed oxide fuel (recycle plutonium in light water-cooled reactors).

The State Clearinghouse makes the following disposition concerning this application:

[X] No Comment Necessary. The application must be submitted as received by the Clearinghouse with this form attached as evidence that the required review has been performed.

[ ] Comments Are Attached. The application must be submitted with this form plus the attached comments as evidence that the required review has been performed.

A. Thomas Wallace
Federal Funds Coordinator

State Identification No: 750101

PLEASE RETURN THIS PORTION OF FORM TO:

OFFICE FOR PLANNING AND PROGRAMMING
523 East 12th Street, Des Moines, Iowa 50319

Comment Letter No. 13

ARIZONA

APPLICANT Organizational Unit: U.S ATOMIC ENERGY COMMISSION

ADDRESS - Street or P. O. Box: NONE

CITY: WASHINGTON | COUNTY | STATE: DC | ZIP CODE: 20545 | FEDERAL AGENCY NO.: 24999 Atomic Energy

TYPE OF ACTION: a [X] New c [ ] Modification; b [ ] Continuation

TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 a [ ] Increased Dollars; b [ ] Decreased Dollars; 12 a [ ] Increased Duration; b [ ] Decreased Duration; 13 a [ ] Other Scope Change; b [ ] Cancellation

REQUESTED FUND START: 19___ (yr mo)

FUNDS DURATION: ____(Months)

EST. PROJECT START: 19___ (yr mo)

EST. PROJECT DURATION: ____(Months)

19. APPLICANT TYPE — Enter Letter [J]

A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; J. Other

FUNDS REQUESTED (For Changes Show Only)

20a. FEDERAL GRANT $ ____
20b. FEDERAL LOAN $ ____
21. STATE $ ____
22. LOCAL $ ____
23. OTHER $ ____
24. TOTAL (20,21,22,23) $ ____

BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXI (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTO

PROJECT ABSTRACT (60 Characters Per Line - 6 Lines) Attach 1-2 Page Project Summary For Review.

DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTO IUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MIN- ING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

CONGRESSIONAL DISTRICT Of Applicant [ ] Districts Impacted By Project [ ]

29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No If Yes, Attach.

30. CLEARINGHOUSE(S) TO WHICH: a [X] State b [X] Area Wide

NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS

ADDRESS - Street or P. O. Box: WASHINGTON D.C. 20545

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

John J. DeBolske, Exec. Dir.
Maricopa Ass'n of Governments
1820 W. Washington Street
Phoenix, AZ 85007

State Application Identifier (SAI)
State AZ Number

DOCKETED
USAEC
OCT 25 1974
Office of the Secretary
Public Document Room

m: Constance LaMonica

is project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

se return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if yo ormation or additional time for review.

[ ] Respond to Applicant

Comment Letter No. 14

PR-Misc Notice (39 FR 30186)
GESMO

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
WASHINGTON, D.C. 20250

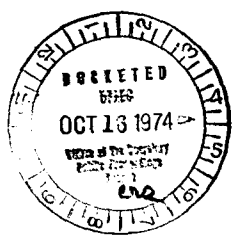
October 8, 1974

Subject: Generic Environmental Statement
Mixed Oxide Fuel (ESMO)

To: Deputy Director for Fuels and Materials
Directorate of Licensing--Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

We have received the August 1974 draft of the subject statement which deals with plutonium recycle in light water cooled and moderated nuclear power reactors. We have no comments to make at the present time.

Carl W. Carlson
Assistant Administrator
National Program Staff



Comment Letter No. 15

DOCKET NUMBER PR-Misc Notice (39 FR 30196)
PROPOSED RULE
GESMO

October 16, 1974

Deputy Director for Fuels and Materials
Directorate of Licensing - Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Sir:

Enclosed are comments on WASH-1327, GESMO. I have talked to Tom Cochran of NRDC, Inc., and wish the enclosed comments to be included with NRDC's. Thank you.

Sincerely yours,

M. Resnikoff

Marvin Resnikoff
Rachel Carson College
SUNY at Buffalo
Buffalo, NY 14126

RECEIVED OCT 30 1974 ORB

DOCKET NUMBER PR-Misc Notice (39 FR 30186)
PROPOSED RULE
GESMO

RECEIVED OCT 16 1974 U.S. ATOMIC ENERGY COMMISSION REGULATORY MAIL SECTION

DOCKETED USAEC OCT 16 1974 Office of the Secretary Public Proceedings Branch ERB

COMMENTS ON WASH-1327

Generic Environmental Statement on the use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors

Re: Fuel Reprocessing

Dr. Marvin Resnikoff
Rachel Carson College
SUNY at Buffalo
Buffalo, N.Y. 14120

SUMMARY

GESMO is not a fair and open statement by the Atomic Energy Commission. The costs to society due to the use of mixed oxide fuel have been greatly underestimated, in terms of effluent releases from fuel reprocessing plants, worker exposure and actual reprocessing costs. The benefits have been greatly overestimated in terms of the value of recovered uranium and plutonium. By using these arbitrary and unrealistic figures, the AEC arrives at the immediate use of plutonium in mixed oxide fuel as the best alternative; GESMO is therefore self-serving. Realistic cost figures decidedly tilt the balance towards burying fuel elements in the near term.

INTRODUCTION

According to the NEPA and the Atomic Energy Commission's interpretation in 10 CFR Part 50, Appendix D, an environmental statement on the use of MO fuel should include a discussion of the environmental impact of the proposed action, "any adverse environmental effects which cannot be avoided should the proposal be implemented", and the alternatives to the proposed action. This document is then to serve as a basis for the proposed action. In order to make a reasoned judgment on the

Dr. Marvin Resnikoff, Chairman
Energy Task Force
Sierra Club, Niagra Group
Box 123, Market Station
Buffalo, New York 14203

Acknowledged by card 10-16-74 cbo

use of MO fuel, the AEC must have a document which discusses these matters truthfully; a cover-up simply defeats the purposes of NEPA and makes a mockery of the entire proceeding.

The public has become more sophisticated in the matter of fuel reprocessing, as it has with reactor safety, and it is no longer possible for the AEC to hide the problems and present a rosy picture; we now demand realism. We maintain and will show in the following Sections that the costs and benefits presented in WASH-1327 are not realistic, perhaps deliberately so.

In Section I, we demonstrate that the costs are greatly underestimated. Section I.A. is a discussion of the effluent releases from fuel reprocessing plants. Based on the past operating experience and projections of AEC contractors, such as Oak Ridge, we find that the effluent releases will be greater than GESMO estimates, that the population-rem estimates will be correspondingly greater, and in particular, that thyroid dose estimates will be orders of magnitude greater. For example, Tables IV E-9,10 present no increases in iodine releases due to MO fuel.

Section I.B. discusses the question of worker exposures at fuel reprocessing plants. Experience at Nuclear Fuel Services, the only commercial reprocessing facility, has shown worker exposures to be 6 to 7 times greater than that amount, and there is no showing by GESMO that they will be

less. In fact, the high neutron activity of MO fuel, due mainly to Cm-244, should increase the exposures. The total personnel exposure of 3000 man-rems for 7 reprocessing plants is ridiculously low; one plant alone, Nuclear Fuel Services, may have exposures of that magnitude. In addition, the plutonium inhalation incidents should also increase proportionally to the quantity of plutonium processed, unless a showing can be made that new fuel reprocessing plants are inherently much safer than old plants.

Section I.C. discusses the costs of reprocessing fuel. The basic cost of reprocessing UO_2 fuels quoted by GESMO is $30/kg; a more realistic figure, quoted by the AEC itself, and by the same engineer, is $100/kg. The GESMO estimate is that these costs will increase by 20% with MO fuel; this figure has no basis since the technology for dissolving MO fuel and containing the radioactive effluents has not yet been finalized.

Section II discusses the alleged benefits of recovering uranium and plutonium. There is a serious question as to whether recycled U can be used in fuel elements, that is, whether it is technologically and economically feasible to re-use uranium. There is no showing by GESMO that it is possible.

Finally, Section III discusses the cost-benefit alternatives. If the uranium from spent fuel elements is not re-

cycled, and if the reprocessing costs are realistically estimated, we are led to the conclusion that alternative 2, burying the fuel rods for later use, is the most viable alternative, both economically and environmentally, in the near term. We also believe that the utilities will choose this option if they are allowed to choose between the alternatives.

We believe that the conclusion reached in this report is a realistic assessment of the technology, economics and environmental impact of MO fuels, and that a reasoned judgment would lead the AEC to the same conclusions. There is a possibility that many of the technological problems in fuel reprocessing can be solved, with the requisite economic transfusions (which are not part of the costs in GESMO), but this can only be done at the expense of alternate, more environmentally compatible, sources of energy. We believe that the AEC will continue down the Pu path, no matter the costs. If reason does not deter the AEC, then the only halt to their arbitrary power will be through the courts and the electoral process and not through environmental impact statements such as GESMO.

I. GESMO GREATLY UNDERESTIMATES THE ENVIRONMENTAL AND ECONOMIC COSTS OF MIXED OXIDE FUELS

A. EFFLUENT RELEASES

It is the view of the AEC that, in terms of effluent releases, reprocessing of MO fuel is not much different than the reprocessing of UO_2 fuel. This viewpoint is expressed several times in the GESMO. For example, on p.VI-3,

> The materials, properties and performance of mixed oxide fuels are in some instances indistinguishable from the corresponding UO_2 fuels and in most cases the differences are small.

This point is reiterated on p.VI-4:

> ...it is judged by the staff that under both normal and accident conditions, the effects of fuel type (MO fuel versus UO_2 fuel in LWR's) is not significant in terms of radiological impact to the environment.

And again on p. VI-5:

> Plutonium recycle is not expected to have significant effects on the capacity or effluents of the spent fuel reprocessing industry.

We take issue with this point of view. In order to determine the effluents which are released from fuel reprocessing plants, we examine specific nuclides in detail. We make two general assumptions in the calculation that follows. We assume the 1990 nuclear fuel cycle to be operating at equilibrium SGE (rather than 1.15 SGR). We therefore assume 32.4% of the assemblies in a reactor are fueled with Pu of 61.3% initial fissile content and discharged at 55.4% Pu fissile content (2nd generation). The remaining 67.6% of

the fuel assemblies are enriched UO_2 fuel elements which produce, on discharge, 70.64% fissile content Pu and which, when blended with the 55.4% fissile 2nd generation Pu, yields 61.3% fissile Pu. This leads to no substantive change in the calculations, but allows us to use results which have already appeared in the AEC literature. We further assume, except when otherwise noted, that a reprocessing plant is reprocessing only the above 32.4/67.6 mixture of MO/UO_2 fuels, in order to determine the full environmental impact of MO fuel. GESMO considers the entire LWR industry at 1.15 SGR, consisting of 120 MO LWR reactors and 310 UO_2 LWR reactors, which dilutes and obscures the full environmental impact of MO fuel by itself, and perhaps the local impact about specific reprocessing sites, though it should represent the entire 1990 nuclear industry, if done correctly, of course.

1. Ruthenium

GESMO states, on p.IV E-16,

> It has been assumed that the off-gas system will reduce the ruthenium release from the reprocessing plant (including waste solidification) to 1 x 10^{-9} throughput.

No basis for this statement is presented in the GESMO; there exists contrary evidence. At Nuclear Fuel Services, based on average yearly concentrations as reported by the New York State Department of Environmental Conservation, and average yearly flow rates in Cattaraugus Creek, the release of ruthenium was on the order of 100 to 200 Ci/year. The average reactor exposure of the fuel processed, in 1971, for example, was 790,000 mwd, cooled for greater than 160 days. Based on the above reactor exposure, and the effluent release, the decontamination factor was on the order of 4 x 10^{-5}. There is a major discrepancy between this number and that given by GESMO; the burden of proof is on the AEC to show a decontamination factor of 10^{-9}.

Further, the ruthenium content of MO fuel is approximately 50% greater than UO_2 fuel; the net change for a plant processing only SGR reactors is a 22.6% increase. Needless to say, these numbers are vastly different than those which appear in Table IV A-2 and Table IV E-8. The latter Table claims 0.13 Ci from a 1500 MT(U + Pu)/yr plant; NFS put out 100 to 200 Ci/yr of Ru-106, processing, on the average, only 100 MTU/yr of aged fuel. The point is, in assuming a decontamination factor as small as 10^{-9}(rather than 10^{-5}), GESMO masks the 50% increase in ruthenium due to MO fuel.

2. Iodine

GESMO claims that a model reprocessing facility plus UF_6 conversion, Pu solidification and high level waste solidification, will put out 0.10 Ci/yr I-129, and 0.50 Ci/yr I-131 in processing 1500 MT/yr. Assuming the reprocessing plant effluent system of Fig. IV E-6, Orlan Yarbro, AEC consultant, in testimony at the BNFP gearings, showed that 10%

of the total I-129 content would be released as a gaseous effluent. The addition of mercury to a final vaporizer, not shown in Fig. IV E-6, reduced the I-129 releases to 5% or 3.3 Ci/yr; the I-131 releases were estimated as ten times that amount. Based on NFS experience, Mr. Yarro's estimates are conservative. The reprocessing of SGR fuels increases the above amounts by 9%. The thyroid dose commitments in Tables IV E-9,10 must therefore be increased by more than an order of magnitude; the burden of proof is on the AEC to show that the iodine effluent releases from a model reprocessing plant are as low as 0.10 Ci/yr.

3. Transuranium Isotopes

The transuranium isotopes are similarly underestimated. From Table 4.5 and 4.6 of ORNL-TM-3965, we extract the following information which we present as Table I.

Table I. Transuranium isotopes in LWR Waste

Isotope	PWR-UO_2 fuel (Ci)*	MO fuel (Ci)**	32.4% MO 67.6% UO_2	% Change from PWR-UO_2 fuel
Am-241	1.59×10^2	1.58×10^3	6.17×10^2	+ 288%
Am-242	9.14	2.27×10^2	7.92×10^1	+ 767%
Am-243	1.82×10^1	5.14×10^2	1.75×10^2	+ 863%
Cm-242	1.70×10^4	2.40×10^5	8.95×10^4	+ 427%
Cm-243	3.68	3.85×10^1	1.50×10^1	+ 308%
Cm-244	2.40×10^3	1.36×10^5	4.56×10^4	+1800%

* Fuel burnup 33,000 mwd, cooled 160 days
**Fuel burnup 33,000 mwd, cooled 150 days

The transuranium isotopes increase dramatically in MO fuel. If a single reprocessing plant processed only SGR reactors, as is possible for the older reprocessing plants that will service the older reactors, the local environmental effects should increase. This point is emphasized because it is possible that some effects of MO fuel may be localized and place an unfair burden on one section of the population, while the larger society accepted most of the benefits.

The staff further claims that

> committed reprocessing plants can dissolve fuels irradiated to the design level of 33,000 mwd/MT without increasing significantly the environmental impact from the dissolution

Since the dissolution of PuO_2 fuel, mechanically blended with UO_2 fuel, is not well understood, the effluents and environmental impact are not completely known. GESMO's confidence in this regard is not understandable:

> MO fuel made by mechanically blending can be rendered substantially completely soluble in nitric acid by control of fabrication variables (homogeneity and sintering temperature) and by irradiation, although different dissolver conditions (higher acid concentration, higher temperature, longer time) may be required than those used for UO_2 dissolution. In addition, MO fuels can be completely dissolved in nitric acid acid that contains fluoride ion.

We wish to draw out some of the consequences of the above remark. According to ORNL-4436,

> mechanically blended PuO_2-UO_2 could be converted to a leachable product by sintering at 1600°C for 16 to 48 hr.

Temperatures of that magnitude would volatilize the cesium, and other radionuclides. What would be the consequences? Studies at ORNL indicate that 1 to 10% of the Pu did not dissolve in 8 M HNO_3; the suggestion is made that the insoluble residues could be recycled to the dissolver for a longer dissolution time, but that more leaching experiments were necessary. What mechanical devices are required for this recycling of insoluble residues? The implication of the 400 page ORNL-4436 study on aqueous processing is that the problems of Pu dissolvability had not been solved. The use of HF as a catalyst would dissolve the Pu and the dissolver vessel as well, as would say 14 M HNO_3 at 1700°C for 8 hours. The effluent releases of iodine or cesium are not well known under these conditions; it is clear that the composition of the DOG and the HAW depend on the exact dissolution conditions, and so do the effluent releases.

B. WORKER EXPOSURE

GESMO's remarks concerning worker exposure are entirely inadequate, unfounded and unrealistic. From p.IV D-26,

> External exposure of personnel is controlled by the use of shielding and special work permits. The introduction of Pu recycle is not expected to change the external exposure of personnel, estimated to be 350 man-rem/yr at the reprocessing plant.

In Table IV D-1, GESMO estimates the environmental effects for the entire reprocessing industry, 7 reprocessing plants, processing 8800 MT/yr; the total worker exposure is 3000 man-rem with no difference for Pu recycle. The basis for these remarks is not contained in GESMO. However, based on the experiences of Nuclear Fuel Services, the only commercial fuel reprocessing plant that has operated so far in the United States, the above estimates are completely unrealistic.

In 1971, NFS processed about 100 MTU, reactor exposure 790,000 mwd, aged more than 150 days. The plant employed 164 full-time employees and approximately 1000 short term employees. The full-time employees received approximately 7.2 rems per employee; the short term employees, some 18 and 19 year olds, received approximately 1 rem/employee. The total worker exposure at NFS was over 2300 man-rem for the year. If the AEC had allowed the plant to continue processing, most probably the worker exposures would have continued the steady upward rise, as shown from a March 16, 1972 inspection report:

year	1968	1969	1970	1971	1972
exposure(rem)	2.74	3.81	6.76	7.15	closed

A large contributor to this worker exposure was Ru-106, mentioned on p.6, which plated the pipes and increased the general radiation level in the plant.

There is no showing in GESMO that a plant processing 1500 MTU/yr, 15 times as much as NFS with more highly irradiated fuel, will have less worker exposure. To compound the

seriousness of the problem, the introduction of MO fuels will most probably increase the exposures even further. The essential reason for this increase is the increase in Cm, shown in Table 1, and illustrated more clearly in Table 2 below (Table 4.16 of ORNL-4436):

Table 2. Estimated Neutron Source Strengths of Spent Power Reactor Fuels

	LWR[a]			LWR-Pu Recycle[a]		
	Isotope	Neutron Source		Isotope	Neutron Source	
Isotope	Content (gm/MT)	(α,n) ($sec^{-1}MT^{-1}x10^{-6}$)	SF[b]	Content	(α,n) ($sec^{-1}MT^{-1}x10^{-6}$)	SF[b]
^{238}Pu	160	5.0	0.4	45	1.4	0.1
^{239}Pu	5400	0.4	0.0	1500	0.1	0.0
^{240}Pu	2200	0.6	2.0	1000	0.3	0.9
^{241}Am	62	0.4	0.0	60	0.4	0.0
^{242}Cm	4.4	52.9	87.7	35	418	693
^{244}Cm	30	7.3	326	510	124	5560
Total		66.	416.		544.	6250.
Overall Total		480			6800	

a Fuel irradiated,33,000mwd/MT, cooled 150 days
b SF = spontaneous fission

According to ORNL-4436 (p.195),

> the neutrons produced by spontaneous fission and (α,n) reactions constitute the important source of penetrating radiation in plutonium product (and recycle plutonium feed).

The dramatic increase in Curium content in Pu recycle will most probably increase the worker exposures. It is possible

that ½ to 1 ft of additional shielding would be required for spent fuel processing cells; it is not clear that BNFP and NFS are designed for this alteration.

Another important area of concern is the number of workers who have received Pu inhalations, and the projections for the future. In the 6 years of operation of NFS, a total of 39 persons involved in 13 separate inhalation incidents have been reported; NFS was processing, on the average, 1 kg of Pu/day (see Science, Sept. 20 and 27 issues). A 1500 MTU/yr reprocessing plant, processing fuel with burnup of 33,000 mwd/MT, will process over 50 kg/day, and 3 times that for MO fuel. Many of the NFS incidents involved normal human error and would not have led to serious consequences in other industries. Therefore, based on previous history, we would expect that the number of inhalation incidents will increase by an alarming amount in a Pu economy.

C. REPROCESSING COSTS

The reprocessing costs have been greatly underestimated in GESMO. On p.VIII-8, the reprocessing plus transportaion costs are quoted as $35/kg; this cost is to be compared to the value of the recovered U and Pu of approximately $95/kg, providing a clear economic incentive to reprocess. GESMO mentions, on p.VIII-21, that the cost of reprocessing MO fuel is assumed to be 20% greater than for UO_2

fuel "due to potential difficulties in dissolution of the MO fuel" and nuclear safety restrictions.

The above costs of $35/kg are based on the past reprocessing costs at NFS, and are not a realistic estimate of the future costs of reprocessing. NFS is presently in the throes of a construction permit hearing. Our assessment of the costs to modify the plant to meet AEC regulations, and to process 750 MTU/yr is approximately $200 million; we estimate that the reprocessing costs will exceed $100/kg.

In Supplemental Testimony at the BNFP construction permit hearing, Ms. Kathleen Black estimated the reprocessing costs for BNFP as $100/kg. This figure was based on a complete plant cost of $500 million. The original cost estimate for the BNFP was $80 million, escalated to $274 million last year and $500 million this year; the reprocessing costs had to be similarly escalated. This new reprocessing cost by Ms. Black cannot be lightly dismissed since she participated in the preparation of the GESMO.

GESMO estimates the future costs of constructing reprocessing plants as $938 million. Five additional plants the size of Barnwell should cost $2.5 billion, or 3 times as much as the original AEC estimate; the reprocessing costs should correspondingly be tripled. As we shall show in Section III, a reprocessing cost 3 times as great as the GESMO estimate tilts the balance towards alternative 2.

II. GESMO GREATLY OVERESTIMATES THE BENEFITS OF REPROCESSING

GESMO has made no showing that uranium can be recovered and recycled. The SGR model assumes natural uranium (p.IV C-58), but mentions that depleted uranium could also be used, if possible. On p.IV E-5, GESMO states

> At present it is planned that recovered uranium will be recycled to the reactor after reenrichment in the gaseous diffusion plant. Recovery of fissile material from the spent fuel elements is economically advantageous <u>if the fissile material can be recycled</u>.

Is there a question that the fissile material cannot be recycled?

Other publications indicate that recycled uranium will not be used till the far distant future, much past the cut-off date of 1995 assumed by GESMO. ORNL-4436 (p.116) states

> It seems likely that, for many decades, make-up uranium for the LMFBR fuel cycle will be derived from the stockpile of gaseous diffusion tailings rather than by recycle of uranium from LMFBR fuel reprocessing plants. The latter uranium will probably simply be stored until needed.

WASH-1535 re-affirms this view (p.4.4-25)

> Studies indicate that the uranium from the LMFBR fuel processing plant will not be used to fabricate new fuel elements until the supply of uranium from the gaseous diffusion plant tailings is no longer available (perhaps <u>after year 2020</u>).

These studies are with respect to the LMFBR fuel cycle, and may not hold for the SGR reactor; nevertheless, the burden is on GESMO to prove that uranium recycle is useful. We assume therefore that unless the AEC buys back uranium from utilities

thereby creating a false market and value for uranium, that the utilities have no economic incentive to recycle uranium.

There may be technical reasons for not recycling uranium. Recycled uranium contains U-236 which is a poison; it must absorb 3 neutrons before becoming fissile Pu-239. From Table 3.13 of ORNL-4451, we note that a MT of spent UO_2 fuel contains 4.08 kg of U-236 and 7.95 kg of U-235. In terms of radioactivity, a MT of spent UO_2 fuel contains 0.288 Ci of U-236 and 0.0171 Ci of U-235. If this recycled uranium were introduced to a gaseous diffusion plant, the U-236 poison would also be enriched; there is no known means to economically separate the two isotopes

Since GESMO has not made a showing that recycled uranium can be used quantitatively, we assume in the following that recycled uranium has no value. The only reason for reprocessing spent fuel is to extract the plutonium. The question comes down to-is the cost of reprocessing greater than the value of recovered plutonium?

III. COST-BENEFIT ANALYSIS

With the failure of the GE Midwest Fuel Recovery Plant and the possibility that NFS will not be licensed, or could not process MO fuel, the AEC has only one potential plant that may be operating by July, 1976, the Barnwell Nuclear Fuel Plant in South Carolina. It is not clear that the plant

can operate up to capacity due to the enormous projected iodine releases. An additional 5 or 6 plants of 1500 MTU capacity will be required, at a capital outlay of at least $2.5 billion. The GESMO estimates of the costs and the number of reprocessing plants (Table IV E-4) are out-of-date and must be revised. For example, on p.VIII-43, GESMO states that the elimination of four additional reprocessing plants in 1990 would provide a savings of $650 million; this figure should be over $2.5 billion (these plants are not"eliminated", just not being built).

The dollar estimate of present day plants is also in error. The economic loss of the present 3 plants is estimated at $330 million (p.VIII-43), but escalated to $400 million on p.XI-42. In fact, the Midwest plant can be written off. The NFS facility when new was worth $32 million, but has depreciated in value and may be worthless at present; it is known that Getty Oil cannot find a buyer for the subsidiary. On the other hand, the Barnwell facility could be worth $500 million. If alternative 2 were adopted, therefore, this would entail a capital write-off of over $500 million. The cost and failure escalation of the reprocessing industry is not only due to inflationary price rises, but everchanging regulations by the AEC, changes which reflect some increasing realism to the problems brought to its attention by citizen groups such as NRDC, Inc.

These minor corrections to the GESMO estimates skirt the real question in choosing between alternatives 2 and 3, between storing the spent fuel rods for later use, or reprocessing and re-using the plutonium immediately. The real question is, how much money will be saved with plutonium recycle in terms of dollar savings on uranium mined and fabricated into fuel elements, and how much does it cost to extract this amount of plutonium? If the costs are greater than the savings, then alternative 2 is more viable at the present time. As the supply of uranium decreases, it will be more economically advantageous at some future time to extract plutonium; from the analysis below, that time is not now. We believe that the AEC should insert realistic dollar figures and predict when that time will be.

To determine the viable alternative, we ask first what is the dollar savings in alternative 3? Ten percent less uranium will be mined and processed. The savings is approximately $281 million for yellowcake, $274 million for enrichment, and $21 million for UF_6 conversion, or a total of $576 million. With Pu recycle, this amount is saved as contrasted with UO_2 fabrication. This savings in uranium is equivalent to 44,300 kg of Pu_f; this plutonium would therefore have a value of $1.3 x 10^4/kg. These figures should be updated by GESMO. Next, what is the cost in extracting Pu from spent fuel? According to the Supplemental Testimony

of Ms. Kathleen Black, the cost of reprocessing, storing, safeguarding, etc., spent fuel, excluding transportation (which is approximately the same under both alternatives is $132/kg. Each kg. of spent fuel contains 6.12 gm Pu_f, and therefore the cost of reprocessing is $2.16 x 10^4/kg Pu_f. At present, therefore, alternative 2 is more viable from an economic viepoint. However, this analysis does not include the costs for storing spent fuel at each reactor, estimated by GESMO to be $2 million, and does not include the increased costs, upwards of 20%, for fabricating and dissolving MO fuel.

The key variables above are the costs of reprocessing and anciliary costs versus the costs of mining, and enriching uranium. It is clear that as the price of electricity rises, estimated by the EPA to be 13% per year, exclusive of inflation, solely due to the costs of constructing new nuclear facilities at a 7% yearly increase, the enrichment costs should increase at approximately the same rate. The AEC is caught in a peculiar bind: if enrichment prices are raised too drastically, utilities will not construct nuclear plants. On the other hand, they cannot pressure utilities to use Pu recycle unless the cost of uranium rises above the cost to extract Pu. The other variable in the price of uran-

ium is the cost of mining and milling uranium. As the supply decreases, this cost should also increase. Eventually there will be a crossover point where alternative 3 is more viable economically.

From the point of view of the utilities, there are three options if they wish to continue the nuclear route. Not going the nuclear route is, of course, not one of the GESMO options. The AEC can continue the present managed nuclear economy, buying back the uranium, and allowing the utilities to retain rights on the plutonium. This provides a clear incentive to reprocess. Or, the AEC can present the following free economy options to the utilities: alternative 2 allows the utilities to store the spent fuel rods for later use. The utilities would have to supply capital for a storage pool, or perhaps a private firm would initiate a fuel storage business/ The utilities would save themselves the reprocessing charges, and the fuel rods would constitute some uncertain amassed capital. Or alternative 3 assumes the utilities could elect to ship their spent fuel to a reprocessor. It is assumed that the uranium would have no value to the utility, and that the plutonium would be recovered and re-used, in MO fuel. The utility would know that fabrication costs and reprocessing costs would be

20% more than for UO_2 fuel. On the basis od costs and free choice to the utilities, it is assumed that the utilities would elect alternative 2. At a cost of $132/kg to reprocess, safeguard and storewastes, one year's spent fuel shipment of 30 MT would cost $4 million to reprocess; it makes sense to pay $2 million for a storage pool.

As mentioned previously, the AEC has it within its power to force the Pu economy on the utilities. It could raise the enrichment price; it could take over the reprocessing industry, as has been recommended by Hosmer of the JCAE. But on the basis of a free nuclear economy, Pu recycle is definitely economically and environmentally disadvantageous. If the AEC neglects the reasonable conclusions of citizen groups and proceeds on alternative 3, by whatever means they choose, then the only alternative to the public is through the courts and the electoral process, and not through environmental impact statements such as GESMO.

NRC Staff Response to Specific Comments by Dr. Marvin Resnikoff

1. Comment:

"In Section I, we demonstrate that the costs are greatly underestimated. Section I.A is a discussion of the effluent releases from fuel reprocessing plants. Based on the past operating experience and projections of AEC contractors, such as Oak Ridge, we find that the effluent releases will be greater than GESMO estimates, that the population-rem estimates will be correspondingly greater, and in particular, that thyroid dose estimates will be orders of greater magnitude. For example, Tables IV E-9 and 10 present no increases in iodine releases due to MOX Fuel."

Response:

Past operating experience in one plant is not necessarily relevant to the expected overall performance of another plant which differs significantly in design and the types of installed effluent treatment systems. For the most part, except for iodine, the independent judgments of the staff and its consultants are in reasonably close agreement with respect to estimating an upper limit for the prospective effluent releases from fuel reprocessing plants. Since there is little data that is directly relevant to how iodine will be distributed in the liquid waste treatment and acid recovery systems within proposed new plants, this assessment was based on an overstatement of projected iodine releases from fuel reprocessing plants. This does not necessarily mean, however, that this amount of iodine will actually be released annually over the life of fuel reprocessing plants. Rather, it means that a conservative judgement was made, and that the environmental impact, if any, related to iodine release is expected to be less than that shown in this assessment.

Table IV E-8 of CHAPTER IV, Section E, indicates the relatively small increase in the prospective average annual iodine release that might result from the introduction of Pu recycle fuel. Tables IV E-9, 10 and 11 indicate the potential effect on the population's thyroid exposure as a result of iodine releases, if, indeed, these amounts of iodine were actually released from a fuel reprocessing plant. Additional discussion related to iodine removal is presented in CHAPTER IV, Section E, paragraph 2.5, Ruthenium and Iodine Removal.

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2. Comment:

"Section I.B. discusses the question of worker exposures at fuel reprocessing plants. Experience at Nuclear Fuel Services, the only commerical reprocessing facility, has shown worker exposures to be 6 to 7 times greater than that amount, and there is no showing by GESMO that they will be less. In fact, the high neutron activity of MO fuel, due mainly to Cm-244, should increase the exposures. The total personnel exposure of 3,000 man-rems for 7 reprocessing plants is ridiculously low; one plant alone, Nuclear Fuel Services, may have exposures of that magnitude. In addition, the plutonium inhalation incidents should also increase proportionally to the quantity of plutonium processed, unless a showing can be made that new fuel reprocessing plants are inherently much safer than old plants."

Response:

Operating experience at the NFS plant between April 1966 and December 1971 identified certain design deficiencies, including some that contributed to worker exposures. In early 1972, the NFS plant was shut down for modifications to correct deficiencies and to expand the plant's reprocessing capacity to approximately 750 metric tons annually. The experience in this plant is not necessarily relevant to other plants which differ significantly in design. In CHAPTER IV, Section E, paragraph 3.4, a revised assessment is shown of occupational exposure related to a fuel reprocessing plant complex which includes a separation facility, a UF_6 conversion facility, a PuO_2 conversion facility, and waste solidification and packaging facilities.

Except for plutonium, the transuranium elements such as ^{244}Cm follow the fission products, in the co-decontamination cycle, to the high level radioactive waste. Therefore, there would be little, if any, significant effect on worker exposure due to the introduction of Pu recycle fuel in the separations facility. However, the isotopic composition of plutonium, and the amount of plutonium to be handled, does change with the introduction of Pu cycle. This could result in some increase in exposure to those operating personnel in the PuO_2 conversion facility whose activities involve physical handling of plutonium in glove boxes, etc. Plutonium inhalation incidents are not directly related to the quantity of plutonium processed and, thus, would not necessarily increase proportionally to the quantity of plutonium processed.

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3. Comment:

"Section I.C. discusses the costs of reprocessing fuel. The basic cost of reprocessing UO_2 fuels quoted by GESMO is $30/kg; a more realistic figure, quoted by the AEC staff, and by the same engineer, is $100/kg. The GESMO estimate is that these costs will increase by 20% with MO fuel; this figure has no basis since the technology for dissolving MO fuel and containing the radioactive effluents has not yet finalized.

Response:

Mixed oxide fuels made by mechanical blending to achieve homogeniety, and sintered at about 1,650°C for about four hours, are not expected to cause any problem with respect to the dissolution of irradiated LWR fuel. The technology for containing the radioactive effluents from the dissolution of mixed oxide fuel is the same well established technology that is used in present installations.

The current estimated MOX fuel reprocessing costs and comparisons to estimated UO_2 fuel reprocessing costs are included in the cost-benefit discussions in CHAPTERS VIII and XI. The costs related to fuel reprocessing have been changed ($110 to $190/kg); discussions of UO_2 and MOX reprocessing costs are included in CHAPTER XI, paragraph 2.6.

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4. Comment:

"Section II discusses the alleged benefits of recovering uranium and plutonium. There is a serious question as to whether recycled U can be used in fuel elements, that is, whether it is technologically and economically feasible to reuse uranium. There is no showing by GESMO that it is possible."

Response:

The technical and economic feasibility of recycling recovered uranium to enrichment facilities has been discussed in detail by A. de la Garza in testimony responding to contention 8.b. in the Barnwell Nuclear Fuel Plant hearing (copy follows). In summary, Mr. de la Garza states, "In my opinion, there are no effects associated with uranium isotopic contaminants in recycled light-water reactor fuel which would make the use of recycled fuel in the form of accepted UF_6 operationally infeasible and economically undesirable at an enrichment plant producing fresh fuel for light-water reactors." The prospective neutronic penalty related to recycle uranium is discussed in CHAPTER VIII, Appendix B.

UNITED STATES OF AMERICA
ATOMIC ENERGY COMMISSION

BARNWELL NUCLEAR FUEL PLANT
Docket No. 50-332

SUPPLEMENTARY TESTIMONY RELATED TO
ENRICHMENT OF RECYCLED FUEL FROM
LIGHT WATER REACTORS

BY

A. de la Garza

I. INTRODUCTION

This testimony, which supplements the testimony of T. R. Workinger on Contention 8.b, is limited to considerations in the U-235 enriching step of the light water reactor fuel cycle in partial response to Contention 8.b[1]. This contention reads:

"8.b. There is no reasonable assurance that uranium can be economically recycled as a fuel for light water reactors because of technological problems experienced with uranium produced by commerical reprocessing efforts to date, including inadequate purification and removal of such contaminants as U-233 and U-236."

U-233 and U-236 are isotopes of uranium. Their removal from a mixture of uranium isotopes would entail use of an isotope separation process, as is used for the enriching of U-235. To my knowledge, removal of U-233 and U-236 as a target in itself has never been entertained. Accordingly, my remarks assume the presence of U-233 and U-236 and other pertinent isotopes in U-235 enriching.

In my opinion, there are no effects associated with uranium isotopic contaminants in recycled light water reactor fuel which would make the use of recycled fuel in the form of accepted UF_6 operationally infeasible and economically undesirable at an enriching plant producing fresh fuel for light water reactors.

In support of my opinion, after some preliminary general information on isotopic contaminants, I will discuss how recycling reprocessed spent fuel to enriching plant relates technologically and economically to enriching plant operations. In doing so for purposes of illustration, I employ some referenced data from the power reactor field, which is outside my competency. I trust that I have selected representative data for these illustrative purposes. The presentations made permit use of other data, if so desired. I will then review experience to date at AEC facilities with deliveries to the AEC of reprocessed spent fuel uranium. Finally, I will discuss briefly how characteristics of the centrifuge process might relate to the presence of isotopic contaminants in centrifuge enriching plant.

II. BACKGROUND

Uranium as found in nature is a mixture of three isotopes: U-234, U-235, and U-238. Although the exact isotopic composition may vary

slightly depending on the origin of the ore, the currently accepted standard composition of natural uranium is:

U-234: 0.0054 wt %
U-235: 0.711 wt %
U-238: 99.2836 wt %

Other isotopes of uranium, U-232, U-233, and U-236, are generated in light water reactors through successive neutron reactions and decay chains. Of these isotopes, U-236, mainly formed by neutron capture by U-235, has the highest concentration in spent fuel. The concentrations of these three isotopes in discharged light water reactor fuel will vary depending on the initial fuel composition and reactor operations. Illustrative isotopic concentrations of discharged spent fuel, originally made entirely from natural uranium enriched to about 3.1% U-235, are as follows:

U-232: 0.03×10^{-6} wt % or 35 parts U-232 per billion parts U-235
U-233: 0.5×10^{-6} wt % or 0.6 parts U-233 per million parts U-235
U-234: 0.015 wt %
U-235: 0.875 wt %
U-236: 0.425 wt %
U-238: 98.685 wt %

On the assumption of repeated recycling of spent fuel to enriching plant, the U-236 concentration could ultimately approach about 0.875% U-236 in

a situation representative of an enriching plant devoted entirely to sustaining light water reactors recycling spent fuel, i.e., without making fuel for initial cores of new reactors from virgin natural uranium. The U-236 equilibrium level (0.875%) in this situation might occur in the 1990s.

Because of their small concentrations relative to that of U-238, the natural occurring U-234 and the U-232, U-233, and U-236 are commonly called the "minor isotopes" in the U-235 enriching business. The economic effects on U-235 enriching associated with the recycling of light water reactor fuel revolve about the presence of these minor isotopes in feed to the U-235 enriching plants. Such effects, due to the isotopes introduced by the reactors, are now discussed.

III. DISCUSSION

A. The Direct Presence Effect of Minor Isotopes on Separative Work Requirements

When the feed to an enriching plant is natural uranium, it is permissible in most situations of interest to treat the U-234 concentration as being negligibly small, and thus, to regard uranium as a mixture of the two isotopes, U-235 and U-238. The AEC schedule of base charges and the standard table of enriching services are based on the assumption of a simple U-235, U-238 two-component mixture.[2] When the concentration of an isotopic contaminant is

greater than the naturally occurring level of U-234, its effect on U-235 enrichment may not be negligible. More separative work would be required by an enriching plant to hold the same uranium flows and U-235 concentrations in the presence of such a contaminant than without it.

I have previously indicated that of the minor isotopes in spent fuel the U-236 concentration is the highest. The attached Figure 1 presents a comparison of enriching plant flowsheets with and without U-236, illustrating its direct effects in a case approximately representative of an enriching plant devoted entirely to sustaining light water reactors with recycling of spent fuel. It is estimated that in this situation, which assuredly maximizes input of U-236 to enriching plant, the U-236 concentration of the recycled spent fuel approaches 0.875% U-236.

All separative work calculations for Figure 1 were based on a U-235, U-236, U-238 three-component mixture[3,4], rather than the usual U-235, U-238 two-component mixture, thus including increased separative work due to the U-236.

It may be seen that the increase in separative work due to the presence of U-236 in an extreme situation is small in the practical

sense, amounting only to about 0.25%, which could be compensated economically by an increase of 10¢ per separative work unit (SWU) in the base charge of $42.10/SWU.[5]

Incidentally, Figure 1 also illustrates why the U-236 concentration in spent fuel approaches a limiting U-236 concentration on repeated recycling. It may be noticed that the enriching plant waste or tails contains about half of the U-236 contained in the recycled fuel fed to the plant. Equilibrium of U-236 in the cycle is reached when the U-236 removed in enriching plant waste equals the net U-236 formed in the reactors. Thus, the U-236 concentration in the first discharged spent fuel from a reactor may be about 0.4% U-236 and on repeated recycling, increase to about 0.875% U-236.

As stated earlier, the projected concentrations of other minor uranium isotopes are much smaller than that of U-236, and the effect on separative work due to their presence is likewise correspondingly smaller.

B. Indirect Effects of U-236 on U-235 Concentration in Enriching Plant Product

In contrast to the fissile U-235 and the fertile U-238, U-236 is neither fissile nor fertile, and is essentially a parasitic neutron absorber in light water reactor fuel. As a result, to maintain an

equal energy output of a light water reactor, fuel containing U-236 will require a slightly greater U-235 enrichment than fuel without U-236.

The U-235 enrichment increase required to compensate for the presence of U-236 may be expressed as

$$\Delta e \text{ \% U-235} = K \times (\text{\% U-236 in fuel charge}),$$

with the value of K possibly depending on reactor type and operations, and on the level of U-236 in the fuel. Sprague reports K = 0.6 for a "typical BWR in the enrichment range of 2.2 to 2.8% U-235,"[6] and elsewhere,[7] provides information indicating that a value of K = 0.6 is applicable to fuel of very low U-236 concentration, while a value of K = 0.3 is applicable to fuel with about 1% U-236. For other reactors, a more stable single value of about K = 0.3 is reported over the stated level of U-236 in fuel.[8] Be that as it may, for purposes of illustration here, I have assumed that K ranges between 0.3 and 0.6. With these values, necessary increases in the U-235 concentration of enriching plant product for fuel may be scoped.

For the situation in Figure 1, approximately representative of enriching plant devoted entirely to sustaining light water reactors with recycling of spent fuel, the U-236 concentration in product is 0.49% U-236. The necessary increase in U-235 enrichment would thus range from

$$\Delta e = 0.3 \times 0.49\% = 0.15\% \text{ U-235},$$

$$\text{to } \Delta e = 0.6 \times 0.49\% = 0.30\% \text{ U-235}.$$

Then, for example, instead of requesting fuel enriched to 3.1% U-235 without U-236, to keep the same energy output, a power reactor might request fuel enriched from

$$\text{a low of: } 3.1 + 0.15 = 3.25\% \text{ U-235}$$

$$\text{to a high of: } 3.1 + 0.30 = 3.4\% \text{ U-235}$$

in the presence of 0.49% U-236 in the fuel.

In a situation closer in the future than the above sustaining one, enriching plant would be making initial fuel charges from virgin natural uranium in addition to recycling for reloads. The recycled uranium per unit of enriched product uranium would therefore be less than in the sustaining situation in which this ratio is about one. Also, since the spent fuel recycled would be from early discharges, its U-236 concentration would be lower than the 0.875% U-236 equilibrium value in the sustaining situation. Accordingly, the U-236 concentration in enriching plant product would be decreased, and increases in U-235 enrichment in product should not be greater.

Increases in product enrichment for fuel in the range of 0.15% to 0.30% U-235 for any reason, including compensation for the presence of U-236, even if applicable to all product streams at an enriching plant, are inconsequential in enriching plant operations. The AEC

gaseous diffusion plant complex has produced enrichments ranging to over 90% U-235 during most of its operating history, and would, of course, accommodate such increases. But suppose an enriching plant is designed for optimal operation limited exactly to a U-235 concentration span from 0.3% U-235 in tails or waste to 3.1% U-235 in its top product, and now, the top product concentration must be increased to 3.4% U-235. This can be done by means of adjustments to the interstage flows. At the increased concentration, plant operation would not be optimal, but the decrease in plant separative capacity would only be about 0.15%, which could be compensated economically by an increase of 7¢/SWU in a base charge of $42.10/SWU. In the case of the AEC gaseous diffusion plant complex, the effect would be less.

C. Changes in Enriching Plant Flowsheet Brought About by Spent Fuel Recycle

When fresh fuel is made under the assumption of spent fuel recycling, a different resource mix of natural feed and separative work is used at enriching plant than when the fresh fuel is made without recycling of spent fuel. In effect, the plant does a different separation job and sees different flowsheets. The magnitudes of these changes are of interest.

The attached Figure 2 presents a comparison of enriching plant flowsheets, making fuel without and with recycling in the limiting case

approximated by enriching plant sustaining light water reactors with recycle, that is, without making fuel for initial cores of new reactors from natural uranium. It may be noticed that in this mode, the fuel U-235 enrichment has been increased to compensate for the presence of U-236. A value of K = 0.3 for the Δe enrichment has been assumed. Furthermore, all separative work calculations were based on a U-235, U-236, U-238 three-component mixture,[3,4] rather than the usual U-235, U-238 two-component mixture, thus including increased separative work due to the third component U-236. The depicted flowsheet with recycle is the last of a sequence of calculated flowsheets, starting with recycle of a first discharge, then a second, and so on, until isotopic concentrations approached equilibrium. Recent more complete calculations on projected operations of the existing gaseous diffusion plants have indicated a U-236 concentration in recycled uranium of 0.6 to 0.8% in the 1990s, in contrast to the projected equilibrium level of 0.875% U-236 for the Figure 2 situation.

From the illustrations in Figure 2, it may be seen that at the enriching plant the production of a unit of fuel of equal energy output with fuel recycling in an extreme case results in a decrease of about 15% in natural uranium feed requirements and an increase of only about 4.5% in separative work requirements relative to producing the fuel without recycling. In total uranium quantity, however, the

total uranium fed to the plant is very nearly the same. Incidentally, if the increase in separative work needed for recycling were not available (due to plant equipment or power restrictions), the incremental separative work needed in this case could be replaced by incremental natural feed at the rate of 2kg natural feed per separative work unit, and the increased natural feed at constant separative capacity would increase slightly the plant's tails U-235 concentration.

The attached Figure 3 presents another comparison of enriching plant flowsheets, making fuel without and with recycling. In this illustration, the recycled spent fuel (in total uranium) has been set to 10% of the total feed to the plant. The situation, which could occur in the early 1980s, would be representative of recycling first discharges, while the plant's major load is making initial cores for new reactors delivering natural uranium. Accordingly, the U-236 concentration of the recycled uranium has been assumed to be 0.425% U-236, typical for a first discharge. A value of K = 0.6 for the Δe enrichment has been assumed.

From the illustrations in Figure 3, it may be seen that at the enriching plant the production of a unit of fuel of equal energy output with recycling now results in a decrease of 11% in natural uranium feed requirements and an increase of only about 2.5% in

separative work requirements relative to producing the fuel without recycling. Again, as before, in total uranium quantity, the total uranium fed to the plant is very nearly the same. The changes in plant flowsheet, from operating without recycling to operating with recycling, would call for minor changes in operating conditions internal to the enriching plant. Enriching plant, whether gaseous diffusion or centrifuge, is flexible in this regard, and the indicated internal operational changes may be accommodated.

An example of a severe change in flowsheet for AEC gaseous diffusion plants may serve to illustrate enriching plant operational flexibility in practice.[9] The fully improved and uprated AEC three-plant complex is designed for optimal operation at a tails concentration between 0.2 to 0.3% U-235 with the required products and available feeds projected for the early 1980s. If feed were to be increased to the plant above levels corresponding to the design tails range, production of enriched uranium would increase, but separative capacity of the plant would decrease. Aside from the question of availability of natural uranium, if feed were to be increased to the plant by 50%, the U-235 concentration in enriching plant tails would increase from 0.3 to 0.4% U-235, with product rate increasing by nearly 20%. Such a change in plant flowsheet would be most severe. Still, the three-plant separative capacity would decrease by only 3% at the same plant total power level, and this decrease in plant efficiency could be compensated economically by an increase of $1.25/SWU in a separative

work charge of $42.10/SWU. The points being made here are that enriching plant can maintain its separative work output over a large range of imposed flowsheets, and that therefore, separative work economics are remarkably stable with respect to such changes.

D. Value of Recycled Spent Fuel at Enriching Plant

Figures 2 and 3 have been used to illustrate changes in plant flowsheet between recycling and not recycling. This same information may be used to obtain a value for recycled uranium at enriching plant. This is done by making a cost balance between recycling and not recycling at the enriching plant for a given situation and finding the "breakeven" value for recycled uranium, i.e., the value leading to cost indifference between recycling and not recycling.

In Figure 2, the indicated cost balance for indifference is (aside from questions of resource price elasticity):

With Recycling		Without Recycling
$D_R + 5.798\ D_N + 3.764\ D_{SW}$	equals	$6.813\ D_N + 3.605\ D_{SW}$

where the D's are unit values for recycled uranium, natural uranium, and separative work as indicated by the appropriate subscript. For the case in which the unit costs of natural uranium (D_N) and of separative work (D_{SW}) are about the same, it is found that the breakeven

value (D_R) for recycled uranium in this case is about 55% of the value of uranium at the same U-235 concentration, but without U-236 present, i.e., calculated as a U-235, U-238 mixture.

Figure 3 is treated in the same manner as above. In this case, the value of the recycled uranium at enriching plant is about 60% of the value of uranium of the same U-235 concentration, but without U-236 present.

The above two examples serve to indicate that, though U-236 reduces its value, recycled uranium nevertheless has appreciable net value as feed material to an enriching plant due to significant reduction in natural uranium requirements. Of course, in its overall valuation there are economic aspects of recycling outside enriching plant, and these I must leave to others.

E. Effects of U-232 and U-233

Contention 8.b.[1] mentioned the isotope U-233, but omitted U-232. Permit me to include U-232, the other minor isotope I mentioned.

Of the four minor isotopes, the AEC has acceptance specifications on only the content of U-232 and U-233 for UF_6 delivered to the AEC. These specifications are:[2]

max. U-232: 110 parts per billion U-235

max. U-233: 500 parts per million U-235

With respect to operations and economic resource tradeoffs at the enriching plant, the projected small concentrations of these isotopes in accepted UF_6 feed result in negligible effects.

F. Experience to Date

During the period of May, 1966, through November, 1971, Nuclear Fuel Services, Inc., West Valley, New York, reprocessed and shipped to the AEC about 243 metric tons of uranium as uranyl nitrate solution. This uranium, which ranged between 0.7 and 2.9 wt % U-235, was recovered from spent power fuel from a total of eight U.S. light water reactors. The uranium was accepted by the AEC as meeting specifications. The AEC chose to use a portion of the NFS material in its plutonium production reactors. However, all of the material was judged to be acceptable for conversion to UF_6 for use as feed to the gaseous diffusion plants. The attached Table I presents a summary of the uranium deliveries and isotopic contents by reactor.

During the period 1970 through 1974, the AEC received and accepted from French and British spent fuel reprocessing plants some 220 metric tons of uranium as UF_6. The ranges in isotopic contents of this material are as follows:

U-235: 0.64 - 4.5%

U-236: 0.009 - 0.34%

U-232: <1 - 101 parts U-232 per billion parts U-235

U-233: 15 - <275 parts U-233 per million parts U-235

The foreign-supplied material has either been fed or is scheduled for feeding to the AEC gaseous diffusion plants over the next few months.

G. Other Specifications for UF_6 Delivered to the AEC

Reference to the specifications for UF_6 delivered to the AEC[2] shows that in addition to the previously mentioned specifications on U-232 and U-233 content, there are specifications on 21 other characteristics.

A gaseous diffusion plant is very sensitive to small concentrations of chemical impurities which corrode system components, deposit in equipment, or contaminate the UF_6 product. Safe handling and storage of containers require specifications on highly volatile impurities and possibly explosive mixtures. Several fission products may deposit on equipment surfaces, and if introduced into the plant in sufficient quantities, would increase the level of penetrating radiation sufficiently to require shielding and remote handling during operation and maintenance procedures. Significant health hazards could result. Other radiation could interfere with methods for locating potentially critical masses of ^{235}U in case of accident.

Reference is made to an AEC Program Status Report, URANIUM HEXAFLUORIDE SPECIFICATION STUDIES,[10] for further information.

Specifications have evolved over nearly 30 years of gaseous diffusion plant operations and UF_6 production from natural uranium and low burnup fuels from AEC production reactors. The published specifications are set to assure safe and economical operation of gaseous diffusion plants with respect to the above mentioned areas of chemical corrosion in equipment, product contamination, storage and handling of material, radiation levels both for equipment in place and for maintenance operation, and detection of possible U-235 deposits. Based on my experiences at gaseous diffusion plants, compliance with published specifications has assured safe and economical operations at these plants. I previously discussed experience to date with recycled fuel from domestic and foreign reactors.

In the criteria for enrichment services,[11] it is stated that the customer warrants that all feed material meets specifications. Accordingly, in my discussion of the use of recycled fuel as UF_6 at an enriching plant, I have assumed that the material meets specifications and is accepted for delivery. Material not meeting the published specifications is not accepted and not used, unless there are valid reasons for exception in limited quantities.

H. Centrifuge Enriching Plant

My testimony has been based on operating experience with gaseous diffusion plants. Enriching plants of the future might employ the centrifuge process. The separation characteristics of both processes are essentially the same, inasmuch as in both, the separation factor for two heavy isotopes is very nearly proportional to the difference in mass between the isotopes. Thus, for example, other things being equal, fuel enriched to the same U-235 concentration will have the same U-236 concentration with both processes.

Experience with centrifuge production plant is not available as yet. Likely, more modular plant construction and flexibility in centrifuge configurations should lead to better accommodation of changes in plant flowsheet. Also, the process characteristics[12] of smaller in-plant inventory, quicker turnover time of in-plant inventory, and likely more frequent equipment maintenance and replacement indicate less concern with the introduction of minor isotopes to centrifuge plant than to gaseous diffusion plant. The AEC is presently starting operations of a centrifuge component test facility (CTF) to proof a centrifuge production system on a pilot-plant scale.[13]

I. Conclusions

This completes my submitted testimony. I have attempted to examine the recycling of spent fuel from light water reactors to enriching

plant from the standpoint of enriching plant operations and economics primarily as affected by the isotopic contaminants U-232, U-233, and U-236 in spent fuel.

I do not see operational changes of consequence at enriching plant resulting from recycling spent fuel accepted for feed to enriching plant.

With respect to economics, the presence of U-236 is identified as detracting the most from the value of spent fuel accepted for feed to enriching plant, but in spite of the U-236, recycling of spent fuel can result in significant savings in natural uranium feed.

In conclusion, in my opinion, there are no effects associated with uranium isotopic contaminants in recycled light water reactor fuel which would make the use of recycled fuel in the form of accepted UF_6 operationally infeasible and economically undesirable at an enriching plant producing fuel for light water reactors.

Thank you.

IV. REFERENCES

1. Docket Nos. 50-332 and 50-332-GL before the Atomic Safety and Licensing Board, Motion to Amend Intervenor's Contentions, Townsend H. Belser, Jr., Attorney for Intervenors, August 23, 1974.

2. Uranium Hexafluoride, Base Charges, Use Charges, Special Charges, Table of Enriching Services, Specifications, and Packaging, as published in the Federal Register and amended from time to time, USAEC.

3. Separative work calculations based on a matched U-235/U-238 abundance ratio cascade as described in Multicomponent Isotope Separation in Cascades, A. de la Garza, G. A. Garrett, J. E. Murphy, Chemical Engineering Science, 1961, Vo. 15, pp. 188-209.

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5. AEC Announces New Charges for Uranium Enrichment (effective Dec. 18, 1974), USAEC Press Release 5020.

6. Fuel Cycle Effect of ^{236}U in Recycled Uranium, Herbert O. Sprague (GE-San Jose), 1974 Annual Meeting, American Nuclear Society, Philadelphia, Pa., June 23-27, 1974.

7. Fuel Cycle Effect of ^{236}U in Recycled Uranium, Herbert O. Sprague, General Electric Company, 175 Curtner Ave., San Jose, California, 95114, for presentation at American Nuclear Society, 1974 Annual Meeting.

8. Effect of Uranium-236 on the Value of the Spent Fuel from Light Water Reactors, Leonard Geller, Henri M. Gueron, Feb. 1, 1969, S. M. Stoller Associates, New York.

9. Versatility of Feed in Supply of Enriched Uranium, F. P. Baranowski, Division of Production and Materials Management, USAEC, Uranium Industry Seminar, Oct. 22-23, 1974.

10. Uranium Hexafluoride Specification Studies, an AEC Program Status Report, ORO-656, Oak Ridge Operations Office, USAEC.

11. Criteria for Uranium Enrichment Services, 38 F.R. 12180, May 9, 1973.

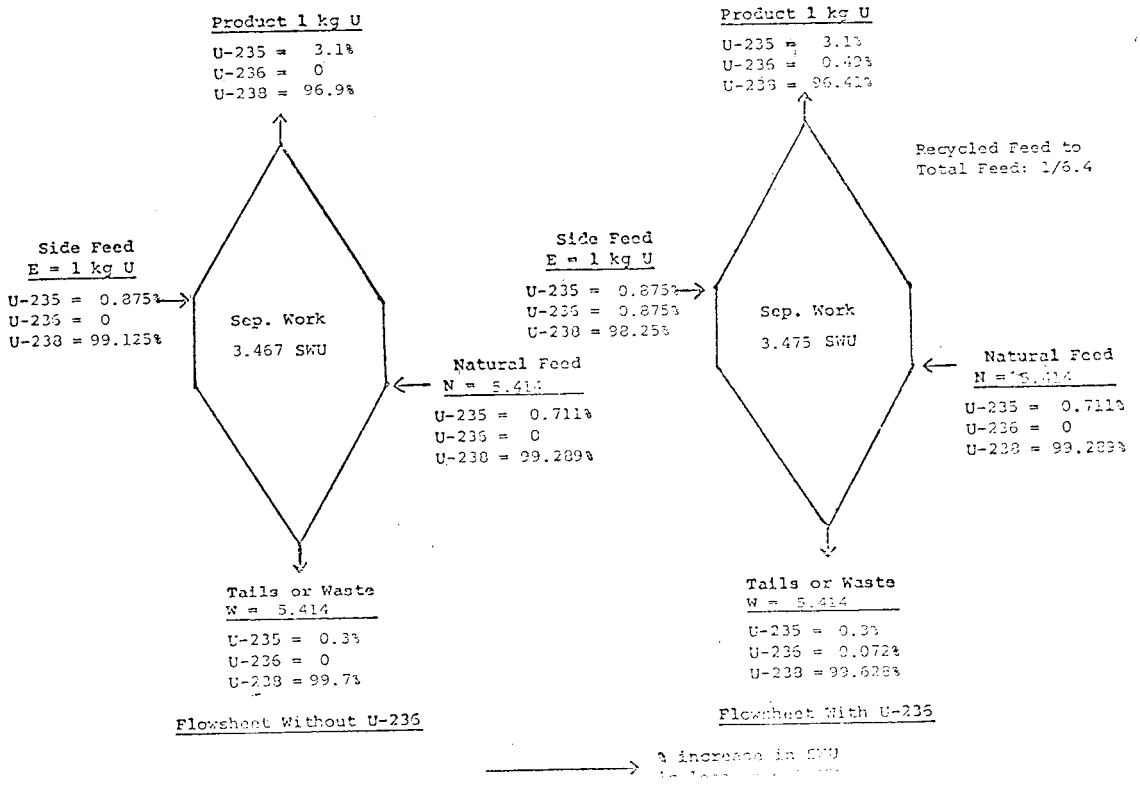
12. Uranium Enrichment Processes, P. R. Vanstrum, Union Carbide Corporation, Nuclear Division, presented at AIF International Conference on Uranium Enrichment, Reston, Va., April 23-26, 1974.

13. U.S. Gas Centrifuge Program Advances Beyond Development Stage, by F. P. Baranowski, Director, Division of Production and Materials Management, USAEC, No. S-1-74, March 5, 1974.

Figure 1

ILLUSTRATION OF THE DIRECT EFFECT OF
THE PRESENCE OF U-236 ON ENRICHING PLANT

(Sustaining Case)

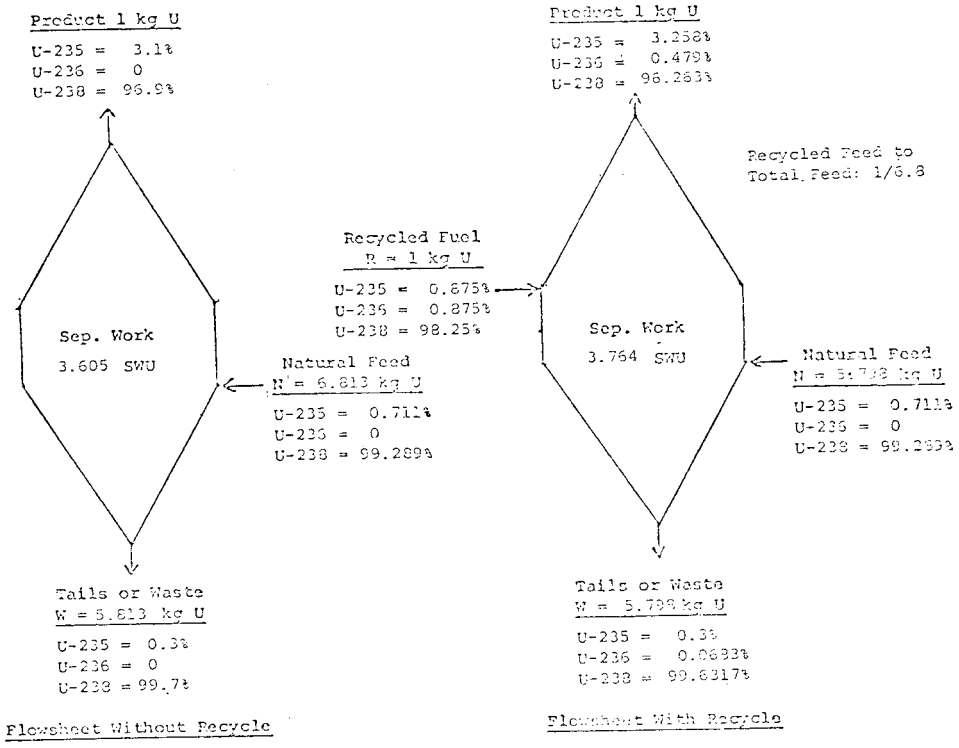


5-15.24

Figure 2

COMPARISON ILLUSTRATING RESOURCE MIX AT SWU
ENRICHING PLANT WITHOUT AND WITH FUEL RECYCLE

(Sustaining Case)



5. Comment:

"Finally, Section III discusses the cost-benefit alternatives. If the uranium from spent fuel elements is not recycled, and if the reprocessing costs are realistically estimated, we are led to the conclusion that Alternative 2, burying the fuel rods for later use, is the most viable alternative, both economically and environmentally, in the near term. We also believe that the utilities will choose this option if they are allowed to choose between the alternatives."

Response:

The cost-benefit comparisons of several alternatives for recycle of uranium only and uranium and plutonium recycle are included in CHAPTER XI. Economic considerations are indicated for each fuel cycle option and effects of delays in the recycle industry as well as comparisons with a throw-away fuel cycle are included in final GESMO. The utilities will be free to choose alternatives even if Pu recycle is approved by NRC.

Compilations of the 26-year (1975-2000) totals of the environmental factors relating to the fuel cycle options are presented in CHAPTER VIII, Appendix A.

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6. Comment:

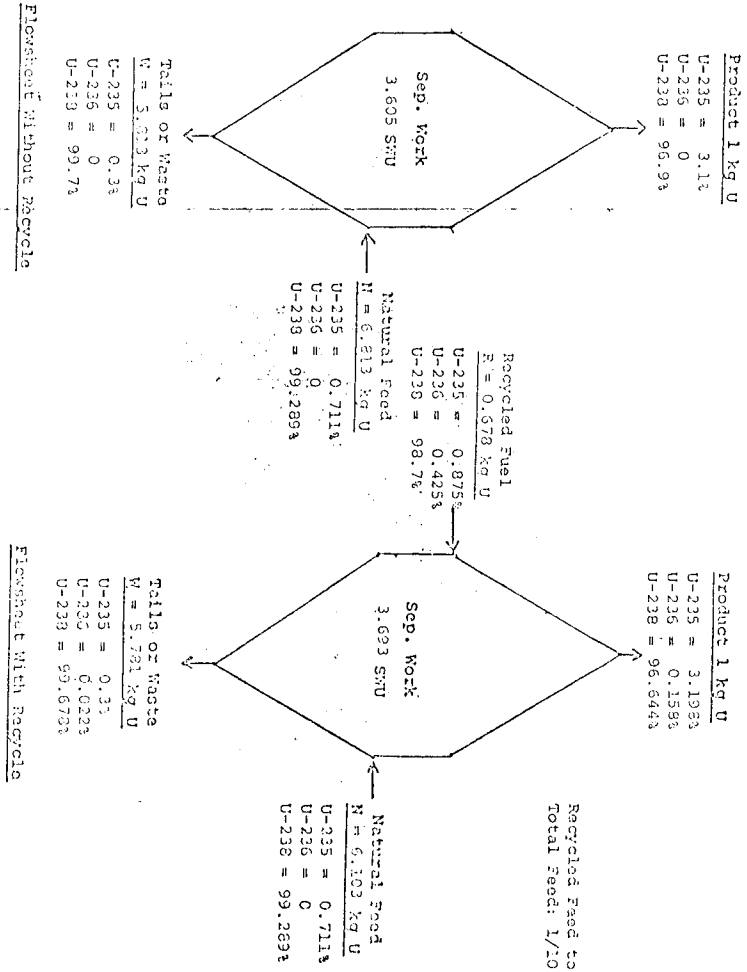
"We believe that the conclusion reached in this report is a realistic assessment of the technology, economics and environmental impact of MO fuels, and that a reasoned judgment would lead the AEC to the same conclusions. There is a possibility that many of the technological problems in fuel reprocessing can be solved, with the requisite economic transfusions (which are not part of the costs in GESMO), but this can only be done at the expense of alternate, more environmentally compatible sources of energy. We believe that the AEC will continue down the Pu path, no matter the costs. If reason does not deter the AEC, then the only halt to their arbitrary power will be through the courts and the electoral process and not through environmental impact statements such as GESMO."

Response:

Environmental impact statements disclose the direct and indirect costs and benefits of a given proposal. For the benefit of both the public and those involved in decision-making, these also explore the advantages and disadvantages of various alternatives. As long as all of the costs are included, the conclusions reached are valid and any prejudgments are effectively precluded.

The subject of GESMO is the implementation of plutonium recycle in LWR's and the assessments of differential impacts on health, safety and environment for three options--no recycle, recycle of uranium only, and recycle of uranium and plutonium. GESMO does not discuss the alternate sources of energy.

In this final GESMO, the cost-benefit analysis in CHAPTER XI has been expanded to compare the economic considerations of three options, no recycle, recycle of uranium only, and the recycle of uranium and plutonium. In addition, sensitivity analyses related to the effects of delays in the reprocessing and possible Pu recycle have been included.



7. Comment:

"We further assume, except when otherwise noted, that a reprocessing plant is reprocessing only the above 32.4/67.6 mixture of MO/UO_2 fuels, in order to determine the full environmental impact of MO fuel. GESMO considers the entire LWR industry at 1.15 SGR, consisting of 120 MO LWR reactors and 310 UO_2 LWR reactors, which dilutes and obscures the full environmental impact of MO fuel by itself, and perhaps the local impact about specific reprocessing sites, though it should represent the entire 1990 nuclear industry, if done correctly, of course."

Response:

Even though it may not be realistic to assume that a reprocessor would contract to reprocess only MOX fuels, such an assumption would not change the environmental impact assessment for the entire fuel reprocessing industry. In a typical year, say about 2000, if a fuel reprocessing plant reprocessed only the mixture of MOX/UO_2 fuel from Pu recycle reactors, the impact on the local population might increase, as shown by the following estimated dose commitment to a maximally exposed individual.

DOSE COMMITMENT TO MAXIMALLY EXPOSED INDIVIDUAL

Basis: 2000 MT/yr Fuel Reprocessing Plant
33,000 MWd/MT fuel exposure, aged 160 days
Blended MOX-UO_2 fuels from Pu recycle LWR's
100% release of ^{3}H, ^{14}C, and ^{85}Kr to air

mrem/yr

Nuclide	Total Body	GI Tract	Bone	Liver	Kidney	Thyroid	Lung	Skin
^{85}Kr	0.36	0.36	0.36	0.36	0.36	0.36	0.79	30.8
^{3}H	4.40	4.40	4.40	4.40	4.40	4.40	4.40	4.40
^{14}C	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.3
^{129}I	0.31	0.29	0.21	0.21	0.21	61.7	0.22	0.2
^{131}I	0.31	0.29	0.21	0.21	0.21	61.7	0.22	0.2
Other F.P.	0.86	42.5	4.07	1.03	1.76	0.58	0.82	0.6
U, Am, Pu & Cm	0.45	0.04	18.5	2.43	2.28	-	0.62	-
TOTAL	7.11	48.9	28.9	9.76	10.3	68.4	8.18	37.3

Thus, compared to reprocessing only UO_2 fuel, if the plant reprocessed only MOX-UO_2 fuel from Pu recycle fueled LWR's, the dose commitment to the local population might be increased by as much as 3% to the total body and by as much as 22% to bone, and GI Tract. Dose commitment to the skin would decrease about 13%.

8. Comment:

"1. Ruthenium

GESMO states, on p. IV E-16,

It has been assumed that the off-gas system will reduce the ruthenium release from the reprocessing plant (including waste solidification) to 1 x 10^{-9} throughput.

No basis for this statement is presented in the GESMO; there exists contrary evidence. At Nuclear Fuel Services, based on average yearly concentrations as reported by the New York State Department of Environmental Conservation, and average yearly flow rates in Cattaraugus Creek, the release of ruthenium was on the order of 100 to 200 Ci/year. The total reactor exposure of the fuel processed in 1971, for example, was 790,000 MWd, cooled for greater than 160 days. Based on the above reactor exposure, and the effluent release, the decontamination factor was on the order of 4 x 10^{-5}. There is a major discrepancy between this number and that given by GESMO; the burden of proof is on the AEC to show a decontamination factor of 10^{-9}.

Further, the ruthenium content of MO fuel is approximately 50% greater than UO_2 fuel; the net change for a plant reprocessing only SGR reactors is a 22.6% increase. Needless to say, these numbers are vastly different than those which appear in Table IV A-2 and Table IV E-8. The latter table claims 0.13 Ci from a 1,500 MT (U + Pu)/yr plant; NFS put out 100 to 200 Ci/year of Ru-106, processing on the average only 100 MTU/yr of aged fuel. The point is, in assuming a decontamination factor as small as 10^{-9} rather than 10^{-5}, GESMO masks the 50% increase in ruthenium due to MO fuel."

Response:

Based upon the measured gross beta activity in the liquid waste discharges from NFS, it is estimated that NFS released a total of less than 250 Ci of ruthenium for the entire period from 1966 through 1974. This assessment has taken into account the increase in the fission yield of ruthenium associated with the fissioning of plutonium in plutonium recycle fuel. In 1971, NFS processed about 790,000 MWd of equivalent fission product activity in fuel aged approximately one year. The measured release of ^{106}Ru in the liquid effluent was approximately 48 Ci. Based on this information, during operations at NFS in 1971, the release factor for ^{106}Ru, was approximately 7 x 10^{-6}, which is equivalent to a retention factor of approximately 1.4 x 10^{-5}. Subsequently designed fuel reprocessing plants, such as BNFP, have additional offgas and liquid effluent treatment systems which are expected to increase the ^{106}Ru retention by a factor of 10^{-4} or more. For the purpose of this assessment, a retention factor (decontamination factor) of 2 x 10^{-8} has been assumed for ruthenium radionuclides. For the effluent treatment systems proposed in current designed plants and for prospective new plants, it is believed that retention factor of 10^{-8} for ruthenium radionuclides is conservative by a factor of more than 10. See CHAPTER IV, Section E, paragraph 2.5.

9. Comment:

"2. Iodine

GESMO claims that a model reprocessing facility plus UF_6 conversion, Pu solidification and high level waste solidification, will put out 0.10 Ci/yr I-129, and 0.50 Ci/yr I-131 in processing 1500 MT/yr. Assuming the reprocessing plant effluent system of Figure IV E-6, Orlan Yarbro, AEC consultant, in testimony at the BNFP hearings, showed that 10% of the total I-129 content would be released as a gaseous effluent. The addition of mercury to a final vaporizer, not shown in Fig. IV E-6, reduced the I-129 releases to 5% or 3.3 Ci/yr; the I-131 releases were estimated as ten times that amount. Based on NFS experience, Mr. Yarbro's estimates are conservative. The reprocessing of SGR fuels increases the above amounts by 9%. The thyroid dose commitments in Tables IV E-9, -10, must therefore be increased by more than an order of magnitude; the burden of proof is on the AEC to show that the iodine effluent releases from a model reprocessing plant are as low as 0.10 Ci/yr."

Response:

For the purpose of this assessment, the revised iodine release estimates used in final GESMO are based on Orlan Yarbro's (ORNL) testimony on the AGNS Barnwell Nuclear Fuel Plant, which is summarized in CHAPTER IV, Section E, paragraph 2.5, Ruthenium and Iodine Removal. Tables IV E-9, 10, and 11 reflect the revised estimate for iodine release and the change related to the introduction of Pu recycle fuel in a reprocessing plant.

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10. Comment:

"3. Transuranium Isotopes

The transuranium isotopes are similarly underestimated. From Table 4.5 and 4.6 or ORNL-TM-3965, we extract the following information which we present as Table I.

Table I. Transuranium Isotopes in LWR Waste

Isotope	PWR-UO_2 fuel(Ci)*	MO fuel(Ci)** 32.4% MO 67.6% UO_2	% Change from PWR-UO_2 fuel
Am-241	1.59×10^2	1.58×10^3 6.17×10^2	+ 288%
Am-242	9.14	2.27×10^2 7.92×10^1	+ 767%
Am-243	1.82×10^1	5.14×10^2 1.75×10^2	+ 863%
Cm-242	1.70×10^4	2.40×10^5 8.95×10^4	+ 427%
Cm-243	3.68	3.85×10^1 1.50×10^1	+ 308%
Cm-244	2.40×10^3	1.36×10^5 4.56×10^4	+ 1800%

*Fuel burnup 33,000 mwd, cooled 160 days
**Fuel burnup 33,000 mwd, cooled 150 days

10. Comment (Cont'd)

The transuranium isotopes increase dramatically in MO fuel. If a single reprocessing plant processed only SGR reactors, as is possible for the older reprocessing plants that will service the older reactors, the local environmental effects should increase. This point is emphasized because it is possible that some effects of MO fuel may be localized and place an unfair burden on one section of the population, while the larger society accepted most of the benefits."

Response:

A more recent estimate of the change in the transuranium radionuclide composition of LWR spent fuel associated with the introduction of Pu recycle is given in Table IV E-7 of this final GESMO. Nearest theoretical neighbor dose commitments have been considered. For a 2,000 MT/yr reprocessing plant the following dose commitments are indicated.

	Uranium Recycle Only		U and Pu Recycle	
	rem/yr	% due to Pu	rem/yr	% due to Pu
Total body	.0075	1.8	.0075	2.5
Bone	.024	27.0	.026	34.0
Lung	.0079	1.8	.008	2.5

The fairness of living at a particular distance from a facility is moot if all available locations meet acceptability standards.

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11. Comment:

"The staff further claims that

> committed reprocessing plants can dissolve fuels irradiated to the design level of 33,000 MWd/MT without increasing significantly the environmental impact from the dissolution

Since the dissolution of PuO_2 fuel, mechanically blended with UO_2 fuel, is not well understood, the effluents and environmental impact are not completely known. GESMO's confidence in this regard is not understandable:

> MO fuel made by mechanically blending can be rendered substantially completly soluble in nitric acid by control of fabrication variables (homogeneity and sintering temperature) and by irradiation, although different dissolver conditions (higher acid concentration, higher temperature, longer time) may be required than those used for UO_2 dissolution. In addition, MO fuels can be completely dissolved in nitric acid that contains fluoride ion.

11. Comment (Cont'd)

We wish to draw out some of the consequences of the above remark. According to ORNL-4436,

> *mechanically blended* PuO_2-UO_2 could be converted to a leachable product by sintering at 1600°C for 16 to 48 hours.

Temperatures of that magnitude would volatilize the cesium, and other radionuclides. What would be the consequences? Studies at ORNL indicate that 1 to 10% of the Pu did not dissolve in 8 M HNO_3; the suggestion is made that the insoluble residues could be recycled to the dissolver for a longer dissolution time, but that more leaching experiments were necessary. What mechanical devices are required for this recycling of insoluble residues? The implication of the 400 page ORNL-4436 study on aqueous processing is that the problems of Pu dissolvability had not been solved. The use of HF as a catalyst would dissolve the Pu and the dissolver as well, as would say 14 M HNO_3 at 1700°C for 8 hours. The effluent releases of iodine or cesium are not well known under these conditions; it is clear that the composition of the DOG and the HAW depend on the exact dissolution conditions, and so do the effluent releases."

Response:

ORNL-4436, Aqueous Reprocessing of LMFBR Fuels - Technical Assessment and Experimental Program Definition, June 1970, indicated that an average fuel residence time of 4 hours (in the dissolver) should be sufficient to obtain complete plutonium recovery from most fuels, since high irradiation levels at the high temperatures present in fuel rods tend to produce a homogeneous and soluble product. Maximum dissolution rates and complete dissolution are obtained if the fuel is fabricated initially as a solid solution. Although HF could be used to enhance the dissolution of Pu, it would increase the corrosion rate of stainless steel equipment and therefore is not normally used in a fuel reprocessing plant. HF can be used in scrap recovery operations involving unirradiated materials.

The sintering operation pertains to the preparation of the PuO_2 pellets prior to the fabrication of fuel elements by the fuel fabricator. There are no iodine or cesium radionuclides in the PuO_2 or UO_2 fuel material, and therefore no such releases are expected during the sintering of the mixed oxide fuel pellets prior to the assembly of fuel elements. Furthermore, it would be physically impossible to carry out dissolution in a dissolver at 1700°C for 8 hours in 14 M HNO_3. It appears that the information in the referenced material has been misinterpreted as related to Pu dissolution, particularly with respect to possible volatilization of cesium and other radionuclides.

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12. Comment:

"To compound the seriousness of the problem, the introduction of MO fuels will most probably increase the exposures even further. The essential reason for this increase is the increase in Cm, shown in Table 1, and illustrated more clearly in Table 2 below (Table 4.16 of ORNL-4436):

12. Comment (Cont'd)

Table 2. Estimated Neutron Source Strengths of Spent Power Reactor Fuels

	LWR[a]			LWR-Pu Recycle[a]		
	Isotope Content	Neutron Source (α, n)	SF[b]	Isotope Content	Neutron Source (α, n)	SF[b]
Isotope	(gm/MT)	($sec^{-1}MT^{-1}x10^{-6}$)			($sec^{-1}MT^{-1}x10^{-6}$)	
^{238}Pu	160	5.0	0.4	45	1.4	0.1
^{239}Pu	5400	0.4	0.0	1500	0.1	0.0
^{240}Pu	2200	0.6	2.0	1000	0.3	0.9
^{241}Am	62	0.4	0.0	60	0.4	0.0
^{242}Cm	4.4	52.9	87.7	35	418	693
^{244}Cm	30	7.3	326	510	124	5560
Total		66.	416.		544.	6250.
Overall Total		480			6800	

[a] Fuel irradiated, 33,000 MWd/MT, cooled 150 days

[b] $_{SF}$ = spontaneous fission

According to ORNL-4436 (p.195),

> The neutrons produced by spontaneous fission and (α, n) reactions constitute the important source of penetrating radiation in plutonium product (and recycle plutonium feed).

The dramatic increase in Curium content in Pu recycle will most probably increase the worker exposures. It is possible that 1/2 to 1 ft. of additional shielding would be required for spent fuel processing cells; it is not clear that BNFP and NFS are designed for this alteration."

Response:

For the most part, the neutrons produced by spontaneous fission and α, n reactions are associated with the curium isotopes which will follow the bulk of the fission products to the high level radioactive waste in the reprocessing system. A PWR-MOX fuel element irradiated to 33,000 MWd/MT and cooled 160 days would emit approximately fifty times more neutrons than a similarly irradiated PWR-UO_2 fuel element. The dose rate from a PWR-UO_2 fuel element on the conveyor in the Remote Process Cell of the BNFP, which is behind five feet of concrete shielding, is calculated to be approximately 0.02 mr/hr. The dose rate from a PWR-MOX fuel element, which emits fifty times more neutrons, compared to a PWR-UO_2 fuel element, would increase approximately 10%. This illustrates the effect of the increased neutron emissions with respect to shielding for gamma energy, and also the conservatism inherent in shielding design for the separation facility. The referenced document (ORNL-4436) states that additional shielding may be required for LMFBR fuel processing, i.e., "The higher burnup and specific power of LMFBR fuel necessitate the use of 1/2 to 1 foot of additional shielding as compared with a similar mass of LWR fuel at the same post-irradiation decay time (pg. 199)." It appears that the information in the referenced material has been misinterpreted and raises unfounded concerns about shielding adequacy.

Comment Letter No. 16

GESMO Misc. Notice (39 FR 30186)

STATE OF ALASKA

WILLIAM A. EGAN, GOVERNOR

OFFICE OF THE GOVERNOR

STATE PLANNING AND RESEARCH

Phone 465-3512

POUCH AD – JUNEAU 99801

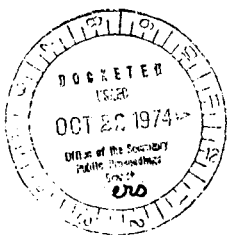
September 26, 1974

U.S. Atomic Energy Commission
Washington, D.C. 20545

Subject: Draft Environmental Impact Statement
Generic Environmental Statement
Mixed Oxide Fuel (Recycle Plutonium
in Light Water--Cooled Reactors)
State I.D. No. 74082701

Dear Sirs:

The Alaska State Clearinghouse has no comments on this draft environmental impact statement.



Sincerely,

Raymond W. Estess
State-Federal Coordinator

Comment Letter No. 17

-Misc Notice (39 FR

GESMO

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Administration
STATEWIDE PLANNING PROGRAM
265 Melrose Street
Providence, Rhode Island 02907

October 17, 1974

S.H. Smiley
Deputy Director for
Fuels and Materials
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Smiley:

This is to inform you that this agency has reviewed the Environmental Impact Statement on the Use of Mixed Oxide Fuel in TWR's (August, 1974) in accordance with OMB Circular A-95.

After having reviewed the proposals and having been in contact with other state agencies on the matter, we would like to forward the comments on the R.I. Public Utilities Commission and the R.I. Department of Health.

Yours very truly,

Daniel W. Varin
Chief, Statewide Planning

DWV/JOB/jl

Encl. 2

cc: Mr. Robert Mendoza

Rec'd

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Business Regulation
DIVISION OF PUBLIC UTILITIES AND CARRIERS
160 Weybosset Street
Providence, R.I. 02903

September 11, 1974

Mr. Daniel Varin
Rhode Island Statewide Planning Program
265 Melrose Street
Providence, Rhode Island 02907

Subject: File EIS-74-11
Environmental Impact Statement
Mixed Oxide Fuel
U. S. Atomic Energy Commission

Dear Mr. Varin:

Since recycling plutonium in order to obtain a mixed oxide fuel for reactors will save 130,000 tons of uranium oxide, which is equivalent to 10 billion bbls. of oil in the next 20 years and since this practice has been widely followed in England for some time, it should very definitely be adopted here.

Before doing so, however, the six additional safeguards listed on Page S7 of the Environmental Impact Statement should be adopted and strictly enforced. Presumably this would be a function of the U. S. Atomic Energy Commission but due to the seriousness of any laxity in this respect a separate independent agency, such as the nuclear weapons division of the military service should make periodical inspections as well.

It would be irresponsible and inexcusable for the government to allow any individual or group of individuals the possibility of acquiring or accumulating a supply of plutonium.

Very truly yours,

Archie Smith, Chairman
Public Utilities Commission

AS:ABP

RECEIVED SEP 13 1974

5-17.1

State of Rhode Island

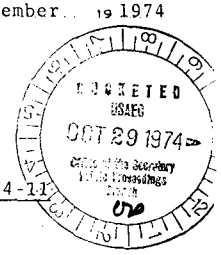
INTER-DEPARTMENTAL COMMUNICATION

4 September 19 1974

TO: Mr. Walter J. Shea
Assistant Director for Environmental Health
DEPT: Water Supply and Pollution Control

FROM: Mr. James E. Hickey
Radiological Health Specialist
DEPT: Occupational Health

SUBJECT: Review of DRAFT ENVIRONMENTAL IMPACT STATEMENT, EIS-74-11



As requested I have reviewed the summary of the draft statement of the USAEC on the proposed use of recycled plutonium in combination with uranium as fuel in light water-cooled reactors concerning which I have the following comments.

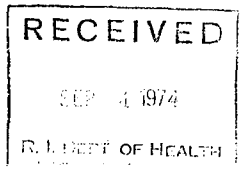
The document suggests that the use of recycled plutonium should be allowed since significant economic and fuel conservation benefits would result with essentially no increase in adverse environmental impact over present nuclear fuel cycle operations. This conclusion would seem to be supported in terms of the principal issues stated in paragraph A on page S-1.

Not considered as a major issue, but of some concern to me, is the increased hazards to workers which might result. Plutonium when handled in high specific activity quantities presents extreme hazards to workers from flammability, chemical toxicity, and inhalation of alpha-emitting radioactive particles. Also, increased external exposure might result from use of "spiked" plutonium.

It appears that the handling and working of plutonium would increase greatly if the proposal is adopted.

While the A.E.C. has been successful in the past in controlling the risks to the general population from the normal operations of the nuclear industry, reports of overexposures to workers continue to appear. I feel that more emphasis should be given occupational exposure in assessing the impact of any increase in handling of plutonium. Only brief mention is made of this adverse aspect (lines 4 and 5 on page 2 of the summary).

There appears to be a typographical error in line 4 of the third paragraph on page S-10. The year 1955 is used, whereas, 1995 seems to be intended.



RECEIVED SEP 6 19

NRC Staff Response to Specific Comments by D. W. Varin, State of Rhode Island

1. Comment:

"Not considered as a major issue, but of some concern to me, is the increased hazards to workers which might result. Plutonium when handled in high specific activity quantities presents extreme hazards to workers from flammability of plutonium per se, chemical toxicity, and inhalation of alpha-emitting radioactive particles. Also, increased external exposure might result from use of 'spiked' plutonium."

Response:

The potential hazards of handling plutonium oxide in the MOX fuel manufacturing processes are reduced to close to zero by the rigid requirements for total confinement. Flammability of plutonium per se, does not apply to the MOX fuel industry as the oxides of plutonium are not pyrophoric; however, great care is taken to prevent fires in MOX facilities and design measures are imposed to mitigate the consequences of fire. Because of the rigid provisions taken to confine the α emitting particles in the processes used when handling MOX, any chemical toxicity per se is of no consequence since exposures are far below the threshold for chemical toxicity effects. For the record the risk of chemical toxicity of plutonium is not noticeably different from that of uranium oxides or other industrial chemicals.

The confinement systems, glove boxes and high quality air handling and filtering equipment minimize the possibility for alpha emitting particles being released to the work areas at the plants.

The considerations and effects of "spiking" is reviewed in the safeguards supplement to the GESMO.

-Misc Notice (39 FR 30186

GESMO

EDISON ELECTRIC INSTITUTE
90 PARK AVENUE • NEW YORK 10016 • (212) 986-4100

October 25, 1974

Mr S H Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing-Regulation
U S Atomic Energy Commission
Washington, D C 20545

Dear Mr Smiley

The Edison Electric Institute appreciates having an opportunity to comment on the Atomic Energy Commission's draft generic environmental statement on the use of recycled plutonium in mixed oxide fuel for light water reactors (WASH-1327). The Institute is the principal national association of investor-owned electric light and power companies in this country. Its 198 member companies serve some 99 percent of the customers served by the investor-owned electric utility industry.

We would like to compliment the Commission on a thorough treatment and a generally good appraisal of a complex subject. The potential for savings in the order of 10 billion barrels of oil by 1995 provides substantial incentive for introduction of plutonium recycle. These savings, however, must be weighed against the possible environmental, social and economic costs resulting from this mode of reactor operation. WASH-1327 has provided a careful assessment of the considerations involved.

The Institute is in general agreement with the conclusions of this study. The following comments and observations are offered with the thought that they will assist the AEC staff in preparing the final report.

The most important point EEI wishes to raise is the recommendation that approval of reactor operations with recycled plutonium equivalent to more than 115% of that which could be self-generated within the core (1.15SGR) should not be given on the basis that it would constitute an unjustifiable extension of present UO_2 reactor technology. It would be extremely unfortunate if this blanket limit were adopted without compelling reasons. Many utilities and reactor manufacturers are considering fuel cycle schemes involving use of SGR limits approaching 2.0. In addition, some reactors have somewhat greater recycle capability than others. The Institute believes it would be more appropriate to rely on

substantially higher than those used in the WASH-1327 analysis. The effect of this understatement of expected costs is to depreciate the economic benefit of using mixed oxide fuels. We urge revision of this section of the report with current cost data in order to avoid the piecemeal revisions which may be attempted should the study be published with obsolete costs.

The study does not recognize possible delays in plutonium availability which may occur as a result of recent setbacks in the reprocessing industry. Without reprocessing and recycle, the imbalance between plutonium generation and recycle builds at a rate ranging between 100 to 200 kg per unit per operating year. Considerable time will be required to absorb such overages, particularly if the 1.15 SGR limit is adopted. In fact, the impact of reprocessing delays is expected to be so extensive as to make Alternative 2 the more likely base case, at least until the early 1980's.

Since evaluation of the study alternatives is the principal reason for this report, it would seem that consideration of these alternatives should be included in the "principal issues" that are being addressed in WASH-1327. The base case assumption of a coordinated maturing of the mixed oxide fabrication and reprocessing industries is somewhat overly optimistic. Because of inadequate fabrication capacity, early recycle may well require the use of foreign mixed oxide fuel fabrication facilities to offset domestic deficiencies.

In the comparison of the various alternatives, the impact of Alternative 2 is shown to be the same as that for Alternative 6. This is misleading because the ultimate environmental impact of Alternative 2 after recovery is surely different than the Alternative 6 case in which the fuel is never recovered. While we assume that the reason for this is the selection of the year 1990 for making the comparisons, we suggest that the point be made that a future differential impact would exist.

The point is made (page S-14, Volume I) that adoption of plutonium recycle could defer the need for new enrichment capacity and that this delay might make a significant difference in the development of centrifuge technology. The implication that plutonium recycle may be the deciding factor between the selection of diffusion or centrifuge technology for the next increment of enrichment capacity is highly questionable because many other factors are expected to be more significant in making this choice.

WASH-1327 seems to imply that the industry can calculate mixed oxide cores as accurately as enriched UO_2 cores. There are, however, greater uncertainties in mixed oxide analyses which must be taken into account. More importantly, the AEC study should not serve as a basis for curtailment of development work to improve current calculation abilities for mixed oxide cores.

The conclusion regarding decrease of radiological dose to total population with plutonium recycle will become a target for critics of the report, even though the data presented support the conclusion. We hope that the report is accurate in its presentation of the underlying assumptions related to those calculations, particularly those related to the calculation model for exposure to plutonium, both from a radiological and a toxicity standpoint. It might be helpful if the consequences of alternative assumptions were indicated where appropriate.

In addition to these general observations, we have enclosed a list of detailed comments, most of which appear to be typographical errors or inconsistencies.

Sincerely yours

W Donham Crawford

W Donham Crawford
President

rce
attachment

DETAILED COMMENTS OF EDISON ELECTRIC INSTITUTE
ON
ATOMIC ENERGY COMMISSION
DRAFT GENERIC ENVIRONMENTAL STATEMENT
ON
MIXED OXIDE FUEL (WASH 1327)

Volume I

Page S-10

In the third sentence of Paragraph 3 the statement is made "The only potential use of plutonium prior to 2000 would be for recycle in LWR's. Should this not read, "The only potential additional use of plutonium..."?

In the 8th sentence of Paragraph 3 the statement that "essentially no research and development has been undertaken relative to such utilization" of plutonium in HTGR's ignores the EEI and subsequent EPRI programs. A more accurate statement is made at the top of Page S-49 that "Little research and development has been undertaken relative to such utilization".

Page S-36

In Paragraph 4 the numbers for decrease in cancers in genetic defects require dimensions.

Page S-41

In Paragraph 3 it isn't clear that possible accidents occurring in a mixed oxide fabrication plant should be considered as incremental effects. The total volume of fuel fabrication would be about the same, and we suspect the probability of accidents is proportional to the total volume of fuel fabrication.

Page S-61

In Paragraph 4 the statement is made that, "Future costs for reprocessing and mixed oxide fuel fabrication are considered". It is not clear that these cost figures have been incorporated in the data presented, and we suggest this should be clarified.

Table S-3

The whole body exposure for Alternative 2 appears to have the wrong sign. We believe this should have the same sign as Alternative 6.

Table S-6

Under Fossil Fuel, the savings indicated for natural gas appear to refer to gas used in mills and conversion facilities and would be additive to that shown in terms of equivalent coal. We suggest a footnote for explanation.

Table S-6

Under Solid Wastes, we suggest that the category of actinides should show a breakdown of isotopes similar to that for gases and liquids, and in particular should indicate inclusion of any plutonium.

Table S-9

The impact of transportation accidents is covered in this table, but this subject appears to have been omitted from the discussion.

Table S-11

There appears to be a sign error in the whole body exposure for Alternative 2.

Table S-13

This again is a comment similar to that for Table S-6 questioning whether an isotopic breakdown should be shown for the category of actinides under high level waste.

Volume II

Chapter 1, Page 7

The second paragraph, last sentence fails to recognize or mention the americium-241 buildup problem which is associated with the Pu-241 decay problem. This buildup creates additional problems for recycle.

Chapter 2, Page 18

The second paragraph reads, "In a typical fuel management scheme the fuel will remain in the reactor for about 2 years". This should be revised to read 3 to 4 years.

Chapter 2, Page 19

The first two equations at the top of the page are identical.

Chapter 2, Page 38

In the second paragraph: "...and high linear heat ratings (approximately 20,000 MWd/Mt)" should be struck, as it is redundant.

Chapter 2, Page 40

The last sentence of the first paragraph is internally inconsistent.

Chapter 2, Page 44

The second paragraph reads that: "An average enrichment of 4.2 w/o fissile plutonium..." We believe the intention is 4.2 w/o PuO_2.

Chapter 3, Appendix A

The first 8 pages are not clearly labeled. The first 4 pages cannot be distinguished from the next four pages, although the data are different.

Volume III

Chapter IV-D

This chapter assumes that glove-box type operations will continue to be the design basis for mixed oxide fabrication facilities. The accuracy of this assumption is questioned in that higher radiation and neutron fields are anticipated in the future with the use of plutonium containing higher percentages of the heavier isotopes.

NRC Staff Response to Specific Comments by Edison Electric Institute

1. Comment:

"The most important point EEI wishes to raise is the recommendation that approval of reactor operations with recycled plutonium equivalent to more than 115% of that which could be self-generated within the core (1.15 SGR) should not be given on the basis that it would constitute an unjustifiable extension of present UO_2 reactor technology. It would be extremely unfortunate if this blanket limit were adopted without compelling reasons. Many utilities and reactor manufacturers are considering fuel cycle schemes involving use of SGR limits approaching 2.0. In addition, some reactors have somewhat greater recycle capability than others. The Institute believes it would be more appropriate to rely on case-by-case analysis to establish this limit."

Response:

The use of 1.15 SGR as a model reactor was based on the results of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's. The specific value of 1.15 SGR should not be interpreted to mean that there is an inherent safety or environmental limit at 1.15 SGR (or close to this value) on the use of recycled plutonium in reactors. This is not the case. On the other hand, it should not be concluded that there is not some limit beyond 1.15 SGR at which the safety and/or environmental consequences of the use of recycle plutonium in reactors are not comparable to that of UO_2. To identify this limit precisely was not considered to be justified in this generic analysis of Pu recycle in LWR's. Refer to CHAPTER IV, Section C-4.0.

---

2. Comment:

"The cost-benefit analysis appears to be overly conservative, particularly in light of the presently projected costs for the year 1990. Cost projections in common use by utilities are substantially higher than those used in the WASH-1327 analysis. The effect of this understatement of expected costs is to depreciate the economic benefit of using mixed oxide fuels. We urge revision of this section of the report with current cost data in order to avoid the piecemeal revisions which may be attempted should the study be published with obsolete costs."

Response:

Costs, throughout GESMO, have been revised and reflect the best available estimates. The bases for these estimates are discussed in CHAPTER XI, Section 2.0, and also parameterized in CHAPTER XI, Section 3.0.

---

3. Comment:

"The study does not recognize possible delays in plutonium availability which may occur as a result of recent setbacks in the reprocessing industry. Without reprocessing and recycle, the imbalance between plutonium generation and recycle builds at a rate ranging between 100 to 200 kg per unit per operating year. Considerable time will be required to absorb such overages, particularly if the 1.15 SGR limit is adopted."

Response:

In line with the current status of the industry, the assessments in final GESMO discuss that the earliest date for starting plutonium recycle is 1981. See CHAPTER VIII, paragraph 4.2.1. The effects of delays in the implementation of Pu reycle and of the uncertainties in the economic parameters are assessed in CHAPTER XI, Sections 3.0 and 4.0. Even if reprocessing is delayed for a few years, the 1.15 SGR nominal loading of LWR's is adequate to utilize the plutonium as it might be recovered without requiring an excessive buildup of plutonium inventories.

---

4. Comment:

"In fact, the impact of reprocessing delays is expected to be so extensive as to make Alternative 2 the more likely base case, at least until the early 1980's and in the comparison of the various alternatives, the impact of Alternative 2 is shown to be the same as that for Alternative 6. This is misleading because the ultimate environmental impact of Alternative 2 after recovery is surely different than the Alternative 6 case in which the fuel is never recovered. While we assume that the reason for this is the selection of the year 1990 for making the comparisons, we suggest that the point be made that a future differential impact would exist."

Response:

The alternatives in the final GESMO have been revised to reflect realistic (current) industry. The resulting impacts are integrated over the time period 1975 - 2000; the impacts of the new Alternative 2, delayed reprocessing of recycle, are very different from those of Alternative 6, which is the fuel cycle -- no recycle. The alternatives and impacts on the environment are discussed in CHAPTER VIII and the related cost-benefits are reviewed in detail in CHAPTER XI.

---

5. Comment:

"Since evaluation of the study alternatives is the principal reason for this report, it would seem that consideration of these alternatives should be included in the 'principal issues' that are being addressed in WASH-1327. The base case assumption of a coordinated maturing of the mixed oxide fabrication and reprocessing industries is somewhat overly optimistic. Because of inadequate fabrication capacity, early recycle may well require the use of foreign mixed oxide fuel fabrication facilities to offset domestic deficiencies."

Response:

Although there are presently no commercial-scale MOX fabrication plants, it is anticipated that private industry in the United States will provide sufficient capacity to meet domestic requirements. Fabrication capacity can, of course, be added more rapidly than reprocessing capacity.

In the event early recycle were to require consideration of the use of foreign MOX fabrication facilities, any proposed export would be reviewed with the Executive Branch and by the NRC prior to any export authorization. As required by the Atomic Energy Act of 1954, this review would need to ensure, among other things, that the export would be subject to the terms of an Agreement for Cooperation (which include provisions for the application of safeguards) and would not be inimical to the common defense and security of the United States. No such export would be authorized unless it was assured that adequate safeguards and physical security measures would be in effect in the importing country.

6. Comment:

"The point is made (page S-14, Volume I) that adoption of plutonium recycle could defer the need for new enrichment capacity and that this delay might make a significant difference in the development of centrifuge technology. The implication that plutonium recycle may be the deciding factor between the selection of diffusion or centrifuge technology for the next increment of enrichment capacity is highly questionable because many other factors are expected to be more significant in making this choice."

Response:

This statement made in the draft GESMO was not intended to imply that Pu recycle was the deciding factor in selecting an enrichment process. The selection of the manufacturing process to be used in the expansion of the uranium enrichment industry is not considered to be within the scope of the final GESMO. Consequently, the projection of the enrichment industry in the FES is based on the new plant construction schedule proposed in the Draft Statement, "Environmental Statement, Expansion of U.S. Enrichment Capacity," ERDA-1543. This schedule assumes that the first new enrichment plant would be a gaseous diffusion facility while all subsequent plants would use the gas centrifuge process. In addition, in final GESMO, assessments have also been included for an alternative wherein all future enrichment plants will be the gas centrifuge type. Refer to CHAPTER IV, Section F, paragraph 4.4.1.

---

7. Comment:

"WASH-1327 seems to imply that the industry can calculate mixed oxide cores as accurately as enriched UO_2 cores. There are, however, greater uncertainties in mixed oxide analyses which must be taken into account. More importantly, the AEC study should not serve as a basis for curtailment of development work to improve current calculation abilities for mixed oxide cores."

Response:

The discussion in CHAPTER IV-C-3 was intended to delineate the differences in neutronics of all-UO_2 cores and mixed oxide cores. The section has been rewritten and the conclusions strengthened. One reason for the shortness of the section is the availability of comprehensive literature surveys and critiques on the subject.

Although the NRC position is that the state-of-the-art is such that cores with partial mixed oxide loadings can be safely designed, it is agreed that considerably more research and methods development is desirable. There is great incentive to reduce uncertainties in accuracy of determining power distributions, reactivity coefficients and control rod worths to reduce the margins in design that must be incorporated to allow for uncertainties. Improvements will be reflected in improved performance and economics due to a reduction in conservative allowances that must be considered in safety related quantities.

Refer to CHAPTER IV, Section C, paragraph 3.3

---

8. Comment:

"The conclusion regarding decrease of radiological dose to total population with plutonium recycle will become a target for critics of the report, even though the data presented support the conclusion. We hope that the report is accurate in its presentation of the underlying assumptions related to those calculations, particularly those related to the calculation model for exposure to plutonium, both from a radiological and a toxicity standpoint. It might be helpful if the consequences of alternative assumptions were indicated where appropriate."

Response:

Plutonium dosage calculations and syndrome risk estimates are treated on a par with those of other radionuclides in GESMO. An effort has been made to not favor plutonium, where inequitabilities of conservatism chosen seen inevitable.

Detailed Comments

Plutonium is treated equally with other radionuclides, in final GESMO, for estimating dose commitments, and health effects. However, because of the special interest in plutonium, its contribution to the dose commitment is described in the text and in addition, CHAPTER IV, Section J, Appendix C contains a detailed discussion of plutonium in man and the environment.

---

9. Comment: (reference pg S-41)

"In Paragraph 3, it isn't clear that possible accidents occurring in a mixed oxide fabrication plant should be considered as incremental effects. The total volume of fuel fabrication would be about the same, and we suspect the probability of accidents is proportional to the total volume of fuel fabrication."

Response:

The probability of fuel fabrication accidents may be proportional to the volume of fuel handled; however, the impact from a MOX fuel fabrication plant accident could be different than an accident in a UO_2 fuel fabrication plant. For this reason, the impacts were assessed and considered incremental impacts. See CHAPTER IV, Section D for details on this subject.

---

10. Comment: (reference Table S-6)

"Under Fossil Fuel, the savings indicated for natural gas appear to refer to gas used in mills and conversion facilities and would be additive to that shown in terms of equivalent coal. We suggest a footnote for explanation."

Response:

In final GESMO, the following data on the energy used in the total fuel cycle of the three fuel cycle options (no recycle, recycle of uranium only, and recycle of uranium and plutonium) are tabulated: therms of gas; gallons of fuel oil; gigawatts of electricity; tons of coal per year, used in producing 66% of the required electricity. Refer to CHAPTER VIII, Appendix A.

---

11. Comment: (reference Table S-6)

"Under Solid Wastes, we suggest that the category of actinides should show a breakdown of isotopes similar to that for gases and liquids, and in particular should indicate inclusion of any plutonium."

Response

The principal environmental impact related to the disposal of radioactive wastes generated by the LWR fuel cycle industry is the long term commitment of land. This is tabulated in the Summary and Conclusions. Additional information about the types and quantities of radioactive waste generated by the LWR fuel cycle industry may be found in CHAPTER IV, Section H. Because these radioactive wastes are not dispersed in the environment, a breakdown of the quantity of isotopes similar to that given for release of gaseous and liquid effluents would not add similar relevant information.

---

12. Comment: (reference Table S-9)

"The impact of transportation accidents is covered in this table, but this subject appears to have been omitted from this discussion."

Response:

The impacts of transportation accidents are discussed in detail in CHAPTER IV, Section G.

---

13. Comment: (reference Chapter I, pg. 7)

"The second paragraph, last sentence, fails to recognize or mention the americium-241 buildup problem which is associated with the Pu-241 decay problem. This buildup creates additional problems for recycle."

Response:

This comment which refers to the first paragraph relating to a discussion of the "additional problems of recycle" caused by the buildup of ^{241}Am from the decay of ^{241}Pu is covered in more detail in CHAPTER IV, Section I, paragraph 2.2.

---

14. Comment: (reference Chapter 3, Appendix A)

"The first 8 pages are not clearly labeled. The first 4 pages cannot be distinguished from the next four pages, although the data are different."

Response:

Appendix A is a replication of the computer printout based on the ERDA NUFUEL program forecasting nuclear capacity showing nuclear power projections and associated supporting fuel cycle data. The difference in the data related to certain tables which list values on a calendar year basis while others are on a fiscal year basis. This final statement has a new set of data in Appendix A based on more recent nuclear power capacity projections. All tables are on a calendar year basis and cover the three options, no recycle, recycle of uranium only, and recycle of uranium and plutonium.

---

15. Comment: (CHAPTER IV-D)

"This chapter assumes that glove-box type operations will continue to be the design basis for mixed oxide fabrication facilities. The accuracy of this assumption is questioned in that higher radiation and neutron fields are anticipated in the future with the use of plutonium containing higher percentages of the heavier isotopes."

Response:

The discussion on the handling of recycle plutonium has been revised to indicate requirements for shielded cells (see CHAPTER IV, Section D, paragraph 2.1.2.6).

-Misc Notice (39 FR 30186)

GESMD

State Board of Health

OTHO R. WHITENECK, D.D.S., PRESIDENT
ROBERT D. McCULLOUGH, D.O., VICE PRESIDENT
GLEN L. BERKENBILE, M.D.
THOMAS DONICA, M.D.
ARNOLD HELVEY
CARL D. OSBURN, M.D.
EUGENE A. OWENS, M.D.
W. A. "TATE" TAYLOR
HAROLD A. TOAZ

Commissioner
R. LEROY CARPENTER, M.

Oklahoma
State Department of Health
N.E. 10th & Stonewall, Oklahoma City, Oklahoma 73105

October 23, 1974

U. S. Atomic Energy Commission
Washington, D.C.

Attention Deputy Director for Fuels and Materials
Directorate of Licensing - Regulations

Dear Sir:

With respect to the draft, Generic Environmental Statement Mixed Oxide Fuel, and to the request for comments thereon, we have no adverse comments to make at this time.

Very truly yours,

Robert L. Craig

Robert L. Craig, Director
Radiation Protection Division

RLC:cb

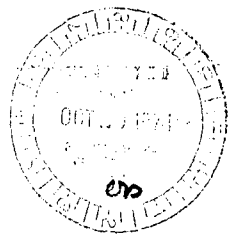
-Misc. Notice (39 FR 3

GESMO

PUBLIC INTEREST RESEARCH GROUP
2000 P STREET, N.W.
SUITE 711
WASHINGTON, D.C. 20036
(202) 833-9700

October 29, 1974

Deputy Director for Fuels and Materials
Directorate of Licensing-Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545



Dear Sir:

The enclosed statement is submitted as a comment invited by the Commission's notice of publication of the draft Generic Environmental Statement on Mixed Oxide Fuel (39 FR 30186). The Generic Environmental Statement indicates the Commission's determination to implement the policy of recycling plutonium into light water reactors. The enclosed statement contains comments on this proposed policy, as well as on the Environmental Statement itself.

Yours truly,

John Abbotts

John Abbotts

G-26

Comments on WASH-1327
Generic Environmental Statement On The Use
Of Recycle Plutonium In Mixed Oxide Fuel In
Light Water Reactors

John Abbotts
Public Interest Research Group
Washington, D.C.

1. Introduction

The decision by the Atomic Energy Commission (AEC) to recycle plutonium in light water reactor fuel increases the dangers of the nuclear-fuel cycle by a quantum jump. Plutonium recycle will drastically increase the potential risks of nuclear theft, occupational radiation exposure, and general population radiation exposure. The decision to implement plutonium recycle is particularly disturbing because the AEC does not seem adequately concerned over the potential dangers.

The Generic Environmental Statement on Mixed Oxide Fuel (GESMO), prepared by the AEC, does not realistically address these potential dangers. Where it does recognize that problems exist, GESMO promises that they can be solved by the AEC--if not presently, then at some unspecified time in the future. Solution details, however, have not been formulated.

It is instructive, therefore, to ignore GESMO's reassuring tone and examine the actual experiences of the nuclear industry with plutonium and other special nuclear material. Such an examination reveals that present safeguards practices are inadequate and that the companies that deal with plutonium have demonstrated an inability to properly handle or account for that substance. Serious upgrading in these areas is required even if no plutonium is ever recycled.

There are thus unresolved problems which must be resolved before plutonium recycle is implemented. At least one of these problems, the safeguards issue, is so serious that its proper resolution could drastically alter the structure of American society. The dangers of the "plutonium economy" are many in number and large in magnitude. It would be illogical and imprudent to subject this country to those dangers until some basic actions are taken to mitigate their potential consequences.

2. The Safeguards Problem

The introduction of plutonium recycle will increase the problem of safeguarding nuclear material from theft for the following reasons:

1. In the uranium fuel cycle, the predominant species of Special Nuclear Material (SNM) is Uranium 235. The uranium fuel is enriched in U-235 only in small percentages. If a terrorist were to steal a fuel rod, he would have to carry out the steps of chemical separation and several stages of enrichment to create weapons-grade uranium. Creation of an unauthorized nuclear weapon from the uranium in reactor fuel would be extremely difficult.

2. In the uranium fuel cycle, plutonium exists only in spent fuel. A terrorist desiring plutonium would have to steal a spent fuel assembly and reprocess the plutonium himself, or acquire the plutonium after it is separated at a reprocessing plant.

3. In the mixed oxide fuel cycle, only chemical separation would be necessary for a terrorist to acquire weapons-grade plutonium from any fuel rod, virgin or spent.

4. Plutonium recycle will add the mixed oxide fabrication plant. Plutonium stolen at the fabrication plant or in transport to the plant would require relatively simple chemical separation for the thief who desires weapons-grade material.

5. A terrorist with plutonium could create havoc even without fashioning a bomb. Because of plutonium's extreme toxicity, a terrorist could achieve his ends merely by threatening to disperse the plutonium among a concentrated population. Such a grave toxicity problem does not exist with uranium.

GESMO recognizes the increased dangers which plutonium recycle will introduce when it states:[1]

"The areas of greatest difference between the present uranium fuel cycle for LWR's and the LWR mixed oxide fuel cycle, where additional safeguards must be considered are:
-shipment of plutonium from reprocessing plants to mixed oxide fuel fabrication plants,
-conversion and fabrication of mixed oxide fuel,
-shipment of fabricated mixed oxide fuel to LWR's, and
-storage at the reactor sites." (emphasis added)

and:[2]

"...uranium used in mixed oxide fuel is not essentially different from that used in the UO2 fuel cycle and is not a material of high strategic importance in that it cannot be used to construct a nuclear explosive and would not pose much of a radiation hazard if dispersed by sabotage. Plutonium, on the other hand, can be used to produce a nuclear explosive and, because of its high radiotoxicity, could be a threat to the public health and safety if released through an act of sabotage or by other means."

In spite of these statements, GESMO does not seem to appreciate the gravity of the safeguards problem. The publication comes to the conclusion that:[3]

"The introduction of plutonium recycle into a situation already dominated by other strategic SNM materials would not in itself significantly affect the required safeguards measures. Based upon the projected utilization of strategic SNM until the year 2000, it is noted that plutonium recycle would constitute less than one half of the total strategic SNM handled except for a few years in the 1980's when it is about 50% of the total."

But this is hardly reassuring. It is difficult to understand how the AEC can come to the above conclusion. The non-weapons use of SNM has thus far been limited almost entirely to the Naval Reactors program. Plutonium recycle will introduce SNM in large amounts into new areas of the commercial sector. And the SNM introduced will be plutonium, which the AEC acknowledges presents a substantially greater threat than uranium. By 1980, the non-weapons sector can expect to handle as much plutonium as the total SNM it handles today.[4]

Nor is it reassuring to find that[5]

"After /the 1980's/, the projected growth of the HTGR /High Temperature Gas Reactor/ and the LMFBR /Liquid Metal Fast Breeder Reactor/ create the need for quantities of SNM that are significantly in excess of the quantities involved from plutonium recycle in LWR's"

The drastic increase in danger presented by plutonium recycle is horrifying enough. The thought that the plutonium from plutonium recycle might one day be dwarfed by other sources is even more horrifying, especially if safeguards practices are not drastically improved.

Recently, several different groups or persons have found the AEC's safeguards inadequate.[6,7,8,9] Inspections of three facilities authorized to handle SNM performed by the General Accounting Office (GAO) found discrepancies such as the following:

1. Weaknesses in fences existed.

2. Guards were unqualified to fire their small arms, could not see all areas of the plant from the points at which they stood guard, and did not vary the times or routes of their patrols.

3. Locks on doors were broken; alarms were inoperative or easily defeated.

4. At one facility, the inspectors actuated an alarm and waited 30 minutes for someone to respond. No one did.

5. At another facility, upon request of the inspectors the facility failed to make a periodic check-in with local police. The police responded as they were supposed to, dispatching a patrol car to the facility. The patrol car went to the wrong facility, 14 miles away.

6. GAO inspectors found serious discrepancies at each of the three facilities. Each facility had been visited by AEC inspectors within the previous year, and each AEC inspection reported that the plant "met" or "exceeded" AEC safeguards requirements.

Inspections performed by the GAO on the transportation of SNM found the following problems:[7]

1. In one case, a flatbed truck with an open cargo compartment was used to ship SNM.

2. Drivers of the trucks with SNM were alone and unarmed.

3. The trucks had no alarm or communications systems.

4. One truck had no preplanned route, and no call-in points.

Following the GAO reports, the AEC instituted new safeguards requirements. These may very well correct all the GAO inspection deficiencies. But there is a difference between making regulations and demonstrating that they have been implemented. GESMO should give some assurance that the basic deficiencies discovered by GAO have been resolved.

The safeguards measures which GESMO introduces are largely in response to criticisms of the Rosenbaum[8] and Ford Foundation[9] reports. GESMO proposes six possible measures that might be taken to solve the safeguards problem. They are:[10]

1. Locating mixed oxide fuel fabrication plants together with reprocessing plants in Integrated Fuel Cycle Facilities (IFCF's). This would eliminate a key transportation step.

2. Improving protection during transportation, through such measures as hardening vehicles or containers against attack.

3. Additional hardening of facilities.

4. "Upgrading of operating and guard functions through the use of personnel security clearance procedures, a Federally operated nuclear security system, more advanced systems for monitoring and searching of personnel, and closer liaison with law enforcement authorities."

5. Improving the system of internal control and accountability of plutonium.

6. Use of "spiked" plutonium (containing isotopes issuing high levels of penetrating radiation).

The AEC is advancing these proposals as suggestions only, and has not made a final decision on which safeguards should be implemented for plutonium recycle. Each of these options requires further study and analysis. For example, the use of spiked plutonium would make it more difficult for a saboteur to fashion a nuclear explosive. But it would also present shielding requirements for industry which could impose a severe economic penalty.[11] In addition, spiked plutonium

is more convenient for the terrorist who wishes to create havoc without fashioning a bomb. A spiked fuel rod would provide the terrorist with intense penetrating radiation, in addition to plutonium, to use against the populace.

The establishment of IFCF's requires even more careful study. GESMO admits that[12]

"such a plan would require careful analysis of a number of social, economic, environmental, and political factors."

GESMO rejects the concept of "nuclear parks", sites composed of reactors in addition to IFCF's. Part of the reason for this rejection is that[13]

"The danger of having such a large fraction of an area's total generating capacity concentrated in one site, with the resultant vulnerability to a single natural or man made disaster, is obvious."

The question must be asked if IFCF's, with a large and concentrated inventory of radioactive material, do not also present unacceptable vulnerability to disasters. A related problem which must be evaluated is the potential of a nuclear accident in one portion of the facility to affect other portions of the facility--either through direct effects; or through a required evacuation which would leave the radioactive inventory unattended.

But the GESMO safeguards proposal with the most far-reaching ramifications is number 4. This would establish a national plutonium police force and initiate a plutonium reliability system, with security checks on all persons who would be involved in handling plutonium. Such steps would go far to solve the safeguards problem, but might in turn affect civil liberties to an unacceptable extent.

GESMO admits the potential impact of plutonium recycle on individual liberties when it addresses one possible safeguards solution:[14]

"Require AEC clearance of all personnel with access to plutonium, material records or vital equipment. Security problems are much simplified when it can be established with high probability that the persons who are responsible for the handling of plutonium or implementing of related safeguards programs are trustworthy. Various court rulings in recent years have been favorable to the protection of individual privacy and of individual right-to-work. These rulings have made it difficult to make a personnel background check of an individual in commercial activities to assure with high probability that he is trustworthy and, hence, potentially acceptable as a steward for the protection of plutonium." (emphasis added)

In spite of these disturbing implications, recent legislation granted the AEC power to conduct security clearance checks on non-government employees.[15] One can only ask that the AEC proceed with great caution in exercising this power. Any widespread program of security checks should be preceded by a careful analysis of the possible effects of such a program on civil liberties.

There also exists the question of whether the American people would be willing to accept another national police force, were the plutonium force established. This force would be likely to have enormous powers to invade individual privacy, particularly if investigating nuclear theft. "No knock" drug raids on the wrong homes, which several people have experienced, might seem mild when compared to the abuses possible with a plutonium police force. In summary, a careful analysis of the damage such proposals might do to the structure of American democracy must be undertaken before reliability

screening, wide-spread background checks, and another national police force are established as policy.

The AEC has admitted that present safeguards are inadequate for plutonium recycle:[16]

"Safeguards measures are designed to deter, prevent, or respond to (1) the unauthorized possession or use of significant quantities of nuclear materials through theft or diversion; and (2) sabotage of nuclear facilities. The safeguards program has as its objective achieving a level of protection against such acts to insure against significant increase in the overall risk of death, injury, or property damage to the public from other causes beyond the control of the individual. It is judged that this objective will not be fully met for Pu recycle by current safeguards measures;" (emphasis added)

But in almost the same breath, the agency indicates its intent to proceed with plutonium recycle:[17]

"Indications at this time point to decisions on upgrading /safeguards/ within about 1 year after issuance of the final GESMO statement."

The AEC approach to the safeguards problem is clearly inadequate. The agency admits that present safeguards are inadequate for plutonium recycle. While failing to address basic discrepancies such as broken locks and unqualified guards, the AEC puts forth six proposals for possible action. None of these proposals has even been developed on paper. This is so even though some of them may have serious political and environmental effects, and one proposal has the potential to change the character of American civil liberties. Yet the agency reassuringly states that it will implement plutonium recycle, and solve the safeguards problem in perhaps a year's time.

The rationale for proceeding with plutonium recycle before establishing a safeguards program is that only small quantities of plutonium will be handled while the safeguards decision is being made.[18] But this would seem to discount the possibility that unforseen delays or complications could postpone the safeguards decision. Implementation of a safeguards program would also take some finite time, and might also experience delays. With each delay, the amount of plutonium in circulation would increase. It thus seems illogical to implement plutonium recycle before implementing a program to mitigate plutonium's safeguards dangers. It would seem more prudent to delay plutonium recycle at least long enough for the safeguards solution to catch up to the problem. Beyond this delay, there are other steps that must be taken in the safeguards area before plutonium is recycled for commercial use:

1. The AEC must demonstrate that it has adequately corrected the discrepancies of the GAO reports. The GAO or another independent agency should certify that this is so. Such certification would not mean that AEC safeguards were adequate for plutonium recycle. But it would indicate that AEC safeguards have in fact improved, and would provide a basis for some confidence in the agency's ability.

2. The six possible solutions enumerated in GESMO[10] should be subjected to the most detailed review and analysis.

a. In particular, the AEC after careful analysis must state its position on the establishment of Integrated

Fuel Cycle Facilities. If the agency feels that IFCF's are necessary and justified, an Environmental Impact Statement (EIS) should be submitted, and construction of IFCF's should not begin until this EIS has completed its review cycle. This may be performed as part of the Nuclear Energy Center Site Survey required by the recent Energy Reorganization Act[19], as long as the problem of IFCF's is separately addressed.

b. In particular, the agency after exceedingly careful study must state its position on the establishment of a national plutonium police force, plutonium reliability screening, and widespread security clearance checks. If the agency believes such measures are necessary and justified, they should be taken only with the approval of Congress described below. This step may be performed as part of the safeguards study required by the recent Energy Reorganization Act,[20] as long as widespread reliability screening and security checks are separately addressed; and as long as potential civil liberties effects are addressed for all areas.

3. The AEC must have an adequate safeguards program for plutonium recycle at least drawn up on paper. The program should be submitted to Congress with a detailed statement on the program's potential effects on civil liberties. The safeguards program should be implemented only with Congressional approval.

Section 2-Footnotes:

1. WASH-1327, The Generic Environmental Statement On The Use Of Recycle Plutonium In Mixed Oxide Fuel In LWR's (GESMO)-Draft, U.S. Atomic Energy Commission, August 1974, p. V-4

2. GESMO, p. V-9

3. GESMO, p. V-49

4. GESMO, p. V-8, Table V-1

5. GESMO, p. V-4

6. General Accounting Office Report to Congress: "Improvements Needed in the Program for the Physical Protection of Special Nuclear Materials", November 1973

7. General Accounting Office Report to Congress: "Protecting Special Nuclear Material in Transit: Improvements Made and Existing Problems", April 1974

8. "A Special Safeguards Study", a report to the AEC on the Adequacy of Current Safeguards (the "Rosenbaum report"), Congressional Record, 120: S6623-S6626, April 30, 1974

9. Mason Willrich and Theodore B. Taylor, Nuclear Theft: Risks and Safeguards, Cambridge, 1974. Study for the Ford Foundation Energy Policy Project.

10. GESMO, p. V-50

11. GESMO, p. V-45

12. GESMO, p. V-50

13. GESMO, p. VIII-69

14. GESMO, p. V-42

15. U.S. Public Law 93-377, 93rd Congress, August 17, 1974, Section 7

16. GESMO, p. V-49 and V-50

17. GESMO, p. V-50

18. GESMO, p. V-51

19. Energy Reorganization Act of 1974, Section 207, Congressional Record, 120: H10128-H10139, October 8, 1974

20. Ibid., Section 204

3. Inability of private industry to handle Plutonium

Plutonium recycle will add the mixed oxide fuel fabrication plant to the nuclear fuel cycle, and will increase the amount of plutonium handled by private industry. Some non-governmental facilities have already been involved in handling and recycling plutonium into fuel, chiefly in connection with the Fast Flux Test Facility. The records of facilities which presently handle plutonium do not inspire confidence. The nuclear industry has shown that it cannot safely handle plutonium and that it cannot properly account for special nuclear material. Plutonium occupational exposures and plutonium environmental contamination have resulted from industry ineptness. The performance of plutonium handling facilities should be drastically upgraded prior to implementing plutonium recycle.

Following are the performance records of some companies which have handled plutonium:

1. Gulf United Nuclear Fuels produced small amounts of plutonium fuel in a Long Island laboratory from 1970 to 1972. Operations were terminated some time after a fire and explosion on December 21, 1972 injured one worker, contaminated two, and "grossly contaminated" a working area.[1,2]

2. Kerr-McGee operates a plant at Cimarron, Oklahoma. Since April 1970 the plant, which employs only 100 workers, has reported 17 overexposure incidents involving a total of 73 persons. The most serious of these was a fire on March 5, 1973 which ignited spontaneously in a bag of plutonium waste and contaminated seven persons.[1]

3. At the Nuclear Fuel Services (NFS) plant in West Valley, New York at least 15 separate incidents between 1966 and 1973 resulted in overexposures to at least 38 persons.[1] At a meeting in February, 1972 between the AEC and NFS, AEC officials accused the company of a "failure to make reasonable efforts to maintain the lowest levels of contamination and radiation" and of a "failure to adequately instruct or effectively train employees ... in the radiation hazards involved in their job assignments."[1] Three months later the plant shut down for expansion, and has not operated since.

The Nuclear Fuel Services plant has also caused degradation of the environment near the plant. Plutonium contamination, along with contamination by other radioactive elements, has been found in the air around the plant and in Buttermilk and Cattaraugus Creeks, on the plant boundary.[3,4,5] The NFS performance has been so inept that it has inspired the Attorney General of the State of New York to petition the AEC. The petition asked that NFS not be allowed to resume operations until it has demonstrated that it has adequate safety precautions to protect workers, that the site on Buttermilk Creek is environmentally suitable for the plant, and that there is a public need for the expansion of the plant.[6]

4. Nuclear Materials and Engineering Corporation (NUMEC), a subsidiary of Babcock and Wilcox, operates two plants in Pennsylvania. These plants have several deficiencies in several areas. In the fall of 1965, NUMEC was unable to

account for 100 kilograms of weapons-grade uranium.[7] Although the working crew is only about 100, 30 persons were overexposed to airborne plutonium in at least 13 incidents from 1969 to the present. Six of these resulted from repeated leaks in a sintering furnace over a one-month period during the summer of 1973.[1]

On August 12, 1974 the AEC fined NUMEC $12,170 for 16 separate violations related to health, safety, and security.[8] In a letter to NUMEC citing the reasons for the fine, the AEC stated:[9]

"Our review of the NUMEC enforcement history for the calendar year 1973 and the violations noted in inspections during calendar year 1974 indicates a history of repeated violations and unfulfilled commitments to correct violations."

The AEC informed NUMEC of its intent to fine the company on June 5, 1974. As an indication of the company's problems, six days later a worker was contaminated by plutonium as a result of a failure in a glove box.[10] NUMEC paid its fine on August 12, 1974. Fifteen days later, yet another worker suffered plutonium contamination by another gove box failure.[11]

Kerr-McGee, NFS, and NUMEC represent the country's three main commercial plutonium processors. Their records have led an independent viewer to observe:[1]

"... it is hard to see that any of them is quite in command of the technology.

The record reveals a dismal repetition of leaks in glove boxes; of inoperative radiation monitors; of employees who failed to follow instructions; of managers accused by the AEC of ineptness and failing to provide safety supervision or training to employees; of numerous violations of federal regulations and license requirements; of plutonium spills tracked through corridors, and, in half a dozen cases, beyond plant boundaries to automobiles, homes, at least one restaurant, and in one instance to a county sheriff's office in New York."

Parenthetically, industries outside the uranium fuel cycle and even the AEC itself have also demonstrated an inability to handle plutonium. The most notorious examples of this include the 1969 Rocky Flats fire, the Rocky Flats Oil Storage Contamination area, and 250 square miles of plutonium-contaminated land at the Nevada Test Site. The most recent examples of such accidents include the spill from an industrial treatment system at an AEC plant into a city street in Los Alamos, and the discovery of Pu-238 outside the Monsanto plant at Miamisburg, Ohio. In the latter case, industry spokesmen admit they have no idea how the plutonium got outside the plant.

There is thus much logic in asking for an upgrading in industry's ability to handle plutonium before workers and the general population are asked to endure the risks of greater plutonium contamination. The following action should be taken to demonstrate that commercial industry can handle plutonium before plutonium recycle is implemented:

1. The AEC should draw up an action plan for facilities which presently handle plutonium. The purpose of this plan would be to upgrade the training of workers, the maintenance of equipment, and the operation of the plants, including the security and accountability areas.

2. This plan should be implemented along with rigorous AEC on-site inspection. After at least a one-year observation period, the AEC should report to Congress when it believes that the industry's ability to handle plutonium is satisfactory.

3. Upon receiving this report from the AEC, the Congress should designate an independent agency, such as the GAO, to certify that the AEC's assertion is correct and that industry's ability has improved to a point where plutonium recycle can be implemented with acceptable risk from environmental plutonium contamination.

Section 3-Footnotes:

1. "Plutonium (I): Questions of Health in a New Industry", Robert Gillette, Science, 185: 1027-1032, September 20, 1974

2. Telegram from Gulf United Nuclear Fuels to AEC Region I Directorate of Regulatory Operations, December 21, 1972, AEC Docket 70-36

3. The Nuclear Fuel Cycle, Chapter VI, "Nuclear Fuel Reprocessing: Radiological Impact of West Valley Plant", Union of Concerned Scientists, Cambridge, 1973

4. State of New York, Department of Environmental Conservation, 1970 Annual Report of Environmental Radiation in New York State

5. State of New York, Department of Environmental Conservation, 1971 Annual Report of Environmental Radiation in New York State

6. Buffalo, New York Courier Express, September 14, 1974

7. "Fear of Nuclear Theft Stirs Experts, AEC", Thomas O'Toole, Washington Post, May 26, 1974

8. Letter from AEC Directorate of Regulatory Operations to NUMEC, August 12, 1974, AEC Dockets 70-135 and 70-364

9. Letter from AEC Directorate of Regulatory Operations to NUMEC, June 5, 1974, AEC Dockets 70-135 and 70-364

10. Letter from NUMEC to AEC Directorate of Regulatory Operations, July 5, 1974 reporting exposure of June 11, 1974, AEC Docket 70-364

11. Letter from NUMEC to AEC Directorate of Regulatory Operations, August 28, 1974 reporting exposure of August 27, 1974, AEC Docket 70-135

4. Other Recommendations

In addition to the action that must be taken on safeguards and industry practices, there are other steps which must be taken before plutonium is recycled in light water reactors for commercial use:

1. The AEC must require that no plutonium from American reactors be recycled as reactor fuel to foreign countries. GESMO recognizes that International Atomic Energy Agency safeguards are not adequate because they rely on bookkeeping methods, and ignore physical security measures.[1] It is also obvious that transporting plutonium overseas would make the safeguards problem more difficult. This recommendation must be accepted to deter the proliferation of nuclear-weapons capable countries and limit the chances of plutonium theft by international terrorist groups.

2. The pages above demonstrate that plutonium recycle will greatly increase the dangers of nuclear fuel cycle. Before plutonium recycle is implemented, the potential effects of such a policy must be scrutinized in the closest manner, and should be subject to extensive national debate. There is thus a strong reason to hold public hearings-several if necessary-on this policy. Specifically, a generic hearing, including the right of cross-examination, must be held on plutonium issues at least by the time the final Generic Environmental Statement is available.

3. Following public debate and the further research required by other recommendations in this statement, plutonium recycle should be implemented only with the consent of Congress. A policy with so many potential dangers should not be implemented by mere agency fiat.

Section 4-Footnote:

1. GESMO, p. V-38

5. Summary

Following are the recommendations made in other parts of this statement. All actions outlined below should be completed before plutonium is recycled into light water reactors for commercial use:

Safeguards:

1. The GAO or another independent agency should certify that the safeguards discrepancies discovered by previous GAO inspections have been corrected.(p. 2-9)

2. The six possible safeguards enumerated in GESMO should be subjected to further review and analysis:

a. In particular, the AEC must state a position on the establishment of IFCF's. If the agency feels IFCF's are necessary, an EIS should be submitted and review of the EIS completed before construction of IFCF's begins. (p. 2-10)

b. In particular, the AEC must state a position on the establishment of a plutonium police force and widespread plutonium reliability screening. If the agency feels these programs are necessary, Congressional approval should be required prior to implementation. (p. 2-10)

3. The entire safeguards program for plutonium recycle must be drawn up at least on paper. The proposed program should be submitted to Congress with a detailed statement on the program's potential effects on civil liberties. The safeguards program should be implemented only with Congressional approval. (p. 2-10)

Inability of industry to handle plutonium:

1. The AEC should draw up an action plan to upgrade the performance of plutonium-handling facilities. (p. 3-4)

2. This action plan should be implemented along with rigorous AEC on-site inspection. After at least a one-year period, the AEC should report to Congress when it is satisfied with the industry's ability to handle plutonium. (p. 3-4)

3. The Congress shall then designate an independent agency to confirm the AEC assertion and certify that industry's ability is acceptable for implementation of plutonium recycle. (p. 3-5)

Other recommendations:

1. The AEC must forbid any plutonium from American reactors to be recycled as reactor fuel in foreign countires. (p. 4-1)

2. Public hearings must be held on the plutonium recycle issue. (p. 4-1)

3. Congressional approval must be required before plutonium recycle is initiated. This shall be beyond and in addition to Congressional approval of a plutonium safeguards program recommended above. (p. 4-2)

NRC Staff Response to Comments by Public Interest Research Group

1. Comment:

"The decision to implement plutonium recycle is particularly disturbing because the AEC does not seem adequately concerned over the potential dangers.

The Generic Environmental Statement on Mixed Oxide Fuel (GESMO), prepared by the AEC, does not realistically address these potential dangers. Where it does recognize that problems exist, GESMO promises that they can be solved by the AEC -- if not presently, then at some unspecified time in the future. Solution details, however, have not been formulated."

Response:

The decision to implement plutonium recycle will be made only after the health, safety and environmental (HS&E) impacts are fully assessed in the Final NEPA Environmental Impact Statement - (HS&E); the safeguards (SG) considerations, in supplemental draft to GESMO, completed; a detailed cost-benefit analysis prepared; and the preparation of proposed standards and amended associated rules on plutonium recycle and safeguards. Public comments on the draft (SG) supplement will be solicited and public hearings will be held prior to any decisions on the rulemaking for or against the use of MOX fuels in LWR's.

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2. Comment:

"The records of facilities which presently handle plutonium do not inspire confidence. The nuclear industry has shown that it cannot safely handle plutonium and that it cannot properly account for special nuclear material. Plutonium occupational exposures and plutonium environmental contamination have resulted from industry ineptness. The performance of plutonium handling facilities should be drastically upgraded prior to implementing plutonium recycle.

Response:

The safeguarding of plutonium and the measures to be recommended for accountability are reviewed in the safeguards draft supplement. The plutonium handling facilities required for Pu recycle have been modeled for assessment of environmental impacts for both the public and workers. Prior to the licensing of each plutonium facility, a full safety report as well as the NEPA environmental report will be submitted for review by the NRC to ensure conformance with all of the latest regulations related to Pu handling under normal and accident conditions. GESMO is not a substitute for the case-by-case license application reviews to be prepared by the NRC.

The existing licensed facilities where plutonium is handled are pilot scale operations or for multi-purpose custom manufacturing. These plants cannot be compared to the single purpose commercial facilities represented by the model plants assessed for environmental impacts in final GESMO.

3. Comment:

"The Nuclear Fuel Services plant has also caused degradation of the environment near the plant. Plutonium contamination, along with contamination by other radioactive elements, has been found

in the air around the plant and in Buttermilk and Cattaraugus Creeks, on the plant boundary.[3,4,5] The NFS performance has been so inept that it has inspired the Attorney General of the State of New York to petition the AEC. The petition asked that NFS not be allowed to resume operations until it has demonstrated that it has adequate safety precautions to protect workers, that the site on Buttermilk Creek is environmentally suitable for the plant, and that there is a public need for the expansion of the plant.[6]"

Response:

The NFS plant was designed and operated to meet the requirements of 10 CFR Part 20, that at the time of licensing was considered adequate. However, the spent fuel reprocessing operations were shut down in 1972 to expand plant capacity and upgrade the operations to be responsive to the present regulatory principle of "as low as reasonably achievable".

Licensing actions covering construction and operations will be evaluated against current licensing requirements, for potential environmental and societal economic impacts.

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4. Comment:

"Parenthetically, industries outside the uranium fuel cycle and even the AEC itself have also demonstrated an inability to handle plutonium.

"There is this much logic in asking for an upgrading in industry's ability to handle plutonium before workers and the general population are asked to endure the risks of greater plutonium contamination. The following action should be taken to demonstrate that commercial industry can handle plutonium before plutonium recycle is implemented:

1. The AEC should draw up an action plan for facilities which presently handle plutonium. The purpose of this plan would be to upgrade the training of workers, the maintenance of equipment, and the operation of the plants, including the security and accountability areas."

Response:

Federal regulations require that applicants for licenses for handling special nuclear materials, including plutonium, must be qualified by reason of training and experience to use the material for the purpose of the license application. The following is quoted from Part 19 of the Code of Federal Regulations:

"§ 19.12 Instructions to workers.

All individuals working in or frequenting any portion of a restricted area shall be kept informed of the storage, transfer, or use of radioactive materials or of radiation in such portions of the restricted area shall be instructed in the health protection problems associated with exposure to such radioactive materials or radiation; in precautions or procedures to minimize exposure, and in the purposes and

4. Comment (Cont'd)

functions of protective devices employed; shall be instructed in, and instructed to observe, to the extent within the worker's control, the applicable provisions of Commission regulations and licenses for the protection of personnel from exposures to radiation or radioactive materials occurring in such areas; shall be instructed of their responsibility to report promptly to the licensee any condition which may lead to or cause a violation of Commission regulations and licenses or unnecessary exposure to radiation or to radioactive material; shall be instructed in the appropriate response to warnings made in the event of any unusual occurrence or malfunction that may involve exposure to radiation or radioactive material; and shall be advised as to the radiation exposure reports which workers may request pursuant to § 19.13. The extent of these instructions shall be commensurate with potential radiological health protection problems in the restricted area."

The plans and procedures for training of workers, the maintenance of equipment, operation, safety and safeguarding of plant and material are detailed in the safety and environmental impact assessments of the operations. These are reviewed and assessed in detail prior to licensing. These plans, when approved, become the basis for the regular inspections of a licensee by NRC for conformance.

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5. Comment:

"2. This plan should be implemented along with rigorous AEC on-site inspection. After at least a one-year observation period, the AEC should report to Congress when it believes that the industry's ability to handle plutonium is satisfactory.

"3. Upon receiving this report from the AEC, the Congress should designate an independent agency, such as the GAO, to certify that the AEC's assertion is correct and that industry's ability has improved to a point where plutonium recycle can be implemented with acceptable risk from environmental plutonium contamination."

Response:

The Congress has established NRC as an independent agency to regulate the nuclear industry and make determinations concerning adequacy of industry's ability to handle plutonium.

Inspection plans for plants where special nuclear material is handled are prepared in accordance with the technical specifications or license conditions prepared as part of the licensing procedures.

The operation of licensed LWR fuel cycle facilities are under continuous review and steps are taken to upgrade operations as the need arises on a plant-by-plant basis.

---

6. Comment:

"1. The AEC must require that no plutonium from American reactors be recycled as reactor fuel to foreign countries."

Response:

There is a large and growing LWR industry throughout the world capable of producing and utilizing plutonium for use in foreign recycle programs. Whether and to what degree there will be a foreign demand for U.S. produced plutonium cannot be determined at this time, as it will depend upon several variables in and decisions by foreign countries.

Should other countries request U.S. produced plutonium, any proposed export would be carefully reviewed both within the Executive Branch and by the NRC before any export authorization would be granted. The determinations and findings which would have to be made prior to authorizing any such export are discussed in the response to Comment Letter 18, Comment 5. A review of a license application to export U.S. produced plutonium would also carefully consider the form in which the material would be exported (for example, as separated plutonium, mixed oxide fuel, or fabricated fuel rods).

---

7. Comment:

"2. The pages above demonstrate that plutonium recycle will greatly increase the dangers of nuclear fuel cycle. Before plutonium recycle is implemented, the potential effects of such a policy must be scrutinized in the closest manner, and should be subject to extensive national debate. There is thus a strong reason to hold public hearings several if necessary on this policy. Specifically, a generic hearing, including the right of cross-examination, must be held on plutonium issues at least by the time the final Generic Environmental Statement is available."

Response:

The NRC recognizes the importance of the issues related to Pu recycle and accordingly has issued a public notice indicating a comprehensive program as follows:

1. Prepare a final statement on the health, safety and environmental issues of Pu recycle.

2. Prepare a draft supplement statement on the alternatives and recommend safeguards considerations for Pu recycle - followed by a final statement after a public comment period.

3. Issue proposed rules on the use of MOX fuels in LWR's.

4. Hold public hearings on Items 1, 2 and 3.

5. Render a Commission decision and final rules for Pu recycle after the public hearings.

---

8. Comment:

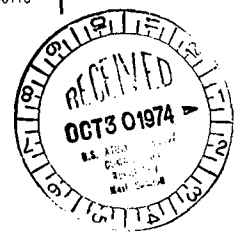
"3. Following public debate and the further research required by other recommendations in this statement, plutonium recycle should be implemented only with the consent of Congress. A policy with so many potential dangers should not be implemented by mere agency fiat."

Response:

Refer to response to Comment No. 7. During the period of the preparation of the draft GESMO and now the final GESMO on health, safety and environment (and the new supplement on safeguards considerations), the Joint Committee on Atomic Energy is advised of actions relating to the actions being taken by the NRC. The decision of Pu recycle is the responsibility of the Nuclear Regulatory Commission.

It is again restated that, should the NRC decision approve the implementation of Pu recycle, GESMO, per se, is not a vehicle for the licensing of widescale use but each Pu facility must be licensed on a case-by-case basis.

...L ELECTRIC COMPANY, 175 CURTNER AVENUE, SAN JOSE, CALIFORNIA 95125
...de ———— Phone (408) 297-3000, TWX NO. 910-338-0116



October 25, 1974

Mr. S. H. Smiley, Deputy Director
Fuels and Materials
Directorate of Licensing - Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Subject: Generic Environmental Statement - Mixed Oxide Fuel

Dear Mr. Smiley:

The Nuclear Energy Division of the General Electric Company is pleased to provide comments to the Commission on the Generic Environmental Statement - Mixed Oxide Fuel (GESMO) and its analysis of this subject. General Electric concurs that a comparison of the use of mixed oxide (MO_2) with uranium oxide fuel is the most reasonable method of presenting the information.

GESMO utilizes an assumed simplistic model for comparing the environmental effect of MO_2 fuel use with the environmental effect of the same electrical generating capacity using only uranium fuel. In general, the model and method of comparison provide a reasonable basis for deriving a conclusion concerning the environmental effect of mixed oxide fuel in light water reactors. However, it appears that certain details of the model and of the comparison should be modified for clarity and completeness. The comments attached to this letter are offered for the Commission's consideration with the view toward making GESMO a more comprehensive document. The attachment contains two parts: General Comments and Detailed Comments.

General Electric has not commented on the cost-benefit section of GESMO because all of the bases used in the preliminary analyses are not set forth in the draft GESMO document. Meaningful assessments as to the viability of plutonium recycle and the impact of alternate courses require comprehensive cost projections, supported by validated data.

Also, some subjects are yet to be resolved with respect to the transportation of plutonium, safeguards, fabrication plant requirements (such as location, design, process requirements, handling and accountability) and the transportation of mixed oxide rods and fuel bundles. Resolution of these subjects must, in the end, be reduced to a set of regulatory requirements which can be applied with consistency and which form the basis for the development of the commercial plutonium recycle industry.

General Electric has conducted detailed technical and commercial evaluations of the mixed oxide fuel business, reflecting utility requirements and needs. Extensive product development, testing and commercial reactor irradiation programs have demonstrated the performance characteristics and capability of BWR systems to utilize mixed oxide fuel. The technology exists to manufacture and operate recycled fuel in the BWR. However, with the many regulatory issues yet to be resolved, there is no firm basis at the present time on which General Electric can make a commitment for a commercial mixed oxide facility. It appears that it will be some time before all the uncertainties will be resolved to the degree such a commitment can be made.

Until the issues are resolved satisfactorily, General Electric will continue to make mixed oxide offerings on a price-in-effect basis to cover future requirements.

We appreciate the opportunity to review the GESMO document and trust that our comments will contribute to a more meaningful evaluation of the environmental effects of the use of mixed oxide fuel in light water reactors.

Very truly yours,

G. J. Stathakis
Vice President and General Manager
Nuclear Energy Products Division

GENERAL ELECTRIC

ATTACHMENT

PART A

GENERAL COMMENTS ON GESMO

1. GE supports the proposed gradual transition into the plutonium recycle era. During the transition period, the 115% Self-Generation Reactor (SGR) would provide this gradual changeover. However, the simplified formula on page IV B-7 of Volume 3 limits the ratio of the total plutonium to fissile nuclides in the as-charged fuel to 0.65. Such a limit on this ratio might accelerate plutonium loadings in the first few years and is not consistent with the pattern shown in Figure IV C-27. Resolution of this question would be helpful. Beyond the transition period, these values would be inappropriate to use as limits for Boiling Water Reactors (BWR) because the BWR fuel bundle design uses the mixed oxide in an island surrounded by uranium oxide (UO_2) fuel rods. Each mixed oxide bundle is designed to be essentially identical to an all UO_2 bundle in important operating characteristics; thus, UO_2 reactor technology is generally applicable.

   It may be desirable to use certain reactors as plutonium burners. Such a BWR could load more than double the plutonium which would be loaded in the 115% SGR case in the early years. If this were done, the plutonium would be concentrated in a fewer number of reactors which would further reduce the net total environmental impact.

   Before the Atomic Energy Commission makes a final regulatory decision on this subject, further technical discussions should be held concerning the details of various possible methods of defining plutonium loading limits.

2. GESMO should clarify whether the 115% SGR value is a limit or a modeling concept.

3. GESMO uses the BEIR Report* as a basis for stating risk estimates. Most of the base data in the BEIR Report come from experience with high doses, high dose rates, or both. The BEIR Report uses the assumption of a linear relation between dose and effect in extrapolating

*The effects on Populations of Exposure to Low Levels of Ionizing Radiation

to predicted effects at low doses and low dose rates. It is generally recognized that those assumptions represent the upper bound of the risk and that the actual risk lies somewhere between zero and the effects quoted. The BEIR Report is recognized as conservative because no credit is taken for either threshold effects or biological repair mechanisms that operate at low dose rates. Therefore, it is suggested that the first complete paragraph on page S-2 of Volume 1 be revised to read as follows:

> "Using estimates (BEIR Report)[1] for hypothetical cancer and genetic risk from radiation dose, the reductions in dose reported in Table S-1 have been calculated to reduce the annual hypothetical risk to the whole population . . . ."

In addition, it is suggested that the conservatisms of the BEIR Report be described in GESMO. Such material should appear as an appendix in Volume 3 and should include at least the information given in Appendix B of the Attachment to this letter.

4. Mixed oxide fuel, as used in GESMO, is referred to as oxide fuel containing 3 to 5% plutonium oxide (PuO_2) in natural UO_2. Previous mixed oxide fuels and present mixed oxide fuel assembly designs contain individual fuel rods which exceed 5% fissile plutonium per mixed oxide rod. Also, although PuO_2 is frequently mixed with natural UO_2, depleted UO_2 or UO_2 reclaimed in a fuel reprocessing plant may also be used. GE suggests that the definition of mixed oxide fuel be clarified throughout GESMO as referring to a maximum of 5% average fissile PuO_2 in UO_2-plus-PuO_2 per fuel assembly.

5. Paragraph F on pages S-46 and S-47 in Volume 1 contains a summary of adverse environmental effects and mitigating actions which might be taken to offset these effects, including the possible future retention of Krypton 85 at reprocessing plants. GESMO should clearly indicate that retention of Krypton 85 in facilities in the United States will not significantly alter the United States population dose because retention of Krypton 85 at all reprocessing plants throughout the world would be required to achieve the United States population dose reduction alluded to in the GESMO. General Electric first commented to the AEC on this matter in our comments on draft Document No. WASH-1250. Included in the GE comments (letter dated January 16, 1973, from G. J. Stathakis to Milton Shaw) was the following:

"The report in several places assumes that retention of Krypton 85 and tritium from reprocessing will take place in the future on the basis that the technology can be developed. We suggest that this future decision is properly subject to an evaluation of the need, cost and advantage of the very minor reduction in dose that can be achieved. Also, we note that the effectiveness of this step depends on similar action on a world-wide basis."

6. Paragraph 3 of Volume 1, on page S-47, includes a general statement of actinide removal from wastes, and the high (40,000 to 70,000) decontamination factors required to limit the need for long-term storage of high-level wastes to 600 years. Paragraph 11 of Chapter XI should include a description of the feasibility and cost of such decontamination action, or paragraph 3 on page S-47 should be deleted.

7. Radiation doses that might be delivered to individuals at locations on the boundaries of sites and beyond were calculated for the six possible combinations of reactor types and fuel. Such calculations are based on assumptions and result in conservative estimates (as stated, for example, on page IV C-101 in Volume 3). We believe that environmental statements should utilize as bases the best-estimate of what is to be expected. This concept is consistent with the Annex to Appendix D, 10 CFR 50. Most of the overly conservative assumptions which appear in GESMO do not permit a true evaluation of mixed oxide or of the differences between mixed oxide and uranium oxide fuels. A particular conservatism arises from the overly conservative assumptions of source terms and methods of evaluating dose from a given release. Most of these assumptions and methods result from the use of the final environmental statement for the "as low as practicable" evaluation of the effect of light water reactors on the environment (ALAP-FES); but in some cases, GESMO uses even more conservative assumptions and methods than does the ALAP-FES.

General Electric's detailed comments on the various factors of conservatism are provided in the Attachment to this letter. It is concluded that GESMO overestimates doses from both the UO_2 and MO_2 reactor plants by significant factors. Doses from liquid effluents are overestimated by one to two orders of magnitude. The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude or more (depending on actual milk usage pathways). We believe that these conservatisms, further detailed herein, should be removed from the GESMO document because such overstatement of impact is not in the best interest of the public, the industry, or the regulatory agencies.

8. Section B of Chapter 4 discusses mixed oxide fuel fabrication. The method used in the model analyzed includes only blending of plutonium oxide and uranium oxide powders. Other processes and shipping forms under development by the industry include alternatives such as co-precipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated waste generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described, and the risk to the environment may be not greater than that which is produced by a process which blends the plutonium and uranium oxide powders. Accordingly, the second paragraph on page IV D-3 should be revised to add the following statement:

"Other processes and shipping forms under development by the industry include alternatives such as co-precipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated wastes generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described herein."

9. Paragraph G, "Occupational Exposure," on page IV D-31 discusses exposures in mixed oxide fuel fabrication plants. For clarity, to more adequately describe the mixed oxide fuel fabrication plant occupational exposure situation, that paragraph should be revised to read as follows:

> "10 CFR 20 limits require that external dose not exceed 5 rem/year or accumulated value of 5 (N-18) where N is the worker's present age. Although as low as practicable limits have not been determined for plutonium fabrication plants, it has been assumed that gross shielding will be used to reduce the level to a design limit of 0.25 mRem/hour. Continuous exposure of operators at this dose rate would result in normal exposures of about 10% of 10 CFR 20 limits. Maintenance operations will give rise to additional exposure. For purposes of this statement, it has been assumed that external exposure to the plant work force will average about 40% of 10 CFR 20 limits, or 2 rem/year. Data show ..."

10. General Electric recognizes the importance of safeguards in the use of special nuclear material. Chapter 5 of GESMO contains a comprehensive summary of current requirements for safeguarding special nuclear materials in existing and future facilities. Since current experience with safeguards has been almost solely with existing facilities which have been backfitted to meet present requirements, it is difficult to assess the long term results on future facilities where early design can incorporate present requirements. However, it probably will be shown that current requirements do not represent optimum conditions for efficient effective and prudent safeguards of special nuclear material throughout the fuel cycle. It is further likely that the mere inclusion of some or all of the potential additional measures proposed in GESMO would not optimize safeguards for plutonium recycle. It is essential that safeguards be analyzed as a total system, with results of that analysis resulting in a framework within which flexibility is available to accomplish determined

results. Concepts such as co-location of plants, spiking of separated plutonium, additional transportation restraints and personnel and guard security measures have long-term, far-reaching effects and must be considered in the analysis. We are concerned that describing "what could be done" in GESMO may be tantamount to suggesting "it should be done." GESMO must remove this inference. For this reason, we do not comment specifically on the proposed additional safeguards listed in GESMO, although we concur with some of them as useful within the total safeguards system concept.

Safeguards must be treated as a generic subject applicable to the entire nuclear power generation industry. Therefore, an independent environmental statement should be developed which demonstrates the effect of current and future safeguards requirements. Such an analysis should put safeguards risks in perspective with other risks to the general public such as has been done for nuclear power reactor operation. This analysis, and any resulting regulatory requirements, must be completed and issued prior to publication of the final GESMO document. A separate environmental statement on safeguards is consistent with the reference in GESMO on the subject of waste disposal to another environmental statement referenced in GESMO which has been recently published as Document No. WASH-1539, "Management of Commercial High Level and Transuranium-Contaminated Radioactive Waste."

11. Section G of Chapter 4 contains the radiological health assessment for the recycle of plutonium in mixed oxide fuel. Tables IV J-4 through IV J-6 compare 50-year dose commitments to certain organs of the entire population resulting from the anticipated use of recycled plutonium in 1990 with the dose commitments that would be expected if only UO_2 fuel were used. For the analysis, the entire population dose is divided into occupational and general public doses. Occupational doses are shown in Table IV J-2. However, only whole body dose is given in that table. Only the external whole body occupational dose is factored into the dose comparisons in Tables IV J-4 through IV J-6. Occupational internal dose commitments are omitted. In the use of both the uranium and mixed oxide fuel, some relatively low level internal exposures occur. GESMO should

acknowledge this fact, as appropriate, throughout the document; for example, in paragraph IV D.2.G on page IV D-31 which discusses occupational exposure in a commercial scale mixed oxide fuel fabrication plant. It is believed that this internal exposure should be included in the dose equivalent evaluations and will not change the conclusions of GESMO.

12. GESMO makes no reference to the export and import implications of the use of mixed oxide fuel. The implications upon the United States of the international shipment of plutonium including imports of plutonium processed outside the United States, overseas fabrication of mixed oxide fuel for domestic use and international shipments of mixed oxide fuel rods need to be considered in this environmental statement.

ATTACHMENT

PART B

DETAILED COMMENTS ON GESMO

Volume 1 - Summary and Conclusions:

Page S-3

Table S-1 - The column heading Population Rem should be revised to read, "Population Rem Per Year."

Page S-13

Paragraph 2 - The definition of mixed oxide which limits MO_2 fuel to plutonium oxide in natural uranium oxide, and Figure S-5 on page S-26 of Volume 1 does not credit recovered uranium to the recovery-mixed oxide fuel cycle. These references and definitions of mixed oxide conflict with the footnote on page IV C-20 in Volume 3 which states: "In the SGR mode of operation, the fissile plutonium discharge in a previous cycle is reprocessed, blended with natural uranium, depleted uranium, or uranium tailings ...." (Emphasis Added)

GESMO should be revised here, and elsewhere, to take credit for all reuseable components of spent fuel as mixed oxide; otherwise, the entire waste management recovery cycle and mixed oxide aspects of the nuclear fuel industry are detrimentally represented. For example, the third sentence of paragraph 2 on page S-13 should be revised to read as follows:

> "Mixed oxide fuels, as used in this statement, referes to oxide fuel containing plutonium oxide (PuO_2) in uranium oxide (UO_2), and plutonium recycle refers to their direct substitution for equivalent slightly enriched UO_2 fuels."

Page S-36

Third Complete Paragraph - The sentence, "these reductions are insignificant compared to the 30,000,000 cancers and 12,000,000 genetic defects

expected in 1990 in just the United States population" needs clarification as to whether it refers to new cases occurring in the year 1990, or deaths, or to something else. The basis for those numbers should be referenced and should appear somewhere else in the GESMO document.

Volume 2 - Chapters I, II, III:

Page I-13

Table I-I - The table of permissible air concentrations for uranium and plutonium for occupational exposure is given without the important explanation of relation to period of exposure. For uranium, an MPC is correct after a few weeks of exposure because of the relatively short biological half-life in the body. But, since plutonium has a very long biological half-life, the MPC for the long radiological half-life plutonium isotopes is correct only at the end of 50 years of occupational exposure, with inhalation at MPC assumed during the entire period. For a short inhalation period, use of the MPC grossly overestimates the resulting dose. Therefore, a footnote should be added to Table I-I which reads as follows:

> "Due to effective half-life in the body, the uranium MPC's are correct after a few weeks of continuous exposure. For a long-lived plutonium isotope, the MPC assumes continuous exposure for a working lifetime, and thus, the MPC's are conservative for shorter periods of exposure."

Page I-14

Paragraph 1 - The last sentence, "Pu contents of mixed oxide fuels are expected to be less than 5% of total U + Pu" should be clarified to read "average fissile Pu contents of mixed oxide fuel assemblies are expected to be less than 5% of total U + Pu."

Page I-14

Paragraph 2 - The definition and application of 1.15 self-generation reactor (SGR) as used in GESMO is not clearly stated. The concept is used as a "reference or model reactor upon which the safety and environmental impact of limited substitution of plutonium for U-235 is based"; but it is also stated that "plutonium recycle limitations imposed by the Model 1.15 SGR will not cause significant revision of plans to recycle the plutonium in LWR's." The use of 1.15 SGR as a model is clear; its impact as a limit is confusing. The use of 1.15 SGR as a limit is difficult to evaluate and can result in varying quantities of recycle plutonium because it is highly dependent on the fuel design and the previous fuel cycle history for a particular reactor. There are several inconsistent statements in GESMO when referring to the quantity of fuel implied by 1.15 SGR which also make it difficult to interpret as a limit:

a. Volume 2, Page I-14

   "1.15 SGR would contain about one-third MO_2 fuel rods ... ."

b. Volume 3, Page IV A-2

   "MO_2 fuel being of the order of 30-40% of the fuel reload"

c. Volume 3, Page IV B-7

   "about 1/3 of the pins contain MO_2"

d. Volume 3, Page IV C-63

   "Approximately 40% of the fuel rods in the 1.15 SGR reload assemblies contain recycle plutonium in the form of mixed oxides ... ."

e. Volume 3, Page IV C-64, Figure IV C-27

Whereas the above statements all refer to equilibrium 1.15 SGR, this figure shows the buildup of mixed oxide fuel timed from the startup of uranium cores. This should be indicated as a typical case and should clearly indicate whether the ordinate axis is % MO_2 fuel by weight or by number of rods.

On the basis of the above comments, we suggest that the 1.15 SGR be clearly and consistently defined as values used for evaluation purposes only, and that if a regulatory limit is to be applied, it will be carefully defined and determined after an in-depth review and discussion with industry.

Page I (A)-3

The plutonium 241 half-life is stated here as 13 years. This value should be revised to read 15 years for internal consistency within GESMO.

Page II-3

Second complete paragraph - The second sentence uses the words "credible conditions," an obsolete term. It is suggested that this term be replaced with the words "conservatively selected design-basis conditions."

Page II-27

Paragraph 5 - The location of reference lists in this section is confusing. For example, reference (6) noted at the top of this page is on a list on page II-65, after several other subsidiary reference lists on intervening pages. It is suggested that a page number for the references be indicated, or some other means of clearly identifying the location of the references should be provided.

Page II-30

Paragraph e. - The last three words of this paragraph, "credible environmental conditions," should be replaced with the words "conservatively selected design-basis conditions," for consistency in considering expected conditions in an environmental statement rather than hypothetical possible conditions.

Page II-48

Table II-12 - The table should be corrected by replacing it with the following:

	Solid	Dished	Annular Hole 0.1 in.	Annular Hole 0.2 in.
Density, % of theoretical	92	95	92	92
Enrichment, %	1.22*	1.22*	1.36	1.59
Hole Size, diam., inches	-	-	0.100**	0.200**
Dishing, %	-	3.0	-	-
Rod, No.	4	4	12	12

Page II-50

Table II-14 - The value for the "fuel density, % of theoretical" for dished fuel should be 94 instead of the 92 shown.

Page II-51

Paragraph (3) - The information in paragraph (3) should be replaced with the current information as shown in Appendix A to this attachment.

Page II-62

Paragraph 1 - The fourth sentence should be revised by replacing the phrase "under all credible accident conditions" with the phrase "under conservatively selected design-basis conditions" for consistency with current terminology.

Volume 3 - Chapter IV:

Page IV A-9

Table A-5 - It should be clarified that the stated natural background dose is per year.

Page IV A-11

Table A-6 - The table heading should clarify that doses are to off-site individuals. It is assumed that the accident impacts were taken from a particular SAR or SER; the references should be given.

Page IV C-3

Paragraph "Accidents" - This paragraph appears mislabeled because the paragraph discusses normal operating conditions. The discussion states that fission gases are removed from the coolant and dispersed into the atmosphere under controlled conditions via tall stacks. The "controlled conditions" should be clarified or this statement should be deleted. The "tall stacks" is not correct for plants with radiogas decay systems, such as those PWR's with storage tanks or the BWR's with charcoal systems. Accordingly, the paragraph should be revised as follows:

1. Revise the heading "Accidents" to "Operational Releases to the Atmosphere."

2. The second and third sentences should be deleted and replaced with the following:

> "The fission gases released to the coolant are removed from the process, treated as necessary, and released to the atmosphere in accordance with pre-established technical specifications."

3. The fourth sentence should be deleted and replaced with the following:

> "Similar specifications will be applied for the use of MO_2 fuel to achieve the same environmental dose objectives."

Page IV C-8

Figure IV C-4 - This figure shows a typical core-lattice unit which, in this case, includes temporary control curtains for initial core loadings. This figure should be replaced with a core-lattice unit drawing for a BWR/5, or BWR/6, which does not use temporary control curtains, but uses, instead, selected rods which contain gadolinia burnable poison.

Page IV C-9

First Paragraph - The last sentence should be revised by replacing the words "coolant-injection" with the words "core spray" so that the sentence reads as follows:

> "Typical emergency core cooling systems involve either a low pressure core spray system (early BWR's) or a high pressure core spray system (latest BWR's) which are provided to assure adequate cooling of the core in the event of a leak that results in depressurization of the reactor system."

Page IV C-13

First Paragraph - The shield building described in this paragraph is not for "radiation emanating from the reactor proper" but rather for radiation

sources which may exist in the containment as the result of an accident. Accordingly, this paragraph should be revised to read as follows:

> "The most advanced BWR plants ... to the escape of gaseous effluents, as well as shielding to minimize radiation levels from sources inside the containment as a result of design-basis accidents."

Page IV C-74

Third Complete Paragraph - With regard to the BWR, the assumption that all the tritium in effluents comes from the fission source is incorrect, as the sources include the deuterium in reactor water and minor leakage from both control blades and fuel. Therefore, the sentence which begins, "In a BWR ...," should be deleted through the end of the equation and should be replaced with the following:

> "In a BWR, minor sources of tritium in effluents arise from deuterium in reactor water and minor leakages from control blades, as well as fission tritium in fuel. The formation rate of fission tritium in MO_2 fuel will be somewhat higher than in the UO_2 fuel, but its effect on tritium effluents will be small. Therefore, the overall source term should show little change, and current experience may be used."

Also, on page IV C-75, Table IV C-9, item 5, should be revised by replacing 26 curies/year/reactor with 20 curies/year/reactor, which is the same as the UO_2-fuel reactor source term.

Page IV C-76

Table IV C-9, Items 13 and 14 - A basis is not stated for the assumption that turbine building iodine all originates from steam leakage and that a partition factor of one applies (see GE-ALAP testimony of P. R. Hill, GE Exhibit #5, November 9, 1973). Therefore, items 13 and 14 should be deleted and replaced with the modified approach as will appear in the

AEC Regulatory Guide 1-CC when it is issued after the promulgation of 10 CFR 50, Appendix I.

Page IV C-77

Table IV C-9, Item 22 - The fraction of the primary coolant activity levels shown are generally overestimates (see GE-ALAP testimony of H. L. Loy, GE Exhibit #4, November 9, 1973). Therefore, item 22 should be modified in accordance with AEC Regulatory Guide 1-CC when issued after the promulgation of 10 CFR 50, Appendix I.

Page IV C-77

Table IV C-9, Item 23.a.(3) - This item appears to be a misprint. It should be revised to read as follows:

> "Hold-up time - Xe 43 days; Kr 2 days."

Page IV C-77

Table IV C-9, Item 23.c.(1) - There is no basis for indicating the need for charcoal absorbers (called adsorbers in this paragraph) on the reactor building exhaust, based on the source terms given in items 3, 11 and 14 in Table IV C-9. Therefore, this item which now reads "treatment: charcoal absorbers" should be replaced with the following: "treatment: none."

Page IV C-78

Table IV C-9, Item 24 - There is no basis given for the assumption that as much as 10% of the treated high-purity and low-purity wastes will be released rather than recycled. This is far in excess of what might reasonably be expected in a maximum recycle system (see GE-ALAP testimony of H. L. Loy, GE Exhibit #4, November 9, 1973). The most probable percentage release of treated high-purity wastes is zero percent. Therefore, all sources originating with the high-purity waste system should

be deleted and activity levels from the low-purity systems should be modified in accordance with our comment above concerning item 22 of Table IV C-9.

Page IV C-87, C-88

Table IV C-11 - The liquid effluent releases shown are high based on the comments above concerning source terms. This table should be corrected based on all changes made in accordance with comments above concerning items 5, 22 and 24 in Table IV C-9.

Page IV C-89

Table IV C-12 - There appear to be some errors in the gaseous effluent release values. For example, the values in this table are inconsistent with the source term, item 16, in Table IV C-9 on page IV C-76. Apparently, Table IV C-12 is for steam jet air ejector and ventilation releases only. Since the source of these releases cannot be deduced from preceding data in the GESMO document, the values should be revised according to the comments above. Also, it appears that no credit is given for the fact that the ALAP hearing record shows that iodine releases in ventilation were about one-half organic iodine which is known to contribute no significant dose on pathways dependent upon deposition on the ground. Therefore, a factor of two reduction in iodine source terms should be applied or otherwise corrected for in the agricultural dose estimates.

Page IV C-95

First Paragraph and Table IV C-18 - This discussion concerns a reactor plant which has once-through condenser cooling. Plants which utilize cooling towers or ponds are not mentioned. This appears to be a major omission in GESMO as many large dual unit stations will have some form of closed cooling water systems with coolant effluent limited to blowdown and other minor coolant flows. A section should be added to the report which describes this situation. In that section it will be important to

evaluate doses with realistic waterway dilution factors, avoiding the unrealistic assumption that aquatic organisms and water users live in the coolant discharge pipes (see the comment on page IV C-99 below).

Page IV C-95

Last Paragraph on Page - It is apparent that the X/Q values for atmospheric diffusion are taken from the ALAP-FES where ground level or 10-meter height release assumptions were made. Tests at the operating Peach Bottom reactor have shown that diffusion from a roof vent is much better than is assumed by the AEC. Therefore, all of the evaluations in GESMO should be revised using an increased atmospheric diffusion factor of about three for noble gas release and a factor of about ten for radioiodine releases.

Page IV C-99

Paragraph Titled, "Dose Rate Estimates" - Apparently, the aquatic doses are based on concentration in the discharge canal. A statement is made that mobile life forms do not spend much time at these concentrations, however, dose estimates should be made at a more realistic dilution location. All doses from liquid effluents should be evaluated based on realistic waterway dilution as it applies to each dose pathway. In the minimum case, this should include the dilution achieved in the mixing zone evaluated for conformance to thermal release requirements.

Page IV C-102

Paragraph Titled, "Direct Radiation" - No reference could be found in GESMO as to how the direct radiation doses were estimated. Footnotes to tables on pages IV C-103 and IV C-104 say only "calculated from power level, distance to boundary, use factor and shielding considerations." The calculational method should be referenced or shown.

Page IV C-103

Table IV C-21 - The table shows off-plant doses from a two-unit BWR station. The air submersion doses from noble gases are shown to produce 5.7 millirem per year to the skin and 3 millirem per year to the total body. The total body dose is also applied to the GI tract, thyroid and bone; since the total body dose is not an ingestion dose, this analysis

is not in agreement with methods of revised proposed Appendix I, dated February 20, 1974, which shows external dose as not being applied to individual organs. In addition, the noble gas release of 2200 curies per year (see page IV C-89) per unit is only 140 micro-curies per second for the two-unit station. At such a release rate, the skin and total body doses in Table IV C-21 appear high by about an order of magnitude. It is believed that some of this overestimate probably comes from the semi-infinite cloud calculational error (see comment below concerning page IV J(A)-2). Details of how doses were estimated are not evident and should be shown or referenced. The dose estimates apparently include assumption of outdoor exposure at the fence post all year. The same is true for the iodine inhalation doses of 3 to 4 millirem per year. The iodine milk doses of 50 millirem per year to adult thyroid and 460 millirem per year to child thyroid include all the overestimates which General Electric has called to the Commission's attention in the ALAP hearing, principally:

A. Iodine chemical form; overestimate by a factor of two.

B. Roof vent diffusion; overestimate by a factor of ten.

C. High iodine deposition velocity; overestimate by a factor of about two.

D. High transfer, grass to milk; overestimate by a factor of two.

E. Assumption of fence post cow and baby; overestimate by a factor of two to 100, depending on actual cow location and actual milk usage.

It should be noted that the Commission abandoned the fence post cow concept on February 20, 1974.

Detailed technical comments of the General Electric position on realistic dose evaluation are available in the ALAP record as follows:

1. GE-ALAP reply statement, filed March 14, 1974.

2. Transcript, oral argument, ALAP, before AEC Commissioners, June 6, 1974, pages 91 to 134.

3. GE-ALAP comments on dose evaluation, filed July 16, 1974.

Therefore, it is suggested that dose estimates should be revised as appropriate. The finite cloud calculation method should be used for noble gas gamma doses. The atmospheric diffusion for a roof vent should be used (see above comment on page IV C-95, last paragraph on the page). Reasonable occupancy factors should be included. The atmospheric diffusion factor should be revised for calculation of iodine inhalation dose (see comment above on page IV C-95, last paragraph on the page) and a reasonable occupancy factor should be included. On iodine agricultural pathways, corrections should be applied for iodine chemical form, roof vent diffusion, deposition velocity, and grass-to-milk transfer factor, all as indicated above. On milk usage, the three likely modes should be evaluated: 1) a baby drinking raw milk directly from the family cow; 2) adult only usage of such milk; 3) commercial dairy dilution of such milk.

Page IV C-104

Table IV C-22 - The BWR direct radiation dose should be listed in the total body column rather than in the dose (mRem/year) GI tract.

Page IV C-109

Tables IV C-27 and 28 - The BWR population man-rem and millirem per year doses should be recalculated based on the above comments. Tables IV C-27 and 28 indicate a significant inconsistency with current AEC evaluations on actual projects. The tables indicate that total doses of 13 to 14 man-rem apply to a 50-mile radius population of 3-1/2 million. The final environmental statement for the Perry Plant, issued in June, 1974, contains the AEC calculation of a dose of 1.8 man-rem for a very

similar 50-mile population of 2-3/4 million. We believe the approximate order of magnitude difference may be due to the various overestimates of factors as enumerated in comments above.

Page IV D-7

Table IV D-2 - The table should be revised to show a plutonium possession limit (kg) for General Electric Company of 150 instead of the 15 shown.

Page IV D-13

Paragraph D.1.c (2) - The co-precipitation process description in the last sentence should be revised to show that the milling and screening step is not different than for the oxalate process. It is suggested that this revision be accomplished by modifying the description of the last process step on the top of page IV D-13 to read: "Milling and screening to the desired mesh size, producing the (U, Pu)O_2 powder."

Page IV D-16

Paragraph D.1.e - The third paragraph concerning sources of plutonium-contaminated liquids should be expanded to include other most likely process liquids such as those from off-gas scrubbing systems, nitrate conversion filtrates, fire protection systems, and secondary cooling systems; the least likely sources should be at the end of the list, i.e., "scrub water or ... ." The paragraph should be revised to read as follows:

"Liquids contaminated with plutonium arise from operations such as--

- dirty scrap recovery operations (wet processing of contaminated scrap)
- maintenance operations (cleanup of process enclosures after equipment failures)
- off-gas scrubbing system (scrubbing solutions)

- nitrate conversion processes (filtrates and wash solutions)
- secondary cooling systems
- fire protection systems in plutonium processing areas (abnormal occurrences)
- scrub water or hot shower water from first aid facility (abnormal occurrences)."

Page IV D-18

Paragraph D.2.a - The first sentence after Table IV D-5 is: "Plutonium handling operations are carried out inside equipment located within process enclosures (glove boxes) ... ." Radiation from plutonium material will, in many cases, preclude operations within unshielded glove boxes. Therefore, shielded cells will be required. The sentence should be revised to read as follows:

"Plutonium handling ... (e.g., glove boxes) ... ."

Page IV D-29

Paragraph D.2.c (2) - Calculations of the nonradiological process effluent emitted from the fabrication plant, set forth in D.2.c (2), page IV D-29, are not consistent with Table IV D-12 on page IV D-41. For example: 1.5 kg per year of fluoride ion translates to 20.5 grams per day, assuming 20% operation of the dirty scrap line. (1.5 kg/year = [4.1 grams/day] [20%] = 20.5 grams/day.) This does not check with the 0.1 gram per day set forth in the first line on page IV D-29. We believe these calculations should be reviewed and revised as appropriate.

Page IV E-22

Table E-8 - There appears to be an arithmatic error in the I-131 entry since 0.50 plus 0.50 does not equal 0.50.

Page IV J(A)-2

Paragraph a. - The use of the semi-infinite cloud for gamma dose may be approximately correct at some great distance from the point of release, but it greatly overestimates doses at distances of usual interest beyond a site boundary. The degree of overestimation of dose depends on whether the release is from a stack, a roof elevation vent, or some lower elevation; but this model always overestimates the dose. All doses in GESMO based on the assumption of a semi-infinite cloud should be appropriately revised as mentioned in our comments above.

The deposition velocity of one centimeter per second may be only slightly conservative for elemental iodine, but that velocity results in large dose overestimates for organic iodine and particulates. As discussed in our comments above, a more realistic deposition velocity should be used throughout dose calculations in GESMO.

APPENDIX A

SAMPLE BWR MO_2 FUEL DESIGN

- Design Description

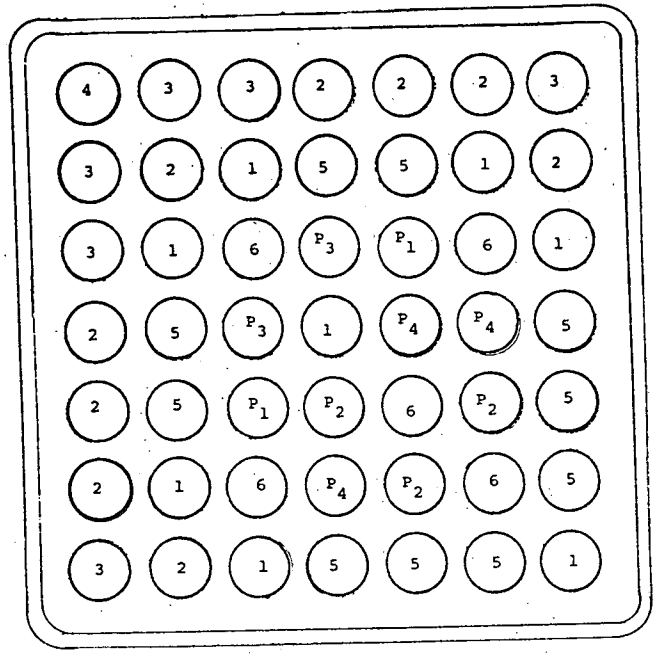
The reload Plutonium Recycle Prototype fuel for the Quad Cities I reactor is designed with the same envelope dimensions as the initial core fuel. It can, therefore, be inserted, without restriction, into all locations within the reactor core. Figures 1 and 2 describe the general characteristics of the prototype reload plutonium recycle fuel bundles and Tables 11 and 12 summarize the significant characteristics and differences relative to the initial and the planned UO_2 reload fuel. The basic lattice arrangement of 49 rods in a 7x7 array remains the same as the initial core fuel, with a centrally located spacer capture rod, and eight tie rods located symmetrically around the periphery of the fuel bundle.

The prototype Pu recycle reload fuel bundle is of the same general mechanical configuration that the General Electric Company has been designing and manufacturing for the past twelve years. The reload fuel uses gadolinium for reactivity control augmentation. Gadolinium containing reload fuel has been the subject of past AEC dockets, i.e., Dresden-1, Big Rock Point, Humboldt Bay Unit 3, Dresden-2, and 3, Quad Cities 1 and 2, and Nine Mile Point. The first core fuel also contained gadolina. The reload fuel incorporates design improvements recently implemented in initial core fuel such as Browns Ferry-1, Peach Bottom-2, and Cooper Station and is the same fuel as previously loaded in Dresden-3 and other stations.

Two types of prototype Pu recycle assemblies were designed. Four assemblies of Type A31 contain 40 of the 48 rods and are designed to be loaded in the central reactor positions around the center control blade. The fuel rod array for these assemblies is shown in Figure 1. The uranium enrichments are the same as the standard UO_2 reload fuel with the exception of the 10 Type 5 high-enrichment UO_2 rods which were introduced to improve power distributions. The four identical Type A31 assemblies are designed to be irradiated under well controlled conditions in the center of the reactor so as to maximize the benefits of possible follow-on program gamma scans and isotopic measurements.

Two types of plutonium are utilized: Dresden-1 recycle (80% fissile) and AEC plutonium (90% fissile). The Dresden-1 recycle plutonium is used in the reduced concentration mixed oxide (MO_2) rods at the outside of the MO_2 rod island and provides some local power peaking flattening as well as improving the steam void dependence of the local power peaking.

The remaining eight MO_2 rods were utilized in a special peripheral fuel assembly design, Type A32, shown in Figure 2. Two rods of each of the four mixed oxide rod types are incorporated in this design. Irradiation of the Type A32 assembly will provide a directly comparable low power environment for fuel rods identical to those located in the central fuel assemblies, thus aiding future evaluations of the observed fuel performance. The environment at the periphery also results in the coolest possible BWR neutron spectrum and will provide reactor physics data of significance.

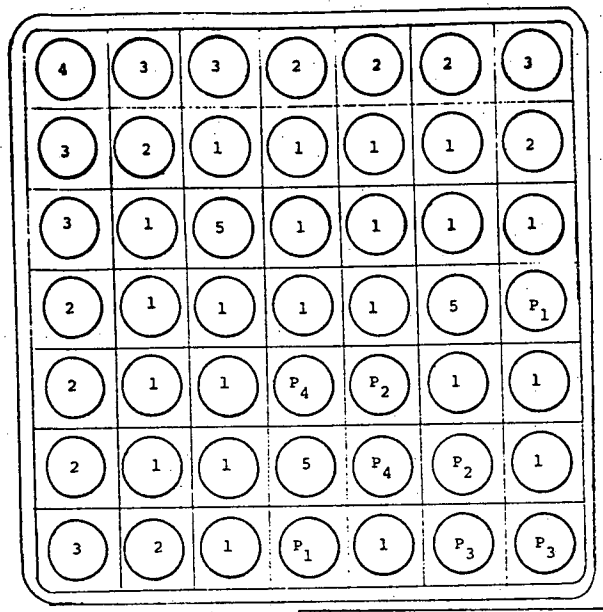


URANIUM FUEL
FUEL TYPE
1 - 2.56 wt% U-235
2 - 1.94
3 - 1.69
4 - 1.33
5 - 3.30
6 - 2.56 + Gd_2O_3

PLUTONIUM FUEL (NATURAL U, 91% TD)	
HOLLOW PELLETS (0.15 i.d. CORE)	SOLID PELLETS
P_3*-2.34 wt% fissile	P_1*-2.14% wt% Pu fissile
P_4 -3.62	P_2 -3.52

*80% FISSILE PuO_2, ALL OTHERS 90% FISSILE

FIGURE 1 Prototypical Island Design-Pu Recycle Fuel Assembly, Type A31



URANIUM FUEL	
No. of Rods	Fuel Type
22	1 - 2.56 wt% U-235
9	2 - 1.94 wt% U-235
8	3 - 1.69 wt% U-235
1	4 - 1.33 wt% U-235
3	5 - 2.56 wt% U-235 + Gd_2O_3

PLUTONIUM FUEL (Natural U, 95% T.D.)			
HOLLOW PELLETS (0.150 i.d. Core)		SOLID PELLETS	
No. of Rods	Fuel Type	No. of Rods	Fuel Type
2	P_3*-2.34 wt% Fissile	2	P_1* - 2.14 wt% Fissile
2	P_4 -3.62 25% Fissile	2	P_2 - 3.52 wt% Fissile

*80% Fissile Pu, All Others 90% Fissile

FIGURE 2 Peripheral Fuel Assembly Design, Type A32

TABLE 1

INITIAL CORE AND RELOAD FUEL ROD DESIGN SPECIFICATION

FUEL	INITIAL CORE FUEL	RELOAD 1 FUEL	
Material	UO_2	UO_2	48 MIXED OXIDE RODS
Initial Enrichment, w/o Fissile			
High	2.47	2.56	3.6
Medium	1.70	1.94	3.5
Medium Low	1.20	1.69	2.35
Low		1.33	2.15
Average for Bundle	2.12	2.30	
Pellet Geometry			
Long Dished	26 rods	0 rods	
Long Undished	23 rods	0 rods	
Short Chamfered (undished)	0 rods	49 rods	
Short (undished)			24 rods
Short Annular			24 rods
Pellet Diameter, inches	0.487	0.477	0.487
Pellet Inside Diameter, inches	----	----	0.15
Pellet Density % of Theoretical	95.0	95.0	91.0
Melting Point, °F	5080	5080	5000
CLADDING			
Material	Zr-2	Zr-2	Zr-2
Thickness, inches	0.032	0.037	.032
Fuel Rod O.D., inches	0.563	0.563	.563
FUEL RODS			
Active length, inches	144.0	144.0	144.0
Gas plenum length	11-1/4	11	11
	Helium	Helium	Helium

5-21.15

TABLE 2

INITIAL CORE AND RELOAD FUEL ASSEMBLY DESIGN SPECIFICATIONS

FUEL BUNDLE	INITIAL CORE FUEL UO_2	RELOAD 1 FUEL UO_2	RELOAD 1 FUEL 48 MIXED OXIDE CENTRAL A31 ASSEMBLIES	RELOAD 1 FUEL 48 MIXED OXIDE PERIPHERAL A32 ASSEMBLIES
Geometry	7x7	7x7	7x7	7x7
High Enrichment Rods	30	32	22	24
Medium High Enrichment Rods	16	10	10	10
Medium Low Enrichment Rods	3	6	6	6
Low Enrichment Rods		1	1	1
Poison Rods Per Bundle	2-3	3	5	3
Mixed Oxide Rods	None	None	10	8
Rod Pitch, inches	0.738	0.738	.738	.738
Water to Fuel Volume Ratio	2.42	2.53	2.53	2.53
Heat Transfer Area, ft^2	86.5	86.5	86.5	86.5
CHANNELS				
Material	Zr-4	Zr-4	Zr-4	
Outside Dimension, inches	5.438	5.438	5.438	
Wall Thickness, inches	0.080	0.080	0.080	
Channel Length, inches	162-1/8	162-1/8	162-1/8	
SPACERS				
Number per bundle	7	7	7	
Material	Zr-4 with Inconel Springs		Zr-4 with Inconel Springs	

APPENDIX B

EXCERPTS FROM THE RASSMUSSEN REPORT

"Late effects of nuclear radiation have recently been treated in detail by the BEIR Committee of the National Academy of Sciences - National Research Council (ref. 13), and by the United Nations Scientific Committee on Effects of Atomic Radiation (UNSCEAR) (ref. 14). The two studies differ in philosphy and approach regarding late somatic effects obtained primarily from data at high doses and dose rates to estimate the risk at low doses and low dose rates of most concern to the general population. While the UNSCEAR group did not make such an extrapolation, the BEIR Committee was required to use whatever means were at their disposal to extrapolate risk estimates to very low doses and chose to use the linear dose-effect hypothesis to accomplish this end. It is the general understanding that the estimates arrived at are upper limit figures and that the true values lie somewhere between these values and zero. The magnitude of late effects calculated in this study have used the conservative BEIR Report values.

"Late somatic effects, with few exceptions, are manifested only after an interval of years or decades following the irradiation and are indistinguishable from diseases that occur in non-irradiated populations. Thus, in any specific individual a particular late effect cannot be definitely attributed to radiation. Excess mortality from all forms of radiation induced cancers during the first 25 to 27 years after irradiation is estimated by the BEIR Report to be between 50 and 165 deaths per 10^6 man-rem. This estimate assumes a linear dose-response relationship from high to low doses. This study has used a value of 100 latent deaths per 10^6 man-rem.

"Genetic effects are classified in the BEIR Report into three types: dominant diseases, chromosomal and recessive diseases, and congenital anomalies. Dominant diseases include most of the obvious birth defects. Chromosomal and recessive diseases are produced at such a low level by radiation that, for this study, they are not considered significant in relationship to the other two types of genetic effects. Congenital anomalies refer to more complex inherited traits which cause the person to have a predisposition to certain diseases such as diabetes, cancer, and mental retardation. The BEIR Report estimates the genetic effects of a single exposure of 10^6 man-rem to be between 10 and 100 additional cases of dominant diseases and 1 and 100 additional cases of congenital anomalies." (1)

"6.6.4.2 Latent Somatic Effects of Ionizing Radiation

In a recent publication (ref. 13), prepared by an Advisory Committee of the U. S. National Academy of Sciences-National Research Council, entitled the "Biological Effects of Ionizing Radiation," relevant human and animal data were evaluated in order to appraise the present radiation standards for human exposure and provide risk estimates in terms of population dose.

"The data, although inadequate for a complete evaluation, include populations exposed to external radiation, to internal emitters deposited in lung and bone, and exposure durations from instantaneous to a whole lifetime. Thus, at least some data are available that bears on most of the factors that are suspected to be variables in production of late somatic effects. However, most of the data are obtained from persons exposed to high LET (linear energy transfer) particulate radiation, and do not yield information which is useful in assessing the effect of low LET radiation which are highly dependent upon the rate at which the dose is received. These data do, nevertheless, suggest the need for use of the proper factor for relative biological effectiveness in order to bring data on high and low LET radiations together and justify the utility of expressing the dose in terms of rem. Table VI-13 is a summary from the BEIR Report predicting the increased incidences of various late diseases per year as a function of dose per unit population. Again, it must be remembered that the values are upper limits. The reader is hereby referred to the BEIR Committee Report (ref. 13) for complete details on the source of data and the methods used to derive the values given.

TABLE VI-13

CANCER INCIDENCE RATES

Cancer Type	Deaths Per Year Per Million Man-Rem
Leukemia	1-2
Lung	1.3
Breast	1.5
Bone	0.2
Gastro-intestinal Tract	1.0
Other Cancers	1.0

"The Beir Report estimates that the excess cancer mortality is 50-165 deaths per million man-rem during the first 25 to 27 years after exposure, and that these estimates may be in error by as much as a factor of 5. Note that although these numbers may represent the upper limits for risk, many of the populations from which these risks were derived have not lived out their full lifetime and additional malignancies may yet occur."(2) (Emphasis Added)

(1) Draft WASH-1400, "Reactor Safety Study" (Rassmussen Report), Appendix VI, pp 34-35

(2) Ibid, pp 47-49

NRC Staff Response to Comments by General Electric

1. Comment

"GESMO utilizes an assumed simplistic model for comparing the environmental effect of MO_2 fuel use with the environmental effect of the same electrical generating capacity using only uranium fuel. In general, the model and method of comparison provided a reasonable basis for deriving a conclusion concerning the environmental effect of mixed oxide fuel in light water reactors. However, it appears that certain details of the model and of the comparison should be modified for clarity and completeness."

Response:

In this final GESMO, the description of the model 1.15 SGR has been expanded. Two new tables have been added, Table IV C-9 and IV C-10 to supplement Figure IV C-26, which shows the percent MOX fuel in the reactor at each refueling, as it approaches equilibrium. The amounts and isotopic composition of plutonium and other selected nuclides in the reload and spent fuel assemblies are presented for the 16 annual reloads required to reach equilibrium conditions. Refer to CHAPTER IV, Section C, paragraph 4.2.

2. Comment:

"General Electric has not commented on the cost-benefit section of GESMO because all of the bases used in the preliminary analyses are not set forth in the draft GESMO document. Meaningful assessments as to the viability of plutonium recycle and the impact of alternate courses require comprehensive cost projections, supported by validated data."

Response:

CHAPTERS VIII and XI have been revised to state all bases and assumptions used. Costs figures are carefully developed and documented in CHAPTER XI, Section 2.0. Moreover, the sensitivity of the results of these cost bases is examined in CHAPTER XI, Section 3.0.

3. Comment:

"Also, some subjects are yet to be resolved with respect to the transportation of plutonium, safeguards, fabrication plant requirements (such as location, design, process requirements, handling and accountability) and the transportation of mixed oxide rods and fuel bundles. Resolution of these subjects must, in the end, be reduced to a set of regulatory requirements which can be applied with consistency and which form the basis for the development of the commercial plutonium recycle industry."

3. Comment (Cont'd)

Response:

This comment is well taken in that prior to widescale use of MOX fuels in the LWR industry the regulations for each component of the fuel cycle where Pu is handled will have to be spelled out. At the time of the release of this final statement, the proposed rule changes for the use of MOX fuels in LWR's will be issued. Also, the draft and final supplement on safeguards considerations are in preparation concurrently with the hearings on the proposed rules and the final issues on health, safety and environmental issues of recycle plutonium. It is the intent that final rules be promulgated at the time the final decision is made on Pu recycle.

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4. Comment:

"GE supports the proposed gradual transition into the plutonium recycle era. During the transition period, the 115% Self-Generation Reactor (SGR) would provide this gradual changeover. However, the simplified formula on page IV B-7 of Volume 3 limits the ratio of the total plutonium to fissile nuclides in the as-charged fuel to 0.65. Such a limit on this ratio might accelerate plutonium loadings in the first few years and is not consistent with the pattern shown in Figure IV C-27. Resolution of this question would be helpful. Beyond the transition period, these values would be inappropriate to use as limits for Boiling Water Reactors (BWR) because the BWR fuel bundle design uses the mixed oxide in an island surrounded by uranium oxide (UO_2) fuel rods. Each mixed oxide bundle is designed to be essentially identical to an all UO_2 bundle in important operating characteristics; thus, UO_2 reactor technology is generally applicable.

"It may be desirable to use certain reactors as plutonium burners. Such a BWR could load more than double the plutonium which would be loaded in the 115% SGR case in the early years. If this were done, the plutonium would be concentrated in a fewer number of reactors which would further reduce the net total environmental impact.

"Before the Atomic Energy Commission makes a final regulatory decision on this subject, further technical discussions should be held concerning the details of various possible methods of defining plutonium loading limits."

Response:

The 115% SGR model provides a specific level of plutonium utilization that is used for calculating environmental effects. It does not limit the route to this level of self generation operation, as illustrated in Figure IV C-26, nor does it give specific approval for accelerated plutonium loadings in the first few years of implementation. The prudent transition to large scale use of MOX will be reviewed on a plant-specific basis.

In this final GESMO, the model reactor developed characterizes the 1.15 SGR in terms of a quantity of Pu charged as MOX. For the purposes of the statement an LWR is judged to be within the limits of 1.15 SGR when the weight percent of total Pu to total heavy metal content (Pu + U) in the as-charged fuel is less than 1.8.

4. Comment (Cont'd)

The potential for so-called plutonium burners is acknowledged in final GESMO. A concentration of recycled plutonium somewhat above the concentration expected to be used in most LWR's of current design within the next ten years (1.15 SGR) was examined to determine what effect, if any, its use would have on those reactor characteristics which might affect the probability and consequences of accidents, as compared to currently designed LWR's fueled with UO_2. Refer to CHAPTER IV, Section C, paragraph 4.1.

---

5. Comment:

"GESMO should clarify whether the 1.15% SGR value is a limit or a modeling concept."

Response:

The 1.15 SGR is used in GESMO only as a model. However, in proposed rulemaking action, 1.15 SGR would constitute a limit insofar as requests to use mixed-oxide fuel in quantities less than 1.15 SGR would not require the preparation of an environmental impact statement.

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6. Comment:

"GESMO uses the BEIR Report as a basis for stating risk estimates. Most of the base data in the BEIR Report come from experience with high doses, high dose rates, or both. The BEIR Report uses the assumption of a linear relation between dose and effect in extrapolating to predicted effects at low doses and low dose rates. It is generally recognized that those assumptions represent the upper bound of the risk and that the actual risk lies somewhere between zero and the effects quoted. The BEIR Report is recognized as conservative because no credit is taken for either threshold effects or biological repair mechanisms that operate at low dose rates.

In addition, it is suggested that the conservatisms of the BEIR Report be described in GESMO. Such material should appear as an appendix in Volume 3 and should include at least the information given in Appendix B of the Attachment to this letter."

Response:

In final GESMO, CHAPTER IV, Section J has been revised, referencing NCRP 43 in acknowledgement of the lack of evidence to support extrapolating the linear response theory to extremely low doses and dose rates. However, this practice is followed to show the results of applying the theory.

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7. Comment:

"Mixed oxide fuel, as used in GESMO, is referred to as oxide fuel containing 3 to 5% plutonium oxide (PuO_2) in natural UO_2. Previous mixed oxide fuels and present mixed oxide fuel assembly designs contain individual fuel rods which exceed 5% fissile plutonium per mixed oxide rod. Also, although PuO_2 is frequently mixed with natural UO_2, depleted UO_2 reclaimed in a fuel reprocessing plant may also be used. GE suggests that the definition of mixed oxide fuel be clarified throughout GESMO as referring to a maximum of 5% average fissile PuO_2 in UO_2 - PuO_2 per fuel assembly."

Response:

Five weight percent plutonium in natural UO_2 was chosen as an example. There is no technical basis at this time for restricting the amount of plutonium that may be used in fuel rods for LWR's other than core performance and safety limits as long as handling and transportation requirements are satisfied. Refer to CHAPTER IV, Section C, paragraph 3.4.1.

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8. Comment:

"Paragraph F on pages S-46 and S-47 in Volume 1 contains a summary of adverse environmental effects and mitigating actions which might be taken to offset these effects, including the possible future retention of Krypton 85 at reprocessing plants. GESMO should clearly indicate that retention of Krypton 85 in facilities in the United States will not significantly alter the United States population dose because retention of Krypton 85 at all reprocessing plants throughout the world would be required to achieve the United States population dose reduction alluded to in the GESMO. General Electric first commented to the AEC on this matter in our comments on draft Document No. WASH-1250. Included in the GE comments (letter dated January 16, 1973, from G. J. Stathakis to Milton Shaw) was the following:

> 'The report in several places assumes that retention of Krypton 85 and tritium from reprocessing will take place in the future on the basis that the technology can be developed. We suggest that this future decision is properly subject to an evaluation of the need, cost and advantage of the very minor reduction in dose that can be achieved. Also, we note that the effectiveness of this step depends on similar action on a world-wide basis.'"

Response:

In final GESMO, quanititative releases of ^{85}Kr, ^{3}H, ^{14}C are assumed from spent fuel reprocessing CHAPTER IV, Section J, Table IV J-22 indicates population dose reduction possible by retaining these nuclides.

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9. Comment:

"Paragraph 3 of Volume 1, on page S-47, includes a general statement of actinide removal from wastes, and the high (40,000 to 70,000) decontamination factors required to limit the need for long-term storage of high-level wastes to 600 years. Paragraph 11 of CHAPTER XI should include a description of the feasibility and cost of such decontaimination action, or paragraph 3 on page S-47 should be deleted."

Response:

In final GESMO, the subject of partitioning of actinides in the high level wastes has been clarified. It is not obvious that the separation of actinides would significantly impact on the overall economics of waste mangement or the fuel cycle options assessed.

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10. Comment:

"Radiation doses that might be delivered to individuals at locations on the boundaries of sites and beyond were calculated for the six possible combinations of reactor types and fuel. Such calculations are based on assumptions and result in conservative estimates (as stated, for example, on page IV C-101 in Volume 3). We believe that environmental statements should utilize as bases the best-estimate of what is to be expected. This concept is consistent with the Annex to Appendix D, 10 CFR 50. Most of the overly conservative assumptions which appear in GESMO do not permit a true evaluation of mixed oxide or of the differences between mixed oxide and uranium oxide fuels. A particular conservatism arises from the overly conservative assumptions of source terms and methods of evaluating dose from a given release. Most of these assumptions and methods result from the use of final environmental statement for the 'as low as practicable' evaluation of the effect of light water reactors on the environment (ALAP-FES); but in some cases, GESMO uses even more conservative assumptions and methods than does the ALAP-FES.

"General Electric's detailed comments on the various factors of conservatism are provided in the Attachment to this letter. It is concluded that GESMO overestimates doses from both the UO_2 and MO_2 reactor plants by significant factors. Doses from liquid effluents are overestimated by one or two orders of magnitude. The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude or more (depending on actual milk usage pathways). We believe that these conservatisms further detailed herein, should be removed from the GESMO document because such overstatement of impact is not in the best interest of the public, the industry, or the regulatory agencies."

Response:

In final GESMO, on the health, safety and environmental impacts of Pu recycle, the reader is kept aware where overestimates of releases of radioactivity and calculated doses prevail. In contrast to an environmental statement for a specific installation, where it is appropriate to estimate close to expected performance, a generic statement has the objective of accommodating the licensable spectrum of performance.

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11. Comment:

"Section B of Chapter 4 discusses mixed oxide fuel fabrication. The method used in the model analyzed includes only blending of plutonium oxide and uranium oxide powders. Other processes and shipping forms under development by the industry include alternatives such as coprecipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated waste generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described, and the risk to the environment may be not greater than that which is produced by a process which blends the plutonium

11. Comment (Cont'd)

and uranium oxide powders. Accordingly, the second paragraph on page IV D-3 should be revised to add the following statement:

'Other processes and shipping forms under development by the industry include alternatives such as coprecipitation of mixed oxide, pretreatment of feed precipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated wastes generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described herein.'"

Response:

In the text of final GESMO, other proven processes and forms for MOX fuel fabrication could be used with essentially the same environmental impacts as those of the methods described in the statement. See CHAPTER IV, Section D, paragraph 1.3, for a discussion of other processes.

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12. Comment:

"Paragraph G, 'Occupational Exposure,' on page IV D-31 discusses exposures in mixed oxide fuel fabrication plants. For clarity, to more adequately describe the mixed oxide fuel fabrication plant occupational exposure situation, that paragraph should be revised..."

Response:

This comment was noted but not incorporated into the final text as suggested. Los Alamos Scientific Laboratory (LASL) has performed a study on occupational exposures to be expected in a model GESMO MOX fuel fabrication plant. The maximum estimated exposure, taken from the LASL study and incorporated into the final GESMO, average approximately 23% of the 10 CFR Part 20 external exposure limit and about 1% of the International Commission on Radiological Protection internal exposure recommendation for occupational workers. See CHAPTER IV, Section D, paragraph 4.4.

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13. Comment:

"Section G of Chapter 4 contains the radiological health assessment for the recycle of plutonium in mixed oxide fuel. Tables IV J-4 through IV J-6 compare 50-year dose commitments to certain organs of the entire population resulting from the anticipated use of recycled plutonium in 1990 with the dose commitments that would be expected if only UO_2 fuel were used. For the analysis, the entire population dose is divided into occupational and general public doses. Occupational doses are shown in Table IV J-2. However, only whole body dose is given in that table. Only the external whole body occupational dose is factored into the dose comparisons in Tables IV J-4 through IV J-6. Occupational internal dose commitments are omitted. In the use of both the uranium and mixed oxide fuel, some relatively low level internal exposures occur. GESMO should acknowledge this fact, as appropriate, throughout the document; for example, in paragraph IV D.2.G on page IV D-31,

13. Comment (Cont'd)

which discusses occupational exposure in a commerical scale mixed oxide fuel fabrication plant. It is believed that this internal exposure should be included in the dose equivalent evaluations and will not change the conclusions of GESMO."

Response:

Selected organ doses resulting from occupational exposure are accounted for in new tables in the final GESMO, CHAPTER IV, Section J. The data presented are the dose commitments from a U. S. Nuclear Industry over a 26-year period, 1975 - 2000, comparing the three fuel cycle options, no recycle of uranium or plutonium, recycle of uranium only, and the recycle of uranium and plutonium.

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14. Comment:

"GESMO makes no reference to the export and import implications of the use of mixed oxide fuel. The implications upon the United States of the international shipment of plutonium including imports of plutonium processed outside the United States, overseas fabrication of mixed oxide fuel for domestic use and international shipments of mixed oxide fuel rods need to be considered in this environmental statement."

Response:

GESMO is directed toward the impacts of the recycle of plutonium in LWR's in the United States. Although its scope does not include a specific assessment of probable impacts of processing foreign or imported mixed oxide fuels or fabricating mixed oxide fuels for export, it should be noted that any such foreign business would alter only the numbers proportionate to the degree of associated activity. It would not alter the nature of the already assessed impacts. If the total size of foreign nuclear programs is roughly equivalent to the size of the U.S. programs over the projected time period for GESMO (1975 through 2000) and for example, one were to assume that one-quarter of the plutonium to be available in the rest of the world were to be imported for processing, fabrication and subsequent export, then the impact would be expected to be about one-and-a-quarter times the already assessed impact. Whether and to what degree such foreign business would be brought to the United States cannot be determined at this time. At any rate, it should be noted further that the GESMO study does not substitute for the in depth licensing reviews for individual export and import activities.

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15. Comment: (see page S-13)

"Paragraph 2 -- The definition of mixed oxide which limits MO_2 fuel to plutonium oxide in natural uranium oxide, and Figure S-5 on page S-26 of Volume 1 does not credit recovered uranium to the recovery-mixed oxide fuel cycle. These references and definitions of mixed oxide conflict with the footnote on page IV C-20 in Volume 3 which states: 'In the SGR mode of operation, the fissile plutonium discharge in a previous cycle in reprocessed, blended with natural uranium, depleted uranium, or uranium tailings ...' (emphasis added)

"GESMO should be revised here, and elsewhere, to take credit for all reusable components of spent fuel as mixed oxide; otherwise, the entire waste management recovery cycle and mixed oxide aspects of the nuclear fuel industry are detrimentally represented. For example, the third sentence of paragraph 2 on page S-13 should be revised to read as follows:

15. Comment (Cont'd)

'Mixed oxide fuels, as used in this statement, refers to oxide fuel containing plutonium oxide (PuO_2) in uranium oxide (UO_2), and plutonium recycle refers to their direct substitution for equivalent slightly enriched UO_2 fuels.'"

Response:

In Figure S-5, and also in Figure S-4 and throughout the draft GESMO, recovered uranium has been assumed to be routed through the enrichment plants to eventually reappear in reactor fuel as low enriched uranium. Some portion of the recovered uranium could be alternatively used in MOX fuel as well as enrichment plant tails. However, in the context of the overall LWR industry, the only way to recycle all of the recovered uranium is by re-enrichment of at least the major portion of the uranium. The quantity of the plutonium available for the fabrication of MOX fuel about the year 2000 will be sufficient to utilize only about 2600 MT of recovered uranium in the mixed oxide, whereas there could be at that time about 10,000 MT of recovered uranium.

It is not intended that the use of natural uranium in MOX fuel, as modeled in GESMO, shall be interpreted to preclude the use of recovered uranium or depleted enrichment plant tails or even low enriched uranium in individual reactor cases. Refer to CHAPTER I, paragraph 1.3.2.

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16. Comment: (page S-36)

"Third complete paragraph - the sentence, 'these reductions are insignificant compared to the 30,000,000 cancers and 12,000,000 genetic defects expected in 1990 in just the United States population' needs clarification as to whether it refers to new cases occurring in the year 1990, or deaths, or to something else. The basis for those numbers should be referenced and should appear somewhere else in the GESMO document."

Response:

For the final GESMO the health effects estimates have been recalculated based on new health effects factors that are discussed in CHAPTER IV, Section J, Appendix B.

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17. Comment: (page I-13)

"Table I-I - The table of permissible air concentrations for uranium and plutonium for occupational exposure is given without the important explanation of relation to period of exposure. For uranium, an MPC is correct after a few weeks of exposure because of relatively short biological half-life in the body. But, since plutonium has a very long biological half-life, the MPC for the long radiological half-life plutonium isotopes is correct only at the end of 50 years of occupational exposure, with inhalation at MPC assumed during the entire period. For a short inhalation period, use of the MPC grossly overestimates the resulting dose."

17. Comment (Cont'd)

Response:

This is a valid comment. The subject of application of MPC's is covered in CHAPTER I in the discussion of Table I-1.

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18. Comment: (page I-14)

"Paragraph 2 - The definition and application of 1.15 self-generation reactor (SGR) as used in GESMO is not clearly stated. The concept is used as a 'reference or model reactor upon which the safety and environmental impact of limited substitution of plutonium for U-235 is based;' but it is also stated that 'plutonium recycle limitations imposed by the Model 1.15 SGR will not cause significant revision of plans to recycle the plutonium in LWR's.' The use of 1.15 SGR as a model is clear; its impact as a limit is confusing. The use of 1.15 SGR as a limit is difficult to evaluate and can result in varying quantities of recycle plutonium because it is highly dependent on the fuel design and the previous fuel cycle history for a particular reactor. There are several inconsistent statements in GESMO when referring to the quantity of fuel implied by 1.15 SGR which also make it difficult to interpret as a limit:

'On the basis of the above comments, we suggest that the 1.15 SGR be clearly and consistently defined as values used for evaluation purposes only, and that if a regulatory limit is to be applied, it will be carefully defined and determined after an in-depth review and discussion with industry.'"

Response:

The concept of the 1.15 SGR, the GESMO model reactor, has been defined in detail in final GESMO, CHAPTER IV, Section C, paragraphs 4.1 and 4.2. For a more detailed response for this comment refer to Comment 4 of this Comment Letter No. 21.

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19. Comment: (page IV C-3)

"Paragraph 'Accidents' - This paragraph appears mislabeled because the paragraph discusses normal operating conditions. The discussion states that fission gases are removed from the coolant and dispersed into the atmosphere under controlled conditions via tall stacks. The 'controlled conditions' should be clarified or this statement should be deleted. The 'tall stacks' is not correct for plants with radiogas decay systems, such as those PWR's with storage tanks or the BWR's with charcoal systems. Accordingly, the paragraph should be revised as follows:

"1. Revise the heading 'Accidents' to 'Operational Releases to the Atmosphere.'

"2. The second and third sentences should be deleted and replaced with the following:

19. Comment (Cont'd)

'The fission gases released to the coolant are removed from the processes, treated as necessary, and released to the atmosphere in accordance with pre-established technical specifications.'"

Response:

The paragraph was identified erroneously in the draft GESMO as noted in this comment. The changes suggested have been included in this final GESMO CHAPTER IV, Section C, Summary. The accident discussion appears in CHAPTER IV, Section C, paragraphs 5.3 and 5.4.

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20. Comment: (page IV C-74)

"Third Complete Paragraph - With regard to the BWR, the assumption that all the tritium in effluents comes from the fission source is incorrect, as the sources include the deuterium in reactor water and minor leakage from both control blades and fuel. Therefore, the sentence which begins, 'In a BWR ...,' should be deleted through the end of the equation and should be replaced with the following: ..."

'Also on page IV C-75, Table IV C-9, items 5, should be revised by replacing 26 curies/year/reactor with 20 curies/year/reactor, which is the same as the UO_2-fuel reactor source term.'"

Response:

General Electric Licensing Topical Report NEDO-10871, "Technical Derivation of BWR 1971 Design Basis Source Terms," by J. M. Skarpelos and R. S. Gilbert, dated March 1973, indicates that deuterium activiation and leakage from control blades account for the production of approximately 18 curies per year of tritium, which is approximately 20% of the calculated annual release of tritium. Therefore, the major source of tritium released to the reactor coolant is considered to be leakage of tritium produced in the fuel rods by ternary fission. In the final GESMO, the annual quantity of tritium expected to be released has been revised to take into account releases in gaseous effluents, consistent with Regulatory Guide 1.112 dated April 1976. The revised releases of radioactive materials in liquid and gaseous effluents are given in CHAPTER IV, Section C, Tables IV C-16 and IV C-17.

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21. Comment: (page IV C-76)

"Table IV C-9, Items 13 and 14 - A basis is not stated for the assumption that turbine building iodine all originates from steam leakage and that a partition factor of one applies (see GE-ALAP testimony of P.R. Hill, GE Exhibit # 5, November 9, 1973). Therefore, Items 13 and 14 should be deleted and replaced with the modified approach as will appear in the AEC Regulatory Guide I-CC when it is issued after the promulgation of 10 CFR 50, Appendix I."

21. Comment (Cont'd)

Response:

In the final GESMO, the calculated iodine releases have been revised to be consistent with Regulatory Guide 1.112, "Calculation of Releases of Radioactive Materials in Liquid and Gaseous Effluents from Boiling Water Reactors," dated April 1976, and NUREG-0016 dated April 1976. The revised releases are given in CHAPTER IV, Section C, Table IV C-16 and IV C-17.

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22. Comment: (Page IV C-77)

"Table IV C-9, Item 22 - The fraction of the primary coolant activity levels shown are generally overestimates (see GE-ALAP testimony of H.L. Loy, GE Exhibit #4, November 9, 1973). Therefore, Item 22 should be modified in accordance with AEC Regulatory Guide 1-CC when issued after the promulgation of 10 CFR 50, Appendix I."

Response:

In final GESMO, the fraction of primary coolant activity levels are essentially the same in both WASH-1258, (the source of the values in Table IV C-9) and in Regulatory Guide 1.112, and NUREG-0016, both dated April 1976. Refer to revised parameters are given in CHAPTER IV, Section C, Table IV C-14.

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23. Comment: (page IV C-77)

"Table IV C-9, Item 23.c(1) - There is no basis for indicating the need for charcoal absorbers (called adsorbers in this paragraph) on the reactor building exhaust, based on the source terms given in Items 3, 11 and 14 in Table IV C-9.

Therefore, this item which now reads, 'treatment: charcoal absorbers' should be replaced with the following 'treatment: none.'"

Response:

In the final GESMO, the calculated iodine releases have been revised to be consistent with Regulatory Guide 1.112 and NUREG-0016, both dated April 1976. Based on the revised calculations, the charcoal absorbers are expected to be required for a typical site. The revised iodine releases are given in CHAPTER IV, Section C, Table IV C-17.

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24. Comment: (page IV C-78)

"Table IV C-9, Item 24 - There is no basis given for the assumption that as much as 10% of the treated high-purity and low-purity wastes will be released rather than recycled. This is far in excess of what might

24. Comment (Cont'd)

reasonably be expected in a maximum recycle system (see GE-ALAP testimony of H. L. Loy, GE Exhibit #4, November 9, 1973). The most probable percentage release of treated high-purity wastes is zero percent. Therefore, all sources originating with the high-purity waste system should be deleted and activity levels from the low-purity systems should be modified in accordance with our comment above concerning Item 22 of Table IV C-9."

Response:

In the final GESMO, the percent of processed liquid waste that is discharged has been revised to 1% for high purity waste and 10% for low purity and chemical waste, consistent with Regulatory Guide 1.112 and NUREG-0016, both dated April 1976. The revised releases of radioactive material in liquid effluents are given in CHAPTER IV, Section C, Table IV C-16.

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25. Comment: (page IV C-87, C-88)

"Table IV C-11 - The liquid effluent releases shown are high based on the comments above concerning source terms. This table should be corrected based on all changes made in accordance with comments above concerning Items 5, 22 and 24 in Table IV C-9."

Response:

In the final GESMO, the calculated releases of radioactive material in liquid effluents have been revised to be consistent with Regulatory Guide 1.112 and NUREG-0016, both dated April 1976. The revised releases of radioactive materials in liquid effluents are given in CHAPTER IV, Section C, Table IV C-16.

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26. Comment: (page IV C-89)

Table IV C-12 - There appear to be some errors in the gaseous effluent release values. For example, the values in this table are inconsistent with the source term, ITEM 16, in Table IV C-9 on page IV C-76. Apparently, Table IV C-12 is for steam jet air ejector and ventilation releases only. Since the source of these releases cannot be deduced from preceding data in the GESMO document, the values should be revised according to the comments above. Also, it appears that no credit is given for the fact that the ALSP hearing record shows that iodine releases contribute no significant dose on pathways dependent upon deposition on the ground. Therefore, a factor of two reduction in iodine source terms should be applied or otherwise corrected for in the agricultural dose estimates."

Response:

The values in the table in the draft GESMO were those calculated for the air ejector and ventilation releases only. The calculated releases have been revised in final GESMO to include releases from the mechanical vacuum pump and to include revisions to Regulatory Guide 1.112 and NUREG-0016, both dated April 1976. In the calculation of the thyroid doses to individuals 50% of the iodine-131 was considered to be in the form of organic iodides which did not enter the milk pathway, consistent with Regulatory Guide 1.109, dated March 1976. The revised releases of radioactive materials in gaseous effluents are given in CHAPTER IV, Section C, Table IV C-17.

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27. Comment: (Page IV C-95)

"First Paragraph and Table IV C-18 - This discussion concerns a reactor plant which has once-through condenser cooling. Plants which utilize cooling towers or ponds are not mentioned. This appears to be a major omission in GESMO as many large dual unit stations will have some form of closed cooling water systems with coolant effluent limited to blowdown and other minor coolant flows. A section should be added to the report which describes this situation. In that section, it will be important to evaluate doses with realistic waterway dilution factors, avoiding the unrealistic assumption that aquatic organisms and water users live in the coolant discharge pipes (see the comment on page IV C-99 below)."

Response:

For the final GESMO, doses from radionuclides released in liquid effluents were calculated assuming dilution which is typical of a large number of river-sited reactors. Likewise, the atmospheric dispersion parameters were chosen to correspond to typical site boundary distances and average meteorological conditions. These assumptions are in accordance with the NRC's directive to be realistic as stated in 10 CFR Part 50, Appendix I, issued April 30, 1975.

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28. Comment: (Page IV C-95)

"Last Paragraph on Page - It is apparent that the X/Q values for atmospheric diffusion are taken from the ALAP-FES where ground level or 10-meter height release assumptions were made. Tests at the operating Peach Bottom reactor have shown that diffusion from a roof vent is much better than is assumed by the AEC. Therefore all of the evaluations in GESMO should be revised using an increased atmospheric diffusion factor of about three for noble gas release and a factor of about ten for radioiodine releases."

Response:

The Peach Bottom tests were conducted for a limited number of vent flow rates and the site has unique topographical characteristics. Therefore, the evaluation restricted the application of the test results to only the Peach Bottom Plants. Since the flow rate per vent, which is dependent on the number of release points, can vary widely according to plant design, the result of the Peach Bottom study cannot be applied generically to all sites. The effects of low vent flow and topography have not been demonstrated. Also refer to response to comment No. 27.

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29. Comment: (Page IV C-99)

"Paragraph titled, 'Dose Rate Estimates' - Apparently, the aquatic doses are based on concentration in the discharge canal. A statement is made that mobile life forms do not spend much time at these concentrations; however, dose estimates should be made at a more realistic dilution location. All doses from liquid effluents should be evaluated based on realistic waterway dilution as it applies to each dose pathway. In the minimum case, this should include the dilution achieved in the mixing zone evaluated for conformance to thermal release requirements."

29. Comment (Cont'd)

Response:

For the final GESMO, doses from radionuclides released in reactor liquid effluents were calculated assuming dilution, typical of a large number of river-sited reactors. Likewise, the atmospheric dispersion parameters were chosen to correspond to typical site boundary distances average meteorological conditions. These assumptions are in accordance with the NRC's directive to be realistic as stated in 10 CFR Part 50, Appendix I, issued April 30, 1975.

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30. Comment: (Page IV C-102)

"Paragraph titled, 'Direct Radiation' - No reference could be found in GESMO as to how the direct radiation doses were estimated. Footnotes to tables on pages IV C-103 and IV C-104 say only 'calculated from power level, distance to boundary, use factor and shielding considerations.' The calculational method should be referenced or shown."

Response:

In the final GESMO, direct radiation doses are estimated based on observations at operating plants. No calculational models are used.

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31. Comment: (Page IV C-103)

"Table IV C-21 - The table shows off-plant doses from a two-unit BWR station. The air submersion doses from noble gases are shown to produce 5.7 millirem per year to the skin and 3 millirem per year to the total body. The total body dose is also applied to the GI tract, thyroid and bone; since the total body dose is not an ingestion dose, this analysis is not in agreement with methods of revised proposed Appendix I, dated February 20, 1974, which shows external doses as not being applied to individual organs. In addition, the noble gas release of 2200 curies per year (see page IV C-89) per unit is only 140 microcuries per second for the two-unit station. At such a release rate, the skin and total body doses in Table IV C-21 appear high by about an order of magnitude. It is believed that some of this overestimate probably comes from the semi-infinite cloud calculational error (see comment below concerning page IV J(A)-2). Details of how doses were estimated are not evident and should be shown or referenced. The dose estimates apparently include assumption of outdoor exposure at the fence post all year. The same is true for the iodine inhalation doses of 3 to 4 millirem per year. The iodine mild doses of 50 millirem per year to adult thyroid and 460 millirem per year to child thyroid include all the overestimates which General Electric has called to the Commission's attention in the ALAP hearing, principally:

A. Iodine chemical form; overestimate by a factor of two.

B. Roof vent diffusion; overestimate by a factor of ten.

C. High iodine deposition velocity; overestimate by a factor of about two.

D. High transfer, grass to milk; overestimate by a factor of two.

E. Assumption of fence post cow and baby; overestimate by a factor of two to 100, depending on actual cow location and actual milk usage.

31. Comment (Cont'd)

It should be noted that the Commission abandoned the fence post cow concept on February 20, 1974.

Detalied technical comments of the General Electric position on realistic dose evaluation are available in the ALAP record as follows:

1. GE-ALAP reply statement, filed March 14, 1974.

2. Transcript, oral argument, ALAP, before AEC Commissioners, June 6, 1974, pages 91 to 134.

3. GE-ALAP comments on dose evaluation, filed July 16, 1974.

Therefore, it is suggested that dose estimates should be revised as appropriate. The finite cloud calculation method should be used for noble gas gamma doses. The atmospheric diffusion for a roof vent should be used (see above comment on page IV C-95, last paragraph on the page). Reasonable occupancy factors should be included. The atmospheric diffusion factor should be revised for calculation of iodine inhalation dose (see comment above on page IV C-95, last paragraph on the page) and a reasonable occupancy factor should be included. On iodine agricultural pathways, corrections should be applied for iodine chemical form, roof vent diffusion, deposition velocity, and grass-to-milk transfer factor, all as indicated above. On milk usage, the three likely modes should be evaluated: (1) a baby drinking raw milk directly from the family cow; (2) adult only usage of such milk; (3) commercial dairy dilution of such milk."

Response:

Total body doses result from gamma irradiation reaching a tissue depth of 5 centimeters. At this depth, internal organs are assumed to receive a dose which is numerically equivalent to the total body dose. For comparative purposes, these organ doses are presented for the various cases under consideration.

All calculations are performed using the last NRC staff modeling assumptions which are described in detail in CHAPTER IV, Section J, Appendix A. These latest modeling assumptions are in accordance with NRC's directive to be realistic as stated in 10 CFR 50, Appendix I, issued April 30, 1975.

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32. Comment: (Page IV C-109)

"Table IV C-27 and 28 - The BWR population man-rem and millirem per year doses should be recalculated based on the above comments. Tables IV C-27 and 28 indicate a significant inconsistency with current AEC evaluations on actual projects. The tables indicate that total doses of 13 to 14 man-rem apply to a 50-mile radius population of 3-1/2 million. The final environmental statement for the Perry Plant, issued in June, 1974, contains the AEC calculation of a dose of 1.8 man-rem for a very similar 50-mile population of 2-3/4 million. We believe the approximate order of magnitude difference may be due to the various overestimates of factors as enumerated in comments above."

Response:

Refer to response to Comment 31 of this Comment Letter No. 21.

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33. Comment: (Page IV D-16)

"Paragraph D.1.e - The third paragraph concerning sources of plutonium contaminated liquids should be expanded to include other most likely process liquid such as those from off-gas scrubbing systems, nitrate conversion filtrates, fire protection systems, and secondary cooling systems; the least likely sources should be at the end of the list, i.e., 'scrub water or ...'"

Response:

Additions on the sources of Pu contaminated liquids have been made in the final statement in paragraph 1.5 of CHAPTER IV, Section D.

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34. Comment: (Page IV D-18)

"Paragraph D.2.a - The first sentence after Table IV D-5 is: 'Plutonium handling operations are carried out inside equipment located within process enclosures (glove boxes) ... .' Radiation from plutonium material will, in many cases, preclude operations within unshielded glove boxes. Therefore, shielded cells will be required. The sentence should be revised."

Response:

The discussion on the handling of recycle plutonium has been revised to indicate requirements for shielded cells as well as glove boxes. Refer to CHAPTER IV, Section D, paragraph 2.1.2.6.

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35. Comment: (Page IV D-29)

"Paragraph D.2.c(2) - Calculations of the nonradiological process effluent emitted from the fabrication plant, set forth in D.2.c(2), page IV D-29, are not consistent with Table IV D-12 on page IV D-41. For example: 1.5 kg per year of fluoride ion translates to 20.5 grams per day, assuming 20% operation of the dirty scrap line. (1.5 kg/year = [4.1 grams/day] [20%] = 20.5 grams/day.) This does not check with the 0.1 gram per day set forth in the first line on page IV D-29. We believe these calculations should be reviewed and revised as appropriate."

Response:

The non-radiological process effluents have been re-evaluated and the values have been corrected in the final GESMO. Refer to CHAPTER IV, Section D, paragraph 4.5 and Table IV D-1.

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36. Comment: (Page IV E-22)

"Table E-8 - There appears to be an arithmetic error in the I-131 entry since 0.50 does not equal 0.50."

Response:

In final GESMO CHAPTER IV, Section E, Table IV E-8 has been revised to show this correction.

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37. Comment:

"Paragraph a - The use of the semi-infinite cloud for gamma dose may be approximately correct at some great distance from the point of release, but it greatly overestimates doses at distances of usual interest beyond a site boundary. The degree of overestimation of dose depends on whether the release is from a stack, a roof elevation vent, or some lower elevation; but this model always overestimates the dose. All doses in GESMO based on the assumption of a semi-infinite cloud should be appropriately revised as mentioned in our comments above.

The deposition velocity of one centimeter per second may be only slightly conservative for elemental iodine, but that velocity results in large dose overestimates for organic iodine and particulates. As discussed in our comments above, a more realistic deposition velocity should be used throughout dose calculations in GESMO."

Response:

This comment has failed to recognize that GESMO deals with the total population as well as the hypothetical individual at a plant perimeter, and that an inconsequential few may be located so close that aeolian borne effluent will not have diffused to a radius in excess of a few hundred meters. Futhermore, over the course of the year, the aeolian borne effluent will flow in all directions, so that the perimeter inhabitant is submersed in a concentration item integral of broad extent.

Rounding the deposition velocity from 1.7 to 1 cm per second is not considered excessively conservative in view of the observed variances from 1.7.

Comment Letter No. 22

DOCKET NUMBER Misc Notice (39FR3018
PROJECT GESMO

UNITED STATES
ATOMIC ENERGY COMMISSION
RICHLAND OPERATIONS OFFICE
P. O. BOX 550
RICHLAND, WASHINGTON 99352

October 25, 1974

S. H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing
Headquarters

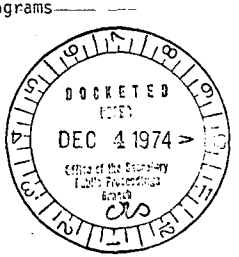
COMMENTS ON DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL

Attached are comments on the subject statement prepared by Westinghouse Hanford Company, which operates the Hanford Engineering Development Laboratory. RL Divisions have no comments to offer.

F. R. Standerfer, Assistant
Manager for Programs

ELP:WVT

Attachment:
As stated



I. COMMENTS ON DRAFT ISSUE OF WASH-1327
"GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL"
(Recycle Plutonium in Light Water-Cooled Reactors)

1. Pp. S-4 and S-42

". . . the introduction of plutonium recycle into a situation already dominated by other strategic SNM materials would not in itself significantly affect the required safeguards measures. Based upon the projected utilization of strategic SNM until the Year 2000, as shown in Table S-2, it is noted that plutonium recycle would constitute less than one-half of the total strategic SNM handled except for a few years in the 1980's when it is slightly more than one-half of the total."

This key issue is presented as clearly, fairly and positively as forecasting of future energy "mixes" permits. However, it is almost certain to be a focal point of criticism by intervenors. They are likely to regard it as obvious buck-passing amongst the LWR and the LMFBR and HTGR programs, each program claiming it only slightly aggravates a problem already inevitable because of other nuclear activities. As the current largest on-going nuclear power generator, LWR and, thus, Pu recycle in LWR's,will have to blaze the trail in answering objections raised by the following statements, without jeopardizing the interests of "future" nuclear systems:

(a) ". . . the greatest potential adverse impact of plutonium recycle involves the increased exposure of plutonium to theft or sabotage." (pg. S-47)

(b) "The transportation of plutonium and unirradiated LWR fuel containing plutonium will require special safeguards to protect against theft or misuse of the plutonium. This is because plutonium can be easily purified chemically and made into a nuclear weapon, whereas low-enrichment uranium must be further enriched." (pg. II-3)

(c) ". . . the biochemistry of plutonium is such that assimilated plutonium is distributed differently within the body and is only very slowly eliminated from the body compared

to uranium. This combined with the very much higher specific activity of plutonium causes the biological hazard of plutonium to be markedly greater than that of uranium." (pp. I-9 and I-13)

2. Pp. S-8 and S-48

"The six alternative dispositions of plutonium produced in LWR's considered in the GFSMO are:

(1) Prompt reprocessing of spent fuel, recycling the recovered uranium, and storing the plutonium for future use. This alternative represents the current situation and is the base case against which the other alternatives were compared."

Prompt reprocessing is not the current situation, with neither NFS, MFRP, nor BNFP operating (see pg. II-25) or expected to be operating before 1978, ?, or 1975. A footnote indicating that alternate 2 "represents the situation" from 1972 to 1975 would be in order.

3. Pp. S-14 and S-15

"Under current conditions of enrichment operation, 3 to 4 tons of natural uranium fuel is needed for each ton of slightly enriched uranium produced. . . . each ton of enriched UO_2 replaced by a ton of MOX results in a net savings of 2 to 3 tons of natural uranium. Based upon AEC projections, the industry requirements for uranium in about 1990 would be reduced by about 9 percent if plutonium were recycled."

With natural uranium containing 0.71% U-235, 6 to 7 tons of natural uranium fuel would be required for each ton of 3% uranium produced, assuming a tails content of 0.2 - 0.3% U-235. Even when augmented with uranium recycle from spent fuel, Fig. S-4 (pg. S-25) shows 5.8 tons of natural uranium being used to produce a ton of slightly enriched material. Thus, the net savings of natural uranium appears significantly underestimated.

Similarly, the recycling of plutonium, present to the extent of 0.6% in spent fuel (pg. S-2) and for which reprocessing losses (equivalent to the "tails" for U-235) are negligible, would appear to reduce uranium requirements by ca. 20% (0.6/3.0) not just 9%. While adjustments for differences in

fission energy, cross section, and lead times may alter these factors somewhat, it appears that the major source of benefit from Pu recycle may have been grossly underestimated in this evaluation.

4. Pg. S-46

"The Commission has a high degree of confidence that through implementation of some combinations of the above concept the safeguards general objective set forth earlier can be met for Pu recycle. Indications at this time point to decisions on upgrading within about 1 year after issuance of the final GFSMO statement. On this basis, it is further believed that the safeguards problem is manageable and that there does not appear to be any safeguards related rationale sufficient to delay a decision to permit the use of plutonium in mixed oxide fuel for light water reactors. The necessity for making an early decision is to assure time for implementation of the measures consistent with the projected phase-in of plutonium recycle. During the decision and implementation period there will be very little plutonium being used as mixed oxide fuel in LWR's (see Table S-10): therefore, there will be essentially no perturbation to the safeguards situation from early plutonium recycle."

As with point (1) above, while this issue is presented fairly and positively, it will almost certainly be a focal point of objection by intervenors. They will want to defer approval of the EIS and of plutonium recycle itself until after decisions and implementation of safeguards upgrading. The justification offered "for making an early decision" is hardly likely to sway them. Thus, they will prefer alternate (4) over alternate (3) (pg. S-48); and, of course, alternate (6) or even alternate (7) (Don't produce spent fuel in the first place!) would be still better.

5. Pg. S-47

"Perhaps the greatest adverse impact of plutonium recycle involves the increased exposure of plutonium to theft or sabotage. This potential would be substantially reduced by close-coupling MOX fuel fabrication plants with spent fuel reprocessing plants."

Both of these statements are very true and basic to the entire document. Accordingly, don't these points deserve greater prominence, e.g., by appearing long before pg. S-47?

6. Pp. S-49, S-22 and S-23

"While significant quantities of plutonium may be required for the initial fueling of FBR's, such requirements are projected to never exceed the then-current plutonium production rates; consequently, storage of plutonium for eventual use in FBR's is not a viable disposition possibility for all of the plutonium produced in LWR's. . . . Thus, if excess plutonium were stored, the only eventual end use for that excess plutonium would be for Pu recycle in LWR's."

There are other scenarios of future nuclear power mixes that project a much larger and earlier penetration of the market by LMFBR's. In fact, considerable concern has recently been expressed -- especially since the release of the Cornell workshop report -- that plutonium availability may be inadequate to support the expected rapid growth of the LMFBR industry. Accordingly, with AEC support from Dixy Lee Ray on down, considerable attention is now being given to achieving higher performance, specifically shorter doubling times, for LMFBR's by means of core and fuel design modifications, including even renewed attention to so-called advanced fuels (carbide or nitride) for this purpose.

The critics are almost certain to pounce on this disparity in scenarios presented by the plutonium recycle (relatively low LMFBR participation in nuclear power generation through Year 2000) and the LMFBR (relatively high) environmental impact statements. The threat of such embarrassment could be conveniently forestalled by candidly acknowledging that (a) a broad range of future scenarios is possible depending on many difficult-to-predict factors, (b) plutonium recycle in LWR's is highly logical and probable but not inevitable, i.e., relative to LMFBR use of plutonium, and (c) for GESMO purposes, a large-scale Pu recycle situation has intentionally been selected to emphasize the prospective impacts. Then, if a smaller scale use of Pu recycle should occur, the impacts would be proportionately less.

Incidentally, for a brief but excellent discussion of alternative nuclear power mix scenarios, and the factors affecting such a mix, see Willrich & Taylor, "Nuclear Theft: Risks and Safeguards," pp. 60-63. In their "scenario that corresponds most closely to the mix of reactor types in the AEC forecast", of the total 1200 thousant megawatts of installed nuclear electrical capacity projected in the Year 2000 (LWR, LMFBR, and HTGR), 412 thousand are LMFBR's.

7. Pg. S-62

"Consequently, it is further concluded that prompt use of plutonium with upgraded safeguards will provide the maximum benefits at the minimum cost and should be implemented by the nuclear industry at an early date."

This appears to be a rather clear recommendation of alternative (4) (prompt reprocessing of spent fuels with U and Pu recycle, with significantly upgraded safeguards procedures). While alternatives (4) and (3) (same, without safeguards upgrading) are clearly quite similar except for the safeguards situation, it may appear strange to many readers that alternative (3) "is the basic plutonium recycle case which is evaluated in this generic statement." See Point 4 above for comment on likely critic reaction.

NRC Staff Response to Specific Comments On Health, Safety & Environment
By Richland Operation Office

1. Comment:

"Prompt reprocessing is not the current situation, with neither NFS, MFRP, nor BNFP operating (see pg II-25) or expected to be operating before 1978, ?, or 1975. A footnote indicating that Alternate 2 'represents the situation from 1972 to 1975 would be in order."

Response:

The reprocessing schedules for all alternatives have been revised to be consistent with the current industry status. See CHAPTER VIII, paragraph 5.2. The prompt recycle, Alternative 3, is defined as: spent fuel reprocessing starting in 1978, uranium recycle starting in 1978 and Pu recycle starting in 1981. However, based on a realistic assessment of further delays in commercial reprocessing, it now appears that reprocessing and recycle could not begin until 1981. Alternative 2 discusses a delay of this magnitude and the economic impacts are detailed in CHAPTER XI. Analysis has shown that there is a slight cost penalty involved in a short delay and almost no change in the environmental costs.

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2. Comment:

"With natural uranium containing 0.71% U-235, 6 to 7 tons of natural uranium fuel would be required for each ton of 3% uranium produced, assuming a tails content of 0.2 - 0.3% U-235. Even when augmented with uranium recycle from spent fuel, Fig. S-4 (pg S-25) shows 5.8 tons of natural uranium being used to produce a ton of slightly enriched material. Thus, the net savings of natural uranium appears significantly underestimated."

Response:

These comments are correct in that the savings of natural uranium indicated in the Summary and Conclusions of the draft GESMO did not correspond with the savings shown in CHAPTER IV, Section F. In this final GESMO, three fuel cycle options are assessed and natural uranium savings with the recycle of uranium only and uranium and Pu recycle are compared to no recycle. See CHAPTER IV, Section F, Table IV F-1.

---

3. Comment:

"Similarly, the recycling of plutonium, present to the extent of 0.6% in spent fuel (pg S-2) and for which reprocessing losses (equivalent to the 'tails' for U-235) are negligible, would appear to reduce uranium requirements by a 20% (0.6/3.0) not just 9%."

Response:

These comments are correct in that the savings of natural uranium indicated in the Summary and Conclusions of the draft GESMO did not correspond with the savings shown in CHAPTER IV, Section F. In this final GESMO, three fuel cycle options are assessed and natural uranium savings with the recycle of uranium only and uranium and Pu recycle are compared to no recycle. See CHAPTER IV, Section F, Tables IV F-1 and Table IV F-1a.

A 9% reduction was an overall industry average where many reactors were relatively new and not yet realizing the full benefits of plutonium recycle. In the final GESMO, the similar industry wide savings for the period 1975 through 2000 are 13% relative to uranium only recycle and 22% relative to no recycle.

---

4. Comment:

"There are other scenarios of future nuclear power mixes that project a much larger and earlier penetration of the market by LMFBR's. In fact, considerable concern has recently been expressed -- especially since the release of the Cornell workshop report -- that plutonium availability may be inadequate to support the expected rapid growth of the LMFBR industry. Accordingly, with AEC support from Dixy Lee Ray on down, considerable attention is now being given to achieving higher performance, specifically shorter doubling times, for LMFBR's by means of core and fuel design modifications, including even renewed attention to so-called advance fuels (carbide or nitride) for this purpose."

Response:

The scenario utilized in the draft GESMO was judged for that purpose to be the most realistic and, hence, was used throughout the environmental statement in order to develop realistic estimates of the impacts of plutonium recycle on the LWR industry. It should be borne in mind that a smaller plutonium recycle industry would involve proportionally smaller impacts, both adverse and favorable and the cost benefit ratio for plutonium recycle would be largely insensitive to the scale of plutonium recycle in LWR's.

This final GESMO assesses the impact on the LWR industry due to the implementation of Pu recycle based on the ERDA low growth energy projection (1975), without the breeder as the reference case. However, cases based on a moderate high growth rate, including FBR's, are treated in some evaluations to provide sensitivity indications. The data indicate no developing shortage of plutonium for fueling in the period studied, 1975 through 2000.

---

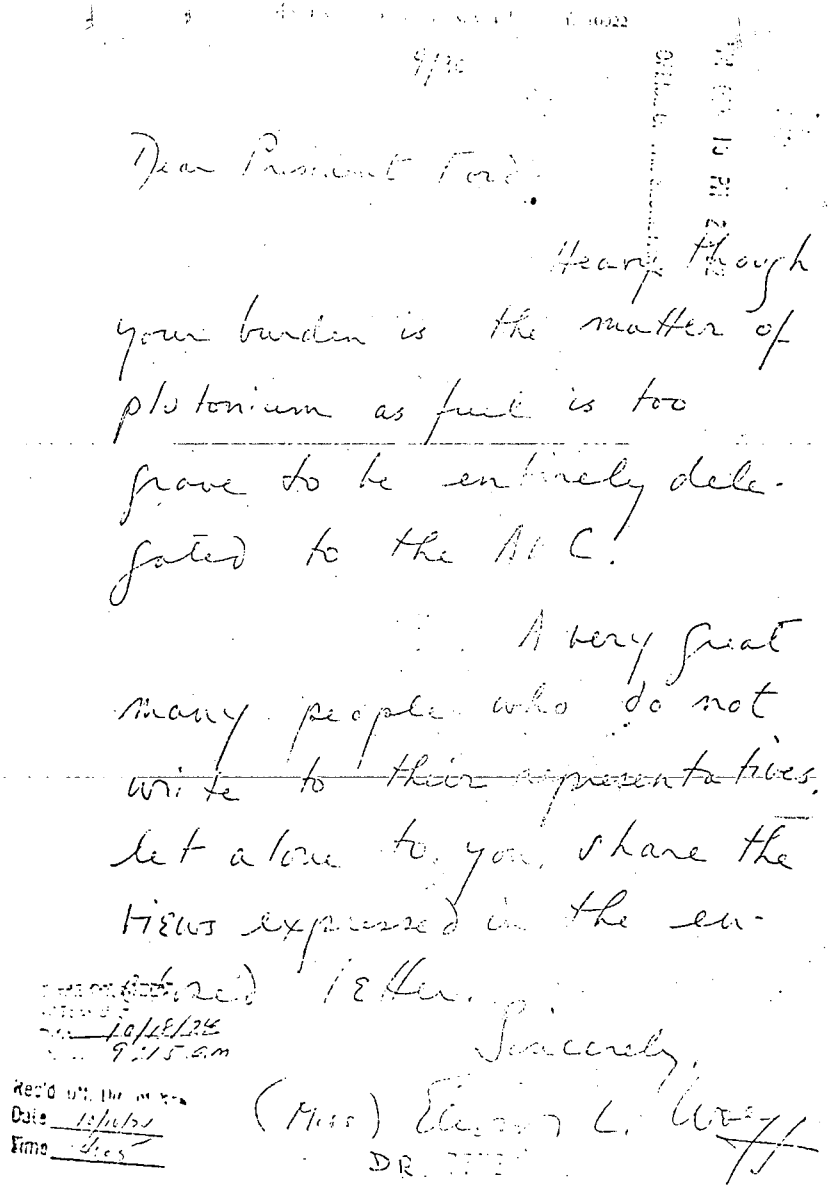
5. Comment:

"This appears to be a rather clear recommendation of alternative (4) (prompt reprocessing of spent fuels with U and Pu recycle, with significantly upgraded safeguards procedures). While alternatives (4) and (3) (same, without safeguards upgrading) are clearly quite similar except for the safeguards situation, it may appear strange to many readers that alternative (3) 'is the basic plutonium recycle case which is evaluated in this generic statement.' See Point 4 above for comment on likely critic reaction."

Response:

The reference alternative dispositions of recycle have been changed in final GESMO to correspond more closely to the current status of the LWR industry. The specific alternative which is labeled as the reference case does not make a difference in the comparisons. Labeling one alternative as a reference case merely affords a common base for comparisons. Alternative 3 in final GESMO assumes reprocessing spent fuel and recycle of uranium only in 1978 and recycle of uranium and plutonium in 1981 as the bounding case. See response to Comment No. 1 of this Comment Letter No. 22 for discussion of delays.

Comment Letter No. 23



9/28

Dear President Ford:

Heartbreak
Your burden is the matter of
plutonium as fuel is too
grave to be entirely dele-
gated to the AEC!

A very great
many people who do not
write to their representatives,
let alone to you, share the
views expressed in the en-
closed letter.

Sincerely,

(Miss) Eleanor L. Wolff

DR. ITT

Rec'd by the White House
Date 10/1/74
Time 9:15 am

ELEANOR L. WOLFF
400 EAST 52ND STREET
NEW YORK, N. Y. 10022

9/28/74

Thankyou, dear Senator Mondale, for expressing to Ms. May of the AEC fears so widely -- and also so helplessly -- held by those who have any inkling of the dangers even now posed by the use of plutonium, and who care at all for their own and others' health and freedom.

It is a pity that the N.Y. TIMES left its quotes of your and Senator Hart's letter to the tenth page: to my mind it is a matter of front-page, headline importance, outweighing even inflation, let alone other matters that appeared on page one.

I forget who said that war was too grave a matter to be left to generals: clearly you and Senator Hart feel the same about plutonium (and atomic energy in general, one assumes) and the AEC. The whole country should be grateful to you, and one can only hope that you are able to enlist the support of the public, the Congress and the Administration.

Sincerely yours,

OCT 29 1974

Ms. Eleanor L. Wolff
400 East 82nd Street
New York, New York 10022

Dear Ms. Wolff:

I am pleased to respond to your letter of September 30, 1974 to President Ford. I have been asked to reply since no decision has been made as yet on the matter of plutonium recycle in light water reactors (LWR's) and my group has been studying this matter in great detail. Be assured that the AEC Regulatory staff, as well as the entire Atomic Energy Commission, feels that a decision to authorize the use of plutonium recycle fuel in light water reactors is an important one.

The Regulatory staff recently performed a detailed and comprehensive assessment of the potential effects of the introduction of plutonium into the light water power reactor industry. This analysis is contained in the four volume, 1100 page draft "Generic Environmental Statement on the Use of Mixed Oxide Fuel in LWR's" (GESMO, WASH-1327), a copy of this document is enclosed for your use. This generic statement includes a review of the extensive background and experience in processing and handling plutonium, projections of the electric power and nuclear industries, safety and environmental assessments, considerations of materials and plant protection (safeguards), probable adverse environmental effects and mitigating actions that might be taken, alternative dispositions of plutonium, and cost-benefit analyses.

Based upon your letter to President Ford and the attached copy of the letter to Senator Mondale, it is not clear whether you received the complete text of the Senator's letter to Chairman Ray. Accordingly, we are providing you a copy of that letter of September 26, 1974 and the response by L. Manning Muntzing, Director of Regulation.

AC No # Pieter
212 -
1/14/75

OFFICE ➤						
SURNAME ➤						
DATE ➤						

Form AEC-318 (Rev. 9-53) AECM 0240 ☆ U.S. GOVERNMENT PRINTING OFFICE: 1974-526-166

We appreciate your interest in this subject of national importance.

Sincerely,

Original signed by
Nicholas M. Ray for

S. H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing

Enclosures
1. GESMO
2. Senator Mondale ltr, Sept. 26, 1974
3. L. Manning Muntzing ltr, Oct. 7, 1974

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NRC Staff Response to Comments by Ms. E. L. Wolff

1. Comment:

"Thank you, dear Senator Mondale, for expressing to Ms. Ray of the AEC fears so widely -- and alas so helplessly -- held by those who have any inkling of the dangers even now posed by the use of plutonium, and who care at all for their own and others' health and freedom."

Response:

Refer to Comment Letter Number 5 from Senators Mondale and Hart and responses thereto.

Comment Letter No. 24

Misc Notice (39 FR 30186)
GESMO

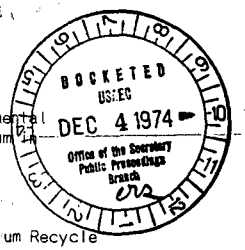
Atomic Industrial Forum, Inc.
475 Park Avenue South
New York, New York 10016
Telephone: (212) 725-8300
Cable: Atomforum Newyork

October 28, 1974

U.S. Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing-Regulation

Subject: Comments on Draft, "The Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in LWR's"(WASH-1327)



Dear Sir:

The attached comments have been developed by an Ad Hoc Plutonium Recycle Task Force of the Atomic Industrial Forum's Committee on Nuclear Fuel Cycle Services. A list of the Task Force membership is also attached.

The Task Force commends the AEC for the staff effort and care reflected in the draft GESMO and believes that the statement will contribute important support to the ultimate recycle of plutonium-bearing fuels in light water reactors. The Task Force also commends the AEC for seeking the comments of the nuclear industry and other interested parties on the draft statement.

The comments are submitted with the objective of strengthening the draft statement and address the following five general areas: cost-benefit analysis, limitations of scope, safeguards, health and safety, and format. Additional comments of a more detailed nature, derived from a page-by-page review of the draft statement are presented separately.

The Task Force's detailed comments seek to correct certain inaccuracies, address additional topics and clarify points that appear to have been based on incomplete or obsolete data. They are offered with the hope that they will shorten review of the statement during the hearing that is to be held. For the most part, the exceptions taken by the Task Force to certain of the proposals set forth in the draft GESMO are attributable to the Task Force's belief that there is a greater need to quantify environmental impacts insofar as possible through cost-benefit analyses. This is especially true in those sections of the statement treating on safeguards.

The Task Force appreciates this opportunity to review the draft statement and hopes its comments will facilitate early issuance and adoption of the final statement.

Sincerely,

Ralph W. Deuster

Ralph W. Deuster, Chairman
Nuclear Fuel Cycle Services Committee

RWD/jmc
Attachments

Atomic Industrial Forum, Inc.
475 Park Avenue South
New York, New York 10016
Telephone: (212) 725-8300
Cable: Atomforum Newyork

General Comments on the GESMO

Cost-Benefit Analysis

It is generally known throughout the industry that the capital costs enumerated in Table S-14, "Capital Invested (Millions of 1974 Dollars about 1990)" are outdated. Table S-14 cost estimates overall are low by about 20%. Selected areas, such as reprocessing and mixed oxide fabrication are perhaps low by several hundred percent. Similarly, the operating cost assumptions for materials and services in Table S-15, "Projected Costs for Materials and Services in 1990 (Millions of 1974 Dollars)" are generally low by varying amounts.

Using more recent estimates of capital and operating costs, the differential annual cost for the year 1990 to the users of LWR's generated electrical energy, if plutonium is not recycled, is approximately 0.8 mil/KWH (compared to 0.4 mills/KWH in Table S-4), or about $2 billion cost penalty compared to the $1 billion penalty indicated in GESMO. If neither plutonium nor uranium is recycled, the cost penalty for the year 1990 will likely be in excess of $2.5 billion. It should be emphasized that the economics for a single future year case are not nearly indicative of the overall magnitude of potential cost savings attributable to plutonium recycle in LWR's. For the year 1980 through the year 2000, the users of LWR's generated electrical energy will pay a cumulative total penalty of nearly $50 billion if plutonium is not used in light water reactors, and nearly $60 billion if neither plutonium nor uranium is recycled. This cumulative penalty to society through the year 2000, which is in 1974 dollars, is more than the total capital investment that will be needed to support the LWR fuel cycle.

In the overall evaluation of plutonium recycle, the most realistic analysis would assume some delays in the schedules as outlined in GESMO. Certainly some slippage in almost all schedules is inevitable without solid commitments to key milestones from the AEC and its licensing and regulatory agencies, from the nuclear industry, from the Government in its energy policies, and from the general public at large. It would be appropriate in GESMO to analyze the impact of schedule slippages on the cost-benefit of plutonium recycle. The initial delays in reprocessing should be addressed. Also, an alternative case analysis which should be included in any further studies on the sensitivity of schedules is that case which considers a slippage in the breeder (FBR's) schedule of 5-10 years. Under these circumstances, a comparison should be made between the alternatives of LWR plutonium recycle through the year 2000 and uranium utilization only. This approach would provide the proper perspective on which to judge the merits of various fuel cycles. Furthermore, this comparison should be carried out on a cumulative basis since the true impact occurs over the number of years the program is implemented.

A critical issue in the consideration of the GESMO assumptions and alternate case studies is the fact that without plutonium recycle in LWR's, the growth of a breeder industry will be slowed considerably. Experience gained with handling large amounts of plutonium through 1990 and beyond is essential to the growth of the industry and will provide the framework for licensing and public acceptance. Under this basis, four of the six cases evaluated by the Commission would no longer be considered viable options for the breeder concept.

Finally, in GESMO, the impact of plutonium recycle on the price elasticity of yellowcake is assumed to be negligible or non-existent. This assumption must be challenged on the basis that the demands placed on U_3O_8 without plutonium recycle are likely to far exceed by a considerable margin the values projected in GESMO.

Limitations of Scope

As we interpret the GESMO, there are severe scope limitations which either restrict the applicability of the GESMO, or imply that operations outside of the GESMO scope will not be permitted.

Manufacturing Facilities

The report would have greater credibility and usefulness if it also covered the period of time when the MOX fuel cycle industry is evolving and growing (1975-1990) as well as when it reaches maturity (estimated - 1990). As the report now exists, it relates only to the wide-scale use of Pu in MOX fuels for LWR's in the year 1990. At that time (1990) an estimated 6-8 MOX fuel fabrication plants of approximately 200-300 MT/yr. capacity would be required, the inference of the report being that these MOX fuel fabrication plants, which do not now exist, would be new and would meet the concepts and requirements of an upgraded safeguards program yet to be defined. No consideration is given to the five pilot-development MOX fuel fabrication facilities now existing and which could be viable for the interim period between 1975 and 1985, provided they are not required to meet 1990 safeguards and other standards during the interim period. (See "Manufacturing" section under "Health & Safety"). These existing plants are needed for developing both LWR and Breeder fuel.

When evaluated in relation to the upgraded safeguards concepts, it is obvious that these existing pilot facilities will be obsolete by 1990 standards. However, it is not clear that the same measures needed under the heavy throughputs of 1990, are needed while throughputs are still very low and adequately controlled by existing safeguards methods. Since there will be a need for these pilot facilities between 1975 and 1990 an environmental assessment and cost-benefit analysis should be made to determine the

extent to which existing plants should be operated, partially upgraded and perhaps even expanded without adversely affecting the environment or detracting from an adequate safeguards program. Inasmuch as the AEC actively encouraged each of the companies operating pilot MOX fuel fabrication facilities to get into the plutonium business, every effort should be made to enable the existing facilities to be gainfully used and fully depreciated in a safe and prudent manner before such facilities are declared obsolete under 1990 standards. As already mentioned, this analysis should consider the small capacities of the existing MOX fuel fabrication plants, and the fact that the facilities have already been upgraded to meet current AEC safeguards requirements.

Limits on Recycle Amounts

Detailed discussion in GESMO relative to the model LWR indicates that the 1.15 self generated recycle (SGR) value used is an average calculated from operating experience with existing LWR's. The report summary, however, goes one step further and implies limiting Pu recycle to the 1.15 SGR level. Since one might expect improved operating performance in all LWR's by 1990 it would seem more appropriate for the report to evaluate the impact on the environment of the highest Pu recycle technically possible for LWR's and to allow each reactor to recycle all the Pu it generates under equilibrium conditions.

In like manner, the report uses an upper limit of 5% Pu in uranium and mentions only natural uranium as the carrier. Some reactors may require slightly higher Pu concentrations than 5% and could economically use depleted or slightly enriched uranium rather than natural uranium as a carrier. These alternatives should be considered by the GESMO report.

Statement of Purpose

It would be most useful if the stated purpose of the GESMO could be enlarged to make it clear that environmental considerations covered by the report need not be duplicated for inclusion in environmental statements submitted by LWR operators, reprocessing plants and mixed oxide fuel fabrication plants when Pu is ultimately recycled or new facilities are constructed. If this is not allowed there seems to be little use for GESMO except as a starting point for more discussion and perhaps the basis for repetitive environmental statements.

Safeguards

We feel that GESMO should emphasize the fact that considering the existing supply of plutonium and its current utilization, the current safeguards

system, as recently promulgated by the Commission, provides reasonable assurance that the health and safety of the public will be protected. We, therefore, concur with the Commission that the active safeguards system should be continued including the ongoing assessment of changing considerations. It is recognized that as safeguards are reassessed, upgrading may be necessary in the future. Future upgrading, particularly in areas of the government's responsibility, was addressed recently (October 9, 1974) in a speech by the Forum's President Carl Walske. His speech is attached for your information.

The GESMO in its present form presents no real cost-benefit analysis with respect to upgraded safeguards programs vs. status-quo programs. The report also seems to imply there are no alternatives to the concepts proposed (although we do not believe this to be the actual intent). Since definitive safeguards programs will not be issued for at least another year, some thought should be given to separating the detailed discussions of safeguards proposals from the GESMO and treating these as a separate issue at a later date.

Of those concepts which have been identified by the Commission as a means to improve safeguards significantly, we consider co-location as having a very long-range potential rather than being a viable near-term alternative. On the negative side, co-location could impose commercial difficulties which would affect the ability of fuel service suppliers to respond in a timely manner to the needs of fuel users.

With respect to the transportation aspects of co-location, we believe that adequate transportation safeguards can be provided within the present system and commensurate with the type, form and amount of the nuclear materials involved. Therefore, there is no absolute requirement to eliminate transportation in any segment of the fuel cycle. In any case, it must be recognized that transportation could not be eliminated altogether. The Commission has indicated as one of the advantages of an integrated fuel cycle facility that it would make use of onsite protection measures more efficient. But on balance, considering the small portion of the total fuel cycle costs which would be incurred for safeguards even with possible improvements, the benefit of any added efficiency gained by reducing transportation or by integrating facilities could not offset the added costs associated with co-location.

We suggest that the concepts involving spiked Pu or debilitating gases be discarded. Considering the fact that there are other reasonable means available which can be employed to attain the Commission's objectives, these schemes are quite unattractive. It is difficult to see how the benefit could outweigh the increased hazard created.

In conclusion, we believe that the present system of safeguards is generally adequate for the current state of the industry and such improvements as are desirable can be made in an orderly evolutionary way. We are convinced that much of the concern being expressed today is based upon situations which may have existed at certain facilities prior to the implementation of the present safeguards system and upon an inadequate understanding of the technological and other improvements that are now incorporated in the present system.

Health and Safety

Environmental Radiation

The radiation doses in the environs from reactors using mixed oxide fuel are calculated using as a basis WASH-1258 "Final Environmental Statement Concerning Proposed Rule Making Action: . . .'As Low As Practicable' . . . Nuclear Power Reactor Effluents". The GESMO evaluation, therefore, contains the same problems of overconservative assumptions and overconservative methods of calculation of doses as that document. In fact, the GESMO evaluation fails to utilize several of the improvements made in calculational techniques and assumptions made by the AEC. Several specific examples are offered to illustrate the nature of overconservatism in Attachment A to the comments.

"Hot Particle" Problem

Possible effects of the so called "hot particle" problem should be discussed in more detail in the final GESMO. As long as the Commission has not developed a final position on this subject, a possibility exists that it will be necessary to reduce the allowable airborne concentrations of plutonium by significant factors. A discussion of the impact of such a potential reduction should be included in the final GESMO.

Manufacturing

The GESMO addresses only hardened manufacturing facilities designed, built, and operated according to some combination of the GESMO assumptions and new regulations which apply to plutonium in the fuel cycle. If mixed oxide fabrication loads are less than projected in the GESMO there may be a need to use existing facilities during the period addressed in the GESMO. The existing facilities will, therefore, have to be modified to meet some interim regulatory safety requirements. As a result, occupational safety and environmental safety impacts of the interim facilities may not be consistent with the GESMO. The final GESMO should present an analysis of this eventuality.

The final GESMO should include additional analysis of the consequences of accidents in the manufacturing facilities. The consequences of loss of confinement and loss of shielding are more severe than in the UO_2 fabrication plant where the uranium has much less radiotoxicity and external radiation exposure is of little concern. In order to reduce the risk of accidents to acceptable levels, design, construction and operation of recycle fuel manufacturing facilities will result in greater capital and operating expenses. The factor of 1.5 greater than the cost of uranium facilities used in GESMO appears to be low.

Format

The following comments are presented as a means of clarifying the GESMO through some changes in format:

Although Volume I contains a good summary of the information presented in GESMO, it is often difficult to locate the detailed discussions in the later volumes which are related to the general statements and tables in Volume I. To clarify these statements and tables, it is recommended that chapter and section numbers of the applicable detailed discussions be referenced in Volume I.

A rather detailed table of contents is provided for the report. However, it would be very helpful if a subject index were also included. The same specific subjects are discussed in several locations throughout the report. Therefore, it is difficult for someone studying a particular aspect to find all of the separate related discussions.

The report, and in particular Volume I, is quite repetitious. The value of a brief summary at the beginning is recognized. However, in reading through the report, one wastes time in covering the same ground several times.

If the data were expanded and all technical inaccuracies corrected, the Volume 3 technical data would be useful with regard to the out-of-reactor portion of the licensing process. The Volume would be extremely useful to industry with regard to the reactor portion of the licensing process if it contained a table for indicating the impact of Pu recycle as was provided by the Commission with respect to the impact of the uranium fuel cycle. This may have been the Commission's intent judging from the titles of the Tables IV A-7 and IV A-8 listed in the Table of Contents, however, these tables of GESMO are missing.

The paragraph designations used in GESMO are confusing, consider the use of a straight number system. With the number system, the reader could easily determine what main section and subsections a specific paragraph is contained in. For example, paragraph I.b.(1).(a) of Chapter IV, Section E could be straightforwardly designated as 1.2.1.1 of Chapter IV, Section E or Paragraph 4.5.1.2.1.1.

Numerous general statements are made in GESMO which should be further clarified by placing them in context. For example, it is stated that the immediate recycling of plutonium would reduce the requirements for uranium mining by about 9% around 1990. It would be beneficial to add what fraction of the total benefit (in dollars) this reduction represents. This type of clarification would make GESMO much easier to understand and it would strengthen many of the arguments presented.

The purpose of the GESMO seems to get lost in the words (page S-13). It should be possible to state the objectives more clearly and then to equate the conclusions to them.

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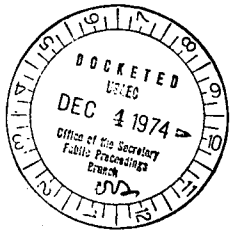
Atomic Industrial Forum, Inc.
475 Park Avenue South
New York, New York 10016
Telephone: (212) 725-8300
Cable: Atomforum Newyork

Attachment 2 of 4



Detailed Comments on the GESMO

DETAILED COMMENTS

Page	
S-2	Paragraph 4. This paragraph states that "accidents in the mixed-oxide fuel fabrication plant, a facility that does not occur in the UO_2 fuel cycle, are similar in consequence to accidents at UO_2 fuel cycle facilities. . .". This is only so if plutonium fabrication plants are designed and built like reprocessing plants. If this is the implication, it should be more clearly stated or the paragraph revised.
S-3	Table S-1. It would help if there was a footnote indicating the size of the 1990 LWR industry and what fraction of the fissile material is plutonium. It is also not clear if the Kr-85 is released or removed from the effluent streams.
S-4	Paragraph 3. The definition of self-generated quantities of recycle is somewhat ambiguous. Does this refer to total amount of plutonium available or equilibrium amounts? Although the choice of 1.15 times self-generated recycle for the reference case is reasonable some statement should be made about the relative effect of larger quantities of plutonium in recycle fuel (up to 200%). In view of the delays in start-ups of spent fuel reprocessing plants it may be necessary or desirable for the industry to recycle larger than self-generated quantities of plutonium in order to work off the backlog of reprocessed plutonium which will develop after a number of reprocessing plants have begun operation. Thus, the report should also consider the relative effects of significantly larger than 115% self-generated plutonium recycle.
S-4	Last Paragraph. The GESMO seems to place unnecessarily heavy reliance on a situation "already dominated" by other strategic SNM materials. There is considerable uncertainty in the timing of the LMFBR and the HTGR programs. Furthermore, it is suggested the amounts of special nuclear material projected for the HTGR and LMFBR programs be more specifically identified. It is not obvious whether Pu for military uses is included in the "other" category. This paragraph also seems inconsistent with later statements since it indicates that plutonium recycle will not significantly affect required safeguards since other SNM dominates the shipping picture. Later, however, on pages S-6 and S-7, the statement is made that the current safeguards provisions are inadequate and further work is being undertaken to study methods of upgrading them.
S-5	Table S-2. Is the bottom line SNM without the plutonium recycle program or SNM less recycle plutonium? Is the top line additional SNM due to plutonium recycle? Also, it is not clear if the quantities are total plutonium or fissile plutonium.

Page

S-7 Paragraph 1. Some reference to the timing for the co-location concept is believed to be important. The concept, if viable, becomes more important as the number of fuel fabrication and reprocessing plants increases. It is not a very important or effective method of improving safeguards while the number of plants are very few. Furthermore, the opportunities of co-locating with any of the partially constructed reprocessing plants are difficult to access so that it is not clear that co-location can be a practical solution for use in time for the first additions of fabrication capacity.

S-7 Concept 6. Some mention of the fact that "spiking" is likely to be the most expensive of all the alternatives should be made.

S-7 Paragraph 7. Although this paragraph implies that the above are only concepts which are under study, it is recommended that the Commission make this more positive. It should be clear that the six listed concepts are merely examples and that the Commission is not now locked into any of these, and that many alternatives will be investigated before firm determinations are made.

S-7 Paragraph 8. Upgrading of safeguards about one year after issuance of the final GESMO is likely to delay decisions on the construction of any manufacturing facilities for mixed oxide fuel. Since the use of additional safeguards seems to be a rather firm conclusion, it would seem more advisable to recognize that evaluation of the alternative safeguards methods will proceed in parallel with the GESMO. The timing on release of upgraded safeguards regulations should not be tied to the timing of the final GESMO but rather proceed as expeditiously as possible.

S-8 Paragraph 9. The conclusion that "alternative 4. ranks best" cannot be made directly from the data presented in Table S-3 (page S-9). Based on that table, alternative 3. is the best.

S-9 Table S-3. Depending on the manner of safeguard upgrading, the whole body radiation exposure for alternative 3. and 4. may not be identical ("spiking" may greatly increase the exposure).

The value under whole body radiation exposure "plus 21%" should be "minus 21%".

The ability to calculate the cost differential between Cases III and IV is highly questionable considering the vast differences between the costs of the six subcases considered in Item 4.

What is the time basis for this table? (Annual?)

Page

S-10 Paragraph 3. "1955" should be "1995".

S-10 Paragraph 4. Clarification is required. This paragraph first implies that some LWR plutonium will feed LMFBR's and then states "the only potential use of Pu" is LWR recycle.

S-10 Paragraph 5. Alternative 5. which involves permanent storage of plutonium is claimed to present a reduced safeguards threat compared to the base case. It is not immediately apparent that having a large stockpile of plutonium involves less of a hazard than smaller amounts in recycle.

S-11 Table S-4 (and preceding text). There is no indication whether the costs presented are based on current dollars or costs escalated to the 1990 comparison date. Also, Table S-4 indicates that costs include upgraded safeguards but does not state which safeguards are included (although it seems apparent that the costs of the various safeguards proposals will vary widely).

S-12 Paragraph 6. In the conclusion to approve plutonium recycle, (and in a number of other places in the report), the implication is that the approval of more than 1.15 SGR would not be given. It would be unfortunate if this blanket limit was adopted without compelling reason and it would be much better to rely on a case-by-case analysis. Some reactors will very likely have greater recycle capabilities and needs than others.

S-12 Conclusion 2.B. Remarks relative to timing of the decisions for upgrading safeguard measures should be omitted as discussed in the comment on Page S-7, Paragraph 8.

S-12 Conclusion 2.C. Some expansion of the statement to identify those safeguard measures which will be promptly implemented would be helpful.

S-13 Paragraph 1. This should be reworded to indicate that plutonium recycle constitutes a federal action which potentially affects the quality of the environment.

S-14 Paragraph 2. The manner in which this paragraph is worded opens up the question as to just what purpose the GESMO does serve. It is recommended that the paragraph be written in a more positive vein, indicating the purposes the GESMO serves, and its limitations.

S-14 Paragraph 3. The uranium prices are too low and need to be updated.

Page

S-15 Paragraph 3. Should ^{238}Pu be ^{239}Pu?

S-15 Paragraph 4. The stated concern for ^{241}Am conflicts in basic approach to the consideration using "spiked" plutonium to improve safeguards.

It does not appear that the costs and effects of plutonium repurification to remove Am have been included in the evaluation of alternatives. In particular, there should be a cost savings for alternatives 3. and 4. (immediate Pu recycle) as opposed to alternative 1 (base case). Undoubtedly the costs are relatively small but they should not be ignored.

S-15 Footnote. Does "other isotopes, e.g., ^{236}Pu" include ^{238}Pu? If so, the statement is incorrect. ^{238}Pu is not an important fissile material but is extremely important to evaluating overall environmental impact, including cost benefit analysis.

S-16 Paragraph 5. This should specify that MOX spent fuel contains larger quantities of Pu and transplutonium isotopes.

S-18 Paragraph 2. In contrast to the judgment made in the GESMO, dissolution of mixed oxide fuels may well present significant difficulties to the reprocessor. Complete dissolution of plutonium will probably require the addition of fluoride in quantities sufficient to cause corrosion in the stainless steels used throughout most head-end processes. Major modifications to flow sheet and equipment will, therefore, be necessary in all existing reprocessing plants.

S-20 Paragraph 2. "TWR" should be "LWR".

S-21 Paragraph 4. Relating plutonium inventory to FBR fuel requirements seems meaningless since FBR requirements increase approximately five times between 1990 and 1995 and approximately twenty times between 1990 and 2000.

S-22,23 Figures S-1, S-2, S-3. Are the amounts in the figures annual or cumulative?

S-27,28 Are the amounts in the tables annual or cumulative?

S-28 Table S-6. The use of fossil fuel should be clarified. What percentage of the energy requirements for the cycle are assumed to be supplied by fossil fuel?

Page

S-31 Table S-7. Assuming that Table S-7 represents the worldwide effects of the U.S. LWR industry, the title of the table should read, ". . .FROM THE U.S. LWR INDUSTRY."

S-35 Paragraph 4. Quantity of 2×10^{16} Btu needs a time dimension (per year?).

S-35 Paragraph 6. Is the "residual heat" the total heat value of the waste from 10 years decay to infinity? The term should be defined or clarified.

The size and capacity of the waste canister (1' Ø x 10' L, 3.2 MT fuel at 2 ft^3 waste/MT) or a reference to Page IV H-12 should be shown in paragraph 6.

S-35 Last sentence, bottom of page. This sentence should be changed to read, "Since the quantity of waste is small and since the waste is stored and not released to the environment, there would be minimal environmental impact."

S-36 Paragraph 3. Change the first sentence to read, ". . .0.27 and 0.18 cases per year respectively".

S-40 Table S-9. An attempt to quantify the radiological effects of transportation accidents should be made. The term "small" is indefinite.

Footnote. The last two sentences in the footnote should be omitted. A reference to Page S-36 might be desirable.

S-43 Table S-10. The estimates of Pu_f utilization in commercial LWR recycle fuel shown in Table S-10 should be updated to reflect the availability of reprocessing facilities. In particular, it appears that there will be no recycle plutonium in 1976 and something less than 2400 kgs Pu in 1977.

S-44 Paragraph 5. A reference should be made to the recommendations of Willrich and Taylor as stated on page V-37.

In the third sentence of Paragraph 5., "ompliment" should be "implement".

S-45 Paragraphs 1. & 2. The element of cost has been omitted from the discussion of safeguards in the first two paragraphs. Any increase or tightening of safeguards measures should consider the cost and cost benefit to be derived from such changes.

Page	
S-45	Concept 1. It should be noted that with Integrated Fuel Cycle Facilities (minimization of Pu shipping) the utility might be forced into using the specific fabrication facility which is on the reprocessing plant site (or vice versa).
S-45	Concept 6. It should be noted that the use of "spiked" plutonium might prove to be impractical or uneconomical due to the cost of processing such material in the PuO_2 conversion and fuel fabrication operations. One of the purposes of reprocessing is to minimize fission product content so that semi-remote handling is possible.
S-46	Paragraph 2. This paragraph expresses a time relationship between the issuance of the final GESMO statement and the decisions on safeguards upgrading. This relationship appears to be contrary to the ultimate purpose of GESMO. Several of the concepts under study could have a significant impact upon the environment and the cost benefit of plutonium recycle. For this reason, decisions on upgrading of safeguards requirements need to be made as soon as possible regardless of the date of the final GESMO statement. In addition, Pu conversion, storage, and MOX fabrication facilities are being designed and/or constructed today. Postponement of safeguards decisions will only lead to inefficient backfitting and costly construction and operational delays. A statement should be made in paragraph 2. acknowledging the existence of present-day MOX fuel fab plants.
S-46	F. Paragraph 3. The statement: "Spent 1.15 SGR fuels would contain about 16% more tritrium and 11% less ^{85}Kr than spent UO_2 fuels" should be referenced.
S-47	Paragraph 3. This paragraph should mention the proposed disposition of the transuranics after separation.
S-47	Paragraph 5. The various safeguards concepts being considered have been detailed earlier and it appears too restrictive to single out one of the concepts in Paragraph 5. It is, therefore, suggested that the second sentence be omitted and the third sentence be restructured.
S-51	Figure S-7. Alternative 1 in this figure should show a Pu Storage "box" (without asterisk) similar to the box in Alternative 5.
S-52	Table S-11. Under Alternative 2, the Whole Body Radiation Exposure should be negative (-21%).

Page	
S-53	Table S-12. Under Alternative 6, the number of Transportation Shipments should be "-2500". The 77,900 MT SWU base case enrichment quantity should be footnoted to the effect that it includes 44% (or 30,000 MT SWU) of foreign enrichment requirements. This note will make Table S-12 consistent with the separative work units discussed on page S-61.
S-54	Last paragraph. Table number should be S-13.
S-55	Table S-13. Under Alternative 6, the kgs. of Pu_f accumulated in storage through 1990 should be "-309,200".
S-57	Paragraph 5. Sentence 4 should read, "Those operations where additional safeguards measures should be considered over Alternative 1. . .". A need or requirement has not been established; reference the wording and intent of the second paragraph on page S-42.
S-58	Paragraph 2. The last sentence speaks of ". . .the AEC's need to upgrade the safeguards program." Again, this need has not been established, and the sentence should probably read, ". . .the AEC's decisions on an upgraded safeguards program." The paragraph entitled Capital Investments should state that costs are calculated in 1974 dollars and that Table S-14 represents total accumulated capital investment to 1990 (if that, in fact, is the case). The paragraph entitled Materials and Services Costs should state that costs are calculated in 1974 dollars and that Table S-15 represents annual expenditures in 1990 (if that, in fact, is the case).
S-59	Table S-14. Under Alternative 6 and in the supporting data in Volume 4, the reason for a $70 million capital cost differential above the base case for "Spent Fuel Transportation" is not clear. Increased mileage accounts for the operating cost differential in Table S-15 (pg. S-60) but the reason for the capital cost differential is not apparent.
S-60	Table S-15. The differential changes in "Mining-Milling" costs between the alternatives in Table S-15 do not appear to be consistent. Table S-12 on page S-53 shows that the increase in mining-milling quantities for Alternatives 2 and 6 is approximately equal to the quantity decrease in Alternatives 3 and 4 (e.g., milling is +11,900 tons U_3O_8 in Alternatives 2 and 6 versus -10,000 tons

Page

S-60 (Cont'd) U_3O_8 in Alternatives 3 and 4). The operating cost figures in Table S-15, however, show a significant dollar change (+$670 million for Alternatives 2 and 6 versus - $300 million for Alternatives 3 and 4). If these figures are correct, some explanation should be given either in this summary section or in Volume 4. It appears that footnote "d" should also apply to the "Waste Management" item since the previous table (S-14) indicated that waste management capital costs were absorbed by the federal government.

S-61 Paragraph 2. The enrichment cost of $48.90/kg SWU for Alternatives 3 and 4 shown in the last line of paragraph 2 appears to be incorrect. Table XI-12 on page XI-35 indicates a figure of $55.06/kg SWU. This latter figure is also consistent with the -$400 million enrichment cost differential for Alternatives 3 and 4 shown in Table S-15. Use of the $48.90/kg SWU cost would yield a differential of about -$600 million.

I-2 Section A. It would be beneficial if the purpose of GESMO should be more simply stated.

I-3 Paragraph 2. Next to last sentence beginning with, "for comparison, . . .". This seems out of place. Makes the whole paragraph sound defensive.

I-3 Section B, 1st sentence. Need to define central station.

I-7 The out-of-reactor fuel cycle operations are presented. Subsequently plutonium and radioactive wastes are discussed. There is a need to establish what is done with "tails".

I-8 Figure I-3. Need to define acronyms and use consistent units. Show depleted "tails" stream from enrichment. The whole balance is difficult to follow.

I-9 Does projected cost of yellowcake include escalation?

I-10 Figure I-4. Consistent units should be used - define acronyms.

I-12 Figure I-6. Is plutonium storage/inventory cumulative to 1990? The depleted U - "tails" - stream should be shown as part of balance. Whole balance is hard to follow.

I-14 Paragraph 1, second sentence. Beginning with "thus, it would be . . ." is very difficult to follow.

Page

I-14 Paragraphs 2 and 3. This seems to establish a firm limit on quantity of plutonium charged in MOX. Is this the intent? MOX should be defined.

I-17 What is the time basis of values in Table I-3.2? Are these annual or cumulative?

II-2 Paragraph 1. "Estimates of nuclear power generation capacity. . ." Where is this shown? A reference should be provided.

II-3 2nd Line from top. . . ."ingested significant amounts of plutonium . . .". What is significant? This should be related to MPC_a.

II-3 Paragraph 2, 2nd sentence. . . ."under the defense in depth design . . .". is not clear.

II-4 Page II-4 and Table II-3 seem to imply an optimistic schedule for spent fuel recovery operations in U.S. (and, therefore, earlier than expected plutonium availability). Start-up date for the plants on Page II-25 is not achievable. This fact is implied in the definition of Case I (Base Case) for the cost/benefit calculations, but may make alternatives 3, 4 and 5 unrealistic. Perhaps more information could be presented on effects of delays in implementation of recycle and on effects of various cost parameters (storage costs, capital investment costs) on the results.

II-5 Paragraph 4, last sentence. Delete "The chart below,".

II-5 Paragraph 5, last sentence. This sentence should reference Table II-2.

II-12 Figure II-4. The cost/unit on right side of chart is confusing.

II-14 Table II-3. This schedule is probably not realistic as noted above (Page II-4 comment).

II-20 Table II-7. Half life of Pu-241 given as 13.2 years. IV C-58 lists the value as 14 years. The currently accepted value is ~15 years (consistent with Volume I S-15).

II-24 Paragraph 2, 1st sentence. correct spelling of "about".

II-24 Paragraph 2. With regard to the coefficients of reactivity "larger" should be "more negative".

The discussion on calculational uncertainties is inconsistent with a subsequent passage (Volume 3, IV. C-59) on the same subject.

Page	
II-25	1st sentence. Need a period after parenthesis.
II-25	Paragraph 1. Since cores containing mixed oxide assemblies are more stable GESMO indicates that "part length fuel rods" may be eliminated. The reference should be to part length control rods.
II-25	Last paragraph. The start-up dates for existing or planned reprocessing plants should be updated.
II-26	Paragraph 3, 1st sentence. Delete "very".
II-27	Paragraph 5. No mention is made of the hazards of plutonium nitrate.
II-27	Paragraph 5. Neutrons due to subcritical multiplication can also be very significant.
II-28	Section b. The beta contribution from Pu-241 is not discussed.
II-29	Section c and d. It is not clear whether this section is still restricted to plutonium oxide. Also, there is a statement that plutonium absorbed through the skin deposits in the bone which seem to contradict section a. on page II-28.
Appendix	In the Appendix to Chapter II, dealing with criticality accidents in chemical processing, it is recommended that the material recently published by Olsen, Hooper, Uotinen and Brown on "Empirical Estimation of Number of Fissions from Accidental Criticality in Uranium or Plutonium Systems" (ANS Transactions, winter meeting, 1974) be included. This work is not merely a compilation of data on miscellaneous accidents, but presents an empirical means of estimating the energy release from various criticality accidents.
II-32	Paragraph 3. 3×10^{4} should be 3×10^{-14}.
II-35	Paragraph 3. ". . ., the fuel fabricators designed their LWR fuel facilities to produce. . .".
II-38	Paragraph 2. There are redundant phrases concerning burn-up and linear heat ratings. Clarification is required.
II-40	Paragraph 1. Statement on cladding material of construction needs clarification.
II-40	It is not clearly stated what type of reactor Saxton was. (PWR)
II-48	Table II-12. No value given for hole size; footnote implies values given for % dishing are hole sizes.

Page	
II-52	Table II-15. "Pu concentration, % + .10 "is not clear (is this on the ratio or a percentage?).
II-62	Paragraph 4. Mixed oxide reprocessing may require additional capacity in the plutonium purification facilities, not additions.
II-64	Paragraph 1. "In all transuranium elements certain small losses. . .". Statement needs clarification. 30% heat generation increase lasts over what time period?
II-64	Paragraph 3. 4.5 microcuries per pound.
II-65	Paragraph 1. "Present plans are to hold. . .". Statement needs clarification.
III-4-7	Figures III-1,2,3. Shouldn't ordinate scale be labeled "10^{3} Megawatts" instead of megawatts x 10^{3}?
III-8,9	Figures III-4A & B are unnecessary. The same information is provided in Table III-1.
III-1	The number of fuel reprocessing plants and mine-mill complexes may not be attainable in the period specified.
IV A-2	Paragraph 1. Reference in the first paragraph to "1/3 of the total power" is confusing, since power is an instantaneous measure. Is the word "energy" meant instead of "power"? This same confusion exists on other pages (e.g. IV B-2).
IV A-5	Figure IV A-2. No stream is shown in this figure for spent recycled plutonium or uranium, which have negligible value. It appears that continuous mixing with newly produced recycled material would not be economical. Also, no tails stream is shown from the enrichment plant on this figure or figure IV A-1 and similar figures in Section 3.
IV A-6	Table IV A-1. What is the basis of values in this table, annual?
IV A-7	Table IV A-2. Units in Table IV A-2 need clarification. ^{3}H & ^{85}Kr in millions Ci per year?
IV A-8	Table IV A-4. Same comment.
IV B-7	Paragraph 1. Regarding the last sentence of the first paragraph under 2.a., did AEC consider the added costs at reactors recycling Pu? This statement implies they did not; in cost/benefit analysis it should be considered.

Page

IV C-2 Paragraph 1. Is "equivalent plutonium" total Pu or fissile Pu?

IV C-3 Under "Accidents" the first sentence seems to be more appropriate to "Normal Operation". This should be clarified.

IV C-3 Is the GESMO serving any purpose if each request for licensing mixed-oxide assemblies must be evaluated on a case-by-case basis? Also line 3 "normaly" should be "normal". At the end of this paragraph, the phrase "just as each new type. . ." could be placed at the end of the second to last sentence, if this is the actual intent. Third line from bottom change "basically" to "initially".

IV C-4 Last paragraph. The last paragraph refers to both 63 rods and 64 rods in a BWR assembly. Actually there are 63 fuel bearing rods plus one non-fuel bearing rod (water-hole rod).

IV C-8 Some figures (such as Figure IV C-4) are out of date and do not match text discussion (e.g., Figure IV C-11).

IV C-13 Paragraph 5. 100 tons - standard or metric? PWR core was expressed in pounds. Also, this description applies to the design of only one of three vendors.

IV C-20 Paragraph 2, line 8. Add "IV" before "C-15".

IV C-24 Second sentence. The intent of the second sentence on this page is unclear. Was 1974 used only to compute the values of isotopic abundance shown in Table IV C-1? If so is this conservative or not?

IV C-28 Paragraph 2, 3.a. Suggest the following wording changes:

in line 2 change "changes are" to "differences is" and add "which" after "isotope."

in line 3 change "and the" to "causes a".

At the end of 3.a. do "thermal-hydraulic consideration" include fuel temperature, fission gas release, etc? If so the statement is not accurate as discussed later in GESMO.

IV C-29 Paragraph 3. Should specify that Saxton and San Onofre were PWR's.

IV C-32 Paragraph 2. Is there an error in the first sentence in the second paragraph under Control Rod Worth, regarding the thermal flux level being "only half"? It is certainly reduced but not by a factor of two. The argument following this statement still stands, however.

Page

IV C-33 Paragraph 5. The fifth paragraph is weak since it implies a difference between UO_2 and MOX. Could it be changed as follows: "The worst-stuck-rod control requirement may be unchanged and is affected by fuel loading patterns."?

Paragraph 7. The meaning of the last sentence in this paragraph is unclear.

Paragraph 8, line 2. Between "in" and "mixed" add "core containing".

IV C-34 Line 5. In line 5 replace "necessity of" with "need for" since it is difficult to imagine reducing a necessity.

Paragraph 3, line 1. Change "effect" to "affect".

At the bottom of page are words "above in Chapter V" correct? If Chapter V is the correct reference, "above" should be "below".

IV C-35 Why are Gd, Xe and Sm cross sections shown?

IV C-38 After first paragraph, there should be two conclusions. From reading the text that follows it is not clear what they are.

Paragraph 2, line 3. Change "since" to "and as a result".

IV C-39 At the bottom of page change "is generally true" to "may be".

IV C-43 First line. Change "would" to "could". No evidence is provided supporting this conclusion. Last sentence in second paragraph is a preferred approach in this area also.

IV C-55 The statement that "these increases are largely offset by the reduction in control. . .of mixed oxides" is not clear as to meaning. What may be meant is that "these increases are largely offset by the lower initial reactivity of mixed oxide fuels."

What is meant by "the required volume of coolant becomes excessive"?

What is referred to at the end of the first paragraph; i.e., "beneficial effect" on what?

IV C-58 Line 2. Change "results in" to "produces".

h., line 2. add "is" after "natural uranium" and in line 3 change "and" to "an".

Page

IV C-59 Should another "bullet" be added stating to the effect that "less experimental data is available for normalization"?

IV C-61 The next to last paragraph should be more fully explained.

IV C-64 Label is missing on ordinate of graph (%I.O.).

IV C-71 Reference 1: ". . .The Big Rock Point. . .".

IV C-72 Item (6). Change "Creaction" to "Creation".

IV C-100 Paragraph 1. The syntax of the first sentence is incorrect.

IV C-100 Paragraph 2. The syntax of the second sentence is incorrect.

IV C-104 Table IV C-22. The dose from direct and scattered radiation should be "Total Body" rather than "GI Tract".

IV C-112 Table IV C-33. Heading should read Man-Rem/Year.

IV C-113 Paragraph 2. It is stated that "The most significant difference in man-rem does occur as a result of water ingestion for river-sited boiling water reactors." While water ingestion shows the largest percentage change, differences in dose from other exposure pathways are more significant, even though the percentage change may be smaller.

IV C-113 Paragraph 5. First sentence should read "The transportation of fresh fuel. . .".

IV C-114 Paragraph 2. A more typical effluent cleanup system should be employed so that infant thyroid doses are typical of that normally expected.

IV C-115 Paragraph 3. The statement that "At worst, some SGR fuels exhibit as much as a 14% increase in the iodine thyroid dose source. . . more typically. . .a 10% increase" is not consistent with Table IV C-36, which shows a maximum increase of 8% and typically no increase in iodine dose source.

IV C-116 Paragraph 1. The last sentence should refer to Table C-37.

IV C-117 Table IV C-37. This table is confusing because of the comparison of different plutonium types at differing exposures. Are the Pu-2 - 3 and Pu-1 - 2 cases selected for the calculation of the element dose ratios the most limiting cases?

Page

IV C-120 Table IV C-40 and IV C-41. In view of the difference in inventory ratios (Table IV C-37), why are the radiological consequences of postulated accidents identical both with and without plutonium recycle.

IV D Chapter IV-D assumes that glove-box type operations will continue to be the design basis for MOX fabrication facilities. The accuracy of this is questioned in that higher radiation and neutron fields are anticipated in the future with the use of plutonium containing higher percentages of the heavier isotopes.

IV D-3 GESMO assumes that eight fabrication plants are operated in 1990 while only five would be required. While there is likely to be some overbuilding, the greater than 50% excess capacity seems large.

IV D-3 Paragraph 4. The 1990 release should be specified as the annual release. Do annual dose commitments include Beta dose from Pu-241?

IV D-4 Are Beta doses included?

IV D-6 Paragraph 1. The enrichment of PuO_2 fuel may be greater than 5%, and the diluent may be depleted or slightly enriched uranium rather than natural UO_2.

IV D-9 Paragraph 6. The production of MO_2 fuel rods by a combination of chemical and mechanical operations would seem to be independent of the installation of equipment at reprocessing plants to convert plutonium nitrate to a solid.

IV D-13 Paragraph 3. Depleted or slightly enriched uranium may also be used in place of natural UO_2.

IV D-17 Paragraph 4. Enrichment of PuO_2 may be greater than 5%. The first sentence should read ". . .enough fuel for about 25 reactors operating at the 115% SGR loading.

IV D-20 Paragraph 5. Slightly enriched uranium may also be employed.

IV D-21 Paragraph 2. Error in syntax.

IV D-26 Paragraph 2. Proven technology may exist for solidifying Purex wastes, but AEC burial and transportation requirements have not been formulated.

IV D-26 Paragraph 7. 9×10^{-6} μCi (·)/sec

IV D-31 Paragraph 2. Isn't 1 rem/yr used in the AEC for interpreting "as-low-as practicable" limits for personnel exposure?

Page	
IV D-32	Paragraph 6. What is the basis for estimating airborne releases of plutonium? Why are releases expressed in alpha curies only; 30-50% of dose from LWR plutonium comes from beta of Pu-241.
IV D-33	Table IV D-8 also indicates alpha curies only. Do estimated doses include beta effects of Pu-241?
IV D-37	Fabrication of MOX fuel may require some operations in remotely-operated cells.
IV D-38	Is the beta dose included in Table IV D-11?
IV D-39	Paragraph 2. The value stated for filter efficiency (10^{-9}) is in error; this is the transmission factor. The basis or reference for this value should be indicated.
IV D-39	Paragraph 1. Basis for filtration efficiency and air loading should be given.
IV E-2	Paragraph 1. Specify "Annual requirements in the year. . .".
IV E-5	The paragraphs on reprocessing facilities are outdated and should be revised.
IV E-7	Paragraph 3. Mixer-settlers are used extensively; centrifugal mixer-settlers aren't.
IV E-14, 15,16	It appears that iodine removal should be discussed. Iodine removal is indicated in Figure IV E-6.
IV E-16	Paragraph 2. Last statement unclear; throughput instead of throughout?
IV E-25	Table IV E-12. The annual dose commitments appear to be high compared to similar numbers in earlier environmental statement submittals and the EPA Environmental Analysis Report, EPA-520/9-73-003D.
IV E-26	Paragraph 4. What is the basis for the statement "the isotopic composition of uranium isotopes is somewhat less biologically hazardous with Pu recycle than without. . ."?
IV E-30	Paragraph 1. Why is the criticality excursion 10 times worse in fuel reprocessing than in the fabrication process (10^{19} vs. 10^{18} fissions)? No justification is given for the difference.

Page	
IV E-31	Paragraph 2. Syntax error in second sentence.
IV F-2	Paragraph 2. What is the basis for the statement "These values (9 and 11% reduction in uranium mining and enrichment demand) are significantly less than the theoretical 15% reduction in uranium consumption. . ."?
IV F-6	U_3O_8 Costs in Table IV F-3 should be $/lb. Although the footnote of Table IV F-3 notes that these costs are the costs at which uranium could be produced, rather than the sales price, greater emphasis should be given to this distinction since the sales price may be 50-100% higher.
IV F-15	Paragraph 1. The decrease in facilities (175 underground mines and 13 open pit mines) is not consistent with Table IV F-4 (total decrease of 180 facilities).
IV F-29	Paragraph 4. ". . .studied including: (1) Phase. . . .".
IV F-32	Table IV F-6. Are the total electrical power needs for added capacity supplied by gas centrifuge plants in addition to or in place of the requirements for gaseous diffusion plants. Why aren't the "Δneeds" for diffusion and centrifuge plants in the ratio of ten assumed in the basis given in the footnote?
IV F-33	Paragraph 7. The reference to Table IV F-5 is incorrect; the reference should be to Table IV V-6 or 7. The minimum range of electrical energy required (75 million megawatt hours) seems low and cannot be obtained from either Table IV F-6 or 7. The quoted values of coal consumption (44.8 and 39.9 million metric tons without and with recycle respectively) are not consistent with Table IV F-7.
IV F-34	Paragraph 4. The next to last sentence should read "Small radiological releases from the diffusion complexes, consisting only of uranium and uranium daughter products, . . .".
IV F-36	Paragraph 1. The quoted reduction of particulates and oxides of nitrogen by about 65,000 metric tonnes each is not consistent with Table IV F-7 which shows a 50,000 MT reduction. The 1.6% reduction in chemical effluents is not consistent with the 1.5% reduction in coal combustion quoted on page IV F-35.
IV F(A)-1	The total for no Pu recycle of the water discharged to ground should read 108,000.

Page

IV G-9 Paragraph 6. Depleted or slightly enriched uranium may also be employed.

IV G-10 Table IV G-3 shows a 30% increase in dose to transport workers and a 47% increase in dose to the general public for transportation of PuO_2 to storage with Pu recycle; in view of the order of magnitude reduction of the quantity of plutonium going into storage, this increase seems unlikely.

IV G-12 Paragraph 4. Depleted or slightly enriched uranium may also be employed.

IV G-13 Paragraph 3. Since the reduction of transportation steps prior to uranium fuel fabrication could have easily been factored into the analysis, why was this conservative simplification made.

IV G-23 Paragraphs 4 and 5. Depleted or slightly enriched uranium may also be employed.

IV G-24 Alpha waste associated with obsolete equipment or decommissioning-related rubble (masonry, structurals, etc.) which will not fit into drums will have to be specially crated and sealed to prevent dispersal of radioactivity. This type of container may be unsuitable for ultimate disposal, but will be required for many years of interim operations.

IV G-30 Line 4, Paragraph 2 should include sorption, followed by shipment to a central facility for incineration, and chemical destruction of organic bulk followed by recovery of Pu from residues or burial.

IV G-39 A more comprehensive analysis of risk may show that PuO_2 shipments in certain areas can be safeguarded more effectively by point-to-point aircraft shipment, using either rotary or fixed-wing equipment rather than by road shipment. This statement is made with full recognition of recent federal legislation to ban all aircraft shipments of Pu.

IV G-42 First sentence. Modify to show dose if half of fuel shipments are made by truck.

Page

IV G-44 Performance of PuO_2 (and Pu nitrate) shipping containers during transportation accidents should reference more recent papers by U.S. (BNWL) and French (CEA) authors, in Sessions 12A and 11 of the Fourth International Symposium on Packaging and Transportation of Radioactive Materials (Sept. 22-27) 1974. AEC-sponsored work at BNWL showed that the Pu transportation risks are three orders magnitude less than for meteorite hits, if current-day fireproof packaging is used. Prior evaluations should be re-ranked and these new findings be incorporated in Table IV-G-9 to give proper perspective to the low risk of shipping Pu nitrate (if correctly packaged). Overseas processors are expected to continue shipping Pu nitrate because of equivalency of risk compared to PuO_2. See author's final manuscripts as presented at September 22-27 meeting in addition to CONF-740991.

IV G-48 Actual data on package closure from an AEC-sponsored survey should be referenced and used. See reference above.

IV G-54 In paragraph 3., use of qualitative phrases such as "very small", "highly unlikely", etc. should be supplanted by probability ranges like 10^{6} to 10^{7} per year where assessments have already been published.

IV G-54 Item (e), Paragraph 1, last sentence should say "oxide or other form shown to be of equal or lower safeguards and transportation risk". AEC criteria for oxide vs. nitrate shipment need to be re-examined in the light of recent findings coupled with safeguards impact.

IV G-55 Accident risk statements, such as last sentence of item f, are not sufficient unless the phrase "in the vicinity of" are made clear by example. Isotope dispersal by waterways from a "major impact" site could be geographically far-reaching. Also amplify results of local confinement and cleanup opportunities if a "major impact" accident occurs.

IV G-56 Last paragraph under "Routing". The railroad associations have passed recent regulations and recommendations which affect the routing of rail cask trains. These details should be explained in the GESMO if AEC and industry perceive them to be long-lasting and relevant to the routing issue.

IV G-59 Line 4 suggests rewording as follows:. . ."assemblies, and limit the shipment of separated plutonium to only that quantity which is needed to balance the manufacturing loads (peak and valley effects) within the network of fabrication and reprocessing facilities." Delete statement referring to "elimination of need to ship separated Pu" because this idealistic condition could not be maintained at all times. Even if idealized IFCF siting could be achieved in 20 years, the transition period would require interplant shipment of plutonium.

Page

IV H-2 Paragraph 1--insertion in line 4 "to increase the total transuranium alpha activity sent to burial by a factor of five. Emphasis in subsequent statements should be on safe long-term alpha management, not just on heat generation and handling.

IV H-2 Paragraph 4 and IV H-10, Paragraph 5. In order to keep the volume down to estimated levels in GESMO report, current proposed AEC rulemaking must be changed to redefine exempt low-level alpha wastes by a new operationally-acceptable criterion (a) because 10 nanocurie per gram level is not practical to measure and administer and (b) because AEC recommendation to include all waste generated in "controlled areas" would inflate the burial volume and cost out of proportion to the benefit, especially considering $100 per cu. ft., projection for transportation and long-term management.

IV H-3 60 megacurie difference in hull burial is explained on Page IV H-20, but long-lived alpha buried with hulls changes in opposite direction from activation products, therefore, actinide curie comparison should be given in separate line.

IV H-4 No explanation is given for the maximum credible accident and why it involves only one waste canister. This section is too brief. The accident safety issues are not adequately covered.

IV H-15 Table IV H-3 should show separate subtotals for long-lived alpha and beta activity.

IV H-21 Footnote** should be reworded to state the end result required, i.e., quantitative leachability and devitrification stability of "glass" and then discuss generic aspects of one or more preferred solidification process routes, rather than deferring the analysis.

IV H-41 See note on IV H-21, also. The conversion to glass would require opening and emptying of the RSSF canisters or total fusion of canister plus contents. Discarded canisters disposal is not mentioned.

In last paragraph and on Page IV H-42, line 6, statements on shielding at RSSF do not seem consistent with high neutron and gamma streaming in storage cask configuration shown on Page IV H-36. A different air duct configuration would be needed to reduce surface dose to 2 mr/hr.

IV H-43 Paragraph 5 "milligrams" and "millicuries" require specific definitions. If this level of alpha release is meant, then it is high relative to MOX fabrication plant normal stack release.

Page

IV H-46 & 47 What is the environmental effect of meltdown in a canister? Can the discharges be controlled. Which concept for RSSF is the safest. Which is most tamper-proof and fail-safe? Such sondierations when left to the imagination of the public reader, are likely to lead to confusion.

Statements made in WASH-1539 "Environmental Statement - Management of Commercial High Level and Transuranium-Contaminated Radioactive Waste" page 2.5-2 indicate that RSSF design includes protection against man-made intervention, assumed to mean with malicious intent. What is actually provided to prevent dispersal by sabotage?

IV H-57 The concept of storing all plutonium waste at remote RSSF's with central incinerators should consider at least one eastern site to serve the fuel fabrication and reprocessing operations in this region of the U.S.

IV H-59 Last paragraph. Volume reduction should be changed to 3 to 4 because field experience survey shows secondary scrap generation (filters, refractory, etc.) affects net volume reduction, especially with incineration.

IV H-61 Paragraph 1. Rationale for considering only remote desert region is not clear for Pu waste RSSF.

IV I-4 Suggest deleting paragraph 3 in its entirety since soft gamma contribution from Am-241 is a minor factor, considering that the new generation of fabrication plants have no choice except to be well-shielded and the Am-241 problem will be taken in stride.

IV I-5 Line 1. After criticality prevention add "high accuracy inventory measurements for safeguards compliance".

III C Change the word "when" to "if" in line 1 of the last paragraph.

IV I-6 The storage inventory without recycle should be changed to show buildup starting in 1978 not 1976 since there will be no reprocessing carryout until about 1978.

IV J-6 Improvements in control of occupational exposure during uranium mining and milling have not been listed as to effect on fifty year dose commitment. This information should be added for balance. Likewise, the impact of several inadvertent releases from reprocessing plants or mixed oxide fabrication plants have not been assessed and listed in the fifty year dose commitment.

Page	
IV J-7	Item C, Line 7. Plutonium fallout of 320 kilocuries ratioed to the area of the United States should be given in addition to the worldwide fallout. Paragraph 4. After reference 2 the text should indicate an analysis by C. R. Richmond which was published in 1974 following the Second Annual Life Sciences Symposium at Los Alamos during May.
IV J-16	Transportation accidents should be included in this table.
IV J(a)-4	Most resuspension data have been based on experiments in arid terrain. There is a lack of useful data in heavily vegetated areas such as the Middle Atlantic Region. Resuspension data with uranium shown on Page IV J(a)-6 may indeed be conservative but considering that the bulk of the population is located in the eastern half of the country, more realistic data should be made available.
IV J(c)-7	Item 2. 1974 publication by C. R. Richmond, LASL, should be listed as a primary reference since it deals with the hot particle problem.
IV J(c)-9-17	The text is silent as to the toxicity of plutonium when combined with uranium in a mixed oxide compound. To date there have been no studies on the radiotoxicity of various mixtures of plutonium with uranium. Although only a small percentage perhaps 5-15% of the total tonnage of mixed oxide being processed in the year 1990 represent solid solution mixed oxide in the finely divided processing stages, if this combined form followed a pathway which resulted in adverse effects in regard to either bone or other critical organs, it should be identified at an earlier enough date to appropriately adjust the models. To our knowledge there are no animal experiments currently funded in the United States which will evaluate the effect of the mixed oxide particle itself. Uranium and plutonium would be expected to disproportionate in the body fluids and the results may be more complex to interpret and apply than for PuO_2 or other 100% plutonium compounds.
V-6	Second paragraph. Improved statistical treatments should probably be included as one of the means of improving safeguards systems.
V-6	Last paragraph. While it is stated that "a early evaluation of the concept is necessary" GESMO should recognize that the decision is already late. One manufacturer is currently faced with siting a mixed oxide fuel plant requiring "large capital investments" for which considerable engineering has been done. Perhaps there should be an acknowledgment that earlier plants may not be co-located, but that as the industry matures co-location would improve the overall safeguards. This would put the concept into proper perspective; it should not be a "go--no go" situation.

Page	
V-7	Section 6. This does not appear to acknowledge the considerably increased difficulty of making fuel with "spiked" plutonium.
V-28	Bottom of page. Here and in other sections of the GESMO the entire approach seems to be based on hardened manufacturing facilities. It would be highly beneficial (and probably a necessity) to address the problem of existing facilities.
V-39	Last paragraph. A similar listing of the disadvantages would seem to put things in better balance.
V-40	Paragraph 3. The weight of shipping containers for LWR plutonium oxide will probably range from 2500 to 5000 pounds due to shielding and confinement requirements.
V-41	Last paragraph. Some estimate of the probable costs of these systems would be appropriate.
V-44	Paragraph 6. This approach (incomplete separation) is not consistent with previous statements which imply conversion would have to be done at the reprocessor due to the ban on plutonium solution shipment.
V-44	Paragraph 7. The implication is that only additional shielding is required for fabrication of spiked fuel. In fact, entire new processes would have to be designed and QA activities would be greatly complicated. It is entirely conceivable that there may be no practical way to fabricate fuel under these conditions.
V-45	Paragraph 1. It seems much more likely that the fuel fabricator would be more concerned with health effects than a bomb builder. The population exposure as related to manufacturing personnel should be taken into consideration.
V-45	Paragraph 2. An increase in fabrication cost of $500/kilogram (which is probably not at all unrealistic) would likely render plutonium recycle uneconomic. Also, the effects decreasing fuel reliability (consequently enhancing population exposure due to fuel failures) because of decreases in the effectiveness of the quality assurance programs is not addressed.
VII-2	Paragraph 1. The lead sentence indicates that not all differential effects are adverse. However, the discussion is limited to only those effects which are adverse to plutonium recycle. Although such an approach is undoubtedly conservative, it serves to weaken the overall impact statement in that it fails to identify both favorable and adverse effects. It is believed this chapter should be expanded to identify both the favorable and adverse unavoidable environmental effects assignable to plutonium recycle as they differ from uranium fuel.

Page

VII-12 Paragraph 4. This indicates "additional measure to further limit any adverse effects may be possible. . .". However, the specific need for implementation of each approach is not justified in the report. Such quantification is believed essential for the final impact statement. Specifically, citing criteria for recycle plutonium facilities, guidelines on "as low as practical" releases for the facilities, improved safeguards, additional spent fuel shipment cask safety design criteria, long term waste management criteria, and possibly other items must be prudently developed and established prior to the accurate assignment of cost benefits to the various alternatives considered.

VII-14 Paragraph 6. The meaning of "action levels" is unclear.

VII-15 Last paragraph. "Fuel melt down" probably refers to clad melting.

VIII-8 Paragraph 4. Spent fuel transportation plus reprocessing cost of approximately $35/kilogram are undoubtedly too low.

VIII-13 Paragraph 3. Under the alternative of reprocessing spent fuel immediately and storing for later use, the build-up of Am in the recovered plutonium during storage and its associated impact seems to be ignored. Americium builds up in the recovered products through the decay of ^{241}Pu and in turn decays with a very strong alpha emission. The concentration of americium in the stored plutonium is dependent on the elapsed time since reprocessing and the isotopic concentration of ^{241}Pu in the plutonium. Typical plutonium recovered from reprocessing LWR fuel which is stored much in excess of one year prior to fabrication no longer can meet the current industry's specifications on americium concentration for recovered plutonium. The presence of americium in the plutonium and its associated strong alpha emission, imposes a significant radiological handling problem to the mixed oxide fabricator. Consequently, the need for chemical separation of the americium from the plutonium is required prior to mixed oxide fabrication. The major disadvantages of this additional separation step are:

(1) the production of additional plutonium bearing waste.

(2) the potential of introducing additional chemical impurities in the plutonium effluent.

(3) the need to reconstitute the plutonium back to its original oxide form for either shipping or uranium blending requirements.

(4) the major economic impact of the additional separation step.

Page

VIII-13 (Cont'd) When assessing this alternative in the final impact statement, both the cost benefit analysis and the environmental consequences of this additional requirement should be considered.

VIII-16 Paragraph 3. The use of depleted uranium as a carrier for the plutonium should be addressed. Utilization of tails assay materials, currently an unused waste from the uranium enriching process, should result in the significant benefits to this alternative.

VIII-16 Paragraph 4. This alternative would also have the same potential benefits of using depleted uranium as a carrier.

VIII-17 Paragraph 2. Alternative 6 seems to be discussed in paragraph i. not j.

VIII-21 Paragraph 1. A mixed oxide cost of twice uranium fuel fabrication is probably too low even considering current regulations, and is likely to increase rather than decrease as additional regulations are implemented. A cost of three times uranium fuel, over the entire time period (a surcharge of two times) should be subject to less argument. (The recent public bid openings at TVA and LADWP provide more concrete information on current pricing.)

VIII-21 Paragraph 2. The $35/kilogram number for reprocessing and spent fuel transportation needs to be updated.

VIII-33 Paragraph 4. The long term plutonium storage costs appear to be exceedingly low. The reason for this is not immediately clear and is recommended that the bases for the estimates be further explained.

VIII-37 There is some question as to the reasonableness of the estimated value of plutonium. Perhaps AEC could indicate the basis on which these estimates were made. Also, it would be desirable to include a statement on the sensitivity to a plus or minus change of $1/gram.

VIII-48 Paragraph 2. See comments under VIII-21, Paragraph 1.

Page

VIII-65 Paragraph 1. The unit costs of separative work, U_3O_8, and other factors used in the calculation of plutonium value need to be reviewed and revised to correspond with recent changes in the industry. Refer to other comments related to unit costs, escalation, and sensitivity to a plus or minus range when estimates are used.

VIII-65 Paragraph 2. The fabrication cost differential discussed in this paragraph does not relate to earlier parts of the GESMO that mention up to $500/Kg increase for safeguards concepts, such as spiking the plutonium. It would be desirable to track all cost-related items through the entire report to assure consistency.

VIII-69 Section C. This paragraph is confusing. It is suggested that it be rewritten to relate more closely with the other paragraphs discussing integrated fuel cycle facilities.

VIII-73 Section D. The cost to protect against theft of fresh fuel and the cost of additional hardening of barriers against theft of plutonium, each estimated at $1,000,000 for each reprocessing plant and for each mixed oxide fuel fabrication plant, is suspect. It is suggested that the discussion be expanded to indicate how these figures were derived.

VIII-75 Section N. The first sentence of this paragraph is not consistent with earlier parts of the GESMO, which indicated that costs would more than double when using "spiked" plutonium. It is suggested that the report be reviewed for consistency in matters of this sort.

XI - General The capital cost of facilities generally looks low. Since the major contributor to the benefits of Alternatives 3 and 4 are the savings in investment in Enrichment and Mining-Milling facilities, this modification will not affect the results.

One item open to question is the capital investment needed at a nuclear power plant to receive, store, and use Pu recycle fuel. It is not clear where this has been included. If one assumes it could add $5 million to the cost of each reactor recycling plutonium, the added costs to reactors is $600 million. If this figure is appropriate, the impact is small but is indicative of hidden costs which may need to be further investigated as licensing regulations evolve. Credibility of the report will be enhanced if all such cost items are identified.

XI-22 The conclusion paragraph should be expanded to discuss the apparent inability of the nuclear industry to get reprocessing and manufacturing facilities constructed. The problem areas should be outlined.

Page

XI-24 Table XI-10. The 1990 $12.83 figure for the U_3O_8 price in the terms of unescalated 1974 dollars is low and will distort the economic comparisons. This is indicative of the low cost numbers used in the report. It is recognized that there has been a dramatic increase in costs related to various components in the fuel cycle during this last year. For this reasons, all cost numbers and related economics should be updated.

XI-29 Table XI-11. The previous comment also applies to this table. All U_3O_8 cost projections used in the report need to be updated in order to enhance the credibility of the economic conclusions.

XI-44 Paragraph 3. Please expand the discussion to point out why the plutonium storage facilities would be similar to high-level waste disposal facilities.

ATTACHMENT A

Examples of Overconservatism in Dose Calculations

1. The use of the semi-infinite cloud model for gamma dose may approach being correct at some great distance from the point of release, but it is not correct at distance of usual interest. The resulting degree of conservatism depends on whether the release is from a stack, a roof vent, or a lower elevation. The correct model to use is the finite cloud gamma model. (p. IV J-(A)-2)

2. The X/Q values used are based on ground level release assumptions. Recent tests have shown that roof vent diffusion is much better than previously assumed by the AEC. (p. IV C-95)

3. The submersion total body dose from noble gases calculation was applied to GI tract, thyroid and bone. The revised Appendix I (2/20/74) does not apply submersion dose to individual organs. (p. IV C-103)

4. Details of iodine inhalation dose calculations are not evident and need to be reviewed. They apparently include assumption of out-door exposure at fence post all year. (p. IV C-103)

5. The iodine milk doses include all the overestimates which were shown to be objectionable at the ALAP hearings, namely (p. IV C-103):

   a. Iodine chemical form-overestimate by a factor of 2

   b. Roof vent diffusion-overestimate by factor of 10

   c. High iodine deposition factor-overestimate by factor of 2

   d. High transfer; grass to milk, overestimate by factor of 2

   e. Assumption of fence post cow and baby factor of 2 to 100 depending on actual cow location and milk usage. (The AEC abandoned fence post cow concept on 2/20/74.)

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SAFEGUARDS–THE INDUSTRY'S ROLE AND VIEWS

Carl Walske
President
Atomic Industrial Forum, Inc.

The U.S. nuclear industry, or nuclear energy community–whatever we may call it–consists of hundreds of companies and other organizations interested in commercial applications of nuclear energy. *Most, if not all, of them are* members of the Atomic Industrial Forum–some 625 as of today. Their opinions naturally vary on any issue which affects the development of nuclear energy, though oftentimes there is a general consensus view. So it is with the matter of safeguarding nuclear material of weapons grade–or special nuclear material.

While the Forum has not polled its membership on safeguards questions we on the staff have had a number of discussions with a good sample of responsible people from our member organizations. These include people from fuel reprocessors and fabricators, utilities, reactor manufacturers and transportation companies. On the basis of these discussions I have some feeling for what "the industry" is thinking about safeguards. As I talk I shall also mix in my own views, identifying them where they may be special to my own experience.

First of all, the industry is proud of the record to date. There have been no diversions. There has been no sabotage. There have been a few cranks, or other malicious persons, who have made threats. Most of these, unfortunately, probably were inspired by the publicity which has been given the subject. In the view of many of us, the publicity *was unfortunate*, but that's water over the dam now and we have to deal with the situation as it is.

I said that the record to date is perfect and that's true. Of course, the quantities of plutonium and highly enriched *uranium handled in the industry* have been miniscule by comparison with what lies ahead as we move toward the eighties. The industry knows this and fully appreciates that strengthened controls are necessary to deal with the large amounts of special nuclear materials which we anticipate.

Now, is it possible to protect special nuclear material sufficiently so that reasonable people will agree that any risk from diversion or sabotage is negligible? I believe that it is and at a cost which, although high, need not be so high as to cripple the economics of nuclear power.

The current safeguards system, as spelled out in new AEC regulations, is a clearly strengthened one as compared to what we had just a year ago. I believe it goes a long way towards what we *need. At the same time there are certain* aspects of this safeguards system which can be further improved. Some are appropriate to the industry's area of responsibility, some to the government's area. The balance of this paper discusses these possible improvements. They are, I believe, supported generally by the nuclear industry.

I shall be talking about the security personnel with the special nuclear material, physical protection, accounting and monitoring of special nuclear material in plants, communications, the command function, reinforcements and *intelligence* information. All these are necessary and complementary in building a first-class protective system for anything–whether it's gold bullion or special nuclear materials. They are necessary for special nuclear material at a fixed installation or in transit.

Guard forces and physical protection with special nuclear material can provide a first line of defense. It is not necessary that this line be impregnable, provided it is backed up with a reliable communications system which can be used to call up adequate reinforcements from a friendly command. Accounting for and monitoring of special nuclear *material, ideally* on a current basis, can signal departures from normal conditions, that is, sound a warning that something has gone wrong. Intelligence information, when available, is even better; it can signal in advance that something is about to go wrong.

Let's talk now about guard forces. First of all, most people in the industry would prefer to manage their own, other things being equal, but there is a problem. AEC regulations call for the use of armed force, if necessary, to prevent *diversion or sabotage of special nuclear* materials. In my own view this is appropriate, but in the civilian nuclear industry it is essentially unprecedented. It brings with it a responsibility beyond the experience of most commercial organizations and one which threatens with a morass of legal liabilities. However, there is a compromise on the question of who *should provide and manage guard forces*. The compromise approach is to divide functions between those requiring the use of armed forces and all others. The former should be performed by governmental forces; the latter by security personnel directed by the company responsible for the special nuclear material.

Presented at the AIF Public Affairs Workshop on Plutonium Safeguards, and the Breeder, 8-11 October 1974, Knoxville Tennessee.

For example, at fixed installations, monitoring and searching, if necessary, of plant personnel; materials accounting and monitoring; and maintenance and testing of physical security systems can all be done perfectly well by personnel under the plant management. In fact, they can be done with less upset to plant operations and to plant personnel—insiders dealing with insiders.

However, should the situation call for the use, or threatened use, of firearms to deal with a security problem—attempted diversion or sabotage—properly authorized public law enforcement forces should be brought into play. Such forces may be stationed at or near the fixed installation, or they may be on call from their normal station nearby. Obviously, they must be in a position where they can provide a timely reaction. For most fixed installations local police units may prove to be the most satisfactory.

Guards accompanying special nuclear material in transit must be able to meet force with force. Local police forces, in general, will not be able to respond rapidly enough to deal with attempted diversion and sabotage. Largely for this reason many in the industry feel that such guards must be under governmental control and must be authorized to act in emergencies under governmental orders. This might be done by using a special, governmentally organized force, or by civilian guards under contract to the government.

In all cases—material at fixed installations or in transit—guard forces should be well trained and required to exceed minimum physical and mental qualifications. They should be requalified by government inspectors on a periodic basis. Most importantly, guards should be given clearly defined authorities to govern their actions in the various emergency situations that could arise.

Physical protection of special nuclear material may include fences, lighting, vaults, and detection and alarm systems at fixed installations; and for material in transit it may include heavy containers or armored vehicles. These complement the assigned guard personnel. In general, the industry has accepted and agreed with AEC requirements for physical protection. There should, however, be a continuing review of these requirements, on the one hand, to see that no "Achilles' heels" are left in the protection systems and, on the other hand, to eliminate costly features which make only marginal additions to security.

AEC regulations currently permit shipment of special nuclear material—as defined in 10 CFR Part 73—either in a conventional truck with an armed escort vehicle manned by two armed guards, or in a specially designed truck or trailer without an armed escort. The design of such a special truck or trailer must include a capability for immobilization of the vehicle and must provide armor and other deterents to physical penetration. In a properly designed overall protective system the deterence to physical penetration will allow sufficient time for reinforcements to arrive at the scene of a diversion attempt.

In general, the industry is sympathetic with the armored vehicle approach when it is applied to special nuclear materials in a sensitive form suited to easy movement and direct usage in nuclear explosives, that is, separated highly enriched uranium or plutonium in the metallic or oxide form. However, when either of these fuels is contained in a fabricated fuel element, they are awkward to transport and they must be separated chemically or physically in order to be used as ingredients in a nuclear explosive. Thus, the industry's feeling is that for truck shipments of separated or concentrated special nuclear material, we should phase over, as practical, to the use of the armored vehicles. Until this is achieved and while conventional trucks are still in use, I believe that more than one armed escort vehicle should accompany shipments and each escort vehicle should have at least two armed guards.

Shipments by air, where possible, can generally be made the most secure. I noticed recently that the JCAE's Conway Committee has recommended against plutonium shipments by air, except in cases involving national security. This appears to me to be unfortunate. The risk of extensive aerial dispersion in a plane crash is certainly minimal. Careful choice of flight paths and special packaging could reduce even this small risk. It seems to me wrong to give up our most secure means of transporting plutonium.

Shipments abroad of special nuclear material must provide for adequate protection until a shipment is safely in the hands of its intended recipient. It goes without saying that precautions must be taken against hijacking and also that recipients must be capable of protecting material in their custody.

Reliable personnel are an absolute must if we are to have good security. Although security-type clearances are foreign to the civilian industry, nevertheless a clearance program appears appropriate. It would apply to all personnel having access to significant quantities of special nuclear materials. The AEC has now obtained legislation necessary for such a program. I believe the industry, in general, understands the need for this and supports it.

Such personnel clearances should certainly reduce the concern of those—such as the author of the Rosenbaum report—who postulate that "insiders", including senior management and operating personnel working within a facility or transportation company, could be involved in sabotage or diversion.

Furthermore, such cleared employees of licensees need be searched only exceptionally on entering or leaving protected areas containing special nuclear materials. Monitoring with instruments should suffice, with spot check searches only infrequently. As I said earlier, any such physical monitoring or searching should be the responsibility of personnel employed by the plant management.

At the same time I must say that security-type clearances are not to be taken lightly. It is most important that our society carefully preserve the rights of its members. Security clearances can obviously be abused. It will be up to all of us to guard vigilantly against any such abuse.

Much effort and much expense have gone into accounting and monitoring systems for special nuclear materials "in process" in a plant. Presently available techniques suffer from two great faults: First, their accuracy is such as to leave sizeable quantities of special nuclear material in a doubtful status; and, second, they report on losses only after they have happened, not as they are happening. All the same, the industry generally supports the rational application of the present techniques. There is, however, a strong feeling that it is illogical to incur greatly increased costs by shutting down plants frequently for overall inventories and by reducing allowed inaccuracies beyond what is straightforward. Unfortunately, the answers from the present system will be inaccurate, whatever the effort expended. Therefore it is sensible to use the present system only for what it is capable of doing—that is, detecting gross losses or diversions.

Beyond the present system, we may hope to have real time and accurate accounting someday. I don't know how achievable this may be, but it is certainly the right objective. Even now we can use special precautions whenever there are inter-area transfers at a plant. These could include independent weighings, checks of seal integrity, and other routine accounting actions and measuring actions to aid in the prompt detection of diversion.

Let us turn now to the question of communication systems. As I said earlier such systems serve the purpose of permitting local guard forces at a fixed installation or with a shipment to call for assistance, that is, to call for reinforcements. Obviously, such a purpose will only be met if the communications are highly reliable and if reinforcement forces are available for timely reaction from authorities having such forces at their disposal.

The AEC presently requires a licensee to maintain communications between his so-called control point and the guard forces at his installation or with shipments containing special nuclear materials. Carriers must make advance arrangements to assure support from law enforcement agencies. For shipments the present system relies on (1) the use of radio-telephones which are not effective in large areas of the United States, although they are working well in present operating areas; (2) local or state law enforcement agencies for reinforcements; and (3) support arrangements as can be made between such law enforcement agencies and the licensee.

There are several important improvements that should be made to the present system. First, the communications should be based on a federally operated, high frequency network. Such a network has proven highly reliable in maintaining radio contact with virtually all areas of the U.S. Second, a federal command center, perhaps supported by regional centers, should be established. It would receive and act promptly on reports of attempted diversion or sabotage involving special nuclear materials. Such a communications system and command center would be for both fixed installations and shipments.

The federal agency responsible for operating the federal command center should be responsible for consummating agreements with local and state police, the national guard and federal armed forces for provision of reinforcements. As mentioned previously, effective local law enforcement agencies are particularly well suited for responding rapidly to incidents at fixed facilities. Generally, state and federal forces will be more effective for incidents affecting material in transit. The agreements will certainly involve state governors for state police and the national guard; they will involve the President for federal armed forces. New legislation may be necessary to implement these arrangements. It is my impression that this area of federal communications, a federal command center and authority and implementing agreements, is the single most important task facing us as we move to improve the protective system. You will note that this, as I have presented it, is a task requiring the initiative and leadership of the federal government.

A special type of reinforcement capability would be needed if a diversion attempt were to prove successful, that is, if a diverter were to escape the first line of defense. In this event retrieval of the special nuclear material would be our objective. A retrieval operation would logically use nationwide intelligence information and therefore would best be handled by using a federal force under federal direction. This might be basically an FBI operation under the Attorney General.

Intelligence information available to the FBI, Treasury Department, CIA, Department of Defense, AEC, and state and local law enforcement agencies will never be sufficient to forecast all threats that may be developing. However, the totality of information available to these agencies can be very helpful in reducing risks. It is not clear to me that a good mechanism now exists for the prompt reporting of such information to a central, responsible command authority of the type previously mentioned and, also, the prompt dessemination of such information to law enforcement agencies. If it is not being done well, as I suspect, it should be corrected.

I have discussed a number of improvements that would strengthen our present safeguards system. The major new tasks are in the area of governmental responsibility, although I have mentioned some additional tasks for the industry. These would not, in my view, involve an appreciable increase in present safeguards costs. In fact, the AEC's new regulations—in effect since December 6, 1973, and now being implemented—went a long way to provide the necessary measures required of the industry.

As we look on ahead to the future, the nuclear industry will continue to work with the AEC to employ more stringent methods and procedures. Safeguards cannot be static as the nature of the problem changes. Both industry and government must move forward together to meet their vital responsibilities in this area.

My main points in this paper, aimed at strengthening our safeguards system are, I believe, generally acceptable to the nuclear industry. These points are:

1. Local guard forces and physical security measures should be sufficient to detect, report and delay attempted sabotage or diversion until reinforcements arrive.
2. Guard and security forces at fixed installations should be under the supervision of the plant management, except for those guards charged with the use of armed force. These last should be governmental forces, or at least governmentally organized and supervised guards.
3. Guards accompanying special nuclear material in transit should be under governmental control and should be authorized to act under governmental orders in emergencies. They may, thus, be government employees or contract guards under government orders.
4. Moreover the federal government should be directly and fully responsible for security of special nuclear materials in transit, coordinating and making use of local, state and federal resources.
5. For shipments of concentrated special nuclear material phasing over of conventional truck transportation should be undertaken, as practical, to the use of armored vehicles with immobilizing features. The design of the transport vehicle should include a strong barrier against penetration, which will allow sufficient time for reinforcements to arrive.
6. Physical protective features for special nuclear materials should complement guard forces in such a way that no "Achilles' heels" are left, but also so that costly features providing marginal additions to security are eliminated.
7. Agreements should be consummated, as necessary, between the responsible federal agency and local, state and federal officials for the prompt use of their forces when necessary. These agreements should include arrangements for operations by a federal retrieval force and for exchanging threat information with law enforcement and other agencies.
8. A federal communication system and command center should be created to support and coordinate the response of local, state and federal security forces in the event of attempted sabotage or diversion attempts at fixed installations or during transport.
9. Improved real time accounting procedures should be developed and implemented, at which time the dependence on MUF and LEMUF for detection of diversion should be greatly reduced.
10. An employee clearance program should be established for licensee personnel who have accesss to significant quantities of special nuclear material.

I regret that adequate safeguards require so much government involvement, particularly by the federal government. It would certainly be preferable if the industry could handle this problem entirely "in-house". Unfortunately, that does not seem to be a practical way to reach our objective of providing proper protection to special nuclear materials. We must, it appears, proceed with an industry-government partnership with each carrying out its role where it can do the best job.

In conclusion, I want to re-emphasize that the nuclear industry recognizes the importance of protecting nuclear facilities and special nuclear materials at fixed sites and in transit. We are confident that potential risks will be held at such a low level that they will be acceptable in the judgment of reasonable people.

Atomic Industrial Forum, Inc.
475 Park Avenue South
New York, New York 10016
Telephone: (212) 725-8300
Cable: Atomforum Newyork

Attachment 4 of 4

Ad Hoc Plutonium Recycle Task Force
of the
Nuclear Fuel Cycle Services Committee

D. R. de Halas (Chairman)	The Babcock & Wilcox Company
Emanuel Gordon (Secretary)	Atomic Industrial Forum
Richard L. Booth	Nuclear Fuel Services, Inc.
Colin S. Caldwell	Nuclear Materials & Equipment Co.
Bernard H. Cherry	General Public Utilities Service Corp.
Joseph Cupo	Westinghouse Electric Corp.
George Darmohray	General Electric Co.
Christopher Fowler	Allied-General Nuclear Services
Rudolph Grube	Yankee Atomic Electric Company
William Macnabb	NUS Corporation
Harvey Price	Atomic Industrial Forum
Raymond Robinson	Exxon Nuclear Company
Norton Shapiro	Combustion Engineering, Inc.
Thomas Snead	Duke Power Company
Wallace Sumner	Allied-General Nuclear Services
Robert Tallman	Bonneville Power Administration
William Utnage	Kerr-McGee Nuclear Corporation
Albert Watson	Carolina Power & Light Company

10/28/74

NRC Staff Response to Specific Comments on Health, Safety & Environment by the Atomic Industrial Forum

1. Comment:

"The attached comments have been developed by an Ad Hoc Plutonium Recycle Task Force of the Atomic Industrial Forum's Committee on Nuclear Fuel Cycle Services.

"For the most part, the exceptions taken by the Task Force to certain of the proposals set forth in the draft GESMO are attributable to the Task Force's belief that there is a greater need to quantify environmental impacts insofar as possible through cost-benefit analyses."

Response:

The environmental impacts of the various alternatives have been quantified in greater detail in this final statement. For those discussions, see CHAPTER IV, Environmental Impacts, and CHAPTER VIII (and Appendix VIII-A) Alternatives for the Pu Recycle Industry.

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2. Comment:

"It is generally known throughout the industry that the capital costs enumerated in Table S-14, 'Capital Invested (Millions of 1974 Dollars about 1990)' are outdated. Table S-14 cost estimates overall are low by about 20%. Selected areas, such as reprocessing and mixed oxide fabrication are perhaps low by several hundred percent. Similarly, the operating cost assumptions for materials and services in Table S-15, 'Projected Costs for Materials and Services in 1990 (Millions of 1974 Dollars)' are generally low by varying amounts.

"Using more recent estimates of capital and operating costs, the differential annual cost for the year 1990 to the users of LWR's generated electrical energy, if plutonium is not recycled, is approximately 0.8 mil/KWH (compared to 0.4 mills/KWH in Table S-4), or about $2 billion cost penalty compared to the $1 billion penalty indicated in GESMO. If neither plutonium nor uranium is recycled, the cost penalty for the year 1990 will likely be in excess of $2.5 billion. It should be emphasized that the economics for a single future year case are not nearly indicative of the overall magnitude of potential cost savings attributable to plutonium recycle in LWR's. For the year 1980 through the year 2000, the users of LWR's generated electrical energy will pay a cumulative total penalty of nearly $50 billion if plutonium is not used in light water reactors, and nearly $60 billion if neither plutonium nor uranium is recycled. This cumulative penalty to society through the year 2000, which is in 1974 dollars, is more than the total capital investment that will be needed to support the LWR fuel cycle."

Response:

All cost figures in final GESMO have been updated to reflect the best current estimates. Fuel cycle costs for each alternative have been cumulated through the year 2000, as recommended in this comment.

The total penalty for failure to recycle is calculated to be about $18 billion ($3 billion discounted). The calculated cost of failure to recycle uranium and plutonium can vary materially depending on assumptions made and discount rates used in the analyses. For additional detail, see CHAPTER XI, Section 3.0.

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3. Comment:

"It would be appropriate in GESMO to analyze the impact of schedule slippages on the cost-benefit of plutonium recycle. The initial delays in reprocessing should be addressed. Also, an alternative case analysis which should be included in any further studies on the sensitivity of schedules in that case which considers a slippage in the breeder (FBR's) schedule of 5-10 years. Under these circumstances, a comparison should be made between the alternatives of LWR plutonium recycle through the year 2000 and uranium utilization only. This approach would provide the proper perspective on which to judge the merits of various fuel cycles. Furthermore, this comparison should be carried out on a cumulative basis since the true impact occurs over the number of years the program is implemented."

Response:

The suggested sensitivity studies are included in CHAPTER XI, Section 3.0. These indicate that delayed reprocessing decreases the economic advantages of recycle.

The question at hand is the recycle of Pu in LWR's. The cross impact of the use of LWR generated plutonium for FBR's has been purposely eliminated in order to be able to evaluate the cost-benefits and assess the environmental impacts of the recycle of Pu in LWR's independently of the fast breeder program.

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4. Comment:

"A critical issue in the consideration of the GESMO assumptions and alternate case studies is the fact that without plutonium recycle in LWR's, the growth of a breeder industry will be slowed considerably. Experience gained with handling large amounts of plutonium through 1990 and beyond is essential to the growth of the industry and will provide the framework for licensing and public acceptance. Under this basis, four of the six cases evaluated by the Commission would no longer be considered viable options for the breeder concept."

Response:

It is felt that the decision to recycle plutonium should be made independently from considerations of the breeder program. Hence, the costs of no recycle for the breeder development are not considered appropriate for discussion in final GESMO. This is discussed in detail in CHAPTER XI, paragraph 3.9. This approach, notwithstanding the above comments, is well taken.

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5. Comment:

"Finally, in GESMO, the impact of plutonium recycle on the price elasticity of yellowcake is assumed to be negligible or nonexistent. This assumption must be challenged on the basis that the demands placed on U_3O_8 without plutonium recycle are likely to far exceed by a considerable margin the values projected in GESMO."

5 Comment Cont'd

Response:

The market price model for yellowcake employed in this final statement is described in CHAPTER XI, Appendix A. The rate of usage of the resources does affect the market price. Additionally, the model uses an "estimated cost of recovery" instead of the "forward cost" concept, thus an estimate of the market price is generated. Because of the inherent uncertainties in such an exercise, the effect of the uncertainties is examined by parameterizing the price of U_3O_8 and looking at the effect on incentives to recycle. See CHAPTER XI, Section 3.0.

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6. Comment:

"Manufacturing Facilities

The report would have greater credibility and usefulness if it also covered the period of time when the MOX fuel cycle industry is evolving and growing (1975-1990) as well as when it reaches maturity (estimated - 1990). As the report now exists, it relates only to the wide scale use of Pu in MOX fuels for LWR's in the year 1990. At that time (1990) an estimated 6-8 MOX fuel fabrication plants of approximately 200-300 MT/yr. capacity would be required, the inference of the report being that these MOX fuel fabrication plants, which do not now exist, would be new and would meet the concepts and requirements of an upgraded safeguards program yet to be defined. No consideration is given to the five pilot-development MOX fuel fabrication facilities now existing and which could be viable for the interim period between 1975 and 1985, provided they are not required to meet 1990 safeguards and other standards during the interim period. (See 'Manufacturing' section under 'Health and Safety'). These existing plants are needed for developing both LWR and Breeder fuel."

Response:

The final GESMO has been revised to include the impacts of three fuel cycle options on the environment and economics: no recycle, recycle of uranium only and uranium and plutonium recycle, all on an integrated basis for 26 years from 1975 through 2000.

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7. Comment:

"Limits On Recycle Amounts

Detailed discussion in GESMO relative to the model LWR indicates that the 1.15 self-generated recycle (SGR) value used is an average calculated from operating experience with existing LWR's. The report summary, however, goes one step further and implies limiting Pu recycle to the 1.15 SGR level. Since one might expect improved operating performance in all LWR's by 1990 it would seem more appropriate for the report to evaluate the impact on the environment of the highest Pu recycle technically possible for LWR's and to allow each reactor to recycle all the Pu it generates under equilibrium conditions.

"In like manner, the report uses an upper limit of 5% Pu in uranium and mentions only natural uranium as the carrier. Some reactors may require slightly higher Pu concentrations than 5% and could economically use depleted or slightly enriched uranium rather than natural uranium as a carrier. These alternatives should be considered by the GESMO report."

7 Comment Con'td

Response:

To perform a quantitative evaluation of recycle plutonium in LWR's, it is necessary to first establish the basic conditions governing the partial substitution of recycle plutonium for uranium-235. For reasons stated in the draft GESMO, 1.15 SGR was selected as the model used in the analysis for assessing reactor performance characteristics during normal operation, accident consequences, and environmental impact during normal and accident conditions. Transportation of fuel assemblies to and from the LWR site and fuel assembly storage and handling at the site have been evaluated consistent with the 1.15 SGR operating mode. Operation at values greater than equilibrium 1.15 SGR would require further evaluation. Refer to CHAPTER IV, Section C, paragraph 4.1.

A concentration of recycled plutonium somewhat above the concentration expected to be used in most LWR's of current design within the next ten years, was examined to determine what effect, if any, its use would have on those reactor characteristics which might affect the probability and consequences of accidents, as compared to currently designed LWR's fueled with UO2. Refer to CHAPTER IV, Section C, paragraph 3.3.

Five weight percent plutonium in natural UO_2 was chosen as an example, not a limit. This is further clarified in final GESMO, CHAPTER IV, Section C, paragraph 3.4.1.

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8. Comment:

"Statement of Purpose

It would be most useful if the stated purpose of the GESMO could be enlarged to make it clear that environmental considerations covered by the report need not be duplicated for inclusion in environmental statements submitted by LWR operators, reprocessing plants and mixed oxide fuel fabrication plants when Pu is ultimately recycled or new facilities are constructed. If this is not allowed there seems to be little use for GESMO except as a starting point for more discussion and perhaps the basis for repetitive environmental statements."

Response:

GESMO is not intended to be a substitute for the environmental reports required by NEPA for licensing applications. Each plant licensing application will be evaluated on a case-by-case basis. In the licensing application for use of recycle Pu in LWR's, if the decision on recycle is positive, it will not be necessary for the reactor applicants to develop the environmental impact data for the entire supporting fuel cycle. GESMO provides a basis for the assessments of the environmental impacts of the supporting fuel cycle including waste management and transportation systems. Case-by-case evaluations will be required for the site and design specific items of the license application.

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9. Comment:

"The GESMO in its present form presents no real cost-benefit analysis with respect to upgraded safeguards programs vs status-quo programs. The report also seems to imply there are no alternatives to the concepts proposed (although we do not believe this to be the actual intent). Since definitive safeguards programs will not be issued for at least another year, some thought should be

given to separating the detailed discussions of safeguards proposals from the GESMO and treating these as a separate issue at a later date."

Response:

The Commission has recognized the importance of a timely decision on Pu recycle and has directed the staff to prepare this final statement on the health, safety and environmental impacts of recycle. While these issues are being heard, an addendum to GESMO on the related safeguards considerations and the overall cost-benefits is being prepared. This addendum will be issued for public comments and only after a final statement and hearings on the safeguards and cost-benefits issues will a decision be made on Pu recycle.

10. Comment:

"Environmental Radiation

The radiation doses in the environs from reactors using mixed oxide fuel are calculated using as a basis WASH-1258, 'Final Environmental Statement Concerning Proposed Rule Making Action: ..... 'As Low As Practicable' ... Nuclear Power Reactor Effluents.' The GESMO evaluation, therefore, contains the same problems of overconservative assumptions and overconservative methods of calculation of doses as that document. In fact, the GESMO evaluation fails to utilize several of the improvements made in calculational techniques and assumptions made by the AEC. Several specific examples are offered to illustrate the nature of overconservatism in Attachment A to the comments."

Response:

The dose calculations performed for the final GESMO are based on the latest NRC staff modeling assumptions and are described in detail in CHAPTER IV, Section J, Appendix A. The latest models reflect the Commission's guidance for realism as stated in 10 CFR Part 50, Appendix I, which was issued April 30, 1975.

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11. Comment:

"'Hot Particle' Problem

Possible effects of the so-called 'hot particle' problem should be discussed in more detail in the final GESMO. As long as the Commission has not developed a final position on this subject, a possibility exists that it will be necessary to reduce the allowable airborne concentrations of plutonium by significant factors. A discussion of the impact of such a potential reduction should be included in the final GESMO."

Response:

The NRC has developed a final position on the so-called 'hot particle' issue. Refer to:

U. S. Atomic Energy Commission; "Plutonium and Other Trans-Uranium Elements: Sources, Environmental Distribution, and Biomedical Effects;" Washington, D. C.: WASH-1359.

U. S. Environmental Protection Agency: "Proceedings of Public Hearings: Plutonium and Other Trans-Uranium Elements;" Washington, D. C.: ORP/CSD-75-1, December 1974.

National Council on Radiation Protection and Measurements; "Alpha-Emitting Particles in Lungs; Washington, D. C.: NCRP Report No. 46, August 15, 1975.

For the NRC denial refer to the:

U. S. Federal Register: "Natural Resources Defense Council (Docket No. PRM-20-5) Denial of Petition for Rule Making;" Washington, D. C.: 41 FR 15371, April 12, 1976. The denial responds to the petition relating to: Stay of approvals; establishment of exposure maxima; establishment of surface contamination levels, amendments to 10 CFR Part 100; and requests for public hearings.

The Federal Register is replicated in CHAPTER IV, Section J, Appendix D.

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12. Comment:

Manufacturing

"The GESMO addresses only hardened manufacturing facilities designed, built, and operated according to some combination of the GESMO assumptions and new regulations which apply to plutonium in the fuel cycle. If mixed oxide fabrication loads are less than projected in the GESMO there may be a need to use existing facilities during the period addressed in the GESMO. The existing facilities will, therefore, have to be modified to meet some interim regulatory safety requirements. As a result, occupational safety and environmental safety impacts of the interim facilities may not be consistent with the GESMO. The final GESMO should present an analysis of this eventuality."

Response:

Existing facilities should have the same impact on the environment as the model plant in proportion to throughput during normal operations. Under accident conditions, however, each existing facility will have a different impact. These impacts have been addressed in the individual environmental impact statement for the licensing of the facilities. The operator of an existing facility is required to comply with new regulations pertaining to the hardening of the facility.

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13. Comment:

"The final GESMO should include additional analysis of the consequences of accidents in the manufacturing facilities. The consequences of loss of confinement and loss of shielding are more severe than in the UO_2 fabrication plant where the uranium has much less radiotoxicity and external radiation exposure is of little concern. In order to reduce the risk of accidents to acceptable levels, design, construction and operation of recycle fuel manufacturing facilities will result in greater capital and operating expenses. The factor of 1.5 greater than the cost of uranium facilities used in GESMO appears to be low."

Response:

The consequences of major accidents were addressed in the draft GESMO in CHAPTER IV, Section D, paragraphs a through d. The accidents addressed were determined to be the accidents that would result in the greatest potential exposure. Minor accidents were considered as part of normal operating releases in GESMO assessments. Estimates of the consequences of accidents like small fires, glovebox tears, etc., are available in

13 Comment Cont'd

BNWL 1697, "Considerations in the Assessment of Effluents from Mixed Oxide Fuel Fabrication Plants." The cost basis (factor between UO_2 and MOX plants) was the best estimate of cost of these facilities at the time. This cost increased as new regulations require more restrictive design for MOX facilities. Details on facility costs are reviewed in CHAPTER XI.

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14. Comment:

"Although Volume 1 contains a good summary of the information presented in GESMO, it is often difficult to locate the detailed discussions in the later volumes which are related to the general statements and tables in Volume 1. To clarify these statements and tables, it is recommended that chapter and section numbers of the applicable detailed discussions be referenced in Volume 1.

"A rather detailed table of contents is provided for the report. However, it would be very helpful if a subject index were also included. The same specific subjects are discussed in several locations throughout the report. Therefore, it is difficult for someone studying a particular aspect to find all of the separate related discussions."

Response:

Volume 1, Summary and Conclusions, of the draft GESMO was a detailed summary of the entire environmental statement which generally tracked the data as presented in the various chapters. The format for the summary for this final statement has been modified to some extent in that a question and answer section has been included in an executive summary. Also, cross references for tables, figures and text have been included in the document to supplement the table of contents and provide the reader with direct references to more detailed descriptions, analyses and bases for materials presented.

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15. Comment:

"The report, and in particular Volume 1, is quite repetitious. The value of a brief summary at the beginning is recognized. However, in reading through the report, one wastes time in covering the same ground several times."

Response:

GESMO covers the complete LWR industry considering the differential impacts on the total fuel cycle with the implementation of plutonium recycle. In order to adequately cover all aspects of the impacts and meet the requirements of the NEPA, this generic statement of necessity becomes rather voluminous. Because of the importance of this document and the widespread interest in the Pu recycle issues, a complete self-standing document, covering all features and assessments of the health, safety and environmental impacts, has been included in Volume 1 - Summary and Conclusions. The final GESMO also has a separate short Executive Summary.

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16. Comment:

"If the data were expanded and all technical inaccuracies corrected, the Volume 3 technical data would be useful with regard to the out-of-reactor portion of the licensing process. The Volume would be extremely useful to industry with regard

16 Comment Cont'd

to the reactor portion of the licensing process if it contained a table for indicating the impact of Pu recycle as was provided by the Commission with respect to the impact of the uranium fuel cycle. This may have been the Commission's intent judging from the titles of the Tables IV A-7 and IV A-8 listed in the Table of Contents, however, these tables of GESMO are missing."

Response:

In final GESMO, the summary tables of environmental effects of the fuel cycle and transportation are maximizing tabulations valid for any choice of recycle option. GESMO provides the environmental impact data for the supporting fuel cycle activities required by licensing actions for the implementation of plutonium recycle in LWR's. These data are summarized in Volume 1, Summary and Conclusions, Tables S-7 and S-8 and in CHAPTER VIII, Appendix A.

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17. Comment:

"The paragraph designations used in GESMO are confusing, consider the use of a straight number system. With the number system, the reader could easily determine what main section and subsections a specific paragraph is contained in. For example, paragraph 1.b.1(1).(a) of Chapter IV, Section E, could be straightforwardly designated as 1.2.1.1 of Chapter IV, Section E, or Paragraph 4.5.1.2.1.1."

Response:

The final GESMO paragraph numbering system has been changed similarly to that indicated in this comment. The identification by chapter numbers of the draft statement have been retained. All page, figure and table numbers for specific chapters include that chapter designation for ready reference.

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18. Comment:

"Numerous general statements are made in GESMO which should be further clarified by placing them in context. For example, it is stated that the immediate recycling of plutonium would reduce the requirements for uranium mining by about 9% around 1990. It would be beneficial to add what fraction of the total benefit (in dollars) this reduction represents. This type of clarification would make GESMO much easier to understand and it would strengthen many of the arguments presented."

Response:

In final GESMO, various parameters on the economics of three fuel cycle options, no recycle, uranium only recycle, and uranium Pu recycle and the impacts of delays have been presented in detail. Refer to CHAPTER VIII, Appendix VIII-A and CHAPTER XI.

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19. Comment:

"The purpose of the GESMO seems to get lost in the words (page S-13). It should be possible to state the objectives more clearly and then to equate the conclusions to them."

Response:

The Commission (AEC) had determined that widescale recycle of plutonium in light water cooled nuclear power reactors constituted a major Federal action significantly affecting the quality of the human environment and required the preparation of an environmental impact statement pursuant to Section 102(C)(2) of NEPA.

GESMO is the EIS required by NEPA in support of Commission proposed regulations relating to widescale use of recycle plutonium in MOX fuels for LWR's.

NOTE: The following comments and responses are related to the "Detailed Comments" by Atomic Industrial Forum, Inc. on health, safety and environmental issues. Where comments relate to general corrections or clarification, responses are incorporated in the final text. Comments related to safeguards considerations are covered in the safeguards supplement to GESMO.

20. Comment:

"S-2 Paragraph 4. This paragraph states that 'accidents in the mixed-oxide fuel fabrication plant, a facility that does not occur in the UO_2 fuel cycle, are similar in consequence to accidents at UO_2 fuel cycle facilities ... .' This is only so if plutonium fabrication plants are designed and built like reprocessing plants. If this is the implication, it should be more clearly stated or the paragraph revised."

Response:

This statement in the draft GESMO relating to potential accidents was not directed at "all facilities"--but was intended to compare the UO_2 and MOX fuel fabrication processes and facilities. For more details on this point, see CHAPTER IV, Section D.

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21. Comment:

"S-3 Table S-1. It would help if there was a footnote indicating the size of the 1990 LWR industry and what fraction of the fissile material is plutonium. It is also not clear if the Kr-85 is released or removed from the effluent streams."

Response:

The three LWR industry options, no recycle, recycle of uranium only, and recycle of uranium and plutonium, are fully described in CHAPTER III based on low growth nuclear energy projections through year 2000. This final GESMO considers the integrated environmental impacts for 26 years and does not consider a specific year for a mature industry. However, a "snapshot" view of what the industry would be composed of in terms of material flows and the number of fuel cycle facilities needed in the year 2000, has been included in several chapters and sections (example CHAPTER I, Figures I-2, I-4, and I-7, CHAPTER III, Figures III-7, III-8, and III-9 show the industry in the year 2000 and the integrated materials flows for the 26-year period. Also, the size of the LWR industry for each of the three recycle options is shown at 5-year intervals in Tables III-1, III-2, and III-3. Materials flows for each option are shown for each year of the 26-year period in Appendix A of Chapter III.

The dose calculations, in final GESMO, are based on the 100% release of ^{85}Kr from the reprocessing plant effluents.

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22. Comment:

"S-4 Paragraph 3. The definition of self-generated quantities of recycle is somewhat ambiguous. Does this refer to total amount of plutonium available or equilibrium amounts? Although the choice of 1.15 times self-generated recycle for the reference case is reasonable some statement should be made about the relative effect of larger quantities of plutonium in recycled fuel (up to 200%). In view of the delays in start-ups of spent fuel reprocessing plants, it may be necessary or desirable for the industry to recycle larger than self-generated quantities of plutonium in order to work off the backlog of reprocessed plutonium which will develop after a number of reprocessing plants have begun operation. Thus, the report should also consider the relative effects of significantly larger than 115% self-generated plutonium recycle."

Response:

Additional details of the model 1.15 SGR have been added to CHAPTER IV, Section C, paragraph 4.2. The 1.15 SGR was selected as a reasonable limit for plutonium recycle based on a survey of the intentions of industry. The 1.15 SGR model was examined for the effects of using recycled plutonium, if any, on the LWR nuclear performance characteristics insofar as those characteristics might affect the environment or change the probability and consequences of accidents. It is clear that at this 1.15 SGR level, the proven UO_2 reactor technology is applicable; and for plutonium recycle at less than 1.15 SGR values, the effects on the health and safety of the public are negligible. The foregoing should not be interpreted to mean that there is an inherent safety or environmental limit at 1.15 SGR (or close to this value) on the use of recycled plutonium in reactors. This is not the case. On the other hand, it should not be concluded that there is not some limit beyond 1.15 SGR at which the safety or environmental or both consequences of the use of recycle plutonium in reactors are not comparable to that of UO_2. To identify this limit precisely was not considered to be justified in light of the results of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's and the results of past MOX demonstrations. Refer to CHAPTER IV, Section C, paragraph 4.1.

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23. Comment:

"S-4 - Last Paragraph. The GESMO seems to place unnecessarily heavy reliance on a situation 'already dominated' by other strategic SNM materials. There is considerable uncertainty in the timing of the LMFBR and the HTGR programs. Furthermore, it is suggested the amounts of special nuclear material projected for the HTGR and LMFBR programs be more specifically identified. It is not obvious whether Pu for military uses is included in the 'other' category.

This paragraph also seems inconsistent with later statements since it indicates that plutonium recycle will not significantly affect required safeguards since other SNM dominates the shipping picture. Later,

23 Comment Cont'd

however, on pages S-6 and S-7, the statement is made that the current safeguards provisions are inadequate and further work is being undertaken to study methods of upgrading them.

S-5 - Table S-2. Is the bottom line SNM without the plutonium recycle program or SNM less recycle plutonium? Is the top line additional SNM due to plutonium recycle? Also, it is not clear if the quantities are total plutonium or fissile plutonium."

Response:

This text material is revised extensively. The centerline assessment of a final GESMO is without considerations for the HTGR and LMFBR and is a full assessment of the impact on the environment due to the possible implementation of Pu recycle in LWR's and assuming that all Pu generated is utilized in MOX fuel for LWR's only.

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24. Comment:

"S-8 - Paragraph 9. The conclusion that 'alternative 4. ranks best' cannot be made directly from the data presented in Tables S-3 (page S-9). Based on that table, alternative 3. is the best.

"S-9 - Table S-3. Depending on the manner of safeguard upgrading, the whole body radiation exposure for alternative 3. and 4. may not be identical ('spiking' may greatly increase the exposure).

"The value under whole body radiation exposure 'plus 21%' should be 'minus 21%'. . .

"What is the time basis for this table? (Annual?)"

Response

S-8 - The comment related to paragraph 9 is valid. The conclusion for ranking of the alternatives in the final GESMO has been derived from the detailed comparisons presented in the Cost-Benefits CHAPTER XI.

S-9 - The whole subject of safeguards considerations are covered in the safeguards supplement to GESMO.

The comment in reference to plus 21% is valid; it should have been minus 21%.

The time basis for the items in Table S-3 are "annual."

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25. Comment:

"S-10 - Paragraph 4. Clarification is required. This paragraph first implies that some LWR plutonium will feed LMFBR's and then states 'the only potential use of Pu' is LWR recycle."

Response:

The draft GESMO statement should have read "The only potential use for the 'bulk' of the LWR-produced Pu. This statement has been clarified in the final GESMO. The draft did consider the growth of the recycle Pu industry up to the time that the recovered Pu would be diverted to the FBR's.

25 Comment Cont'd

In final GESMO the assessments and environmental impacts are on a low growth projection of nuclear energy without the breeder reactor program. This indicates a continuously growing recycle Pu industry for LWR's. The impacts are integrated over the years 1975 through 2000.

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26. Comment:

"S-10 - Paragraph 5. Alternative 5. which involves permanent storage of plutonium is claimed to present a reduced safeguards threat compared to the base case. It is not immediately apparent that having a large stockpile of plutonium involves less of a hazard than smaller amounts in recycle."

Response:

The safeguards considerations are covered in detail in the safeguards supplement to GESMO.

In the evaluation of the safeguarding of plutonium, the bounding conditions are prompt reprocessing and recycle, the base case, Alternative 3, the highest risk and/or no recycle, Alternative 6 (send spent fuel to a Federal repository) the lowest risk. All other alternatives fall within these bounds relating to the safeguard considerations relating to Pu.

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27. Comment:

"S-12 - Paragraph 6. In the conclusion to approve plutonium recycle, (and in a number of other places in the report), the implication is that the approval of more than 1.15 SGR would not be given. It would be unfortunate if this blanket limit was adopted without compelling reason and it would be much better to rely on a case-by-case analysis. Some reactors will very likely have greater recycle capabilities and needs than others."

Response:

Recycle of plutonium in LWR's in quantities greater than the equilibrium 1.15 SGR would require further evaluation. Refer to CHAPTER IV, Section C, paragraph 4.1.

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28. Comment:

"S-14 - Paragraph 2. The manner in which this paragraph is worded opens up the question as to just what purpose the GESMO does serve. It is recommended that the paragraph be written in a more positive vein, indicating the purposes the GESMO serves, and its limitations."

Response:

The need for GESMO is presented in CHAPTER I, as well as the intended purpose. Should Pu recycle be authorized, the assessments presented in final GESMO would cover the requirements for environmental impacts of the fuel cycle and LWR's, which

28 Comment Cont'd

would be necessary to accompany the facility safety analysis for licensing purposes. Of course, each facility will be evaluated on a case-by-case basis for its particular locality, demography, and other site specific requirements such as natural phenomena.

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29. Comment:

"S-15 - Paragraph 3. Should ^{238}Pu be ^{239}Pu?

"S-15 - Paragraph 4. The stated concern for ^{241}Am conflicts in basic approach to the consideration using 'spiked' plutonium to improve safeguards.

"It does not appear that the costs and effects of plutonium repurification to remove Am have been included in the evaluation of alternatives. In particular, there should be a cost savings for alternatives 3. and 4. (immediate Pu recycle) as opposed to alternative 1 (base case). Undoubtedly, the costs are relatively small but they should not be ignored."

Response:

In paragraph 3, ^{239}Pu was inadvertently omitted from the listing of plutonium isotopes.

In this final GESMO, a fully detailed review of the economics relating to delays in reprocessing, storage of plutonium and the three options of no recycle, recycle of Pu only and recycle of uranium and plutonium are included in CHAPTER XI. For plutonium characteristics and americium-241 formation, refer to CHAPTER IV, paragraph 2.3.

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30. Comment:

"S-15 - Footnote. Does 'other isotopes, e.g., ^{236}Pu' include ^{238}Pu? If so, the statement is incorrect. ^{238}Pu is not an important fissile material but is extremely important to evaluating overall environmental impact, including cost benefit analysis."

Response:

As indicated in response to Comment No. 29 above, ^{239}Pu was inadvertently omitted. The statement should have indicated ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, and ^{242}Pu.

It is to be noted that there are other isotopes of plutonium, e.g., ^{236}Pu, but these others are of little importance.

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31. Comment:

"S-18 - Paragraph 2. In contrast to the judgment made in the GESMO, dissolution of mixed oxide fuels may well present significant

31 Comment Cont'd

difficulties to the reprocessor. Complete dissolution of plutonium will probably require the addition of fluoride in quantities sufficient to cause corrosion in the stainless steels used throughout most head-end processes. Major modifications to flow sheet and equipment will, therefore, be necessary in all existing reprocessing plants."

Response:

The dissolution of MOX fuels is discussed in more detail in final GESMO in CHAPTER IV, Section E, paragraph 1.2.1.2. References are made to experimental data wherein irradiated MOX pellets, which were sintered at about 1,650°C for about four hours, showed little difference in dissolvability between MOX and UO_2 pellets. Also, experiments indicated that irradiated MOX fuel pellets were somewhat more soluble than UO_2 pellets.

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32. Comment:

"S-21 - Paragraph 4. Relating plutonium inventory to FBR fuel requirements seems meaningless since FBR requirements increase approximately five times between 1990 and 1995 and approximately twenty times between 1990 and 2000.

"S-28 - Table S-6. The use of fossil fuel should be clarified. What percentage of the energy requirements for the cycle are assumed to be supplied by fossil fuel?"

Response:

Re S-21 - In the final GESMO, the assessments of the impacts on the environment due to the implementation of plutonium recycle were integrated over a 26-year period from 1975 through 2000. All assessments were made on the basis that all of the Pu generated in LWR's would be processed into MOX fuels for fueling LWR's only. No consideration was given and no credit taken for stockpiling recovered Pu for the FBR industry. In addition, the nuclear energy projections used were only for the LWR industry to year 2000 excluding the HTGR and FBR industries.

Re S-28 - The assumption has been made in the final GESMO that over the same 26-year period, two-thirds of the electric power consumed by each element of the LWR industry, including the nuclear reactor plant auxiliaries, is produced by coal burning plants.

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33. Comment:

"S-43 - Table S-10. The estimates of Pu_f utilization in commercial LWR recycle fuel shown in Table S-10 should be updated to reflect the availability of reprocessing facilities. In particular, it appears that there will be no recycle plutonium in 1976 and something less than 2400 kgs Pu in 1977."

Response:

This table has been deleted from the final GESMO. The assessments of the impacts of plutonium recycle are only compared within the LWR industry and the differential impacts related to uranium only recycle and no recycle of uranium or plutonium. The alternatives of delayed reprocessing have been examined in detail with comparative cost-benefits included in CHAPTER XI.

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34. Comment:

"S-47 - Paragraph 3. This paragraph should mention the proposed disposition of the transuranics after separation."

Response:

The potential disposition of transuranium elements is discussed in CHAPTER IV, Section H. The model waste management concept assessed in final GESMO considers the disposition of plutonium for the two fuel cycle options--recycle of uranium only and recycle of uranium and plutonium. In both options, the separation of the plutonium in the reprocessing plants would leave the transuranium elements (i.e., curium, americium, etc.) in the high level wastes which would be solidified and sent to the Federal repository.

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35. Comment:

"S-53 - Table S-12. Under Alternative 6, the number of Transportation Shipments should be '-2500.'

"The 77,900 MT SWU base case enrichment quantity should be footnoted to the effect that it includes 44% (or 30,000 MT SWU) of foreign enrichment requirements. This note will make Table S-12 consistent with the separative work units discussed on page S-61.

"S-55 - Table S-13. Under Alternative 6, the kgs. of Pu_f accumulated in storage through 1990 should be '-309,200.'"

Response:

The data noted in these two comments have been changed in final GESMO to reflect the impacts of recycle of plutonium and uranium in the LWR industry. For detailed information on transportation, refer to CHAPTER IV, Section G, and for Pu storage refer to CHAPTER IV, Section I.

In final GESMO, only the enrichment quantities related to domestic requirements have been used in the impact assessments related to the LWR industry--foreign enrichment requirements are excluded.

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36. Comment:

"S-58 - The paragraph entitled Capital Investments should state that costs are calculated in 1974 dollars and that Table S-14 represents total accumulated capital investment to 1990 (if that, in fact, is the case).

The paragraph entitled Materials and Services Costs should state that costs are calculated in 1974 dollars and that Table S-15 represents annual expenditures in 1990 (if that, in fact, is the case)."

Response:

The fuel cycle costs and the cost-benefits for the alternatives to prompt recycle of plutonium have been expanded in final GESMO, CHAPTER XI. The sensitivity analyses

of the fuel cycle costs using 1975 dollars are based on projected unit costs, and discounted process costs for the various alternatives for recycle described in CHAPTER VIII. The overall cost-benefit analysis including upgraded safeguards considerations are included in the safeguards supplement to GESMO.

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37. Comment:

"S-59 - Table S-14. Under Alternative 6 and in the supporting data in Volume 4, the reason for a $70 million capital cost differential above the base case for 'Spent Fuel Transportation' is not clear. Increased mileage accounts for the operating cost differential in Table S-15 (pg S-60) but the reason for the capital cost differential is not apparent."

Response:

All costs have been updated in final GESMO. Refer to response to Comment No. 36.

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38. Comment:

"S-60 - Table S-15. The differential changes in 'Mining-Milling' costs between the alternatives in Table S-15 do not appear to be consistent. Table S-12 on page S-53 shows that the increase in mining-milling quantities for Alternatives 2 and 6 is approximately equal to the quantity decrease in Alternatives 3 and 4 (e.g., milling is +11,900 tons U_3O_8 in Alternatives 2 and 6 versus -10,000 tons U_3O_8 in Alternatives 3 and 4). The operating cost figures in Table S-15, however, show a significant dollar change (+$670 million for Alternatives 2 and 6 versus -$300 million for Alternatives 3 and 4). If these figures are correct, some explanation should be given either in this summary section or in Volume 4. It appears that footnote 'd' should also apply to the 'Waste Management' item since the previous table (S-14) indicated that waste management capital costs were absorbed by the Federal government."

Response:

All costs for final GESMO have been updated. Refer to response to Comment No. 36. Note that Alternative 4 has been deleted and all costs for safeguarding special nuclear materials are upgraded in the evaluations of all alternatives.

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39. Comment:

"S-61 - Paragraph 2. The enrichment cost of $48.90/kg SWU for Alternatives 3 and 4 shown in the last line of paragraph 2 appears to be incorrect. Table XI-12 on page XI-35 indicates a figure of $55.06/kg SWU. This latter figure is also consistent with the -$400 million enrichment cost differential for Alternatives 3 and 4 shown in Table S-15. Use of the $48.90/kg SWU cost would yield a differential of about -$600 million."

39 Comment Cont'd

Response:

All costs for final GESMO have been updated. Refer to response to Comment No. 36.

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40. Comment:

"I-7 - The out-of-reactor fuel cycle operations are presented. Subsequently plutonium and radioactive wastes are discussed. There is a need to establish what is done with "tails".

Response:

"Tails" from enrichment plants are presently stored as UF_6 in heavy storage cylinders for potential future use and are not included in the differential assessments of impacts on the environment in comparing the three fuel cycle options, no recycle, uranium only recycle and uranium and plutonium recycle. In the context of the decision to recycle plutonium or not, the reduction in tails has an insignificant impact on the environment in relation to the total LWR industry radioactive waste management program.

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41. Comment:

"I-8 - Figure I-3. Need to define acronyms and use consistent units. Show depleted 'tails' stream from enrichment. The whole balance is difficult to follow."

Response:

The numbers in Figure I-3 in draft GESMO represent a "snapshot" of about the year 1990. The flow of materials indicated is not intended to constitute a material balance. The numbers reflect the production quantities projected for 1990 and varying lead times in the growing industry. In final GESMO, similar diagrams are presented but the "snapshot" is taken about the year 2000.

Total impact from depleted tails from the enrichment plant have not been indicated, since there would not be a significant differential environmental impact when comparing the overall impact for the three fuel cycle options.

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42. Comment:

"I-12 - Figure I-6. Is plutonium storage/inventory cumulative to 1990? The depleted U - 'tails' - stream should be shown as part of balance. Whole balance is hard to follow."

Response:

For general comments relating to Figure I-6, flow balance and the depleted tails see the response to the previous comment No. 41.

The plutonium storage/inventory quantity indicated is not cumulative to 1990. The quantities are for 1990 flows with consideration of inventory held in temporary

42 Comment Cont'd

storage at the spent fuel reprocessing plant and at the MOX fuel fabrication plant (often referred to as "pipe line" storage).

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43. Comment:

"I-14 - Paragraphs 2 and 3. This seems to establish a firm limit on quantity of plutonium charged in MOX. Is this the intent? MOX should be defined."

Response:

The wording in the draft was not intended to place a firm limit on the quantity of plutonium used in mixed plutonium dioxide and uranium dioxide (U, Pu) O_2 designated MOX.

In CHAPTER IV, Section C-4.0 presents a detailed description of the final GESMO model reactor and the fuel characteristics for the equilibrium 1.15 SGR. It is not intended to be interpreted as a limit for safe operation for MOX fuel loadings of LWR's.

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44. Comment:

"II-4 - Page II-4 and Table II-3 seem to imply an optimistic schedule for spent fuel recovery operations in U.S. (and, therefore, earlier than expected plutonium availability). Start-up date for the plants on Page II-25 is not achievable. This fact is implied in the definition of Case 1 (Base Case) for the cost/benefit calculations, but may make alternatives 3, 4, and 5 unrealistic. Perhaps more information could be presented on effects of delays in implementation of recycle and on effects of various cost parameters (storage costs, capital investment costs) on the results."

Response:

Descriptions of plans for reprocessing reactor fuels have been revised in light of the existing industry. The alternatives assessed and the cost benefit analysis in this final statement consider several perturbations of the recycle industry including the option of no recycle. A full discussion of cost parameters and related sensitivities to recycle values is included in CHAPTER XI.

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45. Comment:

"II-27 - Paragraph 5. No mention is made of the hazards of plutonium nitrate."

Response:

CHAPTER II provides an overview of background and experience with plutonium. For a full discussion on the effects and impacts of Pu, refer to CHAPTER IV, Section J.

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46. Comment:

"II-28 - Section b. The beta contribution from Pu-241 is not discussed."

Response:

The beta contribution is considered in dose calculations presented in CHAPTER IV, Section E and summarized in CHAPTER IV, Section J.

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47. Comment:

"II-29 - Sections c and d. It is not clear whether this section is still restricted to plutonium oxide. Also, there is a statement that plutonium absorbed through the skin deposits in the bone which seems to contradict section a. on page II-28."

Response:

Refer to CHAPTER IV, Section J for a full discussion on plutonium radiological effects and impacts.

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48. Comment:

"Appendix - In the Appendix to Chapter II, dealing with criticality accidents in chemical processing, it is recommended that the material recently published by Olsen, Hooper, Uotinin and Brown on "Empirical Estimation of Number of Fissions from Accidental Criticality in Uranium or Plutonium Systems" (ANS Transactions, winter meeting, 1974) be included. This work is not merely a compilation of data on miscellaneous accidents, but presents an empirical means of estimating the energy release from various criticality accidents."

Response:

The Appendices A & B are included in the final statement to help the informed layman gain an appreciation for the special problems that would be associated with the processing of plutonium. The inclusion of the technical information on empirical estimation of the number of fissions from criticality is not appropriate for this chapter. It is to be noted that all Pu facility licensing applications must include a complete safety analysis which will be evaluated on a case-by-case basis by the NRC prior to the granting of construction permits and operating licenses.

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49. Comment:

"III-8,9-Figures III-4A & B are unnecessary. The same information is provided in Table III-I."

Response:

This comment is only partially true, since the figures III-4A and III-4B were included in draft GESMO to reflect the growth pattern of the LWR industry up to the reference year (1990).

49 Comment Cont'd

In the final GESMO the tabulations have been expanded to show the industry growth at 5-year intervals up to year 2000. The industry size in the year 2000 and total quantity of materials handled over the 26-year period are indicated in Figures III-7, III-8 and III-9.

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50. Comment:

"III-1. The number of fuel reprocessing plants and mine-mill complexes may not be attainable in the period specified."

Response:

In the draft GESMO, the numbers of facilities indicated were for the LWR industry in the reference year 1990. The numbers of fuel cycle facilities required in final GESMO are based on projections for nuclear power growth through 2000. The purpose and scope of the statement is to assess the differential environmental and economic impacts that would be attributed to the projected number of model plants and facilities needed to meet this LWR industry growth, utilizing recycle Pu as compared to the recycle of uranium only and the no recycle options. An evaluation of the industry capability to expand at the required rate is not considered to be within the scope of GESMO.

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51. Comment:

"IV A-5 - Figure IV A-2. No stream is shown in this figure for spent recycled plutonium or uranium, which have negligible value. It appears that continuous mixing with newly produced recycled material would not be economical. Also, no tails stream is shown from the enrichment plant on this figure or figure IV A-1 and similar figures in Section 3."

Response:

Refer to the response to Comment No. 41 for the purpose of these flow charts. Spent uranium and plutonium per se have not been considered to be a deterrent to the growing LWR fuel cycle for the 26 year period assessed in final GESMO. Any spent uranium would be handled much the same as "tails" from an enrichment plant in terms of storage or disposal.

In establishing the model reactor, consideration was given to the generation of plutonium over an extended period until it reaches, after 16 years, a 1.15 SGR at equilibrium by recycling the Pu generated back into the reactor, where it was generated each successive year. Thus, the recovered Pu after the first year (Pu-1), would be recycled and the recovered Pu after the 2nd year would be "2nd year plutonium," etc. Under these hypothetical conditions, the Pu mix would be the worst possible in terms of undesirable isotopes, particularly ^{242}Pu. Actually it would not be economically feasible to segregate the Pu-1, Pu-2, Pu-3, etc., as noted above, in the reprocessing plant and then keep strict control of the specific Pu through fuel fabrication. In the period through the year 2000 essentially all the Pu generated and separated will undergo a natural blending in the processes obviating the need for any bleeding off of so called "spent Pu."

There would be no need to discard any of this recycled Pu over the period assessed but the continuing recycle does present a neutronic penalty to the LWR cycle and economic and neutronic penalties have been incorporated in the sensitivity studies presented in CHAPTER XI.

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52. Comment:

"IV B-7 - Paragraph 1. Regarding the last sentence of the first paragraph under 2.a., did AEC consider the added costs at reactors recycling Pu? This statement implies they did not; in cost/benefit analysis it should be considered."

Response:

The economics related to recycle plutonium in the entire LWR cycle are reviewed in detail in CHAPTER XI. Cost-benefits and cost comparisons have been made for the 3 fuel cycle options of no recycle, recycle uranium only and recycle of uranium and plutonium. The impacts of delays in recycle have also been included in the economics evaluations. The incremental cost of handling MOX fuels compared to UO_2 fuels is judged to be insignificant and is not included in the overall cost-benefit analysis.

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53. Comment:

"IV C-2 - Paragraph 1. Is 'equivalent plutonium' total Pu or fissile Pu?

"IV C-3 - Under 'Accidents' the first sentence seems to be more appropriate to 'Normal Operation.' This should be clarified.

"IV C-3 - Is the GESMO serving any purpose if each request for licensing mixed-oxide assemblies must be evaluated on a case-by-case basis? Also line 3 'normally' should be 'normal'. At the end of this paragraph, the phrase 'just as each new type...' could be placed at the end of the second to last sentence, if this is the actual intent. Third line from bottom change 'basically' to 'initially'."

Response:

"Equivalent plutonium". Equivalent plutonium is the designation for the plutonium recovered from LWR's in contrast to plutonium recovered from one specific reactor for the 1.15 SGR model. Refer to CHAPTER IV, Section C-4.0.

"Accidents". This heading was in error in draft GESMO. "Operational Releases to the Atmosphere" is the proper identification for this paragraph where fuel clad defects and fission product leakage into the coolant is discussed.

Aside from addressing the balance of the fuel cycle, GESMO addresses the licensing of fuel assemblies in several important ways. First of all, GESMO assesses the most adverse environmental impact from the operation of an LWR with mixed oxide fuel in quantities related to the 1.15 SGR level. Proposals to use MOX fuel in quantities less than GESMO values would not require the preparation of an additional environmental impact statement. Secondly, GESMO discusses the performance of reactors containing MOX fuel. The underlying physical and neutronic properties of MOX fuel can be described generically and the description could be presented as a topical report to the NRC for approval and then referenced in the case-by-case plant analysis.

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54. Comment:

"IV C-4 - Last paragraph. The last paragraph refers to both 63 rods and 64 rods in a BWR assembly. Actually there are 63 fuel bearing rods plus one non-fuel bearing rod (water-hole rod)."

Response:

This paragraph has been changed in final GESMO to refer to the 63 fuel bearing rods only. Refer to CHAPTER IV, Section C, paragraph 1.1.

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55. Comment:

"IV C-8 - Some figures (such as Figure IV C-4) are out of date and do not match text discussion (e.g., Figure IV C-11)."

Response:

The text of final GESMO has been changed to note that Figures IV C-3 and C-4 show only 49 fuel rods but are representative of the 63 fuel rod assemblies in all other respects. Except for the number of fuel rods in the fuel assemblies the figures are adequate for the illustrative purposes intended. Refer to CHAPTER IV, Section C, paragraph 1.1.

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56. Comment:

"IV C-13 - Paragraph 5. 100 tons - standard or metric? PWR core was expressed in pounds. Also, this description applies to the design of only one of three vendors."

Response:

The text in final GESMO has been changed to refer to one of the PWR core types that contains about 92 metric tons of slightly enriched uranium dioxide. Refer to CHAPTER IV, Section C, paragraph 1.2.

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57. Comment:

"IV C-24 - Second sentence. The intent of the second sentence on this page is unclear. Was 1974 used only to compute the values of isotopic abundance shown in Table IV C-1? If so, is this conservative or not?"

Response:

The text of final GESMO has been changed to note that for purposes of calculation it was assumed that all available plutonium was to have been recycled beginning 1974. Table IV C-1 is based on this assumption. The Table illustrates the gradual change in plutonium composition with time, after plutonium recycle is initiated. The final GESMO core analysis is based on the equilibrium conditions shown in Tables IV C-5, C-9, C-11, C-12, and C-13 where the amount of fissile Pu

57 Comment Cont'd

is even lower than the 66% total for the year 1985 taken from Table IV C-1 and is therefore more conservative in the allowance for aged plutonium and associated radioactivity effects. Refer to CHAPTER IV, Section C-4.0.

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58. Comment:

"IV C-113 - Paragraph 2. It is stated that "The most significant difference in man-rem doses occur as a result of water ingestion for river-sited boiling water reactors." While water ingestion shows the largest percentage change, differences in dose from other exposure pathways are more significant, even though the percentage change may be smaller."

Response:

This comment on dose differences has been reflected in the final GESMO CHAPTER IV, Section C, paragraph 5.2.

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59. Comment:

"IV C-114 - Paragraph 2. A more typical effluent cleanup system should be employed so that infant thyroid doses are typical of that normally expected."

Response:

This comment on doses has been reflected in final GESMO in CHAPTER IV, Section C, paragraph 5.2.

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60. Comment:

"IV C-115 - Paragraph 3. The statement that "At worst, some SGR fuels exhibit as much as a 14% increase in the iodine thyroid dose source ... more typically ... a 10% increase' is not consistent with Table IV C-36, which shows a maximum increase of 8% and typically no increase in iodine dose source."

Response:

The average increase of ^{131}I in the GESMO model reactor compared to the uranium only reactor is 4%. See Table IV C-13 in final GESMO. Table IV C-36 in the draft GESMO, identified as Table IV C-35 in the final GESMO, has been revised accordingly. The maximum thyroid dose ratio of 1.14 relates to the small fraction of the plutonium that has been recycled once to about 27,500 MWd/MTHM, recovered along with new plutonium generated in the UO_2 of the rods containing this plutonium, and recycled again for about one-fourth of its second recycle.

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61. Comment:

"IV C-117 - Table IV C-37. This table is confusing because of the comparison of different plutonium types at differing exposures. Are the Pu-2 -3 and Pu-1 -2 cases selected for the calculation of element dose ratios the most limiting cases?"

61 Comment Cont'd

Response:

Table IV C-37 of the draft GESMO is identified as Table IV C-36 of the final GESMO. The various plutonium compositions defined at the bottom of the table represent the compositions of plutonium that is recovered from a uranium core, and MOX rods that contain plutonium that has been recycled once or twice. It is assumed that the plutonium recovered from LWR's is blended and that the identity of plutonium that has been recycled once or twice as shown here is not retained. The blended GESMO model LWR plutonium contains a portion of each. Refer to CHAPTER IV, Section C-4.0.

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62. Comment:

"IV C-120 - Table IV C-40 and IV C-41. In view of the difference in inventory ratios (Table IV C-37), why are the radiological consequences of postulated accidents identical both with and without plutonium recycle?"

Response:

Tables IV C-40 and C-41 of the draft GESMO are identified as Tables IV C-39 and C-40 of the final GESMO. When the isotopic inventories are weighted by dose conversion factors--Table IV C-37 in final GESMO--the differences between the GESMO model reactor and uranium only cores are less pronounced. Also, the slight increase in radiation dose due to the model reactor increase in ^{131}I is offset by the decrease in krypton and xenon radiation doses.

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63. Comment:

"IV D- Chapter IV-D assumes that glove-box type operations will continue to be the design basis for MOX fabrication facilities. The accuracy of this is questioned in that higher radiation and neutron fields are anticipated in the future with the use of plutonium containing higher percentages of the heavier isotopes."

Response:

The final GESMO has been modified to state that gloveboxes and shielded cells may be used in MOX fabrication facilities. Refer to CHAPTER IV, Section D, paragraph 2.1.

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64. Comment:

"IV D-3 - GESMO assumes that eight fabrication plants are operated in 1990 while only five would be required. While there is likely to be some overbuilding, the greater than 50% excess capacity seems large."

Response:

In final GESMO the MOX production requirements were used as the basis for the integrated dose commitments and other impacts for the industry using a model plant size of 360 MT/y In the year 2000 about eight model size plants would be required.

65. Comment:

"IV D-6 - Paragraph 1. The enrichment of PuO_2 fuel may be greater than 5% and the diluent may be depleted or slightly enriched uranium rather than natural UO_2."

Response:

These facts are recognized and addressed in the final statement. The model for the environmental impact, however, is based upon about 5% fissile Pu and using natural uranium. The environmental impacts, using depleted or slightly enriched uranium, do not differ significantly from that when using natural uranium.

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66. Comment:

"IV D-9 - Paragraph 6. The production of MO_2 fuel rods by a combination of chemical and mechanical operations would seem to be independent of the installation of equipment at reprocessing plants to convert plutonium to a solid."

Response:

This sentence was intended to indicate that when reprocessing plants install nitrate to oxide conversion equipment it is expected that the oxide produced will be suitable for MOX fabrication without further chemical treatment. The final text of CHAPTER IV, Section D, paragraph 1.3 has been revised in the final GESMO to clarify this statement.

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67. Comment:

"IV D-13 - Paragraph 3. Depleted of slightly enriched uranium may also be used in place of natural UO_2."

Response:

This comment is true; however, natural uranium was used as the calculational model. Because of its higher plutonium content it produces a slightly greater overall radiological impact than when slightly enriched recovered uranium is mixed with PuO_2 to make MOX fuel.

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68. Comment:

"IV D-17 - Paragraph 4. Enrichment of PuO_2 may be greater than 5%. The first sentence should read '...enough fuel for about 25 reactors operating at the 115% SGR loading.'"

Response:

In the final GESMO text, CHAPTER IV, Section D-1.0 has been revised to indicate that with the low growth nuclear projection used for this statement, 25,000 MT of MOX fuel would be available for about 13% of the total LWR fuel requirements for the period 1975 through 2000.

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69. Comment:

"IV D-26 - Paragraph 2. Proven technology may exist for solidifying Purex wastes, but AEC burial and transportation requirements have not been formulated."

Response:

This comment is correct. Specific requirements are yet to be developed; however, the existing regulations indicate safety measures to be taken for interim handling of solidified wastes until this can be done. Refer to CHAPTER IV, Section H for the concepts for radioactive waste management being pursued by ERDA, which are the basis for assessment in final GESMO.

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70. Comment:

"IV D-32 - Paragraph 6. What is the basis for estimating airborne releases of plutonium? Why are releases expressed in alpha curies only; 30-50% of dose from LWR to plutonium comes from beta of Pu-241."

"IV D-33 - Table IV D-8 indicates alpha curies only. Do estimated doses include beta effects of Pu-241?"

Response:

Airborne releases are based on the model plant and some operating experience at existing MOX plants. Alpha curies were used because it is common analytical technique to measure releases according to the alpha content. Beta doses, however, are included in the total doses reported. An explanation of the use of the alpha curie in this way is contained in the final GESMO text. Refer to CHAPTER IV, Section J.

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71. Comment:

"IV D-39 - Paragraph 2. The value stated for filter efficiency (10^{-9}) is in error; this is the transmission factor. The basis or reference for this value should be indicated."

"IV D-39 - Paragraph 1. Basis for filtration efficiency and air loading should be given."

Response:

Radioactive airborne effluent quantities from the model MOX plant incorporated in the final GESMO have been determined from actual operating experience rather than by engineering analysis of the ventilation system. The final GESMO employs the terminology "release fraction", which is defined as the fraction of plant throughput which is discharged to the atmosphere. The release fraction of 10^{-9} was determined by Los Alamos Scientific Laboratory from operating experience data recorded at existing plutonium plants. See CHAPTER IV, Section D-2.0.

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72. Comment:

"IV E-7 - Paragraph 3. Mixer-settlers are used extensively; centrifugal mixer-settlers aren't."

72 Comment Cont'd

Response:

The test on process equipment in final GESMO has been revised to indicate mixer-settlers (see CHAPTER IV, Section E-1.0).

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73. Comment:

"IV E-14, 15, 16 - It appears that iodine removal should be discussed. Iodine removal is indicated in Figure IV E-6."

Response

Iodine removal is discussed in final GESMO CHAPTER IV, Section E, paragraph 2.1.4.

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74. Comment:

"IV E-25 - Table IV E-12. The annual dose commitments appear to be high compared to similar numbers in earlier environmental statement submittals and the EPA Environmental Analysis Report, EPA-520/9-73-003D."

Response:

Table IV E-12 in final GESMO has been revised; however, the revised values are also higher than the subject report. For the purpose of this assessment, conservative judgments were used which, in general, reflect the upper range of source terms (radioactive releases) and the result in conservatively estimated dose commitments.

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75. Comment:

"IV E-26 - Paragraph 4. What is the basis for the statement 'the isotopic composition of uranium isotopes is somewhat less biologically hazardous with Pu recycle than without ...'?"

Response:

This incomplete statement has been deleted in the revised final GESMO text. There is a reduction in ^{85}Kr release when reprocessing MOX fuels. For additional data refer to CHAPTER IV, Section E, paragraph 3.5.

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76. Comment:

"IV E-30 - Paragraph 1. Why is the criticality excursion 10 times worse in fuel reprocessing than in the fabrication process (10^{19} vs. 10^{18} fissions)? No justification is given for the difference."

Response:

The difference in criticality potential in reprocessing plants when dealing with liquid solutions is a magnitude greater than that encountered the handling of solids, oxides, in the MOX fabrication plants.

76 Comment Cont'd

A Review of Criticality Accidents, LA-3611, by William R. Stratton, indicates total fissions for solution systems have ranged from 4×10^{16} to 4×10^{19} fissions. Initial bursts estimated for an incident in a reprocessing plant, on October 16, 1959, was the largest of those excursions. This incident is documented in a report titled Nuclear Incident at the Idaho Chemical Processing Plant, IDO-10035.

In this incident, about 200 liters of highly enriched (93% ^{235}U) uranium solution siphoned to a 5,000-gallon tank containing about 600 liters of water. The initial burst was about 10^{17} fissions, and criticality was sustained for a few minutes. The resulting power excursion created on the order of 10^{19} fissions, sufficient to boil away nearly half of the 800-liter solution volume. Based primarily upon radiochemical analyses for ^{99}Mo in the resulting solution, the magnitude of the total excursion may have been 4×10^{19} fissions. Plant personnel received no significant gamma or neutron doses, but beta dosages were 50 rem (one person), 32 rem (one person), and smaller amounts (17 persons) all obtained while the building was being evacuated. The building was reentered 45 minutes later. No significant property damage resulted from this accident.

A criticality event is postulated to occur in the dissolver if the neutron monitors erroneously permit dissolver acid solution, without the soluble nuclear poison, to fill the dissolver to a satisfactory level to permit operation of the shear. The postulated conditions require a multiple of administrative errors and equipment malfunctions.

Assuming the criticality event (about 5×10^{15} fissions per second) is terminated by emptying the dissolver of solution (an operation requiring about 30-40 minutes), the total fissions would be approximately 10^{19} over a period of 45-60 minutes.

In a recent design change AGNS has modified their evaluation for the Barnwell plant to a conservative value of 2×10^{20}.

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77. Comment:

"IV F-2 - Paragraph 2. What is the basis for the statement 'These values (9 and 11% reduction in uranium mining and enrichment demand) are significantly less than the theoretical 15% reduction in uranium comsumption...'?"

Response:

The statement was based on an observation in WASH-1242, Nuclear Fuel Supply 1973, page 2, that a typical 1,000 MWe LWR requires about 200 tons of U_3O_8 year for refueling while recycling Pu could reduce annual makeup requirements to about 170 tons of U_3O_8 indicating a theoretical reduction in uranium consumption of 15%. However, since only a portion of the LWR's would be operating on recycled plutonium due to the projected industry growth, the actual reduction would be somewhat less than this theoretical value.

This statement no longer applies to the final GESMO assessments wherein comparisons are made for the three fuel cycle options: no recycle, recycle of uranium only and uranium and plutonium recycle.

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78. Comment:

"IV F-6 - U_3O_8 Costs in Table IV F-3 should be $/lb. Although the footnote of Table IV F-3 notes that these costs are the costs at which uranium could

be produced, rather than the sales price, greater emphasis should be given to this distinction since the sales price may be 50-100% higher."

Response:

This error has been corrected in the FES. The table referred to is now Table IV F-2 in the final GESMO. "Forward costs" as used in this section are defined as those operating and capital costs yet to be incurred at the time an estimate is made. Refer to the footnote in Table IV F-2 of CHAPTER IV, Section F, paragraph 1.2.

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79. Comment:

"IV F-15 - Paragraph 1. The decrease in facilities (175 underground mines and 13 open pit mines) is not consistent with Table IV F-4 (total decrease of 180 facilities)."

Response:

Due to revised nuclear power projections used in final GESMO, this comment on the number of mines is no longer directly applicable but is accommodated by the revised text of CHAPTER IV, Section F, paragraph 1.7 and Table IV F-5.

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80. Comment:

"IV F-32 - Table IV F-6. Are the total electrical power needs for added capacity supplied by gas centrifuge plants in addition to or in place of the requirements for gaseous diffusion plants. Why aren't the 'Δneeds' for diffusion and centrifuge plants in the ratio of ten assumed in the basis given in the footpote?"

Response:

This comment is not applicable to the final GESMO because of the changes in energy projections and the bases for assessment that the first new enrichment plant will be gaseous diffusion and subsequent plants will be gas centrifuge. The new data considering the three fuel cycle options are given in Table IV F-11 of CHAPTER IV, Section F, paragraph 4.4.

In addition, in CHAPTER IV, Section F, a comparison was made of effects of the buildup of the enrichment industry considering all of the new plants that would be the gas centrifuge type.

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81. Comment:

"IV F-33 - Paragraph 7. The reference to Table IV F-5 is incorrect; the reference should be to Table IV V-6 or 7. The minimum range of electrical energy required (75 million megawatt hours) seems low and cannot be obtained from either Table IV F-6 or 7. The quoted values of coal consumption (44.8 and 39.9 million metric tons without and with recycle respectively) are not consistent with Table IV F-7."

Response:

This comment is valid relating to the draft GESMO. Revisions have been made in the final statement as reflected in CHAPTER IV, Section F, Tables IV F-12 and 16.

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82. Comment:

"IV F-36 - Paragraph 1. The quoted reduction of particulates and oxides of nitrogen by about 65,000 metric tonnes each is not consistent with Table IV F-7 which shows a 50,000 MT reduction. The 1.6% reduction in chemical effluents is not consistent with the 1.5% reduction in coal combustion quoted on page IV F-35."

Response:

This comment is correct relating to the draft GESMO. Revisions have been made in this final environmental statement on the basis of the industry requirements to meet revised energy growth projections. Table IV F-16A of CHAPTER IV, Section F lists estimated environmental impacts from plant effluents, resource use and power consumption assuming the next new enrichment plant would be gaseous diffusion and subsequent plants gas centrifuge.

The consideration that all of the new enrichment plants would be the gas centrifuge type has been included for comparisons of overall impacts. See Table IV F-16B of CHAPTER IV, Section F.

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83. Comment:

"IV G-9 - Paragraph 6. Depleted or slightly enriched uranium may also be employed."

Response:

Throughout the final GESMO where it is pertinent to refer to the uranium used in the MOX fuel for environmental assessments, reference has been made to the use of natural uranium. Final GESMO also points out that while natural uranium has been used for assessing the effects on the environment, there is no intent to reject the possible use of depleted or slightly enriched uranium. For an economic discussion on the use of depleted uranium, refer to the response to Comment No. 123 of this comment letter.

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84. Comment:

"IV G-10 - Table IV G-3 shows a 30% increase in dose to transport workers and a 47% increase in dose to the general public for transportation of PuO_2 to storage with Pu recycle; in view of the order of magnitude reduction of the quantity of plutonium going into storage, this increase seems unlikely."

Response:

In the draft GESMO, the dose estimates for the single entry "PuO_2 to storage or other uses" include the two items of transportation shown in Table IV G-1, "PuO_2 to Storage or Other Uses" and "PuO_2 to MOX Fuel Fabrication Plant."

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85. Comment:

"IV G-13 - Paragraph 3. Since the reduction of transportation steps prior to uranium fuel fabrication could have easily been factored into the analysis, why was this conservative simplification made?"

Response:

In final GESMO, the decrease in the environmental effects, due to the reduction in the transportation steps prior to UO_2 fuel fabrication, has been quantified. Refer to CHAPTER IV, Section G, paragraph 1.3.

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86. Comment:

"IV G-24 - Alpha waste associated with obsolete equipment or decommissioning-related rubble (masonry, structurals, etc.) which will not fit into drums will have to be specially crated and sealed to prevent dispersal of radioactivity. This type of container may be unsuitable for ultimate disposal, but will be required for many years of interim operations."

Response:

The paragraph has been revised in final GESMO to indicate that, alternatively, waste that will not fit into a 55-gallon drum will be specially crated and shipped in protective overpacks such as the Super Tiger. Refer to CHAPTER IV, Section G, paragraph 3.2.3.

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87. Comment:

"IV G-30 - Line 4, Paragraph 2 should include sorption, followed by shipment to a central facility for incineration, and chemical destruction of organic bulk followed by recovery of Pu from residues or burial."

Response:

Currently, there are no known plans to utilize a central facility to process alpha wastes for plutonium recovery prior to disposal. Accordingly, this has not been included in this scenario.

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88. Comment:

"IV G-39 - A more comprehensive analysis of risk may show that PuO_2 shipments in certain areas can be safeguarded more effectively by point-to-point aircraft shipment, using either rotary or fixed-wing equipment rather than by road shipment. This statement is made with full recognition of recent federal legislation to ban all aircraft shipments of Pu."

Response:

This comment on shipment by air being more effective regarding safeguards consideration is noted. Safeguards considerations are being evaluated in a supplement to this health, safety and environmental portion of GESMO.

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89. Comment:

"IV G-42, First Sentence. Modify to show dose if half of fuel shipments are made by truck."

Response:

In final GESMO, dose assessments are based on 40% of the shipments of irradiated fuel will be shipped by truck and 60% by rail. Refer to CHAPTER IV, Section G.

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90. Comment:

"IV G-44 - Performance of PuO_2 (and Pu nitrate) shipping containers during transportation accidents should reference more recent papers by U. S. (BNWL) and French (CEA) authors, in Sessions 12A and 11 of the Fourth International Symposium on Packaging and Transportation of Radioactive Materials (Sept. 22-27) 1974. AEC-sponsored work at BNWL showed that the Pu transportation risks are three orders magnitude less than for meteorite hits, if current-day fireproof packaging is used. Prior evaluations should be re-ranked and these new findings be incorporated in Table IV G-9 to give proper perspective to the low risk of shipping Pu nitrate (if correctly packaged). Overseas processors are expected to continue shipping Pu nitrate because of equivalency of risk compared to PuO_2. See author's final manuscripts as presented at September 22-27 meeting in addition to CONF-740991.

"IV G-48 - Actual data on package closure from an AEC-sponsored survey should be referenced and used. See reference above."

Response:

Tables IV G-7 and IV G-9 of the draft GESMO--now IV G-8 and IV G-10 in final GESMO--have been updated to reflect latest accident data which is based on "Draft Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes," NUREG-0034 (March 1976).

Since an effective rule requires that quantities of plutonium greater than 20 ci be shipped as solids after June 17, 1978, shipments of plutonium nitrate solution have not been considered in GESMO.

Actual data taken from the Battelle survey have been referenced in the GESMO report.

For the revised discussion on transportation accidents, see CHAPTER IV, Section G-5.0.

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91. Comment:

"IV G-54 - In paragraph 3., use of qualitative phrases such as 'very small,' 'highly unlikely,' etc., should be supplanted by probability ranges like 10^{6} to 10^{7} per year where assessments have already been published."

Response:

In final draft, the text has been revised to refer to Table IV G-10 which refers to projected probabilities for extra severe accidents for the various nuclear materials under consideration. Refer to CHAPTER IV, Section G-5.0, Transportation Accidents.

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92. Comment:

"IV G-54 - Item (e), Paragraph 1, last sentence should say 'oxide or other form shown to be of equal or lower safeguards and transportation risk.' AEC criteria for oxide vs. nitrate shipment need to be re-examined in the light of recent findings coupled with safeguards impact."

Response:

For discussion on "oxide or other form," refer to previous response to Comment No. 90 of this comment letter.

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93. Comment:

"IV G-55. Accident risk statements, such as last sentence of item f. are not sufficient unless the phrase 'in the vicinity of' are made clear by example. Isotope dispersal by waterways from a 'major impact' site could be geographically far-reaching. Also, amplify results of local confinement and clean-up opportunities if a 'major impact' accident occurs."

Response:

The text of final GESMO has been revised. Cleaning activities have been considered in CHAPTER IV, Section G, Appendix A.

In final GESMO the accident risk statements have been amplified. Refer to CHAPTER IV, Section G, paragraph 5.6. Clean-up after an incident information has been included in CHAPTER IV, Section G, Appendix A.

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94. Comment:

"IV G-56 - Last paragraph under 'Routing.' The railroad associations have passed recent regulations and recommendations which affect the routing of rail cask trains. These details should be explained in the GESMO if AEC and industry perceive them to be long-lasting and relevant to the routing issue."

Response:

Routings of rail cask trains issues are still unresolved. The outcome of the recommendations would probably have no significant radiological impact on the results already considered.

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95. Comment:

"IV G-59 - Line 4 suggests rewording as follows: ...'assemblies, and limit the shipment of separated plutonium to only that quantity which is needed to balance the manufacturing loads (peak and valley effects) within the network of fabrication and reprocessing facilities.' Delete statement referring to 'elimination of need to ship separated Pu' because this idealistic condition could not be maintained at all times. Even if idealized IFCF siting could be achieved in 20 years, the transition period would require interplant shipment of plutonium."

Response:

This is a valid comment and this statement relating to transporting quantities of plutonium related to manufacturing loads is not included in the final GESMO text.

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96. Comment:

"IV H-2 - Paragraph 1 -- insertion in line 4 'to increase the total transuranium alpha activity sent to burial by a factor of five. Emphasis in subsequent statements should be on safe long-term alpha management, not just on heat generation and handling."

Response:

In final GESMO, additional data on transuranic wastes, including increase in volumes with Pu recycle, has been included in CHAPTER IV, Section H. Safe long-term waste storage or disposal is required for all fuel cycle options, no recycle (storage and disposal of spent fuel), uranium recycle only, and uranium and plutonium recycle; the objective of this statement is to identify the incremental effect of Pu recycle.

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97. Comment:

"Paragraph 4 and IV H-10, Paragraph 5. In order to keep the volume down to estimated levels in GESMO report, current proposed AEC rulemaking must be changed to redefine exempt low-level alpha wastes by a new operationally-acceptable criterion (a) because 10 nanocurie per gram level is not practical to measure and administer and (b) because AEC recommendation to include all waste generated in 'controlled areas' would inflate the burial volume and cost out of proportion to the benefit, especially considering $100 per cu ft, projection for transportation and long-term management."

Response:

In final GESMO, it is assumed that the proposed amendment to 10 CFR Part 20 will be adopted, wherein transuranic (TRU) wastes will be transferred to a Federal repository. Non-TRU wastes would be buried in licensed burial grounds. The estimated volumes of wastes from MOX fabrication and spent fuel reprocessing plants have been derived based on the best available data from operating experience. The costs and cost-benefits detailed in final GESMO CHAPTER XI deal with the costs of handling and storage/disposal of TRU wastes in a Federal repository.

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98. Comment:

"IV 11-3 - 60 megacurie difference hull burial is explained on Page IV 11-20, but long-lived alpha buried with hulls changes in opposite direction from activation products, therefore, actinide curie comparison should be given in separate line."

Response:

The table in final GESMO has been revised. Refer to CHAPTER IV, Section H.

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99. Comment:

"IV H-4 - No explanation is given for the maximum credible accident and why it involves only one waste canister. This section is too brief. The accident safety issues are not adequately covered."

Response:

In final GESMO, the discussion and assessment of accidents at the waste repository have been included in CHAPTER IV, Section H-3.0.

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100. Comment:

"IV H-15 - Table IV H-3 should show separate subtotals for long-lived alpha and beta activity."

Response:

In final GESMO, CHAPTER IV, Section H has been revised and now reflects and assesses waste characteristics based on the three fuel cycle options integrated over the 26-year period from 1975 through 2000.

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101. Comment:

"IV H-21 - Footnote** should be reworded to state the end result required, i.e., quantitative leachability and devitrification stability of 'glass' and then discuss generic aspects of one or more preferred solidification process routes, rather than deferring the analysis."

Response:

The "end result required" in the solidification of high level wastes for disposal in a Federal repository is now being formulated by ERDA. At present, there exist the general criteria listed in 10 CFR Part 50, Appendix F.

In this final GESMO, the environmental impact related to the disposal of solidified high level radioactive waste is based on an assumption that these wastes would likely go into a Federal geological repository.

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102. Comment:

"IV H-41 - See note on IV H-21, also. The conversion to glass would require opening and emptying of the RSSF canisters or total fusion of canister plus contents. Discarded canisters disposal is not mentioned."

Response:

The final process for conversion of waste from liquid to solid has not been established. The general sequence of events in the handling of waste canisters at the geologic repository has been included in CHAPTER IV, Section H. Inasmuch as such facilities have not been in operation, estimates of annual individual dose commitments have been calculated based on release data from similar activities.

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103. Comment:

"In last paragraph and on Page IV H-42, line 6, statements on shielding at RSSF do not seem consistent with high neutron and gamma streaming in storage cask configuration shown on page IV H-36. A different air duct configuration would be needed to reduce surface dose to 2 mr/hr."

Response:

This comment is appropriate based on the preliminary design concepts included in draft GESMO (Figure IV H-10 was a simplified sketch of the RSSF storage unit). Neutron and gamma streaming is a significant factor in these storage units. Several conceptual designs have been developed more recently that reduce the radiation streaming to acceptable levels. Experimental-calculational studies were performed at Hanford to verify design calculations with the use of a prototype storage unit.

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104. Comment:

"IV H-43 - Paragraph 5 'milligrams' and 'millicuries' require specific definitions. If this level of alpha release is meant, then it is high relative to MOX fabrication plant normal stack release."

Response:

In final GESMO, reference is made to the total milligrams of waste that have been estimated to be released from the waste repository under a credible accident condition. Refer to CHAPTER IV, Section H.

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105. Comment

"IV H-46 & 47 - What is the environmental effect of meltdown in a canister? Can the discharges be controlled? Which concept for RSSF is the safest? Which is most tamper-proof and fail-safe? Such sondierations (considerations) when left to the imagination of the public reader, are likely to lead to confusion."

Response:

The radioactive waste management program in the final GESMO is focused on geologic disposal of HLW, plutonium and transuranic wastes. The following data is based on conceptual designs, not the final designs of the RSSF evaluated in the draft GESMO.

-- Environmental Effect of Meltdown of Canister

In the design of interim storage facilities for solidified high level waste, various cooling concepts can be satisfactorily applied. Sufficient engineering safety can be utilized in the design of any of the cooling concepts (water basin, air cooled vault or sealed storage cask) to preclude a canister meltdown occurrence. However, should a meltdown occur more than one canister would most likely be involved except for possibly the Sealed Storage Cask Concept. Heat transfer calculations, using pessimistic assumptions, indicate that the canisters could melt and a puddle of molten waste and molten metal could build up on the concrete floor of the vault or water basin. The molten mass would boil off the more volatile constituents of the waste, including certain fission products and possibly some transuranics. The temperature attained and the amount of radiation present would be high enough to prevent personnel from occupying or maintaining the structure. Hence, these volatilized con-

stituents would ultimately be released to the atmosphere.

As the molten puddle increased in size, it would move through the concrete into the ground below and the depth that it travels into the ground would depend upon the amount of waste involved and the density of the molten mass in relation to that of the surrounding earth materials. Ultimately, it would form a molten pool in the ground as it reaches temperature equilibrium with the surrounding earth, and a crust would form to contain the molten mass. The pool of molten material would stay within the crust and slowly bubble until, in time, the heat generation rate would be sufficiently reduced through radioactive decay to allow the molten material to resolidify.

-- Control of Meltdown Discharge

Controls would be exercised to prevent a meltdown from occurring.

-- Relative Safety of the RSSF Concepts

It is believed that all of the RSSF concepts under consideration can be designed to equivalent degrees of safety. The designs of these concepts are not sufficiently advanced to allow a judgment of which particular storage concept could be designated as safest. At any stage of design development, selection of the safest concept would depend upon judgmental considerations, since rigorous evaluations of accident probabilities and consequences are heavily dependent on the calculational assumptions which are chosen.

-- Most Tamper-Proof and Fail-Safe Comparison

The Sealed Storage Cask Concept is generally considered to be the most tamper-proof and fail-safe storage concept, since the high level waste canisters are stored individually, with passive cooling, and each canister is contained within a rugged steel cask and further protected by a massive concrete radiation shield. Safe storage area operation requires little, if any, attention by Man. Constant human surveillance is considered prudent, however, since malicious tampering could reduce heat removal capability or cause a loss of radioactive material confinement.

-- Disposal of Radioactive Material by Sabotage

No nuclear facility can be designed to maintain radioactive material confinement despite any conceivable sabotage technique. While the various RSSF's are designed with heavy shielding and protection against natural phenomena that provide some protection, none of the facilities are intended to be designed specifically to withstand sabotage attempts. The planned plant physical protection systems would be designed to resist entry of potential saboteurs. These facilities would include certain features that are required for facilities that possess fissile material; these requirements are specified in the Code of Federal Regulations, Title 10, Part 73, entitled, "Physical Protection of Plants and Materials." Safeguards considerations are covered in a supplement to GESMO.

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106. Comment:

"IV H-57 - The concept of storing all plutonium waste at remote RSSF's with central incinerators should consider at least one eastern site to serve the fuel fabrication and reprocessing operations in this region of the U. S."

Response:

The types of facilities and locations for storage and disposal of transuranic waste are being studied by ERDA and final decisions have not yet been made.

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107. Comment

"IV H-59 - Last paragraph. Volume reduction should be changed to 3 to 4 because field experience survey shows secondary scrap generation (filters, refractory, etc.) affects net volume reduction, especially with incineration."

Response:

In final GESMO the discussions of the incinerator concept for volume reduction of TRU wastes have been deleted.

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108. Comment:

"IV H-61 - Paragraph 1. Rationale for considering only remote desert region is not clear for Pu waste RSSF."

Response:

The waste management chapter in final GESMO has been revised, indicating that the wastes will be sent to a Federal repository. The repository considered in CHAPTER IV, Section H, is the geological disposal concept.

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109. Comment:

"IV I-4 - Suggest deleting paragraph 3 in its entirety since soft gamma contribution from Am-241 is a minor factor, considering that the new generation of fabrication plants have no choice except to be well-shielded and the Am-241 problem will be taken in stride."

Response:

This paragraph has been deleted from the final GESMO. This comment is valid in that the shielding for added neutron radiation, required at the Pu storage facility will also serve to shield the soft gamma radiation from ^{241}Am.

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110. Comment:

"IV I-6 - The storage inventory without recycle should be changed to show buildup starting in 1978 not 1976 since there will be no reprocessing carryout until about 1978."

Response:

This section has been revised in the final statement, CHAPTER IV, Section I, paragraph 2.2 to indicate the requirements of Pu storage for delayed recycle of plutonium and considering the possibility of reprocessing and recycle of uranium only starting after 1978. CHAPTER VIII reviews in detail the alternatives of delayed reprocessing of spent fuels.

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111. Comment:

"IV J-6. Improvements in control of occupational exposure during uranium mining and milling have not been listed as to effect on fifty-year dose commitment. This information should be added for balance. Likewise, the impact of several inadvertent releases from reprocessing plants or mixed oxide fabrication plants have not been assessed and listed in the fifty-year dose commitment."

Response:

The application of future improvements in radiation exposure control have not been taken into account in final GESMO, except to recognize that the estimated exposures are greater than the average to be expected in most steps of the fuel cycle.

It is now indicated that the low impact from accidental releases, multiplied by their low frequency of occurrence is accommodated by the conservatisms compounded into the estimates of dose commitments from routine operation.

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112. Comment:

"IV J-7. Item C, Line 7. Plutonium fallout of 320 kilocuries ratioed to the area of the United States should be given in addition to the worldwide fallout."

Response:

In the final GESMO, this datum was not used to establish the areal concentration in particular locale, but to indicate that man's habitat is already committed to the accommodation of plutonium.

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113. Comment:

"Paragraph 4. After reference 2, the text should indicate an analysis by C. R. Richmond which was published in 1974 following the Second Annual Life Sciences Symposium at Los Alamos during May."

Response:

Several 1974 publications in which C. R. Richmond participated are among the references listed in the Federal Register Notice, 41 FR 15371, April 12, 1976, "Natural Resources Defense Council (Docket No. PRM-20-5) Denial of Petition for Rule Making," which is Reference 15 in CHAPTER IV, Section J of final GESMO.

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114. Comment:

"IV J-16 - Transportation accidents should be included in this table."

Response:

In final GESMO, transportation accidents have been included in CHAPTER IV, Section J, Table IV J-26. This table replaces Table IV J-15 of draft GESMO.

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115. Comment:

"IV J(a)-4 - Most resuspension data have been based on experiments in arid terrain. There is a lack of useful data in heavily vegetated areas such as the Middle Atlantic Region. Resuspension data with uranium shown on Page IV J(a)-6 may indeed be conservative but considering that the bulk of the population is located in the eastern half of the country, more realistic data should be made available."

Response:

The assessments on resuspension have been made on available information, which included more than data based only on experiments in arid lands as indicated in this comment.

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116. Comment:

"IV J(c)-7 - Item 2. 1974 publication by C. R. Richmond, LASL, should be listed as a primary reference since it deals with the hot particle problem."

Response:

Refer to response to Comment No. 113 of Comment Letter No. 24.

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117. Comment:

"IV J(c)-9-17 - The text is silent as to the toxicity of plutonium when combined with uranium in a mixed oxide compound. To date, there have been no studies on the radiotoxicity of various mixtures of plutonium with uranium. Although only a small percentage, perhaps 5-15% of 1990 represent solid solution mixed oxide in the finely divided processing stages, if this combined form followed a pathway which resulted in adverse effects in regard to either bone or other critical organs, it should be identified at an earlier enough date to appropriately adjust the models. To our knowledge there are no animal experiments currently funded in the United States which will evaluate the effect of the mixed oxide particle itself. Uranium and plutonium would be expected to disproportionate in the body fluids and the results may be more complex to interpret and apply than for PuO_2 or other 100% plutonium compounds."

Response:

Although the suggested information would be useful to health physicists working with MOX exposure cases, GESMO's treatment of considering Pu as a soluble ion for the dose estimates to all organs except the lung and as an insoluble particulate in the lung would still be used to maintain the conservative stance of the generic assessment.

---

118. Comment:

"VII-2 - Paragraph 1. The lead sentence indicates that not all differential effects are adverse. However, the discussion is limited to only those effects which are adverse to plutonium recycle. Although such an approach is undoubtedly conservative, it serves to weaken the overall impact statement in that it

118 Comment Cont'd

fails to identify both favorable and adverse effects assignable to plutonium recycle as they differ from uranium fuel."

Response:

CHAPTER VII was planned to comply with the guidelines for preparation of environmental statements, which call for the inclusion of a discussion of means for mitigating adverse environmental effects of the proposed action. In earlier chapters, beginning with the Summary and Conclusions in Volume 1, emphasis is given to the fact that the net effect of plutonium recycle is a reduction in environmental impact of the nuclear fuel cycle. The comparative environmental effects of all LWR fuel cycle plants and activities are described in detail and evaluated in CHAPTER IV.

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119. Comment:

"VII-12 - Paragraph 4. This indicates 'additional measure to further limit any adverse effects may be possible....' However, the specific need for implementation of each approach is not justified in the report. Such quantification is believed essential for the final impact statement. Specifically, citing criteria for recycle plutonium facilities, guidelines on 'as low as practical' releases for the facilities, improved safeguards, additional spent fuel shipment cask safety design criteria, long term waste management criteria, and possibly other items must be prudently developed and established prior to the accurate assignment of cost/benefit to the various alternatives considered."

Response:

It is beyond the scope of this generic environmental statement to develop and discuss in detail future criteria and guidelines for design and operation of LWR fuel cycle facilities. The discussions in CHAPTER VII are intended to describe aspects of the fuel cycle that may benefit from application of new technology for reducing environmental impacts and thus to give an idea of what improvements one could reasonably expect to be made. GESMO has assessed the differential impacts on the LWR fuel supply industry due to the implementation of uranium only and uranium and plutonium recycle based on current technology.

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120. Comment:

"VIII-14 - Paragraph 6. The meaning of 'action levels' is unclear."

Response:

The phrase, "the levels at which corrective responses are triggered," was inserted after "action levels" in the final statement.

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121. Comment:

"VIII-8 - Paragraph 4. Spent fuel transportation plus reprocessing cost of approximately $35/kilogram are undoubtedly too low.

121 Comment Cont'd

Response:

The costs have been updated in final GESMO. Now spent fuel transportation and reprocessing costs total approximately $165 (CHAPTER XI, Section 2.0).

---

122. Comment:

"VIII-13 - Paragraph 3. Under the alternative of reprocessing spent fuel immediately and storing plutonium for later use, the build-up of americium in the recovered plutonium during storage and its associated impact seems to be ignored. Americium builds up in the recovered products through the decay of ^{241}Pu and in turn decays with a very strong alpha emission. The concentration of americium in the stored plutonium is dependent on the elapsed time since reprocessing and the isotopic concentration of ^{241}Pu in the plutonium. Typical plutonium recovered from reprocessing LWR fuel which is stored much in excess of one year prior to fabrication no longer can meet the current industry's specifications on americium concentration for recovered plutonium. The presence of americium in the plutonium and its associated strong alpha emission, imposes a significant radiological handling problem to the mixed oxide fabricator. Consequently, the need for chemical separation of the americium from the plutonium is required prior to mixed oxide fabrication. The major disadvantages of this additional separation step are:

(1) the production of additional plutonium bearing waste.

(2) the potential of introducing additional chemical impurities in the plutonium effluent.

(3) the need to reconstitute the plutonium back to its original oxide form for either shipping or uranium blending requirements.

(4) the major economic impact of the additional separation step.

When assessing this alternative in the final impact statement, both the cost benefit analysis and the environmental consequences of this additional requirement should be considered."

Response:

In final GESMO the subject of the storage of plutonium is addressed in CHAPTER IV, Section I. However, the conditions of storage were assumed to involve only first cycle plutonium and this only for a maximum of seven years. With these assumptions, the buildup of ^{241}Am is not considered a serious problem.

If future commercial specifications on the ^{241}Am content of MOX fuels are more stringent than now anticipated, provisions could be made at any one of the plutonium handling facilities for the required plutonium repurification operations. The need for such facilities is not anticipated, hence these have not been provided in any of the GESMO model plants.

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123. Comment:

"VIII-16 - Paragraph 3. The use of depleted uranium as a carrier for the plutonium should be addressed. Utilization of tails assay materials, currently

an unused waste from the uranium enriching process, should result in the significant benefits to this alternative.

"VIII-16 - Paragraph 4. This alternative would also have the same potential benefits of using depleted uranium as a carrier."

Response:

Although depleted uranium could be, as indicated in these comments, "used as a carrier for plutonium," to do so leads to a higher cost substitute fuel than does MOX made with natural uranium. The additional plutonium required to replace the ^{235}U present in a kg of natural uranium MOX would be, for example, 4.9 g Pu_f.*

The cost of natural uranium in a kg of MOX (using the use weighted average cost for U_3O_8) would be about $71.**

If the depleted uranium were acquired free and then converted to UO_2 for the same cost as the incremental cost for conversion of natural uranium there would be a saving of $70.60 in U_3O_8 costs afforded by the additional expenditure of 4.9 g of fissile plutonium. Since that same fissile plutonium has a use weighted fuel value of $24/g Pu_f (see CHAPTER VIII) or $119 total when used with natural uranium for plutonium recycle, its use in conjunction with depleted uranium is decidedly less economical. The above analysis ignores several higher order effects and interactions, because their combined effects are small and would not change the conclusion.

*Considering ^{235}U equivalent enrichment + 0.033 in MOX
Depleted tails at .003
Amount of UO_2 in MOX fuel = .95
^{235}U in natural J = .007115
Substitution value Pu/U = 0.8

Additional Pu required in a kg of natural uranium = [(0.033 - 0.003) x 0.95 - (0.033 - 0.007115) x 0.95] 1.24 x 1000 g/kg = 4.9 g Pu_f

**Cost of natural uranium in kg of MOX natural uranium cost in a kg of MOX = 0.95 x 2.204 lbs/kg x 1.179 lbs U_3O_8/uranium x 28.1 lbs/lb U_3O_8.

---

124. Comment:

"VIII-21 - Paragraph 1. A mixed oxide cost of twice uranium fuel fabrication is probably too low even considering current regulations, and is likely to increase rather than decrease as additional regulations are implemented. A cost of three times uranium fuel, over the entire time period (a surcharge of two times) should be subject to less argument. (The recent public bid openings at TVA and LADWP provide more concrete information on current pricing)."

Response:

The MOX fabrication cost in final GESMO has been updated to reflect the best current estimate of three times the uranium fabrication cost. The basis for this estimate is developed in CHAPTER XI, Section 2.0. The sensitivity of the results to this factor is examined in CHAPTER XI, Section 3.0.

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125. Comment:

"VIII-21 - Paragraph 2. The $35/kilogram number for reprocessing and spent fuel transportation needs to be updated."

"VIII-33 - Paragraph 4. The long term plutonium storage costs appear to be exceedingly low. The reason for this is not immediately clear and is recommended that the bases for the estimates be further explained."

Response:

The costs in final GESMO have been updated to reflect best current estimates. The basis for the cost estimates is discussed in CHAPTER XI, Section 2.0.

---

126. Comment

"VIII-37 - There is some question as to the reasonableness of the estimated value of plutonium. Perhaps AEC could indicate the basis on which these estimates were made. Also, it would be desirable to include a statement on the sensitivity to a plus or minus change of $1/gram."

Response:

In the final statement, the values of plutonium are calculated for various years and the components of that calculation are presented in detail. Refer to CHAPTER VIII, Alternatives and CHAPTER XI, Cost-Benefits. The major components of the value of plutonium are the prices of yellowcake and separative work and the increased cost of MOX fabrication over that for UO_2 fuel. The average value for plutonium for Alternative 3, prompt reprocessing and recycle, over the period 1975-2000 is about $24 per gram Pu fissile.

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127. Comment:

"VIII-65 - Paragraph 1. The unit costs of separative work, U_3O_8 and other factors used in the calculation of plutonium value need to be reviewed and revised to correspond with recent changes in the industry. Refer to other comments related to unit costs, escalation, and sensitivity to a plus or minus range when estimates are used."

Response:

The market place model employed in this study is described in CHAPTER XI, Appendix A. The rate of usage of the resources does affect the market price. Additionally the model uses an "estimated cost of recovery" instead of the "forward cost" concept; thus an estimate of the market price is generated. Because of the inherent uncertainties in such an exercise, the effect of the uncertainties is examined by parameterizing the price of U_3O_8 and looking at the effect on incentives to recycle. See CHAPTER XI, Section 3.0.

The separative work cost was taken as $75/SWU, the generally accepted price at which private industry may enter the market. This cost is also parameterized and varied to see the effect on the incentives to recycle. See CHAPTER XI, Section 3.0.

---

128. Comment:

"VIII-65 - Paragraph 2. The fabrication cost differential discussed in this paragraph does not relate to earlier parts of the GESMO that mention up to $500/Kg increase for safeguards concepts, such as spiking the plutonium. It would be desirable to track all cost-related items through the entire report to assure consistency."

Response:

The particular inconsistency noted in this comment has been eliminated in this part of final GESMO. Safeguards considerations and safeguards costs are analyzed in the safeguards supplement.

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129. Comment:

"XI - General - The capital cost of facilities generally looks low. Since the major contributor to the benefits of Alternatives 3 and 4 are the savings in investment in Enrichment and Mining-Milling facilities, this modification will not affect the results.

"One item open to question is the capital investment needed at a nuclear power plant to receive, store, and use Pu recycle fuel. It is not clear where this has been included. If one assumes it could add $5 million to the cost of each reactor recycling plutonium, the added costs to reactors is $600 million. If this figure is appropriate, the impact is small but is indicative of hidden costs which may need to be further investigated as licensing regulations evolve. Credibility of the report will be enhanced if all such cost items are identified."

Response:

The capital costs of facilities reported in the draft statement are low. These costs were formulated at a time when all capital costs were undergoing extremely rapid, almost unprecedented escalation. The cost estimates used in the final statement are generally higher and are thought to be realistic based on 1975 prices.

The capital investment required at the power plants was estimated to be $0.5 million per reactor plant for additional safeguards handling MOX fuels. Other incremental costs would be insignificant.

The final assessment of the safeguards considerations and related costs will be included in the final safeguards supplement statement.

In final GESMO in CHAPTER XI, an effort has been made to identify and quantify all cost items of the fuel cycle. Where quantification was not practical, cost items have been identified, a range of costs established, and the effects on the cost-benefits qualified.

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130. Comment

"XI-22 - The conclusion paragraph should be expanded to discuss the apparent inability of the nuclear industry to get reprocessing and manufacturing facilities constructed. The problem areas should be outlined."

Response:

130 Comment Cont'd

The purpose of GESMO is to explore the environmental impacts and the benefits and costs of various alternatives for Pu recycle. An exploration of the state of the nation's present reprocessing industry would tend to confuse rather than elucidate the issues assessed based on an assumed future mature Pu recycle industry.

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131. Comment:

"XI-24 - Table XI-10. The 1990 $12.83 figure for the U_3O_8 price in the terms of unescalated 1974 dollars is low and will distort the economic comparisons. This is indicative of the low cost numbers used in the report. It is recognized that there has been a dramatic increase in costs related to various components in the fuel cycle during this last year. For this reason, all cost numbers and related economics should be updated."

"XI-29 - Table XI-11. The previous comment also applies to this table. All U_3O_8 cost projections used in the report need to be updated in order to enhance the credibility of the economic conclusions."

Response:

See response and Comment No. 127 of this comment letter.

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132. Comment:

"XI-44 - Paragraph 3. Please expand the discussion to point out why the plutonium storage facilities would be similar to high-level waste disposal facilities."

Response:

There are numerous differences between plutonium storage facilities and high level waste disposal facilities. Plutonium storage is now thoroughly discussed in CHAPTER IV, Section I.

For the fuel cycle option of uranium recycle only the plutonium would be treated as high level wastes and be sent to a Federal repository.

---

133. Comment:

"Attachment A - Examples of Overconservatism in Dose Calculations

1. The use of the semi-infinite cloud model for gamma dose may approach being correct at some great distance from the point of release, but it is not correct at distance of usual interest. The resulting degree of conservatism depends on whether the release is from a stack, a roof vent, or a lower elevation. The correct model to use is the finite cloud gamma model. (P. IV J-(A)-2)

2. The X/Q values used are based on ground level release assumptions. Recent tests have shown that roof vent diffusion is much better than previously assumed by the AEC. (P. IV C-95)

3. The submersion total body dose from noble gases calculation was applied to GI tract, thyroid and bone. The revised Appendix I (2/20/74) does not apply submersion dose to individual organs. (P. IV C-103)

4. Details of iodine inhalation dose calculations are not evident and need to be reviewed. They apparently include assumption of out-door exposure at fence post all year. (P. IV C-103)

   The iodine milk doses include all the overestimates which were shown to be objectionable at the ALAP hearings, namely (P. IV C-103):

   a. Iodine chemical form-overestimate by a factor of 2

   b. Roof vent diffusion-overestimate by a factor of 10

   c. High iodine deposition factor-overestimate by a factor of 2

   d. High transfer; grass to milk, overestimate by a factor of 2

   e. Assumption of fence post cow and baby factor of 2 to 100 depending on actual cow location and milk usage. (The AEC abandoned fence post cow concept on 2/20/74.)"

Response:

Dose calculations in final GESMO have been recalculated, not to eliminate conservative methods, but to utilize the same codes for all steps of the fuel cycle as are used for reactor effluent dose evaluations. The methods are described in a rewritten Appendix A of CHAPTER IV, Section J.

Docket [illegible] Misc Notice (39FR30186)
PROPOSED [illegible] GESMO

(G-31)

Natural Resources Defense Council, Inc.

1710 N STREET, N.W.
WASHINGTON, D.C. 20036
202 783-5710

New York Office
15 WEST 44th STREET
NEW YORK, N.Y. 10036
212 869-0150

Palo Alto Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

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Deputy Director for Fuels and Materials
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Sir:

Enclosed are two sets of the Natural Resources Defense Council's comments on the Atomic Energy Commission's draft generic environmental impact statement on the use of mixed oxide fuels (DRAFT GESMO). These comments consist of the following parts:

1. "The Plutonium Decision: A Report on the Risks of Plutonium Recycle," dated September, 1974. This report raises a number of questions and issues to which we believe the AEC should respond, including issues relating to plutonium toxicity, safeguards, socio-political implications of plutonium recycle, and the question of whether the "plutonium economy" can be successfully regulated both now and into the indefinite future.

2. "NRDC Comments on WASH-1327: General Comments."

3. "NRDC Comments on WASH-1327: Volume 3, Chapter IV, Section J," relating to plutonium hot particles.

4. "NRDC Comments on WASH-1327: Volume 4, Chapter V," relating to safeguards. These comments are being forwarded to you under separate cover.

5. Letter from Senators Walter F. Mondale and Philip A. Hart to Chairman Dixy Lee Ray, dated September 26, 1974. We have reviewed Mr. Muntzing's October 7 response to the questions raised by Senators Mondale and Hart and consider that response to be superficial and inadequate. In our judgment the senators have raised important questions which deserve careful and considered discussion in GESMO.

We would also like to associate ourselves with the "Comments on WASH-1327: Fuel Reprocessing" prepared by Dr. Marvin Resnikoff, Rachel Carson College, SUNY at Buffalo, New York.

The West Michigan Environmental Action Council joins with NRDC in offering these comments for your consideration in revising the DRAFT GESMO.

Sincerely,

J.G. Speth

JGS/pa

Enclosures

5-25.1

Natu l Resources Defense C. ncil, Inc.

1710 N STREET, N.W.
WASHINGTON, D.C. 20036
202 783-5710

New York Office
15 WEST 44th STREET
NEW YORK, N.Y. 10036
212 869-0150

Palo Alto Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

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J. Willard Roosevelt
David Sive, Esq.
Dr. George M. Woodwell
Edwin M. Zimmerman, Esq.

NRDC Comments on WASH 1327

DRAFT Generic Environmental Impact

Statement on Mixed Oxide Fuels

[GESMO]

Thomas B. Cochran
J.G. Speth

General Comments

The Atomic Energy Commission's draft Generic Environmental Statement on Mixed Oxide Fuels (DRAFT GESMO) is hopelessly biased and one-sided. It consistently presents the case for permitting the nuclear industry to process plutonium and use it as fuel in present-day reactors while at the same time ignoring and belittling the tremendous risks to the public health and safety associated with such a course.

In its concerted effort to justify the prompt initiation of plutonium recycle, the draft GESMO:

- ignores the major controversy over the adequacy of the AEC's current radiation protection standards applicable to plutonium and simply assumes the present standards are adequate to protect the public;
- fails to describe in any meaningful way the unprecedented horror of nuclear terrorism and omits discussion of the costs in terms of human freedom and privacy of the measures proposed to safeguard nuclear materials from theft and sabotage;
- consistently fails to recognize and discuss fairly both facts (e.g., the poor record of the nuclear industry to date in implementing safeguards and in protecting industry workers from exposure to plutonium) and opinions (e.g., those of Drs. Willrich, Taylor, Feld, Alfven, Weinberg, Sheinman and others regarding the severe difficulties of developing and implementing an "adequate" system of safeguards) which cast doubts on the advisability of recycling plutonium;
- blithely assumes that additional safeguards measures yet to be devised and implemented will have the effect of reducing the risk of nuclear terrorism to the level of other social risks beyond the control of the individual;
- inflates the projected economic benefits of recycling plutonium but minimizes the economic costs of proposed safeguards; and

- overlooks completely one of the principal alternatives to the agency's plan to move swiftly to authorize plutonium recycle: the deferral of any decision on plutonium recycle unless and until current uncertainties regarding plutonium toxicity and adequate and acceptable safeguards are satisfactorily resolved.

In light of these and other shortcomings, the DRAFT GESMO must be judged to be seriously misleading concerning the options before us and their actual risks. The basic purpose of an environmental impact statement is to provide federal decisionmakers and the public generally with a fair and accurate appraisal of the environmental risks and benefits of a particular federal proposal and the alternatives. This objective is fully applicable to draft, as well as final, impact statements. As stated in the Council on Environmental Quality's NEPA Guidelines:

> "The draft statement must fulfill and satisfy to the fullest extent possible at the time the draft is prepared the requirements established for final statements by section 102(2)(C)." 40 C.F.R. § 1500.7(a).

In particular, the CEQ Guidelines emphasize the requirements of fairness and full disclosure in draft statements:

> "Agencies should make every effort to discover and discuss all major points of view on the environmental effects of the proposed action and its alternatives in the draft statement itself." 40 C.F.R. § 1500.10(a).

The DRAFT GESMO fails to satisfy these important NEPA requirements. Because the DRAFT GESMO fails to present relevant facts and responsible opposing views, because the risk and economic analyses of the statement proceed from erroneous or unsupportable premises, and because the statement does not embody the good faith objectivity that is required, the AEC has not fulfilled its responsibility to provide the information and analysis mandated by NEPA.

AEC Response to These Comments

In preparing certain previous impact statements we have examined, the AEC has paid little attention to comments received from members of the public or other federal agencies in the text of the statement itself but has instead simply "answered" these comments in a separate section of the statement. Frequently these "answers" represent an incomplete and inadequate response. Occasionally, the agency even rephrases the comment in order to make it easier to respond.

We believe these procedures are inconsistent with NEPA's requirements:

- that the statement be "responsive to the comments received;"
- that "comments received shall be carefully evaluated and considered in the decision process;" and
- that the statement "remain an essentially self-contained instrument"[1]

The CEQ NEPA Guidelines specifically provide that

> "where opposing professional views and responsible opinion have been overlooked in the draft statement and are brought to the agency's attention through the commenting process, the agency should review the environmental effects of the action in light of those views and should make a meaningful reference to the existence of any responsible opposing view not adequately discussed in the draft statement, indicating the agency's response to the issues raised." 40 C.F.R. § 1500.10(a).

The NEPA Guidelines then indicate that the required discussion of responsible comments must be "in the text of the statement." Id.

1/ CEQ NEPA Guidelines, 40 C.F.R. §§ 1500.2(b), 1500.7(a), 1500.8(b).

General Deficiencies

This section of our comments discusses certain general deficiencies which we find in the DRAFT GESMO and which, like the more detailed comments which follow, must be corrected in any subsequent version of GESMO. These deficiencies are first listed and then discussed.

1. The deferral of a decision regarding plutonium recycle, and of course plutonium recycle itself, for several years (as opposed to indefinitely) until present uncertainties regarding safeguards and plutonium toxicity are satisfactorily resolved is not discussed as an alternative.

2. The cost-benefit analyses are limited to the year 1990 with the stream of benefits and costs for other years excluded.

3. The occupational exposures and environmental costs for alternatives are based in large part on data presented in "Environmental Survey of the Uranium Fuel Cycle," WASH-1248.[2] This biases the results in favor of plutonium recycle. Similarly, the "without plutonium recycle" case used throughout the DRAFT GESMO (e.g., Chapter IV) includes reprocessing of spent fuel even though the realistic alternative to plutonium recycle is storage of unreprocessed spent fuel, an alternative the DRAFT GESMO states would "eliminate the reprocessing industry" (pages 5-10). This use of the wrong base case biases the results in favor of plutonium recycle.

4. The costs to society due to the use of mixed oxide fuel have been greatly underestimated, in terms of effluent releases from fuel

2/ U.S. AEC, Fuels and Materials Directorate of Licensing, "Environmental Survey of the Uranium Fuel Cycle," WASH-1248 (April, 1974).

reprocessing plants, worker exposure, and actual reprocessing costs. The occupational exposures and radiological effluents associated with model spent fuel reprocessing and mixed oxide fuel fabricating facilities appear to bear little resemblance to historical and present operating experiences. This biases the results in favor of plutonium recycle.

5. The analysis of the health risk associated with inhalation of hot particles is based on the invalid assumption that it is conservative to average the dose to the lung tissue over the entire lung, thereby ignoring the potential enhanced risk of hot particles (particularly plutonium dioxide particulates), where hot particles are defined in NRDC's report, "Radiation Standards for Hot Particles."[3]

6. The conclusion that there are no safeguard related reasons for delaying plutonium recycle is based upon the wholly unsupported and unjustified assumption that in the future safeguards capable of reducing the risks of nuclear theft, terrorism and sabotage to a level commensurate with other involuntary public risks (i) can be devised in theory, (ii) can be made acceptable both politically and economically, and (iii) will be implemented in practice with the perpetual vigilance and meticulous attention to detail that are essential.

Discussion

1. Deferral of the plutonium recycle decision -- An option that we believe must command general support is to defer for several years

3/ Tamplin, Arthur R. and Thomas B. Cochran, "Radiation Standards for Hot Particles: A Report on the Inadequacy of Existing Radiation Protection Standards Related to Internal Exposure of Man to Insoluble Particles of Plutonium and Other Alpha-Emitting Hot Particles," Natural Resources Defense Council, Washington, D. C. (February 14, 1974).

the decision to recycle plutonium, until such time that present uncertainties regarding safeguards and plutonium toxicity are satisfactorily resolved and a basis has been laid for a more intelligent judgment regarding the risks and benefits of the commercialization of plutonium. This is the third option discussed in the NRDC report, "The Plutonium Decision."[4] The FINAL GESMO should display the costs and benefits of delaying the recycle of plutonium by X years, where X = 2, 4, . . . 10, for alternatives (1) and (2) discussed on page S-8 of DRAFT GESMO. Alternative (4) becomes the limiting case (X = 0). Alternative (3) would still be the same as alternative (4) without upgrading safeguards.

Nucleonics Week on October 24, 1974, reported that GE is offering to customers of its "indefinitely incapacitated Midwest Fuel Recovery Plant" a proposal to store spent nuclear fuel in lieu of reprocessing and noted that an industry source

> "argues that $10,000/tonne/yr for storing spent fuel is cheap when compared to the projected cost of storing plutonium -- 'in the event plutonium recycle is not allowed.' He says a charge of $3 per gram of plutonium per year is very likely, and that this equates roughly to a charge of $20,000/tonne/yr for storing uranium in the original spent fuel. 'And that,' he adds, 'is in addition to whatever you pay for the reprocessing itself. It may turn out that for the next decade or so it will be cheaper to store spent fuel rather than do anything with it.'" (Emphasis added)

In the same report, Nucleonics Week discussed a joint venture (E.R., Johnson Associates and Merril, Lynch, Pierce, Fenner & Smith) to design, finance, build and operate a spent nuclear fuel storage facility, and also reported,

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4/ Speth, J. Gustave, Arthur R. Tamplin and Thomas B. Cochran, "The Plutonium Decision: A Report on the Risks of Plutonium Recycle," Natural Resources Defense Council, Washington, D. C. (September, 1974), page 28.

> "AEC is now looking at the potential spent-fuel storage problem from two sides. The commission this month began a survey of available utility-owned storage pool capacity in an effort to determine how imminent the prospect of a bottleneck is; previously, AEC informed GE officials -- in response to their request -- that government-owned spent-fuel storage capacity was extremely limited and that expensive modifications would be required to make even that suitable for commercial fuel assemblies. At the same time, the commission has announced that by the end of this year it will issue a regulatory guide on the licensing, design, and plant-protection requirements for independent spent-fuel storage installations."

Clearly, delaying plutonium recycle a few years is a very real alternative actively being considered by the nuclear industry and the AEC. By ignoring this alternative DRAFT GESMO has demonstrated that it is out of touch with the realities that presently confront the utilities.

2. Limiting the cost benefit analysis to 1990 -- As a first cut it may be useful to examine the benefits and costs of an alternative in a single year, however, decisions involving important societal issues should be based on a weighting of all the costs against all the benefits. This of necessity requires an examining of the entire stream of benefits and costs over a time as long as they are felt. Clearly, one can not adequately compare the costs and benefits of delaying the recycling of plutonium 0, 2, 4, . . . years, simply by looking at the costs and benefits of each alternative delay period in the year 1990. For this and other reasons, the present analysis in DRAFT GESMO does not comply with NEPA's cost-benefit analysis requirement.

3. Environmental costs based on WASH-1248 -- WASH-1248 was meant to provide a "conservative or pessimistic" (by AEC evaluation) estimate of the environmental cost of the uranium fuel cycle based

on today's (1973) operations. The summary of WASH-1248 states that the primary basis of the survey, "is today's industry with only minimal allowances for advances that may be accomplished in the future,"[5] and "Where a single predominant operation has not been used, the mode of operation that imposes the most significant impact on the environment has been selected as the model."[6] For example, Kr-85 removal at fuel reprocessing plants was not considered as a future basis of operation, although this is considered feasible and desirable by EPA; and the model uranium mining operation was an open pit mine although open pit mining accounts for about one-half of the ore production in this country to date. As noted in DRAFT GESMO, "If Kr-85 removal were implemented, population dose commitments with plutonium recycle would exceed those without recycle.[7] Since the alleged benefits in plutonium recycle are largely attributable to reductions in environment costs associated with the uranium fuel cycle, the use of pessimistic or conservative assumptions in assigning environmental cost associated with the uranium cycle leads to bias in favor of recycling plutonium.

Similarly, the DRAFT GESMO assumes that spent fuel reprocessing and plutonium separation will occur in both "with plutonium recycle" and "without plutonium recycle" cases. This assumption, which is completely unjustified in the "without recycle" case, deprives the

5/ WASH-1248, op. cit., p. S-2.

6/ Ibid, pp. S-4, S-6.

7/ DRAFT GESMO: U.S. AEC, "Draft Generic Environmental Statement Mixed Oxide Fuel (Recycle Plutonium in Light Water-Cooled Reactors)," WASH-1327 (August, 1974), Volume 3, Chapter IV, p. IV E-5.

reader of an accurate assessment of the public health consequences of foregoing plutonium recycle and, since the risks associated with fuel reprocessing are substantial, strongly biases the results in favor of the recycle option.

4. Understatement of the costs to society due to the use of mixed oxide fuel -- Radiological effluents, occupational exposures and reprocessing costs at the model fuel reprocessing plant in DRAFT GESMO appear to bear little resemblance to the NFS operation at West Valley, New York, before it was shut down. The model mixed oxide fuel fabricating plant in DRAFT GESMO is based on the proposed Westinghouse Recycle Fuels Plant Environmental Report. Operational exposures and radiological effluents estimated for this model plant bear little resemblance to present practices at the Kerr-McGee plant at Crescent, Oklahoma, the Nuclear Fuel Services Plant (NFS) in Erwin, Tennessee, and Nuclear Materials and Equipment Corporation (NUMEC) in Apollo, Pennsylvania.

With respect to the NFS facility in West Valley, the comments by Dr. Resnikoff provide clear evidence that DRAFT GESMO estimates the occupational exposure at fuel reprocessing plants is completely unrealistic, based on the history of NFS's operation at West Valley, the only commercial fuel reprocessing plant that has operated so far in the United States.[8] A most blatant omission is the exposure to short term, "transient" nuclear workers, discussed more fully in the Science article, "Transient Nuclear Workers: A Special Case

8/ Resnikoff, Dr. Marvin, "Comments on WASH-1327: Generic Environmental Statement on the use of Recycle Plutonium in Mixed Oxide Fuel in Light Water Reactors. Re: Fuel Reprocessing," Rachel Carson College, Buffalo, New York (October, 1974).

for Standards,"[9] by Robert Gillette. We attach this (and two other articles by Gillette discussed subsequently) as an integral part of these comments.

Resnikoff notes that GESMO underestimates the cost of reprocessing by a factor of three, citing the testimony of Ms. Kathleen Black in the Barnwell Nuclear Fuel Plant construction permit hearings.[10] As Resnikoff notes, this estimate cannot be taken lightly since Ms. Black is a member of the AEC staff, and helped prepare the DRAFT GESMO.

The safety record at NFS at West Valley, Kerr McGee at Crescent, and NUMEC at Apollo, are discussed more fully by Robert Gillette in the attached Science article, "Plutonium (I): Questions of Health in a New Industry." Gillette reports:

> "The safety record compiled by the three main commercial processors [NFS (West Valley), Kerr McGee, and NUMEC] is subject to differing interpretations, but from a review of inspection reports made public by the AEC, it is hard to see that any of them is quite in command of the technology.
>
> The record reveals a dismal repetition of leaks in glove boxes; of inoperative radiation monitors; of employees who failed to follow instructions; of managers accused by the AEC of ineptness and failing to provide safety supervision or training to employees; of numerous violations of federal regulations and license requirements; of plutonium spills tracked through corridors, and, in half a dozen cases, beyond plant boundaries to automobiles, homes, at least one restaurant, and in one instance to a county sheriff's office in New York."[11]

9/ Gillette, Robert, "'Transient' Nuclear Workers: A Special Case for Standards," Science 186 (11 October 1974).

10/ Black, Kathleen, "U.S. Atomic Energy Commission, Barnwell Nuclear Fuel Plant, Docket No. 50-332: Supplemental Testimony Related to the Net Value of Uranium and Plutonium Recovered by Reprocessing," (1974).

11/ Gillette, Robert, "Plutonium (I): Questions of Health in a New Industry," Science 185 (20 September 1974), pp. 1029-1030.

The reader is referred to pages 1031-1032 of the attached article for a compilation of exposure incidents based on interviews and on inspection and investigative reports made public by the AEC.

It appears that the authors of DRAFT GESMO are totally unfamiliar with the record at these facilities, particularly as it pertains to health and safety practices. For example, the DRAFT GESMO states, "The probability of a major fire in a plutonium facility is small,"[12] yet Gulf United's Plutonium Facility at Pawling, New York, was permanently closed following a chemical explosion, a fire and a second explosion on December 21, 1972. This accident resulted in extensive plutonium contamination within the facility, a breach in the exhaust system in the plutonium handling room area, and the release of an undetermined quantity of plutonium from the building through blown out windows. According to Gulf United's analysis of the accident,

> "At the time of the explosion, one employee was standing directly in front of a large window in the north wall of the facility. He observed that the window was intact when he left the building. It was subsequently found that every pane in this window had been blown out or broken, which suggests that a second explosion took place, presumably when all of the employees were at the remote assembly building 0.9 mile away, and the plutonium facility itself was unattended. It is evident that a fire followed the initial explosion and it is plausible that this fire caused one of the bottles of flammable solvent to gradually heat up and rupture, dispersing its contents in air to form another explosive mixture. That no one heard a second explosion is understandable if it occurred when all of the personnel were in the remote assembly building."[13]

12/ DRAFT GESMO, op. cit., Volume 3, Chapter IV, p. IV D-39.

13/ Gulf United Nuclear Fuels Corporation, "Report of Incident at Gulf United's Plutonium Facility at Pawling, New York," Elmsford, New York (January 19, 1973), p. 11.

The DRAFT GESMO implies that such fires should be rare, and in any case small, because the licensees follow AEC Regulations, proported to be adequate. For example, the AEC states in DRAFT GESMO,

> "Regulatory Guide 3.6 presents methods acceptable to the Regulatory staff for a fire protection program which should prevent, detect, extinguish, limit, or control fires and explosions and their concomitant hazards and damaging effects. Licensees must operate within these or equivalent constraints. Under these conditions, the probability of having a fire of the magnitude considered in this statement is considered highly unlikely."[14] (emphasis added)

This statement could not be further from the truth, since licensees are notorious for failing to follow regulations. For example, following the explosions and fire at Gulf United's facility, AEC inspections at this facility between December 21, 1972 and October 31, 1973 identified the following violations and safety items:

> "A. Violations
>
> 1. Failure to continuously evaluate the stack effluent."[15]
>
> [Gulf United failed to make such surveys as were necessary to assure compliance with 10 CFR 20.106, "Concentrations in effluents to unrestricted areas."]
>
> B. Safety Items
>
> "Accepted radiological and nuclear safety practices dictate that: (1) procedures, facilities, and equipment are adequate for effective control during emergencies: and (2) that emergency drills be routinely conducted.

14/ DRAFT GESMO, op. cit., Volume 3, Chapter IV, p. IV D-39.

15/ U.S. AEC, Directorate of Regulatory Operations, Region I. "Inspection Report No.: 70-903/72-02," special inspection conducted by Mr. Lorenz on December 21, 22, 26, 27 and 29, 1972 of activities authorized by AEC License No. SNM-871 at "Licensee: Gulf United Nuclear Fuels Corporation, Grasslands Road, Elmsford, New York," Docket No. 70-903.

> a. Contrary to the above, your [Gulf United's] emergency alarm signal system was inadequate in that the alarm was not audible to all persons at the main site location.
>
> b. Contrary to the above, your [Gulf United's] Emergency Policy and Procedures were not maintained by the current emergency call list. . . .
>
> c. Contrary to the above, and as prescribed in your [Gulf United's] Emergency Policy and Procedures, no annual emergency training drill was conducted in 1972, and the formal training program for personnel was not scheduled.
>
> d. Contrary to the above, your [Gulf United's] remote assembly building was inadequate for personnel decontamination in that drain water from shower and wash facilities could not be collected and analyzed prior to release.
>
> e. Contrary to the above, your [Gulf United's] procedures did not provide that proper survey instruments accompany injured contaminated personnel when referred for medical treatment."[16]

A subsequent AEC inspection in June, 1973, during cleanup operations identified the following additional violations:

> 1. Failure to have waste drums properly stored inside building. The drums of unrecoverable waste were stored outside of any builidngs... . .
>
> 2. Failure to have a contamination survey station at the exit of the Plutonium Laboratory and to require personnel to perform surveys prior to leaving the contamination zone. . . .
>
> 3. Failure to either provide a criticality monitoring device for material stored in the Plutonium Laboratory vault or to analyze whether or not a criticality monitoring device located about 15 feet away with about 3 feet of intervening concrete would provide the required radiation detection."[17]

16/ Letter from James P. O'Reilly, Directer, U.S. AEC Directorate of Regulatory Operations, Region I, to Gulf United Nuclear Fuels Corporation in reference to Docket No. 70-903, dated May 17, 1973, Enclosure No. 2, Description of Safety Items.

17/ U.S. AEC, Directorate of Regulatory Operations, Region I. "Inspection Report No.: 70-903/73-02," routine-unannounced inspection conducted by Mr. Kinney on June 28-29, 1973 of activities authorized by AEC License No. 871 at "Licensee: Gulf United Nuclear Fuels Corporation, Grassland Road, Elmsford, New York," Docket No. 70-903.

Gulf United is not unique in its failure to follow regulations. NUMEC was recently fined $13,720 for a sixteen count violation of AEC regulations ranging from failing to follow radiation monitoring to failure to comply with certain safeguards requirements.[18] One of these pertained to the failure to install an adequate fire alarm system, and another pertained to the storage of flammable materials in a glove box. Similarly, NFS Erwin facility was recently cited for five licensing violations all related to health and safety.[19] These cases represent a small sample of the total AEC licensing violations, and the cases where fines have been levied, such as NUMEC, are rare. On August 25, 1974, the New York Times reported,

> "For the year ending June 30, for example, commission inspectors found a total of 3,333 violations in 1,288 of the 3,047 installations they examined.
>
> According to the commission's own definition, 98 of these charges were considered to be the most serious of three categories of violation. By this definition, they posed a health threat in that they caused or were likely to cause radiation exposures to employees or the public in excess of permitted limits, involved the release of radioactive materials in the environment beyond permitted limits or were a security threat.
>
> During the year, however, the commission imposed punishments on only eight occasions. It revoked the license of two small companies and levied civil penalties against six others totaling $37,000."

The same article quotes Anthony Mazzocchi, legislative director for the Oil Chemical and Atomic Workers,

> "The fact that the A.E.C. finds violations in one-third of the installations it inspects is clear evidence the regulations do not work,"

18/ AEC News Releases, Vol. V (August 14, 1974), p. 4.

19/ Letter from N.C. Moseley, Director, U.S. AEC Directorate of Regulatory Operations, Region II to Mr. William Manser, Jr., Plant Manager, Nuclear Fuel Services, Inc., Erwin, Tennessee (18 October 1974), Re: "RO:II:FJL 70-143/74-01."

Mazzocchi also noted that,

> "he was aware of a number of situations where inspectors had found repeated violations but had taken no action.
>
> He cited Nuclear Fuel Services of Erwin, Tenn., where he said there had been at least 15 separate incidents since 1969 in which more than 50 workers had been exposed to radiation above permissible limits. Despite these repeated incidents a commission spokesman confirmed Mr. Mazzochi's statement that the agency had never suspended or revoked or otherwise penalized Nuclear Fuel Services."

Finally, we note that the violations cited by the AEC probably represent a small sample of the total. For example, the violations at the NFS Erwin facility, noted above, were discovered only after production workers requested a meeting (held August 13, 1974) with AEC to complain about unsafe working conditions at that facility, and we would hasten to add that NFS is not unique in this respect.

A second example of the misrepresentation in the DRAFT GESMO of current practices at fuel fabrication facilities is the following discussion:

> "An explosion in a mixed oxide fuel fabrication plant can occur at the sintering furnace, at the clean scrap reduction operation, in the dirty scrap recycle operation, or at locations where combustible material may be located.
>
> Sintering furnaces and the clean scrap reduction operations used hydrogen diluted with an inert gas. The hydrogen is mixed with the diluent gas outside of the building. Several sets of redundant controls are installed on the gas supply to prevent gases with high concentrations of hydrogen from entering the building.
>
> The dirty scrap process uses a solvent, generally kerosene, that does not present a major explosive hazard. The use of solvents in process enclosures is limited.
>
> The consequences of an explosion are similar to those of a fire. The amount of plutonium reaching and passing through the filters is estimated to be the same as that in the fire (see above), and has the same offsite effects."[20] (emphasis added).

20/ DRAFT GESMO, op. cit., Volume 3, Chapter IV, p. IV D-40.

Production workers from Nuclear Fuel Services facility in Erwin, Tennessee, meeting with AEC inspectors on August 13, 1974, reported that the NFS scrap recovery operation was conducted in a building with 5 "barn" doors which remained open during scrap recovery operations, the building being ventilated directly through these doors with the aid of large fans (no filters). One of the NFS Erwin licensing violations noted above pertained to excessive contamination in the scrap recovery building.[21] While this was a UO_2 scrap recovery operation -- no PuO_2 had been processed within the past year -- it exemplifies the differences between the real world and the theoretical operations of the DRAFT GESMO model facilities.

5. Ignoring the enhanced health risk of plutonium hot particles -- Among the most serious failings of the DRAFT GESMO is the fact that the health consequences of plutonium recycle using the hot particle risk estimate are not presented. We have provided under separate cover comments on the DRAFT GESMO related to the hot particle discussion.[22] Subsequent to the submission of our comments on the hot particle discussion in DRAFT GESMO, the AEC has released a white paper, "A Radiobiological Assessment of the Spatial Distribution of Radiation Dose from Inhaled Plutonium," [WASH-1320] by W. J. Bair, C. R. Richmond, and B. W. Wachholz. NRDC has in preparation a critique of this report which will be available by

21/ Letter from N.C. Moseley, Director, U.S. AEC Directorate of Regulatory Operations, Region II to Mr. William Manser, Jr., Plant Manager, Nuclear Fuel Services, Inc., Erwin, Tennessee (11 October 1974), Re: "RO:II:FJL 70-143/74-01."

22/ Tamplin, A.R. and Thomas B. Cochran, "NRDC Comments on WASH-1327 DRAFT Generic Environmental Impact Statement on Mixed Oxide Fuels [GESMO] Re: The Hot Particle Discussion in Volume 3, Chapter IV, Section J.1. and Section J, Appendix D, Pages IV J-7, IV J(D)-1 to 41." Natural Resources Defense Council, Washington, D. C. (September 1974).

mid-November. If the AEC intends to use WASH-1320 in preparation of the FINAL GESMO, we request that our critique of WASH-1320 be an integral part of our comments.

Westinghouse's Environmental Report on its Recycle Fuel Facility (the facility on which the GESMO model mixed oxide fabrication plant is based) provides estimates of the airborne particle size distributions both before and after filtration by HEPA filters at this proposed facility. These distributions are dominated by hot particles.

Unless the AEC is implying a commitment to promulgate regulations which are consistent with the assumption in DRAFT GESMO and which are applicable to hot particles, the health effect from normal and accidental releases from facilities processing spent fuel and fabricating mixed oxide fuel are indeterminate. They could be more than 10,000 times the estimated health effects associated with plutonium in DRAFT GESMO.[23]

6. Inadequate assessment of safeguards problem -- The treatment of the safeguards problem in the DRAFT GESMO is grossly inadequate on several counts.[23a] First, the societal risk is not meaningfully explained. The nature and magnitude of the threat posed by terrorist and black marketeers is not described. For example, one searches in the DRAFT GESMO for an elaboration of, and comment on, the "Rosenbaum Report's" conclusion that the terrorist threat has "changed rapidly for the worse." Does the AEC staff agree with this assessment of its own consultants, or is it a responsible

23/ See discussion, pp. 5-7 of "NRDC Comments on WASH-1535, Re: Plutonium Toxicity," Submitted to the AEC February, 1974 by the Natural Resources Defense Council, Washington, D. C.

23a/ Additional comments of safeguards issues and their treatment in DRAFT GESMO are to be found in the NRDC report, "The Plutonium Decision," op. cit.

opposing view? What are the factors making the terrorist threat increasingly real and potent? Is this threat likely to get worse in the future? Another dimension of the societal risk is the consequences of acts of nuclear malevolence or of the development of a plutonium black market. A brief discussion of this critical issue is tucked away in Chapter V, but no where is the public really presented with the facts of what might be in store for it if the AEC's untested proposals do not work. Second, the DRAFT GESMO consistently underestimates the difficulty of developing effective safeguards, of securing their adoption and of ensuring their effective implementation both now and into the indefinite future. Much of the data and many of the considerations relevant to these points -- little of which is discussed in the DRAFT GESMO -- are set out in the accompanying report, "The Plutonium Decision: A Report on the Risks of Plutonium Recycle." A third topic which is not addressed in the DRAFT GESMO is the socio-political impact of effective safeguards, e.g., their effect on personal privacy and civil liberties. These issues are likewise discussed in "The Plutonium Decision." In light of all of these considerations, it is imperative for the AEC staff in responding to these and other comments (1) to state with clarity and precision exactly what additional safeguard measures it considers essential and what level of protection such safeguards would provide to the public and (2) to recommend that plutonium recycle not proceed until such measures are adopted and put into effect. Any other response by the staff would be irresponsible in light of the gravity of the problem and the mandate of the AEC.

Detailed Comments

Volume 1 -- Summary and Conclusions

The Summary and Conclusions sections of the DRAFT GESMO are even more biased, monolithic and unresponsive to the facts than the statement as a whole. Since these sections will be the most widely read portions of the statement, they must include a discussion of responsible opposing views in each section and subsection. Also, the summary sections must meet the same standards of candor and objectivity required for the overall statement and must accurately reflect the underlying statement. They cannot be the place where the AEC edits out unflattering observations and unpleasant facts in order to present a carefully edited picture of plutonium recycle to the public.

Volume 3 -- Chapter IV

Section A -- Summary

As noted previously data are provided for the year 1990 only. Data for other years (e.g., 1980 and 1985) should also be provided either here or somewhere else in the report. The figures and tables in the Summary should be cross-referenced with figures, tables and discussion in other parts of the report so the reader can easily figure out how and where the data were obtained, and what assumptions were made. For example, the reader does not know where the data in Table IV A-5 (p. IV A-9) comes from, what assumptions were made, etc., without reading the entire report and then trying to figure out what data in other tables were summarized to get these figures.

2.b Fuel Cycle Facilities (pp. IV A-10, 11)

It is stated,

> "The history of the fuel cycle operations to date indicates that accidents in fuel cycle facilities that could result in significant effects on the offsite environment are highly improbable. This record of the commercial nuclear fuel cycle industry has been accomplished by the consideration of safety as a controlling factor in all its functions."[24]

This is pure bunkum which is unsupported by the history of plutonium facilities, licensed or AEC-owned. The DRAFT GESMO fails to mention, much less discuss the GULF-United facility at Pawling, New York, which as noted earlier was closed permanently following a severe explosion.

The AEC's plutonium weapons facility at Rocky Flats was the site of one of the most costly industrial fires in history. It has been reported that there were 70 small fires in 1969 and 35 in 1970.[25] While this facility works with pyrophoric plutonium metal as opposed to PuO_2 it would be interesting to know how many of these fires could similarly occur in commercial mixed oxide plants.

Also, the leakage of plutonium from contaminated oil at the Rocky Flats site led to an uncontrolled source of plutonium which was some orders of magnitude larger than the integrated effluent loss during the 17 years of plant operation. Clearly this type of off-site release is not unique to the weapons facility. In fact, as noted previously, Gulf-United's plutonium facility at Pawling, New York, was cited for storing contaminated waste outside any building in violation of its license.

Section B -- Introduction

1.a The LWR Industry -- UO_2 Fuel Only (p. IV B-2)

The LWR uranium fuel cycle (Figure IV B-1) is defined to include fuel reprocessing and plutonium storage. There are presently no

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24/ DRAFT GESMO, op. cit., Volume 3, Chapter IV, pp. IV A-10, IV A-12, and again on IV B-12.

25/ Shapley, Deborah, "Rocky Flats: Credibility Gap Widens on Plutonium Plant Safety, Science 174 (November 1971), pp. 569-571.

commercial fuel reprocessing plants operating or licensed and none are required under alternative (6) or alternative (2) until some undetermined future date. GESMO should give equal billing to these other alternatives here and in the summaries and of course equal billing to the additional alternatives we propose (deferral of recycle for 2, 4 . . . 10 years).

2.a MOX Loading of Reference Reactor (p. IV B-7)

DRAFT GESMO assumes here and elsewhere that the reference reactor uses a MOX loading corresponding to 115% of the Self Generating Reactor (SGR). However on p. IV C-59 it is stated, ". . . there is some doubt that 100% plutonium as a fissile fuel (no enriched uranium rods) will ever be proposed for a LWR," and on p. IV C-2,

> "It is believed that by the time the performance characteristics for plutonium utilization in LWR's, in quantities greater than 1.15 SGR values have been determined to be acceptable, sufficient fuel and core performance data as well as plutonium recovery and fabrication experience will be available from LWR's that recycle plutonium at less than 1.15 SGR values and the choice of a full plutonium LWR or other intermediate loading may then be optional."

The implication here is that MOX loadings somewhat greater than 1.15 SGR can be expected but are presently unacceptable. Since the AEC has not promulgated standards restricting reactor loadings to 115% SGR even temporarily GESMO should discuss fully the safety and environmental implications of fuel management concepts up to and including 100% plutonium as fissile fuel in a reactor.

3. Effect of Pu Utilization

3.a Summary (p. IV C-28)

The following statement appears:

> "The inhomogeneity of fissile material in physically blended mixed-oxide fuel pellets can be controlled in fabrication such that the materials behavior approximates the homogeneous case."

GESMO should discuss fully the quality control measures to assure this inhomogeneity, their effectiveness, and the safety and environmental implications if the required homogeneity is not met, i.e., if a large number of fuel rods contain a large number of PuO_2 particles greater than 500 u diameter (see discussion pp. IV C-43 to IV C-47).

3.b MOX Fuel Fabricating Plant (p. IV B-8)

The DRAFT GESMO should discuss fully the environmental and safety implications of present day scrap recovery processes, particularly the operation at the NFS facility in Erwin, Tennessee.

Section C The Light Water Reactor with Plutonium Recycle

Summary

General (p. IV C-2)

See discussion of B 2a (p. IV B-7 above)

3.b LWR Plutonium Irradiation Experience (p. IV C-29)

To what extent can and does the U.S. AEC have control over U.S. manufacturers experimenting with recycled plutonium in foreign reactors, e.g., General Electric's large reload program in the Garigliano reactor in Italy?

Control Rod Worth and Control Requirements (p. IV C-32)

The following statements appear:

"If too large a fraction of the core contains mixed oxides, this flexibility is lost and substantially more control rods may be required to provide the necessary control and safety margins."

and

"In BWR's, the loss of control-rod worth is avoided by locating UO2 fuel pins adjacent to the control-rod locations and placing the mixed oxide fuel rods in islands in the interior of fuel assemblies, away from the control rods."

and

"Assuming that the fraction of mixed oxide fuel rods in the core is small enough to allow good fuel management . . ."

It is clear that reactor control can be significantly affected by MOX concentrations greater than 115% SGR assumed in the DRAFT GESMO. This is a clear example of the need to discuss fully the safety and environmental implications of fuel management concepts up to and including 100% plutonium as fissile fuel in the reactor.

c. Behavior of Plutonium-Fueled LWR's

Transients and Accidents (p. IV C-55)

This discussion is woefully inadequate. Presumably it is relevant to MOX loading 115% SGR, or less.

It is stated,

"The PWR steam-break accident may require more control rods or a higher boron-injection rate, but careful fuel management will minimize these requirements. The rod-ejection accident may be more or less severe, depending on the core design."

These accidents and their consequences should be discussed fully. What, for example, happens if fuel management is not careful; if several MOX rods are misplaced?

5. Radioactive Releases (pp. IV C-72 to IV C-122)

The comparative assessments of public exposure due to routine and accidental releases of radioactive releases from U-fuel and 115% SGR MOX fueled reactors are based on source terms which in turn are based on fission product inventories (and corrosive products, etc.) and release fractions. It is assumed implicitly that the accident frequencies and routine leakages rates are the same for both reactor fuels. But it is clear from previous discussions that MOX fueled reactors require a higher degree of quality control

both at the fuel fabrication plant (to insure homogeniety of MOX fuel and proper fuel management) and at the reactor (to insure proper fuel management). This could inhance considerably the level of routine and accidental releases from MOX fueled reactors. We are at a loss to understand why the AEC does not include this consideration when comparing exposures -- public and occupational -- for the two types of fuel, since this factor could more than off-set any apparent differences due to inventories of radioactivity in the reactor.

Mixed Oxide Fuel Fabrication (p. IV D)

NRDC's principal criticisms of this section have been covered earlier in the discussion of critical deficiencies, particularly deficiencies (4) and (5).

Figure IV D-3 (p. IV D-14)

In view of the NFS-Erwin operation, it is erroneous to assume that radioactive gaseous effluents from the recycle scrap recovery operation are controlled by HEPA filters.

2. Commercial Scale Mixed Oxide Fuel Fabrication Plant

a Model Plant (p. IV D-17)

The model plant is assumed to be "located on a 1000-acre site in a rural location." The Exxon Nuclear facility is located in the heart of downtown Richland, Washington. It is certainly not conservative to assume the model plant is remotely located.

(p. IV D-20) The radioactive gaseous effluents from the model plant assume the HEPA filters are reliable, yet we believe a careful review of AEC inspection reports would reveal discovery of breaches

in the air filter systems,[26] and failures to monitor the pressure differential across filters as frequently as required in the facility license.[27]

It is stated, "The CSMOFFP is designed and operated to minimize the probability of accidents." The facility is not operating, and if this statement were true with regard to the design, it could not operate economically.

(1) Radiological Effluents from CSMOFFP, Table IV D-6 (p. IV D-28)

The concentration for an alpha-emitter in stack for LASL should read $\sim 0.5 \times 10^{-14}$. The FINAL GESMO should present data for all facilities, including NFS-Erwin, Exxon and DOW-Rocky Flats, for each year of operation. Where data is not available an explanation should be given, for example, with respect to the total release from NUMEC. There is no excuse for that information not being available. This table should also present data on the yearly plutonium throughput. The DRAFT GESMO referenced the LASL data presented in "Plutonium Information meeting Transcript,"[28] but fails to note the observation on page 66 of the Transcript, that when the facility (Building 12) was torn down, the discharge was 2.9×10^{-12} pCi/ml, or a total of 1400 uCi(α) which is 100 times the reported annual release.

4. Environmental Impact of Plant Operation (p. IV D-32)

These calculations neglect the hot particle effect as we have previously discussed.

26/ Gulf United Nuclear Fuels Corporation, "Report of Incident at Gulf United's Plutonium Facility at Pawling, New York," Elmsford, New York (January 19, 1973), p. 4.

27/ U.S. AEC, Directorate of Regulatory Operations, RegionI. "Inspection Report No.: 70-364/73-01," routine, unannounced inspection conducted by W.W. Kinney on March 7-9, 1973 of activities authorized by AEC License No. SNM-414 at NUMEC, Docket No. 70-364, p. 5.

28/ U.S. AEC, Meeting of the Advisory Committee on Reactor Safeguards, Plutonium Information Meeting, Los Alamos, New Mexico (January 4, 1974).

5. Accidents (p. IV D-36)

This discussion is contrary to the record of the industry as previously discussed.

Section E Reprocessing Operations

Summary

General (p. IV E-2)

This discussion begins with the erroneous statement,

"The introduction of plutonium recycle in LWR's does not affect the total amount of fuel reprocessing required."

The point is, without plutonium recycle, reprocessing is not a necessary option. The discussion throughout this section is based on the biased assumption that the alternative to plutonium recycle is reprocessing and storage of plutonium.

1. The Irradiated Fuel Reprocessing Industry (p. IV E-5 to E-9)

All references to General Electric's Midwest Fuel Recovery Plant should be revised to reflect the debacle that this facility represents. Also, it is not at all clear that NFS at West Valley will resume operation. We understand that Getty Oil, which owns the facility, would like to unload it, but are unable to find a buyer. Finally, we doubt anyone realistically believes the Barnwell facility will be reprocessing 1500 MTU in 1976. Projections of fuel reprocessing through-put in the near term (See Table IV E-3 on p. IV E-6) need to be revised to reflect the realities of the present fuel reprocessing industry.

(a) Particulate Removal (pp. IV E-14 to E-15). See Detailed Comments with reference to page IV D-20 pertaining to HEPA filters. What were the particulate release fractions at the NFS-West Valley plant when it was operating? How do these compare with the values assumed for the model facility?

(b) Krypton 85 Removal (p. IV E-15). What are EPA's views on the feasibility, and implementation schedule for Kr-85 removal at fuel reprocessing plants? Why wasn't EPA's schedule used for the model plant? Who has final authority on setting Kr-85 release standards for the uranium and plutonium fuel cycles -- EPA or AEC?

(d) Ruthenium Removal (p. IV E-16). See page 6 of Dr. Resnikoff's comment on WASH-1327 [GESMO].

Iodine Removal (Table IV E-9 and E-10) and Worker Exposure. See pages 7 and 10 of Dr. Resnikoff's comments on WASH-1327 [GESMO].

Transuranium Isotopes (Table IV E-9 and E-10). Hot particle considerations have been ignored as previously discussed.

e. Accidents (pp. IV E-26 to E-34). Here again, hot particle considerations have been ignored.

One class of accidents that have been ignored are those which are human deliberate. The following discussion by Professor Donald Geesaman, while directed at reactor accidents, is equally applicable to the fuel reprocessing plant.

> "A major reactor accident, i.e., one that is not included in the design basis envelope, can derive from various sources. One such source is the random, but sequential, failure of engineered components in a way that the sufficient conditions for a major accident mode are satisfied. Redundancy, quality control and engineered safeguards can, in principle, make the incidence of such accidents arbitrarily small.
>
> "Another possible source of major accident is technological oversight. Using the aerospace industry as an analogous industry that is based on a high technology and carries an obvious residium of risk, then examples of technological oversight are the material fatigue history of the Comet I, and the airfoil instabilities of the early Electras. Comparable oversights in nuclear technology may result in major reactor accidents. Technological remedy should avoid repetition.
>
> "A third source class is defined by accidents derived from human error of an operational nature. Again drawing on the aircraft analogy, the occasional accidents caused by pilot error would be of this type.

Such accidents are presumably a possibility in nuclear industry, but again, in principle, training, engineered safeguards and redundancy may make the possibility vanishingly small.

"Fourth are the act of God class of accidents. Crashes due to violent weather, or accountable to foreign objects striking the jet intake of pilot's glass shield, are examples from the aircraft industry. Earthquakes or meteors could be of sufficient physical magnitude to cause a major accident at a nuclear reactor. The likelihood is or can be made small.

"I have somewhat arbitrarily indicated that the incidence for all four of these source classes of accident can be made small. This judgment is made relative to a fifth class of accidents which are human deliberate. The previously described sources of major accidents ignore the primary causal agent for technological events in contemporary society. That agent is rational man. Human intelligence has become the whole thrust of evolution, and most of life is subjugated to it. Things occur on earth usually because men have willed it. Thousands of aircraft crashes have occurred and they have mostly occurred as a result of deliberate human efforts directed to that end. Over a thousand high technology aircraft were destroyed over Vietnam more than would probably be lost due to other accident sources in hundreds of years of commercial aviation. This obvious class of hazards is generally ignored, though politically motivated international hijackings, crank of kidnap domestic hijackings, and rare insurance motivated air disasters, have drawn subliminal attention to the inherent frailty of a technology that puts hundreds of people in a cylinder of aluminum moving at 600 mph some seven miles up in the air. Are the aircraft systems stable against pilot incapacitation, small disruptive fires, or even high altitude decompression? Fortunately the size and nature of the population aboard a single aircraft makes destructive intervention politically unattractive. Nor is there substantial economic motivation. These fortuitous circumstances do far more to protect against aircraft disaster, than all the luggage scanning and human surveillance combined.

"Reactor accidents will happen when men want them to happen. The Second Law of Thermodynamics is almost an elegant way of stating that it is easier to destroy something than it is to construct it. Sabotaging a reactor is necessarily a minor technological task compared to building one. There is a technology of disordering order. It is a low technology and it cannot be ignored.

"The argument can be carried to an extreme without sacrificing meaning. Automobiles happen in our natural world, but they don't happen in a random natural way. They happen in an ordered natural way mediated by human

intelligence. Compute the probability of the appropriate proportions of iron, copper, aluminum, carbon, etc. assembling themselves by random process into a functional motor vehicle. It is an unlikely event, much as it is an unlikely event that fluctuations in the random motions of air molecules will break a window or lift a table. Automobiles happen, but they happen through human intervention, and similarly for reactors. If the human factor is neglected from hazard considerations, then one can infer not only that there will be very few accidents, but in fact, no accidents at all since it can equally well be argued on this basis that there will be no reactors available to have accidents.

"How does the above relate to the AEC's stated objective for reactor safety? For this objective there must be some accompanying aerospace ritual in which conditional probabilities are multiplied to obtain the probability of a possible failure mode, and a sum done over such failure modes. This may lead to a crude representation of the first four sources of major accident, which may in turn provoke technological, economic and social response that will bring the real incidence into compliance with the objective, or will modify the objective itself. It is not the intention here to approve or to criticize that ritual. The point is that the fifth source of accidents will not and cannot be included there, and in the process the baby goes out with the bathwater.

"Reality is more inclusive than the wet dreams of the systems analysts. There are Klaus Fuchs and Lee Harvey Oswald. There are heroin thefts at the New York Police Department and gambling hanky-panky in the highest echelons of AEC security personnel. There are Huston plans and White House plumbers; Argentinian kidnappings and Chilean coups. There are the angry sectarian confrontations by the Spanish Basques and the Canadian Separatists and the I.R.A. There is terrorist violence at Khartoum and Munich and Tel Aviv; the attack on Princess Anne and the Hearst Kidnapping. There are resurgent nationalism and alienated minorities, the hopeless, the poor, the vicious, the pathological, and most important of all, the brilliant, for raw human intelligence spreads across all human classifications; and 'where there's a will there's a way.' So when the nuclear kilowatts start humming in the electric blankets, and night is at the window, only a society of blind eyed energy addicts will find comfort in the remote numerata of conditional probabilities."[29]

29/ Geesaman, Donald P., "Comments on the Draft Environmental Impact Statement Liquid Metal Fast Breeder Reactor Program (WASH-1535)," School of Public Affairs, Univ. of Minnesota, Minneapolis, Minnesota (24 April 1974), pp. 2-5.

To appreciate the possible consequences of a deliberate terrorist attack on a fuel reprocessing plant we attach as Appendix D the testimony of Dr. John Gofman, presented before the South Carolina State Legislature. One of the calculations that Dr. Gofman presented was the fallout from a radioactive cloud representing 1% of the Barnwell high level radioactive waste inventory following the explosion at the Barnwell facility of a 5 to 20 kilowatt fission weapon. Gofman estimated . . .

> "Fresh agricultural produce from this region of 144,000 square miles would be obviously unsalable. While, after a period of months, the milk level will be much reduced, the agricultural produce from the region would be unacceptable for many years, because of radioactivity acquired in the produce via the soil-root pathway (much, much less active than the early milk, but unacceptable).
>
> "It is important to have a good idea of what 144,000 square miles of agricultural land being rendered unusable really means. For the wind direction considered, this would mean rendering unusable for agriculture the following:
>
> Approx. 1/10 of South Carolina
> plus approx. 1/10 of North Carolina
> plus approx. 1/5 of Virginia
> plus most . of West Virginia
> plus approx. 1/6 of Ohio
> plus more than 1/2 of Pennsylvania
> plus approx. 1/4 of New York State
> plus a significant part of Ontario province in Canada.
>
> "This represents a miminum tabulation, for fallout rendering agricultural land unusable will still be occurring beyond 48 hours, and hence encompassing more of Ontario province, Quebec and much more of New York State.
>
> "The economic costs alone will undoubtedly be in the multi-billion dollar category, not to mention indignation, rage, fear, and dislocation." [30]

If one considered a plant located in another portion of the country, similar results could be anticipated. In fact, wind trajectories for other locations would be more compatible with the

30/ Gofman, John W., M.D., Ph.D., Some Important Unexamined Questions Concerning The Barnwell Nuclear Fuel Reprocessing Plant, Testimony before the Nuclear Study Committee of The Legislature of the State of South Carolina, Colombia, South Carolina (January 7, 1972).

prospects of contaminating the area discussed by Gofman. By the year 2020, some 25 reprocessing plants of the size discussed by Gofman may be in existence.

In NRDC's Comments on WASH-1535, "Socio-Political Impacts," we noted,

> "If a nominal yield nuclear bomb (5-20kt) were exploded at the Barnwell facility and thereby injected 1% of the inventory (assuming ten years storage) into the atmosphere, this would be equivalent to the Cs^{137} and Sr^{90} in the fallout from all previous atmospheric nuclear weapons test (22 megacuries of Cs^{137} and 15 megacuries of Sr^{90}). The population dosage would therefore be similar to that from weapons test fallout. Table 2 presents these dosages to some 2 billion people in the north temperate latitude resulting from Cs^{137} and Sr^{90}. The shorter half-lived material would be expected to add some 10% to these dosages but we shall not use it here.
>
> "The gonad dose in Table 2 is also the whole body dose. Considering this is the average dose to 2×10^9 persons, it implies a population dose (whole body or gonad) of 170×10^6 man rem. Using the data from the BEIR Report* on the somatic and genetic effects of radiation, we obtain the following health effects:
>
> 15,000 to 75,000 cancer deaths from Cs^{137}
> 5,000 bone cancers and leukemias from Sr^{90}
> 10,000 to 250,000 genetic disorders from Cs^{137}

*/ NAS-NRC, Report of the Advisory Committee on the Biological Effects of Ionizing Radiation, The Effects on Populations of Exposure to Low Levels of Ionizing Radiation, (The BEIR Report), National Academy of Sciences - National Research Council, Washington, D.C. 20006, Nov. 1972.

TABLE 1

Hard Gamma Ray Contributors Built Up in the Fuel Reprocessing Plant Inventory at 5 & 10 years

Isotope	Half-Life	Megacuries per ton daily input	Megacuries per 5 tons daily input	Final Equilibrium Inventory (Megacuries) corrected for decay at 5 years	10 years
Zr^{95}	65 days	0.3774	1.887	176.2	176.2
Nb^{95}	35 days	0.7127	3.564	180.0	180.0
Ru^{103}	40 days	0.1329	0.665	38.4	38.4
Ru^{106}	1.0 year	0.7641	3.821	2011.0	2071.0
Cs^{134}	2.1 years	0.2031	1.016	1128.8	1340.0
Cs^{137}	30 years	0.1329	0.665	1165.1*	2200.0
Total				4700	6000.0

*The Cs^{137} inventory has been corrected for the slight decay it undergoe while in storage.

Since we will require it later, the Sr^{90} inventory is expected to be 91/133 x Cs^{137} inventory, or (0.68)xCs^{137} inventory.

In megacuries, this is 792 megacuries of Sr^{90} at 5 years and 1500 at 10 years.

**We calculated these using Gofman's value at 5 years.

TABLE 2

Fallout Dosage in North American Latitudes

SOURCE	mrads GONADS	BONE MARROW
EXTERNAL		
Cs^{137}	59	59
INTERNAL		
Sr^{90}		62
Cs^{137}	26	26
	85	147

Source: UNSCEAR, Ionizing Radiation: Levels and Effects. Volume 1: Levals, A report of the United Nations Scientific Committee on the Effects of Atomic Radiation to the General Assembly, United Nations, New York, 1972.

> In considering these numbers, it is important to recall that only 1% of the inventory was assumed to be injected into the atmosphere. It is conceivable that the amount released could be an order of magnitude larger. As a consequence, the estimate of the health effects could be an order of magnitude larger as could the effects estimated by Gofman. And we have not considered here the very sizable early effects of the local fallout."[31]

As Gofman has said, the consequence could be, "a lot of diplomatic leverage for terrorists," and we might add, a militant small nation.

Section F Supporting Uranium Fuel Cycle

The discussion of availability of domestic uranium resources and the domestic uranium mining industry should include a discussion of the three uranium studies cited by Nucleonics Week (October 24, 1974, pp. 6-7), namely: (1) EPRI's report, "Uranium Resources to Meet Long-Term Uranium Requirements;" (2) the Battelle study headed by John Burnham; and (3) the working paper, "Uranium Resources in the United States: An Overview," prepared for MIT's Energy Lab. by Richard Graves.

In connection with the third alternative that NRDC proposed -- delaying plutonium recycle for several years until safeguards and plutonium toxicity issues are resolved, we note that many of the environmental impacts, including those related to uranium production, would be essentially unchanged from the immediate plutonium recycle case. This is because the stored plutonium would be eventually recycled at which time the environmental costs (and benefits)

31/ Tamplin, A.R., J.G. Speth, and T.B. Cochran, "NRDC Comments on WASH-1535 Draft Environmental Statement Liquid Metal Fast Breeder Reactor Program Re: Volume III, Section 5.4, Socio-Political Impacts, pages 5-29 to 5-35," Natural Resources Defense Council, Washington, D.C. (1974), pp. 11-14.

would be realized. In other words, the net costs (or benefits) would be those associated with the shift in the time over which the costs (or benefits) are felt.

Section G Transportation of Radioactive Materials

Since the environmental impacts of transport in nuclear fuel are of most significance as they relate to the safeguards issue (discussed in Chapter V), additional comments on this section of DRAFT GESMO will not be made.

Section H Radioactive Waste Management

The decisions regarding plutonium recycle and high-level radioactive waste management are inseparable since it is not necessary to process spent fuel and recover the high-level waste until plutonium recycle commences. We note that the AEC chose to address these two issues (plutonium recycle and radioactive waste management) in separate environmental impact statements (WASH-1327 and WASH-1539, respectively), and that with the creation of ERDA and NRC these statements will be completed by separate agencies. Despite the institutional difficulties, we believe it is imperative that these two statements be coordinated, cross referenced, and consistent.

NRDC has submitted separately detailed comments on the waste management environmental impact statement (WASH-1539). Hence, we are not providing extensive comments on this, the waste management section of DRAFT GESMO. However, we offer the following brief comments.

(1) The discussion in the Radioactive Waste Management section is based on the biased assumption that if plutonium recycle is not approved the spent fuel will be reprocessed, the plutonium stored,

and the high-level radioactive waste shipped to the RSSF. This is nowhere more evident than in the first paragraph that begins,

> "The impact of plutonium recycle in LWR's on waste management will be to reduce the quantity of wastes associated with the uranium feed chain activities . . . by 9 to 11 percent, and to increase plutonium-contained wastes generated at the reprocessing plant by 1 to 2 percent, and to generate wastes from mixed oxide fabrication plants . . . . High-level wastes resulting from the reprocessing operations will contain larger quantities of transplutonium elements (americium and curium). The volumes of these later wastes will not be necessarily increased, . . ." (p. IV H-2)

Equal consideration must be given to other alternatives (storage of spent fuel with no reprocessing) including deferral of recycle for 2, 4, . . . 10 years.

Accidents (p. IV H-4)

The discussion here begins with,

> "Credible accidents in waste management facilities are expected to be of very low frequency, and if they occur, to have little environmental effect."

We take strong issue with this statement. As noted earlier (pp. 32 to 35) in NRDC's Comments on WASH-1535, "Socio-Political Impacts," we discussed the effect of a 5 - 10 kt nuclear weapon (delivered by a national, subnational or terrorist organization) on the waste storage area of a fuel reprocessing plant. This was followed by the following discussion of the effect of a 1 megaton weapon on the RSSF reference design (water basin concept):

> "Moreover, the Cs^{137} and Sr^{90} inventory at a repository is anticipated to be 5 to 10 times larger than that at a reprocessing plant. As a result, such an incident at a repository could produce effects that would be 5 to 10 times greater. In the extreme, the effects could be 1,000 times greater than those from the fallout of nuclear weapons tests, i.e., 10 to 250 million genetic disorders and 20 to 80 million cancer deaths. It would appear that a successful nuclear attack on one of these surface storage facilities could be far worse than the AEC believes." (p. 14)

Such an unscheduled event falls in Geesaman's fifth class of accidents, those which are human deliberate (See discussion on pp. 28 to 30). These cannot be ignored, there is no basis for assuming them to be of sufficiently low frequency, and they clearly have an enormous -- unequaled -- environmental effect.

Chapter VI Probable Adverse Effects Which Cannot be Avoided,

Chapter VII Means for Mitigating Adverse Environmental Effects,

Chapter VIII Alternative Disposition of Plutonium, and

Chapter IX Relationship Between Local, Short-Term Use of Man's Environment and the Maintenance of Long-Term Productivity

The discussion in these chapters contains a number of previously identified errors and deficiencies which have been carried over from other sections of the report, e.g., defining the fuel cycle (without plutonium recycle) to include fuel reprocessing and plutonium storage, and the inadequate treatment of plutonium toxicity and safeguards. These errors and deficiencies should be corrected.

Chapter VIII

Appendix A -- Tables of Environmental Factors

For reasons stated previously, e.g., the reliance on WASH-1248 for uranium fuel cycle data, many of the entries in Table VIII A1 are biased in favor of plutonium recycle and should be corrected.

Chapter XI

Cost Benefit Analysis of Alternative Dispositions of Plutonium

As noted in our discussion of "General Deficiencies" this cost-benefit analysis is wholly inadequate primarily because of an erroneous economic data base and because the entire stream of costs and benefits was not considered. The cost-benefit analysis

does not meet the requirements of NEPA, or for that matter, the standards required of utilities by the AEC as set forth in Regulatory Guide 4.2. It is imperative that the AEC set forth (in one place) all the economic assumptions, and sources of data used to calculate the cost of reprocessing, fabrication, enrichment, uranium value, etc. It appears that the cost estimates in DRAFT GESMO are a mixture of old, outdated, estimates, e.g., assuming reprocessing costs are $30/kg, and some newer estimates, e.g., separative work prices. The age of the data base should be presented wherever possible. For example, is the reprocessing cost estimate an old mid-1960 estimate escalated to 1974 dollars?

The cost-benefit analysis is almost completely void of sensitivity analyses that would show the effect of changes in the key cost assumptions. Predicting whether plutonium recycle is economically attractive is like predicting the winner of a floating crap game. The outcome is fairly sensitive to several key cost assumptions, for example, reprocessing costs, which have changed dramatically in the last few years and/or which can be expected to change in the future.

many preclinical departments, more student teaching could be done without seriously detracting from the other important activities of the professional faculty, and that small increments in numbers of teachers can result in large increments in numbers of students (*13*). While this view does not go unchallenged, enrollments of upward of 200 students per class are not uncommon in the United States, now. There are no reasons to suspect that such numbers would not be realistic for British schools.

The fundamental principle of the Todd commission recommendations is the "divided" school, with preclinical teaching in one place, and clinical teaching in another. This is as Oxford and Cambridge used to be. The Oxbridge schools are now building to the day when they will be able to provide all clinical instruction for their students in their own clinical facilities. With regard to London, the results of my survey, and the alternative proposals that have been discussed, would imply that the Todd commission recommendations for increased school size make good long-range planning, but that removal of the preclinical departments from proximity to their parent teaching hospitals is misguided and, in the long run, ruinous to the preclinical departments.

Finally, the Todd commission recommendations with regard to London have relevance to other medical educational problems in the United States. London is a great metropolis with 12 medical schools, and it is the only city in Great Britain with more than one medical school. In the United States, there are many cities with more than one medical school and six cities have three or more. Competition, conflicts, and duplication are inevitable in these situations. The Todd commission recommendations on London provide a model, albeit imperfect, of overall planning for medical education and, therefore, for health care, in American cities with more than one medical school. While "Todd pairing" has many opponents, in those instances where such pairing is already being put into effect there are many evidences of the pairs gaining mutual benefits, including the centering of excellence in certain clinical disciplines at one institution or another, and long-range planning for shared or coordinated laboratory and teaching services.

Conclusion

In the United States, circumstances still permit each university to set its own course under relatively broad and generous guidelines. The options for our faculties are relatively unrestricted and they can play important roles in determining university policy. We need never reach a stage which many can label "crisis," if events are predetermined by appropriate planning. The survey described herein points to the need for specific long-range planning of the future of preclinical departments in each university. The overall health care system is clearly involved in the problems described in Britain. The coming of a new order of health care in the United States should cause planners to accelerate their work.

References and Notes

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3. E. Braunwald, *N. Engl. J. Med.* 286, 1031 (1972).
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6. Comments and data showing this reference number are from announcements and letters circulated among faculty and administrators of medical schools in the United Kingdom. They have no titles and are not available in the literature. I have examined all of these personally.
7. *Reports of the Review Body on Doctor's and Dentists' Remuneration* (Her Majesty's Stationery Office, London, 1971 and 1972).
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10. Joint statement by the University of London and the University Grants Committee (University Grants Committee, Medical subcommittee, London, 1972).
11. M. B. Visscher, *Physiologist* 16, 43 (1973).
12. E. Braunwald and C. Grobstein, *J. Med. Educ.* 45, 525 (1970); D. Steinberg, *Clin. Res.* 21, 906 (1973).
13. J. C. Rose, *J. Am. Med. Assoc.* 213, 597 (1970).

14. I am grateful to many medical school administrators and faculty members in Great Britain for their time and their views. I also received valuable assistance from officials of the University Grants Committee, Medical Research Council, and Health Department. I am particularly indebted to the chairmen of the departments of physiology at the universities of Aberdeen, Glasgow, and Edinburgh; Bristol, Leeds, and Nottingham; Oxford; and, in London, St. Bartholomew's, The London Hospital, St. Mary's, Middlesex, and University College. Finally, this study was expedited greatly through the generous hospitality of Dr. J. C. Houston, Dean of Guy's Hospital Medical School, and Professor J. N. Hunt, Chairman of the Department of Physiology at Guy's, which served as a "home base" from which to make these observations.

NEWS AND COMMENT

Plutonium (I): Questions of Health in a New Industry

Will Martin is an assembly-line worker at an automobile plant near Buffalo, New York. He is a genial and soft-spoken bachelor of 29, and a troubled young man. Doctors have told him that he has little reason for concern, but Martin worries nonetheless about the possible effects on his future health of an unusual and very modern kind of industrial accident he suffered 7 years ago.

It happened one September afternoon in 1967 while Martin was employed at a nuclear fuel reprocessing plant located in the green rolling hills south of Buffalo and owned by Nuclear Fuels Services, Inc., a subsidiary of the Getty Oil Company. The $35 million plant, which is closed down now for repairs and a major enlargement, chemically extracted uranium and by-product plutonium from the used fuel rods of nuclear power reactors. Simply put, Martin's accident amounted to breathing at the wrong time and place (see page 1028), with the result that he inhaled a massive dose of airborne plutonium.

He left the plant in 1968, but much of the plutonium is still inside him. He remains in apparently robust health, but he wonders about the future. It is true, doctors have told him, that plutonium is one of the most potent carcinogens known, at least in animals. But it is also true, they have pointed out, that in 30 years no human malignancy or other illness has been tied to plutonium inhalation. But the doctors aren't sure why, and Martin continues to worry that the mildly radioactive "hot spots" in his chest and underneath his sacrum may, in time, lead to cancer.

"What does this really mean for me, that's what I want to know," he said

5-25.21

in a recent conversation [illegible] e living room of his parents' home. He answers his own question: "I guess I won't know what's going to happen until it happens."

"Will Martin" is a pseudony[illegible] to protect the man's privacy, but his experiences and his anxieties are real. In many ways he is typical of a small but growing number of Americans—a little more than 200 out of some 10,000 who have worked with plutonium—who have accumulated a "body burden" greater than radiological health authorities consider safe or prudent for this metal. It would be an exaggeration to say that their lives are in jeopardy, or, alternatively, that they have absolutely nothing to worry about. Some reassurance can be gleaned from the fact that detailed medical studies of some 25 GI's heavily dosed with plutonium at Los Alamos during World War II have revealed no signs of disease over a period of 30 years. But the truth seems to be that the long-term occupational health effects of plutonium are still very much a mystery.

It is not a trivial mystery, for a small commercial plutonium industry now

On Inhaling Plutonium:

It was less of an "accident" in the ordinary sense of the word than an indiscretion, a momentary lapse of discipline whose consequences thus far have been either nonexistent or too subtle to detect.

Martin had gone to work in 1965 at the Nuclear Fuels Services reprocessing plant at the age of 19, directly from the Army, and 2 years out of high school. Lacking any special skills in nuclear matters, he was designated as an "unlicensed operator" and assigned an assortment of tasks such as decontaminating equipment, helping to load reclaimed plutonium and uranium for shipment and storage, and taking samples from the plant's chemical process lines. All of these tasks involved a relatively high risk of contamination in a plant that was quickly gaining a reputation for such accidents.

On the afternoon of 9 September 1967, Martin's assignment was to enter the "Sample Extraction Aisle"—one of many airtight, concrete corridors in the plant's massive, windowless main building—to fill seven glass vials with plutonium nitrate for laboratory analysis. The sample area was known to be heavily contaminated from leaks and spills, and regulations called for a "contamination suit." More a cocoon than a suit, it consisted of two pairs of coveralls, multiple layers of plastic and rubber gloves and shoe covers, a cloth hood, and a heavy rubber "respirator" that looked like a gas mask.

Martin recalls that temperatures in the sample aisle that day hovered near 90 degrees. His task took more than an hour. The air that came through the face mask filter was hot and stale and smelled of rubber and sweat. Perspiration streamed down his face and steamed the window of the mask. At 4:35 in the afternoon, as he stepped through an airlock and out of the aisle, the foremost thought on his mind was to breathe fresh air, and that was his undoing.

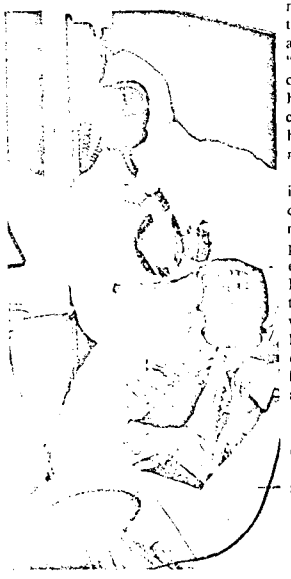
His suit was laden with plutonium dust by now, and to avoid inhaling it meant following an elaborate minuet of disrobing. First would come the outer shoe covers and gloves, followed by the outer coveralls. Then, without breathing, would come the face mask and hood, to be sealed in a plastic bag. Then and only then was breathing allowed.

Martin couldn't wait. He got as far as the first shoe covers, then pulled off his hood and mask and gulped fresh air. As he moved toward the radiation monitors, the alarms went off.

Someone stepped toward him with an alpha radiation counter. It buzzed madly near his hair and hands. Plutonium dust was up his nose and down his throat. A technician held the microphone-like probe near his mouth. Martin exhaled and the instrument's counter swung off scale. Even his breath was radioactive.

Health and safety technicians sped Martin to an emergency room for decontamination. Several hours later, after repeated "nasal douches" with saline water and several shampooings to remove external plutonium dust, Martin was sent home. No one yet knew how much he had inhaled and how much was left in him, but he remembers that someone told him that night to drink beer—that urination would help remove whatever remained. Martin replied that he didn't drink.

It was an unsettling experience, but Martin continued working at the plant as health technicians awaited the results of a urinalysis. A few days after the incident the results came back from a Buffalo laboratory: ordinarily one "alpha count" per minute from a liter of urine indicated some degree of inhalation; Martin's registered 7800 counts per minute, indicating an inhalation of 40 to 50 times the maximum permissible lung burden.



"Contamination suits" worn by radiation workers.

By now the AEC had begun to look into the incident, and company doctors decided to hospitalize Martin for treatments to accelerate his excretion of plutonium. It was to be as alien an experience for the Bertram Chaffee Memorial Hospital in the small rural town of Springville, New York, as it was for Martin. To the medical staff, he was a source of trepidation and an object of curiosity. Here, he began to learn first hand about the mystique, and the stigma, that is part of being a radiation accident "victim."

"All they knew was that I was a contamination case. They didn't know what to make of it," Martin said in a recent conversation. "They covered the walls and corridors in plastic, I guess because they thought I'd spread the stuff."

Treatment consisted of several intravenous, 1-gram doses of a chelating agent called DTPA (diethylene triaminepentaacetic acid) that chemically captures heavy metal compounds and aids in flushing them through the kidneys and intestinal tract.

Martin lay in bed for a week, feeling fine except for the needle in his arm and the doubts and uncertainties that had begun to settle upon him. Company officials, fearing that events might seriously upset Martin, briefly barred AEC investigators from interviewing him. While the AEC was barred from his room, Martin recalls, nurses and other hospital staff peered in on him more often than seemed necessary. "They seemed to think something was happening to me, maybe that I was changing, growing vampire teeth, or something."

Several years later, the hospital's administrator would confide to an AEC official that he and his staff were a bit leery of treating contamination victims from the nuclear plant. The administrator guessed that perhaps half the medical staff would be willing to respond to a radiation emergency at the plant.

By October, Martin had returned to work but was restricted from further contact with plutonium. He had begun the first of a series of "whole-body counts"—six scanning sessions, all with negative results, would ensue in the next 4 years—but the story does not end there.

Martin says the company assured him that he was "clean," but before long he began experiencing crushing headaches that he attributed to a new sensitivity to radiation. The headaches would last 3 and 4 days, and the best his doctor (who was also the plant physician) could suggest was that he needed an eye examination. Martin's solution instead was to leave the NFS plant, in October 1968, for a new job that involved no contact with radioactivity.

Although assured that he was free of plutonium, the company continued to contact him occasionally for additional whole-body counts. A seventh came in July 1972. This time the results left Martin badly shaken. The first six had been negative, but this one showed plutonium deposits in his ribs and lungs—as much as 98 nanocuries, or 2.5 times the maximum permissible body burden.

For several weeks Martin brooded about this turn of events. He confided to friends that he was worried about leukemia. He broached the subject of workman's compensation to a lawyer acquaintance, but the lawyer, noting that he was in apparent good health, told him it was a rather "strange" case and one that he was not qualified to pursue. Then in early February 1973 he appealed to the AEC for help. It was a long, handwritten exegesis of the accident and subsequent events and it ended by saying that "I never had the shakes before, but now since I have been told this I am shaking frequently. I appeal to you for help in my case."

One Man's Long Story

The letter was addressed only to "Atomic Energy Commission, Washington, D.C.," and it posed a test of the severest kind for a large bureaucracy. In this case, the AEC responded swiftly and beyond the bare requirements of the law.

Within a few days the letter had reached James P. O'Reilly, the commission's chief regulatory officer for the region covering Buffalo; he and his inspectors were intimately familiar with the NFS plant and its long history of contamination incidents. O'Reilly sent inspectors to the plant to dig up Martin's files and interview the principals in the case. Later, the commission hired a medical consultant to review these records and the new analyses that would be made. New radioanalyses of urine were performed. The AEC made arrangements for Martin to travel to the Monsanto Corporation's Mound Laboratory in Dayton (a major weapons facility) for another, authoritative whole-body count. The conclusion now was that Martin retained 40 nanocuries, the maximum permissible body burden. AEC officials say they discussed this with him, and assured him that there is very little chance of harm resulting.

The AEC had gone to considerable expense to set Martin's mind at ease. To headquarters, O'Reilly justified it on grounds that it was useful research—another bit of data to calibrate internal dose measurements. He also had a more personal justification: "When a guy gets different answers from different people and he's frightened to death, then it's time for the government to step in."

Martin says he was impressed with the way the AEC stepped in without taking sides. He seems to harbor no real bitterness toward the company, which bore the cost of the initial treatment and subsequent tests. And still, questions remain. Clutching a thick sheaf of papers from the AEC's medical consultant, which explained the test results in rather technical terms, he still wonders what it all means. "How do they know nothing's going to happen? Who's going to compensate if something does? I feel that I'm at a standstill in this now," Martin says.

The record of 30 years of human contact with plutonium is strongly in his favor, but statistics are cold comfort to a man in doubt. And he is not alone. A friend, who underwent a similar experience at the same plant in 1973, was briefly hospitalized shortly thereafter for an emotional disturbance. Martin's friend believes that a contributing factor was the gnawing and persistent uncertainty that goes with being "contaminated." However little physical basis there may be for such concerns, it is a Promethean punishment that they share. "He will always be questioning himself, always wondering," says the friend.—R.G.

5-25.22

stands at the threshold of a maj x-pansion in the 1970's, as the stun of bombs takes on an important new role as a fuel for generating electric power.

The vast majority of human exposures and overexposures to plutonium during the past 30 years have occurred, in the name of national security, in the half-dozen huge and quasi-secret industrial plants from Hanford to Los Alamos to Denver and Dayton and Aiken, South Carolina, that comprise the nation's nuclear weapons complex.

In the past few years, however, a new pattern has begun to emerge. Increasingly, and with a frequency that seems disproportionately high, incidents of plutonium inhalation are being recorded from a small group of privately owned and operated facilities engaged not in weapons work but in reclaiming plutonium from reactor fuel and recycling it in new reactor fuel. The Nuclear Fuels Services plant near Buffalo is one such plant. Two others are the Nuclear Materials and Engineering Corporation (NUMEC) plant near Pittsburgh and a Kerr-McGee plant at Cimarron, Oklahoma. Both are engaged in making plutonium fuel—mainly for the Atomic Energy Commission's Fast Flux Test Reactor at Hanford, Washington, a key element of the government's breeder reactor program.

A fourth company, Gulf United Nuclear Fuels, produced small amounts of plutonium fuel at a Long Island laboratory between 1970 and 1972, then dropped out of the field after a fire and explosion on 21 December 1972 injured one worker, contaminated two, and, according to AEC's investigative report of the accident, "grossly contaminated" a working area with plutonium.

The three remaining companies, plus five others waiting in the wings, form the vanguard of a budding new "commercial" plutonium industry. In spite of a strikingly blemished safety record chalked up by the active three, and in spite of the continuing uncertainty of the occupational health hazards involved, the AEC is moving now to encourage a major expansion of the plutonium fuel industry.

Having thought about it since the mid-1950's, the commission has concluded that the time is ripe at last for "plutonium recycling." By the time this new industry hits its stride in the late 1970's, the AEC expects to have licensed three large fuel reprocessing plants and eight big new fuel fabrication plants handling a flow of 7000 kilograms of plutonium a year—a vast increase over the present-day trickle of a few tens of kilograms. With the advent of breeder reactors in the 1980's, the AEC predicts, the flow will swell to several tens of thousands of kilograms a year. The justification for all of this is that not recycling spare plutonium to generate electric power would be a waste of a natural resource; and using it in present-day reactors is expected to reduce the nation's annual demand for uranium by as much as 10 percent.

Because of its extreme toxicity and its tendency to burn spontaneously, plutonium is customarily treated with a degree of caution accorded few other substances. When possible, it is handled by remote control; when human hands are necessary, it is handled in clear plastic or glass glove boxes, with arm-length rubber gloves built into access ports. Working areas are briskly ventilated and air is finely filtered. Air samplers and radiation monitors abound and, ideally, they work.

The safety record compiled by the three main commercial processors is subject to differing interpretations, but from a review of inspection reports made public by the AEC, it is hard to see that any of them is quite in command of the technology.

The record reveals a dismal repetition of leaks in glove boxes; of inoperative radiation monitors; of employees who failed to follow instructions; of managers accused by the AEC of ineptness and failing to provide safety supervision or training to employees; of numerous violations of federal regulations and license requirements; of plutonium spills tracked through corridors, and, in half a dozen cases, beyond plant boundaries to automobiles, homes, at least one restaurant, and in one instance to a county sheriff's office in New York.

The following compilation of exposure incidents is based on interviews and on inspection and investigative reports made public by the AEC:

Nuclear Fuels Services. At least 15 separate incidents between late 1966 and early 1973 exposed at least 38 persons to "excessive concentrations of radioactive materials" and all inhaled or ingested these materials. Amounts generally were below maximum permissible lung or body burdens, although measurements often proved faulty or imprecise.

An incident at the NFS plant on 5 January 1973 seems typical, although it occurred after the plant had closed for decontamination and enlargement. As two workers were pumping contaminated water into a tank, the hose slipped free, spraying one with radioactive sludge from a decontamination pit.

"I ducked but it caught me right in the face," the worker told *Science* in a recent interview. (He and others were located in spite of the fact that the AEC deletes workers' names from reports it releases to the public.) "The water had filter medium in it that catches fission products from the pit," the man explained. "I remember that it tasted gritty."

A Geiger counter held near his face registered 15,000 counts per minute. This contamination was removed by repeated scrubbings, but later analysis showed that he had inhaled or swallowed small amounts of radioactive ruthenium, cobalt, cesium, and 12 percent of the maximum allowable lung burden of plutonium.

Kerr-McGee. Since April 1970 the company's plutonium plant, employing 100 workers, has reported 17 overexposure incidents involving a total of 73 persons. An AEC spokesman noted that fewer than 73 *individuals* were overexposed, but that some persons were involved in more than one incident.

The most serious of these was a fire on 5 March 1973 which broke out

NSF Gets a Record $768 Million

The National Science Foundation (NSF) budget for the current fiscal year will be $768 million—a record high and about $100 million above last year's figure. Some $666 million of the total was included in a regular appropriations bill signed on 6 September by President Ford and the rest provided in special energy R & D funds. Although NSF must now work out the apportionment of the money to programs with the Office of Management and Budget, NSF officials expect a substantial increase in funds for the agency's basic research budget as well as for energy research.

NSF's RANN (Research Applied to National Needs) program is scheduled for another big increase this year with $149 million earmarked for the program. Congress voted a $50 million limit on RANN research not related to energy this year. Last year, RANN spent a total of about $93 million with nonenergy research limited to $47 million.

The time may not be far off when a beginning will be made in shifting energy research projects from NSF authority. The assumption has been that RANN would initiate research in major problem areas and then transfer the R & D programs to operating agencies. Passage of a bill creating an Energy Research and Development Administration (ERDA), which is now before a House-Senate conference committee, would create a new base for energy R & D.

Science education, a section of NSF which hasn't shared the rising trend in the agency's budget in recent years, will actually have its funds reduced from $67.5 million last year to $65.15 million for this year. Also singled out for restraint was research in the social sciences. As a result of misgivings over the record of social science research in NSF expressed in Senate hearings, particularly by Senator William Proxmire (D–Wis.) (*Science*, 16 August), it appears likely that expenditures will be held at about last year's level of $41.8 million.

NSF officials expect a sizable increase in funds this year above the $291.3 million spent last year in scientific research project support, which goes primarily to fund basic research in the universities. Despite spending floors and ceilings imposed on certain portions of the NSF budget by Congress and cuts decreed by the Executive, as much as $50 million more may be available for basic research. Inflation, of course, will reduce the effects of any increases.

Congress this year has been more active than usual in attaching instructions for spending on specific programs. As a result, NSF officials regret having less flexibility in allocating funds among programs, but in general seem pleased with the size and shape of this year's budget.—J.W.

A "Giant Step" in Power Pricing

A recent decision by the Wisconsin Public Service Commission may prove to be the opening wedge toward changing the traditional declining block rate structure employed by utilities throughout the country.

The commission, in considering an application for a rate increase by the Madison Gas and Electric Company, said the system of reducing unit charges for electricity for bulk users should be modified in favor of "flat" rates, except in cases where the declining rate can be proved to encourage the most efficient allocation of energy. It also ordered the company to inaugurate a system of peak load pricing, with higher rates set for summer months when air conditioning puts the greatest stress on the system.

What started out as a routine application for rate increases was turned into a precedent-breaking proceeding when two consumer groups, the Environmental Defense Fund (EDF) and a local group called Capitol Community Citizens (CCC), intervened in the case. The commission agreed in all essential respects with the EDF-CCC brief, which argued that a system of "marginal cost pricing" based on estimates of "long-run incremental cost" to the company would lead to efficient energy used at the most equitable cost to consumers. Simply put, this means prices should be set to reflect the actual cost of production and transmission of a customer's gas and electricity and should not be designed, as the declining block rate structure is, to stimulate consumption by reducing unit (kilowatt-hour) prices as consumption increases. Higher unit costs during peak load times reflect the fact that auxiliary generating facilities are inefficient and, therefore, more costly to operate. The immediate effect of marginal cost pricing is to make users aware of the actual costs of their electricity, with the result that sensible decisions by the individual customer are reflected in more efficient energy allocation by the producer. The long-run effect of this policy should be to curb expansion by utilities because price structures will discourage profligate power use and reduce peak demands.

In addition to calling for a winter-summer price differential, the commission directed that different day and nighttime rates be implemented for large industrial users. The cost of metering appears to prohibit time-of-day pricing for small users, but the commission has ordered the company to study and experiment with this policy as well.

Utilities have so far shown little interest in dropping their time-honored rate structure in favor of marginal cost pricing. Yet they may find it to their advantage as fuel becomes more expensive and it becomes clear to them that the days of uninterrupted growth—a phenomenon on which the industry is based—are past.

As the commission chairman pointed out, the Wisconsin case, which took 2 years to wrap up, has become a "national test case on electric rate design." It has received considerable notice among economists as well as environmentalists, and a number of other state public service commissions have asked the EDF, which has already been intervening in selected rate cases around the country, to present its reasoning at similar proceedings.

David Freeman, who heads the Ford Foundation's Energy Policy Project, calls the Wisconsin case "a giant step out of the promotional age and into the conservation age." It is also tangible evidence of the dramatic shifts in the economy in recent years. Ernest R. Habicht of the EDF points out that the Wisconsin decision embraces well-known economic theories "that have lain on the shelf for the past 75 years." Now, says Habicht, resistance to change has been eroded by the fact that utilities are being "eaten alive" by inflation. Utilities have run out of economies of scale and there is no new technology imminent to reverse the dismal trends. This being so, the declining block rate structure has changed from a lift to a drag.—C.H.

5-25.23

spontaneously in a bag of [illegible]nium waste, contaminating seven persons and a large working area. No overexposures at Kerr-McGee were felt to be "significant," the AEC spokesman said, adding that definition of this term "is something of a gray area."

NUMEC. Figures are imprecise, but the record shows that at least 30 persons (among a working crew of around 100) were overexposed to airborne plutonium in at least 13 incidents from late 1969 to the present. Six of these exposures resulted from repeated leaks in the same piece of equipment—a plutonium oxide sintering furnace—in a 1-month period in the summer of 1973. Fourteen other workers near the furnace were found to have fresh plutonium in their nasal passages but none was counted as having been overexposed.

AEC officials make the point that reports of overexposure do not necessarily mean that a worker has inhaled more than regulations allow. This is because AEC licensees are required to report every instance in which ambient air concentrations of plutonium (and other radioactive substances) exceed prescribed limits, regardless of whether excessive uptake by workers is detected. Mindful of this caveat, S. H. Smiley, the AEC's deputy director of licensing for fuels, says that on the whole "We've had a rather excellent record compared to other industries. These exposures are mostly minor stuff. Nothing in the way of a 'problem' has come to our attention that would cause us alarm, although anything we can do to reduce these incidents, and is practical, is worth doing."

Indeed, the AEC's official registry of radiation overexposures—encompassing events from 1968 to this May—lists only five plutonium inhalation incidents. Two occurred at AEC weapons facilities, one at NFS (the hose incident), and two at NUMEC.

There is an important reason for this disparity, apart from the fact that some overexposures truly represent an intake no larger than that caused by normal, chronic inhalation. It also happens that the registry counts only those overexposures in which inhalation is unambiguously confirmed. And confirming that inhalation has actually taken place—to say nothing of measuring the amount inhaled—is difficult and fraught with opportunities for error.

There are two methods of confirmation and measurement. One is to analyze an exposed worker's urine or fecal voids for plutonium and the o[illegible] is to scan his body with special radiation counting instruments to pick up emissions characteristic of this element. Both methods—"bioassay" and "counting"—have often produced results of questionable reliability and lung counting equipment is notoriously insensitive. AEC reports contain a number of instances in which "bioassay" data have been lost, mislabeled, or otherwise rendered useless. Moreover, the minimum amount of plutonium detectable by lung scanning instruments often equals half or more of the maximum burden permitted.

"You can measure external radiation doses simply, directly, and unambiguously," Gen W. Roy, the AEC's chief of radiological and environmental health for operations, acknowledged in an interview. "But internal doses are a horse of another color. Quantifying this is extremely difficult."

The end result of this difficulty is that the finding of "less than detectable" amounts of plutonium in an overexposed worker may mean very little, except to disqualify him from inclusion in the official registry.

Given the uncertainties of long-term effects of quantities that are difficult to measure, how does the AEC justify a major expansion of the commercial plutonium industry?

Smiley, among others, contends that most overexposures are minor, and he says that new and more sophisticated plants coming up for licensing will be far cleaner than their predecessors. "There will be more automation, less human contact," he says. "I would look for the number of these incidents to decline in the future."

Roy is similarly sanguine about future plants. "There has been a recognition of this kind of problem. And so much is known now about the design of [plutonium] plants that wasn't known in the early '60's."

Improving the technology of plutonium confinement may help, but past experience suggests that technology isn't everything. At least as essential is an enlightened corporate management, willing to spend money on employee training, on maintenance of equipment, and on adequate staffs of health and safety technicians.

The record thus far depicts a continuing struggle between the managers of the three commercial plutonium plants and AEC inspectors, with the latter scoring only mixed success.

Three times in 1967 and 1968 the AEC presented the NFS plant near Buffalo with the choice of closing down temporarily or being closed down to remedy health, safety, and environmental violations. The denouement of several years' struggle came in a meeting between the two sides at NFS headquarters in Rockville, Maryland, in February 1972. There, AEC officials accused the company of a "failure to make reasonable efforts to maintain the lowest levels of contamination and radiation . . ." and of a "failure to adequately instruct or effectively train employees . . . in the radiation hazards involved in their job assignments."

Three months later the plant began what company officials describe as a long-planned shutdown. Whether it would have been allowed to keep running is problematical. "They were heading for a shut-down," one AEC official said.

At the Kerr-McGee plutonium plant in 1973, AEC inspectors found 16 violations of plant license requirements or federal radiation regulations, all of which regulatory officials attributed to a "lack of management controls" and to inadequate staffing.

Although the AEC has been empowered since late 1971 to levy civil fines for safety violations, regulatory officials say that present policy is to do so only when a licensee fails to take prompt remedial action or seems willfully to disregard AEC regulations and license requirements.

Such apparently was the case this year with NUMEC. In June, the AEC fined the company's Pennsylvania fuels plant $12,000 for 16 separate violations relating to health, safety, and security. This was the first time the commission had fined a nuclear fuel facility. In a 5 June letter to NUMEC, James P. O'Reilly, the AEC's chief regulatory officer for the northeastern states, explained this unusual action by noting that the company's performance during the previous 20 months "indicates a history of repeated violations and unfulfilled commitments to correct violations."

Six days later a pinhole leak in a plutonium glove box at NUMEC contaminated one worker. The amount inhaled was said to be "significant" but nevertheless "far below" the level that would impair his health.

All in all, it would seem that the long-heralded debut of a "plutonium economy" has been less than auspicious.

—ROBERT GILLETTE

generator in the base of the cell [illegible]ots the cone-shaped rocket out through the flying shards of the cell cover and, a few feet clear of the ground, the rocket motor ignites. Almost simultaneously, the missile pitches over on its set course, aimed by a split-second injection of Freon into its rocket exhaust, and becomes a distant streak in the sky almost before onlookers realize it has left its cell.

Sprint is controlled at each instant of its flight by Central Logic and Control, a computer designed by Bell Laboratories, the research arm of the Bell telephone system. The unique feature of the machine is that to handle its rather elaborate task in real time it contains not one but a tandem of 10 central processors, with a capacity of performing about 10 million operations a second.

Besides its 10 central processors, Central Logic and Control consists of 12 program stores, each with a capacity of 16,000 words, 15 variable stores constituting a "scratch-pad memory" for radar data that need only be held a short time, two input/output controls, and two timing and status units. The system can be divided into formally equal "green" and "amber" partitions, which check each other in real time for malfunction. The green partition components are the ones that fight the battle, the amber are for testing and maintenance. If the amber side detects any malfunction in the green, it instantly switches in one of its own corresponding components in place of the faulty green component. As with the radars, redundancy is cultivated to a high degree to ensure the equipment stays on line when needed.

The essence of the Safeguard system is the system design and its embodiment in the software, written by Bell Laboratories with IBM as a subcontractor. According to Shea, Bell has performed the software job in an "exemplary fashion," notably by designing in a significant performance margin.

Bell Laboratories, with its production arm, Western Electric, is the prime contractor for the whole Safeguard system, a job which it undertook at the request of the Army. Unlike other defense contractors, Bell's main business is not dependent on Defense Department contracts, which may make for greater objectivity in rendering advice. "Bell Labs has dealt very candidly with the government and has never overstated what they felt could be accomplished," says Shea. By all accounts the Bell design team has played its part in putting Safeguard together with remarkable efficiency—all performance specifications have been met or exceeded, and the North Dakota site is being completed on schedule. The cost, however, has been greatly exceeded—running some $1.3 billion above the 1969 estimate for Safeguard—but for reasons largely beyond Bell's control, such as inflation and schedule changes. The story of Bell's achievements in designing Safeguard cannot, however, be told, since the company declines to discuss this ultimate service to its subscribers.

When completed the Safeguard site in North Dakota will be operated for a year and a half to gain operational experience and may then be reduced to working a 40-hour week. The critics may be right in doubting its strategic effectiveness—"Technically it's a fine thing, but it's like a train that doesn't go anywhere," says one opponent—yet anyone visiting the pyramid in the North Dakota wheatfields crammed with its powerful and elegant machinery cannot help absorbing a sense that it will work, and that the Soviet Union was well advised to bargain for its limitation. It is, if nothing else, a notable monument to Western technology and preoccupations, one which, like the funerary pyramids of ancient Egypt, will move future generations to marvel equally at the civilization's extraordinary technical skills and at its unswerving devotion to the mortuary arts.

—NICHOLAS WADE

Plutonium (II): Watching and Waiting for Adverse Effects

If any of you have a pet beagle, guinea pig, or hamster that is involved in a plutonium spill, we can make a fairly accurate prognosis and outline an adequate course of treatment. [But] at best, the practice of extrapolating animal data to man is of questionable validity, and the extent to which this may be done with confidence should be established by human data as soon as possible.—JOHN A. NORCROSS, former director of the United States Transuranium Registry, 1972

Almost from the time of its discovery in 1940, and certainly by the late 1940's, radiological health researchers were well aware that plutonium's great potential value was fully matched by its enormous biological hazard. Studies with laboratory animals 25 years ago, for example, quickly established that internal doses of plutonium measured in micrograms were an even more potent carcinogen than radium.

A great deal more has been learned since then about the behavior of plutonium in animals, as the above quotation suggests. But even though plutonium has become an increasingly important and abundant industrial substance, the effects of small internal doses on workers exposed to this strange metal remain uncomfortably uncertain. "The record so far is pretty good," says Walter S. Snyder, an authority on the subject and for many years a leading health physicist at Oak Ridge National Laboratory. But, Snyder adds, "we are still on edge about this."

Faced with this uncertainty—and with the rising prospect that plutonium would begin to spawn a commercial nuclear fuel industry in the mid- or late 1970's—the Atomic Energy Commission (AEC) began in the summer of 1968 to set up a medical data bank to monitor the health of thousands of men occupationally exposed to plutonium. It was hoped that the data bank, which the AEC now calls the United States Transuranium Registry, would serve as a medical trip wire—an early warning system—that would either confirm by its silence that exposure limits adopted in the late 1940's were adequate for workers, or sound an alarm soon enough to head off the kind of occupational health disaster that befell radium workers in the early part of the century, some of whom are still developing malignancies traceable to their jobs.

5-25.24

Today, the Transuranium Reg has passed beyond many of its initial organizational difficulties and has settled into what promises to be a long, quiet watch for signs of adverse health effects. Centered at the AEC's Hanford Reservation in eastern Washington state, the registry has become the repository for medical data on some 6000 nuclear workers, almost all in plutonium operations. And it has begun to report the results of autopsies on plutonium workers as the information becomes available. About 40 autopsies have been performed thus far.

Peaceful as its existence is, the registry is not without its problems and its critics. For one thing, selling industry on the concept of a medical data bank has not been easy, and the job is not yet finished. It also happens that medical data collected so far comes almost entirely from those men most recently exposed to plutonium and other radionuclides, and who are therefore least likely to show any adverse effects in the near future—if such effects are ever to be found at exposure levels currently encountered by nuclear workers.

Whatever its shortcomings, though, the registry represents an innovation in preventive medicine and, in a sense, a novel experiment in technology assessment. As such, it serves to illustrate the difficulties—both social and scientific—of guarding against future catastrophes of occupational health.

Officially, the Transuranium Registry is part of the Hanford Environmental Health Foundation, a private organization that the AEC has contracted to provide medical services for the nearly 7100 employees at the 570-square mile Hanford Reservation. With an annual budget that fluctuates between $80,000 and $105,000, the registry employs one full-time administrative assistant, a part-time consultant, and a part-time director, William D. Norwood. A physician and researcher at Hanford for many years, Norwood, at the age of 72, says that he's looking for a younger man to take over but hasn't yet found a replacement.

The registry's basic approach has been one of classic epidemiology. It seeks to collect medical records of as many plutonium workers as possible and then to find correlations, if any, between "body burdens" of plutonium or other radioactive elements and any changes in longevity or patterns of disease that develop. The registry is especially—but not exclusively—interested in men known to have absorbed relatively large amounts of plutonium, either through inhalation or through contaminated skin wounds, the two main routes of intake. Most careful watch is kept for workers who may develop malignancies of the bone, lung, liver, or tracheobronchial lymph nodes, where plutonium tends to concentrate.

Those workers who sign authorization forms for autopsies are given a special identity card to carry, and if they leave the nuclear industry before they die, the registry pays for them to have periodic physical exams and "body burden" measurements. When the worker dies, the registry pays the family $350 toward funeral expenses. Other deceased enrollees can be traced, and their death certificates located, through their social security numbers.

Problems of Privacy

All of this brushes up against sticky questions about an individual's right to privacy. To avoid problems in this area, the AEC has made cooperation with the registry—both by companies and by their individual employees—entirely voluntary. In addition, all medical data, which is stored on computer tapes, is numerically coded by the registry to protect each worker's identity. Even so, Norwood said in a recent telephone conversation, "We've really had to sell the idea to industry." Besides questions of privacy, he said, "Some companies are afraid that we'll scare their employees by talking about the hazards of plutonium. So we have gotten varying degrees of cooperation."

After some initial resistance, the national laboratories and the big nuclear weapons plants handling large amounts of plutonium have all begun cooperating fully, with the exception of the Savannah River production plants run by DuPont at Aiken, South Carolina.*

In contrast with AEC's own facilities and those run by its contractors, the registry has encountered a stonewall of resistance from some of the smaller private companies in the vanguard of a new and potentially major new segment of the nuclear industry—the manufacture of "mixed" uranium and plutonium oxide fuel for conventional nuclear power plants. The AEC is expected to move toward encouraging production of this new fuel within the next year (*Science*, 20 September).

Two companies that intend to make plutonium fuel on a large scale—Westinghouse and Exxon Nuclear—have agreed to cooperate fully with the registry, once production begins in about 3 years.

But two other companies in the plutonium fuel business have balked. These are Nuclear Fuel Services, Inc. (NFS), whose spent fuel reprocessing plant near Buffalo, New York, is closed pending AEC approval of a major enlargement; and the Nuclear Materials and Equipment Corporation (NUMEC), whose plutonium plant at Leechburg, Pennsylvania, near Pittsburgh, is producing fuel for the AEC's breeder reactor program. Together, and when fully operating, the two companies employ only about 200 persons "at risk" of exposure. But both plants have suffered a number of leaks and spills of plutonium that have led to contamination of workers, seemingly in disproportionately high numbers.

Norwood said that NUMEC "hasn't said yes and they haven't said no," but that NFS seemed to have stopped answering his letters. "They haven't responded to my last two or three."

A spokesman for NFS told *Science* that he wasn't familiar with the letters, but that the company's management at present regards participation in the Transuranium Registry as "inappropriate," although no final decision has been made. The spokesman, vice president Claude E. Fountain, said that the company's position was that even inviting employees to participate in the registry voluntarily might be construed as "coercion."

Did the company invite employees to contribute to United Fund and local blood banks? "Of course," said Fountain, "But we view that differently."

A spokesman for a third private plutonium plant, located near Cimarron, Oklahoma, and owned by Kerr-McGee, said the company does not yet know enough about the registry to give it a "blanket endorsement" but that Kerr-McGee "welcomes added information."

In Norwood's view, the noncooperating companies are more likely to hurt themselves than the registry and its goals, although their resistance does deny the registry access to a number of persons exposed to plutonium oxide, a form of the element considered by some authorities to be particularly hazardous. He notes that, "If some former employee comes along and sues these companies for compensation, it might look to the people trying the case that the company did not do anything it possibly could to protect employee health."

Norwood said that he had been informed that the Nuclear Energy Liability-Property Insurance Association, the national insurance pool that underwrites private nuclear facilities, had strongly urged the noncooperating companies to change their position.

How successful has the registry's recruitment been? No accurate figures are available, but upwards of 7000 to 8000 persons may now be employed in plutonium operations. The registry has signed up about 6000 of these workers, and some 850 of them have agreed to autopsies.

According to rough estimates supplied to *Science* by the AEC, however, about 17,000 persons are thought to have worked in plutonium operations from the beginning of the Manhattan project to the present. If so, that means the registry is monitoring only the most recent one-third of the population considered to have been occupationally "at risk" to exposure to plutonium. But finding and enlisting the cooperation of the first two-thirds has so far not been practical, Norwood said, explaining that, for one thing, early employment records are far from complete.

Even so, the apparent loss of the first 11,000 plutonium workers would seem

* DuPont gives the registry data only on workers known to have taken in more than 5 percent of the maximum permissible body burden of 40 nanocuries, a determination that is often difficult to make. The company replaces workers' names with coded numbers.

Briefing

NAS Okays Auto Emission Standards

The health-related auto emission standards embodied in the 1970 Clean Air Act are basically on target and there is "no substantial basis for changing the standards," according to a recently completed report by the National Academy of Sciences–National Academy of Engineering. Presumably the report will help buttress the act against weakening amendments when it comes up for review and overhaul next year. The act was supposed to be up for renewal this year, but it has been carried over with an interim appropriation.

The half-million dollar study was ordered by the Senate Public Works Committee last year following extensive hearings at which auto makers took issue with the standards, saying they were too strict and the required emission control devices were not cost-effective.

The academy committee disagrees with both contentions. While data are still inadequate, it says, the evidence that has accumulated since the standards were promulgated tends to confirm their desirability, and the safety margins are indeed "relatively modest." What's more, the report says the standards are justifiable in cost-benefit terms. It estimates the annual cost of reaching statutory emission standards at $5 to $8 billion, and assesses the benefits of clean air at between $2.5 and $10 billion a year.

The study was structured in three parts to analyze the effects on human health of specified pollutants, the relation of auto emissions to ambient air quality, and the costs and benefits associated with auto emission control.

The report estimates that air pollution can be said to be implicated in about 1 percent of all U.S. deaths each year and that automobiles contribute up to one-fourth of this pollution. So automobile exhaust fumes may send as many as 4000 people over the edge each year.—C.H.

Weather Mod Research Under a Cloud

The U.S. government has been trying to mount successful weather modification research programs since the late 1940's, but "an effective national weather modification research program has not been established," according to a recent report of the General Accounting Office (GAO).

If successful, such research could help "alleviate drought, reduce the destructive forces of hurricanes, suppress lightning . . . and dissipate fog," the study says. But the country lacks the capability to do these things operationally in part because the research has been conducted in a fragmented way by seven federal agencies and departments, the report says.

In fiscal 1974 the government spent $17.4 million on this research, but GAO concludes that the money could have been better used if all weather modification research programs were consolidated into a single agency.

The GAO employed unusually crisp language to describe the failure of the Interdepartmental Committee for Atmospheric Sciences (ICAS) in coordinating these programs. ICAS was set up in 1959 as a solution to the problem of fragmentation among agencies which was apparent even then. But now, "ICAS apparently has had little or no impact on increasing coordination and accelerating progress in weather modification research."

As an example of the inability of agencies to sacrifice their priorities to joint endeavors, GAO looked at the 5-year National Hail Research Experiment, begun in 1972, for which the National Science Foundation is chiefly responsible. After several agencies agreed on a plan, the following defections occurred: the Agriculture Department decided not to study the economic benefits of hail suppression (so NSF did) and did not make a study of lightning which was considered "imperative" to the project. The National Oceanic and Atmospheric Administratinon supplied one airplane for 1 year only, instead of the three pledged for the life of the project. The Atomic Energy Commission did not measure hailstones and make planned tracer studies. And the Department of Defense, instead of supplying two helicopters, told NSF it could have one, provided that NSF paid the bill—which NSF couldn't. GAO did not say whether the truncated project has been a scientific success: ". . . we found, comparing the planned efforts with the actual efforts that, for the most part, agencies could not and did not meet all their obligations."

Most of the federal agencies asked to comment on the study criticized it. The Agriculture Department's comment said GAO had not substantiated its premise that existing research programs were defective. Like most of the comments, it fought the proposed unified program: "I would not wish to defend a budget request on the basis that it enabled us to participate in a national weather modification program," the author said.—D.S.

5-25.25

to represent a considerable handica addition, some scientists who are especially worried about the health effects of plutonium question the registry's heavy emphasis on long-term epidemiology. Among them is Donald P. Geesaman, a biophysicist at the University of Minnesota's School of Public Affairs.

"If all they're looking at is body burdens and the cause of death, this may be next to useless," Geesaman says. "God only knows what else plutonium workers are exposed to—tritium, other radionuclides, hydrocarbons you never dreamed of. For meaningful results you have to look on a fine scale for pathology near local depositions in tissues."

Norwood replies that a few close examinations of autopsied bone have been done, but that techniques need refinement and uncommonly large depositions are necessary now.

In large measure the Transuranium Registry's sensitivity as an early warning system depends upon the nature of the effects, if any, to be discovered. The appearance of a rare malignancy—a bone sarcoma, for example—among the first few dozen autopsies would be a clear signal that something was amiss. But hundreds of deaths among the registry's enrollees might be required to detect a statistical increase in garden variety lung cancer.

In the meantime, there is a growing urgency to the central question: Are current occupational standards for plutonium, set in 1949, still adequate? As the nation moves toward the commercialization of plutonium, the standards have become an issue between environmentalists on one side and the proponents of nuclear power and the radiation standards community on the other. Earlier this year, for instance, the Natural Resources Defense Council, a respected environmental law group, contended in a lengthy technical paper that current exposure limits for airborne plutonium were too high by a factor of at least 100,000. Others, like Karl Z. Morgan, an eminent health physicist at the Georgia Institute of Technology, believe that a solid biological case exists for reducing the present maximum permissible body burden of plutonium by a factor of 40 or 50. This limit is now set at 40 nanocuries, an amount of material about equal to a pencil-point dot on a piece of paper.

Many health physicists, however, believe that no change in the standards, or only a small one, is warranted. Frequently cited as a reason for reassurance is the lack of apparent effects in a group of 25 GI's who were heavily contaminated by plutonium during the Manhattan Project and who have been monitored carefully ever since by researchers at Los Alamos. Chester Richmond, for any years a leader in plutonium effects work at Los Alamos, notes that the only signs of pathology in these men so far are "metaplastic changes found in the sputum" of some of the men. Such changes, though a possible precursor of malignancy, are not uncommon in middle-aged men who smoke.

Even though their number is small, Richmond continues, "I feel very reassured that our standards are not way out of line as some have suggested. If they were—by orders of magnitude—you would have seen something in this group, perhaps a bone sarcoma. They would have raised a red flag."

Walter S. Snyder, a member of the internal exposure committee of the International Commission on Radiological Protection, the leading standards organization, is similarly sanguine but cautious. No adverse effects have been seen thus far, he notes, but if there was one lesson learned from the radium workers a half century ago it is that radiation-caused malignancies may take decades to manifest themselves.

"We are still on edge about this," Snyder says of plutonium. "We're playing a game with very little human data."

—ROBERT GILLETTE

Erratum: In the first of this two-part series on 20 September the Nuclear Materials and Equipment Corporation was incorrectly identified as the Nuclear Materials and Engineering Corp.

UN Conferences: Topping Any Agenda Is the Question of Development

The World Population Conference ended on 30 August in Bucharest without producing explicit agreement that there was a world population problem, and the United Nations Law of the Sea Conference in Caracas wound up a day earlier without doing any legislating. What both the UN-sponsored meetings did contribute was sharper definition of the division between the developing countries and the Western industrialized countries, particularly the United States. Does this mean that the conferences were failures—perhaps that the world conference is likelier to produce confrontation than cooperation? Or does it simply mean that the problems addressed at Bucharest and Caracas are of such magnitude and complexity that it is naive to expect instant results?

The question is a fair one since the world conference form is very much in vogue. A cycle that began with the Conference on the Human Environment in Stockholm in 1972 accelerated with this summer's meetings, and will continue with a World Food Conference from 5–16 November in Rome, an International Women's Year Conference in Bogotá next summer, and a World Conference on Human Settlements in Vancouver in 1976.

The UN Conference on the Law of the Sea, which is the third of its kind, was, in effect, recessed, and is scheduled to resume in Geneva from 17 March to 3 April next year and, with good luck, to conclude with a treaty-signing session back in Venezuela next summer. Not all world conferences are the same, of course. The Law of the Sea Conference differs significantly in aim and in dynamics from the population and food conferences, for example. Its object is a major revision of maritime law, with the stormiest issues involving territorial limits, fishing rights, and the exploitation of minerals beneath the seas. The conferences on environment, population, and food do not focus on specific questions of international law but, to make progress, require the accommodation of social and cultural differences as well as the reconciliation of conflicting economic and political interests. The issues under discussion can all be viewed as different aspects of the problems of underdevelopment.

A familiar phenomenon at the conferences has been the bitter, often ritualistic criticism of the United States by the developing countries and socialist

be growing agreement among econ-
nists that efficiency in the economy
being significantly hampered by ar-
ngements favoring special interests
d by sheer bureaucratic meddling.
There was not much sign at the sum-
it of an impending great leap forward
economic theory. Of course, no
arxist or New Left economists were
vited to the Washington session.
here is concern among many econ-
nists about finding ways to assess the
creased impact of international eco-
omic developments on the American
onomy and also to understand do-
estic economic behavior that doesn't
:cord with the assumptions which
overn orthodox economic policy deci-
ons. But no new "general theory
appeared to be threatening the Keynesian conventional wisdom.

Macroeconomics, the study of the economy as a whole, which might be expected to produce promising ideas for public policy, seems to be in something of a recession. Microeconomics, the study of portions of the economy, on the other hand, is where many professional economists say the most interesting work is being done these days. Microeconomic study, not only of business firms or particular industries, but of such things as crime, marriage, welfare programs, and environmental problems seems to be yielding illuminating results.

Econometric model builders have had serious disappointments with big mathematical models of the U.S. economy. Some observers think that, when ways are found to aggregate the new data from the microeconomists into the big models, it will prove possible to improve the quality of the forecasting which is so important to making Keynesian policy work.

It may be that the results of perfecting Keynesian policies would be only academic in the face of the quadrupling of oil prices. The lesson taught by experience with the New Economics of the Kennedy-Johnson era and the Nixon New Economic Policy is that economic theory often gives way to political reality, and this may prove true, in spades, of Fordian economic policy as well.—JOHN WALSH

"Transient" Nuclear Workers: A Special Case for Standards

Buffalo, New York. For the Buffalo
ea's unemployed laborers, for the
oonlighters, college students, and the
oung men recruited from small farm-
g towns south of the city, the guar-
ntee of half a day's pay for a few
inutes' work was an offer they couldn't
:fuse. Attracted by the prospect of
sy money, they flocked by the hun-
reds to the Nuclear Fuel Services com-
any between 1966 and the middle of
972 to perform some of the dirtiest
bs in what one official of the Atomic
nergy Commission (AEC) calls "the
irty end of the nuclear business."

The business of Nuclear Fuel Ser-
ices (NFS) is the chemical extraction
f uranium and plutonium from the
ighly radioactive spent fuel rods of
uclear power reactors. Situated in pas-
oral, wooded hills 40 miles south of
uffalo, the chemical plant was the
ation's first commercial fuel process-
g facility. Although the technology it
sed was far from experimental, the
IFS plant proved less than a smashing
echnical success. Almost from the time
opened in 1966 until it ceased operat-
g in June of 1972 (for a major repair
nd enlargement program to be finished
1977) the plant suffered repeated
reakdowns and leaks of radioactivity.
o clean things up and make repairs,
he company relied heavily on the Buf-
alo area's abundant labor pool.

During 5½ years of operation, according to correspondence between NFS and the AEC, the company each year hired an average of 1400 "supplemental" workers from surrounding communities, making up a temporary, continually changing work force that outnumbered the plant's permanent, trained operating staff by more than 10 to 1. With an apparent minimum of instruction in safety procedures and the potential hazards of their jobs, the supplemental men were put to work decontaminating equipment and working areas, burying low-level nuclear waste, and repairing radioactive equipment.

Some of these workers were as young as 18 and others are alleged to have been recruited from bars for an afternoon's work. Some would last a week or more on the job. Others reached legal exposure limits within minutes and were promptly paid off—half a day's pay (at around $3 an hour)—and replaced, in the derisive phrase of a former full-time employee, by "fresh bodies."

On the average, according to AEC inspection reports, the plant's temporary workers received a whole-body radiation dose of 1.73 to 2 rems, an amount not considered harmful, but the equivalent nevertheless of five chest x-rays. This is less than the maximum the AEC allows for full-time radiation workers but much more than the industrywide average of 0.2 rem per year and more than the 0.5 rem allowed for members of the general public.*

The temporary workers, like the plant's permanent staff, also were exposed to small airborne concentrations of plutonium and other radioactive fission products whose hazards are under debate (*Science*, 20 and 27 September).

At one time the plant and its radioactive effluents were the focus of environmental protests, but these objections largely subsided, first as waste treatment improved and later when the plant closed. The company's public relations efforts have generally been effective, and a predominantly blue-collar region now seems to regard NFS as a welcome source of jobs. Local opposition to a planned tripling of the plant's capacity thus have been limited to a handful of conservationists and a few families whose sons worked at the plant. It is expected to reopen in about 3 years, at which time, AEC officials say, the plant will be much cleaner. If it isn't, one official adds, "we're in trouble."

Dormant as it is right now, the NFS plant provides a particularly vivid example of a common and long-standing practice in the nuclear industry. The AEC has long condoned the use of

* Federal radiation protection guidelines in force since 1960 recommend that individuals in the general population receive no more than 0.5 rem per year of nonmedical radiation to the whole body. Nuclear workers are limited to 5 rems per year, but the guidelines allow a worker to accumulate unused exposure according to the formula $5(n-18)$ where n is his age. The worker may draw on his "body bank" at a rate up to 3 rems per quarter or 12 rems per year.

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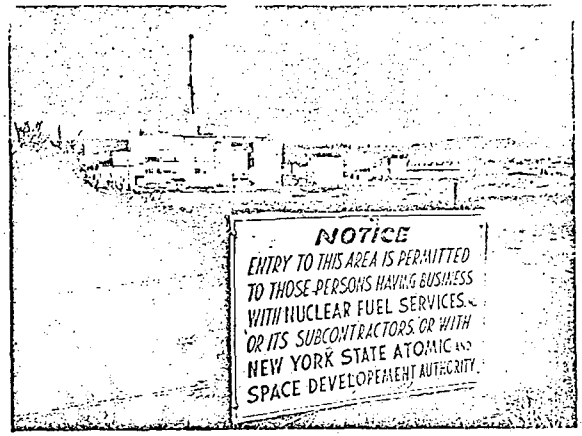

Photo by R. Gillette

Nuclear Fuel Services' chemical reprocessing plant near Buffalo, New York, is dormant now but plans to expand and reopen in 1977.

virtually untrained supplemental or "transient" workers in potentially hazardous radiation jobs, as long as they received some instruction in safety procedures and close supervision. One important effect of the widespread use of temporary workers, however, is to blur a traditionally sharp distinction between radiation workers and the general public. Nuclear workers are allowed to receive ten times more radiation than everyone else. But should there be no limits on the extent to which nuclear facilities may spread the burden of occupational exposure?

Any sharp restrictions on temporary employment would no doubt cause considerable anguish in the nuclear industry, for indications are that transient workers comprise a large portion of the industry's labor force. According to figures compiled by the AEC's division of operational safety, 54,675 persons left their jobs at government and private nuclear facilities in the 4 years between February 1969 and December 1972; of this number, 16,165 or 30 percent were employed less than 3 months.

To some degree the revolving-door character of the industry stems from demands for welders, pipefitters, and other craftsmen who are not always available within a company's full-time staff, or at least not in sufficient numbers. As an illustration, AEC officials say that some utilities (notably Consolidated Edison in New York) have occasionally had to hire 50 to 100 welders to complete a small number of welds in a radiation environment. Each welder works for a few minutes until he is "burned out"—that is, until he reaches his dose limit for the quarter—and a new man takes his place.

The practice is well enough established, in fact, that no one in regulatory circles seemed to raise an eyebrow in the summer of 1969 when the AEC's Rocky Flats plutonium fabrication plant near Denver brought in outside cleanup crews in the wake of a devastating $45-million fire. The Rocky Flats weapons plant, run for the AEC by the Dow Chemical Company, hired 60 college students that summer to help decontaminate the plutonium shop where the fire occurred.

Few nuclear facilities, however, have felt the need to raise quite so large an army of the untrained to keep things neat and clean as NFS did. Company officials at Buffalo blame their need for battalions of outside workers partly on the nature of the business and partly on problems of plant design.

The chemical plant is perched on a hillside amid the meadows and woods of a 3500-acre nuclear storage and waste burial site owned by the state of New York. The dominant building is a chunky concrete box with a smokestack on top for releasing gaseous wastes such as krypton-85. Barbed-wire and chain link fences mark the plant perimeter, giving it a distinctly military look. Inside, behind massive concrete partitions and leaded glass windows 4 feet thick, is a kind of nuclear refinery.

Spent or "irradiated" nuclear fuel is shipped to the plant in heavy casks for storage in a deep pool of water. After a cooling period, a heavy crane hoists up the long, squarish bundles of fuel rods, which emit a blue Cerenkov glow under water, and transfers them, one at a time, to a cavernous "cell" where a remotely operated shearing machine slices the bundles into small pieces. From here steel baskets carry the chopped fuel to another cell, to be dissolved in a vat of nitric acid. Then a series of chemical extractions separates the dissolved uranium, plutonium, and waste fission elements.

In a little more than 5 years of operation the plant processed 600 tons of fuel containing upward of 2 billion curies of radioactive material. Company officials say that with all this radioactivity passing through the plant, a little of it was bound to come out in undesirable places from time to time, and it did.

A certain amount of spillage and leakage was anticipated. But a fundamental design decision in the early 1960's appears to have compounded the problem of human exposure resulting from normal contamination. Evidently in an effort to hold capital costs down to around $32 million, NFS and its design firm, the Bechtel Corporation, decided not to make use of "remote-maintenance" technology developed at the AEC fuel processing plants at Hanford, Washington. NFS and Bechtel opted instead for a "contact" maintenance approach, which meant that when equipment needed repair it would have to be moved by crane, decontaminated by workers, and repaired by hand. The inevitable increase in exposure was further compounded by equipment failures that made contact maintenance necessary more often than originally expected.

The net result was that by 1971 the average yearly radiation dose for the plant's permanent operating staff of around 100 men had crept up to 7.2 rems—a dose that was within the law, but one so high as to be almost without precedent in a major nuclear facility. To make matters worse, a number of workers at the plant (most of whom apparently were permanent staff) suffered repeated overexposure to radiation, some through accidental inhalation of plutonium and other radioactive elements.

By 1972, the AEC's periodic inspection reports had begun to sound a continuous note of dismay at the performance of the plant—and of its management. In November 1971, AEC regulatory officials accused the company of a "failure to adequately instruct or effectively train employees and other personnel in the radiation hazards involved in their job assignments."

The AEC said further that efforts to control the spread and buildup of contamination in the plant and immediately around it had been "ineffective," and that the "data . . . do not seem to show any improvement in the exposure controls or the radiological safety conditions over the operating history of the plant."

These, then, were the circumstances under which the company hired its hundreds of supplemental workers. Essential maintenance had to be done. And, as plant manager James Duckworth saw it, there were only two choices: The plant could divert trained operators from their usual jobs and risk pushing them up to their quarterly dose limits, at which point they would have to be furloughed; or it could hire temporary help.

In a recent interview, Duckworth explained it this way:

> Say you have a ventilation pump that needs replacing, and it's "hot," and the sooner you get it out the better off everyone will be. There is no sense in using our qualified personnel to take three bolts off the base of an ordinary pump. And you might really create a safety problem by dosing up [a trained operator] and putting him off the job temporarily. No matter who does it, it'll take the same amount of exposure. So we have contractors who get us outside help.

The company relied mainly on a local labor contractor, the Benz Construction Corporation, and the Buffalo branch of a nationwide temporary labor firm, Manpower, Inc. Former employees of NFS and Buffalo officials of the International Association of Machinists and Aerospace Workers (IAM), which represented NFS's full-time employees, say that the two contractors drew heavily on moonlighters, students, and men seasonally employed at area automobile plants. In addition, Anthony J. Nitkowski, a district official of the IAM, said that between a third and half of workers hired by Manpower for jobs at NFS could have been described as "down-and-out" men from skid-row areas.

But William O'Rourke, of Manpower's Buffalo office, denies that his firm recruited men from skid-row areas.

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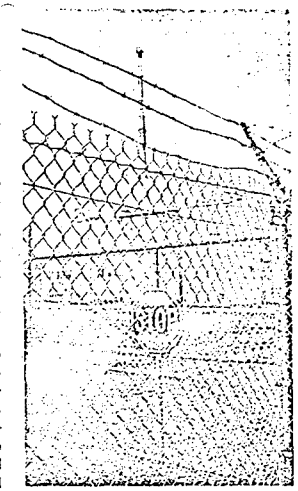


Photo by R. Gillette

"We're too sophisticated for that. Maybe some of these mickey-mouse storefront operations do that, but not us."

Qualifications for temporary employment at NFS were, in any case, not stringent. One had to be 18 years or older and physically able to do the job.

The procedure was simple. Upon arriving at the plant, workers would fill out a form for exposure records required by the AEC, then wait in the lunchroom for an hour or two. As each worker's turn came, he was escorted to his job, given protective clothing and instructions—how to clean a wall, which bolt to turn—and then would work for a predetermined number of minutes, so as to limit his exposure.

Views as to the quality of instruction and supervision vary. Says Duckworth:

> No, we didn't give them a course in atomic physics. Yes, we did indoctrinate them. We tell a guy where he's going to work, how to do it, what exposure he'll receive, what equipment he's to wear. Sometimes we use mockups or pictures to show them what they'll be doing. And they're supervised by a health and safety man and an operator.
>
> I've used six guys to get one nut off. Each guy may work 3 minutes, but he's paid for 4 hours. And we have [an exposure] record for every damn one of these people.

O'Rourke, of Manpower, Inc., says that he was given to understand that temporary workers could receive no more than a tenth of the [illegible] allowed by the AEC (which would be 0.3 rem per quarter). Duckworth says that every effort was made to hold exposures to 1 rem. According to an AEC inspection report dated September, 1972, temporary employees at NFS "work until a whole body exposure of 2 rems per calendar quarter has been received."

Over the years, AEC inspectors found many things wrong with the reprocessing plant and its management; but the handling of transient help was not one of them. James P. O'Reilly, the commission's chief regulatory officer for the northeastern states, said in an interview that supervision appeared adequate and instructions were "clear and reasonable." O'Reilly acknowledged that federal regulations do require that training be commensurate with risk in radiation jobs, but he said that, "with someone looking over your shoulder, the risk may be less. . . . In fact these people received a hell of a lot of attention. Control usually was tighter over them than on full-time people."

This is somewhat at variance, however, with circumstances described by half a dozen former employees at NFS, some of whom supervised supplemental laborers. As these workers described it, temporary men were told virtually nothing about the potential hazards of their jobs. They were generally left in the charge of men with no special training in health and safety procedures. And they often could not be seen or directly monitored by the men who "supervised" them.

The experience of David R. Whitehead, an elementary school teacher from Boston Spa, New York, who signed on for work one summer, appears to be typical.

A few days after applying to the Benz company, Whitehead was called to the plant to help decontaminate a crane room. He and several other men were suited up in protective clothing—two pairs of coveralls, rubber gloves, shoe covers, a paper hat and hood, and an air line for breathing. Instruction, he recalls, centered on the use of a hose and brush outfit:

> I don't recall a lecture about safety procedures as such. Mainly someone told us about the tools we would be using, that we had to remove some particles [from the walls] and they [NFS] didn't want to burn out their technicians on the job.
>
> We worked in a team, rotating one at a time, 10 minutes in the room, half an hour out. You'd be all alone in there.

he technician was outside, on the other de of an airlock and around a corner.

Did he feel that instruction and ıpervision were adequate?

I don't know how much supervision is :cessary, but I trusted them. I guess I as too dumb to be frightened. But if I known more about what I was getting to I would have been more wary on e job.

After 3 days the company told White-ead that he'd reached his exposure mit. That was the end of his job.

David Pyles, a former laboratory ıpervisor at the plant, said that many the temporary workers were openly sdainful about the hazards of radia-on, while others were apprehensive. ill others, he said, seemed simply un-ert.

You'd see all these people sitting around e lunchroom—that was the real gravy, itting paid to sit—and you felt that a t of them shouldn't even be in the ant. They were risking not only their vn health, but everyone else's.

Some were really afraid, and they'd ask lot of questions, I just tried to talk them to going home, but they wanted the oney.

Said Michael Lord, a former labora-ıry technician at the reprocessing ant, "The prevalent feeling was that ese people were nuts for going in ere and doing what they did."

For an industry that prides itself on ing one of the safest and most closely gulated in America—and one that is owing rapidly—continued reliance on mporary workers for the hot and dirty bs raises questions of the industry's udence. The AEC's position is that ere is nothing inherently unsafe about nploying untrained men in a radiation vironment if instruction and super-sion are adequate. But what assur-ace is there that brief instructions are derstood, that potential dangers are preciated, that supervision is in fact fective?

Roger Mattson, the AEC's newly ppointed assistant director for health d site standards, acknowledges that resent regulations do not specify the ind of instruction and supervision ansient workers are to have; nor is ere a requirement for testing or other eans of demonstrating that workers ave understood what they have been ld.

"The regulations now leave a lot up the licensee's judgment," Mattson aid in a recent conversation. "It has ccurred to us that they could be a lot ore explicit."

Regulatory officials also say they are concerned about the possibility of workers receiving a full quarterly dose at one plant then picking up still more in the same quarter somewhere else. Robert Alexander, the chief of occupational health standards, says that a review of the AEC's central record files on transient workers shows that only a very few men have actually done this. Even so, Alexander says, "We feel we haven't gone far enough to control this problem."

Four years ago, however, one possible solution to this problem—and to the blurred distinction between nuclear workers and the public—was suggested by the National Council on Radiation Protection and Measurements (NCRP), a leading advisory group on radiation standards since the 1930's.

The NCRP, whose proposal has not been adopted by the AEC, recommended in January of 1971 that persons doing only "occasional radiation work" be given special consideration in radiation protection standards. The NCRP said that persons whose occupational exposure was "truly sporadic"—a description that would fit the vast majority of men who passed through the Buffalo plant—should be limited to the same radiation dose as the general population or one-tenth that of full-fledged nuclear workers.

Recently, the AEC has begun to discourage the industry from spreading the burden of exposure to droves of part-time workers, but this discouragement has taken the form of a "regulatory guide" (issued last April) which is not subject to enforcement. Moreover, the AEC continues to regard anyone who accepts employment "inside the fence" of a nuclear installation as a full-fledged nuclear worker, whether he works for 3 minutes or 3 years.

In the meantime, the Environmental Protection Agency has begun a cautious and methodical review of the basic federal radiation protection guidelines dating back to 1959, under which the AEC still operates. One of the key issues to be examined, says Luis Garcia, the EPA official in charge of the review, "is this dichotomy of occupationally exposed people" recommended by the NCRP. "We will look at [the proposal] in light of its practicality."

Distilled to its essence, the question of transient workers in the nuclear industry becomes one of risk and benefit. Whether a worker receives his quarterly maximum of 3 rems in 3 months or in 3 ...ites may make no biological difference. But if, as is generally assumed, every exposure carries some discrete risk of genetic damage or illness, then the full-time worker who earns 3 months pay for 3 months' radiation benefits considerably more than the worker who accepts the same risk—knowingly or not—for half a day's pay.

In some ways the nuclear plant that hires men not for their skills but for their capacity to absorb radiation seems not so very different from the commercial blood bank that pays premium prices for a pint of plasma. Both solicit, and profit from, a small sacrifice. Both raise questions as to the ethics of drawing indiscriminately on the human population as a biological resource.

—ROBERT GILLETTE

RECENT DEATHS

George D. Gammon, 72; retired chairman, neurology department, University of Pennsylvania; 9 May.

Paul E. Guenther, 58; professor of mathematics and statistics, Case Western Reserve University; 28 April.

William Z. Hassid, 76; professor emeritus of biochemistry, University of California, Berkeley; 28 April.

Jack W. Keuffel, 55; professor of physics, University of Utah; 23 May.

Regis J. Leonard, 61; professor of education, School of Education, Fordham University; 26 May.

Walter C. Lowdermilk, 86; professor emeritus of agriculture, Israel Institute of Technology; 6 May.

John H. Mulholland, 73; former professor of surgery, New York University; 6 May.

Philip A. Munz, 82; former professor of botany and horticulture, Graduate School, Claremont College; 13 April.

Hubert J. Sloan, 70; acting deputy vice president for agriculture, forestry, and home economics, University of Minnesota; 1 May.

O. E. Van Alyea, 87; professor emeritus of otolaryngology, University of Illinois; 10 May.

Richard Wagner, 86; professor emeritus of clinical pediatrics, Tufts University; 19 April.

David R. Waldbaum, 37; associate professor of geological and geophysical sciences, Princeton University; 15 April.

APPENDIX

D

T-11

SOME IMPORTANT UNEXAMINED QUESTIONS CONCERNING THE BARNWELL NUCLEAR FUEL REPROCESSING PLANT

John W. Gofman, M.D., Ph.D.

Division of Medical Physics

University of California

Berkeley, California

TESTIMONY BEFORE THE

NUCLEAR STUDY COMMITTEE

THE LEGISLATURE OF THE STATE OF SOUTH CAROLINA

COLUMBIA, SOUTH CAROLINA

January 7, 1972

5-25.28

Introduction

I consider it a privilege to discuss with you some crucial questions concerning the siting and operation of the proposed Barnwell Nuclear Fuel Reprocessing Plant of Allied-Gulf Nuclear Services. And I wish to express my appreciation to Mr. H. J. Larson, President, and Mr. R. I. Newman, Vice President of the Allied-Gulf Nuclear Services Company. They have both been gracious and totally cooperative in making available to me for study the full Environmental Report on the proposed Barnwell Plant. More than that, they have both expressed their sincere desire to have my comments and suggestions.

Allied Chemical and Gulf Oil Corporations are two of our foremost U.S. industrial corporations. I accept completely the statement of Mr. R. I. Newman in a recent letter to me that:

"It has been, is and will continue to be our prime goal to insure the safety of the public as well as our workers, and to insure that our operations have a negligible, if any, impact on the environment."

Therefore, the issues I shall raise here are addressed to these two great American corporations, as well as to the South Carolina Legislature. As we get into the discussions more deeply, I hope it will become clear that the Barnwell facility raises questions requiring that the necessary participants are far beyond Allied-Gulf and South Carolina - indeed, we must truly consider the interests of everyone living on the Eastern Seaboard of the United States, as well as those of more inland States. Some of the considerations will demonstrate that because of potential risk of requiring evacuation of Washington, D.C., the entire National interest is definitely involved in our considerations.

Some of you may have heard that I am a "nuclear critic". Let me assure you that this is absolutely correct. I am a critic because I have found through my long period of association with and research in nuclear energy that some extremely serious questions concerning nuclear power generation have not been adequately examined, while the industry moves forward at a rapid rate. But while critical questions are being raised, let me assure you that I have no interest in doomsday predictions, no interest in alarmism.

We in America all must share in the task of insuring a good quality of life for Americans, and that means due attention to providing energy, including electric energy, for our industry and our home uses, to sustaining a healthy economy (and here I am particularly cognizant of South Carolina's needs for industry and jobs), and above all, to insuring that we provide such energy consistent with the good health and safety of Americans. You of the South Carolina Legislature surely share these views, and I am certain that the Allied Chemical Corporation and Gulf Oil Corporation both share these views completely.

It is precisely because of the enthusiasm all of us share about "getting on with the job", that we must pause to examine whether we may not have overlooked some very disturbing possibilities associated with nuclear fuel reprocessing plants such as the Barnwell Facility. While it may seem that a facility ultimately employing only some 300 employees (1000 during construction) is a small industry, other associated factors make this industry and its development one of the most far-reaching, significant industrial developments of all time. Neither the South Carolina Legislature nor the Board of Directors of both Allied Chemical and Gulf Oil can afford to leave questions of all-time importance unanswered. I hardly think the

stockholders of these two great corporations would appreciate a venture that might ultimately destroy these Corporations. Nor would the people of South Carolina appreciate the overlooking, by this Legislature, of questions that deal with the possible evacuation of a large part of the State of South Carolina.

It will be necessary for us, mutually, to examine two major areas:

(a) The question of financial liability and how it relates to critical examination of the dangers of the Barnwell Facility.

(b) The technical question of possible accidents at Barnwell and their local and national consequences.

Financial Liability and Critical Evaluation of Risks

Every great corporation must necessarily consider financial liability for its ventures and the implications of such liability for the Corporation's future.

Unfortunately, through the existence of the so-called Price-Anderson Act, liability for the consequences of a serious accident at Barnwell is limited to 560-Million Dollars. But I propose to discuss with you accidents that could easily lead to damages in the neighborhood of 10-Billion Dollars or more, to say nothing of the most massive civilian dislocations and suffering in peacetime history. The existence of the Price-Anderson Act means that no one carries the financial liability for about 95% of the damages that could accrue - no one at all.

I happen to regard the Price-Anderson Act as unconstitutional. There is a bill in the U.S. Senate, introduced by Senator Gravel, to repeal this Act. So the Act may be repealed, or there may in time be a Supreme Court test of its constitutionality. If this Act is repealed or declared unconstitutional, are the Allied Chemical Corporation and the Gulf Oil

Corporation prepared to risk their assets, even though large, on a $10-Billion liability?

Even if the Price-Anderson Act is not repealed, the situation for these two corporations is hardly better. There can be no doubt that if an accident involving $10-Billion in uncompensable damages occurs, the reputation of both corporations will suffer irreparably, and the revulsion in the public may, in effect, destroy both corporations and much of the value of their securities in the marketplace.

It is neither my intent nor my ability to estimate the probability of such an accident occurring. But I am frankly amazed that both the South Carolina Legislature and the Boards of Directors of both great corporations involved have not insisted upon a fully independent engineering assessment of such probabilities, including especially the possible effects of internal or external sabotage. We live in perilous times, and to neglect such possibilities as sabotage is simply to bury our heads in the sand in the fashion of ostriches.

I have a high regard for the detailed efforts of Allied-Gulf Nuclear Services and their consultants who prepared the Environmental Report on Barnwell. But simple, hard-headed business sense tells us that this must necessarily be the last source one would go to for a critical, independent assessment of the probability of a serious accident. What is required is assignment of responsibility to an independent group of engineers to figure out all the ways it is possible for such an accident to occur, and to try to assess the probability of its occurring. Such assessment would not be very costly. I believe the South Carolina Legislature and the Boards of Directors of both major corporations can accept no less. I have seen no such independent assessment. Under no circumstances should reviews either

by the Atomic Energy Commission or any of its Licensing or Advisory Boards be misconstrued as an acceptable assessment.

Once such an independent assessment is made, the evidence on both sides deserves debate and presentation in a full open public forum. Nothing less will allay public concern, a concern that will grow.

If everything goes as planned and as considered in the AGNS Environmental Report, there is probably no problem of health, safety, or environmental damage. I would hardly wish to quibble over minor questions I have about that report, especially when viewed against the vastly more important questions that must be answered, and which are not described in that Report.

There are two very simple questions I propose to discuss with you:

(1) What are the consequences of 1% (that is, one-hundredth) of the radioactive inventory of Barnwell at full operation being released to the environment?

(2) What are the consequences of 0.01% (that is, one-ten thousandth) of the radioactive inventory being released?

To do this we must turn our attention to some simple technical realities of Barnwell at full operation.

The Radioactivity Inventory at Barnwell at Full Operation

The Barnwell facility proposes to process 5 metric tons of spent nuclear fuel per day, or 1500 metric tons per year. The long-lived radioactive waste, after processing, will remain at Barnwell between 5 and 10 years, assuming optimistically that some Federal repository can be developed, which is very much in doubt. Let us minimize the problem, and assume that the radioactive waste is at Barnwell for only 5 years even though it may remain in South Carolina indefinitely.

The processing of 5 metric tons per day of spent uranium fuel means the servicing of about the equivalent of 50 large nuclear power plants, each, say, of 1000 megawatts electrical [MW(e)] generating capacity. Since each plant discharges 1/3 of its fuel each year, the Barnwell receipts will be of fuel elements each having spent an average of 2 years in the power plant. The equivalent delivery to Barnwell is 2/3 of the yearly long-lived radioactivity produced in the 50 plants, which is equivalent to the output of 35 such 1000 MW(e) plants.

Each 1000 MW plant produces, in one year, the long-lived radioactivity of 22 megatons of atomic fission bombs. So, 35 x 22 = 770 megatons of bombs. And for a five-year storage period, this means 5 x 770, or 3850 megatons. Note, nothing of this should be misconstrued to mean any explosive power of this radioactive waste. It is simply necessary to give you an idea of the astronomical quantity of radioactive waste in inventory at Barnwell, at full operation. We may express this in three ways:

The radioactivity (long-lived) in the Barnwell inventory will be:

(a) Approximately fifteen times as much as all the fission product radioactivity produced by all atmospheric weapons tests in all time by the combined testing of the USA plus the USSR.

(b) Approximately the radioactivity that would be left decaying for 10's and 100's of years from a large, full-scale nuclear war.

(c) Approximately the long-lived radioactivity of 192,000 Hiroshima or Nagasaki atom bombs.

Let us turn to the kinds of radioactive substances present after the Barnwell plant has been in full operation, using the 5-year residence time for radioactive waste (remembering that the AGNS report suggests an even higher residence time). Again, from the point of view of minimizing

the potential hazard, I shall consider only the major radioactive materials, and shall consider only those species which produce a hard gamma ray on decay, (more than 400 KEV).

The AGNS Environmental Report will serve as a source to ascertain the total radioactivity inventory at 5 years of operation. (Table 3.6-1, page 74, Section 3, of the Barnwell Nuclear Fuel Plant Environmental Report). I shall add one additional radioactive substance, Strontium-90, which although it does not emit a hard gamma ray, is very important for consideration of certain accident consequences.

After correcting for radioactive decay, one reaches the final figures for radioactive inventory of hard gamma emitters presented in the following table, (Table 1).

TABLE 1

Hard Gamma Ray Contributors Built Up in the Fuel Reprocessing Plant Inventory at Five Years

Isotope	Half-Life	Megacuries per ton daily input	Megacuries per 5 tons daily input	Final Equilibrium Inventory at 5 years, corrected for decay (Megacuries)
Zr^{95}	65 days	0.3774	1.887	176.2
Nb^{95}	35 days	0.7127	3.564	180.0
Ru^{103}	40 days	0.1329	0.665	38.4
Ru^{106}	1.0 year	0.7641	3.821	2011.0
Cs^{134}	2.1 years	0.2031	1.016	1128.8
Cs^{137}	30 years	0.1329	0.665	1165.1*
Total				4700 Megacuries

* The Cs^{137} inventory has been corrected for the slight decay it undergoes while in storage.

Since we will require it later, the Sr^{90} inventory is expected to be 91/133 x Cs^{137} inventory, or (0.68)xCs^{137} inventory. In megacuries, this is 792 megacuries of Sr^{90}.

The Consequences of a One Percent Release of the Barnwell Inventory

We shall consider here how large an area and how many people might require evacuation if one percent of the inventory of the Barnwell plant were to be released to the atmosphere. Note, it is not our purpose to examine the probability of such an occurrence, but the consequences. If the consequences are very serious, then the fullest independent assessment of the probability is urgent and essential.

Prediction of which region of the United States will be affected and how much affected depends, of course, on the weather circumstances at the time of the release. We shall consider a couple of possibilities, including the local South Carolina situation and that for more distant regions. With differing weather conditions, the regions affected will, of course, be different, but the order of magnitude of consequences not very different.

Some Consequences at a Distance.

1. Assume 1% of the radioactivity inventory released to the atmosphere.
2. It is approximately 465 miles, straight line, from Barnwell, S.C. to Washington, D.C.
3. Assume a wind in the direction of Washington, D.C. of 19.3 miles per hour. Thus, in 24 hours, the center of the radioactive "cloud" will be over the Washington, D.C. area.

From the reports of Tamplin (Tamplin, A.R., "Prediction of the Maximum Dosage to Man From Fallout of Nuclear Devices I. Estimation of the Maximum Contamination of Agricultural Land, UCRL-50163 Part 1, January 3, 1967), the radius of such a cloud at 24 hours is approximately 103 miles. (Using the radius as 2σ - two times the horizontal standard deviation of dispersion of the material) σ = 51.6 miles at 24 hours.

Now let us consider that rainfall occurred at this time, which at a maximum, can wash all the radioactivity to earth in the region under the cloud. What is the deposition on the ground?

The Area of the Cloud = $\pi(103)^2 \cong$ 33,400 sq. miles.

One percent of Barnwell Inventory = (0.01)(4700) = 47 megacuries or 47,000,000 curies. (1 megacurie = 1-million curies).

Deposition, average, per sq. mile = $\frac{47,000,000}{33,400}$ = 1407 curies/sq.mile

Now, from the book, "Effects of Nuclear Weapons, p. 491-2, Samuel Glasstone, Editor, USAEC, 1962", it is known that a deposition of hard gamma emitters of 1 curie/sq.mile leads to a dose of 1.2×10^{-4} R/day from external radiation, just by being in such an environment. No eating of contaminated foods is required. Just being there guarantees the radiation.

But we have 1407 curies/sq.mile, so the dose will be

$(1407)(1.2 \times 10^{-4}) = 0.169$ R per day.

The R unit is a measure of radiation exposure. Note that 0.169 R is equal to the so-called "allowable" exposure for one whole year for peaceful atomic energy purposes, and it is widely agreed that this latter exposure would have serious consequences. So, people in this vicinity would get their yearly "allowance" in one day. In a year they would get roughly 300 times as much, or about 50 R. While there will be some decay, it will not be reduced to 25 R per year for several years, and will continue at nearly that level for over a decade. It is obvious that such exposure is not thinkable, and that evacuation of the affected area must be considered. This means evacuation of Washington, D.C., Baltimore, Maryland, Annapolis, Maryland, Wilmington, Delaware - everywhere within a radius of 100 miles from Washington, D.C. In effect, this includes all of the District of Columbia, most of Maryland, most of Delaware, a good part of Virginia and West Virginia.

If the wind were blowing a little faster, before the radioactive cloud encountered a rainstorm, it could center on Trenton, New Jersey, in which case it would be necessary to evacuate Philadelphia, Pennsylvania, New York City, most of New Jersey, a fair part of eastern Pennsylvania, and a fair part of southern New York State.

It is seen that we are dealing with a situation that might require evacuating millions, or tens of millions, of people, or acceptance of the severe radiation injuries, in the form of cancer and leukemia, that would otherwise result.

If anyone doubts that the economic consequences of such evacuation could run into tens of billions of dollars, he is not being realistic. And this says nothing of the societal dislocation of evacuation of Washington, D.C., the capital of the United States.

Of course, the wind might blow in a different direction, and a rainstorm might intersect the radioactive cloud in a region with somewhat fewer people. In any event, whichever way the wind is blowing, some 33,000 square miles of the U.S. would become uninhabitable. The winds might be such that it would mean evacuation of most of the State of Florida instead.

Some More Local Possible Consequences.

Columbia, South Carolina is about 55 miles from Barnwell. Atlanta, Georgia is about 180 miles from Barnwell.

Let us consider the prospects at 8 hours after release of 1% of the Barnwell inventory, with winds to place the cloud over Columbia, South Carolina (requires 7 miles per hour wind) or over Atlanta, Georgia (requires 22 miles per hour wind). If the radioactive cloud then encountered a rainstorm, over one or the other of these areas, we can calculate the dosage.

The radius of the cloud at 8 hours is approximately 36 miles (again, using 2σ as the radius). The area of deposition is $\pi (36)^2$ = 4076 square miles.

$$\text{Deposition} = \frac{47{,}000{,}000}{4076} = 11{,}530 \text{ curies/sq. mile.}$$

The dosage received by being in this vicinity is

$$(11{,}530)(1.2 \times 10^{-4}) = 1.38 \text{ R per day,}$$

or about 400 R per year. This is simply deadly, and in the one case Columbia, South Carolina and everything on a radius of 36 miles from Columbia would obviously have to be evacuated. In the other case, Atlanta, Georgia and everything 36 miles away from it must be evacuated.

In summary, under highly credible meteorological conditions, the consequences of a 1% release of the radioactivity inventory at Barnwell would be a disaster unimagined for any peacetime situation in the United States. The economic cost, to say nothing of making millions of people refugees from radioactivity, will undoubtedly be measured in the billions or tens of billions of dollars.

In Case There is No Rain:

Agricultural Consequences of a 1% Release of the Radioactivity Inventory at Barnwell at Full Operation

We might suppose that "luck" would be on our side, and that the radioactivity cloud won't run into a washout by rain, after a 1% release of the Barnwell radioactivity inventory. In that case we will, of course, still have what is known as "dry" fallout. While this may mean we wouldn't face evacuation of millions of people, the agricultural consequences, as we shall see below, can be almost equally devastating. Let us consider the "no-rain" situation in detail.

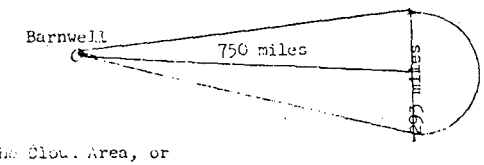
1. Let us assume the wind were blowing at about 15 miles per hour in the direction of Buffalo, New York.

2. The distance from Buffalo to Barnwell is about 750 miles, so the center of the radioactive cloud will reach the US border at Niagara Falls at some 48 hours.

From Tamplin's data* on maximum expected by fallout at 48 hours, we can expect the fraction of the total cloud radioactivity that will fall out is 3×10^{-14} per sq. meter.

Now, let us estimate the agricultural contamination. At 48 hours, dispersion of the cloud will make the cloud diameter approximately 293 miles ($\sigma = 1.18 \times 10^5$ meters, diameter in 4σ, so diameter = 4.72×10^5 meters, or 293 miles).

So, a sector of the country, centering upon Barnwell will be involved.



The overall area involved will be (750x293) + 1/2 the Cloud Area, or

$$110{,}000 + 1/2\ (67{,}300) = 110000 + 33{,}900 \approx 144{,}000 \text{ sq. miles.}$$

* See previous Tamplin reference

How badly will milk from this region of 144,000 square miles be contaminated? We can be conservative, and thereby underestimate the seriousness of the problem by considering all parts of the region to be contaminated only as badly as the most distant region - that is at 750 miles from Barnwell. We can be certain that in all regions closer to Barnwell the contamination will be more severe.

We recall that our inventory (Table I) contains

Cs^{137} 1165 megacuries, or 1165×10^{12} microcuries.

Cs^{134} 1129 megacuries, or 1129×10^{12} microcuries.

Sr^{90} 792 megacuries, or 792×10^{12} microcuries.

(1 Megacurie = 10^{12} microcuries)

The dry fallout depositions, for 1% inventory release, will be

For Cs^{137} $(11.65 \times 10^{12})(8 \times 10^{-14}) = 0.93$ microcuries/sq. meter

Cs^{134} $(11.29 \times 10^{12})(8 \times 10^{-14}) = 0.90$ microcuries/sq. meter

Sr^{90} $(7.92 \times 10^{12})(8 \times 10^{-14}) = 0.64$ microcuries/sq. meter

And from Table 3, we can estimate the dosage to be received via milk for forage receiving such depositions. These are tabulated in Table 2.

Table 2

Dosage to Children via the Milk Pathway

Radionuclide	Deposition	Deposition required to give 1 Rad via Milk (Whole Body)	Dosage in Rads via Milk (Whole Body)
	Microcurie/ sq. meter	Microcurie/ Sq meter	
Cs^{137}	0.93	0.12	7.8
Cs^{134}	0.90	0.058	15.6
Sr^{90}	0.64	0.038	16.9
		Total Dosage in Rads (via Milk)	40.3 Rads

It is absolutely unthinkable that milk contaminated to this degree can be consumed. Children drinking such milk would have a four-fold increase in risk

of cancer and leukemia. Fresh agricultural produce from this region of 144,000 square miles would be obviously unsalable. While, after a period of months, the milk level will be much reduced, the agricultural produce from the region would be unacceptable for many years, because of radioactivity acquired in the produce via the soil-root pathway (much, much less active than the early milk, but unacceptable).

It is important to have a good idea of what 144,000 square miles of agricultural land being rendered unusable really means. For the wind direction considered, this would mean rendering unusable for agriculture the following:

Approx. 1/10 of South Carolina
plus approx. 1/10 of North Carolina
plus approx. 1/5 of Virginia
plus most of West Virginia
plus approx. 1/6 of Ohio
plus more than 1/2 of Pennsylvania
plus approx. 1/4 of New York State
plus a significant part of Ontario province in Canada.

This represents a minimum tabulation, for fallout rendering agricultural land unusable will still be occurring beyond 48 hours, and hence encompassing more of Ontario province, Quebec and much more of New York State.

The economic costs alone will undoubtedly be in the multi-billion dollar category, not to mention indignation, rage, fear, and dislocation.

And of course, if the wind were blowing in some different direction, the areas involved will be the same, but the victimized states would be different. It would only be lessened if the wind happened to be blowing to the Southeast, since much of the fallout would then be over the ocean.

Thus, the overall magnitude of the disaster will be comparable with that previously described for rainout of the radioactivity. In one case (with rain) we contemplate evacuation of millions of people; in the other case (without rain), the agricultural loss is staggering beyond usual comprehension.

The Consequences of an 0.01% Release of the Barnwell Inventory (One-ten thousandth of the Total Inventory)

We have seen above that 1% release can lead to massive evacuation of major population centers. And we shall now see the very serious economic consequences of even one-hundredth of this quantity released. For this we shall direct our attention to the effect of deposited radioactivity upon forage, thence to milk to be consumed by children.

We shall consider three radionuclides, Cs^{137}, Cs^{134}, and Sr^{90}.

From Table 1 we have the inventory at 5 years as 1165 Megacuries of Cs^{137}, 1129 Megacuries of Cs^{134}, and separately, that there would be 792 Megacuries of Sr^{90}.

Ng and co-workers* have calculated the minimum deposition of these radionuclides required to deliver 1 Rad to children drinking 1 liter of milk per day. This is the so-called "grass-cow-milk-child" pathway. The values are listed below in Table 3. (1 Rad is approximately equivalent to 1R).

Table 3

Minimum Deposition on Forage to Give 1 Rad to Children Via the Forage to Milk Pathway (Whole Body)

Radionuclide	Half Life	Minimum Deposition required to give 1 Rad** microcuries/sq. meter	curies/sq. mile
Cs^{137}	30 years	1.2×10^{-1}	0.31
Cs^{134}	2.1 years	5.8×10^{-2}	0.15
Sr^{90}	28 years	3.8×10^{-2}	0.098

Let us consider the case described above, rainout at 24 hours, such that 85,400 sq. miles of land receives the deposition. Since we are here concerned with agricultural land, it is of little moment what the wind direction or speed is.

*UCRL 50163 Part IV, May 14, 1968.

**Dr. Ng (personal communication) suggests the Cs^{137} and Cs^{134} values may be raised, from more recent data, which would reduce their contribution to dosage. However, the changes would not materially alter conclusions about unacceptability of milk contaminated by Cs^{137}, Cs^{134}, and Sr^{90}.

And we are assuming $\frac{1}{10,000}$ of the inventory at Barnwell to be involved in the deposition.

Therefore

$\frac{1}{10000}$ X 1165 = 0.1165 megacuries Cs^{137} (116,500 curies)

$\frac{1}{10000}$ X 1129 = 0.1129 megacuries Cs^{134} (112900 curies)

$\frac{1}{10000}$ X 792 = 0.0792 megacuries Sr^{90} (79,200 curies)

Depositions are

For Cs^{137}, $\frac{116500}{33400}$ = 3.5 curies/sq. mile

For Cs^{134}, $\frac{112900}{33400}$ = 3.4 curies/sq. mile

For Sr^{90}, $\frac{79200}{33400}$ = 2.4 curies/sq. mile

Translating these into rads delivered via the milk pathway

For Cs^{137}	3.5/0.31	= 11.2 rads
For Cs^{134}	3.4/0.15	= 22.7 rads
For Sr^{90}	2.4/0.098	= 24.5 rads
	Total	58.4 rads

Children drinking such milk would receive 58.4 rads, which is more than 100 times the yearly "allowable" dose. Such a dose would cause a many-fold increase in cancers and leukemias in such children. It is obvious that milk from these 33,400 square miles is unthinkable for drinking purposes. The loss to agriculture from this and crop contamination would be phenomenal. In time, the Cs^{134}, Cs^{137}, and Sr^{90} would find their way into the soil, having been weathered off the forage. But the agricultural problem is not over, for we must now consider crops grown in the area, the so-called "soil-root pathway".

From Ng et al, we have the data for the deposition required to give one Rad by the soil-root pathway, presented in Table IV.

Table 4

Minimum Deposition Required to Give 1 Rad to Children via the Soil-Root Pathway

Radionuclide	Half Life	Deposition Required to Give 1 rad microcuries/sq meter	curies/sq. mile
Cs^{137}	30 years	4.2×10^2	1090
Cs^{134}	2.1 years	1.3×10^3	3370
Sr^{90}	28 years	4.8×10	124

Contribution from Cs^{137} = 3.5/1090 = 0.003 rads

Cs^{134} = 3.4/3370 = 0.001 rads

Sr^{90} 2.4/124 = 0.019 rads

Total = 0.023 rads

While these doses are not "disastrously" high, I would doubt that such agricultural products would be salable, and the effect would last for many years. The combination of severe early contamination of milk and crops from such a region, followed by long term significant, unacceptable contamination of crops from an area like 35,000 square miles (that happens to be an area just a little larger than South Carolina) would represent economic losses in the billion dollar class. And all this if only one ten-thousandth of the Barnwell inventory of radioactivity were released to the atmosphere.

Some Side Effects of Either Type of Accident

There is little doubt about one primary effect of either type of accident, which would be an immediate demand by the public for a shutdown, not only of Barnwell but also of the entire nuclear power industry. And I must say I believe this reaction would be totally appropriate, since the warnings concerning such possibilities have been quite broadly presented. There would be no reasonable excuse by the nuclear industry. And the widespread public antipathy to Allied Chemical and Gulf Oil Corporation might lead to boycotts that could shake these industries economically beyond repair. The South Carolina Legislature would have great deal of explaining to do to the citizens of South Carolina and other states.

The Plutonium Product

There are two products of the Barnwell Facility, uranium and plutonium. There is little, if any reason to be concerned about the uranium product. There are several reasons to consider that the plutonium product may be a total nightmare. The AGNS report states carefully that plutonium must be absolutely contained in the course of shipment away from the plant. And it states further that there exists considerable difference of opinion concerning how this may be accomplished. But one does not acquire a real feeling for the fantastic implications of the quantities of plutonium that will be shipped.

There are two problems presented by the plutonium product:

(1) The Safeguards Problem

(2) The Extreme Toxicity of Plutonium

The Safeguards Problem

Plutonium has other uses besides its being a fuel for electric power production. Specifically it is the basic ingredient for the simple fabrication of atom bombs. Throughout the world, authorities on nuclear energy regard the danger of diversion of plutonium by black market techniques either to governments or to private organizations as a major, unsolved problem.

Let us consider some of the quantities involved in Barnwell shipments and compare them with the 14 pounds (7 kilograms) widely stated to be about the amount required for a 20 Kiloton atom bomb like that which demolished Nagasaki.

From Table 5.6-1 in the Barnwell report, the datum is given that each ton of uranium processed will yield 338 Curies of Plutonium-239, the desired product. One Curie of Plutonium represents approximately 16 grams of Pu^{239}. In one year at Barnwell, there will be 1500 tons of uranium processed, so the annual plutonium product requiring shipment will be (338)(16)(1500) = 8,110,000 grams of plutonium,

or 8110 kilograms. That's enough to make about 1100 Nagasaki-type atom bombs, a very interesting quantity indeed for the future black market in plutonium.

On page 30, Appendix VII of the Barnwell Environmental Report, it is stated that the plutonium will be shipped in solution as plutonium nitrate in containers, each holding 25 kilograms of plutonium. It is stated there that 2 to 3 such containers will be carried per truck shipment. So we can say that on the average, there will be approximately 65 kilograms of plutonium per shipment. For a total of 8110 kilograms of plutonium, this means $\frac{8110}{65}$, or about 125 separate shipments per year out of Barnwell.

Each shipment represents enough plutonium for about 9 atom bombs (Nagasaki size). Can such shipments be hijacked? Before answering this question, it is worthwhile asking another question. If, two years ago, one had been asked about the liklihood that three huge airliners would be successfully hijacked to the Middle East *within one week* by terrorists, I am sure the probability estimate would have been vanishingly small. Until it happened. Anyone who *underestimates* the ingenuity of determined terrorists and underworld operators does so at grave peril. The probability that a plutonium shipment will be hijacked successfully will be estimated as very low until the first shipment is hijacked.

The Toxicity of Plutonium

There is a great deal in the Barnwell Report about the irradiation of bone by plutonium. I am more concerned about the production of lung cancer by plutonium. My colleague, Donald Geesaman,* has published estimates that the inhalation of 10,000 particles of plutonium dioxide may produce one fatal human lung cancer. It doesn't require that one person inhale all 10,000 particles - this is a statistical problem, and it means that for every 10,000 particles inhaled into human lungs, there will be one lung cancer. Ten people inhaling 1000 particles each will produce the same effect as one person inhaling 10,000 particles.

* GT-121-70. Plutonium and Public Health. Presented at Univ of Colorado, Boulder, Colorado, April 19, 1970.

Let us go through the arithmetic relating to these plutonium shipments. For example, let us suppose that some terrorists were desirous of spreading plutonium oxide around near a major metropolitan center. Let us suppose that that one container with 25 kilograms of plutonium were exploded open by bombing or by some combination of bombing and fire. With high temperatures, much of the plutonium nitrate would be probably converted to plutonium oxide. We can explore the worst case, namely all 25 kilograms converted to particles averaging one micron in diameter.

1 micron diameter means each particle has a volume of 5×10^{-13} cc. The density of plutonium dioxide is 11.46 gms/cc. So each such particle has $(11.46)(5\times10^{-13})$ or 5.7×10^{-12} grams of plutonium oxide.*

So, for 25 kilograms, we get $\frac{25{,}000}{5.7 \times 10^{-12}}$ or 4.4×10^{15} particles. If all these particles ultimately found their way into human lungs, that represents $\frac{4.4\times10^{15}}{10^4} = 4.4 \times 10^{11}$ lung cancers. Enough plutonium for 440 billion human lung cancers. Now, there are only 3 billion people on earth, so we *aren't* going to get 440 billion lung cancers in any hurry. So, let us suppose there are a number of inefficiencies in this whole process, and as a result, only one particle out of ten million potential plutonium oxide particles finds its way into human inhalation pathways. That still means 44000 lung cancers could be produced as a result of this terrorist act. That's a lot of diplomatic leverage for terrorists. Please note that all the inhalation needn't occur right away. The plutonium oxide particles can settle to the ground, be resuspended and carried by winds over and over, even to very great distances from the point of original dispersal. With a half-life of 24,000 years, such plutonium will be around to produce cases of lung cancer for periods of more than fifty times as long as world history from the birth of Christ to the present time. Every 10,000 particles inhaled can represent one fatal human cancer, wherever and for all practical

*Barnwell Plutonium is even worse than Pu^{239}, because of contamination with Pu^{238} and Pu^{240}.

purposes, whenever the plutonium is inhaled.

We spread plutonium around Palomares, Spain when one of our bombers crashed there. A massive clean-up campaign was carried through and shiploads of contaminated soil were collected to be returned to the USA. But people in Palomares are not too convinced all is well. Palomares is reported to be a ghost town area now. How many people will enjoy living near a site of a massive plutonium dispersal? If we ship enough plutonium on our highways, there are going to be some terrorist explosions and dispersal, and I would suspect there are going to be ghost towns in addition to old mining towns in Nevada and California.

The Barnwell Facility points up some good reasons for the widespread concern over diversion of plutonium into the hands of terrorists and the underworld. One small atom bomb, properly placed on the Barnwell Facility could, I would suspect, release a good deal more than one percent of the radioactivity inventory there. And we have already discussed the catastrophic potential consequences of a one percent release.

Recommendations

We can all hope that neither the 1% release or the 0.01% release accidents ever occur at Barnwell. But hope alone is not enough. As stated at the outset, I am in no position to estimate the probability of either accident, from sabotage, from cooling equipment failure, from earthquake, or from hostile action. Certainly the Barnwell Environmental Report provides nothing in the way of reassurance that such accidents cannot occur. Everything hinges on the probability that such releases may occur. I doubt that anyone can seriously challenge the possible consequences if the releases of this magnitude occur. Depending upon the weather, the precise magnitude of the disaster, and its form, can vary, but the broad outlines are not overstated.

And we can all hope that plutonium diversion or dispersal into the environment will not occur.

I am completely convinced that Allied-Gulf Nuclear Services feels it is doing its very best to make such accidents remote. But that is not sufficient assurance. That the AEC or its advisory committees have reviewed the project is also not good enough.

No one of totally independent stature has been assigned the specific job, of figuring out how such releases could occur, what all the vulnerabilities are, and what the chances are of such occurrence. And it is the absence of such critical engineering adversary review that is precisely what has been missing from every aspect of the entire nuclear power industry.

The Board of Directors of the Allied Chemical Corporation should be demanding such an independent review.

The Board of Directors of Gulf Oil Corporation should be demanding this review.

The Legislature of the State of South Carolina should be demanding this review.

The health and fate of ten million or more Americans may depend upon the answers.

Perhaps this discussion may help clarify why an increasing body of opinion expresses concern over the development of the nuclear power industry. The morality of going ahead with the nuclear power industry deserves serious questioning. Especially is this true when the prospects are so bright for alternatives, such as generation of all the electricity we could ever require from solar energy.

South Carolina, and Barnwell County in particular, needs industry and needs jobs. How much brighter our discussions today would be if Allied Chemical and Gulf Oil Corporations were proposing a major solar electricity research and development program at Barnwell. Such a facility providing 5000 jobs, not 500,

would make excellent sense for the Corporations, for South Carolina, and for the world. Sooner or later, this is inevitable. Why not sooner, and in South Carolina? Why not A.G.S.F. - Allied-Gulf Solar Facility? Toward a bright future, rather than a radioactive one.

THE PLUTONIUM DECISION

A Report on the Risks of Plutonium Recycle

J. Gustave Speth
Arthur R. Tamplin
Thomas B. Cochran

Natural Resources Defense Council
1710 N Street, N.W.
Washington, D.C. 20036

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Natural Resources Defense Council, Inc.

1710 N STREET, N.W.
WASHINGTON, D.C. 20036
202 783-5710

New York Office
15 WEST 44th STREET
NEW YORK, N.Y. 10036
212 869-0130

Palo Alto Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

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The Plutonium Decision

A Report on the Risks of Plutonium Recycle

"I fear that when the history of this century is written, that the greatest debacle of our nation will be seen not to be our tragic involvement in Southeast Asia but our creation of vast armadas of plutonium, whose safe containment will represent a major precondition for human survival, not for a few decades or hundreds of years, but for thousands of years more than human civilization has so far existed."

James D. Watson
Nobel Laureate,
Medicine

By

J. Gustave Speth
Arthur R. Tamplin
Thomas B. Cochran

September, 1974

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I. Introduction

The Atomic Energy Commission, if unchecked, is about to sow the seeds of a national crisis. The Commission now proposes to authorize the nuclear power industry to proceed to use plutonium as fuel in commercial nuclear reactors around the country. The result of a decision approving this commercial use of plutonium will be the creation of a large civilian plutonium industry and a dramatic escalation in the risks posed by nuclear power.

This decision to launch what the AEC calls the "plutonium economy"[1] is the conclusion of the AEC's recently released draft environmental impact statement for plutonium recycle -- the recycling of plutonium as fuel in the present generation of light water reactors.[2] The final version of the impact statement, which is expected to confirm the decision to authorize plutonium recycle, is due in six to nine months.

Plutonium is not native to Earth: the entire present-day inventory is man-made, produced in nuclear reactors. Plutonium-239, the principal isotope of this element, has a half-life of 24,000 years, hence its radioactivity is undiminished within human time scales. It is perhaps the most toxic substance known. One millionth of a gram (there are 28 grams in an ounce) has been shown capable of producing cancer in animals. Plutonium is also the material from which nuclear weapons are made. An amount the size of a softball is enough for a nuclear explosive capable of mass destruction. Scientists now widely recognize that the design and manufacture of a crude nuclear explosive is no longer a difficult task technically, the only real obstacle being the availability of the plutonium itself.

Thus, former AEC physicist Donald Geesaman observes that "plutonium is a fuel that is toxic beyond human experience." Its use, he states, "will inextricably involve our society in the large-scale commercial production of a substance that is a suitable nuclear explosive."[3] The successful theft of this material, as Mason Willrich and Theodore Taylor note, "could enable a small group to threaten the lives of many people, the social order within a nation, and the security of the international community of nations."[4]

It is the burden of this report that the commercialization of plutonium will place an intolerable strain on our society and its institutions. Our unrelenting nuclear technology has presented us with a possible new fuel which we are asked to accept because of its potential commercial value. But our technology has again outstripped our institutions, which are not prepared or suited to deal with plutonium. And those who have asked what changes in our institutions will be necessary to accomodate plutonium have come away from that enquiry profoundly concerned.[5]

The AEC's impact statement assessment of plutonium recycle reinforces, and does not allay, these concerns. It concedes that the problems of plutonium toxicity and nuclear theft are far from solved and indicates that they may not be for some years. Yet it concludes, inexplicably, that we should proceed. Whether stemming from blind faith in the beneficience of the technology it has fostered or from a callous promotion of the bureaucratic and industrial interests of the nuclear power complex, the AEC decision

cannot be justified in light of what we know and, just as important, what we do not know.

II. Dimensions of a Commercial Plutonium Industry

The fuel now used in present-day reactors, the light water reactors or LWR's, is uranium which has been enriched so that the uranium-235 content is increased from the 0.7 percent present in natural uranium to about 3 or 4 percent. Uranium-235 is a fissionable isotope of uranium, the remainder of the fuel being non-fissile uranium-238. Unlike plutonium, this uranium fuel is not extremely toxic, and it is not sufficiently rich in uranium-235 to be fashioned into nuclear weapons.*

While present-day reactors are operating, however, they are also producing as a by-product moderate amounts of plutonium, principally plutonium-239. A typical large reactor produces about 200-250 kilograms of plutonium each year.** Since this plutonium is easily fissioned, it can be used as reactor fuel. "Plutonium recycle" is the nuclear industry-AEC proposal to recover this plutonium produced in LWR's, process it and recycle it as fuel back into LWR's.

Several critical steps are involved in recycling this plutonium. First, the used or "spent" fuel from the reactor must be shipped to a fuel reprocessing plant. The spent fuel contains

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*/ Only with extremely sophisticated technology not available to the public, notably gaseous diffusion plants, can uranium be enriched to weapons grade.

**/ LWR's capable of producing 1000 megawatts (1 million kilowatts) of power are being built today. The plutonium is produced when the uranium-238 in the LWR fuel captures neutrons.

plutonium, uranium and extremely toxic fission products or "high-level wastes" (strontium-90, cesium-137, etc.). The function of the reprocessing plant is to separate these three constituents and prepare them for their next destinations. For example, reprocessing plants are supposed to solidify the high-level wastes and ship them to a permanent AEC repository for perpetual management. As yet, however, the AEC has no such repository. Nor does the agency know whether the technology and social institutions for isolating high-level wastes for geologic periods can be made available.

The principal purpose of a reprocessing plant, however, is to recover plutonium, to convert it to oxide form, and to ship it to the next fuel cycle stages -- the fuel fabricating and assembly plants. At a fuel fabricating plant the plutonium oxide will be mixed with uranium oxide into what is called "mixed oxide" fuel. This mixed oxide fuel will be fabricated into fuel pellets, the pellets will be placed in fuel rods, and these rods will be collected into fuel assemblies. These assemblies will then be sent to the reactors for use, thus completing the fuel cycle.

The only privately owned fuel reprocessing plant which has operated in the United States is the Nuclear Fuel Services (NFS) plant at West Valley, New York. Until recently the AEC purchased the plutonium output of this facility for weapons and research purposes. Recently, however, the AEC stopped purchasing recovered plutonium, and in June, 1972, the NFS plant closed for renovation and enlargement. Since mid-1972, then, all spent fuel from LWR's has been simply stored and not reprocessed, a favorable development in terms of nuclear theft since the penetrating radiation of the high-level wastes virtually insures that plutonium will not be

stolen as long as it is still mixed with these wastes in the spent fuel rods.

Two additional fuel reprocessing plants are now being constructed, a General Electric plant at Morris, Illinois, and an Allied-Gulf plant at Barnwell, South Carolina. GE recently announced, however, that its Morris plant might never operate and that most of its investment would be lost due to faulty design and construction.[6] Operating license proceedings are scheduled to begin shortly for the Barnwell plant.

There are at present no major commercial plutonium fuel fabricating plants operating or under construction.* The first such plant is planned by Westinghouse for Anderson, South Carolina. Nor has there yet been any non-experimental use of plutonium as fuel in light-water reactors, although the AEC attempted such a recycle until stopped by a lawsuit.[7]

In sum, plutonium recycle has not yet begun, and there is no major industrial commitment of resources to it at this point. The reprocessing plants that have been built do not represent a substantial investment in national terms, and reprocessing plants may be needed in any case to prepare spent fuel for long-term storage.

On the other hand, if the plans of the AEC and the nuclear industry are permitted, a major plutonium industry will develop quickly. Some 140 tons of plutonium could be recovered from commercial reactors by 1985 and some 1700 tons by the year 2000.[8] This figure for the year 2000 includes the plutonium that will be

*/ There are currently several small commercial facilities that process plutonium for research and development purposes.

produced in the fast breeder reactor, which the AEC plans to introduce in the mid-1980's. This is a new type of reactor designed to produce more plutonium than it consumes. A plutonium industry by the turn of the century could involve hundreds of LWR's fueled with plutonium, perhaps a score of fuel reprocessing and fabricating plants, and thousands of interstate and international shipments containing hundreds of tons of plutonium.

III. The Toxicity of Plutonium

The most pernicious product of the nuclear industry is plutonium. Microgram quantities in skin wounds cause cancer, and in the body plutonium is a bone seeker where, once deposited, it can cause bone cancer. But plutonium is most dangerous when inhaled. Donald Geesaman explains this hazard:

> "Under a number of probable conditions plutonium forms aerosols of micron-sized particulates. When lost into uncontrolled air these particulates can remain suspended for a significant time, and if inhaled they are preferentially deposited in the deep lung tissue, where their long residence time and high alpha activity can result in a locally intense tissue exposure. The lung cancer risk associated with these radiologically unique aerosols is unknown to orders of magnitude. Present plutonium standards are certainly irrelevant and probably not conservative. Even so, the fact that under present standards, the permissible air concentrations are about one part per million billion is a commentary on plutonium's potential as a pollutant. Its insolubility and long half-life make the continuing resuspension of particulate contamination another unresolved concern of serious proportions."[9]

To determine whether the AEC's radiation protection standards for plutonium are inadequate, as Geesaman suggests, Arthur Tamplin and Thomas Cochran undertook a major review of the biological evidence for the Natural Resources Defense Council. Their conclusions, found in their report "Radiation Standards for Hot Particles,"

are that plutonium particulates or "hot particles" are uniquely virulent carcinogens and that the current AEC radiation protection standards governing the amount of plutonium to which members of the public can be exposed are roughly 100,000 times too lax.[10] The lung cancer risk associated with hot particles of plutonium as estimated by Tamplin and Cochran is comparable to the lethal dose of botulin toxin, a biological warfare agent. Certainly one would hope that this nation would give careful consideration, and pursue all alternatives, before implementing an energy policy based on such toxic materials.

As a result of the Tamplin-Cochran report, NRDC formally petitioned the AEC and the Environmental Protection Agency to reduce the present maximum permissible exposure levels by 100,000. Neither AEC nor EPA have responded finally to the NRDC petition, but the petition is now being considered by the National Commission on Radiation Protection, the National Academy of Sciences, the Biophysical Society and several of the AEC national laboratories. Moreover, EPA will shortly commence a series of hearings and other initiatives on plutonium-related issues, including the hot particle controversy.

Although the adequacy of the AEC's plutonium standards is thus a matter of considerable doubt and great controversy, the AEC's draft impact statement for plutonium recycle simply assumes that the present standards are adequate. The entire risk analysis of the statement, as well as the ultimate decision to proceed with plutonium recycle, are based upon a premature and unexplained rejection of the hot particle hypothesis. Yet, the AEC is forced to concede that this hypothesis "is being given careful consideration in a separate proceeding."[11]

We submit that the AEC has no basis whatever to conclude that plutonium recycle will not cause undue risk to the public health and safety until it has either satisfactorily resolved the hot particle issue or calculated the impacts of plutonium recycle using the assumption that hot particles are uniquely carcinogenic. The draft environmental impact statement for plutonium recycle does neither.

It should be remembered that there is clear experimental evidence that plutonium is one of the most carcinogenic substances known regardless of one's views about the hot particle risk: one millionth of a gram has caused cancer in experimental animals. Thus, the more basic question is whether we want our energy system based on a material of unprecedented toxicity.

Some plutonium contamination of the environment has already occurred, due principally to the atomic weapons program. Aside from the worldwide plutonium contamination associated with the fallout from atmospheric weapons tests, there is significant ground contamination at the Nevada Test Site and the Bikini and Eniwetok Atolls. The AEC's plutonium weapons plant at Rocky Flats, 10 miles west of Denver, Colorado, was the site of one of the most costly industrial fires in history. The leakage of plutonium from contaminated oil at this site led to an uncontrolled source of plutonium which was some orders of magnitude larger than the integrated effluent loss during the 17 years of plant operation. As a result of this source, tens to hundreds of grams of plutonium went off site, 10 miles upwind from Denver. The loss was internally unnoticed, the ultimate deposition is now speculative, as is its human significance.[12]

One can derive little comfort in the current operation of the small commercial plutonium fuel fabrication facilities. The Nuclear Materials and Equipment Corporation (NUMEC) of Apollo, Pennsylvania was recently fined $13,720 for a sixteen count violation of AEC regulations ranging from failure to follow radiation monitoring procedures to failure to comply with certain safeguards requirements.[13] Production workers from the Nuclear Fuel Services facility in Erwin, Tennessee met with AEC inspectors on August 13, 1974 to complain about the absence of even the rudiments of accepted health physics practices at that plant.

Occurrences such as these can reasonably be expected to multiply greatly if plutonium is made a major article of commerce.

IV. Nuclear Theft and Safeguards

A. The Problem Defined

On May 18 of this year the world was made dramatically aware of the relationship between nuclear power and nuclear weapons when India exploded a nuclear device made from plutonium taken from a "peaceful" reactor built with Canadian assistance. The threat posed by the availability of plutonium from power reactors is set out by Willrich and Taylor in their book Nuclear Theft: Risks and Safeguards:

> "As fuel for power reactors, nuclear weapon material will range in commercial value from $3,000 to $15,000 per kilogram - roughly comparable to the value of black market heroin. The same material might be hundreds of times more valuable to some group wanting a powerful means of destruction. Furthermore, the costs to society per kilogram of nuclear material used for destructive purposes would be immense. The dispersal of very small amounts of finely divided plutonium could necessitate evacuation and decontamination operations covering several square kilometers for long periods of time and

fessional skills, intelligence networks, finances and level of armaments throughout the world . . . . Not only do illicit nuclear weapons present a greater potential public hazard than the radiological dangers associated with power plant accidents, but . . . the relevant regulations are much less stringent."[19]

It is not that the AEC has not implemented the necessary safeguards programs; rather it has not even developed an adequate program on paper.

On the subject of safeguards, the AEC's draft impact statement for plutonium recycle is a marvel of clouded reasoning and breezy optimism. The statement concedes that the objective of keeping the risk of nuclear theft small "will not be fully met for the recycle of Pu by current safeguards measures."[20] Steps which might be taken to correct current inadequacies are summarized in the statement as follows:

"1. Minimization or elimination of the transportation of plutonium from reprocessing plants to mixed oxide fuel fabrication facilities which is the operation most vulnerable to an attempted act of theft or sabotage. To the extent that such shipments are minimized or eliminated, the safeguarding of plutonium would be enhanced. This objective can be accomplished by locating mixed oxide fuel fabrication plants in close proximity to or adjacent to reprocessing plants in Integrated Fuel Cycle Facilities . . . .

"2. Further protection of transportation functions by use of massive shipping containers, special escort or convoying measures, vehicle hardening against attack, improved communications and response capabilities.

"3. Additional hardening of facilities through new barrier requirements, new surveillance instrumentation, new delaying capabilities (e.g., incapacitating gases).

"4. Upgrading of operating and guard functions through the use of personnel security clearance procedures, a Federally operated nuclear security system, more advanced

systems for monitoring and searching of personnel, and closer liaison with law enforcement authorities.

"5. Improving the timeliness and sensitivity of the system of internal control and accountability of plutonium.

"6. Use of 'spiked' plutonium which would be less susceptible to theft and would be more difficult to manufacture into a nuclear explosive because of the required elaborate handling procedures."[21]

Despite the facts (1) that these proposals are preliminary and their content not well-defined, (2) that they are still being studied, some for the first time, (3) that several would require Congressional action, (4) that several would necessitate substantial changes in the structure of the U.S. utility industry, and (5) that a sophisticated safeguards program would pose a major threat to civil liberties and personal privacy, the draft impact statement nevertheless recommends that we proceed now with plutonium recycle because "The Commission has a high degree of confidence that through implementation of some combination of the above concepts the safeguards general objective set forth earlier can be met for Pu recycle."[22] The Commission's faith, unfortunately, is hardly reassuring.

The issues of a federal plutonium police force and personnel security and surveillance measures will be discussed in the following section,[23] for they are the entering wedge of what promises to be more pervasive and continuing undermining of our civil rights. Two other potential safeguards should be mentioned here, however, in order to highlight the degree to which the issues remain unresolved. First, the draft statement refers to the possible use of "spiked" plutonium, i.e. plutonium combined with radioactive

costing tens or hundreds of millions of dollars. The damage could run to many millions of dollars per gram of plutonium used. A nuclear explosion with a yield of one kiloton could destroy a major industrial installation or several large office buildings costing hundreds of millions to billions of dollars. The hundreds or thousands of people whose health might be severely damaged by dispersal of plutonium, or the tens of thousands of people who might be killed by a low-yield nuclear explosion in a densely populated area represent incalculable but immense costs to society."[14]

In our troubled world, terrorist activity and other forms of anti-social violence is an almost daily occurrence. A recent AEC study identified more than 400 incidents of international terrorism carried out by small groups during the past six years.[15] In an age of bombs and bomb threats, of aircraft hijacking, of the ransom of diplomats and the murder of Olympic athletes, the risks of nuclear theft, blackmail and terrorism are not minimized even by some of the most ardent supporters of nuclear energy. Thus former Atomic Energy Commissioner Clarence Larson recently described the evolution of a plutonium black market:

"Once special nuclear material is successfully stolen in small and possibly economically acceptable quantities, a supply-stimulated market for such illicit material is bound to develop. And such a market can surely be expected to grow once the source of supply has been identified. As the market grows, the number and size of thefts can be expected to grow with it, and I fear such growth would be extremely rapid once it begins . . . . Such theft would quickly lead to serious economic burdens to the industry, and a threat to the national security."[16]

The critical point here is that these tremendous risks will become real with the advent of plutonium recycle. Unless plutonium is reprocessed and recycled, the possibility that it will be stolen is small, for if the plutonium has not been "detoxified" by separating it from the high-level wastes in the spent fuel, it is very

effectively protected from theft, at least for hundreds of years. Willrich and Taylor explain these important relationships:

"In the light-water reactor (LWR) fuel cycle without plutonium recycle, plutonium which is produced in a power reactor, if reprocessed, might be stolen at the output end of a reprocessing plant, during transit from the reprocessing plant to any separate storage facility used, and from a long-term plutonium storage facility. Until irradiated fuel is reprocessed, the theft possibilities in the LWR fuel cycle are minimal.

"In the LWR fuel cycle with plutonium recycle, in addition to possibilities without recycle, plutonium might be stolen during transit from any separate long-term storage facility, and from a fuel fabrication plant. Complete LWR fuel assemblies, each containing a significant quantity of plutonium might also be stolen during transit from a fuel fabrication plant to a power reactor, and at a power plant prior to loading into the reactor, although the weight of each assembly makes this difficult." (Emphasis added.)[17]

In sum, plutonium recycle will bring with it all the risks associated with nuclear theft that numerous authors have described.[18] Reasonable prudence dictates, therefore, that we have adequate answers to the problem of nuclear theft well in hand before we begin plutonium recycle.

B. Safeguards and the Impact Statement

In the language of the nuclear industry, the various programs and techniques to prevent nuclear theft and recover stolen nuclear material are called "safeguards." There is now widespread agreement, at least among those outside the nuclear industry, that present safeguards are woefully inadequate. The AEC's own Rosenbaum Report concluded:

"In recent years the factors which make safeguards a real, imminent and vital issue have changed rapidly for the worse. Terrorists groups have increased their pro-

material emitting high levels of penetrating radiation. The type of radiation emitted by plutonium -- an alpha particle -- while extremely carcinogenic in soft tissue, is not very penetrating and can be shielded against without heavy concrete or lead structures. The spiking of plutonium with more penetrating radiation would substantially increase the hazards of handling it and thus decrease the theft incentive. This step would appear to be an essential part of any safeguards program, yet it could substantially increase the costs of plutonium recycle, making it much less attractive to the industry.

Second, the AEC's lead safeguards suggestion -- the Integrated Fuel Cycle Facility concept -- actually represents a major watering down of a far more significant concept, that of nuclear power parks where reactors as well as fuel reprocessing and fabricating plants are all located at one site.[24] In our judgment, a safeguards system which does not require nuclear parks is not addressing the problem of theft during transportation in a serious and responsible way. Moreover, the nuclear industry's current plans, already well advanced, do not call for the implementation of even the Integrated Fuel Cycle Facilities concept.

C. Are Adequate Safeguards Possible?

While it may be possible to devise an adequate safeguard system in theory, there is little reason to believe that such a system would be acceptable in practice.[25] This is true for several reasons.

First, the problem is immense. The illegal diversion of weapons material is only one type of anti-social behavior a

safeguards program must protect against. Terrorist acts against the reactors, shipments of radioactive wastes, fuel reprocessing facilities and waste repositories can result in catastrophic releases of radioactivity. Such threats against nuclear facilities have already occurred.[26] Moreover, a safeguards system would have to exist on a vast, worldwide basis. Some 1000 nuclear reactors are projected for the United States in the year 2000, with hundreds of shipments of radioactive materials daily. Hundreds of tons of plutonium will be in the commercial sector of our economy by that date.[27] Abroad, American firms are constructing nuclear reactors in countries that have little political stability and in countries, such as Japan, who have not signed the non-proliferation treaty. Safeguarding nuclear bomb material would ultimately require a restructuring of the socio-political institutions on a worldwide scale. The United Nations unfortunately gives us little reason to believe that this is a practical reality.

Second, safeguards measures are strongly opposed by the nuclear industry. Some indication of the degree to which the industry is sensitive to the diversion hazards, and the degree with which the industry is likely to be an effective partner in the enforcement and implementation of safeguards programs can be gleaned from published accounts of the industry's response to the modest strengthening of the AEC safeguards rules which were first published in the February 1, 1973, Federal Register.

Some of the comments received on these proposed regulations were:

> ". . . it is clear that the severity of the proposed [physical security] procedures greatly exceeds any reasonable relationship to the public need intended to be served. We are unaware, and we believe the industry as a whole is unaware, of occurrences of industrial sabotage which would tend to justify the imposition of requirements as strict as those proposed. The Commission has not demonstrated the need . . . or offered any justification or explanation . . . . Certainly the public interest will not be served by adoption of burdensome requirements disproportionate to the end sought."
>
> ---from comment of Kerr-McGee;

and,

> ". . . a move backward to the types of security practices in the Manhattan District era."
>
> ---from comment of Westinghouse;

and,

> "One principal objection is to the emphasis placed on the use of armed personnel . . . and the seeming reliance on such personnel to protect against threats to the common defense and security . . . . To the extent that the proposed regulations . . . require an armed confrontation between a licensee's security force and potential diverters, the proposed regulations should be amended. The surest and most proper method of protection . . . is prompt detection and reporting . . . ."
>
> ---from comment of United Nuclear.

Third, experience with present safeguards is hardly reassuring. The NUMEC, over several years of operation, was unable to account for six percent (100 kilograms) of the weapons grade material that it handled, and as noted previously was recently fined by the AEC, in part because of safeguards violations. At a recent safeguards symposium the director of the AEC's Office of Safeguards and Materials Management observed that "we have a long way to go to get into that happy land where one can measure scrap effluents, products, inputs and discards to a one percent accuracy."[28] This

statement takes on particular significance when it is realized that only one half of one percent of the plutonium utilized by the commercial sector in the year 2000 is enough to make hundreds of atomic bombs. The editors of Bulletin of the Atomic Scientists have noted that the frequent "misrouting" of nuclear shipments highlights a key safeguards problem -- hijacking. They cite instances where theft of weapons grade materials would have been relatively easy: a shipment bound for Missouri ended up in Boston; another shipment between two California cities was eventually located in Tijuana, Mexico.[29] Finally, a spot check by General Accounting Office investigators at three AEC licensed contractors showed that in some cases access to easily portable quantities of special nuclear material could be gained in less than a minute using the simplest of tools. At two of the three plants checked, GAO found weak physical barriers, ineffective guard patrols, ineffective alarm systems, lack of automatic-detection devices, and the absence of an "action plan" should material be stolen or diverted. In contrast, the AEC's inspectors were giving the same facilities good marks on virtually every security category.[30]

Fourth, and perhaps most basically, there is little reason to believe that safeguards will work when little else does. For example, the AEC supports the creation of a federal police force which might provide an immediate federal presence whenever the use of force may be needed to protect these incredibly dangerous materials from falling into the hands of would-be saboteurs and blackmailers.

But is there anyone who believes that police are effective at a level commensurate with the potential nuclear hazard? The New York City police department was proven incapable of maintaining security over confiscated heroin. Are similar losses of plutonium acceptible? The general point here is that our safeguards system must be essentially infallible; it must maintain what Alvin Weinberg, former Director of the Oak Ridge National Laboratory, has called "unaccustomed vigilance" and "a continuing tradition of meticulous attention to detail."[31] Yet our human institutions are far from infallible. Our experience indicates that rather than sustaining a high degree of esprit, vigilance and meticulous attention to detail, our governmental bureaucracies instead become careless, rigid, defensive and, less frequently, corrupt. A basic question, then, is whether we want to entrust so demanding and unrelenting a technology as plutonium recycle to institutions which are negligent of their own responsibilities and insensitive to the rights of others and to technical fixes which are untried and unproven.

V. The Threat to Civil Liberties

One principal reason for our believing that an adequate safeguards system would not be acceptable in practice is the tremendous social cost of such a system in terms of human freedom and privacy. Safeguards necessarily involve a large expansion of police powers. Some one million persons have been trained in the handling, moving and operation of nuclear weapons. The projected growth of the nuclear industry will give rise to a parallel and an ultimately much larger group of persons, in this case civilians, who will be

subjected to security clearance and other security procedures now commonplace in the military weapons program. Indeed, the AEC makes the following disturbing statement in its draft impact assessment of plutonium recycle:

> "Security problems are much simplified when it can be established with high probability that the persons who are responsible for the handling of plutonium or implementing of related safeguards programs are trustworthy. Various court rulings in recent years have been favorable to the protection of individual privacy and of individual right-to-work. These rulings have made it difficult to make a personnel background check of an individual in commercial activities to assure with high probability that he is trustworthy and, hence, potentially acceptable as a steward for the protection of plutonium. The AEC has requested legislation which would allow background checks of individuals with access to plutonium and related material accountability records. We believe that enabling legislation such as this is necessary to the further improvement of personnel selection practices."[32]

The keeping of police dossiers will not be limited to nuclear industry personnel. The New York Times reported August 11 that Texas state police maintain files on nuclear power plant opponents.[33] The police stated that they had information that some nuclear opponents might attempt to sabotage transmission lines, though they declined to disclose their information or its source. How much more government investigation into the private lives of individuals can be tolerated by a free society? Security and surveillance procedures at best infringe upon the privacy of families and their friends. At worst, they are the instruments of repression and reprisal.

A second AEC safeguards proposal is the creation of a federal police force for the protection of plutonium plants and shipments. The draft impact statement for plutonium recycle justifies such a federal force in the following terms:

> "A federal security system would be less apt to have the variations in staff and capability that would be encountered in use of private security guards. In addition, it should be noted that the consequences of a successful theft or diversion of plutonium would undoubtedly have nationwide impacts and could best be handled by Federal authorities; certainly, with Federal participation, there is the potential for a larger force, more effective weapons, and better communications."[34]

But what standards should govern and restrain the operations of such a force? The AEC has already issued shoot-to-kill orders once to personnel directing the production, shipment and storage of atomic weapons, at the height of the Yom Kippur War.[35] Once a significant theft of plutonium or other weapons material has occurred, how will it be recovered? To prevent traffic in heroin, police have asked for no-knock search laws. This infringes upon one of our most cherished freedoms. To live with plutonium we may have to abandon this freedom along with others. In the presence of nuclear blackmail threats, the institution of martial law seems inevitable. It has been said that the widespread availability of weapons material and terrorists' targets in the nuclear fuel cycle will radically alter the power balance between large and small social units.[36] It should be added that the threatened society will undoubtedly attempt to redress that balance through sophisticated and drastic police action.

In sum, to accommodate plutonium we shall have to move towards a more intimidated society with greatly reduced freedoms. In this respect the following passage from the Report of the distinguished international group of scientists attending the 23rd Pugwash Conference on Science and World Affairs is instructive:

> "The problem of theft of nuclear material by internal groups or individuals intent on sabotage, terrorism or blackmail was agreed to be a very serious one, although there was some sentiment expressed that the possibility of such activity was much smaller in socialist states."

We believe that sentiment to be true. It is also apparent that that is the direction in which we must move to accommodate the nuclear industry. After having spent billions of dollars for our nuclear deterrent, our civilian nuclear industry might well accomplish that which our defense system is trying to prevent.

Dr. Alvin Weinberg, former Director of the Oak Ridge National Laboratory, is one of the few persons closely associated with the nuclear power complex who has looked carefully at the political and regulatory institutions that will be necessary to support a plutonium-based nuclear power economy. Dr. Weinberg's views on this subject merit close attention.

Weinberg's basic premise is stated in his article "Social Institutions and Nuclear Energy" which appeared in the July 7, 1972, issue of Science:

> "We nuclear people have made a Faustian bargain with society. On the one hand, we offer - in the catalytic nuclear burner - an inexhaustible source of energy . . . .
>
> "But the price that we demand of society for this magical energy source is both a vigilance and a longevity of our social institutions that we are quite unaccustomed to . . . . In a sense, we have established a military priesthood which guards against inadvertent use of nuclear weapons, which maintains what a priori seems to be a precarious balance between readiness to go to war and vigilance against human errors that would precipitate war. Moreover, this is not something that will go away, at least not soon. The discovery of the bomb has imposed an additional demand on our social institutions. It has called forth this military priesthood upon which in a way we all depend for our survival.
>
> "It seems to me (and in this I repeat some views expressed very well by Atomic Energy Commissioner Wilfrid Johnson) that peaceful nuclear energy probably will make demands of the same sort on our society, and possibly of even longer duration."[37]

Here Dr. Weinberg observes that nuclear power will place unprecedented strains on our institutions. He correctly states that the nuclear power industry will pose problems for society that eclipse those posed by nuclear weapons.

In an unpublished paper circulated prior to a conference at the Woodrow Wilson International Center for Scholars in Washington, D.C., on June 18, 1973, Dr. Weinberg elaborated his views on the type of institutions required to cope with the plutonium economy:

> "One suggestion (proposed by Sidney Siegal) that is relevant to the situation in the United States would be to establish a national corporation patterned after COMSAT to take charge of the generation of nuclear electricity. Such an organization would have technical resources that must exceed those available to even a large utility: and a high order of technical expertise in operating reactors and their sub-systems is essential to ensuring the continued integrity of these devices. [Here Dr. Weinberg suggests nationalization of the industry.]
>
> "Each country now has its own AEC that sets standards or, in some cases, actually monitors or operates reactors. Perhaps this will be sufficient forever. Yet no government has lasted continuously for 1000 years: only the Catholic Church has survived more or less continuously for 2000 years or so. Our commitment to nuclear energy is assumed to last in perpetuity -- can we think of a national entity that possesses the resiliency to remain alive for even a single half-life of plutonium-239? A permanent cadre of experts that will retain its continuity over immensely long times hardly seems feasible if the cadre is a national body.
>
> "It may be that an International Authority, operating as an agent of the United Nations, could become the focus for this cadre of expertise. The experts themselves would remain under national auspices, but they would be part of a worldwide community of experts who are held together, are monitored, and are given long-term stability by the International Authority. The Catholic Church is the best example of what I have in mind: a central authority that proclaims and to a degree enforces doctrine, maintains its own long-term social stability, and has connections to every country's own Catholic Church." (Emphasis added.)

These are far-reaching concepts presented by Dr. Weinberg. The basic question they pose is: Will the plutonium economy raise socio-political problems of such magnitude that their resolution will be unacceptable to society? In attempting to do the impossible -- live with plutonium -- we may create the intolerable.

VI. The Super-Human Requirements

The commercialization of plutonium will bring with it a major escalation of the risks and problems already associated with nuclear power. Plutonium will further strain the already weakened regulatory fabric of the nuclear industry.

Dr. Hannes Alfven, Nobel Laureate in Physics, has described the regulatory imperatives applicable to the nuclear industry:

> "Fission energy is safe only if a number of critical devices work as they should, if a number of people in key positions follow all their instructions, if there is no sabotage, no hijacking of the transports, if no reactor fuel processing plant or reprocessing plant or repository anywhere in the world is situated in a region of riots or guerilla activity, and no revolution of war -- even a 'conventional one' -- takes place in these regions. The enormous quantities of extremely dangerous material must not get into the hands of ignorant people or desperados. No acts of God can be permitted."[38]

In his article in Science, Dr. Weinberg similarly stresses the need, ". . . of creating a continuing tradition of meticulous attention to detail." It is important to recognize that such a tradition would have to be "created." There are no historical precedents to suggest that this is possible on the scale demanded by the nuclear industry. Dr. Weinberg has also observed that:

> "What is required is a cadre that, from now on, can be counted upon to understand nuclear technology, to control it, to prevent accidents, prevent diversion. Moreover, in this ultimate world, nuclear reactors will be in Uganda as well as the U.S.A., in Ethiopia as well as England. And one must ensure the same high degree of expertise in the underdeveloped country as in the developed country."[39]

We quote Dr. Weinberg because he is one, if not the only, proponent of nuclear power who has given serious thought to its requirements. But the public and its decisionmakers must seriously question whether it will be possible to attract, train and motivate the personnel required for these functions. These must be highly qualified persons who will maintain a tradition of "meticulous attention to detail" even when the glamorous aspects of a new technology become the commonplace operations of an established industry. What are the qualifications of these people? How does the AEC and the nuclear industry plan to attract and continuously motivate them? We suggest that it is beyond human capability to develop a cadre of sufficient size with expertise of "very" high order that can be counted upon to understand nuclear technology, to control it, to prevent accidents and diversion over many generations, or even over the present generation.

There is considerable evidence at the present time to suggest that the fledgling nuclear industry is already unmanageable. For example, in testimony presented to the Congressional Joint Committee on Atomic Energy, Ralph Nader and the Union of Concerned Scientists on January 29, 1974, made public a heretofore secret report by an AEC Task Force dated October, 1973. That report stated the following:

> "Review of the operating history associated with 30 operating nuclear reactors indicated that during the period 1/1/72 - 5/30/73 approximately 850 abnormal occurrences were reported to the AEC. Many of the occurrences were significant and of a generic nature requiring followup investigations at other plants. Forty percent of the occurrences were traceable to some extent to design and/or fabrication related deficiencies. The remaining incidents were caused by operator error, improper maintenance, inadequate erection control, administrative deficiencies, random failure and combinations thereof."

Regarding these incidents, on page 16, the Task Force stated:

> "The large number of reactor incidents, coupled with the fact that many of them had real safety significance, were generic in nature, and were not identified during the normal design, fabrication, erection, and preoperational testing phases, raises a serious question regarding the current review and inspection practices both on the part of the nuclear industry and the AEC."

In addition to these 850 abnormal occurrences, consider the tritium that recently appeared in the drinking water of Broomfield, Colorado. Consider the 115,000 gallons of high level radioactive wastes that leaked from the tank at Hanford over a period of 51 days while no one monitored the tank. Consider that the radioactive releases from the famed Shippingport reactor were higher than recorded. Consider that the executives of the Consumers Power Corporation failed to notify the AEC that their radioactive gas holdup system was not functioning. Consider that two reactors were half completed before the AEC was informed that they were being constructed over an earthquake fault. Consider that the GAO found the security at plutonium storage areas totally inadequate after the AEC inspectors had certified the facilities.

Considering all this, there is good reason to suggest, because of the meticulous attention to detail that will be required at every stage of plutonium recycle, that a decision to proceed with plutonium recycle will precipitate an already unmanageable situation into a national crisis.

VII. Options: Alternatives to Plutonium Recycle

Given that the risks of plutonium recycle are unacceptably high, particularly in light of the present uncertainties, a key question is what are our options -- what are the alternatives to the AEC's proposal to proceed now with plutonium recycle? We believe that there are essentially three options, each of which is preferable to the AEC's announced plan.

First, we could phase out nuclear power reactors. There is mounting apprehension within the scientific community concerning the human and societal hazards of fission reactors which would only be compounded by plutonium recycle. As evidence of this apprehension among scientists, a statement of concern over the environment and world peace (The Menton Statement) which was signed by 2,200 scientists, included a call for an end to the proliferation of nuclear reactors. It was presented to U.N. Secretary U. Thant, and published in the U.N. Courier, July, 1971. Similarly, scientists from all nations at the 23rd Pugwash Conference on Science and World Affairs in September, 1973, concluded:

> "1. Owing to potentially grave and as yet unresolved problems related to waste management, diversion of fissionable material, and major radioactivity releases arising from accidents, natural disasters, sabotage, or acts of war, the wisdom of a commitment to nuclear fission as a principal energy source for mankind must be seriously questioned at the present time.

> "2. Accordingly, research and development on alternative energy sources - particularly solar, geothermal and fusion energy, and cleaner technologies for fossil fuels - should be greatly accelerated.
>
> "3. Broadly based studies aimed at the assessment of the relation between genuine and sustainable energy needs, as opposed to projected demands, are required."

This third recommendation implies the implementation of energy conservation measures. It is important to recognize that energy conservation can be our major energy source between now and the year 2000. Conservation means using our present energy more efficiently; it need not mean a change in life styles. Coupled with the use of solar and geothermal energy, energy conservation could eliminate the need for new nuclear power stations.

Second, we could continue with the present generation of light-water reactors but strictly prohibit plutonium recycle for the foreseeable future. Such a decision would be premised upon a judgment that plutonium is too dangerous because of its toxicity and explosive potential to be allowed to become an article of commerce. Of course, we would still have plutonium to cope with, because it is produced in present-day reactors. But without plutonium recycle there is little incentive to reprocess the plutonium out of the spent fuel, so the plutonium could remain in the spent fuel where it is effectively protected from theft and, hopefully, confined and contained.

The benefits of plutonium recycle are small. Plutonium recycle would reduce the annual uranium requirements by about 10 to 15 percent and reduce the light water reactor fuel cycle cost by about the same amount. But the nuclear fuel cycle cost represents

less than 20 percent of the total cost of power from nuclear plants, and nuclear plants by 1985 will represent less than 40 percent of the electric, or about 15 percent of the total, domestic energy supplied. In other words, plutonium recycle involves an economic savings of less than one-half of one percent.

Plutonium differs from the high-level wastes in the spent fuel in one critical respect: whereas the radioactivity of high-level wastes will continue for thousands of years, that of plutonium will continue for hundreds of thousands. Thus, while the problem of effectively storing both these materials and preventing their entering the environment are unprecedented in human history, plutonium must be contained for eons longer. For this reason, an argument can be made that, ultimately, the safest thing that can be done with plutonium is to burn or fission it in reactors, thus making it into high-level wastes rather than plutonium. But that is an activity that is best left for decades or even centuries hence -- for a society more capable and less violent than today's.

Third -- and we believe that this is an option that must command general support -- a decision regarding plutonium recycle, and of course plutonium recycle itself, could be deferred several years until present uncertainties regarding safeguards and plutonium toxicity are satisfactorily resolved and a basis has been laid for a more intelligent judgment regarding the risks and benefits of the commercialization of plutonium. Too many questions, both technical and social, are unanswered today, and until these questions are answered it would be a grave error, we believe, to rush into the AEC's plutonium economy.

The basic question which must be answered is whether the public is willing to accept the risks of plutonium in exchange for the promised benefits. The national debate which must occur on this basic question has hardly begun.

Footnotes

1. "The Plutonium Economy of the Future," Speech by AEC Chairman Glenn T. Seaborg, AEC Release No. S-33-70, dated October 5, 1970.

2. AEC, Draft Generic Environmental Statement On The Use Of Mixed Oxide Fuel, WASH-1327, July, 1974 [hereinafter cited as WASH-1327].

3. Donald P. Geesaman, "Plutonium and the Energy Decision," in The Energy Crisis, (ed. R.S. Lewis and B.I. Spinrad, 1972), pages 58-59.

4. Mason Willrich and Theodore B. Taylor, Nuclear Theft: Risks and Safeguards (1974), page 1.

5. See the discussion at pages 17-23, infra.

6. "GE Fuel Recovery Plant Inoperable," Weekly Energy Report, Vol. II, July 15, 1974, page 1.

7. West Michigan Environmental Action Council v. AEC (W. D. Mich. Dkt. No. G-58-73).

8. AEC, Nuclear Power Growth: 1974-2000, WASH-1139 (1974), page 34 (Case D projection).

9. Geesaman, op. cit., pages 58-59.

10. Arthur Tamplin and Thomas Cochran, Radiation Standards for Hot Particles, February 14, 1974. Copies of this report are available from NRDC for $3.00 per copy.

11. WASH-1327, Chapt. IV, Section J, page 7.

12. Geesaman, op. cit., page 59.

13. AEC News Releases, Vol. V, August 14, 1974, page 4.

14. Willrich and Taylor, op. cit., pages 107-108.

15. Paper by W.C. Bartels and S.C.T. McDowell of the AEC's Division of Safeguards and Security, reprinted in Nuclear News, Vol. 17, (Aug., 1974), page 46.

16. "Nuclear Materials Safeguards: A Joint Industry-Government Mission," Speech by AEC Commissioner Clarence E. Larson, published in Proceedings of AEC Symposium on Safeguards Research and Development, October 27-29, 1969. See also Deborah Shapley, "Plutonium: Reactor Proliferation Threatens a Nuclear Black Market," Science, 9 April 1971, page 143.

17. Willrich and Taylor, op. cit., page 168.

18. See, e.g., Bernard T. Feld, "The Menace of a Fission Power Economy," Bulletin of the Atomic Scientists, April, 1974, pages 32-34; Lawrence Scheinman, "Safeguarding Nuclear Materials," Bulletin of the Atomic Scientists, April, 1974, pages 34-36; David T. Rose, "Nuclear Electric Power," Science, 19 April 1974, pages 351-359. See also Robert L. Heilbroner, An Inquiry Into The Human Prospect (1974), pages 40-43.

19. See, e.g., "A Special Safeguards Study," a report to the AEC on the Adequacy of Current Safeguards (the "Rosenbaum Report"), reprinted at 120 Cong. Rec. S6623 (April 30, 1974); U.S. General Accounting Office, Improvements Needed in the Program for the Protection of Special Nuclear Material, (GPO: November 7, 1973), reviewed by Robert Gillette in Science, December 14, 1973, pages 1112-1114.

20. WASH-1327, page S-6.

21. WASH-1327, page S-7.

22. WASH-1327, page S-7.

23. See pages 18-24 , infra.

24. See Dean E. Abrahamson, "Energy: Nuclear Theft and Nuclear Parks," Environment, July/August, 1974, page 5.

25. Taylor and Willrich believe that "a system of safeguards can be developed that will keep the risks of theft of nuclear weapon materials from the nuclear power industry at very low levels." Op. cit., page 171. Yet they also emphasize that "regardless of its effectiveness, a nuclear safeguards system applicable to the nuclear power industry in this country cannot provide complete assurance that unannounced fission explosions will not occur in the United States in the future." They point out that "no future safeguards system that will be practical can offer 100% assurance against theft." Op. cit., page 123. They never say what level of nuclear theft, or what size plutonium black market or how many unauthorized nuclear explosions is in fact acceptable.

26. See L. Douglas DeNike, "Radioactive Malevolence," Bulletin of the Atomic Scientists, February, 1974, page 16.

27. See text accompanying note 8, supra.

28. Quoted in Geesaman, op. cit., page 59.

29. The Energy Crisis, op. cit., page 59.

30. GAO, Improvements Needed in the Program for the Protection of Special Nuclear Materials, op. cit.

31. Alvin Weinberg, "Social Institutions and Nuclear Energy," Science, 7 July 1972, pages 33-34.

32. WASH-1327, Chapter V, page 42.

33. New York Times, "News of the Week in Review," August 11, 1974, ("Texas Police Have A List For Dissenters").

34. WASH-1327, Chapter V, page 42.

35. The Washington Post, October 12, 1973, page A-3.

36. DeNike, op. cit.

37. Weinberg, op. cit., pages 33-34.

38. Hannes Alfven, "Energy and Environment," Bulletin of the Atomic Scientists, May, 1972.

39. Weinberg, op. cit.

The Authors

Arthur R. Tamplin has been a biophysicist at the Lawrence Radiation Laboratory in Livermore, California since 1963. During the period June, 1967 to January, 1969 he was a member of the AEC's Division of Biology and Medicine Committee on Space Nuclear Systems Radiological Safety. The primary interest of this committee was the hazard of plutonium. Dr. Tamplin holds a Ph.D. degree in Biophysics from the University of California at Berkeley. He has published and lectured extensively on the problems of nuclear power. His books include Poisoned Power: The Case Against Nuclear Power Plants (with Gofman). For the past year he has been working on the staff of NRDC while on a one-year leave of absence from the Laboratory.

J. Gustave Speth has been an attorney on the staff of NRDC since 1970, specializing on nuclear power problems. He was the attorney for the Scientists' Institute for Public Information in Scientists' Institute v. AEC, 481 F.2d (D.C. Cir. 1973), which required the AEC to prepare an environmental impact statement for its fast breeder reactor development program. He is a former Rhodes Scholar and law clerk to Supreme Court Justice Hugo L. Black and is the author of "The Federal Role in Technology Assessment" in Federal Environmental Law (Environmental Law Institute: 1974).

Thomas B. Cochran is a nuclear physicist on the staff of NRDC. Before joining NRDC, Dr. Cochran was a Senior Research Associate at Resources for the Future. He is the author of The Liquid Metal Fast Breeder Reactor: An Environmental and Economic Critique (1974), which was published by Resources for the Future. He is a member of the Federal Power Commission's Task Force on Energy Conversion Research and Development, part of the National Power Survey. Dr. Cochran holds a Ph.D. degree in physics from Vanderbilt University and is a former AEC Health Physics Fellow.

Natural Resources Defense Council, Inc.
1710 N Street, N.W.
Washington, D.C. 20036
202 783-5710

Palo Alto Office
664 HAMILTON AVENUE
PALO ALTO, CALIF. 94301
415 327-1080

New York Office
15 WEST 44th STREET
NEW YORK, N.Y. 10036
212 869-0150

NRDC Comments on WASH 1327

DRAFT Generic Environmental Impact

Statement on Mixed Oxide Fuels

[GESMO]

Re: The Hot Particle Discussion

in Volume 3

Chapter IV, Section J.1.

and Section J, Appendix D

Pages IV J-7, IV J(D)-1 to 41

September 1974

Arthur R. Tamplin

Thomas B. Cochran

Background

On February 14, 1974, the Natural Resources Defense Council (NRDC) petitioned the Atomic Energy Commission (AEC) and the Environmental Protection Agency (EPA) to amend their radiation protection standards applicable to "hot particles" of plutonium and other actinides where hot particles were defined more fully in an accompanying report by us (Tamplin and Cochran).[1] The report (referred to herein as the Tamplin-Cochran Report) concluded that the existing radiation protection standards are grossly inadequate to protect workers and the public from the high cancer risk posed by occupational exposure to plutonium aerosols and the atmospheric release of plutonium particulates from the nuclear power and weapons industries. The report recommended (and the petition requested) that the current standards be lowered by a factor of 115,000. In the petition NRDC indicated that matters of importance to the public health and safety such as this require prompt action. Allowing a reasonable period for public comment NRDC recommended that the proposed standards be set within six months (by August 14, 1974).

On March 15, 1974, the AEC released its Draft of the Liquid Metal Fast Breeder Reactor Program Environmental Impact Statement (DRAFT LMFBR EIS). This statement contained a 15-page discussion of the hot particle problem.[2] This discussion, based on an earlier report

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1/ Tamplin, A.R. and T.B. Cochran, "Radiation Standards for Hot Particles," Natural Resources Defense Council, Washington, D. C. 14 February, 1974.

2/ DRAFT LMFBR EIS, Vol. II, Part 2, Section 4.G.5, pp. 4.G-89 to 4.G-105.

by J. Healy (referred to herein as the Healy Report) of Los Alamos Scientific Laboratory,[3] was used as justification for ignoring the approach taken in the Tamplin-Cochran Report for estimating the lung cancer incidence associated with the inhalation of hot particles and using instead the assumption of uniform lung exposure even where hot particles are concerned.

On March 28, 1974, the AEC gave notice in the Federal Register (39 Fed. Reg. 11450) of NRDC's filing of its petition and requested public comments by May 28, 1974.

On April 16, 1974, NRDC submitted to the AEC a critique of the hot particle discussion in the DRAFT LMFBR EIS.[4] Since the hot particle discussion in the DRAFT LMFBR EIS drew heavily from the Healy Report (much of it reproduced verbatim), the NRDC comments were a critique of the Healy Report itself.

On August 5, 1974, the AEC announced that it was releasing a draft generic environmental impact statement on the use of mixed oxide fuels (DRAFT GESMO) (i.e., recycled plutonium) in light water reactors. NRDC in a letter of February 21, 1974, had requested that the AEC give in this generic environmental statement a full and candid discussion of the recommendations and supporting evidence presented in the NRDC petition and accompanying report.

In the DRAFT GESMO, just as in the DRAFT LMFBR EIS, the uniform exposure assumption was used to calculate lung dose from hot particle

3/ Healy, John W., "Contamination Limits for Real and Personal Property," Los Alamos Scientific Laboratory, Los Alamos, New Mexico, LA-5482-PR, January, 1974.

4/ NRDC Comments on WASH 1535, Draft Environmental Impact Statement, Liquid Metal Fast Breeder Reactor Program, Re: Volume II, Part 2, Section 4.G.5, Particle Lung Dose Effects, pp. 4.G-89 to 4.G-105, 6 May 1974.

exposures. The first paragraph of the following quote from the DRAFT GESMO gives the justification for this assumption. The two remaining paragraphs describe the AEC's treatment of the NRDC petition and the Tamplin-Cochran Report in the DRAFT GESMO.

> "Over the past 30 years concern has arisen from time to time about the possibility that radioactivity concentrated in discrete particles might be more potent when in contact with living tissue than the same activity diffusely distributed through the same tissue (hot particle hypothesis). Numerous studies to investigate this hypothesis provide evidence that present standards have been established on a sound basis.[2] The standards setting bodies have not set different limits for these two types of exposure to radioactivity. Diffuse radiation of tissues is used to calculate dose. Hence this approach, that is diffuse irradiation of tissues, has been used in the preparation of this statement.
>
> The AEC has been asked by the Natural Resources Defense Council, Inc. (NRDC) to consider the "hot particle" hypothesis in this generic environmental statement on the use of mixed oxide fuel. Appendix D presents key elements of a report by Arthur R. Tamplin and Thomas B. Cochran[3] submitted by NRDC as well as selections from a report by J. W. Healy.[2] The Healy study is a broad review of investigations on this subject and generally supports the prevailing position of the standards setting bodies.
>
> The Natural Resources Defense Council, Inc. has raised again the question of the effect of "hot particles" in a petition filed with the Atomic Energy Commission, requesting that a reduced limit be imposed upon the concentration of plutonium in air for particles of a specified high activity. This matter is being given careful consideration in a separate proceeding."[5]

We found the above quotation to be unbelievable. It is truly remarkable in its reflection upon the professional responsibility of the AEC. It would appear that the AEC and its Regulatory Staff has chosen to abdicate its responsibility to protect the health and safety of the public and the workers from hot particle exposures. In the first paragraph of the above quotation, they state, "The standards setting bodies have not set . . ." It seems somewhat ridiculous for

5/ DRAFT GESMO, p. IV J-7.

us to have to remind the AEC that it is the standard setting body; particularly, when it fought the State of Minnesota all the way to the U. S. Supreme Court in order to fully establish its preeminence in this respect.

We recognize that there are recommending bodies such as the NCRP and the ICRP. But the failure of the NCRP and ICRP to make recommendations with respect to hot particles can not be used by the AEC as justification for its inaction. We submit that this hot particle problem is of such significance that the final GESMO can not be prepared until this issue is fully resolved.

Review of AEC's Response to NRDC's Petition

NRDC filed its petition requesting for the reduction in the plutonium standards with the agencies charged with the responsibility. In its first official statement on this issue subsequent to the NRDC petition, the AEC presented in the DRAFT LMFBR EIS an argument based on the Healy Report. NRDC responded with a critique (NRDC's comments on the DRAFT LMFBR EIS), setting aside the Healy Report by rebutting each of the points raised in the DRAFT LMFBR EIS and showing why the references cited do not support the hypothesis that hot particles can be analyzed in the same manner as uniform organ exposures, either for purposes of estimating carcinogenic risks or for establishing radiation standards. Four months after submitting those comments, we are presented with the next AEC pronouncement on the hot particle issue. Here, the AEC uses as justification the original Healy Report and makes no reference to NRDC's comments. There is absolutely no justification for this aberrant behavior by the AEC.

In NRDC's comments on the DRAFT LMFBR EIS,[6] we noted that we were appalled at the AEC's treatment of the hot particle problem. We noted that this treatment was shallow, self-serving and not supportive of the conclusion reached that the average lung dose is appropriate for estimating the health consequences. We further noted that considering the critical nature of the hot particle problem, and the AEC's budget of $100 million for biomedical research, it was a sad commentary that the general public has to correct the errors of omission and commission in that section of the DRAFT LMFBR EIS. It is even more regrettable and more appalling that we should have to reiterate these arguments to the Commission and its Regulatory Staff in these comments on the DRAFT GESMO. Since the DRAFT LMFBR EIS contains the distilled essence of that part of the Healy Report reproduced in the DRAFT GESMO, in our re-review of this part of the Healy Report we cross-reference our comments with the DRAFT LMFBR EIS and the NRDC comments on the DRAFT LMFBR EIS.

Critique of the Healy Report

The first part of the Healy Report (p. 1 to p. 3, col. 1)[7] is a general discussion outlining the problem and the review approach taken by Healy. As a consequence this section represents material for which little comment is necessary. However, two important sentences appear on page 2, column 2, which also appeared in the DRAFT LMFBR EIS (p. 4.G-90, DRAFT LMFBR EIS):

6/ NRDC Comments on WASH 1535, Op. cit.

7/ Page numbers, unless otherwise noted, refer to the original Healy Report.

> "Certainly, for acute effects occurring shortly after high levels of radiation, limiting the volume of tissue irradiated can greatly ameliorate the outcome. However, adequate data are not available to indicate whether a similar situation exists for the late effects, in particular, carcinogenesis."

As noted in our comments on the DRAFT LMFBR EIS, we find this last point to be incredible. There is an abundance of evidence to demonstrate that when small volumes of tissue are irradiated at high dosages cancer is a frequent, almost inevitable occurrence. In fact, it is this evidence that we have used in the Tamplin-Cochran Report to argue for the enhanced risk of hot particles. In addition to the experiments that we referenced, Table II on page 22 presents data from another experiment in which a high frequency of cancer developed following localized irradiation at high dosage. This was also presented as Table 4.G.2 of the DRAFT LMFBR EIS.

Section A (p. 3, col. 1 to p. 17) is as a review of the literature by J. Furchner. Furchner presents "brief abstracts" of selected "papers and reports on radiation dose to the lung and subsequent damage" (p. 3). The abstracts emphasized the actual data. Since no analysis of these data were presented by Furchner, this section is of little value and requires no comment. We only note that most of these experiments did not involve hot particles as defined in our report. Some of these data are referred to later by Healy and our comments will demonstrate their irrelevance to the hot particle problem.

Section B (p. 18, col. 1 to p. 27, col. 1) is a discussion by Healy. It is this discussion which merits specific comments.

P. 18, col. 1 to p. 19, col. 1 -- These pages present an historical discussion of the NCRP relative to radiation standards. While interesting, it has little relevance to the issue here.

P. 19, col. 2 through p. 20 (also see p. 4.G-91 to 4.G-92, DRAFT LMFBR EIS) -- In the Tamplin-Cochran Report we mentioned lack of guidance from NCRP and ICRP with respect to hot particles. Moreover, in this report we indicate that our analysis is an extension of the work of Professor Donald Geesaman that was published in 1968. It is interesting to note that this work of Geesaman is not referenced in the Healy Report. Moreover, in the quotation (p. 20, col. 1), from ICRP Publication 14, it is not at all clear that the authors, an ICRP Task Group, reviewed Geesaman's work before preparing Publication 14. Moreover, while the opinion of the Task Group may be worth noting, it is important to note that it is only an opinion and is totally unsupported in ICRP Publication 14. Considering this in 1974, it is significant that in the intervening five years since publication of that report, adequate support for that opinion has not been forthcoming. Quite the contrary, the analysis of Geesaman and our report have emerged to support the opposite.

P. 21, col. 1 (also see p. 4.G-94, DRAFT LMFBR EIS) -- On this page, the statement appears:

> ". . . there appears to be a relation between the radiation dose and the time of occurrence of malignancies in animals: In general, the higher the dose (or in case of internal emitters, the dose rate) the shorter the time required for cancer production. This phenomenon is frequently used to invoke the possibility of an 'effective threshold' since the time required to permit cancer formation following a low dose will be so great that it exceeds the normal life span even if the induction follows a linear relation with dose."

As Dr. Miriam Finkel has stated, much of the support for the concept of an "effective threshold" is an artifact of experiments in which too few animals were exposed at the lower dosages. According to Dr. Finkel:

"After a large dose of radiation the point in time when an animal dies with an osteosarcoma may arrive sooner, but this is not necessarily because the actual time elapsing up to the occurrence of irreversible neoplastic change, or the 'true' latent period is shorter when the dose is large. We know that 'tumour pressure,' which is indicated to some extent by final osteosarcoma incidence, is going to be much greater after a large dose--if it is still in the oncogenic range--than after a small one. Therefore, the probability of an animal dying with an osteosarcoma at any particular time will be much greater if it has received an amount of radium that gives a high tumour yield than if it has received an amount that gives a low tumour yield. In other words, if the daily probability of dying with tumour is greater, the chance of seeing a tumour earlier is also greater. Some of us tend to confuse high tumour incidence with short latent period; i.e. we tend to assume that 'tumour pressure,' if I may again use that term, changes the actual time it takes for radiation to induce a tumour instead of recognizing the fact that 'tumour pressure' determines how many tumours there will be, and, as a consequence, determines the probability of there being a tumour at a particular time. This is how I interpret our data. The concept of latent period changing with dose has never made very good sense to me because more of our data contradict it than support it."[8]

P. 21 (footnote) (also see p. 4.G-95, DRAFT LMFBR EIS) --

"Akin to this concept is that of 'overkill' of single cells close to the particle. In the case discussed above, the production of early death by causes other than cancer can be regarded as a result of 'wasted radiation' in interpretations based upon the narrow concept of carcinogenesis as an end point.* From this standpoint, doses which lead to death before cancer appears can be considered to be overkill of the organism since the full expression of the carcinogenic effects is not attained. For a single particle in the lung (or other tissue) the dose rates at close approaches to the particle can be high enough so that even a relatively limited time of residence in the tissue will result in the death of cells within a given radius depending upon the activity of the particle and the type of radiation. Such cells will not be able to later reproduce and,

8/ Finkel, M.P., B.O. Biskis, and P.B. Jinkins, "Toxicity of radium-226 in mice," Radiation-Induced Cancer (Proceedings of a Symposium, Athens, Greece, 28 April-2 May, 1969, Organized by International Atomic Energy Agency in collaboration with the World Health Organization), Vienna, Austria: also, International Atomic Energy Agency, 1969, pp. 389-390.

regardless of the degree of damage, will not lead to cancer.**

*We have already mentioned that this is an appropriate end-point for consideration of dose limitation since it appears to be the latest effect in time to occur even when other effects are relatively ineffective in shortening the life span.

**However, the presence of dead cells, cellular products or fibrosis may be required before a cellular transformation can express itself as a cancer. This is an interesting possibility which needs more study.

The actual killing of cells and the development of a fibrotic lesion surrounding the hot particle is the suggested mechanism of carcinogenesis. As Geesaman stated:

"Summing up, intense radiation exposure of mammalian skin and lung tissue commonly results in cancers. Tissue injury and disturbance are a primary consequence of intense radiation insult, and are observed in association with carcinogenesis. Albert has exhibited a simple proportionality between skin carcinomas and atrophied hair follicles. No general description of precarcinogenic injury exists, but in a crude sense the available observations are compatible with the idea of an injury-mediated carcinogenesis. Cancer is a frequent instability of tissue. Since tissue is more than an aggregate of cells, and has a structural and functional unity of its own, it would not be surprising if some disrupted local integrity, a disturbed ordering, comprises a primary pathway of carcinogenesis. The induction of sarcomas with inert discs of Mylar, cellophane, Teflon and Millipore (Brues, et al.[17]) is indicative that such a mechanism exists. Presumably mitotic sterilization is an important factor in any carcinogenesis mediated by radiation-induced tissue injury. The functional relation of this factor in the carcinogenic response may be quite different from a linearity in the surviving mitotic fraction.

While regrettably unquantitative, the hypothesis of an injury-mediated carcinogenesis is suggestively descriptive. If the respiratory zone of the lung contains a structure analogous to the rat hair follicle, and if a radioactive particulate deposited in the respiratory zone has the capacity to disrupt one or more of these structures

and create a precancerous lesion, then cancer risks of the order of 10^{-3} to 10^{-4} per particle can be expected."[9]

The second footnote on page 21 recognizes this possibility and indicates that it requires more study. The purpose of our comments here, of our petition and of our report is to indicate that this is a very real possibility and that it leads to greatly enhanced risks when hot particles are involved. Any decision, such as that being made relative to the plutonium recycle, must take this enhanced risk from hot particles into account. The failure to do this when estimating biological effects in this DRAFT GESMO is one of its most serious flaws.

P. 21, col. 2 and Table II, p. 22 (also see p. 4.G-95 and 4.G-96, Table 4.G.21 on p. 4.G-97, DRAFT LMFBR EIS) -- The concept of overkill or wasted radiation discussed in the quote above is further discussed here and it is stated:

> "In fact, such a concept would lead immediately to the conclusion that the larger the particle (in terms of activity) the less effective it would be in producing cancer since the dose rates close to the particle would increase as the activity increased thereby leading to a greater fraction of radiation wasted on dead cells. One clear cut experiment possibly showing this effect

9/ Geesaman, Donald P., An Analysis of the Carcinogenic Risk from an Insoluble Alpha-Emitting Aerosol Deposited in Deep Respiratory Tissue, UCRL-50387 Addendum, Lawrence Livermore Laboratory, Livermore, California, 1968, pp. 6-7. Reference 17 contained herein is: Brues, A.M., H. Auerbach, G.M. De Roche, and D. Brube. Mechanisms of carcinogenesis. Argonne National Laboratory, Biological and Medical Research Division Annual Report for 1967, ANL-7409, 151-155, 1967.

> was done by Passoneau[1,53] using Sr-90 beads on rat skin."[10]

The concept of overkill is actually incorporated in our analysis of ths hot particle risk. However, this does not alter the risk per particle. As the particle becomes larger than the critical activity (volume), the risk per uCi will decrease, but not the risk per particle.

The experiment of Passonneau is quite similar to the experiments of Albert which were discussed in the Geesaman quote above and in the Tamplin-Cochran Report. The data in Table II show that irradiating a small portion of rat skin with a high dosage will produce a high incidence of cancer. Albert's experiments gave results similar to the differences observed between the bead and plate studies of Table II. As we stated in the Tamplin-Cochran Report:

> "When exposures were made with stripe and sieve patterns of roughly 1 mm scale, geometrical effects were observed; most notably the cancer induction in the sieve geometry was suppressed at doses of 1700 R, but not at doses of 2300 R. The reduction, however, was again consistent with the reduction in damage as characterized by atrophied hair follicles."

Actually, if one chooses to consider these beads as particles, they would give the following cancer risks:

150 uCi/bead	1 cancer/46 beads or particles
75 uCi/bead	1 cancer/61 beads or particles
30 uCi/bead	1 cancer/107 beads or particles

10/ Reference 1 contained herein is: U.S. National Academy of Sciences - National Research Council. The effects on populations of exposure to low levels of ionizing radiation. Report of the Advisory Committee on the Biological Effects of Ionizing Radiations. Washington, D.C. 1972.
Reference 17 contained herein is: Passoneau, et al., "Carcinogenic Effects of Diffuse and Point-Source Beta Irradiation on Rat Skin: Final Summary," AEC Document ANL-4932, 1952.

On a microcurie basis, the 150 uCi bead is less effective. However, the opposite is true on a per bead basis. But that's not the issue here. The beads demonstrate that irradiation of a small volume of tissue at a high dose leads to cancer. There is no reason for doubting that the cancer induction with these beads also relates to atrophied hair follicles.

P. 22, col. 2 (also see p. 4.G-96, DRAFT LMFBR EIS) -- This section tries to set aside the calculations of Dean and Langham.[11] In the DRAFT LMFBR EIS, with no justification whatsoever, the work of Geesaman[12] is included in the discussion as a "similar analysis." Dean and Langham calculated the dose to individual cells and then made estimates of the cancer risk based upon these cellular dosages. Geesaman, as discussed in the Tamplin-Cochran Report, suggested that, when the dose from a particle to the irradiated tissue mass was sufficient to disturb its architecture, such a disrupted tissue mass in the lung would pose a unique carcinogenic risk -- a risk similar to that posed by a disrupted hair follicle. Nevertheless, regarding both analyses the following criticism is made:

> "The results of this work can be questioned on many grounds including the use of the data on tumors in rat skin for [human] lung tissue, the finding of Albert that the sensitive cells are at the base of the follicle in the rat skin and the fact that the assumed efficiency of production of lung cancer per cell does not conform to the experience with humans in the production of lung tumors from external radiations."

The word [human] was inserted in the DRAFT LMFBR EIS. This is another of the rather incredible tactics employed by the AEC. As

11/ Dean, P.N. and W.H. Langham, "Tumorigenicity of Small Highly Radioactive Particles," Health Physics 16, 1969, pp. 79-84.

12/ Geesaman, Donald P. UCRL-50387, Addendum, Op. cit.

the AEC knows, most of our information in radiobiology comes from animal experiments. Since we are interested here in public health and safety, it is difficult to believe, as this statement would suggest, that the AEC is asking us to wait until we have the human corpses.

Moreover, it is important to note that all of the references in this section are to animal data and strangely, no reference is made to the article of Lushbaugh that deals with a precancerous lesion in human soft tissue caused by a plutonium particle. As we indicated in the Tamplin-Cochran Report, if we had used just the human data in estimating the hot particle risk, we would have had to assign a risk per particle that was greater than 1/1000, rather than the 1/2000 that we assumed. In this respect, it is important to note that Richmond demonstrated that hot particles produce lesions in the lung of hamsters that are similar to that observed by Lushbaugh in human soft tissue. There is little reason to doubt that such a lesion would develop in the human lung and then progress into a cancerous growth.

Finally, it is stated as fact at the end of the same paragraph as quoted above:

> ". . . that the assumed efficiency of production of lung cancer per cell does not conform to the experience with humans in the production of lung tumors from external radiation."

It would be of considerable interest to learn the basis for that statement. Dean and Langham, for example, made no mention of this fact in their article. In fact, the data of Sanders that is referenced later in the section would lead to the opposite conclusion.[13]

13/ This is reference 35, cited on page 27, Sanders, C.L., "Carcinogenicity of Inhaled Plutonium-238 from Crushed Microspheres," Pacific Northwest Laboratories Annual Report 1972, Part 1 BNWL-1750: 28 (1973).

P. 23 (also see pp. 4.G-98 and 4.G-101, DRAFT LMFBR EIS) -- Here again the experiments of Richmond are mentioned, but again no mention is made of the similarity between the lung lesions produced in these experiments and the human soft tissue lesion described by Lushbaugh.

It is stated:

> "In the experiment of Richmond, et al.[8] quoted above, the particles were relatively firmly held in the blood vessels and, therefore, were not representative of particles actually deposited in the alevoli. Movement of such particles is known to occur through ejection with mucus and movement by the cilia and by engulfment by macrophages."[14]

The AEC and Healy are apparently unaware that the alveoli and associated deep respiratory tissue are not ciliated. Macrophage engulfment of the particles does occur, but how this relates to lung clearance is not understood. More significant to the hot particle problem is the measured long term retention of these particles (in excess of 500 days) in the lung, which may be related to the engulfment of these particles by epithelial cells or by cytotoxic effects on macrophages.[15] The discussion following the above quoted statement again digresses into the irrelevant issue of overkill.

Pp. 24 and 25, col. 1 (also see p. 4.G-102, DRAFT LMFBR EIS) -- The material presented here has little relevance to the hot particle problem. However, attention should be called to the following which appears at the top of page 24, col. 2:

14/ Reference 8 contained herein is: Richmond, C.R., et al., Health Physics 18, 1970, p. 406.

15/ Sanders, C.L. and R.R. Adee, Health Physics 18, 1970, pp. 293-295.

> "The fact that leukemia is a relatively rare outcome in experimental animals given plutonium may serve as an indicator that irradiation of a small portion of an organ (the marrow) to a high dose is not particularly troublesome as long as the average dose is low."

There have been no experiments wherein hot particles were introduced directly into bone marrow. Thus, this statement is grossly misleading in the context of the hot particle problem.

P. 25, col. 2 and p. 26, col. 1 -- This section again digresses into the irrelevant issue of overkill. It is unfortunate that Healy was not more familiar with the Geesaman reports, otherwise he might not have continuously resurrected this dead horse.

P. 26, col. 2 and p. 27, col. 1 (also see p. 4.G-102 and 4.G-103, DRAFT LMFBR EIS) -- Considering what has appeared earlier in this section and also what follows, the reader can not help being confused by the following statement on page 26:

> "No clear cut, overall picture of the relative effects of uniform versus focal dose can be drawn from the present data."

We would in a qualitative sense agree with this statement, but we must emphasize that the available data strongly suggests that hot particle radiation leads to an enhanced risk of cancer (as much as 100,000 times that of uniform irradiation).

Following the above sentence, this statement is made:

> "It appears, from the $^{238}PuO_2$ microsphere data and the skin experiments with ^{90}Sr that, in the extreme situation of a single, very active particle, the focal radiation is considerably less damaging."

We have previously discussed both of these experiments in the Tamplin-Cochran Report. As we indicated in these discussions, these experiments do not suggest a reduced risk for hot particles. The Sanders work will be discussed again below. Quite the contrary, they strongly support our analysis of an enhanced risk for hot particles.

Then, with considerable inaccuracy, the next sentence is given as justification for the concluding remark of this section:

> "Cember[15] concludes that the focal source is less damaging for beta emitters than is the uniformly distributed source."[16]

Cember's experiments could not justify this conclusion and, in fact, he did not so conclude. Cember concluded:

> "Experiments with rats have shown that radioactive substances deposited in the lung can lead to pulmonary neoplasia. Radiations from S^{35}, Sr^{90}-Y^{90}, and Ce^{144} elicited bronchogenic carcinoma and alveolar cell carcinoma in addition to several other tumor types. These experiments did not confirm the existence of a unique carcinogenic hazard due to the intense concentration of absorbed energy in the lung tissue immediately surrounding an inhaled radioactive particle."[17]

The major thrust of the Cember article deals with ^{144}Ce particles in the lung. The ^{144}Ce was introduced admixed with stable Ce as either CeF_3 or $CeCl_3$ in particles of about 1 u in diameter (0.5 u^3). ^{144}Ce emits a beta particle of 0.275 MeV and its daughter product ^{144}Pr emits a beta of 3MeV. The rate of energy loss for these beta particles in tissue is about 0.2KeV/u compared to some 94 KeV/u for plutonium alpha particles.

This difference in energy loss per micron indicates that the activity of the ^{144}Ce emitters would have to be some 500 times that of the ^{239}Pu in order to deposit the same energy in the tissue irradiated by ^{239}Pu alpha particles. Moreover, since the QF for alpha particles is 10, the ^{144}Ce particles must have an activity

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16/ Reference 15 contained herein is: Cember, H., "Radiogenic Lung Cancer," Progress in Experimental Tumor Research v4:251 (1964).

17/ Cember, H., Op. cit., pp. 289-290.

(10) x (500) or 5,000 times that of a $^{239}PuO_2$ particle to qualify as a hot particle. Since the limiting activity of a $^{239}PuO_2$ particle is 0.07 pCi, a hot particle of $^{144}CeCl_3$ would have to contain more than 350 pCi. After correcting for the half-life of ^{144}Ce (288 days) a hot particle would have to contain some 500 pCi.

The geometric mean diameter of the particles in these experiments was 1 micron. The highest exposure group received 50 uCi of ^{144}Ce in 30 ug of CeF_3. Allowing a density of 6 g/cm^3 for the CeF_3, the beta-activity per particle of 1 u diameter is only 5 pCi. In other words, these experiments did not involve hot particles as defined above. The carcinogenesis observed in these Cember experiments, which was considerable, was related to high total and rather uniform organ dosage (1,000 - 30,000 rad).

Following the mention of the Cember experiments, this statement is made:

> "The data of Grossman, et al.[27] for ^{210}Po on iron oxide particles indicates a seeming decrease in the tumor incidence as well as increased survival for the focal sources."[18]

As we mentioned previously, this reference is only to an abstract. The AEC and Healy seemed to be more interested in the conclusion than in the validity of the experiment.

In these experiments, the highest exposure involved 0.2 uCi of ^{210}Po absorbed on 3 mg of ferric oxide carrier particles (98% < 0.75 u).

18/ Reference 27 contained herein is: Grossman, B.N., J.B. Little and W.F. O'Toole, "Role of Carrier Particles in the Induction of Bronchial Cancer in Hamsters by ^{210}Po Alpha Particles," Rad. Res. 47: 253 (1971). We do not know whether a more detailed description of these experiments was published. The information given in the abstract was sufficient to demonstrate that the experiment was irrelevant here, regardless of its overall validity.

Allowing a density of 5 g/cm^3 for the particles, the 3 mg would involve 2 x 10^9 particles of 0.8 u diameter. The activity per particle would then be only 1 x 10^{-4} pCi. Again, this experiment does not involve hot particles as defined above. It represents rather uniform irradiation of the lung to high dosage (2,250 to 45,000 rem) and again, these large dosages produce a high incidence of cancer.

Following the reference to the above abstract, this statement appears:

> "Saunders,[35] as a result of his studies with soluble ^{238}Pu derived from crushed microspheres arrives at a conclusion that spreading the dose more uniformly results in an increased cancer incidence due to the greater number of epithelial cells involved. This conclusion was based on the observation of '- - a significant incidence of tumors in the lung and in other tissues at radiation doses that have not previously been shown to be carcinogenic in animals'."[19]

The conclusion of Sanders is not justified by the experiment described in the referenced article. Sanders indicates that hot particles were not involved in this study. The conclusion that is justified by the results of this study is that the exposure standards for plutonium may be much too high (at least 100 times too high) even when hot particles are not involved. The results indicate that a uniform dose of 15 rem doubled the natural incidence of lung cancer in the exposed rats. A worker is allowed this dose each year and a member of the population could accumulate this dose in 10 years. It is somewhat disturbing that the AEC would acknowledge this experiment and then ignore its implications.

19/ Reference 35 contained herein is: Sanders, C.L., "Carcinogenicity of Inhaled Plutonium-238 from Crushed Microspheres," Pacific Northwest Laboratories Annual Report 1972, Part 1 BNWL-1750:28 (1973).

One further point could be made concerning this study. It is not at all clear from the description given in the reference that the exposures did not involve a few hundred hot particles. If this were so, these particles could have been partly responsible for the observed cancers.

On page 27, we find the conclusion reached in this section:

> "The conclusion of this work to date, therefore, is that the preponderance of the evidence indicates that the use of an average lung dose is appropriate in limiting exposures and may well be conservative."

As we have indicated above, there is no justification for this conclusion so far as hot particles are concerned. In fact, while none of the references detract from our conclusions, one of the references used in this section actually supports our contention that hot particles carry greatly enhanced cancer risks.[20] Moreover, the experiment of Sanders suggests that the risk estimates from the BIER Report that were used in the DRAFT GESMO may be serious underestimates of the effects even when hot particles are not involved.

20/ Richmond, C.R., et al., Op. cit.

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United States Senate
COMMITTEE ON FINANCE
WASHINGTON, D.C. 20510

September 26, 1974

The Honorable Dixy Lee Ray
Chairman
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Ray:

We are writing to express our grave reservations regarding the Atomic Energy Commission's proposal to proceed in the next few months to authorize the use of plutonium as fuel in present-day nuclear power plants around the country. In our judgment, a decision to authorize "plutonium recycle" is a momentous one which should only be made after its risks and implications have been thoroughly explored and debated by the public and the Congress.

As you know well, plutonium is one of the most virulent carcinogens known. Many scientists believe it to be as toxic as the most lethal biological warfare agents. Even more significant, plutonium is a material from which atomic bombs are made. Several pounds are enough for a nuclear weapon capable of tremendous destruction. It is now widely recognized that the design and manufacture of a crude atomic bomb is not difficult technically and that the only effective obstacle in making such a weapon is the availability of plutonium itself.

A Commission decision to authorize the commercial use of plutonium here and abroad would dramatically increase the risk that plutonium might be stolen by determined groups of terrorists, blackmailers, or other criminals. Such a decision would result in the creation of a large private plutonium industry which by the turn of the century could be processing hundreds of tons of plutonium annually. The theft of a tiny fraction of this plutonium -- less than one half of one percent -- would be enough to make hundreds of nuclear weapons.

Many reputable scientists informed about the risks of plutonium have warned that its use will pose unprecedented problems. For example, Dr. Bernard T. Feld of M.I.T. wrote recently in the Bulletin of the Atomic Scientists that "within the coming decade or two, the major security problem that the world will face is how to prevent the widespread dissemination of nuclear weapons, not only to governments or semi-governmental bodies, but to groups of unauthorized, even anti-social, elements as well."

We have been particularly impressed by the analysis of the problem prepared by two scientists and an attorney on the staff of the Natural Resources Defense Council. The NRDC report, entitled The Plutonium Decision: A Report on the Risks of Plutonium Recycle, will be published in the November, 1974 issue of the Bulletin. This report expresses great skepticism that safeguards can be implemented which will reduce the risk of plutonium theft to the vanishingly small possibility that is essential. It notes that present safeguard measures are admittedly inadequate and points out the numerous obstacles to upgrading these safeguards to the virtually foolproof system that would be needed. These obstacles include: (1) the sheer difficulty of the task of maintaining perpetual security over immense quantities of this material in a world where law enforcement officials have difficulty securing confiscated heroin and where terrorist activities and sophisticated crime are increasing, (2) the strenuous opposition of the nuclear industry to more strict safeguards, (3) the lax, inadequate enforcement of even present safeguards as described in the recent report of the General Accounting Office, Improvements Needed in the Program for the Protection of Special Nuclear Material (1973), and (4) the fact that the most effective safeguards would exact a tremendous price in terms of civil liberties and privacy and would require social and economic changes that are probably unacceptable to our society.

This last point is of particular concern to us, for we fear that the commercial introduction of plutonium may force choices between personal safety and civil rights -- trade-offs that our country should not have to make. The draft environmental impact statement which the Commission's staff has prepared for its proposal to authorize the commercial use of plutonium fuel expressly mentions as possible new safeguards the creation

of a large federal plutonium police force and the extension of the military security clearance and surveillance system into the rapidly growing private nuclear power industry. The Congress will want to carefully study the implications of these far-reaching proposals and others of similar nature that might follow.

Another problem raised on the NRDC report is the public health risk associated with using a material of plutonium's toxicity as a principal commercial fuel. The adequacy of the Commission's present radiation protection standards applicable to plutonium are under serious challenge, with some qualified experts arguing that those standards are perhaps 100,000 times too lax to protect the public. Until this controversy is resolved, it is impossible to predict the health effects of using plutonium and impossible to know what standards should govern its handling and release to the environment. Moreover, even if the present standards were undisputed, the fact that plutonium is one of the most carcinogenic substances known raises the question of whether we want a material of unprecedented toxicity involved in countless shipments around the country.

Because of the importance of the issues raised in the NRDC report, we are forwarding a copy to you and request the Commission's response to it. In addition to the points raised in the letter, we have attached a list of specific questions we would like you to answer regarding safeguards with respect to plutonium.

In our judgment, it is encumbent upon the Commission to state with clarity and detail the safeguard measures it believes are necessary and to defer any action authorizing plutonium recycle until the public and the Congress have had an opportunity to publicly review the adequacy and the economic and social costs of the Commission's proposals and to take appropriate action. We believe it would be a grave mistake for the Commission to proceed now to authorize plutonium recycle prior to that review. Too many questions, both technical and social, are unanswered today, and arriving at those answers will not be easy. We cannot simply assume, for example, that adequate safeguards are possible or, if they are, that their costs in terms of human freedom and privacy will be acceptable.

These are obviously issues that deserve the most searching public scrutiny while it is still possible to make a decision unencumbered by premature commitments. We look forward to your cooperation in this endeavor.

Sincerely,

Walter F. Mondale, U.S.S.

Philip A. Hart, U.S.S.

The Hon. Dixy Lee Ray
Chairman
U.S. Atomic Energy Commission
Washington, D.C.

Questions on Plutonium Recycle

1) Does the Commission plan to proceed with plutonium recycle with less than a zero risk safeguard system? If greater than zero, what level of risk does the Commission consider acceptable in terms of nuclear theft, terrorist incidents, unauthorized nuclear explosions or plutonium dispersal devices?

2) Does the Commission believe the creation of a federal security or police force is a necessary or desirable safeguard measure? How large would such a force be? What would its functions be? For example, would it merely guard plutonium shipments and facilities, or would it also be responsible for uncovering and preventing possible theft attempts and recovering plutonium after it is stolen? If a plutonium black market does develop, as at least one former A.E.C. Commissioner believes is "likely", would this security force be prepared to carry out sustained operations against such an underworld market? What standards would govern and restrain the operations of this security force? Will the uniquely grave threat posed by nuclear terrorism justify uniquely drastic police action to protect the public safety? If a federal plutonium security force is not created, will it not be necessary to develop an equivalent police capability within the framework of existing institutions such as state and local law enforcement groups and private security and surveillance forces?

3) In its draft environmental impact statement for plutonium recycle the A.E.C. states:

> "Security problems are much simplified when it can be established with high probability that the persons who are responsible for the handling of plutonium or implementing of related safeguards programs are trustworthy. Various court rulings in recent years have been favorable to the protection of individual privacy and of individual right-to-work. These rulings have made it difficult to make a personnel background check of an individual in commercial activities to assure with high probability that he is trustworthy and, hence, potentially acceptable as a steward for the protection of plutonium. The A.E.C. has requested legislation which would allow background checks of individuals with access to plutonium and related material accountability records."

We would appreciate receiving copies of the requested legislation referred to in this passage and also an identification of the recent court rulings at which the legislation is aimed. Has the Commission considered the effects of such a security system on the individual rights and privacy of nuclear industry employees, their families, and friends, and how these effects might compare with those of the military and nuclear weapons security systems?

4) Given that police have been unable to spot the underworld market in heroin or even maintain security over confiscated drugs and that the black market price of plutonium is likely to be even higher than that of heroin, what basis does the Commission have for believeng that plutonium security force, whether public or private, will perform with the requisite perfection both today and into the indefinite future when the enthusiasm of the new security enterprise will have dimmed but the quantity of plutonium in commerce will have swollen dramatically?

5) Does the Commission believe that Integrated Fuel Cycle Facilities, where plutonium fuel cycle plants are located at one site, thereby reducing the transport of plutonium, are a necessary safeguard measure? Do present industry plans call for Integrated Fuel Cycle Facilities? Why did the draft environmental statement for plutonium recycle not discuss the more significant Nuclear Power Park concept, where reactors as well as fuel cycle facilities are located at the same site, thus eliminating the transportation link altogether?

6) Does the Commission agree with the view expressed by former Oak Ridge National Laboratory Director Alvin Weinbert and, more recently, by the editors of The Economist (September 7, 1974) that the nuclear fuel cycle should be brought under international control to prevent nuclear theft and ensure effective, long-term regulations? In the Commission's judgment, what is the near-term feasibility of such a proposal?

NRC Staff Response to Specific Comments on Health, Safety and Environment by J. G. Speth

1. Comment:

"Although the adequacy of the AEC's plutonium standards is thus a matter of considerable doubt and great controversy, the AEC's draft impact statement for plutonium recycle simply assumes that the present standards are adequate. The entire risk analysis of the statement, as well as the ultimate decision to proceed with plutonium recycle, are based upon a premature and unexplained rejection of the hot particle hypothesis. Yet, the AEC is forced to concede that this hypothesis 'is being given careful consideration in a separate proceeding.'[1]

"It should be remembered that there is clear experimental evidence that plutonium is one of the most carcinogenic substances known regardless of one's views about the hot particle risk: one millionth of a gram has caused cancer in experimental animals. Thus, the more basic question is whether we want our energy system based on a material of unprecedented toxicity."

Response:

The "hot particle" hypothesis has been denied and is noted in CHAPTER IV, Section J, Appendix D. The conclusion in Appendix D is that dose calculations assuming uniform distribution of plutonium in the lung represent the most conservative approach.

Final GESMO attempts to address the carcinogenic risks from all radionuclides. Several alpha emitting radionuclides in the fuel cycle, both in the no recycle and uranium/plutonium recycle cases, have hazard potentials of the same magnitude as plutonium. Thus, the environmental impacts from each fuel cycle option are estimated from all radionuclides resulting in radiation exposure of the population or occupational workers. In addition, the risks from plutonium are compared to the total risks. The comparison indicates plutonium is a small contributor to the total risk as discussed in CHAPTER IV, Section J. Also, see the response to Comment No. 5 of this Comment Letter No. 25.

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2. Comment:

"VII. Options: Alternatives to Plutonium Recycle

"Given that the risks of plutonium recycle are unacceptably high, particularly in light of the present uncertainties, a key question is what are our options -- what are the alternatives to the AEC's proposal to proceed now with plutonium recycle? We believe that there are essentially three options, each of which is preferable to the AEC's announced plan.

1. No Nuclear Power
2. No Recycle
3. Delay Recycle"

Response:

A discussion of phase out of nuclear power clearly is not within the scope of GESMO. The other two alternatives are considered in detail in CHAPTER VIII (Alternatives 2, 5 and 6). Risks and uncertainties have been evaluated as well as possible in comparing the alternatives. Benefits are not limited to economic savings, but also include resource conservation and possible environmental improvement. A safeguards program is being developed in a supplement to this final statement which addresses the security risks of plutonium recycle and reviews the final cost-benefits of such an industry.

3. Comment:

"Second, we could continue with the present generation of light-water reactors but strictly prohibit plutonium recycle for the foreseeable future. Such a decision would be premised upon a judgment that plutonium is too dangerous because of its toxicity and explosive potential to be allowed to become an article of commerce. Of course, we would still have plutonium to cope with, because it is produced in present-day reactors. But without plutonium recycle there is little incentive to reprocess the plutonium out of the spent fuel, so the plutonium could remain in the spent fuel where it is effectively protected from theft and, hopefully, confined and contained."

Response:

This alternative is discussed in detail in final GESMO in CHAPTER VIII, Alternative 6. In particular, see CHAPTER VIII, Section 10.0 and CHAPTER XI, Section 4.0.

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4. Comment:

"The Atomic Energy Commission's draft Generic Environmental Statement on Mixed Oxide Fuels (DRAFT GESMO) is hopelessly biased and one-sided. It consistently presents the case for permitting the nuclear industry to process plutonium and use it as fuel in present-day reactors while at the same time ignoring and belittling the tremendous risks to the public health and safety associated with such a course."

Response:

The purpose of GESMO is to assess the environmental impact differential of the LWR industry due to the implementation of Pu recycle. In making this evaluation in the draft it was necessary to tabulate the results comparing the two fuel cycles, with and without Pu recycle (without Pu recycle meant uranium recycle only). In this final statement another cycle option has been added - the no recycle or throw-away cycle has been included. CHAPTER IV, Section J has been updated to show the comparisons of the dose commitments of each fuel cycle option to the general population and the occupational exposures. In this chapter the significance and risks to individuals from irradiation are also reviewed.

The impacts on the environment integrated over the period 1975 through 2000 have been included in CHAPTER VIII and the cost-benefit analysis in CHAPTER XI has been expanded over this same period to provide a full evaluation of each of the three fuel cycle options. These comparisons and the added sensitivity analysis to indicate impacts of no recycle and for delayed recycle over a span of approximately 10 years provides an objective basis for a Commission decision on Pu recycle. Accidents and safety have been assessed in CHAPTER II and Sections of CHAPTER IV relating to fuel cycle components involving Pu processing or handling. In addition the licensing application procedure for each plant or facility where plutonium would be processed or handled requires a safety analysis report prior to any licensing action.

5. Comment:

"...ignores the major controversy over the adequacy of the AEC's current radiation protection standards applicable to plutonium and simply assumes the present standards are adequate to protect the public."

Response:

In the time since the draft GESMO was published and this comment was received, the Nuclear Regulatory Commission has published in the Federal Register (41 FR 15371) April 12, 1976 a notice that the Commission denied a petition for rule making on the hot particle question from the Natural Resources Defense Council. The Commission summarized its findings:

"In summary, the uniform dose model is generally recognized by the scientific community and supported by experimental evidence as a conservative basis for standards for personal protection... Therefore, standards for insoluble alpha-emitting radionuclides, as based on a uniform dose assumption, are believed to be adequately conservative (41 FR 15378)."

To permit a more detailed review of the hot particle hypothesis, the NRDC petition and the NRC denial have been reproduced in their entirety in CHAPTER IV, Section J, Appendix D of the final GESMO.

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6. Comment:

"...draft GESMO...consistently fails to recognize and discuss fairly both facts (e.g., the poor record of the nuclear industry to date in implementing safeguards and in protection of industry workers from exposure to plutonium) and opinions (e.g., those of Drs. Willrich, Taylor, Feld, Alfven, Weinberg, Sheinman and others regarding the severe difficulties of developing and implementing an 'adequate' system of safeguards) which cast doubts on the advisability of recycling plutonium;"

Response:

In paragraph 2.4 of CHAPTER II, the special hazards of plutonium criticality and of plutonium release to the environment have been expanded to give recognition of the accidents that have occurred and to show the effects and impacts of the incidents. CHAPTER II presents descriptions of actual criticality and plutonium release incidents that have occurred in fuel cycle facilities.

The safeguards considerations for facilities and processes required for Pu recycle are discussed in detail in a supplement to GESMO.

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7. Comment:

"... the draft GESMO:

" - inflates the projected economic benefits of recycling plutonium but minimizes the economic costs of proposed safeguards; ..."

Response:

The economic benefits in final GESMO are stated as accurately as possible with sensitivity analyses of the variables. The final safeguards costs will be analyzed after the development of the Safeguards Supplement to GESMO and integrated into the overall cost-benefit analyses considering the recommended safeguards program.

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8. Comment:

"... overlooks completely one of the principal alternatives to the agency's plan to move swiftly to authorize plutonium recycle: the deferral of any decision on plutonium recycle unless and until current uncertainties regarding plutonium toxicity, and adequate and acceptable safeguards are satisfactorily resolved."

Response:

Alternative 2, delayed recycle, is the alternative suggested in this comment. Parametric studies of five- and ten-year recycle delays are considered for Alternative 2 and of a five-year delay for Alternative 1. This means that alternatives are considered where plutonium recycle begins in 1981, 1983, 1986, 1988, or 1991. These cases are a sufficient basis for assessing the impacts of the delayed recycle decision. Refer to CHAPTER VIII for all alternatives assessed.

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9. Comment:

"Because the DRAFT GESMO fails to present relevant facts and responsible opposing views, because the risk and economic analyses of the statement proceed from erroneous or unsupportable premises, and because the statement does not embody the good faith objectivity that is required, the AEC has not fulfilled its responsibility to provide the information and analysis mandated by NEPA."

Response:

The overall impacts of Pu recycle in LWR's as related to the UO_2 fuel cycle have been reassessed in final GESMO with added emphasis on risks, economics and safeguards including comparisons of the three options--no recycle, uranium only recycle and uranium and plutonium recycle. These three options provide a realistic base for comparisons of the environmental impacts of all of the components of the fuel cycle. In CHAPTER VIII, Alternatives, and CHAPTER XI, Cost-Benefits, additional cases were evaluated considering the existing industry and projections of the nuclear energy industry on a moderate high and low growth basis. These assessments, which also considered the cost sensitivities of delays in recycle, provide a wide band of economic impacts on the Pu recycle industry through the year 2000.

The safeguards considerations and final cost-benefits are being prepared in a supplement to GESMO. The complete final GESMO package adequately fulfills the requirements of NEPA and is responsive to the CEQ comments (comment Letter 60) on the draft GESMO.

10. Comment:

"In preparing certain previous impact statements we have examined, the AEC has paid little attention to comments received from members of the public or other federal agencies in the text of the statement itself but has instead simply 'answered' these comments in a separate section of the statement. Frequently these 'answers' represent an incomplete and inadequate response. Occasionally, the agency even rephrases the comment in order to make it easier to respond."

Response:

In this final statement, each public comment letter is reproduced in Volume 5 and is followed by individual comments and responses thereto. Where a response has been incorporated into the body of the GESMO text a specific reference as to chapter and paragraph number has been included as part of the response. The public comments have not been rephrased and are printed verbatim.

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11. Comment:

"The cost-benefit analyses are limited to the year 1990 with the stream of benefits and costs for other years excluded."

Response:

The stream of benefits and costs in final GESMO have been totaled for the period 1975-2000. These totals are the bases for all comparisons presented in CHAPTERS VIII, Alternatives, and CHAPTER XI, Cost-Benefits.

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12. Comment:

"The occupational exposures and environmental costs for alternatives are based in large part on data presented in "Environmental Survey of the Uranium Fuel Cycle," WASH-1248.[2] This biases the results in favor of plutonium recycle. Similarly, the "without plutonium recycle" case used throughout the DRAFT GESMO (e.g., CHAPTER IV) includes reprocessing of spent fuel even though the realistic alternative to plutonium recycle is storage of unreprocessed spent fuel, an alternative the DRAFT GESMO states would "eliminate the reprocessing industry" (pages 5-10). This use of the wrong base case biases the results in favor of plutonium recycle."

Response:

In the final GESMO, the revised CHAPTER IV, Section E, assesses the options of recycling uranium only and recycling both uranium and plutonium. With respect to the no recycle option, refer to CHAPTER IV, Section H, Radioactive Waste Management, since the spent fuels would be treated as high level radioactive waste.

With respect to the second alternative, reprocessing of spent fuel, CHAPTER IV, Section E, assesses the added environmental impact of reprocessing for only UO_2 fuel and of reprocessing the projected mix of spent UO_2 fuel and MOX fuel for the period 1975 through 2000.

As revised, CHAPTER IV, Section J compares the radiological impacts of the fuel cycle with and without a spent fuel reprocessing industry.

For the purpose of this assessment, the fuel reprocessing plants were assessed at the maximum radiological impact associated with the reprocessing of spent fuel 160 days after reactor discharge, and the dose commitments associated with the assumed release of 100% of the ^{3}H, ^{14}C, and ^{85}Kr that might be generated in the irradiated spent fuels. These assumptions tend to state a maximum of the radiological impact associated with spent fuel reprocessing, and, thus, reduce the prospective net benefit, if any, related to fuel reprocessing.

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13. Comment:

"The costs to society due to the use of mixed oxide fuel have been greatly underestimated, in terms of effluent releases from fuel reprocessing plants, worker exposure, and actual reprocessing costs. The occupational exposures and radiological effluents associated with model spent fuel reprocessing and mixed oxide fuel fabricating facilities appear to bear little resemblance to historical and present operating experiences. This biases the results in favor of plutonium recycle."

Response:

The source terms and related dose commitments associated with the model spent fuel reprocessing plant, CHAPTER IV, Section E, have been revised. For the purpose of this assessment, assumed conservative source terms (upper-limit releases) which are not likely to be exceeded by actual plants were used. Moreover, the source terms used in this assessment do not reflect improved designs, improved operating procedures, improved technology, nor corrective actions that are likely to occur during the growth of the prospective fuel reprocessing industry over the next two decades. Thus, contrary to what is implied in this comment relating to bias in favor of Pu recycle, the assessments could show a reduced benefit. The revised costs used in the evaluations of the fuel cycle options are detailed in CHAPTER XI, particularly with respect to reprocessing spent fuels and specifically to reprocessing plutonium recycle fuels.

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14. Comment:

"The analysis of the health risk associated with inhalation of hot particles is based on the invalid assumption that it is conservative to average the dose to the lung tissue over the entire lung, thereby ignoring the potential enhanced risk of hot particles (particularly plutonium dioxide particulates), where hot particles are defined in NRDC's report, 'Radiation Standards for Hot Particles.'"

Response:

The hot particle petition by NRDC has been rejected by NRC. See the response to Comment Number 9 of this Comment Letter Number 25.

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15. Comment:

"Clearly, delaying plutonium recycle a few years is a very real alternative actively being considered by the nuclear industry and the AEC. By ignoring this alternative DRAFT GESMO has demonstrated that it is out of touch with the realities that presently confront the utilities."

Response:

Since the original preparation of the draft GESMO, components of the nuclear industry, specifically the fuels reprocessing and commercial MOX fuel fabrication, have been delayed. In final GESMO, CHAPTER VIII-Alternatives has been recast to include the impacts on the Pu recycle industry with earliest possible reprocessing and recycle in 1978 and possible delays for up to approximately 10 years. In CHAPTER XI, Economic Analyses, a detailed sensitivity analysis has been performed to assess the economic effects of timing with respect to the start of reprocessing for plutonium recycle. CHAPTER XI also includes the accumulated economic impacts for the period 1975 through 2000.

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16. Comment:

"Limiting the cost benefit analysis to 1990 -- As a first cut it may be useful to examine the benefits and costs of an alternative in a single year, however, decisions involving important societal issues should be based on a weighting of all the costs against all the benefits. This of necessity requires an examining of the entire stream of benefits and costs over a time as long as they are felt. Clearly, one cannot adequately compare the costs and benefits of delaying the recycling of plutonium 0, 2, 4, . . . years, simply by looking at the costs and benefits of each alternative delay period in the year 1990. For this and other reasons, the present analysis in DRAFT GESMO does not comply with NEPA's cost-benefit analysis requirement."

Response:

In this final statement all impacts are totaled for the period 1975-2000 and parametric studies are performed on recycling delays. Refer to CHAPTER VIII, Alternatives, and CHAPTER XI, Economic Analyses.

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17. Comment:

"For example, Kr-85 removal at fuel reprocessing plants was not considered as a future basis of operation, although this is considered feasible and desirable by EPA; and the model uranium mining operation was an open pit mine although open pit mining accounts for about one-half of the ore production in this country to date. As noted in DRAFT GESMO, "If Kr-85 removal were implemented, population dose commitments with plutonium recycle would exceed those without recycle."[7]

Since the alleged benefits in plutonium recycle are largely attributable to reductions in environment costs associated with the uranium fuel cycle, the use of pessimistic or conservative assumptions in assigning environmental costs associated with the uranium cycle leads to bias in favor of recycling plutonium."

Response:

The model spent fuel reprocessing plant considered in final GESMO does not include ^{85}Kr removal. For a discussion on this item refer to CHAPTER IV, Section E, paragraph 2.1.2. Refer also to response to Comment No. 44 of the Comment Letter No. 25.

The sensitivity analysis of the economics of Pu recycle are presented in detail in CHAPTER XI.

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18. Comment:

"Similarly, the DRAFT GESMO assumes that spent fuel reprocessing and plutonium separation will occur in both "with plutonium recycle" and "without plutonium recycle" cases. This assumption, which is completely unjustified in the "without recycle" case, deprives the reader of an accurate assessment of the public health consequences of foregoing plutonium recycle and, since the risks associated with fuel reprocessing are substantial, strongly biases the results in favor of the recycle option."

Response:

The final GESMO health, safety and environmental assessments consider the three fuel cycle options, no recycle, recycle of uranium only and recycle of uranium and plutonium.

In Alternative 6, CHAPTER VIII, the no recycle case is assessed. No spent fuel reprocessing occurs in Alternative 6. This alternative considers disposal of spent fuel after a 5-year cooling period. Refer to CHAPTER VIII, Section 11.0, and CHAPTER XI, Section 4.0.

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19. Comment:

"Understatement of the costs to society due to the use of mixed oxide fuel -- Radiological effluents, occupational exposures and reprocessing costs at the model fuel reprocessing plant in DRAFT GESMO appear to bear little resemblance to the NFS operation at West Valley, New York, before it was shut down. The model mixed oxide fuel fabricating plant in DRAFT GESMO is based on the proposed Westinghouse Recycle Fuels Plant Environmental Report. Operational exposures and radiological effluents estimated for this model plant bear little resemblance to present practices at the Kerr-McGee plant at Crescent, Oaklahoma, the Nuclear Fuel Services Plant (NFS) in Erwin, Tennessee, and Nuclear Materials and Equipment Corporation (NUMEC) in Apollo, Pennsylvania."

Response:

None of the plants cited was a true production plant.

The GESMO model plants postulated for environmental impact consider the requirements for new plants to meet the licensing regulations of 10 CFR 50 for spent fuel reprocessing and 10 CFR 70 for MOX fuel fabrication. In the assessments of the environmental impacts from these plants due consideration has been given to the release standards set forth in 10 CFR 20 in the application of minimum permissible concentration of radioactive materials. See response to Comment No. 22.

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20. Comment:

"NFS - Occupational Exposures Transient Workers"

Response:

The original NFS plant was considered a commercial demonstration facility to process varied types of irradiated fuels using the Purex and Thorex processes. During the start up period--the learning period--extra maintenance employees were used to maintain exposure levels below the allowable occupational limits. New plants and the GESMO model plant are postulated to operate with upgraded regulations as compared to the NFS license conditions.

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21. Comment:

"Resnikoff notes that GESMO underestimates the cost of reprocessing by a factor of three, citing the testimony of Ms. Kathleen Black in the Barnwell Nuclear Fuel Plant construction permit hearings.[10] As Resnikoff notes, this estimate cannot be taken lightly since Ms. Black is a member of the AEC staff, and helped prepared the DRAFT GESMO."

Response:

Reprocessing cost figures have been updated to reflect the best current estimates. Refer to CHAPTER XI, Section 2.0. The sensitivity of the results to these costs is discussed in CHAPTER XI, Section 3.0.

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22. Comment:

"It appears that the authors of DRAFT GESMO are totally unfamiliar with the record at these facilities, particularly as it pertains to health and safety practices. For example, the DRAFT GESMO states, "The probability of a major fire in a plutonium facility is small,"[12] yet Gulf United's Plutonium Facility at Pawling, New York, was permanently closed following a chemical explosion, a fire and a second explosion on December 21, 1972. This accident resulted in extensive plutonium contamination within the facility, a breach in the exhaust system in the plutonium handling room area, and the release of an undermined quantity of plutonium from the building through blown out windows."

Response:

The statement in the draft GESMO, "The probability of a major fire in a plutonium facility is small" addressed the model plant during the 1980 to 2000 period which will incorporate major design changes for mitigation or prevention of accidents--not the first and second generation small scale facilities now existing. The paragraph explains after the sentence quoted that probabilities were not included in dose calculations for accident impacts.

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23. Comment:

"The DRAFT GESMO implies that such fires should be rare, and in any case small because the licensees follow AEC Regulations, purported to be adequate. For example, the AEC states in DRAFT:

> "Regulatory Guide 3.6 presents methods acceptable to the Regulatory staff for a fire protection program which should prevent, detect, extinguish, limit, or control fires and explosions and their concomitant hazards and damaging effects. Licensees must operate within these or equivalent constraints. Under these conditions, the probability of having a fire of the magnitude considered in this statement is considered highly unlikely."[14] (emphasis added)

This statement could not be further from the truth, since licensees are notorious for failing to follow regulations."

Response:

The NRC has an Office of Nuclear Materials Safety and Safeguards and an Office of Inspection and Enforcement with the responsibilities for evaluating and inspecting licensees' facilities for conformance to regulations and license conditions. Licensees will be required to operate within these restraints. Regulations are continuously upgraded based on data collected from regular inspections.

As a result of the Browns Ferry fire the NRC has taken additional steps to reduce the possibility of fires in all nuclear facilities. This is a subject of continuous emphasis by the NRC staff.

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24. Comment:

"Ignoring the enhanced health risk of plutonium hot particles -- Among the most serious failings of the DRAFT GESMO is the fact that the health consequences of plutonium recycle using the hot particle risk estimate are not presented. We have provided under separate cover comments on the DRAFT GESMO related to the hot particle discussion.[22] Subsequent to the submission of our comments on the hot particle discussion in DRAFT GESMO, the AEC has released a white paper, "A Radiobiological Assessment of the Spatial Distribution of Radiation Dose from Inhaled Plutonium," (WASH-1320) by W. J. Bair, C. R. Richmond, and B. W. Wachholz. NRDC has in preparation a critique of this report which will be available by mid-November. If the AEC intends to use WASH-1320 in preparation of the FINAL GESMO, we request that our critique of WASH-1320 be an integral part of our comments."

Response:

Both the Bair paper, WASH-1320, and the NRDC paper (Tamplin, A.R. and Cochran, T.B.; The Hot Particle Issue: A Critique of WASH-1320 as it Relates to the Hot Particle Hypothesis, Report of the NRDC, Inc., Washington, D. C., November 1974), have been cited in the NRC denial of the NRDC petition for rulemaking. See CHAPTER IV, Section J, Appendix D and the response to Comment No. 5 of this Comment Letter No. 25.

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25. Comment:

"Westinghouse's Environmental Report on its Recycle Fuel Facility (the facility on which the GESMO model mixed oxide fabrication plant is based) provides estimates of the airborne particle size distributions both before and after filtration by HEPA filters at this proposed facility. These distributions are dominated by hot particles.

Unless the AEC is implying a commitment to promulgate regulations which are consistent with the assumption in DRAFT GESMO and which are applicable to hot particles, the health effect from normal and accidental releases from facilities processing spent fuel and fabricating mixed oxide fuel are indeterminate. They could be more than 10,000 times the estimated health effects associated with plutonium in DRAFT GESMO.[23]"

Response:

This comment dealing with the hot particle issue is similar to Comments 5, 14, and 24. See, in particular, the response to Comment No. 5, Comment Letter No. 25.

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26. Comment:

"Volume 1 - Summary and Conclusions

The Summary and Conclusions sections of the DRAFT GESMO are even more biased, monolithic and unresponsive to the facts than the statement as a whole. Since these sections will be the most widely read portions of the statement, they must include a discussion of responsible opposing views in each section and subsection. Also, the summary sections must meet the same standards of candor and objectivity required for the overall statement and must accurately reflect the underlying statement. They cannot be the place where the AEC edits out unflattering observations and unpleasant facts in order to present a carefully edited picture of plutonium recycle to the public."

Response:

Summary documents, by definition, must omit much of the detail that comprises a complete text. The final GESMO summary emphasizes a discussion of the results of many studies and assessments of the entire LWR fuel cycle with consideration for impacts on the environment, both positive and negative, for the three options, no recycle of uranium or plutonium, recycle of uranium only and recycle of uranium and plutonium.

The format of the detailed Summary and Conclusions of final GESMO reflects the format of the statement as a whole where practical. The language of the summary, the tabulations of assessments and the related fuel cycle figures duplicate those used in the detailed portions of the text. This includes both the risks and the benefits derived from the implementation or disapproval of recycle.

The responses to public comments received on the draft GESMO are covered in detail in this Volume 5. Wherever possible, notations are included referencing specific portions of the text where additional detailed information can be found.

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27. Comment:

"As noted previously data are provided for the year 1990 only. Data for other years (e.g., 1980 and 1985) should also be provided either here or somewhere else in the report. The figures and tables in the Summary should be cross-referenced with figures, tables and discussion in other parts of the report so the reader can easily figure out how and where the data were obtained, and what assumptions were made. For example, the reader does not know where the data in Table IV A-5 (p. IV A-9) comes from, what assumptions were made, etc., without reading the entire report and then trying to figure out what data in other tables were summarized to get these figures."

Response:

In the final GESMO where tables and figures are prepared for detail within chapters and sections and used again in the summary portions of the statement, suitable notations have been added, indicating where the basis for the data presented can be found.

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28. Comment:

"The AEC's plutonium weapons facility at Rocky Flats was the site of one of the most costly industrial fires in history. It has been reported that there were 70 small fires in 1969 and 35 in 1970.[25] While this facility works with pyrophoric plutonium metal as opposed to PuO_2 it would be interesting to know how many of these fires could similarly occur in commercial mixed oxide plants."

Response:

Very few, if any, fires of the type that occurred at Rocky Flats could occur in a model commercial mixed oxide plant. The plutonium in the model commercial mixed oxide plant would not sustain combustion and organic process chemicals, responsible for some fires at Rocky Flats, will not be used in the mixed oxide plant.

As mentioned in the text of the reference cited in this comment, Factory Insurance Association and other groups were conducting fire-safety surveys of the Rocky Flat plant in 1969. These surveys resulted in an "improved risk" criteria which will be used in the future design of plutonium facilities. See WASH-1507, Environmental Statement-Plutonium Recovery Facility, Rocky Flats Plant, Colorado, January, 1972.

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29. Comment:

"The LWR uranium fuel cycle (Figure IV B-1) is defined to include fuel reprocessing and plutonium storage. There are presently no commercial fuel reprocessing plants operating or licensed and none are required under alternative 6 or alternative 2 until some undetermined future date. GESMO should give equal billing to these other alternatives here and in the summaries and of course equal billing to the additional alternatives we proposed (deferral of recycle for 2, 4 ... 10 years).

Response:

The alternatives for recycle are detailed in CHAPTER VIII. Throughout final GESMO, comparisons are made and tabulated to show the integrated impacts of three fuel cycle options, no recycle, recycle uranium only and recycle of uranium and plutonium.

Alternative 2, the storage of spent fuel and delayed recycle, and Alternative 6, the disposal of spent fuel - no recycle, are given equally full evaluations throughout this final statement, especially in CHAPTERS VIII and XI where detailed discussion and comparisons of the alternatives are included. The deferral alternatives are also considered in CHAPTER XI, paragraph 3.6. Parametric studies of 5 and 10 year delays in recycle are considered in the assessments of Alternative 2.

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30. Comment:

"The implication here is that MOX loadings somewhat greater than 1.15 SGR can be expected but are presently unacceptable. Since the AEC has not promulgated standards restricting reactor loadings to 115% SGR even temporarily GESMO should discuss fully the safety and environmental implications of fuel management concepts up to and including 100% plutonium as fissile fuel in a reactor."

Response:

The use of plutonium in quantities greater than 1.15 SGR would require evaluation beyond that presented in GESMO and would be considered on a case-by-case basis. To identify the precise technical limit for plutonium recycle in LWR's at this time was not considered to be justified in light of the results of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's and the results of past MOX demonstrations. Refer to CHAPTER IV, Section C, paragraph 4. For additional response to this comment refer to the response to Comment No. 6 to Comment letter No. 29.

At the time of issue of this final health, safety and environmental statement, proposed changes to rules in 10 CFR 50 and 51* are being proposed. These proposed rule changes outline the conditions under which plutonium recycle can be implemented in the LWR industry.

The proposed amendment to 10 CFR 50 considers the addition a a new paragraph providing additional standards for the use of MOX fuel in LWR's under specified conditions.

The proposed amendment to 10 CFR 51 considers under specified conditions (of amended 10 CFR 50) the substitution of a specified amount of MOX fuel for a portion of the UO_2 fuel in a reactor.

The limitation of MOX in an LWR in the proposed rule change defines the total amount of plutonium in a 1.15 SGR to be "... 1.8% of the total as-fabricated heavy metal content (U and Pu) of that reactor..." as the limit of plutonium (fissile and non-fissile) authorized.

*10 CFR 50 Licensing of Production and Utilization Facilities
10 CFR 51 Licensing and Regulatory Policy and Procedures for Environmental Protection

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31. Comment:

"GESMO should discuss fully the quality control measures to assure this inhomogeneity, their effectiveness, and the safety and environmental implications if the required homogeneity is not met, i.e., if a large number of fuel rods contain a large number of PuO_2 particles greater than 500 μ diameter (see discussion pp. IV C-43 to IV C-47)."

Response:

The paragraphs that discuss PuO_2 particle effects in physically blended mixed oxide fuel pellets have been strengthened to reflect the requirement that these effects be fully evaluated for the manufacturer's specific particle size distribution. Conformance to important fuel fabrication specifications is audited periodically by the Office of Inspection and Enforcement. Assurance that particle-size specifications are being met is provided in this manner. Refer to CHAPTER IV, Section C, paragraphs 2.1 and 3.4.2.

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32. Comment:

"(p. IV B-8) The DRAFT GESMO should discuss fully the environmental and safety implications of present day scrap recovery processes, particularly the operation at the NFS facility in Erwin, Tennessee."

Response:

The environmental safety of present day scrap recovery processes are discussed in the draft GESMO on pages IV D-15, 16 and 21. The final GESMO discusses scrap recovery processes in more detail--including the processes used at the NFS facility in Erwin, Tennessee. See CHAPTER IV, Section D, paragraph 2.2.2.

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33. Comment:

"(p. IV C-29) To what extent can and does the U. S. AEC have control over U. S. manufacturers experimenting with recycled plutonium in foreign reactors, e.g., General Electric's large reload program in the Garigliano reactor in Italy?"

Response:

If the fuel or nuclear material were to be exported from the United States, this would be subject to the NRC export licensing process described in the response to Comment 5, Letter No. 18. If nuclear related parts or components were involved, these would be reviewed by the NRC in its licensing process or in its consultative arrangements with the Department of Commerce, depending on the nature of the proposed export. Otherwise, under current regulations, U.S. manufacturers' activities (such as referred to in the Comment 5, Letter No. 18) in non-communist bloc countries need only be reported to U.S. ERDA. U.S. manufacturers cannot, however, participate in reprocessing, enrichment, or heavy water production abroad without specific authorization from ERDA under 10 CFR Part 810.

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34. Comment:

"It is clear that reactor control can be significantly affected by MOX concentrations greater than 115% SGR assumed in the DRAFT GESMO. This is a clear example of the need to discuss fully the safety and environmental implications of fuel management concepts up to and including 100% plutonium as fissile fuel in the reactor."

Response:

Excess reactivity control is carefully reviewed for every licensed plant, and control capacity depends on plant design. While this is really a plant specific (not generic) consideration, all existing and presently planned plants are capable of using plutonium as fissile fuel in about half of the reactor fuel rods. Since 1.15 SGR corresponds to fewer plutonium rods, less than 40% of the total, sufficient reactivity control is assured in the general case. It is likely that some plants would be capable of utilizing plutonium as fissile fuel in all fuel rods, but GESMO does not cover such cases. Proposals to use plutonium in quantities greater than 1.15 SGR would require evaluation beyond that presented in GESMO. Identification and assessment of a precise upper limit for plutonium recycle in LWR's was not included in the purpose of GESMO and could not be justified in light of the results of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's (mostly self generation limits and a few up to 1.15 SGR) and the results obtained from past MOX demonstrations. Refer to CHAPTER IV, Section C, paragraph 4.

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35. Comment:

"c. Behavior of Plutonium-Fueled LWR's Transients and Accidents (p. IV C-55)
This discussion is woefully inadequate. Presumably it is relevant to MOX loading 115% SGR, or less. It is stated,

"The PWR steam-break accident may require more control rods or a higher boron-injection rate, but careful fuel management will minimize these requirements. The rod-ejection accident may be more or less severe, depending on the core design."

These accidents and their consequences should be discussed fully. What, for example, happens if fuel management is not careful; if several MOX rods are misplaced?"

Response:

The postulated steamline break, rod-ejection and loss-of-coolant accidents are strongly dependent on plant design and are carefully evaluated for each plant whether UO_2 or mixed oxide fuel is used. It is not possible, therefore, to provide a complete description of these accidents in a generic report. It was possible, however, to discuss the underlying reasons for change, to indicate the direction of the change, and imply that the change will be small. This has been done. Thus, it has been pointed out objectively that the steamline break accident will be worse, that the LOCA will be better, and that the rod-ejection may go either way using mixed oxide fuel instead of all UO_2 fuel because of competing phenomena. However, because of the small changes in underlying phenomena, which have been discussed in detail, there should be little change in any of these postulated accidents. Futhermore, each accident condition will be reviewed for each plant application on a case-by-case basis, taking plutonium fuel properties into account, and the required safety margins will be maintained. Refer to CHAPTER IV, Section C, paragraph 3.5.2.

35 Comment Cont'd

Each fuel rod is required to have its own identification for quality assurance purposes. Additionally fuel rods can be designed and fabricated to fit only in pre-designated fuel assembly positions. If, nevertheless, it is assumed that fuel rods can be misplaced within a fuel assembly, the consequences can vary from no noticeable effect to premature fuel rod failure during normal reactor operation or accidents including low probability design basis accidents. Premature failure of misplaced MOX rods during normal reactor operation might, although this is not likely, impose an economic penalty if the total number of failed fuel rods in the core causes radioactivity levels in the coolant and subsequent releases to the atmosphere to exceed the plant operating technical specification limits. Premature fuel rod failure during abnormal operating transients or relatively minor accidents where the primary coolant system integrity is not impaired could also impose economic penalties

if reactor operation could not continue within the limits of the Plant Operating Technical Specifications. For the most severe low probability accidents involving loss of primary coolant integrity, the additional failure of one or several MOX rods would cause release of fission products that are within the allowances that have been provided for calculational uncertainties. Failure of misplaced MOX rods under any of the circumstances mentioned would not be significantly worse than failures of misplaced uranium oxide fuel rods.

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36. Comment:

5. Radioactive Releases (pp. IV C-72 to IV C-122)

"The comparative assessments of public exposure due to routine and accidental releases of radioactive releases for U-fuel and 115% SGR MOX fueled reactors are based on source terms which in turn are based on fission product inventories (and corrosive products, etc.) and release fractions. It is assumed implicitly that the accident frequencies and routine leakages rates are the same for both reactor fuels. But it is clear from previous discussions that MOX fueled reactors require a higher degree of quality control both at the fuel fabrication plant (to insure homogeniety of MOX fuel and proper fuel management) and at the reactor (to insure proper fuel management). This could enhance considerably the level of routine and accidental releases from MOX fueled reactors. We are at a loss to understand why the AEC does not include this consideration when comparing exposures--public and occupational--for the two types of fuel, since this factor could more than off-set any apparent differences due to inventories of radioactivity in the reactor."

Response:

Routine releases of radioactive effluents from LWR's are limited by the plant technical specification. These limits need not and will not be relaxed to permit use of MOX fuel.

Because of the similarity of UO_2 and MOX fuel, it is reasonable to assume that the frequency of abnormal incidents and accidents will be the same for both while the consequences might vary. Considering two aspects of MOX use that are included in this comment, namely; plutonium particle size and fuel management. (1) Plutonium particle size and homogeneity effects are significant only during a postulated rod-ejection accident, and the probability of such an accident does not depend on the fissile isotope. (2) Fuel management is also equally important in UO_2 cores, where enrichment patterns must be maintained. Therefore, the frequency of having an ejected control rod or a fuel rod loading error is unchanged. The consequences of such accidents or incidents are evaluated taking into account the properties of plutonium fuels to assure that equal safety margins are maintained.

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37. Comment:

"Figure IV D-3 (p. IV D-14)

"In view of the NFS-Erwin operation it is erroneous to assume that radioactive gaseous effluents from the recycle scrap recovery operation are controlled by HEPA filters."

Response:

It is erroneous to assume that since NFS-Erwin had no HEPA filter on a uranium scrap recovery operation during early operations that a plutonium scrap recovery operation would be performed in this plant without adequate filtration.

The NRC will require that each new plutonium fuel fabrication plant meet the requirements of Regulatory Guide 3.12, General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants, prior to licensing and during operation.

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38. Comment:

"Commercial Scale Mixed Oxide Fuel Fabrication Plant"

"a Model Plant (p. IV D-17)"

"The model plant is assumed to be "located on a 1000-acre site in a rural location." The Exxon Nuclear facility is located in the heart of downtown Richland, Washington. It is certainly not conservative to assume the model plant is remotely located."

Response:

The model MOX fuel fabrication plant used in GESMO is a production plant having a capacity of about 360 MT/year and would be located in a rural area. The Exxon plant referred to is only a pilot MOX fabrication plant licensed to operate at a capacity of 1/8 MT per day (~40 MT/year) located about 4 miles north of downtown Richland, Washington.

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39. Comment:

"(p. IV D-20) The radioactive gaseous effluents from the model plant assume the HEPA filters are reliable, yet we believe a careful review of AEC inspection reports would reveal discovery of breaches in the air filter systems,[26] and failures to monitor the pressure differential across filters as frequently as required in the facility license.[27]

"It is stated, 'The CSMOFFP is designed and operated to minimize the probability of accidents.' The facility is not operating, and if this statement were true with regard to the design, it could not operate economically."

Response:

1. It is recognized that HEPA filters may develop leaks occasionally in service, and monitoring capability and redundancy are built into filtration systems to provide reliability for these eventualities. Refer to Regulatory Guide 3.12, General Design Guide for Ventilation Systems of Plutonium Processing and Fuel Fabrication Plants.

2. The main purpose of pressure differential tests is not to detect leaks in HEPA filters but to help determine when a filter should be changed because of dust loading. DOP tests and in-duct radioactivity measurements are required by the NRC to show filter efficiency.

3. Estimates made by Westinghouse for their proposed Recycle Fuels plant, which includes all the safety design features of the final GESMO model plant, indicates that this plant can produce MOX fuel economically (within the costs estimated for MOX fuel manufacture by the final GESMO). Refer to sensitivity analyses presented in CHAPTER XI, Cost-Benefits.

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40. Comment:

"(1) Radiological Effluents from CSMOFFP, Table IV D-6 (p. IV D-28)

The concentration for an alpha-emitter in stack for LASL should read $\sim 0.5 \times 10^{-14}$. The FINAL GESMO should present data for all facilities, including NFS-Erwin, Exxon and DOW-Rocky Flats, for each year of operation. Where data is not available an explanation should be given, for example, with respect to the total release from NUMEC. There is no excuse for that information not being available. This table should also present data on the yearly plutonium throughput. The DRAFT GESMO referenced the LASL data presented in "Plutonium Information meeting Transcript,"[28] but fails to note the observation on page 66 of the Transcript, that when the facility (Building 12) was torn down, the discharge was 2.9×10^{-12} pCi/ml, or a total of 1400 uCi(α) which is 100 times the reported annual release."

Response:

This typographical error in the concentration for an alpha-emitter has been corrected in the final GESMO.

Information about the existing MOX plants is given in CHAPTER IV, Section D, IV D-3 which includes specifics as to plant possession, product and production capacity. Table IV D-4 indicates the site size and demography for MOX fuel fabrication plants. The final GESMO uses historical data for plutonium throughput and releases, by reference, to establish a reasonable upper limit (conservative) DF based on prior plutonium fuel fabrication experience. It is expected that the model MOX plant will have releases much lower than the releases from existing pilot size plants.

It is being determined in the assessments included in the safeguards supplement whether or not plutonium throughput should be considered as confidential or classified information.

The information, presented in LASL 5755, Demolition of Building 12-LASL-An old Plutonium Facility is correct; 1370 MCi (α) were released during the decommissioning of the facility. The average concentration released was 2.9×10^{-12} pCi/ml or 2.9×10^{-15}, μCi/ml or about half of the average annual stack concentration during operation. Since no commercial scale MOX plants will be decommissioned before the year 2000, decommissioning impacts were not included in the study. It is estimated that the dose commitment during decommissioning to the nearest neighbor would be approximately one half the dose received in a year from the stack releases during normal operation.

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41. Comment:

"General (p. IV E-2)

This discussion begins with the erroneous statement, 'The introduction of plutonium recycle in LWR's does not affect the total amount of fuel reprocessing required.'

The point is, without plutonium recycle, reprocessing is not a necessary option. The discussion throughout this section is based on the biased assumption that the alternative to plutonium recycle is reprocessing and storage of plutonium."

Response:

In response to this and similar comments, CHAPTER IV, Section E, has been revised to clearly state that the alternative to reprocessing for recovery and recycle of U and Pu is to dispose of spent fuel as high level waste. Moreover, to more clearly indicate which alternative is being addressed, where appropriate in CHAPTER IV, Section E, the qualification has been added -- "if spent fuel is reprocessed, or assuming that spent fuel is reprocessed."

The disposal of spent fuel at a Federal repository is covered in CHAPTER IV, Section H.

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42. Comment:

"1. The Irradiated Fuel Reprocessing Industry (p. IV E-5 to E-9)

All references to General Electric's Midwest Fuel Recovery Plant should be revised to reflect the debacle that this facility represents. Also, it is not at all clear that NFS at West Valley will resume operation. We understand that Getty Oil, which owns the facility, would like to unload it, but are unable to find a buyer. Finally, we doubt anyone realistically believes the Barnwell facility will be reprocessing 1500 MTU in 1976. Projections of fuel reprocessing throughput in the near term (see Table IV E-3 on p. IV E-6) need to be revised to reflect the realities of the present fuel reprocessing industry."

Response:

CHAPTER IV, Section E of final GESMO reflects the status of the fuel reprocessing industry and the realities of the present and prospective fuel reprocessing industry.

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43. [redacted]t:

"(a) Particulate Removal (pp. IV E-14 to E-15). See Detailed Comments with reference to page IV D-20 pertaining to HEPA filters. What were the particulate release fractions at the NFS-West Valley Plant when it was operating? How do these compare with the values assumed for the model facility?"

Response:

Past operating experience in one plant is not necessarily relevant to the expected performance of other plants which differ significantly in design and the types of installed effluent treatment systems.

The particulate release fractions at NFS ranged from 10^{-8} to 10^{-10}. In 1970, for two specific one-month periods where there is reasonable data relating exposure, cooling time, quantities of material reprocessed, and measured particulate releases, the apparent particulate release fraction was approximately 10^{-9}.

For this assessment, the particulate release factors range from 10^{-8} for ruthenium, to 2×10^{-9} for non-volatile fission products and transuranium radionuclides, and 5×10^{-9} for plutonium. These values represent the overall release factors for the entire fuel reprocessing plant complex: receipt of spent fuel through shipment of waste and uranium and plutonium products offsite. For additional information, see CHAPTER IV, Section E-2.0.

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44. Comment:

"(b) Krypton 85 Removal (p. IV I-15). What are EPA's views on the feasibility, and implementation schedule for Kr-85 removal at fuel reprocessing plants? Why wasn't EPA's schedule used for the model plant? Who has final authority on setting Kr-85 release standards for the uranium and plutonium fuel cycles -- EPA or AEC?"

Response:

In May 1975, the Environmental Protection Agency proposed radiation standards (proposed 40 CFR Part 190) for normal operations of the uranium fuel cycle, which if adopted would require, among other things, that effective January 1, 1983, the total quantity of ^{85}Kr entering the general environment from the entire uranium fuel cycle shall contain less than 50,000 curies of ^{85}Kr per gigawatt-year of electrical energy produced by the fuel cycle. EPA estimates the cost of implementing the proposed standards for these long-lived radioactive materials to be less than $100,000 per potential case of cancer, leukemia, or serious genetic effect averted (less than $75 per person-rem). In view of the above considerations, EPA believes that the proposed standards, which limit the number of curies of certain of these radionuclides released to the general environment for each gigawatt-year of electricity produced by the fuel cycle, represent the most reasonable means of providing required protection of the general environment for the present and future generations. The EPA also recognizes that implementation of the standards for ^{85}Kr by the proposed effective data of January 1, 1983, will require successful demonstration of krypton control technology for commercial use that is now being developed. EPA intends to review all of these standards in at least five-year intervals. If substantial difficulty should develop for implementing the standards for ^{85}Kr with respect to the proposed levels, facility safety, or cost, EPA will give these factors careful and appropriate considerations prior to the effective date.

For this assessment--if the irradiated spent fuels were reprocessed--the reprocessing industry was assessed based on the full radiological impact on the world population from the prospective release of 100% of the ^{85}Kr. This, along with other assumptions, maximize the adverse effects that might be attributed to reprocessing. See CHAPTER IV, Section E, paragraph 2.3.

EPA has responsibility for establishing generally applicable standards for radiation in the general ambient environment; NRC sets ^{85}Kr release limits for facilities.

45. Comment:

"One class of accidents that have been ignored are those which are human deliberate. The following discussion by Professor Donald Geesaman, while directed at reactor accidents, is equally applicable to the fuel reprocessing plant:

"A major reactor accident, i.e., one that is not included in the design basis envelope, can derive from various sources. One such source is the random, but sequential, failure of engineered components in a way that the sufficient conditions for a major accident mode are satisfied. Redundancy quality control and engineered safeguards can, in principle, make the incidence of such accidents arbitrarily small.

"... Another possible source of major accident is technological oversight ... Using the aerospace industry as an analogous industry that is based on a high technology and carries an obvious residium of risk, then examples of technological oversight are the material fatigue history of the Comet I, and the airfoil instabilities of the early Electras. Comparable oversights in nuclear technology may result in major reactor accidents. Technological remedy should avoid repetition.

"... A third source class is defined by accidents derived from human error of a operational nature ..."

Response:

This comment is not totally accurate as reactor and reprocessing operations and accident potentials are similar. Much thought has gone into the design of components and systems to achieve fail safe operation, even in the event of human deliberate or inadvertent actions. Moreover, as noted above, technological remedies should avoid repetition of the few accidents which occurred in the past, and the added engineered safeguards should make the incidents of major accidents very small.

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46. Comment:

"The discussion of availability of domestic uranium resources and the domestic uranium mining industry should include a discussion of the three uranium studies cited by Nucleonics Week (October 24, 1974, pp. 6-7), namely: (1) EPRI's report, 'Uranium Resources to Meet Long-Term Uranium Requirements;' (2) the Battelle study headed by John Burnham; and (3) the working paper, 'Uranium Resources in the United States: An Overview,' prepared for MIT's Energy Lab. by Richard Graves."

Response:

The references noted are now outdated. A detailed discussion presenting various viewpoints concerning the probability of having sufficient domestic uranium available to meet projected requirements is considered to be outside the scope of this statement. Since the primary objective of the study is to assess and compare the costs and benefits of recycling recovered uranium or uranium and plutonium to light water reactors, it has been postulated that all of the fuel cycle industries can be expanded to meet projections.

Discussion of the domestic mining industry in final GESMO has therefore been limited primarily to the most recent infromation available on the subject, namely that presented in a paper by J. A. Patterson, ERDA, AIF Conference - Phoenix, Arizona - March 22, 1976.

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47. Comment:

"(1) The discussion in the Radioactive Waste Management section is based on the biased assumption that if plutonium recycle is not approved the spent fuel will be reprocessed, the plutonium stored, and the high-level radioactive waste shipped to the RSSF. This is nowhere more evident than in the first paragraph that begins, 'Equal consideration must be given to other alternatives (storage of spent fuel with no reprocessing) including deferral of recycle for 2, 4, ... 10 years.'"

Response:

In final GESMO, wherein the three options are assessed (no recycle, recycle of uranium only and recycle of uranium and plutonium), spent fuel will not be reprocessed under the no recycle option. The spent fuel assembly is disposed of after a 5 year cooling period, as described in CHAPTER XI, Section 2.0. Refer to CHAPTER XI, Section 4.0 for an analysis of this alternative. The impacts of the storage and disposal of spent fuel elements are discussed in detail in CHAPTER IV, Section H.

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48. Comment:

"Accidents (p. IV H-4)

The discussion here begins with,

'Credible accidents in waste management facilities are expected to be of very low frequency, and if they occur, to have little environmental effect.

We take strong issue with this statement. As noted earlier (pp. 32 to 35) in NRDC's Comments on WASH-1535, 'Socio-Political Impacts,' we discussed the effect of a 5-10 kt nuclear weapon (delivered by a national, subnational or terrorist organization) on the waste storage area of a fuel reprocessing plant. This was followed by the following discussion of the effect of a 1 megaton weapon on the RSSF reference design (water basin concept):

'Moreover, the Cs^{137} and Sr^{90} inventory at a repository is anticipated to be 5 to 10 times larger than that at a reprocessing plant. As a result, such an incident at a repository could produce effects that would be 5 to 10 times greater. In the extreme, the effects could be 1,000 times greater than those from the fallout of nuclear weapons tests, i.e., 10 to 250 million genetic disorders and 20 to 80 million cancer deaths. It would appear that a successful nuclear attack on one of these surface storage facilities could be far worse than the AEC believes.' (p. 14)

Such an unscheduled event falls in Geesaman's fifth class of accidents, those which are human deliberate (see discussion on pp. 28 to 30). These cannot be ignored, there is no basis for assuming them to be of sufficiently low frequency, and they clearly have an enormous -- unequaled -- environmental effect."

Response:

The objective of GESMO is to evaluate the incremental effect of no recycle, recycle of uranium only or the recycle of uranium and plutonium in a nuclear economy. The effect of an explosion of a nuclear weapon at a waste storage site would be substantial in any case.

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49. Comment:

"Appendix A -- Tables of Environmental Factors

For reasons stated previously, e.g., the reliance on WASH 1248 for uranium fuel cycle data, many of the entries in Table VIII A-1 are biased in favor of plutonium recycle and should be corrected."

Response:

In final GESMO, the tables in CHAPTER VIII, Appendix A have been completely revised. These tables now indicate the integrated environmental factors for the three fuel cycle options, no recycle, uranium recycle only, and uranium and plutonium recycle, offering a direct comparison of the environmental impacts of each fuel cycle option.

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50. Comment:

"Cost Benefit Analysis of Alternative Dispositions of Plutonium

As noted in our discussion of 'General Deficiencies' this cost-benefit analysis is wholly inadequate primarily because of an erroneous economic data base and because the entire stream of costs and benefits was not considered. The cost-benefit analysis does not meet the requirements of NEPA, or for that matter, the standards required of utilities by the AEC as set forth in Regulatory Guide 4.2. It is imperative that the AEC set forth (in one place) all the economic assumptions, and sources of data used to calculate the cost of reprocessing, fabrication, enrichment, uranium value, etc."

Response:

In final GESMO, the cost figures have been updated to best current projections. The bases for all cost estimates are developed and documented in CHAPTER XI, Section 2.0. High and low figures for each cost estimate have also been selected for sensitivity studies and discussed in CHAPTER XI, Section 3.0. The cost benefit analysis now uses the entire stream of costs and impacts for the period 1975-2000.

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51. Comment:

"The cost-benefit analysis is almost completely void of sensitivity analyses that would show the effect of changes in the key cost assumptions. Predicting whether plutonium recycle is economically attractive is like predicting the winner of a floating crap game. The outcome is fairly sensitive to several key cost assumptions, for example, reprocessing costs, which have changed dramatically in the last few years and/or which can be expected to change in the future."

Response:

Cost-benefit sensitivity analyses have now been performed and are included in final GESMO. Refer to CHAPTER XI, Section 3.0.

. Comment:

Respond to "Some important unexplained questions concerning the Barnwell nuclear fuel reprocessing plant," by Dr. John Gofman. One of the calculations that Dr. Gofman presented was the fallout from a radioactive cloud representing 1% of the Barnwell high level radioactive waste inventory following the explosion at the Barnwell facility of a 5 to 20 kilowatt fission weapon.

Response:

The "unexamined questions" posed by Dr. Gofman depend upon a hypothetical assumption that 1% of the total accumulation of high level waste stored over a 5-year period can somehow become airborne and escape into the environment at relatively high altitude so that it will be carried without loss to distant points. Waste storage tanks for high level liquid wastes are part of the reprocessing plant and as such will be protected by the safeguards provisions that are required for the plant area, including physical barriers at the site perimeter and intrusion devices to detect unauthorized entry. In addition, waste storage facilities are required to meet rigorous design criteria and construction specifications to assure that releases of radioactivity will be kept as low as reasonably achievable even under severe conditions of earthquake, fire, flood or tornado. With these multiple barriers, it is judged to be highly unlikely that the hypothetical events postulated by Dr. Gofman would actually occur. Underground tanks for high level liquid wastes have experienced leaks and other releases of radioactive material over the past 30 years, but these occurred in tanks that were designed and constructed many years ago, mostly under the wartime Manhattan Project. The waste facility design criteria and Safeguards requirements for modern commercial facilities of a similar nature are for more rigorous. In the modern facilities which would be associated with commercial reprocessing plants, even small releases of radioactive materials are considered to be very unlikely. The occurrence of a nuclear explosion resulting from an act of terrorism or sabotage is an event which the whole Safeguards program is designed to make impossible. This is discussed in detail in the Safeguards Supplement to GESMO.

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54. Comment:

"Attachment 5 to the NRDC Comment Letter No. 25.

'Copy of letter from Honorable Senators W. F. Mondale and Phillip A. Hart to Honorable Dixy Lee Ray, Chairperson, U.S.A.E.C., relating to the decision on plutonium recycle.'"

Response:

Detailed responses to the comments made by Senators Mondale and Hart have been made directly to their letter to Honorable Dixy Lee Ray -- Comment Letter 5.

The Commission decision to authorize the commercial widescale use of Pu recycle in light water reactors will be made only after:

-- Publication of and public hearings on final GESMO health, safety and environmental issues.

-- The publication of a draft supplement on safeguards considerations for public comment.

-- The publication of a final safeguards statement with considerations for the overall cost-benefit of Pu recycle.

-- Public hearings on safeguards and cost-benefit issues and rules relating to the widescale use of recycle Pu in MOX fuels for LWR's.

Comment Letter 26

Misc Notice (39 FR 30186
GESMO

STATE OF TENNESSEE
OFFICE OF URBAN AND FEDERAL AFFAIRS
SUITE 1312
ANDREW JACKSON STATE OFFICE BUILDING
NASHVILLE 37219

JAMES A. PAYNE
DIRECTOR

615-741-2714

October 25, 1974

Mr. S. H. Smiley, Deputy Director
Fuels and Materials
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

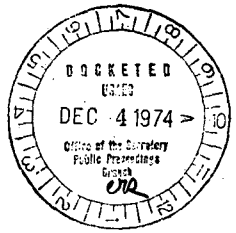
RE: WASH-1327
Draft Environmental Impact Statement (EIS)

Dear Mr. Smiley:

As the designated State Clearinghouse for Federal grant programs under OMB Circular A-95 guidelines, we have reviewed the above referenced proposal entitled, "Generic EIS on the Use of Recycled Plutonium in Mixed Oxide Fuels in Light Water-Cooled Nuclear Power Reactors."

Enclosed are comments submitted by the Tennessee Wildlife Resources Agency. We urge that you consider their request to more fully address the question of potential impact on aquatic life. We reserve the right to comment until such time as our staff personnel within the appropriate affected agencies are equipped to adequately review the subject material.

This office, as the State Clearinghouse, appreciates the notification of issuance of this draft statement, and would further appreciate your forwarding us five copies of the final statement. May we call to your attention that we normally request fifteen (15) copies of any draft environmental impact statement and ten (10) copies of the final statement.



Sincerely,

Stephen H. Norris
Grant Review Coordinator

SHN:mn

Enclosure

TENNESSEE WILDLIFE RESOURCES AGENCY

ELLINGTON AGRICULTURAL CENTER
P. O. BOX 10747
NASHVILLE, TENNESSEE 37204

HARVEY G. BRAY, Director
ROY H. ANDERSON, Ass't. Dir.

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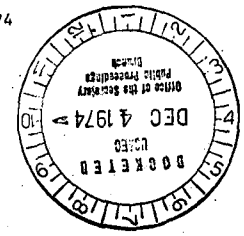
October 21, 1974



Mr. Stephen H. Norris
Grant Review Coordinator
Office of Urban and Federal Affairs
Suite 1312
Andrew Jackson State Office Building
Nashville, Tennessee 37219

Re: AEC-WASH 1327; Draft EIS - Recycle Plutonium in Light Water - Cooled Reactors

Dear Mr. Norris:

We have reviewed the four-volume draft EIS concerning the above-captioned project.

We understand that the conventional light water cooled nuclear reactors (LWR's) have characteristically been fueled with slightly enriched uranium dioxide fuel. It is proposed to substitute recycled plutonium fuel in commercial LWR's, with the mixed uranium oxide fuel being 30-40% of the fuel reload.

We understand that advantage of the proposed change would include the following projections for the year 1990:

1). About 5,200,000 less metric tons of uranium ore would be required (reduction of 11%).

2). Total land committed to the operation of LWR's would be reduced by 24,000 acres or four percent.

3). Water discharged to water bodies would be reduced by four percent.

4). A saving of 4,900,000 metric tons of coal would be achieved (11%).

5). The quantity of liquid chemicals discharged to streams would be reduced by about 10%.

6). Releases of uranium and its daughter products to the environment (both gaseous and liquid) would be reduced by nine percent.

5-26.1

7). The probability of an accident would be reduced by nine percent, due to a decreased number of facilities by an equal amount.

8). The consequences of any accident in the supporting uranium fuel cycle facilities would remain the same.

9). There is no significant passage of plutonium through the food chain from soil to man.

10). Plutonium has a low solubility in water and would, therefore, pose a more limited threat to the aquatic environment.

Disadvantages of the proposed change would include the following:

1). Substantially greater quantities of transplutonium will be needed.

2). There will be an increased exposure of plutonium to theft or sabotage.

3). Plutonium has an extremely long half-life.

4). The change to the plutonium recycle process would result in a 40% greater emission of plutonium into the environment by the year 1990.

We conclude that the greatest potential environmental impact would concern human health, which is outside our jurisdiction. However, we find little information in the draft EIS concerning potential impact on aquatic life. We recommend that the final EIS address itself in more detail to effects on aquatic life, especially in the event of accidental spill.

We appreciate this opportunity for comment

Sincerely,

Harvey Bray

Harvey Bray, Director
Tennessee Wildlife Resources Agency

RMH/ss

cc: Mr. Wilbur Vaughan
Mr. Larry McGinn
Mr. Reid Tatum
Mr. Harold Hurst

NRC Staff Response to Specific Comments on Health, Safety and Environment, by Stephen H. Norris

1. Comment:

"We conclude that the greatest potential environmental impact would concern human health, which is outside our jurisdiction. However, we find little information in the draft EIS concerning potential impact on aquatic life. We recommend that the final EIS address itself in more detail to effects on aquatic life, especially in the event of accidental spill."

Response:

Routine releases of chemicals and radioactivity from plants would be kept within the limits prescribed by laws and regulations, and these are expected to satisfactorily protect aquatic life. In the unlikely event of a spill severe enough to damage aquatic life, corrective measures would probably be needed in the public domain in the interest of human protection. Following such restoration, the usual recovery of ecological balance in the locale would be expected to follow by the natural succession of species.

In addition, it is not intended that GESMO supplant the individual fuel cycle plant or facility site specific environmental impact statements required by NEPA.

Comment Letter No. 27

SECRET NUMBER
PROPOSED R PR-Misc Notice (39 FR 30186)
GESMO

STATE OF IDAHO
DIVISION OF BUDGET, POLICY PLANNING AND COORDINATION
BOISE, IDAHO 83720

CECIL D. ANDRUS
GOVERNOR

H. W. TURNER
ADMINISTRATOR

October 28, 1974

RECEIVED
OCT 31 1974
U.S. ATOMIC ENERGY COMMISSION
Regulatory Mail Section

U. S. Atomic Energy Commission
Washington D. C. 20545

Attention: Mr. S. H. Smiley
Deputy Director for Fuels and Materials,
Directorate of Licensing-Regulation

Dear Mr. Smiley:

The State Clearinghouse has notified the following State Agencies and Regional Clearinghouses of the availability of the draft "Generic Environmental Statement Mixed Oxide Fuel, WASH-1327" for review and comment:

Department of Water Resources
Department of Lands
Department of Health and Welfare, Environmental Services
Department of Fish and Game
Department of Parks and Recreation
Idaho Nuclear Energy Commission
Panhandle Planning and Development Association
Clearwater Economic Development Association
Magic Valley Association of Governments
Southeast Idaho Council of Governments
Ada Council of Governments
Ada Council of Governments
Ida-Ore Regional Planning and Development Association

DOCKETED
USAEC
DEC 4 1974
Office of the Secretary
Public Proceedings
Branch

Comments were submitted by the Idaho Department of Health and Welfare, Environmental Services and the Idaho Nuclear Energy Commission. Those comments are enclosed for your careful consideration.

We appreciate this opportunity for review and encourage your future use of the State Clearinghouse for review and comment.

Sincerely,

Karl Tueller

Karl Tueller,
Associate Chief for
Statewide Planning

KT:s/lf

cc: DHW, Environmental Services
Idaho Nuclear Energy Commission

5-27.1

IDAHO DEPARTMENT OF HEALTH AND WELFARE

COMMENTS ON DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUELS, WASH-1327, August, 1974

We have reviewed the radioactive waste management[1] portion of the U.S. Atomic Energy Commission's draft Generic Environmental Statement Mixed Oxide Fuels (WASH-1327) and offer the following comments:

Helium Accumulation In differentiating between uranium oxide and mixed oxide fuel wastes, the draft statement notes that there is a 50 times greater rate of helium accumulation in the mixed oxide vs. the uranium oxide waste. It was stated that the subsequent borosilicate glassification of the calcined waste would require an increased glass porosity (3% vs. 0.2%) in order to decrease internal stresses due to helium accumulation. The draft statement does not discuss whether or not there is any increase in the leachability of the glassified calcine due to the increased porosity, i.e. is the integrity of the glassified mixed oxide fuel waste less than that of the uranium oxide fuel waste.

Glassification Program It is noted in the draft statement that research and development is continuing on the conversion of the highly leachable calcined radioactive waste into a less leachable form as, for example, a borosilicate glass. As this work is now over 15 years old, we are critical of the AEC's chronic refusal to make a decision as to the final form the solidified radioactive waste will take. As planned in this statement, the calcine essentially remains in a potential environmentally-reactive state whereas if a decision were to be reached it would be rendered environmentally-inert. It is our feeling that AEC plans for commerical wastes of the 1980's and 1990's should call for the rendering of the waste into an unleachable, inert solid.

Storage Location We object to the draft statement concept that the high-level radioactive waste and the other-than-high-level radioactive waste (i.e. transuranics greater than 10 nanocuries/gram) be considered for storage at two geographically separated AEC facilities. It appears to be a poor health physics practice to separate two wastes into two locations when they individually hold a significant potential environmental insult. As noted in the draft statement, we do not feel that transportation logistics or similar relatively minor economic considerations warrant the geographic separation of the two wastes. Our recommendation is that the wastes be held within individually appropriate structures at a single geographic location.

(Continued on Page 2)

[1]Part II, Radioactive Waste Management, Volume 3, Chapter IV, "Environmental Impact Due to the Implementation of Plutonium Recycle," draft Generic Environmental Statement Mixed Oxide Fuel, WASH-1327, August, 1974, U.S. Atomic Energy Commission.

Site Considerations For the reasons outlined above, we disagree that the National Reactor Testing Station in eastern Idaho should be used as a "reference site" in the draft statement for the future location of commerically-originated, other-than-high-level radioactive wastes.

IDAHO NUCLEAR ENERGY COMMISSION

COMMENTS ON DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUELS, WASH-1327, October, 1974

Summary Statement

The Draft Environmental Statement, WASH-1327, GESMO, covers the requirements for utilization of mixed oxide fueld very well. A strong case is made for the program and the INEC does support it.

The GESMO document prepared by USAEC clearly demonstrates overwhelmingly the need to pursue the recycle of plutonium in LWR as soon as possible. The savings in equivalent energy and resource demand results in a net environmental benefit without sacrificing any nuclear material theft safeguards.

Comment #1

Any plant using MOX should be required to perform a very careful environmental survey prior to the MOX program to establish a record of alpha emitting radionuclides at or near the plant. It is a well known fact that there are many alpha emitters scattered around the country and that we have been living with them for years. There is essentially no hazard associated with the naturally occurring uranium and thorium present in much of our soil. However, if a careful survey is not made prior to the MOX program and alpha emitters are found later, the alphas will all be attributed to plutonium by those who may wish to jeopardize the program. Establishing a bench mark prior to using MOX would seem to be a good practice. It may also be desirable to require that the survey be repeated at specified intervals as a monitoring program.

Comment #2

The advisability of spiking recycled plutonium with high level gamma emitters as an additional method of safeguarding the storage and transportation of the material is questioned.

Comment #3

Further studies should be made in an effort to determine operational options that will minimize transportation of MOX fuels and thereby decrease both environmental hazards and material theft possibilities.

Comment #4

The net reduction (or increase) in plutonium waste storage that would accompany the recycle is not identified in the draft statement.

NRC Staff Response to Specific Comments on Health, Safety and Environment, by Karl Tueller

1. Comment:

"Helium Accumulation - In differentiating between urainum oxide and mixed oxide fuel wastes, the draft statement notes that there is a 50 times greater rate of helium accumulation in the mixed oxide vs the uranium oxide waste. It was stated that the subsequent borosilicate glassification of the calcined waste would require an increased glass porosity (3% vs 0.2) in order to decrease internal stresses due to helium accumulation. The draft statement does not discuss whether or not there is any increase in the leachability of the glassified calcine due to the increased porosity, i.e., is the integrity of the glassified mixed oxide fuel waste less than that of the uranium oxide fuel waste."

Response:

This comment is valid in that there may be a slight difference in the leachability of UO_2 only and MOX spent fuel wastes. In this final statement, assessments are based on a 11% MOX and 89% UO_2 spent fuel mix through the reprocessing plant. With this proportion, there should be very little difference in the wastes. In any case, when the final processes for waste solidification are approved, specific limits on leachability will be established, regardless of the waste source, to ensure confinement integrity.

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2. Comment:

"Glassification Program - It is noted in the draft statement that research and development is continuing on the conversion of the highly leachable calcined radioactive waste into a less leachable form as, for example, a borosilicate glass. As this work is now over 15 years old, we are critical of the AEC's chronic refusal to make a decision as to the final form the solidified radioactive waste will take. As planned in this statement, the calcine essentially remains in a potential environmentally-reactive state whereas if a decision were to be reached it would be rendered environmentally-inert. It is our feeling that AEC plans for commercial wastes of the 1980's and 1990's should call for the rendering of the waste into an unleachable, inert solid."

Response:

ERDA plans to demonstrate the solidification process on actual commercial high level wastes in about the year 1979. A pilot scale operation has been proposed to be installed at the Hanford plant and other demonstrations have been proposed to be installed at commercial reprocessing plants. It is expected that full scale liquid-solid conversion process will be operational to meet the requirement of 10 CFR 50, Appendix F, which requires the solidification of wastes within 5 years after generation. It is also planned to place solidified wastes into sealed containers prior to transfer to a Federal repository no later than 5 years following separation of fission products from irradiated fuel.

---

3. Comment:

"Storage Location - We object to the draft statement concept that the high-level radioactive waste and the other-than-high-level radioactive waste (i.e., transuranics greater than 10 nanocuries/gram) be considered for storage at two geographically separated AEC facilities. It appears to be a poor health physics practice to separate two wastes into two locations when they individually hold a significant potential environmental insult. As noted in the draft statement, we do not feel that transportation logistics or similar relatively minor economic considerations warrant the geographic separation of the two wastes. Our recommendation is that the wastes be held within individually appropriate structures at a single geographic location."

Response:

The ERDA planning for disposal of wastes is based on the use of Federal geologic repositories for both high level and transuranic wastes. See CHAPTER IV, Section H-3.0 for a discussion on the disposal of high level, plutonium and transuranic wastes and also low level wastes from the LWR industry.

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4. Comment:

"Site Considerations - For the reasons outlined above, we disagree that the National Reactor Testing Station in eastern Idaho should be used as a "reference site" in the draft statement for the future location of commercially-originated other-than-high-level radioactive wastes."

Response:

In final GESMO, the reference plan for the final disposal of commercial other-than high level wastes is a geologic Federal repository and is not site specific. Storage of plutonium contaminated transuranic waste is described in CHAPTER IV, Section H.

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5. Comment:

"Any plant using MOX should be required to perform a very careful environmental survey prior to the MOX program to establish a record of alpha emitting radionuclides at or near the plant. It is a well known fact that there are many alpha emitters scattered around the country and that we have been living with them for years. There is essentially no hazard associated with the naturally occurring uranium and thorium present in much of our soil. However, if a careful survey is not made prior to the MOX program and alpha emitters are found later, the alphas will all be attributed to plutonium by those who may wish to jeopardize the program. Establishing a bench mark prior to using MOX would seem to be a good practice. It may also be desirable to require that the survey be repeated at specified intervals as a monitoring program."

Response:

This is a good recommendation for a prudent facility operator. Environmental monitoring requirements imposed on licensees attempt to provide detection of incipient difficulties as well as to establish the prevalence of radiological safety; alpha emitters are not normally present around the country except for almost non-detectable amounts from fallout or possibly at a nuclear operating site. These sites are continuously monitored. Should a new MOX plant be collocated on an existing nuclear plant site, full meteorological and background data would be readily available and would be included in the applicants site reports submitted for licensing as required by 10 CFR 70 and the environmental impact report required by 10 CFR 51.

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6. Comment:

"Comment #3 - Further studies should be made in an effort to determine operational options that will minimize transportation of MOX fuels and thereby decrease both environmental hazards and material theft possibilities."

Response:

In final GESMO, comparisons are made of the impacts due to total transportation requirements for the three fuel cycle options, no recycle, recycle of uranium only, and recycle of uranium and plutonium for the integrated period 1975 through 2000. For dose estimates due to transportation of fuel and waste material, see Tables IV G-3 and IV G-4, respectively. In addition, in CHAPTER IV, Section L, assessments of impacts on the environment considered the processing and shipment of dilute PuO_2 mixtures from spent fuel reprocessing to the MOX fabrication sites. The studies for the safeguarding of MOX fuels is covered in the safeguards supplement to GESMO.

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7. Comment:

"Comment #4 - The net reduction (or increase) in plutonium waste storage that would accompany the recycle is not identified in the draft statement."

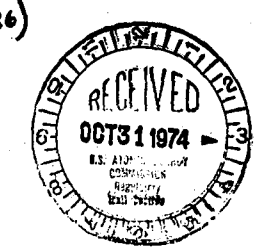
Response:

In final GESMO, comparisons are made of the quantities of waste material handled for the three fuel cycle options, no recycle, recycle of uranium only, and recycle of uranium and plutonium. See CHAPTER IV, Section H-4.0.

Comment Letter No. 28

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

Enfield, CT
October 28, 1974



Deputy Director for Fuels & Materials
Directorate of Licensing-Regulation
USAEC
Washington DC 20545

Dear Sir;

After a review of WASH-1327, I have the following comments:

1) Definitions and a glossary of acronyms should be at the front of the document.

2) The statement on page S-18, Vol. 1, that says there has been no measurable plutonium concentration in people, etc., in Palomares, Spain, has no reference to back it up.

3) The reference listings in Volume 2 are extremely confusing-- There is a listing of references at the end of Chapter II, and there are listings after each of the subsections. It is nearly impossible to determine whether the superscripts refer to the references at the end of the subsection or at end of the chapter.

4) Why is there a difference in annual dose from PWR's with U-tube steam generators and those with Once-through steam generators? (Volume 3, page IV C-100)

5) For conservatism, small site size for mixed oxide fuel plant should be used. (Volume 3, page IV D-17)

6) Page IV E-28, Table IV E-8, I-131 Ci/yr quantities change is in apparent error.

7) On page IV C-58, there is no corroborative data to back up the statement of the second paragraph on the page.

8) On page IV H-11, the footnote marked ***, how can one be sure the owners, due to press of work or profitx motive, don't underrate waste that is actually greater than 10 nCi/gm?

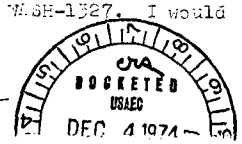
9) Page IV H-44 comment on tornado dampers & blowout panels. There is strong likelihood of internal contamination accident simultaneous with a tornado, thus spreading contamination.

10) Two references that should have been used and answered in this Statement are FDA-75-8024, "An Epidemiologist Takes a Look at Radiation Risks," and NP-19922, the GAO report on security problems at AEC installations and contractor installations.

11) Finally, the Science plutonium articles of Sept. 20 and 27 must be answered in the final environmental statement.

Thank you for the opportunity to comment on WASH-1327. I would appreciate a copy of the final Statement.

Very truly yours,
Neal E. Wilson
3 Brook Road



NRC Staff Response to Specific Comments on Health, Safety and Environment, by Neal E. Wilson

NOTE: Detailed comments relating to editorial and clarification items have been incorporated in the text. Responses to the specific items follow.

1. Comment:

"The reference listings in Volume 2 are extremely confusing -- there is a listing of references at the end of CHAPTER II, and there are listings after each of the subsections. It is nearly impossible to determine whether the superscripts refer to the references at the end of the subsection or at end of the chapter."

Response:

The lists of references for this chapter in this final statement have been consolidated into a single list at the end of the chapter.

---

2. Comment:

"Why is there a difference in annual dose from PWR's with U-tube steams generators and those with once-through steam generators? (Volume 3, page IV C-100)"

Response:

There is no difference in the annual dose from the PWR's listed. The final GESMO text has been corrected.

---

3. Comment:

"For conservatism, small site size for mixed oxide fuel plant should be used. (Volume 3, page IV D-17)"

Response:

To provide conservatism, a large plant site area was chosen to maximize the land use impact. Calculations of dose commitments in final GESMO, however, are based on an individual residing 500 meters from the plant. This assumption has the effect of placing the plant within 500 meters of one of the plant boundaries which in turn increases the maximum individual dose commitment.

---

4. Comment:

"On page IV C-58, there is no corroborative data to back up the statement of the second paragraph on the page."

Response:

This paragraph in the final GESMO has been changed to include a sentence to justify the 2-year time lapse between discharge of spent fuel and reload with MOX fuel. Refer to CHAPTER IV, Section C, Paragraph 4.2.

---

5. Comment:

"On page IV H-11, the footnote marked ***, how can one be sure the owners, due to press of work or profit motive, don't underrate waste that is actually greater than 10 nCi/gm?"

Response:

The proposed 10 nCi/gm limit on Pu contaminated wastes is still under consideration and is presently being re-evaluated in terms of detectability. The level that will finally be established will have to be a detectable limit. This limit will be a condition for licensing and subject to monitoring and recording by the licensee's plant operator. Surveillance and regular inspection to ensure that plant operation meets regulatory requirements will be accomplished by the Office of Inspection and Enforcement of the Nuclear Regulatory Commission.

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6. Comment:

"9) Page IV H-44 comment on tornado dampers and blowout panels. There is strong likelihood of internal contamination accident simultaneous with a tornado, thus spreading contamination."

Response:

In final GESMO, CHAPTER IV, Section H, Radioactive Waste Management, has been completely revised. The assessments assure that high-level radioactive wastes and transuranic wastes are disposed of in a Federal geologic repository.

---

7. Comment:

"10) Two references that should have been used and answered in this Statement are FDA-73-8024, 'An Epidemiologist Takes a Look at Radiation Risks,' and NP-19932, the GAO report on security problems at AEC installations and contractor installations."

Response:

The toxicology and risks in handling plutonium related to the implementation of recycle plutonium in LWR's is covered in detail in CHAPTER IV, Section J. Appendix A of this section includes the methodology used in calculating doses attributed to the Pu recycle integrated over the period 1975 through 2000. Security and safeguards considerations are included in the safeguards supplement to draft GESMO.

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8. Comment:

"11) Finally, the Science plutonium articles of September 20 and 27 must be answered in the final environmental statement."

Response:

Refer to response to Comment No. 7 of this Comment Letter No. 28.

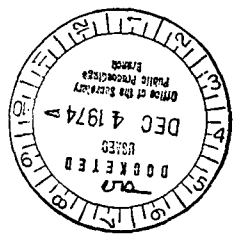
Comment Letter No. 29

ET NUMBER PR - Misc Notice (39 FR 30186)
D RULE
GESMO

Babcock & Wilcox

Power Generation Group
P.O. Box 1260, Lynchburg, Va. 24505
Telephone: (804) 384-5111

October 29, 1974



Mr. S.H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing
Office of Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Smiley:

B&W wishes to thank you for the opportunity to comment on the draft Generic Environmental Statement on Mixed Oxide Fuel. Our detailed comments are attached.

B&W recognizes the major effort put forth by your staff and others to prepare this report and you are to be complimented. B&W's comments cover four general areas: safeguards, waste management, cost benefits, and the implications of using 115% of self-generated plutonium as the basis for the report. We have also included comments on other specific items.

We hope our comments are constructive in assisting you to develop the final version of GESMO, which we consider to be very important to the future of the nuclear industry.

Very truly yours,

BABCOCK & WILCOX COMPANY
Nuclear Power Generation

James F. Mallay,
Manager, Licensing

JFM/bmm

Enclosure

GENERAL COMMENTS

The GESMO represents a major effort on the part of the AEC to compile and assess the data on plutonium recycle. The comments that follow are made to assist the AEC in conducting the fullest possible evaluation of the impact of plutonium recycle and thereby benefit both the public and the industry.

The GESMO should establish that the generic concept of plutonium recycle is environmentally acceptable. Subsequently licensing hearings should be able to reference GESMO for all but specific site or specific design-related items. This should apply equally to reactor licensing for use of mixed oxide fuel, plutonium and mixed oxide processing facilities, and plutonium and mixed oxide transportation systems. The "Summary Effects" (page S-12) support this GESMO goal; however, the conclusions in some areas should be reevaluated.

The issue of safeguards tends to override other subjects in GESMO and our comments on that subject follow along with comments on three other areas of waste management, alternative dispositions, and the arbitrary 115% self generating reactor (SGR) limit. Some specific comments on individual items in GESMO are also included.

Safeguards

A number of additional concepts which could improve safeguards of strategic nuclear materials are described on page S-45 and mentioned at various places throughout GESMO. The most far-reaching of these concepts is the integrated fuel facility concept whereby the fuel reprocessing and the mixed oxide fuel fabrication plants would be located on the same site. It should be noted that such facilities would not eliminate all plutonium shipment since some shipments would

be required to balance the reprocessing/fabrication loads of the various complexes and for non-reactor uses of plutonium. The practicability of such facilities in a commercial industry is highly questionable. Legal commercial relations and antitrust considerations alone pose a formidable obstacle. Careful analysis might well indicate that such a concept is viable only for a nationalized nuclear industry or a nationalized electric utility industry. It should be noted further that large capital commitments have already been made to independently sited facilities and others are pending in the near future. The added costs of this concept appear enormous compared to the benefits contemplated from it; that is, we are simply making a small reduction in an already extremely low risk in shipping SNM compared to other risks that society normally takes. If elimination of transportation of plutonium from the reprocessor to the fabricator is being seriously considered (or is deemed necessary), the "Integrated Fuel Cycle Facilities" concept should be evaluated by the AEC immediately, and the resulting position made public. Such a decision would have a major impact on fabrication facility plans.

The concept of "spiked" plutonium seems to have been included with no consideration given to the enormous increase ir capital requirements and operating costs associated with processing such material. Nor apparently was consideration given to the increase in dose commitment that would necessarily accompany the use of such material. This concept would be in direct opposition to the conclusion in Chapter 9, page 2, that "reduction of the occupational radiation exposure at the mixed oxide fuel fabrication plant is the most effective way to lessen the environmental impact resulting from plutonium recycle." Furthermore, the concept would not prevent the theft of the plutonium, only exact a toll if it were attempted. It would not deter the theft by anyone sufficiently dedicated or desperate to pay the price. The spiked plutonium concept is not well founded and should be dropped from further consideration.

There has been no discussion of the need to improve safeguards beyond their present level in relationship to the added benefit gained thereby. For example, there is no comparison of the relative difficulty of obtaining SNM material under existing safeguards regulations with that of obtaining other chemical and bacteriological agents suitable for use by extremists. An assessment from the extremist's point-of-view in terms of ease of acquisition, detectability, reliability in use and effects would probably show that many substances rank higher than plutonium. Furthermore, there is no mention in GESMO of the fact that other nations are going ahead with plutonium recycle and fast breeder reactors. Therefore, plutonium availability to extremists will not be greatly dependent on measures taken within the United States. These factors should all be carefully assessed before concluding that additional safeguards requirements are necessary.

In addition to the question of whether additional safeguards are necessary at all is the question of the validity of the conclusion that more stringent safeguards measures should be adopted within one year. Full consideration should be given to the gradual development of the plutonium recycle industry. The AEC should consider, analyze and develop alternative implementation schedules which account for (1) the economic costs; (2) the volume of plutonium in the fuel cycle versus time; and (3) the relationship between the purported reduction in risk stemming from more stringent safeguards measures and the broad effects on the public interest resulting from impediments to developing a full-scale mixed oxide fuel cycle. If the implementation of more stringent safeguards measures is accomplished without regard for the capital cost increases and the relationship between the safeguards risk and the volume of plutonium in the fuel cycle, then a strong impediment to the mixed oxide fuel cycle would exist.

It seems evident that the safeguards risk is closely related to the volume of plutonium in the fuel cycle at any given time. Moreover, the capability of the industry to finance more stringent safeguards measures will follow the volume of mixed oxide business and the internally generated funds from that business.

Finally, the market for mixed oxide fuel will be related to licensing and construction lead times in all phases of the fuel cycle. The AEC should undertake to perform a detailed analysis of alternative implementation schedules which account for the foregoing factors and which would select the best implementation schedule from a risk-benefit-cost standpoint. The AEC's one-year interval is clearly arbitrary and irrational when viewed against a realistic assessment of the economic factors prevailing in the industry.

The cost of the currently promulgated regulatory requirements are enormous compared to the volume of mixed oxide business available in the near future. Therefore the preceding arguments are equally valid for an individual plant as for the industry as a whole. It should be unnecessary to establish the maximum safeguards at the beginning of a given plant's operation with mixed oxides. Rather, as the mixed oxide throughput gradually increases, the safeguards requirements would increase appropriately from a cost-benefit-risk standpoint.

Waste Management

The general concept of retrievable surface storage for an interim period (estimated to be 20 to 30 years) and subsequent permanent disposal under government control for transuranic and high level waste represents a conservative assumption in GESMO. Since this concept is the subject of a separate environmental impact statement (WASH-1539), detailed comment is not desirable here. However, it should be noted that such details as 10 nanocuries per gram being a workable value for segregation of waste or of concreting being the acceptable form for solidifying low level liquids are still subject to modification. It is agreed that whatever final form these details take they will not have a major influence on the comparison between the various alternatives available to the plutonium fuel cycle industry.

Comparison of Alternatives - Costs/Benefits Analysis

In discussing the proposed alternatives it should be noted that Alternative 2 is closer to the current status of the industry than is Alternative 1. However, for comparison purposes, it makes little difference which is selected as the base ca[illegible] The capital costs shown in Table S-14 are underestimated for the mixed oxide fuel fabrication plants. We estimate these to be approximately $640 million for the eight plants shown in Alternative 3. For Alternative 4 this could be very much higher depending on what final additional safeguards requirements are adopted. For Alternative 3 the projected annual costs for mixed oxide fuel fabrication as shown in Table S-15 are low by a factor of about two. For Alternative 4 there could be a significant increase in operating costs in addition to the direct charges for the material and plant protection depending upon the increased safeguards regulations adopted. These are impossible to estimate without assuming some specific combination of the proposed safeguards alternatives.

The capital cost for fuel reprocessing plants also appears to be grossly underestimated. Seven postulated reprocessing plants might require as much as 500 million each for a total of 3-1/2 billion for the industry in 1990. Presumably the operating costs for fuel reprocessing plants has also been underestimated by the amount that represents the amortization of the additional capital requirements. It would also appear from reading the cost benefit section that other costs have been underestimated, for example, the cost of uranium in the period of the 1990s. The cost benefit analysis should be redone using corrected values as input by the various segments of the industry. It may well be that because of compensating underestimation for the various alternatives that the ranking will not greatly change. A possible exception is that Alternative 6 may become increasingly attractive.

An alternative that is not discussed in GESMO is as follows. Reprocess spent fuel promptly and/or perform mixed oxide fuel fabrication in the facilities of other nations. For the U.S. industry this would eliminate the capital costs and the environmental impact associated with those facilities. It would add the overseas transportation costs, possible import taxes, and environmental impacts associated with that transportation. Presumably the costs of mixed oxide fuel would be higher by at least the amount of the transportation and any import taxes. Discussion of this alternative should also

include the effect on balance of payments and the added dependence on foreign sources for our energy requirements. Given the increasing difficulty of meeting capital requirements in this country, this alternative may very well be the most favorable of all when considering total costs and resource availability.

Mixed Oxide Loading Limits

The AEC's choice of 115% of self-generated quantities of plutonium as a current maximum seems reasonable, but needs to be recognized as an arbitrary choice. One could have chosen 125% or 133% just as well. Although 115% should not be too restrictive for the time being, a firmer statement regarding the acceptability of future operation with Pu quantities greater than 115% SGR should also be included. For example, it would be good to have a clear statement that once satisfactory operation between 70% SGR and 115% SGR is demonstrated, then an increase up to 200% SGR would represent a reasonable further extension of Pu-recycle technology. In like manner, the inference that the 115% SGR limit will be applied at least to 1991 should be recognized as arbitrary and unduly restrictive.

Additional Documentation

While the GESMO is a necessary document, industry needs a supplemental document which would show the major program steps required for the existing industry to achieve the status of the mature industry projected for 1990. Particularly, a schedule is needed of milestone events such as firm safeguards regulations (implemented in a series of steps over time), completed development of waste solidification methods, transportation methods and regulations, etc. This document would provide the basis framework around which industry could plan for firm decisions and schedules on commitment of capital, R&D requirements, etc. The report should address itself also to the resources required by government and industry to achieve a mature industry. It also should address itself to the availability of those resources. Without some firm goals and commitments the plutonium recycle industry may well be delayed indefinitely.

SPECIFIC COMMENTS *

Page No.	Comment
S-6	Safeguards will have to be increased at Central Power Stations also.
S-8	Alternative 1 "The Prompt Reprocessing of Plutonium Storage" is not current practice since no commercial processing facilities are in operation. Alternative 2 "Storage of Spent Fuel for Later Recovery and Recycle" comes closest to representing current practice.
S-11	The discussion on the effect of plutonium recycle costs on the utility decisions on the reprocessing of spent fuel should be based on projected uranium values and projected reprocessing costs. This would probably show, based on economic considerations only, that without plutonium recycle, reprocessing would not occur.
S-39	In Table S-8 "Liquid Effluents", RU-106 and tritium are not effluents from fuel fabrication plants. This is probably meant to be from fuel reprocessing plants.
II-33	Table II-8, units appear to be rems not rads.
II-34	The statement "it has been demonstrated that plutonium recycle is technically feasible", appears inconsistent with the stance on maturity; i.e., why limit 1.15% SGR until 1991?
II-64	The 10 nanocuries per gram limit for burial of solid in soil is not measurable by current technology and hence is not a realistic value.

* Items known to be in comments from other sources were not repeated

Page No.	Comments
IV-C-104	Table IV-C-22. Dose to the whole body from swimming appears high by two orders of magnitude.
IV-C-106	Table IV-C-24. Whole body dose for boating appears high.
IV-D-20	The requirement for triple filtration during normal operation is unnecessary. NUMEC has demonstrated consistently low releases with double filtration. Note that in Table IV-D-6 NUMEC has the lowest stack releases of any of the plants. This demonstrates the efficiency that can be achieved with proper design and double filtration.
IV-D-42	The reference in Reference 3 is incorrect, it should be NUMEC 70-364 not NUMEC 70-135.
Chapter IV, Section E	The write-up on Reprocessing Plants should be updated to include an assessment of the effects of the delay (or abandonment) of GE's Morris, Illinois, plant. A delay of several years in reprocessing facility availability will delay the start of Pu recycle by several years. This forced delay will impact economics and mode of recycle. For example, once the reprocessing capability is on line, it may be desirable to load larger quantities of Pu in reactors than is currently planned.

NRC Staff Response to Specific Comments on Health, Safety and Environment, by James F. Malloy

1. Comment:

"The GESMO should establish that the generic concept of plutonium recycle is environmentally acceptable. Subsequently licensing hearings should be able to reference GESMO for all but specific site or specific design-related items. This should apply equally to reactor licensing for use of mixed oxide fuel, plutonium and mixed oxide transportation systems. The "Summary Effects" (page S-12) support this GESMO goal; however, the conclusions in some areas should be reevaluated."

Response:

The intent of GESMO is to provide a basis for the assessments of environmental impacts of the supporting fuel cycle (including the reactor) for the licensing of LWR's for the use of recycle plutonium in MOX fuels. Each fuel cycle facility including waste management and transportation systems will be evaluated on a case by case basis considering site and design specific items.

The nuclide core inventory of the model 1.15 SGR and inventory of nuclides of the spent fuel are the bases used in the overall assessments of impacts on the environment for the entire LWR fuel cycle when operating in the uranium and plutonium recycle mode. In final GESMO, the environmental impacts of the entire fuel cycle are summarized in CHAPTER VIII, Appendix A. Radiological impacts are summarized in CHAPTER IV, Section J.

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2. Comment:

Waste Management

"The general concept of retrievable surface storage for an interim period (estimated to be 20 to 30 years) and subsequent permanent disposal under government control for transuranic and high level waste represents a conservative assumption in GESMO. Since this concept is the subject of a separate environmental impact statement (WASH-1539), detailed comment is not desirable here. However, it should be noted that such details as 10 nanocuries per gram being a workable value for segregation of waste or of concreting being the acceptable form for solidifying low level liquids are still subject to modification. It is agreed that whatever final form these details take they will not have a major influence on the comparison between the various alternatives available to the plutonium fuel cycle industry."

Response:

The general statements of this comment are correct. In the final GESMO, CHAPTER IV, Section H, Radioactive Waste Management has been revised to indicate that permanent storage of high level and transuranic wastes will be placed in a Federal geologic repository.

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3. Comment:

"Comparison of Alternatives - Costs/Benefits Analysis

In discussing the proposed alternatives it should be noted that Alternative 2 is closer to the current status of the industry than is Alternative 1. However, for comparison purposes, it makes little difference which is selected as the base case. The capital costs shown in Table S-14 are underestimated for the mixed oxide fuel fabrication plants. We estimate these to be approximately $640 million for the eight plants shown in Alternative 3."

Response:

As is stated in this final statement, it makes no difference for comparison purposes which alternative is called the reference case. In final GESMO, Alternative 3 is taken as a reference case considering earliest commercial reprocessing in 1978 and earliest plutonium recycle in 1981. The costs have been updated to reflect current estimates. The detailed updated costs are included in CHAPTER XI.

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4. Comment:

"The capital cost for fuel reprocessing plants also appears to be grossly underestimated. Seven postulated reprocessing plants might require as much as 500 million each for a total of 3-1/2 billion for the industry in 1990. Presumably the operating costs for fuel reprocessing plants has also been underestimated by the amount that represents the amortization of the additonal capital requirements. It would also appear from reading the cost benefit section that other costs have been underestimated, for example, the cost of uranium in the period of the 1990s. The cost benefit analysis should be redone using corrected values as input by the various segments of the industry. It may well be that because of compensating underestimation for the various alternatives that the ranking will not greatly change. A possible exception is that Alternative 6 may become increasingly attractive."

Response:

Costs throughout final GESMO have been updated to reflect the best current estimates. The cost benefit analysis was completely revised to incorporate the latest cost data and comparisons included for the various fuel cycle options of no recycle, recycle of uranium only and recycle of uranium and plutonium. See CHAPTER XI, Sections 2.0 and 4.0.

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5. Comment:

"An alternative that is not discussed in GESMO is as follows. Reprocess spent fuel promptly and/or perform mixed oxide fuel fabrication in the facilities of other nations. For the U.S. industry this would eliminate the capital costs and the environmental impact associated with those facilities. It would add the overseas transportation costs, possible import taxes, and environmental impacts associated with the transportation. Presumably the costs of mixed oxide fuel would be higher by at least the amount of the transportation and any import taxes. Discussion of this alternative should also include the effect on balance of payments and the added dependence on foreign sources for our energy requirements. Given the increasing difficulty of meeting capital requirements in this country this alternative may very well be the most favorable of all when considering total costs and resource availability."

5. Comment (Cont'd)

Response:

Because of the national commitment to energy independence and the widespread concern over safeguarding of special nuclear materials, the proposed alternative does not appear to be acceptable. If fuel processing were done in other nations, U.S. would lose control over the safeguarding of plutonium. GESMO is an assessment of the U.S. LWR industry.

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6. Comment:

"Mixed Oxide Loading Limits

The AEC's choice of 115% of self-generated quantities of plutonium as a current maximum seems reasonable, but needs to be recognized as an arbitrary choice. One could have chosen 125% or 133% just as well. Although 115% should not be too restrictive for the time being, a firmer statement regarding the acceptability of future operation with Pu quantities greater than 115% SGR should also be included. For example, it would be good to have a clear statement that once satisfactory operation between 70% SGR and 115% SGR is demonstrated, then an increase up to 200% SGR would represent a reasonable further extension of Pu-recycle technology. In like manner, the inference that the 115% SGR limit will be applied at least to 1991 should be recognized as arbitrary and unduly restrictive."

Response:

CHAPTER IV, Section C, paragraph 4.1, in final GESMO notes that "... in the more distant future, all of the fuel rods in an LWR could be (Pu, U)O_2 mixed oxide ..." and that "... it is reasonable to expect that more than self-generation quantities can be recycled safely utilizing current technology but a precise upper limit has not been determined." Further, it is believed that by the time the performance characteristics for plutonium utilization in LWR's in quantities greater than 1.15 SGR values have been determined to be acceptable, sufficient fuel and core performance data as well as fuel recovery and fabrication experience will be available from the LWR's that recycle plutonium in quantities less than 1.15 SGR values and the choice of full plutonium LWR or other intermediate loading greater than 1.15 SGR may then be optional.

The results of a survey of the LWR industry indicated that most recycled plutonium is likely to be used in currently designed LWR's in concentrations ranging from two-thirds to just above the self-generation reactor equilibrium values. Since it was clear that at the 1.15 SGR level of plutonium usage UO_2 reactor technology would be applicable with only minor details requiring reviews on a plant-by-plant basis, it was concluded that the changes in radiological and environmental effects of using plutonium recycle fuel at concentrations up to 115% of the self-generation rate would be appropriate and representative for the Pu recycle industry. Refer to CHAPTER IV, Sections C-4.0 and C-5.0.

The foregoing should not be interpreted to mean that there is an inherent safety or environmental limit at 1.15 SGR (or close to this value) on the use of recycled plutonium in reactors. On the other hand, it should not be concluded that there is not some limit beyond 1.15 SGR at which the safety and environmental consequences of the use of recycle plutonium in reactors are not comparable to that of UO_2. To identify this limit precisely was not considered to be justified in light of the results of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's and results of MOX demonstrations.

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7. Comment:

"Additional Documentation

While the GESMO is a necessary document, industry needs a supplemental document which would show the major program steps required for the existing industry to achieve the status of the mature industry projected for 1990. Particularly, a schedule is needed of milestone events such as firm safeguards regulations (implemented in a series of steps over time), completed development of waste solidification methods, transportation methods and regulations, etc. This document would provide the basis framework around which industry could plan for firm decisions and schedules on commitment of capital, R&D requirements, etc. The report should address itself also to the resources required by government and industry to achieve mature industry. It also should address itself to the availability of those resources. Without some firm goals and commitments the plutonium recycle industry may well be delayed indefinitely."

Response:

The assessments on the impacts on health, safety and the environment in this final GESMO are made over a period of 26 years, 1975 through 2000. The safeguards considerations are covered in a supplementary safeguards statement. GESMO provides data on the differential impacts on the LWR industry due to the implementation of recycle uranium only or uranium and plutonium when compared to no recycle. In final GESMO, CHAPTER IV, Section H, the concept of the geologic Federal repository for wastes is described and reference is made to the ERDA waste management programs. CHAPTER IV, Section G, provides data on transportation of materials and an assessment of the impacts of the three fuel cycle options. Proposed new and revised regulations are prepared and issued at the time that final GESMO is issued and will be dependent on the final decision on plutonium recycle.

The supplement resources required by the government is outside the scope of GESMO.

NOTE: Specific comments relating to editorial and clarification items have been incorporated in the text. Responses to selected comments follow:

8. Comment:

"S-8 - Alternative 1, "The Prompt Reprocessing of Plutonium Storage" is not current practice since no commercial processing facilities are in operation. Alternative 2 "Storage of Spent Fuel for Later Recovery and Recycle" comes closest to representing current practice."

Response:

Schedules in the final GESMO have been revised to be consistent with the current industry status. Thus, in the prompt recycle Alternative 3 reprocessing occurs in 1978. For the purposes of comparison, there is no significance to the choice of the reference alternative. As explained in CHAPTER XI, Section 4.0, Alternative 3 has the lowest economic cost, and generally the lowest environmental cost; it is thus a convenient choice as a reference.

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9. Comment:

"S-11 - The discussion on the effect of plutonium recycle costs on the utility decisions on the reprocessing of spent fuel should be based on projected uranium values and projected reprocessing costs. This would probably show, based on economic considerations only, that without plutonium recycle, reprocessing would not occur."

Response:

In this final statement considerations of projected values are incorporated in the analysis, including the effects of ore depletion and plutonium recycle on uranium and plutonium values. See CHAPTER XI, Sections 2.0, 3.0 and 4.0.

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10. Comment:

"II-34 - The statement 'it has been demonstrated that plutonium recycle is technically feasible,' appears inconsistent with the stance on maturity; i.e., why limit 1.15% SGR until 1991?"

Response:

This final generic statement is intended to assess the widescale use of recycle Pu in LWR's. The demonstration to date has been limited to experimental reactors and partial loadings in commercial LWR's. The 1.15 SGR at equilibrium has been set as a model to be able to assess impacts to the environment for the 26-year period 1975 through 2000, from the use of MOX fuels in the reactor, the supporting fuel cycle components, the fuel fabrication, spent fuel reprocessing, waste management and transportation.

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11. Comment:

"II-64 - The 10 nanocuries per gram limit for burial of solid in soil is not measurable by current technology and hence is not a realistic value."

Response:

The reference to this concentration has been deleted from final GESMO CHAPTER II - Background and Experience with Plutonium. The subject of waste management is discussed fully in CHAPTER IV, Section H. It is recognized that the ability to measure 10 nanocuries per gram with existing technology is difficult and is currently being studied for specific regulation by NRC.

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12. Comment:

"IV-C-104 - Table IV-C-22. Dose to the whole body from swimming appears high by two orders of magnitude."

Response:

In the revised calculations for the final GESMO, it was determined that the whole body dose from recreational activities in the downstream region of a river was insignificant, and it is not listed as specific a item in the tabular data.

The total annual individual and population doses from liquid releases for the GESMO model reactors, BWR's and LWR's (MOX), compared to UO_2 only fueled reactors are listed in Tables IV C-25; -28; -29; -31; and -34 of CHAPTER IV, Section C, paragraphs 5.2.2.2 and 5.2.2.3.

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13. Comment:

"IV-C-106 - Table IV-C-24. Whole body dose for boating appears high."

Response:

See Response to Comment Number 12.

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14. Comment:

"IV-D-20 - The requirement for triple filtration during normal operation is unnecessary. NUMEC has demonstrated consistently low releases with double filtration. Note that in Table IV-D-6 NUMEC has the lowest stack releases of any of the plants. This demonstrates the efficiency that can be achieved with proper design and double filtration."

Response:

Filtration tests by LASL show that HEPA filters are capable of 99.99+% efficiency under ideal conditions. Three filters were included in the model plant because the specific activity of the plutonium handled will be higher than that presently being processed. The third HEPA also provides additional protection in emergency or accident situations and is normally located at the glove box to keep the ventilation system ducts relatively clean.

Table IV D-6 of the draft GESMO has been removed from the final GESMO because the specific activity of the material processed by the existing MOX plants during the full operating period cannot be determined. Without this data, a realistic comparison of relative efficiency cannot be made for the filtration systems of these plants.

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15. Comment:

"Chapter IV, Section E - The write-up on Reprocessing Plants should be updated to include an assessment of the effects of the delay (or abandonment) of GE's Morris, Illinois, plant. A delay of several years in reprocessing facility availability will delay the start of Pu recycle by several years. This forced delay will impact economics and mode of recycle. For example, once the reprocessing capability is on line, it may be desirable to load larger quantities of Pu in reactors than is currently planned."

Response:

In final GESMO, the impacts of delayed reprocessing of spent fuels due to the closing of GE's Morris Plant and delays in start-up of the AGNS reprocessing plant are detailed in CHAPTERS VIII and XI. The Alternatives 1 and 3 in CHAPTER VIII review several cases of delay and in CHAPTER XI the economics are compared for several parameters of plant loadings. The considerations for loadings of larger quantities of MOX to meet the 1.15 SGR mode are discussed in CHAPTER IV, Section C-4.0.

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

Westinghouse Electric Corporation Power Systems

PWR Systems Division
Box 355
Pittsburgh Pennsylvania 15230

October 30, 1974

DOCKETED USAEC DEC 4 1974 Office of the Secretary Public Proceedings Branch

RECEIVED NOV 01 1974

United States Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing - Regulation

Re: WASH-1327, Generic Environmental Statement Mixed Oxide Fuel (GESMO), August 1974

Gentlemen:

These comments are submitted on behalf of the Westinghouse Electric Corporation ("Westinghouse"), in response to the notice published in 39 F.R. 30186 on August 21, 1974 concerning the referenced draft statement on the recycle of plutonium in light-water-cooled reactors (GESMO).

For your convenience in evaluating these comments, we have divided this response into two parts -- this part covering our general comments on various subject areas of GESMO, the second covering detailed comments offered to help improve the technical accuracy of GESMO which are attached.

GENERAL

Considered on an overall basis, the Commission is to be commended for performing an objective and comprehensive job on the GESMO draft. The experience referred to in the report, both in the United States and abroad, shows that the use of plutonium as a power reactor fuel is out of the experimental stage. However, recycle of plutonium has been demonstrated to be safe and commercially viable, only limited by the present lack of reprocessing and production facilities and firm regulatory guidelines.

As we interpret GESMO, the Commission has concluded and we concur that

(1) the use of mixed-oxide fuels in light-water reactors should be approved,

(2) the total environmental impact of the nuclear fuel cycle (previously determined to be small) would be further reduced if mixed-oxide fuel is used,

(3) the safety of light-water reactor operations would not be adversely affected, and in addition, no significant differences were found between plants using mixed-oxide fuel and those using low enriched uranium fuel,

(4) there is sufficient experimental work and demonstration of mixed-oxide fuel performance to warrant full-scale commercial use,

(5) any differences between the material properties and performance of mixed-oxide fuel and low-enriched uranium fuel are small,

(6) the use of recycled plutonium can reduce the overall uranium requirements for nuclear fuel about 10% by the year 1990 and consequently reduce the environmental impact of natural resource consumption,

(7) the radiological impact of the production of nuclear fuel would be reduced by plutonium recycle,

(8) problems associated with safeguarding plutonium against theft and diversion and nuclear facilities against sabotage are considered manageable, and there are no safeguards-related issues which should delay a decision to permit the full-scale commercial use of mixed-oxide fuel for light-water reactors.

SAFEGUARDS

We wish to make special mention of one area of particular concern to Westinghouse with respect to its direct involvement in and commercial commitments to plutonium recycle. With reference to the proposed implementation of additional measures to improve safeguards, the Commission has indicated that it expects essentially no perturbation to the safeguards situation from plutonium recycle during the decision and implementation period. While it may be true that there will probably be very little plutonium being used as mixed-oxide fuel during this period, plutonium conversion, storage, and mixed oxide fabrication facilities are being designed and/or constructed today on schedules which will permit an orderly development of an overall recycle capability. Significant changes in the ground rules for safeguards a year or more from now could create an undue economic burden by substantially delaying the efforts of those engaged in and committed to this development. A one-year wait from issuance of the final GESMO to a decision on safeguards upgrading appears contrary to the purpose of GESMO. We believe that a number of the concepts being considered would have a significant impact on plutonium recycle, and urge therefore that any determination as to the necessary additional safeguards requirements, be made at the time GESMO is finalized. This action would enable those organizations having ongoing efforts to

incorporate any additional requirements and meet the demands of the nuclear industry in a responsible manner. In short, prompt and timely safeguards decisions will explicitly eliminate inefficient backfitting, costly construction and operational delays, and protraction of the timely recycle of plutonium on a commercial scale; and will thereby contribute to the early adoption of an energy alternative significant from the standpoint of both economics and the conservation of energy resources.

We feel that GESMO should emphasize the fact that, considering the existing supply of plutonium and its current utilization, the current safeguards system, as recently promulgated by the Commission, provides the necessary assurance that the public will be protected. We therefore concur with the Commission that the active safeguards system should be continued. It is recognized that, as safeguards are regularly reassessed, possible improvements may be identified. We firmly believe that any upgrading should be based upon its demonstrated merits and an appropriate cost benefit analysis should be performed to serve as the basis for any changes.

We believe that the present system of safeguards is adequate for the current state of the industry, and that the necessary technology exists to establish, as needed, security provisions which can substantially reduce the likelihood of nuclear material diversion for illicit purposes. We are firmly convinced that much of the concern being expressed today is based upon situations which may have existed at certain facilities prior to the implementation of the present safeguards system and upon an inadequate understanding of the technological advancements which have been incorporated into the present system. We urge that any change in this system be accomplished through an evolutionary process.

Of those concepts which have been identified by the Commission as a means to significantly improve safeguards, we consider fuel cycle facility integration to have a very long-range potential rather than being a viable near-term alternative. Such integration or co-location has possible long-term merit only if a multitude of problems such as the following can be satisfactorily resolved:

1. Maintenance of competition among suppliers
2. Freedom of fuel cycle service purchasers to select specific suppliers for each phase
3. Fungibility of reprocessor outputs from the standpoint of economic value
4. Availability of a sufficient labor pool
5. Disruption of an entire site by difficulties with materials, labor, services or other factors.

For the near term, co-location is not feasible because of pre-existing major commitments to non-contiguous sites and the present size of the reprocessing and recycle industry, which does not allow the needed capacity match between the reprocessing facility and the particular fuel fabricator at present or in the near future. Without a precise match, some movement of plutonium to or from the site is inevitable.

We agree that integrated fuel cycle facilities provide a means for minimizing transportation risks. However, it is incorrect for GESMO to imply that such integration can eliminate all transportation of fuel materials. Further, we believe that within the present system, adequate safeguards can be provided for the transportation aspects of the fuel cycle, commensurate with the type, form and amount of the nuclear materials involved. Application of such safeguards to the limited transportation required in the early years of plutonium recycle should allow for continuation of present facility plans as well as an orderly evaluation of the necessity and means for co-location.

The Commission has indicated as one of the few advantages of an integrated fuel cycle facility that it would make the use of onsite protection measures more efficient. On balance, considering the small portion of the total fuel cycle costs which could be incurred for safeguards even with suggested improvements, the benefit of any added efficiency gained might not offset the potential added costs necessitated by co-location.

One of the other concepts being considered by the Commission to significantly improve safeguards deserves specific mention. We suggest that the concept involving spiked plutonium or debilitating gases be discarded. Considering the fact that there are other reasonable means available which might be employed to attain the Commission's objectives, such extreme measures are quite unnecessary.

"Spiking" plutonium, whether achieved by incomplete separation of fission products or by the addition of selected radionuclides, will substantially increase its radioactivity. While this action will hamper diversion efforts, it runs directly counter to the second major safeguards objective, which is to prevent serious contamination due to the dispersion of plutonium. The logic for spiking plutonium is difficult to accept, since increasing its radioactivity would enhance its potential for serious contamination rather than reduce it.

We believe that, rather than over-emphasizing the prevention of theft, more attention should be directed to minimizing the likelihood of plutonium being utilized in a manner contrary to the objectives of the safeguards program. In this regard, it seems to us that the Commission has not taken sufficient credit in GESMO for the defense-in-depth concept which has been applied in the development of the present safeguards system. As we see it, the Commission has:

1. Taken reasonable steps to reduce the likelihood of anyone obtaining illicit possession of nuclear materials;

2. Required a security system to reduce the possible means for removing nuclear material from location where it was illicitly obtained; and

3. Required backup means for tracing and recovering the nuclear material.

As we interpret GESMO, the Commission intends to continue this philosophy to maintain a balanced safeguards system. We concur with this approach.

IN-REACTOR USE OF MIXED OXIDE FUEL

Westinghouse fully agrees with the assessments in GESMO regarding the favorable background and experience in plutonium reactor utilization to support near-term implementation of the use of mixed oxide fuel in light-water reactors (LWR). In fact we feel GESMO should even more strongly emphasize and take credit for technology gained through applied research programs and extensive analyses. Particular emphasis should be given to experimental and demonstration irradiation programs which have provided a solid technical basis to justify large-scale use of mixed-oxide fuel in commercial LWR's. For example, the writeup of the EEI/Westinghouse program should be expanded to properly reflect the significant usefulness of this program to plutonium recycle.

Furthermore, we believe it is essential to stress that a large fraction of the core may contain mixed oxide fuel with no significant adverse effect on reactor performance or identified safety limitations. For example, the GESMO draft aptly points out that "Operation of recycle plutonium LWR's will be in accordance with the existing Technical Specifications that set conditions for safe plant operation including requirements for engineered safety features and limits on radioactive releases to the environment." This statement could be strengthened by deleting the word "will" after "plutonium LWR's" and adding in lieu thereof the words "has been and will continue to."

A significant amount of discussion in the GESMO draft is devoted to what might be interpreted as a limitation on the amount of mixed oxide fuel to be placed in operating LWR's. We strongly recommend that the actual amount of mixed-oxide fuel to be allowed to be inserted in each reactor be considered on a case-by-case basis. As we said in our letter dated March 14, 1973:

> "Flexibility should be maintained by the Commission in its statement which should consider the use of plutonium recycle to the fullest extent each reactor is capable of achieving. The use of plutonium fuel in the operation of a reactor

> should be considered by the Commission on a case by case basis. This determination should be based upon the reactor's plutonium recycle capabilities and a careful balancing of the economic, technical, environmental, and safety factors relating to the operation of that particular reactor. Each reactor has different recycle capabilities. Therefore, the amount of plutonium fuel that can be utilized in any core will also depend upon a consideration of the fuel management techniques, modes of operation, and the control capabilities of each specific reactor."

RADIOLOGICAL HEALTH AND SAFETY

Overall, the Commission is to be commended for its assessment of the radiological impact for "normal" operation and accident conditions.

We believe that more backup information should be provided in many radiological areas, notably in Appendix A of Section J, Chapter IV, to permit an independent verification of the evaluated impact. Additional backup information should also be provided for the sections which pertain to waste management (Section H, Chapter IV) and plutonium storage (Section I, Chapter IV). In this regard, we assume that the results of the Draft Environmental Statement, WASH-1539, will be germane.

COST-BENEFIT ANALYSIS

The cost benefit sections prepared by the Commission appear to be a reasonable assessment in that the appropriate factors and options have been identified. However, in light of today's economic conditions, we believe there may be some readers who will question the validity of the costs assigned to these factors. We recognize the inherent difficulty in attempting to arrive at firm cost predictions. In our opinion, the credibility of the cost benefit analysis could be substantially enhanced if the Commission would perform an evaluation of the effect of using a range of values, such that the results would be valid over a period of time. This would provide a more quantitative backup for the Commission's statement that the cost differences between alternatives will still be valid even though the absolute magnitude of the numbers may be in error.

We would like to thank the Commission for the opportunity to furnish these comments. We would be pleased to furnish assistance to the Commission in the finalization of GESMO.

Very truly yours,

for

Romano Salvatori, Manager
Nuclear Safety Department

ATTACHMENT
DETAILED COMMENTS

VOLUME 1 - SUMMARY

1. Page S-1, under paragraph B. Under the list of activities which might be expected to change environmental impact, the item "Environmental Monitoring" should be added.

2. Table S-3 on page S-9 and Table S-11 on page S-52. It is believed that the whole body exposure for Case 2 should be -21% instead of +21%. Also, the Whole Body Radiation Exposure column should contain a footnote noting that this pertains to "General Public Offsite and Occupational Workers".

3. Page S-10, 3rd paragraph, 4th line. The year should be 1995 not 1955.

4. Page S-11, 2nd paragraph, 2nd line. Alternatives 1 through 6 (not 2 through 6) are shown in Table S-4.

5. Page S-17, last paragraph, last sentence. This sentence should be qualified for the case that plutonium is processed immediately, e.g., for Case 2 this statement would need to be further qualified.

6. Page S-25, Figures S-4 and S-5. It would appear that more important than the 2800 canisters is the total area committed and the total Ci involved.

7. Page S-27, Table S-5. The column headings "Requirements" and "Facilities" are vague. If these were further qualified as "Material/Environmental Requirements" and "Facility Requirements" this would improve the clarity of the table.

8. Page S-29, Table S-6. Under the solid wastes, it should be stated where the α and β actinides will be stored, or are they stored at the RSSF along with the high level wastes?

9. Table S-13, page S-56. Under accumulated storage of Pu through year 1990, shouldn't this value be the same for alternates 2 and 6?

10. Page S-A-1, Appendix A Glossary of Acronyms and Terms. The term nanocurie should also be defined since this is not a standard radiation unit and in any case, is less well known than MeV which is included.

11. Page iii, S-7. Should be "DOSE".

12. Page vi, II-7. Should be "^{239}Pu".

VOLUME 2, CHAPTER II - Background and Experience With Plutonium

1. Page II-39; Last sentence change to "The characteristics of the Saxton Reactor during the period of Core II operation are summarized in Table II-11."

2. Page II-40; Change the title to Table II-11 to "The Saxton Core II Design Operating Conditions".

3. Page II-40; Mid-page, change appropriate sentence to, "With the exception of some thirty fuel rods which were clad with 304 stainless steel, the mixed oxide fuel rods were clad with Zircaloy 4". (Underlined words are repeated.)

4. Page II-42; suggested substitute for the top line; "performance limitation in Zircaloy-clad mixed oxide fuel but appear to be related to the presence of significant quantities of adherent crud which suggests a change in core environment such as water chemistry after the mid-life shutdown." Eliminate the words "... but are believed to be the result of inadequate feedwater control".

5. Page II-42; the list of references for the Saxton Plutonium Program should include the complete series of progress reports from WCAP-3395-1 through WCAP-3385-37 and also the final report WCAP-3385-57 dated July, 1974.

6. Page II-45, second paragraph, second sentence, should read, "During the first San Onofre refueling at the end of Cycle 1, 105 fuel assemblies ..." Last sentence, same paragraph, should read, "Four of these rods were replaced with natural UO_2 rods. Two of the four discharged rods were subjected to post-irradiation examinations".

7. Page II-45, Paragraph 4, add the following sentence between "There was one irradiation ... one of the assemblies", and "Rod length ... after one cycle of irradiation". "The rod was still intact with no evidence of mechanical degradation".

8. Page II-46, Reference 4; Author's name should be spelled J. B. Melehan.

VOLUME 3, CHAPTER IV, SECTION C - The Light-Water Reactor With Plutonium

1. On page IV C-25 the reference in paragraph 3 should be to Table IV C-2 rather than Table IV B-2.

2. LWR Plutonium Irradiation Experience (page IV C-28):

The Saxton Plutonium Project and the EEI/Westinghouse Plutonium Demonstration Program represent two large programs that have been previously discussed in Volume 2, Section C of GESMO.

These two programs provided significant and extensive experience in dealing with (U, Pu) O_2 mixed oxide fuel in both experimental and power reactors. These programs should be stressed in this section or else reference made to the other sections where they are covered (Volume 2, Section C).

Note that Saxton Core II contained 638 mixed oxide rods which achieved a maximum peak pellet burnup of 28,000 MWD/MTU while Saxton Core III (loose lattice) contained only 250 of these rods, however, achieved peak pellet burnup of about 51,000 MWD/MTU.

3. Nuclear Design of Mixed Oxide Cores

a. Local Power Peaking (page IV C-31)

There is no reason to believe the uncertainties in the measurement of power peaking in reactors containing mixed-oxide is significantly different than in al all UO_2 core.

b. Control Requirements (page IV C-32)

The implication should not be given that part length rods are necessary in PWR's to maintain core stability.

The implication that "excessive power peaking" may ensue in a second cycle if "a high fuel exposure in the first cycle" is not achieved is misleading and should not be made; proper fuel management is a requirement for both UO_2 cores and cores containing (U, Pu) O_2.

c. Xe 135 (page IV C-33)

The emphasis on core stability improvement for (U, Pu) O_2 bearing cores is unnecessary and gives the impression that UO_2 cores are likely to run wild after about the first half of cycle 1 which simply is not the case.

d. Calculational methods (page IV C-38)

The implication is given here that "major problem areas in calculational techniques" abound, and that significant uncertainties in determining power distributions exist. This is overstated and a wealth of experience has given Westinghouse confidence that nuclear design can be accomplished to the same degree of accuracy for (U, Pu) O_2 bearing cores as for UO_2 cores.

4. Characteristics of Mixed Oxide Fuels

a. Physical and Mechanical Properties of (U, Pu) O_2 (page IV C-38,ff)

This section discusses physical properties and performance characteristics of a "nominal 5% Plutonium mixed-oxide fuel" compared with those of UO_2 fuel. It should be clearly pointed out that Westinghouse has significant amount of experience with mixed oxide fuel at greater than 5% Plutonium, namely Saxton fuel at 6.6% of Plutonium. It should be clear in GESMO that 5% is not intended as an upper limit.

b. Performance Characteristics of (U, Pu) O_2 Fuel Rods (page IV C-43,ff)

The AEC interpretation of Westinghouse densification data from mixed-oxide fuels is not quite correct. On page IV C-51 it is stated that Westinghouse data (from Saxton) indicate less densification in mixed-oxide fuel than in UO_2 fuel, but other data from San Onofre (SCE) show an increase in the extent of densification of mixed-oxide fuels. It is then concluded, "Precision data are not yet available to resolve any differences in the densification behavior of mixed-oxide fuels compared with UO_2 fuels. It is generally expected that no significant differences will be found ... but it will be necessary to demonstrate that an appropriate densification model will adequately describe mixed-oxide fuel". In Westinghouse submittal to the AEC (February 1974), we presented mixed-oxide densification data from Saxton and SCE, and compared them with comparable data from UO_2 fuels. The SCE data contained mixed-oxides fabricated by two methods; one by mechanical mixing of UO_2 powder with pure PuO_2 powder (standard process to be used in fabrication of recycle fuel) and another by mixing of UO_2 powder with particles of co-precipitated UO_2 -- 30% PuO_2 (so called master -- mixed oxide). Densification data from mechanically mixed-oxide fuel showed slightly less densification than those from comparable UO_2 fuel while data from master-mixed oxide fuel showed slightly greater densification. Only mechanically mixed-oxide pellets were used in

Saxton data and they showed less densification in mixed-oxide fuel than in UO_2 fuel. Based on these observations, we concluded that the densification behavior of mechanically mixed-oxide pellets is identical to or slightly better than that of UO_2 pellets. Further, the comparison of mixed-oxide data with predictions by the Westinghouse densification model showed that the Westinghouse model which was developed based on in-core data from UO_2 fuel rods applies conservatively to mechanically mixed (U, Pu) O_2 fuel. It should be stressed here that the current Westinghouse fabrication technique employs the mechanically mixed-oxide process described above.

c. References (page IV C-56)

Only non-proprietary references should be used in GESMO. Change reference 28 from WCAP-8174 to WCAP-8202.

5. Page IV C-99, Table IV C-19. Some of the bioaccumulation factors in Table IV C-19 are inconsistent with those given in WASH-1248. Does this mean that the values quoted are more accurate than the WASH-1248 values? The most notable departures are Cr (10 x higher), Mn (20 x lower) and Zr (110 x lower).

6. Pages IV C-103 and 104. The calculated thryoid doses from milk are too high relative to present 10 CFR 50, Appendix I, Guidelines (460 and 490 mrem/yr vs 60 mrem/yr allowed). Since Appendix I now permits use of "real cow" instead of "fencepost cow", the assumed location of the cow may be too conservative. The dose from eating leafy vegetables, also seems to be high relative to the 10 CFR 50, Appendix I guidelines (17 vs 5 mrem/yr) perhaps for the same reason that assumptions used are too conservative.

VOLUME 3, CHAPTER IV, SECTION D - Mixed-Oxide Fuel Fabrication

Page IV D-40. Do the population-rem calculated in the paragraph, Contributions to the General Exposure, include the dose contributions from curium and the uranium daughters?

VOLUME 3, CHAPTER IV, Section H - Radioactive Waste Management

1. In the last paragraph of Page IV H-2, the first sentence indicates that "the volume of high-level solid wastes will not increase" is perhaps misleading since the radioactivity will increase by 50,000,000 Ci according to Table IV H-1. Also, it is noted that the parentheses around the 50,000,000 Ci in Table IV H-1 should not be there since parentheses according to footnote 2 indicate reductions due to recycle.

2. In the last paragraph on Page IV H-10. It is stated that the basis for analysis of fuel fabrication plant impact is that "0.3 percent of the throughput could end up in the waste..." Can the rationale for this basis be documented or referenced to support the values chosen?

3. On Page IV H-22. There are three high level storage concepts and several site locations suggested although a reference concept (water basin) and reference site (Hanford) is chosen for the environmental analysis. If the reference site is Hanford, it is questioned whether or not contamination from previous or future Hanford operations may not interfere with environmental surveillance measurements at the Retrievable Source Storage Facility (RSSF).

4. On Page IV H-46. In view of the extremely high dose rates (10,000 Rads/hour) for the maximum credible accident at the RSSF for the water basis concept, it would appear that this concept should be selected only if: (1) an instantaneous dose level warning system along with remotely positioned shielding system is available (2) borosilicate glass secondary waste product containment is incorporated or (3) preferably both items 1 and 2.

5. On Page IV H-59, 5th paragraph. The release to the environment of 6 μg out 100 kg processed by the proposed incinerator is suggested. Thus, the fraction released is estimated to be 6×10^{-11}. For fuel reprocessing plants, this release fraction is more typically not lower than 10^{-9}. Is the additional factor of 17 reduction attainable in practice?

VOLUME 3, CHAPTER IV, Section I - Storage of Plutonium

On page IV I-4, 3rd paragraph. It is noted that "within one year after chemical purification of Pu, the Americium becomes an important contributor to the gamma dose rate... If gamma dose rates are excessive it may be necessary to chemically repurify the oxide before shipment for fabrication into fuel rods... would increase the cost considerably. Such costs have not been estimated for this environmental statement." Our experience and analyses show that the gamma dose rates do not become excessive because the gamma is relatively easy to shield against. Further the Americium gamma dose becomes relatively less important with each successive recycling. Therefore, this is not a source of considerable cost increase and the Commission is correct for not including it.

VOLUME 4, CHAPTER VIII - Alternative Dispositions of Plutonium

1. In several places, the discussions center on the idea that temporary storage of spent fuel for significant periods of time would result in significantly less shielding required for shipping containers and reprocessing facilities. No advantage could be taken of this since the design criteria for the shipping containers and reprocessing facilities would have to assume 150 day cooled fuel which would be expected to be seen during the life of the shipping container.

2. The differential problems between permanent storage of High Level Waste (HLW) and spent fuel assemblies are not identified or addressed. It is possible that the preferred disposal of spent fuel assemblies would be to reprocess the fuel to solidify the HLW. Hence, the cost

of reprocessing must be borne even in the so-called "throw away" cycle.

3. For Alternative #5, it is assumed that the preferred disposal method is to isolate the plutonium for permanent disposal separate from the HLW. Since the only reason for this alternative is to eliminate the potential for diversion of plutonium, it would seem much more logical to leave the plutonium in the HLW. The discussion on page VIII-77 of the reasons for separating out the plutonium are inadequate justification if that course of action were to be followed. It is noted however that changing the assumptions of how the plutonium is disposed of would probably not change the result of the comparison.

4. Page VIII-33 - It does not seem reasonable that the storage costs should be so much lower for "inactive" vs. "active" storage. The security and building requirements should be nearly identical in either case and one must assume that all containers would remain sealed eliminating any analytical chemistry requirements.

5. Conclusion on Page VIII-48 (10th line from bottom) should clearly be in the negative. The 9$/Kg carrying charges due to storage more than offsets the 2.50 $/Kg escalation in value: "the value increase is <u>not</u> adequate to cover the carrying charges."

6. Page VIII-79 - (Item 4) - This is double counting to take credit for both the value of plutonium <u>and</u> the fuel it would have replaced.

<u>VOLUME 4, CHAPTER XI - Cost Benefit Analyses or Alternative Dispositions of plutonium</u>

1. Page XI-39 - The quoted transportation cost of $5.02/g plutonium for each trip appears to be inconsistent with the $0.02/g plutonium cost given on page XI-(c)-3.

2. Page XI-43 - The last paragraph states that reprocessing is not required with Alternative #2. This is not correct since the storage of spent fuel is only temporary and Alternative #2 assumes eventual reprocessing.

NRC Staff Response to Specific Comments on Health, Safety and Environment, by Romano Salvatori (Westinghouse)

1. Comment:

"GESMO should even more strongly emphasize and take credit for technology gained through applied research programs and extensive analyses. Particular emphasis should be given to experimental and demonstration irradiation programs which have provided a solid technical basis to justify large-scale use of mixed-oxide fuel in commercial LWR's."

Response:

The text of this final statement has been expanded to give a better idea of the extent to which the use of mixed oxide fuel has been explored and tested in foreign countries. The EEI/W program has been summarized with references to reports where more detailed information can be found.

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2. Comment:

"It is essential to stress that a large fraction of the core may contain mixed oxide fuel with no significant adverse effect on reactor performance or identified safety limitations. For example, the GESMO draft aptly points out that 'Operation of recycle plutonium LWR's will be in accordance with the existing Technical Specifications that set conditions for safe plant operation including requirements for engineered safety features and limits on radioactive releases to the environment.' This statement could be strengthened by deleting the word 'will' after 'Plutonium LWR's' and additing in lieu thereof the words 'has been and will continue to.'"

Response:

Since final GESMO addresses the widescale use of mixed oxide fuels in LWR's, which, if approved, will be in the future (some time in the mid-1980's, considering the earliest start around 1981), the future tense "will" is appropriate. Refer to CHAPTER IV, Sections C-2.0 and 4.0.

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3. Comment:

"A significant amount of discussion in the GESMO draft is devoted to what might be interpreted as a limitation on the amount of mixed oxide fuel to be placed in operating LWR's. We strongly recommend that the actual amount of mixed-oxide fuel to be allowed to be inserted in each reactor be considered on a case-by-case basis."

Response:

As noted in final GESMO, "Plans to use recycle plutonium in operating or new LWR's will be reviewed by the Officeof Nuclear Reactor Regulation of NRC on a case-by-case basis to provide individual assurances that the risk associated with such operations and hazards to the public are not changed significantly and remain acceptably low." For plutonium recycle at less than 1.15 SGR, the environmental impact is satisfactorily evaluated by the GESMO. Refer to CHAPTER IV, Sections C-4.0 and 5.0.

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4. Comment:

"More backup information should be provided in many areas, notably in Appendix A of Section J, Chapter IV, to permit an independent verification of the evaluated impact. Additional backup information should also be provided for the sections which pertain to waste management (Section H, Chapter IV) and plutonium storage (Section I, Chapter IV). In this regard, we assume that the results of the Draft Environmental Statement, Wash-1539, will be germane."

Response:

In the final GESMO, the radiological assessments summarized in Section J of CHAPTER IV have been extensively revised. Appendix A of CHAPTER IV, Section J has been expanded to show the basis for the biological assessments.

CHAPTER IV, Section H, in final GESMO, has been revised to include the latest considerations for geologic disposal at Federal repositories being considered by ERDA.

The occupational exposure in the Pu storage facility was calculated using the maximum permissible dose rate on the shipping container established by DOT regulations. Refer to CHAPTER IV, Section I, paragraph 3.1.

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5. Comment:

"The credibility of the cost benefit analysis could be substantially enhanced if the Commission would perform an evaluation of the effect of using a range of values, such that the results would be valid over a period of time. This would provide a more quantitative backup for the Commission's statement that the cost differences between alternatives will still be valid even though the absolute magnitude of the numbers may be in error."

Response:

This is a valid comment. The cost-benefit analysis of final GESMO uses a range of values, developed in CHAPTER XI, Section 2.0. In CHAPTER XI, Section 3.0, sensitivity studies are performed usign the range of values. The comparisons between alternatives described in CHAPTER VIII and the impacts of specified delays have also been factored into the cost-benefit analyses.

NOTE: SPECIFIC COMMENTS RELATED TO EDITORIAL AND CLARIFICATION ITEMS HAVE BEEN INCORPORATED IN THE TEXT - RESPONSES TO OTHER DETAIL COMMENTS FOLLOW

6. Comment:

"Under the list of activities which might be expected to change environmental impacts, the item 'Environmental Monitoring' should be added."

Response:

This listing in the draft GESMO refers to the differential impacts occasioned by the implementation of plutonium recycle in the LWR fuel cycle. Environmental monitoring, per se, should not change the relative impacts of fuel cycle activities with or without recycle of uranium only or uranium and plutonium recycle.

7. Comment:

"Page S17, past paragraph, last sentence. This sentence should be qualified for the case that plutonium is processed immediately, e.g., for Case 2 this statement would need to be further qualified."

Response:

The page reference in this comment does not relate to the subject matter indicated. This comment might relate to the impacts of delay in recycle of plutonium after reprocessing the spent fuel (reviewed on page 15 of the draft GESMO). The economic impacts of the Alternatives to prompt reprocessing of spent fuel and the recycle of plutonium and delays in recycle are reviewed in detail in CHAPTERS VIII and XI. Alternative 3 has been taken as the reference case with the spent fuel reprocessing projected for 1978 and plutonium recycle in year 1981.

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8. Comment:

"Page S-25, Figures S-4, and S-5. It would appear that more important that the 2800 canisters is the total area committed and the total Ci involved."

Response:

Figures S-4 and S-5 of the draft GESMO were intended to show only the material flows for the two fuel cycles. The detailed analysis of the waste management and radiation assessments are included in CHAPTER IV, Section H. The material flows of the total fuel cycle for the three options, no recycle, recycle of uranium only, and recycle of uranium and plutonium, are for the year 2000 and are shown on Figures I-2, I-4, and I-7 in CHAPTER I.

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9. Comment:

"Page S-29, Table S-6. Under the solid wastes, it should be stated where the α and β actinides will be stored, or are they stored at the RSSF along with the high level wastes?"

Response:

In the final GESMO, it is indicated that the α and β actinides will be stored with the high level wastes at a Federal repository. Refer to CHAPTER IV, Section H.

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10. Comment:

"Table S-13, page S-56. Under accumulated storage of Pu through year 1990, shouldn't this value be the same for alternates 2 and 6?"

Response:

This comment is valid. It is also pointed out that final GESMO is center-lined on a low growth and the alternatives assessed in CHAPTER VIII are on a somewhat different basis than the draft. Prompt reprocessing and delayed recycle, as well as delayed reprocessing and recycle, economics are evaluated. The impacts on plutonium storage are discussed in CHAPTER IV, Section I, and the comparisons of the integrated assessments over the period from 1975 through 2000 are indicated in the tables of CHAPTER VIII, Appendix A.

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11. Comment:

"Page II-39; Last sentence change to 'The characteristics of the Saxton Reactor during the period of Core II operation are summarized in Table II-11."

Response:

The wording change recommended was made and has been included in this final statement, CHAPTER II, paragraph 3.1.2.

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12. Comment:

"The Saxton Plutonium Project and the EEI/Westinghouse Plutonium Demonstration Program represents two large programs that have been previously discussed in Volume 2, Section C of GESMO.

"These two programs provided significant and extensive experience in dealing with (U, Pu) O_2 mixed oxide fuel in both experimental and power reactors. These programs should be stressed in this section or else reference made to the other sections where they are covered (Volume 2, Section C)."

Response:

The introductory remarks to Section IV C-3 in draft GESMO were not intended to be extensive but give a balanced, brief summary of LWR plutonium irradiation experience. However, some reorganization of GESMO has been made and this portion is cross-referenced. See CHAPTER II, Background and Experience with Plutonium, paragraph 3.1.2.

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13. Comment:

"a. Local Power Peaking (page IV C-131)

There is no reason to believe the uncertainties in the measurement of power peaking in reactors containing mixed-oxide is significantly different than in an all UO_2 core."

Response:

The matter of uncertainties in the measurement of power peaking due to the presence of plutonium is currently under review. The Adivisory Committee on Reactor Safeguards continues to explore the matter. With higher local loadings of plutonium, it is not clear that uncertainties do not increase in the extrapolation from ^{235}U fission chambers to fuel rod power. For more discussion on this item, refer to CHAPTER IV, Section C, paragraph 3.3.1.

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14. Comment:

"b. Control Requirements (page IV C-32)

The implication should not be given that part length rods are necessary in PWR's to maintain core stability. The implication that 'excessive power peaking' may ensue in a second cycle if 'a high fuel exposure in the first cycle' is not achieved is misleading and should not be made; proper fuel management is a requirement for both UO_2 cores and cores containing (U, Pu) O_2."

14. Comment (Cont'd)

Response:

All domestic PWR's with 12-foot long cores have been supplied by the reactor vendors with part length rods to control axial power distributions. The ability to follow load without part length rods at end of cycle may exist, but no consensus exists between vendors and utilities on the point. Clearly, a mixed oxide core is more stable. For additional discussion, refer to CHAPTER IV, Section C, paragraph 3.3.5.

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15. Comment:

"c. Xe 135 (page IV C-33)

The emphasis on core stability improvement for (U, Pu) O_2 bearing cores is unnecessary and gives the impression that UO_2 cores are likely to run wild after about the first half of cycle 1 which simply is not the case."

Response:

Mixed oxide cores have a larger stability index than all UO_2 cores (at the same power density) due to a lower thermal flux. No inference is made that UO_2 cores are likely to "run wild." Operating twelve-foot cores have shown axial instabilities near the end of the first cycles. No statement has been made that the instabilities are uncontrollable. Refer to CHAPTER IV, Section C, paragraph 3.3.5.

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16. Comment:

"d. Calculational methods (page IV C-38)

The implication is given here that 'major problem areas in calculational techniques' abound, and that significant uncertainties in determining power distributions exist.' This is overstated and a wealth of experience has given Westinghouse confidence that nuclear design can be accomplished to the same degree of accuracy for (U, Pu) O_2 bearing cores as for UO_2 cores."

Response:

The ability of reactor vendors to design safe and operable mixed oxide cores has not been questioned. See CHAPTER IV, Section C, paragraph 3.1. The consensus of other respondents is that additional effort is needed on methods development to improve accuracy in the calculation of core parameters, e.g., control rod worths, reactivity coefficients and local flux distributions. Refer to CHAPTER IV, Section C, paragraph 3.3.7.

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17. Comment:

"b. Performance Characteristics of (U, Pu) O_2 Fuel Rods (page IV C-43, ff)

The AEC interpretation of Westinghouse densification data from mixed-oxide fuels is not quite correct. On page IV C-51, it is stated that Westinghouse data (from Saxton) indicate less densification in mixed-oxide fuel than in UO_2 fuel, but other data from San Onofre (SCE) show an increase in the extent of densification of mixed-oxide fuels. It is then concluded, 'Precision data are not yet available to resolve any differences in the densification behavior of mixed-oxide fuels compared with UO_2 fuels. It

17. Comment (Cont'd)

is generally expected that no significant differences will be found ... but it will be necessary to demonstrate than an appropriate densification model will adequately describe mixed-oxide fuel.' In Westinghouse submittal to the AEC (February 1974), we presented mixed-oxide densification data from Saxton and SCE, and compared them with comparable data from UO_2 fuels. The SCE data contained mixed-oxides fabricated by two methods; one by mechanical mixing of UO_2 powder with pure PuO_2 powder (standard process to be used in fabrication of recycle fuel) and another by mixing of UO_2 powder with particles of co-precipitated UO_2 -- 30% PuO_2 (so called master -- mixed oxide). Densification data from mechanically mixed-oxide fuel showed slightly less densification than those from comparable UO_2 fuel while data from master-mixed oxide fuel showed slightly greater densification. Only mechanically mixed-oxide pellets were used in Saxton data and they showed less densification in mixed-oxide fuel than in UO_2 fuel. Based on these observations, we concluded that the densification behavior of mechanically mixed-oxide pellets is identical to or slightly better than that of UO_2 pellets. Further, the comparison of mixed-oxide data with predictions by the Westinghouse densification model showed that the Westinghouse model which was developed based on in-core data from UO_2 fuel rods applies conservatively to mechanically mixed (U, Pu) O_2 fuel. It should be stressed here that the current Westinghouse fabrication technique employs the mechanically mixed-oxide process described above.

Response:

Substantial changes to the densification paragraphs in final GESMO were made independently of the present Westinghouse comments and it is believe these changes reflect improved understanding of the phenomenon. However, it is not agreed that the Westinghouse data demonstrate improved densification behavior that is related to mechanically mixing the oxides. While this possibility is mentioned in the revised writeup, NRC is not prepared to acknowledge it as more than a hypothesis. Refer to CHAPTER IV, Section C, paragraph 3.4.2.

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18. Comment:

"Page IV C-99, Table IV C-19. Some of the bioaccumulation factors in Table IV C-19 are inconsistent with those given in WASH-1248. Does this mean that the values quoted are more accurate than the WASH-1248 values? The most notable departures are Cr (10 x higher), Mn (20 x lower) and Zr (110 x lower)."

Response:

Notes: It is assumed that this comment refers to WASH-1258 - "Nuclear Reactor Effluents-ALAP"

The bioaccumulation factors used for calculating the doses presented in the final GESMO were chosen after a careful examination of the literature. These factors are subject to continual re-evaluation as more data become available. Doses presented in the final GESMO are based on the most recent bioaccumulation factors which are different from the values used in either WASH-1258 or the draft GESMO for some radionuclides.

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19. Comment:

"Pages IV C-103 and 104. The calculated thyroid doses from milk are too high relative to present 10 CFR 50, Appendix I, Guidelines (460 and 490 mrem/yr vs 60 mrem/yr allowed). Since Appendix I now permits use of 'real cow' instead of 'fencepost cow,' the assumed location of the cow may be too conservative. The

19. Comment (Cont'd)

dose from eating leafy vegetables, also seems to be high relative to the 10 CFR 50, Appendix I guidelines (17 vs 5 mrem/yr) perhaps for the same reason that assumptions used are too conservative."

Response:

In final GESMO, revised doses have been included in CHAPTER IV, Section C-5.0. The dose assessments are included in the summary tables of CHAPER IV, Section J. The methodology of calculating doses, using 10 CFR 5, Appendix I guidelines, is included in CHAPTER IV, Section J, Appendix A.

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20. Comment:

"Page IV D-40. Do the population-rem calculated in the paragraph, Contributions to the General Exposure, include the dose contributions from curium and the uranium daughters?"

Response:

Only the americium and plutonium isotopes were consdiered in the draft GESMO because of the insignificant contribution of the uranium isotopes in MOX fuels. The final GESMO includes dose calculations for the uranium isotopes and daughters which contribute less than 0.00001 of the total dose. Curium dose contribution will not be addressed in the final GESMO since no significant amount will be present in the Pu fuel fabrication plant feed, i.e., in the chemical separations of the spent fuel reprocessing the plutonium and uranium are extracted and the curium goes in to the high level wastes. For additional details on the contribution to general exposure from high level wastes, see CHAPTER IV, Section H, and CHAPER IV, Section J, Appendix A.

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21. Comment:

"In the last paragraph on Page IV II-10. It is stated that the basis for analysis of fuel fabrication plant impact is that '0.3 percent of the throughput could end up in the waste ...' Can the rationale for this basis be documented or referenced to support the values chosen?"

Response:

This value is based on observed measurements of waste from existing plutonium facilities.

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22. Comment:

"On page IV H-22. There are three high level storage concepts and several site locations suggested although a reference concept (water basin) and reference site (Hanford) is chosen for the environmental analysis. If the reference site is Hanford, it is questioned whether or not contamination from previous or future Hanford operations may not interfere with environmental surveillance measurements at the Retrievable Surface Storage Facility (RSSF)."

Response:

In the draft GESMO, a site similar to Hanford was considered for reference purposes. Environmental contamination levels from operation at Hanford are continuously monitored, are known, and any contamination from future operations will immediately be detected as it might happen. Differences in age of the contamination can be determined by

22. Comment (Cont'd)

fission product ratios. It is expected that a much more thorough pre-operational survey will be required of a licensee in areas where past nuclear activities could have raised normal background levels in the environment.

In final GESMO, a Federal repository has been assessed as the mode of disposal for high level and transuranic wastes.

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23. Comment:

"On Page IV H-26. In view of the extremely high dose rates (10,000 Rads/hour) for the maxium credible accident at the RSSF for the water basis concept, it would appear that this concept should be selected only if: (1) an instantaneous dose level warning system along with remotely positioned shielding system is available (2) borosilicate glass secondary waste product containment is incorporated or (3) preferably both items 1 and 2.

Response:

In the water basis concept for the RSSF under operating conditions, the water pools would be shielded at all times except when making an addition to or removal from the pool. At all times continuous monitors would relate the conditions of the water in the pool. In the final GESMO, the RSSF is not the primary concept for long term waste management, but is considered a concept for interim storage. The points raised would be considered in any licensing review for such a facility.

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24. Comment

"The differential problems between permanent storage of High Level Waste (HLW) and spent fuel assemblies are not identified or addressed. It is possible that the preferred disposal of spent fuel assemblies would be to reprocess the fuel to solidify the HLW. Hence, the cost of reprocessing must be borne even in the so-called "throw away" cycle.

Response:

It is very unlikely that fuel would be processed just to solidify wastes for disposal. Spent fuel is in a solid inert form and contained in a capsule (the cladding).

A discussion on the preparation of spent fuel for storage/disposal in a Federal repository is included in CHAPTER IV, Section H-3.0.

---

25. Comment:

"For Alternative #5, it is assumed that the preferred disposal method is to isolate the plutonium for permanent disposal separate from the HLW. Since the only reason for this alternative is to eliminate the potential for diversion of plutonium, it would seem much more logical to leave the plutonium in the HLW. The discussion on page VIII-77 of the reasons for separating out the plutonium are inadequate justification if that course of action were to be followed. It is noted however that changing the assumptions of how the plutonium is disposed of would probably not change the result of the comparison."

Response:

This comment is valid in reference to the safeguarding of plutonium and fuel cycle costs. There would be an unresolved question of criticality considerations and until this could be resolved it is inappropriate to specify the precise form of the plutonium

disposal. In final GESMO, impact assessments are made with the consideration that, with the recycle of uranium only, the plutonium would be placed into the Federal respository in an impure form. Refer to CHAPTER IV, Section H.

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26. Comment:

"Conclusion on Page VIII-48 (10th line from bottom) should clearly be in the negative. The 9$/Kg carrying charges due to storage more than offsets the 2.50 $/Kg escalation in value: 'the value increases is not adequate to cover the carrying charges.'"

Response:

This is a valid comment. The negative (not) was inadvertently omitted. For revised economics data and comparisons of the alternatives for the three fuel cycle options, see CHAPTERS VIII and XI.

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27. Comment:

"Page VIII-79 - (Item 4) - This is double counting to take credit for both the value of plutonium and the fuel it would have replaced."

Response:

In final GESMO, the plutonium values have been clarified in CHAPTER VIII, paragraphs 10.4 and 11.4, so that the value of plutonium is clearly defined.

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28. Comment:

"Page XI-39 - The quoted transportation cost of $5.02/g plutonium for each trip appears to be inconsistent with the $0.02/g plutonium cost given on page XI-(c)-3."

Response:

The inconsistency is an error in the draft GESMO. The cost of plutonium transportation has been updated to $0.04/g plutonium in this final GESMO. This case has also been parameterized in CHAPTER XI, Section 3.0.

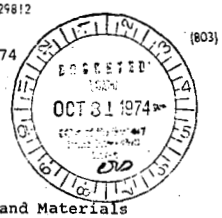
DOCKET NUMBER
PROPOSED RULE PR - Misc. Notice GESMO (39 FR 30186)

Allied-General Nuclear Services
Post Office Box 847
Barnwell, South Carolina 29812

W. J. Price
Executive Vice President

(803) 259-1711

October 30, 1974



United States Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing
Regulation

Dear Mr. Smiley:

This is in response to the invitation for comments on the draft of WASH-1327 "Generic Environmental Statement on the Use of Mixed Oxide Fuel in LWRs" (GESMO) issued in August, 1974.

Allied-General fully concurs with the conclusion in GESMO that the utilization of plutonium resources as recycle fuel in light water reactors should be approved. In recent months, we have independently reviewed the impact of delays in the recycle of recovered plutonium and uranium on the national energy-fuel supply situation. Our review convinces us that not only would failure to promptly recycle these recovered products incur substantial economic penalties but that such prompt utilization should be a matter of top national priority in our nation's goal to achieve independence in the generation of energy. Any delay in the issuance of the final GESMO Report and of any proposed pertinent amendments to the Commission's rules would have most serious adverse effects.

Decisions affecting the wide-scale recycle of plutonium in LWRs are of paramount importance to the entire nuclear fuel cycle industry. Allied-General Nuclear Services has participated in the broad-scale review of GESMO by the Plutonium Subcommittee of the Atomic Industrial Forum. Consequently, we shall limit our comments in this letter to those matters which have a direct bearing on the primary activities of Allied-General, namely reprocessing (including conversion of recovered plutonium nitrate to plutonium oxide), storage of recovered products and transportation of such recovered products to other locations.

Allowing for the differences in the model reprocessing plant assumed in GESMO and the Barnwell Nuclear Fuel Plant (BNFP), our assessment of environmental effects of all plant effluents agrees quite well with the results given in GESMO. We have also found that the difference in environmental effects attributable to mixed oxide fuels is not significant.

The actual investment necessary to construct a licensable fuel reprocessing plant and the charges which likely will be necessary to support such investment and waste management services are considerably higher than the estimates used in the cost-benefit analysis portion of the draft GESMO. However, this is no way detracts from the conclusions reached in GESMO, as the differential cost between an LWR industry with, and without, plutonium recycle would not be greatly affected. The higher actual investment requirements of a reprocessing plant necessitated by increasingly more rigorous regulatory criteria and inflationary trends will also apply to other nuclear fuel cycle operations, particularly enrichment and mining-milling. Such increased costs, obviously, also enhance the value of uranium and plutonium recovered from irradiated fuel. Nevertheless, we are concerned that cost inputs in the draft GESMO Report could lead to industry expectations of costs and charges which are unachievable. Adjustment of such costs to reflect more accurately the investment currently required to construct licensable facilities should not, however, be allowed to delay issuance of the final GESMO. We trust the AEC can utilize other means at its disposal to effect such updating of these cost estimates.

In arriving at the "state of maturity" of the LWR industry in 1990, many assumptions were, of necessity, made in GESMO regarding the date of availability, number, and capacities of specific types of facilities. We note one such assumption, namely of a United States reprocessing capacity of 4,200 MTUs per year in 1982. As with the GESMO capital and cost estimates, previously discussed, this estimate does not reflect the lead time necessary to design, construct, license and place in commercial operation nuclear facilities meeting current regulatory criteria. Unless a dramatic change can be realistically projected in the current pace of licensing procedures, we suggest that ten years be allowed from the initiation of a reprocessing plant project to commencement of commercial operation.

Regarding the transportation of radioactive materials covered in Section IV G, we submit the following comments:

a. The listing of shipment steps (page IV G-12) should also make allowance for possible infrequent shipments of uranyl nitrate from a reprocessing plant to a mixed oxide fuel plant and for possible shipment of plutonium scrap between a mixed oxide fuel plant and a reprocessing plant.

b. With reference to page IV G-39, we believe that the projected shipments of about 300 kilograms of plutonium oxide are realistic. However, we do not consider realistic a concept under which this size shipment is made up of 40 separate containers, each holding only 8 kilograms. Such a mode would result in a significant increase in cost of containers as well as in the handling cost over a more practical mode involving, say, ten containers, each holding about 30 kilograms. We feel this point to be important since, to the best of our knowledge, neither reprocessing nor fuel fabrication plants are projecting facilities capable of handling large numbers of individual drums; a content of 25 to 35 kilograms of plutonium per drum would be a more reasonable target for shipments.

Added safeguards measures are now under intensive review and should be available in time for facilities which will handle significant amounts of plutonium. These have been under development and many have already been implemented. They represent an area of importance not only to plutonium recycle but to other nuclear industry activities as well. It is our understanding that the work under way on safeguards is proceeding, and that the intention in this portion of GESMO was to invite attention to the consideration being separately given to such subjects. At the appropriate time we plan to make comments on safeguards separately from these comments.

In summary, we believe that the main conclusions presented in the Draft GESMO (page XI-58) are sound. The detailed analyses presented in GESMO indicate no need for postponing the recycle of plutonium to LWRs, and provide abundant support for going ahead with such recycle as expeditiously as possible.

In our view, the Commission should proceed promptly with the issuance of the necessary Regulations for the further use of mixed oxide fuel in light water reactors.

Sincerely yours,

W. J. Price
Executive Vice President

NRC Staff Response to Specific Comments on Health, Safety & Environment by W. J. Price (AGNS)

1. Comment:

Allowing for the difference in the model reprocessing plant assumed in GESMO and the Barnwell Nuclear Fuel Plant, our assessment of environmental effects of all plant effluents agrees quite well with the results given in GESMO. We have also found that the difference in environmental effects attributable to mixed oxide fuels is not significant."

Response:

In the assessments in the draft GESMO the model reprocessing plant size was set at 1,500 MTM/year and the environmental effects indicated for the then considered mature industry in the year 1990. In consideration of the changing nuclear energy projections and the indication from industry that the future spent fuel reprocessing plants will most likely be larger, the model plant size for final GESMO was set at 2,000 MTM/year. The effluents and assessments of the environmental impacts are now integrated over the period 1975 to 2000 and are discussed in detail in CHAPTER IV, Section E.

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2. Comment:

"The actual investment necessary to construct a licensable fuel reprocessing plant and the charges which likely will be necessary to support such investment and waste management services are considerably higher than the estimates used in the cost-benefit analysis portion of the draft GESMO."

Response:

The costs have been updated in final GESMO to reflect the best current estimates. See CHAPTER XI, Section 2.0. The sensitivity analyses of costs on the LWR fuel cycle due to delays in reprocessing and plutonium recycle are detailed in CHAPTER XI, Section 3.0.

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3. Comment:

"The higher actual investment requirements of a reprocessing plant necessitated by increasingly more rigorous regulatory criteria and inflationary trends will also apply to other nuclear fuel cycle operations, particularly enrichment and mining-milling. Such increased costs, obviously, also enhance the value of uranium and plutonium recovered from irradiated fuel."

Response:

This comment is true in that it points out that as the cost of producing fresh uranium increases, so will the value of the replacement recycled uranium or plutonium. In CHAPTER VIII, Alternatives, and CHAPTER XI, Cost-Benefits, of final GESMO, numerous cases of delayed recycle and varied estimated costs of processes and materials were analyzed to compare the value and timing of three fuel cycle options--no recycle, recycle of uranium only and plutonium and uranium recyle.

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4. Comment:

"Nevertheless, we are concerned that cost inputs in the draft GESMO Report could lead to industry expectations of costs and charges which are unachievable. Adjustment of such costs to reflect more accurately the investment currently required to construct licensable facilities should not, however, be allowed to delay issuance of the final GESMO. We trust the AEC can utilize other means at its disposal to effect such updating of these cost estimates."

Response:

A complete updating of all costs has been done in CHAPTER XI, Section 2.0 of this final GESMO. Also the costs have been parameterized in CHAPTER XI, Section 3.0.

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5. Comment:

"In arriving at the 'state of maturity' of the LWR indsutry in 1990, many assumption were, of necessity, made in GESMO regarding the date of availability, number, and capacities of specific types of facilities. We note one such assumption, namely of a United States reprocessing capacity of 4,200 MTUs per year in 1982. As with the GESMO capital and cost estimates, previously discussed, this estimate does not reflect the lead time necessary to design, construct, license and place in commercial operation nuclear facilities meeting current regulatory criteria. Unless a dramatic change can be realistically projected in the current pace of licensing procedures, we suggest that ten years be allowed from the initation of a reprocessing plant project to commencement of commercial operation."

Response:

In final GESMO assessments of impacts on the environment and economics of a plutonium recycle industry were integrated over a 26-year period to the end of this century. These values have been compared to the other fuel cycle options--no recycle and recycle of uranium only. Environmental impacts of all the components of the LWR fuel cycle are analyzed in CHAPTER IV and cost-benefits in CHAPTER XI. Costs of reprocessing include all capital costs including interest during construction, startup period and taxes and profit over the entire project life time (normally considered 8 to 10 years for planning and design to hot startup).

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6. Comment:

"The listing of shipment steps (page IV G-12) should also make allowance for possible infrequent shipments of uranyl nitrate from a reprocessing plant to a mixed oxide fuel plant and for possible shipment of plutonium scrap between a mixed oxide fuel plant and a reprocessing plant."

Response:

The assessments on the transportation of nuclear materials are based on metric tons of heavy metal (MTHM) and the amount of MTHM considered for shipment as uranyl nitrate is insignificant. In addition the MTHM to a fabrication plant would normally be in UF_6 form and any shipments of uranyl nitrate would decrease the MTHM quantities assigned to UF_6 transportation.

The amount of Pu scrap shipments is not expected to have a significant effect on the overall transportation scenario for the fuel cycle. For the comparison of the quantities of materials shipped for the various fuel cycle options refer to CHAPTER IV, Section G, Tables IV G-1 and IV G-2.

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7. Comment:

"With reference to page IV G-39, we believe that the projected shipments of about 300 kilograms of plutonium oxide are realistic. However, we do not consider realistic a concept under which this size shipment is made up of 40 separate containers, each holding only 8 kilograms. Such a mode would result in a significant increase in cost of containers as well as in the handling cost over a practical mode involving, say, ten containers, each holding about 30 kilograms. We feel this point to be important since, to the best of our knowledge, neither reprocessing nor fuel fabrication plants are projecting facilities capable of handling large numbers of individual drums; a content of 25 to 35 kilograms of plutonium per drum would be a more reasonable target for shipments.

Response:

Final GESMO has been revised to consider a semi-trailer Integrated Container Vehicle (ICV). This is a specially built shipping vehicle provided with features for protection against deliberate damage and will be under continuous guard escort. The ICV will hold about 500 kg of UO_2. Refer to CHAPTER IV, Section G, paragraph 4.2.3.

Comment Letter No. 32

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

Dennis W. Wilson, Chairman
Safeguards Committee
General Electric Company
175 Curtner Avenue, M/C 179
San Jose, California 95125

INSTITUTE OF NUCLEAR MATERIALS MANAGEMENT

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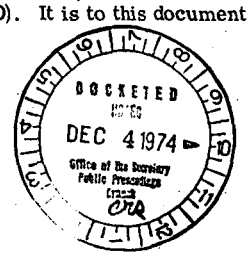
Sheldon Kops
Harley L. Toy

October 30, 1974

Mr. S. H. Smiley, Deputy Director
Fuels and Materials
Directorate of Licensing
United States Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

As you are aware, the Institute of Nuclear Materials Management (INMM) is the one professional organization in the United States which is specifically involved with the management of special nuclear material. As such, the Institute is committed to 1) advancement of nuclear materials management in all its aspects, 2) promotion of research in the field of nuclear materials management, 3) establishment of standards for use in nuclear materials management, 4) improvement of the qualifications and usefulness of those engaged in nuclear materials management and 5) the increase and dissemination of nuclear materials management knowledge. The Institute's membership includes experts, both government and private industry, in all fields of nuclear materials management such as accounting, chemistry, physics, engineering, measurement, physical protection, facility operation, government regulation and compliance, transportation, and audit. Among the numerous Institute activities is a standing committee on safeguards. Committee members representing Institute membership examine specific safeguards issues and generate professional opinions, comments and recommendations as appropriate. Results of the Safeguards Committee's work, while representative of INMM membership opinion, do not necessarily provide total membership consensus on study topics. In this light, the Safeguards Committee has made an evaluation of current and proposed safeguards as discussed in WASH-1327, "Generic Environmental Statement Mixed Oxide Fuel" (GESMO). It is to this document that our current comments are addressed.



We consider effective, sound and meaningful safeguards to be a dominant factor in the successful utilization of plutonium in the fuel cycle. We are firm in our belief that this valuable material can be integrated safely with appropriate safeguards controls. In this regard much has been done during the past few years, and GESMO contains a comprehensive summary of current safeguards requirements. These requirements apply to all segments of the fuel cycle, and are currently only in effect on back-fitted facilities. The important aspects of pre-design and subsequent implementation have not been tested for effectiveness. In all probability, however, it will be determined that current requirements do not represent optimized safeguards and responsible society will continue to implement improved safeguards. We emphasize the word "improved" and avoid the word "additional" in this connotation since we do not believe that merely adding requirements necessarily betters the resulting system. Additionally, considerations of the degree of vulnerability versus form of plutonium should be addressed. Meaningful safeguards will provide emphasis on the concentrated forms of strategic SNM because physically small quantities are more attractive to the diverter, easier to conceal, and more difficult to detect and recover. These same material quantities contained, for example, in fabricated fuel elements are more difficult to transport and require complex chemical or physical separation processes in order to be used for unauthorized purposes. Therefore, we urge the Commission to consider future requirements in light of a "total safeguards" system and to provide flexibility within the system to attain overall safeguards objectives. This approach appears necessary if provisions are to be made for growth within the framework of a responsible society.

In this light, GESMO describes a number of possible additional safeguards requirements. We suggest that the Commission carefully analyze these concepts in light of the overall system to earnestly seek improved safeguards. For example, an uninformed reader of GESMO may conclude that if it "could be done" it "should be done" in the name of safeguards. We do not feel that this approach is in the best interest of improved safeguards. We do concur, however, that several of the new concepts may be useful in conjunction with a systems approach to safeguards. Each of these has far reaching impact and should be considered carefully before implementation. We see, for example, significant suggestions of protective measures which go beyond anything ever before attempted in a free society and in interaction between governments and private industry. The necessity of assessing the high reliability of people, providing dedicated armed resistance to would-be thieves and saboteurs, and implementing highly sophisticated and dedicated communications systems will go beyond resources available to private industry. However, we firmly believe that effective and comprehensive safeguards are practical where effective coordination between industry and government is maximized. In this respect, we offer the following comments on proposed additional safeguards.

1. Co-location of Fuel Cycle Plants

The concept of locating reprocessing plants next to fuel fabrication plants - and the broader aspect of integrated fuel cycle facilities - has major ramifications on the fuel cycle. The concept has obvious safeguards advantages. At the extreme end, this concept could effectively eliminate the transportation of separated plutonium along with its myriad postulated safeguards difficulties, and could offer the most significant step available in reducing the overall plutonium safeguards problem. For example, it is conceivable that routine production of separated plutonium could be eliminated entirely through development of processing techniques which could leave plutonium diluted (denatured) with uranium throughout the reprocessing-fuel fabrication cycle. Elimination of the availability of separated plutonium could alter considerably the entire safeguards picture. However, safeguards is only one of the many concerns involved. The concept has high impact on a number of areas of public interest including waste management, perpetual land dedication, national security, environmental protection, and the consequences arising from disasters involving radio-toxic materials. Although safeguards is only one of the issues, it is apparent that it could play a major role in justifying the adoption of the co-location concept. On the other hand, prohibiting transport of separated plutonium may create difficulties in utilizing alternate plants and processes; thus available capacities could not be used to economic advantage. This lack of flexibility in the growing industry could stifle competition with adverse effects on economics. Thus, it is important that a thorough and objective evaluation of safeguards be made to determine the ramifications on the fuel cycle.

2. Additional Transportation Requirements

While we generally feel that transportation safeguards need improvement, the need for additional transportation requirements should be directly keyed to the final form of plutonium as shipped. For example, if separated plutonium products were excluded from shipment through utilization of co-located plants, the necessity for upgrading current practices should be carefully examined in terms of a cost-benefit evaluation. Since transportation remains the weak link in fuel cycle material protection, we strongly support prudent efforts which provide meaningful improvement to the safeguards system. In this regard, we comment on the GESMO recommendations as follows:

a) Use of massive shipping containers - While this technique offers some increased resistance to access to shipped products, we feel that any immediate benefit may be more than offset by substantially increased difficulties in handling and shipping techniques. Large, heavy shipments tend to slow transport and limit routes; limitations which appear inconsistent with safeguards objectives.

b) Use of special vehicles - Positive support is given for use of special vehicles where design and operation of such vehicles can be shown to be incrementally useful in increasing protection within the established safeguards system.

c) Use of special escorts or convoys - The use of sufficiently armed escorts is considered an appropriate course of supportive safeguards action. However, numbers and techniques of assistance should be carefully evaluated to assure meaningful and direct improvement in the total system.

d) Establish communication system - We are strongly supportive of measures which provide increased assurance that continuous communication is available as required for safeguards in the fuel cycle. Development of such communications measures should not be delayed for the several years necessary for satellite relay communications development. If such delays are inherent with satellite use, acceptable interim measures should be made available.

3. Additional Hardening of Facilities

Facilities should be designed to provide considerable resistance to overt or covert acts directed at theft or sabotage of nuclear materials. We recommend that current requirements be carefully evaluated such as by fault tree analysis of postulated design basis incidents to determine adequacy. Arbitrary additional requirements should be avoided. Where additional restraints are determined to be advisable, we generally suggest improved reliability on response and mechanical obstacles which provide dealying measures to lessen the probability of a successful entry and exit. These restraints may include physical barrier and advance admittance systems. We advise caution in considering deterrents which repel or immobilize individuals. Such systems may offer more vulnerability to jeopardizing normal operations through accidental use with subsequent deleterious effects on legitimate operations.

4. Upgrading of Operating Functions

We offer support for measures which effectively strengthen operating surveillance functions. Based on current experience, for example, it appears that electronic surveillance offers superior search capability over manual hands-on methods. Such measures are more consistent, more thorough and decidely less offensive. While there exists differences of opinion within the Institute, we generally support measures which allow screening and federally sponsored clearances for individuals involved in operations involving special nuclear material where such clearances could reduce the necessity of individual searches and could be an effective criterion in improving the overall quality of individuals working within nuclear facilities.

5. Guard and Police Functions

The subject of guarding special nuclear material and interaction with law enforcement authorities remains a frustrating and difficult one. On one hand, considerable interest is shown in maintaining control over facility operations which includes administering security functions. On the other hand, significant reservations are evident about the responsibility of private industry to maintain citadels of armed individuals whose charter is to provide hardened resistance to actual or suspected diversion or sabotage. In general, we feel that solutions to the overpowering problems of law enforcement liaison, armed defense of materials and recovery of diverted material are within the purview of federal authorities. Licensee responsibility should include measures to detect, communicate and delay. In this regard, security in transit and security at fixed sites may be the logical separation point. Communication to, liaison with and response by local law enforcement authorities must be strengthened to ensure consistently effective systems. While we prefer techniques which provide for industrial control, we recognize that federal coordination may be required. We urge that immediate effort be initiated to analyze in depth this overall security problem in all its aspects to provide long-term resolution to the armed guard requirements.

6. Improving Accountability Systems

We support activities which provide meaningful improvement in measurement systems. Such measurement systems in production facilities become extremely complex, however, and considerable effort must be directed to ensure that improvement emphasis is expanded in areas shown deficient or in areas affording marked improvement. Overall significant measurement improvement is not likely to occur since present, primarily chemical, techniques offer good overall measurement results. However, considerable effort could be directed to replacing many current methods with faster techniques which approach or improve upon current measurement capability and which emphasizes on-line accountability rather than physical inventory. In our opinion, Real Time Materials Control (RETIMAC) systems have potential application. However, such systems will need additional development and are not likely to drastically improve the currently available measurement systems.

7. Use of "Spiked" Plutonium

The concept of increasing the harm to the diverter by introducing radioactive material is not new. This concept has been considered before in the case of high enriched uranium. Because of the many obvious economic and practical disadvantages, the concept was not seriously considered. In general, we do not regard the adulterating of plutonium with other perhaps more hazardous materials, as a reasonable and responsible approach to improving safeguards measures. The obviously severe complications of handling these materials in normal operations would adversely effect economics and technical operations considerably more than any estimated benefit. However, if the concept is to be evaluated again, the safeguards impact and limitations should be considered in detail. Some of these include:

- The level of spike needed to provide a deterrent to diversion as opposed to the level of spike needed to immediately incapacitate a would-be diverter.
- The question of detectability of concealed plutonium versus measurability. Could detectability goals be reached without greatly reducing the exactness of accountability-type measurements?

- The uniformity of application of such a spike concept to other strategic SNM materials such as ^{233}U and high enriched ^{235}U.

As professional nuclear materials managers we are strongly supportive of well-planned measures which offer assurance that special nuclear materials receive protective measures commensurate with their strategic importance and the risk of loss or diversion to unauthorized uses remains acceptably low. We feel measures presently in place, while not optimum, represent useful approaches. Improved systems should be examined in a "total safeguards" approach with flexibility available to provide consistently adequate safeguards. In this regard, we feel that safeguards systems must be an integral part of mixed oxide concept development, and therefore, it does not seem prudent to delay final safeguards systems until one year after issuance of the final GESMO statement. We recommend full evaluation before final decisions are offered. We believe that future safeguards developments will be influenced by Pu recycle and the pattern these set will apply for the later HTGR and LMFBR material flows. For this reason, the Institute of Nuclear Materials Management is vitally interested in safeguards evolution. We stand ready to offer our expertise in important areas.

We appreciate the opportunity to review and comment on the safeguards aspect of GESMO. Although we believe there are issues yet to be resolved in the safeguards system, we are confident that appropriate safeguards are practical. We stand committed to this end.

Very truly yours,

D. W. Wilson, Chairman
Safeguards Committee

DWW:gy

Comment Letter No. 33

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

UNIVERSITY OF MINNESOTA
TWIN CITIES

School of Public Affairs
Social Sciences Building
Minneapolis, Minnesota 55455

October 28, 1974

Deputy Director for Fuels and Materials
Directorate of Licensing-Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Sir: Re: WASH-1327, Draft GESMO

The draft statement is, in my view, seriously lacking as it deals with: (1) safeguards, (2) diversion of SNM by sub-national groups or even by individuals, (3) nuclear parks, (4) avoidance of plutonium exposures - both occupational and to the general public - associated with fuel fabrication and reprocessing, and (5) possible infringement of personal freedoms associated with the above.

It is not sufficient for the Commission to state "its objectives", or that these "problems are manageable", or that "additional measures should be, or will be, implemented in a timely fashion".

These views, and others, have been expressed by others (for example the comments of the Natural Resources Defense Council, and Senators Mondale and Hart) in considerable detail and I will not further detail them in this short comment.

Sincerely yours,

Dean E. Abrahamson, M.D., Ph.D.
Professor

dea/cc

NRC Staff Responses to Specific Comments
on Health, Safety, and Environment
by Dean E. Abrahamson

1. Comment:

"It is not sufficient for the Commission to state 'its objectives', or that these problems are manageable', or that 'additional measures should be, or will be, implemented in a timely fashion'.

"These views, and others, have been expressed by others (for example, the comments of the Natural Resources Defense Council and Senators Mondale, and Hart) in considerable detail and I will not further detail them in this short comment."

Response:

Responses to this general comment can be found in responses to Comment Letter Number 5, from Senators Mondale and Hart and Comment Letter Number 25 from Natural Resources Defense Council.

A full discussion on public and occupational exposures from spent fuel reprocessing and MOX fuel fabrication is covered in CHAPER IV, Sections D, E, and J.

Comment Letter No. 34

DOCKET NUMBER
PROPOSED RULE PR-Misc Not (39 FR 30180)
GESMD

Detroit Edison
2000 Second Avenue
Detroit, Michigan 48226
(313) 237-8000

October 30, 1974

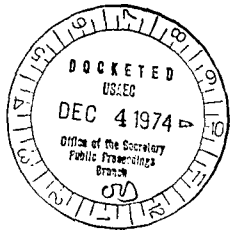
U.S. Atomic Energy Commission
Washington, D. C.

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing - Regulation

Gentlemen:

We have reviewed the AEC draft report, "Generic Environmental Statement on Mixed Oxide Fuel (GESMO)," WASH-1327. It is our general opinion that GESMO represents a thorough and comprehensive study of the environmental impact of plutonium recycle in the light water reactor industry. In many of the subject areas covered, there is complete agreement with the conclusions drawn, and it is felt that the breadth and depth of the study are to be commended. In such areas, the only comment is that certain studies already in progress should be aggressively pursued until a satisfactory resolution of the problem is effected.

Other comments are concerned with logic in presentation, emphasis, and updating with respect to the current projections of plutonium recycle fuel, typographical errors, and clarity. Comments are listed in the attachment.



Sincerely,

Harry Tauber
Manager-Generation Engineering
and Construction

Attachment

Attachment

Comments on Draft Report GESMO

1. We support the position that cost benefit studies related to the removal of KR-85 and H-3 from the effluent gases discharged from reprocessing facilities be aggessively continued until a satisfactory resolution of the problem is effected.

2. Although the number of plutonium oxide shipments from reprocessing facilities to mixed oxide fuel fabricating facilities is not excessive (in the neighborhood of 260 shipments per year in the year 1990), the threat of diversion and the spector of armed escorts over the public highways will be eliminated by the concept of integrated reprocessing and mixed oxide fuel fabrication facilities.

3. Pages S-1, S-2, S-4

   There appears to be some inconsistency in statements concerning the level of fission products in mixed oxide fuel compared to uranium fuel. One statement on the bottom of Page S-1 states that mixed oxide fuel has a fission product inventory different from uranium fuel; two paragraphs later, the fission product inventory is stated to be about the same. In this context, then it is not clear how "reduction in uranium requirements coupled with the different fission product content of mixed oxide fuel," results in decreases in "radiological exposure of the general population."

4. Page S-9

   The whole body value for Case 2 in Table S-3 should be -21% and not +21%.

5. Page S-15

   It may be helpful to relate the reduced separative work required to the reduction in electrical energy required. In addition, large-scale plutonium recycle in 1977 appears extremely optimistic.

6. Page II-14

   In Table II-3, more specific explanation could be given to the difference in values listed in the two columns entitled, "Without Recycle" and "With Recycle."

7. Page II-25

   Estimated start-up dates for commercial reprocessing facilities should be updated.

8. Page II-27

   The energy of 256 Mev associated with decay of plutonium is not correct.

9. Page IV C-25

   Table IV B-2 should read Table IV C-2.

10. Page IV C-32

In the section on "Control Requirements," it is not clear what is meant by "good fuel management."

11. Page IV C-33

In the third paragraph, the statement that "control rod insertion requirements will be unchanged" should be explained in view of the statement made in the last paragraph of Page IV C-32 and first paragraph of Page IV C-55.

12. Page IV C-44

It is not clear how the results of the measurement described in the fourth paragraph and given in Figure IV C-22 can lead to the statement that "large PuO_2 particles will have no measurable effect during steady state operation." The experimental results deal only with the DNB heat flux. What about the fact that the operating heat flux will be closer to the DNB heat flux if an unexpected power spike is experienced. Moreover, to complete the logic, some information on particle size and population distribution of large particles should be presented. Furthermore, BWR application is not covered.

13. Page IV C-51

Necessity for appropriate fuel densification model should be mentioned in the summary and conclusions. What is the status of demonstration program?

14. Page IV C-55

More explanation of PWR steam line break phenomena would be helpful since it is adversely affected by mixed oxide fuel.

15. Page IV C-59 Footnote

What is the impact of the 5% of the LWR's which will exceed twice SGR?

16. Page IV D-40

Why couldn't an explosion rupture the building and release more plutonium than is projected for the model under consideration?

17. A list of items yet to be resolved and the status of the programs aimed at their resolution should be presented.

18. Page 5-61

The ore and enrichment prices quoted are comparable to the mid-1973 prices and escalations. Present day prices, however, are such that those utilized in the study are about half of the present projected prices for 1990. Also, further increase in the enrichment costs due to private management of enrichment facilities should be considered.

J. E. Meyers/gt
10/30/74

NRC Staff Responses to Specific Comments On Health, Safety, and Environment by Harry Tauber

1. Comment:

"Pages S-1, S-2, and S-4. There appears to be some inconsistency in statements concerning the level of fission products in mixed oxide fuel compared to uranium fuel. One statement on the bottom of Page S-1 states that mixed oxide fuel has a fission product inventory different from uranium fuel; two paragraphs later, the fission product inventory is stated to be about the same. In this context, then it is not clear how 'reduction in uranium requirements coupled with the different fission product content of mixed oxide fuel.' results in decreases in radiological exposure of the general population.'"

Response:

What appears to be an inconsistency stems from the very small differences in the levels of fission product inventories from MOX and UO_2 and UO_2 only spent fuels. In CHAPTER IV, Section J, a full assessment of radiological exposures of the general population and workers is made with comparisons of the three fuel cycle options: no recycle, recycle of uranium only and recycle of uranium and plutonium.

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2. Comment:

"Page IV C-33. In the third paragraph, the statement that 'control rod insertion requirements will be unchanged' should be explained in view of the statement made in the last paragraph of Page IV C-32 and first paragraph of Page IV C055."

Response:

The paragraph in question has been rewritten in the final GESMO to indicate that the rod insertion limits will not be changed appreciably with the introduction of MOX fuel in LWR's. Refer to CHAPTER IV, Section C, paragraph 3.3.5.

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3. Comment:

"Page IV C-44. It is not clear how the results of the measurement in the fourth paragraph and given in Figure IV C-22 can lead to the statement that 'large PuO_2 particles will have no measurabel effect during steady state operation. The experimental results deal only with the DNB heat flux. What about the fact that the operating heat flux will be closer to the DNB heat flux if an unexpected power spike is experienced. Moreover, to complete the logic, some information on particle size and population distribution of large particles should be presented. Futhermore, BWR application is not covered."

Response:

A change has been made in this paragraph of final GESMO to clarify the fact that thermal conductivities of the fuel, gap and cladding will dissipate a heat spike during steady state operation. This may not be true during a reactivity initiated transient, which is discussed in the paragraphs (also modified) on incipient cladding failure thresholds. Refer to CHAPTER IV, Section C, paragraph 3.4.2.

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4. Comment:

"Page IV C-51. Necessity for appropriate fuel densification model should be mentioned in the summary and conclusions. What is the status of demonstration program?"

Response:

In the final GESMO the densification paragrphs have been rewritten and a brief discussion of MOX densification programs is given. Densification in MOX fuels, however, is not a major technical concern. The use of verified MOX densification models is required as described in CHAPTER IV, Section C, 3.0. It is not appropriate to discuss these details in the summary. The summary paragraph has been revised to include a general statement on the use of MOX data and assumptions.

---

5. Comment:

"Page IV C-59 Footnote. What is the impact of the 5% of the LWR's which will exceed twice SGR?"

Response:

Refer to CHAPTER IV, Section C, paragraph 4.1, it is believed that by the time the performance characteristics for plutonium utilization in quantities greater than 1.15 SGR values have been determined to be acceptable, sufficient fuel and core performance data as well as fuel recovery and fabrication experience will be available from the LWR's that recycle plutonium in quantities less than 1.15 SGR values and the choice of full plutonium LWR or other intermediate loading greater than 1.15 SGR may then be optional. The impact of recycling plutonium in quantities greater than 1.15 SGR would have to be evaluated, if proposed, on a case-by case basis.

The results of an industry survey indicated that most recycled plutonium would likely be used, in currently designed LRW's, in concentrations ranging from two-thirds to just above the self-generating reactor equilibrium values. A concentration of recycled plutonium somewhat above the concentration expected to be used in most LWR's of current design within the next ten years (1.15 SGR) was examined to determine what effect, if any, its use would have on those reactor characteristics which might affect the probability and consequences of accidents, as compared to currently designed LWR's fueld with UO_2.

Since it was clear than, at this 1.15 level of plutonium usage, UO_2 reactor technology would be applicable with only minor details requiring review on a plant by plant basis. It was concluded that the changes in radiological and environmental effects of using varying generation rates would be negligible. Accordingly, it was decided that the 1.15 SGR plutonium recycle reactor model should be used to portray the environmental effects of reactor use of recycled plutonium in the draft GESMO.

The foregoing should not be interpreted to mean that there is an inherent safety or environmental limit at 1.15 SGR (or close to this value) on the use of recycled plutonium in reactors. This is not the case. On the other hand, it should not be concluded that there is not some limit beyond 1.15 SGR at which the safety and environmental consequences of the use of recycle plutonium in reactors are not comparable to that of UO_2. To identify this limit precisely was not considered to be justified in light of the resutls of the survey of the industry plans for the use of recycled plutonium in currently designed LWR's. Refer to CHAPTER IV, Section C, paragraph 4.2.

---

6. Comment:

"Page IV D-40. Why couldn't an explosion rupture the building and release more plutonium than is projected for the model under consideration?"

Response:

There will not be enough explosive force in all of the potentially explosive material present in the plant to rupture the confinement wall, e.g.; the model plant final confinement structure is considered to be designed to withstand the maximum explosion that could be postulated. In addition, the quantities of potentially explosive materials required by the manufacturing process would not be large enough to supply an explosive force that would breech the confinement.

An explosion, by sabotage, could possibly rupture the wall. This aspect is addressed in the safeguards supplement to GESMO.

---

7. Comment:

"A list of items yet to be resolved and the status of the programs aimed at their resolution should be presented."

Response:

It is not clear what is meant by this comment, "A list of itmes yet to be resolved...". License application procedures for a MOX fabrication plant include Safety Analysis Reports and these reports are evaluated on a case-by-case basis by the NRC staff. The reports must list all safety items and a list of items to be considered and yet to be resolved, related to plant operation, for staff evaluation.

---

8. Comment:

"Page 5-61. The ore enrichment prices quoted are comparable to the mid-1973 prices and escalations. Present day prices, however, are such that those utilized in the study are about half of the present projected prices for 1990. Also, further increase in the enrichment costs due to private management of enrichment facilities should be considered."

Response:

The market place model employed in this final GESMO is described in CHAPTER XI, Appendix A. The rate of usage of the resources does affect the market price. Additionally, the model uses an "estimated cost of recovery" instead of the "forward cost" concept, thus an estimate of the market price is generated. Because of the inherent uncertainties in such an exercise, the effect of the uncertainties is examined by parameterizing the price of U_3O_8 and looking at the effect on incentives to recycle. See CHAPTER XI, paragraph 3.1.

The separative work cost was taken as $75/SWU, the generally accepted price at which private industry may enter the market. This cost is also parameterized and varied to see the effect on the incentives to recycle. See CHAPTER XI, Section 3.0.

Response:

The use of natural uranium in the MOX fuel fabrication has been noted in final GESMO as a basis for dose assessments and environmental impacts and is not limiting in the method of MOX fuel manufacture.

The overall economics of using uranium tails from the enrichment plant are reviewed in the reponse to Comment No. 123 of Comment Letter No. 24.

Comment Letter No. 35

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

Nuclear Fuel Services, Inc. 6000 Executive Boulevard, Suite 600, Rockville, Maryland • 20852
A Subsidiary of Getty Oil Company
(301) 770-5510

October 30, 1974

U. S. Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing
Office of Regulation

Gentlemen:

Nuclear Fuel Services, Inc. (NFS) submits the following comments and suggestions on the draft Generic Environmental Statement on the use of Mixed Oxide fuel (GESMO) as issued by the Commission on August 15, 1974.

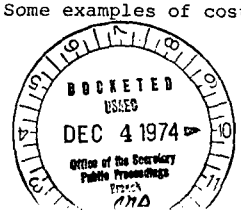
The basic conclusion reached by GESMO that plutonium should be immediately recycled as mixed oxide fuel in LWRs appears to be logical, sound, and well supported. The recycle of plutonium is required in order to assure the long term availability of sufficient electrical power in this country. Further, the experience gained from LWR Pu recycle will be invaluable in preparing for the future breeder economy.

NFS is the only private company that has had experience in all phases of the out-of-reactor fuel cycle which involve plutonium recycle; this includes mixed oxide fuel design and fabrication, reprocessing, plutonium recovery, waste handling, and fuel transportation. Based on our experience, NFS believes that plutonium recycle is practical, viable, and safe. NFS also believes that the overall environmental impact of the fuel cycle without Pu recycle will be greater than the impact would be with Pu recycle. Safeguards requirements consistent with the threat of diversion or sabotage have been identified and implemented.

The following comments are directed towards specific areas within GESMO that NFS believes should be strengthened:

COSTS

Cost figures throughout the report should be revised to reflect current rates or estimates. Some examples of cost which appear to be understated are:



- projected value of uranium (as U_3O_8);
- projected value of plutonium;
- reprocessing costs; and
- long-term spent fuel storage costs.

SCHEDULES

The GESMO estimate of plutonium utilization in the early years (1976-1980) should be revised to reflect the unavailability of reprocessing facilities in that period.

EXISTING FACILITIES

GESMO appears to ignore existing manufacturing and processing facilities in favor of future hardened facilities constructed in accordance with new regulations and guidelines. There must necessarily be an overlapping interface between existing and new facilities during which time the environmental impact conclusions of GESMO may not be totally valid. The existence of present day facilities should be acknowledged, and their expected environmental effect should be discussed.

SAFEGUARDS

NFS strongly recommends that any safeguards upgrading required for the protection of the projected MOX fuel cycle be identified as soon as possible (such identification need not be tied to the approval of a final GESMO statement). Each alternative for the upgrading of the safeguards system should be independently evaluated on a cost-benefit basis prior to implementation.

The safeguards concepts involving "spiked" plutonium and debilitating gases do not appear practical. NFS believes that such schemes would create an employee hazard far in excess of any safeguards gains.

BASIS ASSUMPTIONS

GESMO should state that the introductory assumptions (e.g.: 3-5% PuO_2 in MOX fuels, use of natural uranium in MOX fuels, and 1.15 SGR) are adopted for convenience and consistency only.

They should not be considered as limiting conditions such that other options are excluded from coverage by GESMO.

Very truly yours,

J. R. Clark, Manager
Environmental Protection
and Licensing

JRC:kac

NRC Staff Responses to Specific Comments
on Health, Safety, and Environment
by J. R. Clark

1. Comment:

"Cost figures throughout the report should be revised to reflect current rates or estimates. Some examples of cost which appear to be understated are:

-projected value of uranium (as U_3O_8);

-projected value of plutonium;

-reprocessing costs; and

-long-term spent fuel storage costs."

Response:

All costs throughout final GESMO have been updated to reflect the best current estimates. See CHAPER XI, Section 2.0, for a parameterization of costs to see the effect on the incentives to recycle.

---

2. Comment:

"GESMO appears to ignore existing manufacturing and processing facilities in favor of hardened facilities constructed in accordance with new regulations and guidelines. There must necessarily be an overlapping interface between existing and new facilities during which time the environmental impact conclusions of GESMO may not be totally valid. The existence of present day facilities should be acknowledged, and their expected environmental effect should be discussed."

Response:

In final GESMO the environmental effects are based on model commercial size spent fuel reprocessing and MOX fuel fabrication plants. The dose assessments from releases for these plants are integrated over the period 1975 to 2000. When considering the earliest possible recycle occurrring in 1981 (Alternative 3) and the industry requirements through the year 2000, the effects of the small existing plants on the overall industry would have little or no impact. It is postulated that if any existing plant remains in production handling plutonium, all regulations on safety and safeguards would prevail.

---

3. Comment:

"GESMO should state that the introductory assumptions (e.g.,: 3-5% PuO_2 in MOX fuels, use of natural uranium in MOX fuels, and 1.15 SGR) are adopted for convenience and consistency only.

"They should not be considered as limiting conditions such that other options are excluded from coverage by GESMO."

DOCKET NUMBER
PROPOSED RULE PR - Misc Matic (39 FR 30180)
GESMO

PROTECT THE PENINSULA'S FUTURE
P.O. Box 1677, Sequim, Washington, 98382

A non-profit corporation dedicated to the wise land use of the North Olympic Peninsula

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U.S. ATOMIC ENERGY COMMISSION
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October 29, 1974

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Harriet Herr
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U.S. Atomic Energy Commission
Attention: Deputy Director for Fuels and Materials,
Directorate of Licensing-Regulation
Washington, D.C. 20545

Dear Mr. Smiley:

Thank you for the opportunity to comment on the draft Generic Environmental Statement on the use of Mixed Oxide fuel in LWRs.

Our comments are attached. We found it difficult to cover the amount of material provided in the time available to study it and hope we did not accuse you of any omissions incorrectly by virtue of the haste necessitated by the time frame.

Yours truly,

Joyce S. Tuck, Research Committee
and
Eloise W. Kailin, President (1974)

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COMMENTARY ON WASH 1327, Draft EIS of Generic Environmental Statement Mixed Oxide Fuel, by AEC. 10/29/74 Joyce S. Tuck, Eloise W. Kailin
Rt. 1, Box 253, Sequim, Wash. 98382

As background, we wish to observe that we do not believe that the light water reactor with uranium fuel is sufficiently safe for general commercial use. We are keenly aware that what is not safe enough to put near large load centers must be looked on askance by those of us in more sparsely settled areas where power requirements do not justify such an installation. The continuation of the Price -Anderson Act and the absolute unavailability of privately obtainable insurance tell us that financial institutions also have serious doubts on the risk issue.

The mixed oxide fuel which is proposed introduces considerably more danger into the LWR particularly since it has not been designed for this. We note that the criticality mass for plutonium is much smaller than that for uranium. The biologic hazard of the increased plutonium load surely must play a role in the possible magnitude of accidents breaching the containment and in the risks in transportation accidents.

There appears to be no data available on worst-case effects of a criticality accident comparable to the 1965 Brookhaven report but adjusted for the changed conditions when MOX is used. Since tritium production is greater with MOX, what are the implications for chemical explosiveness of the core under melt-down conditions? What would be the temperature and propulsive forces in the reactor containment vessel with a loss-of-coolant accident? Will the older plants be retro-fitted with better hydrogen suppression systems, and if so what will the cost be?

Radioiodine is of critical interest because of its entry into the grass-milk food chain of man and because of its concentration by the thyroid gland. It may be one of the limiting factors in population dose in a serious accident. What are the consequences of an 8% higher inventory in the core when MOX is used, in day-to-day emissions and under accident conditions? Will additional hold-up facilities or absorption have to be added? And what will the cost be?

The fission cross-section of plutonium being twice that for U235, it takes only about half as many neutrons to cause the same number of fissions in Pu239. This would seem to imply the possibility of even more rapid attainment of supercriticality and raises in our minds the question of adequacy of the control rods in this situation. What is the added risk-of-frequency of supercriticality? We note the presence of from 6 to 8 times as much Pu at the start of a fuel cycle and double the amount of Pu at the end of a fuel cycle as compared with uranium oxide loading. How can this possibly fail to have a significant effect on either the liklihood or the consequences of an accident?

The paucity of operating experience in reactors of 1000 MWe or greater is evident in this report. Predictions of reactor core behavior are mainly extrapolations from uranium fuel and may or may not prove to be applicable. We have already experienced fuel fabrication problems with plain uranium oxide; now we are to

try to produce a mixed fuel which is free of hot spots. How will quality control for this task be implemented? What consequences can be anticipated in the event of production of defective fuel?

We are already committed to a program of importation of uranium from foreign sources on an escalating schedule which this program apparently would not substantially alter. To achieve what is in effect about a 1 and 1/2 years of extension of the uranium fuel supply economically extractable, we must pay for

1. 8 MOX plants
2. Solid transuranic waste accumulation 50% greater in volume and particularly expensive to compact and to store
3. The release of an extra 200,000 curies of tritium per year in air and 8,000 into water
4. Wastes almost 30% hotter requiring extra shipments, special provisions for storage due to heat and due to the accumulating plutonium with its diversion hazards, and the need to reprocess the plutonium if it is held for a long period because of Americum 241 build-up.
5. An increase in complications due to leaching of the transuranic stored wastes.
6. Increased risk of diversion of plutonium because of:
   a) 17% more miles traveled
   b) 50% more shipments by 1990
   c) Much more plutonium in purified form making it much easier to steal.

The difference in the amount of plutonium handled at reprocessing plants with the MOX fuel plan would be roughly sufficient to construct 1300 plutonium "devices". The extra cost of safeguards may be of the order of $2 million per plant per year--or close to a billion dollars/ year for 500 plants--but what about the costs in terms ofblackmail activities assosciated with diversion, and what about the risk to our civil liberties which would result from hijacking and terrorist activities? Will Price-Anderson insurance cover any radiation damages inflicted from this type of activity or would this be considered civil disobediance and, like war, escape coverage?

Alternatives to this program have not been dealt with sufficiently. What is the possibility that the 1 and 1/2 years of uranium extension--not to mention the extended nuclear reactor program--can be handled by a combination of the following: Conservation of energy: cut out the waste as suggested by the Ford Foundation report.

Use existing dams at their fully designed capacity.
Develop the rich and much less expensive geothermal sites
Follow through on utilization of solar energy, starting with the provisions of the Solar and Heating and Cooling Demonstration Act and proceding withstudies for electricity generation from solar power
Put a lot more work into development of fuel cells, both large ones for power generation at central plants and small ones for electricity generation on a single-home basis.

Until the above questionsreceive satisfactory answers we urge that the MOX program not be implemented. It is certainly NOT insignificant.

NRC Staff Response to Specific Comments on Health, Safety and Environment (Protect the Peninsula's Future), by J. S. Tuck and E. W. Kailin

1. Comment:

"The mixed oxide fuel which is proposed introduces considerably more danger into the LWR particularly since it has not been designed for this. We note that the criticality mass for plutonium is much smaller than that for uranium. The biologic hazard of the increased plutonium load surely must play a role in the possible magnitude of accidents breaching the containment and in the risks in transportation accidents.

"There appears to be no data available on worst-case efffects of a criticality accident comparable to the 1965 Brookhaven report but adjusted for the changed conditions when MOX is used."

Response:

About 30-35% of all the energy produced in an LWR reactor comes from the fission of plutonium without plutonium recycle. The discharge fuel from an LWR (without mixed oxide [MOX] fuel) following 3 or 4 years of irradiation contains about 9 kilograms of plutonium for every metric ton of uranium initially charged to the reactor. The use of MOX fuel in an LWR would increase the amount of plutonium in the reactor by about a factor of 4. The plutonium could be used to enrich depleted, natural or slightly enriched uranium. The MOX fuel assemblies would not be more reactive than the fuel elements currently being used in a given reactor. The neutron flux spectrum around the control rods would be kept about the same as now such that the positioning worth of the control rods will not change.

The shipment of plutonium has been carried on for many years, especially in the nuclear weapons field without serious incidents (no loss of life). In general, the given hazards will not change; however, there will be additional plutonium shipments due to plutonium recycle. For more details on the reactor operaton with MOX fuels, plutonium recycle, see CHAPTER IV, Section C-3.0 and C-4.0. For the differential transportation activities with and without MOX fuels, see CHAPTER IV, Section G.

---

2. Comment:

"Since tritium production is greater with MOX, what are the implications for chemical explosiveness of the core under meltdown conditions? What would be the temperature and propulsive forces in the reactor containment vessel with a loss-of-coolant accident? Will the older plants be retrofitted with better hydrogen suppression systems, and if so, what will the cost be?"

Response:

As presented in Table IV C-13 in final GESMO, the maximum core inventory of tritium (tritium production) is 3.66 grams for a reactor containment slighly enriched uranium fuel assemblies only and 4.0 grams for the model 1.15 SGR fuel assemblies. This change, equivalent to less than cubic ft of tritium at atmospheric pressure and temperature, is insignificant relative to the evaluation of combustible gas hazards following very low probability accidents and the design of hydrogen suppression systems. Refer to CHAPTER IV, Section C, Table IV C-13.

---

3. [redacted]nt:

"Radioiodine is of critical interest because of its entry into the grass-milk food chain of Man and because of its concentration by the thyroid gland. It may be one of the limiting factors in population dose in a serious accident. What are the consequences of an 8% higher inventory in the core when MOX is used, in day-to-day emissions and under accident conditions? Will additional holdup facilities or absorption have to be added? And what will the cost be?"

Response:

In final GESMO assessments, it has been determined that with MOX fuels, there will be only a 5% increase in the radioiodine. Additional absorption and storage facilities would not be required.

---

4. Comment:

"The fission cross-section of plutonium being twice that for U-235, it takes only about half as many neutrons to cause the same number of fissions in ^{239}Pu. This would seem to imply the possibility of even more rapid attainment of supercriticality and raises in our minds the question of adequacy of the control rods in this situation. What is the added risk-of-frequency of supercriticality? We note the presence of from 6 to 8 times as much Pu at the start of a fuel cycle and double the amount of Pu at the end of a fuel cycle as compared with uranium oxide loading. How can this possibly fail to have a significant effect on either the likelihood or the consequences of an accident?"

Response:

CHAPTER IV, Section C in final GESMO addresses plutonium recycle in LWR's. Based on the quantitative and descriptive information presented, it is concluded that plutonium can be recycled in LWR's within the limits of the equilibrium model 1.15 SGR (refer to Figure IV-C-26) without noticeable changes in core performance characteristics or the consequences of design basis accidents.

The technical specifications relatated to operation of the nuclear power plant will not be changed to permit higher releases of radioactivity to the environment during normal or design basis accident conditions, i.e., there will be no increase in hazards to the health and safety of the public by recycling plutonium within the limits that have been evaluated.

Changing the fuel composition from UO_2 only to MOX will not affect the probability or the consequences of the design basis accidents (major pipe ruptures-LOCA, major steam pipe breaks or control rod ejection), upon which the requirements for engineered safety features are based. Refer to CHAPTER IV, Section C, paragraph 5.4.

---

5. Comment:

"The paucity of operating experience in reactors of 1000 MWe or greater is evident in this report. Predictions of reactor core behavior are mainly extrapolations from uranium fuel and may or may not prove to be applicable. We have already experienced fuel fabrication problems with plain uranium oxide; now we are to try to produce a mixed fuel which is free of hot spots. How will quality control for this task be implemented? What consequences can be anticipated in the event of production of defective fuel?"

5. Comment (Cont'd)

Response:

In final GESMO, the core performance of an LWR charged with MOX fuel is reviewed in detail in CHAPTER IV, Section C-3.0. In this review of the core performance, a fuel discussion is included on the homogeneity in the fuel of MOX fuels in paragraph 3.4.2.

The quality control on MOX fuels will be similar to that used in the manufacture of UO_2 only fuels and the final neutron radiography inspection should be more effective in the detection of flaws when using the recycled plutonium ingredient because of higher activities of the blended oxide powders.

---

6. Comment:

"We are already committed to a program of importation of uranium from foreign sources on an escalating schedule which this program apparently would not substantially alter. To achieve what is in effect about a 1 and 1/2 years of extension of the uranium fuel supply economically extractable, we must pay for:

1. 8 MOX plants
2. Solid transuranic waste accumulation 50% greater in volume and particularly expensive to compact and to store
3. The release of an extra 200,000 curies of tritium per year in air and 8,000 into water
4. Wastes almost 30% hotter requiring extra shipments, special provisions for storage due to heat and due to the accumulating plutonium with its diversion hazards, and the need to reprocess the plutonium if it is held for a long period because of ^{241}Am build-up.
5. An increase in complications due to leaching of the transuranic stored wastes
6. Increased risk of divesion of plutonium because of:
   a. 17% more miles traveled
   b. 50% more shipments by 1990"

Response:

The impacts on the environment in the draft GESMO considered the mature Pu recycle industry in year 1990. The final GESMO compares the impacts of three fuel cycle options integrated over a 26-year period--no recycle option, uranium recycle only, and uranium and plutonium recycle. Over the period 1975 through 2000, the recycle of uranium and plutonium would conserve approximately 22% of the virgin uranium that would be consumed for the generation of electrical power without recycle. This could extend the nuclear fuel supply about 3 years beyond the year 2000. However, over the same period, spent fuel reprocessing would release about 60 million curies of tritium to the hydrosphere. This would increase the world population dose commitment over the 26-year period about 0.006% of that received from natural radiation. On the other hand, the recycle of uranium and polutonium would replace the prospective need for the additional strip mining of about 10 billion tons of cover soil and ore. CHAPTER IV includes individual sections which include detailed assessments of all the components of the LWR fuel cycle.

---

7. Comment:

"Alternatives to this program have not been dealt with sufficiently. What is the possibility that the 1 and 1/2 years of uranium extension -- not to mention the extended nuclear reactor program -- can be handled by a combination of the following: Conservation of energy: cut out the waste as suggested by the Ford Foundation report.

Comment (Cont'd.)

Use existing dams at their fully designed capacity.
Develop the rich and much less expensive geothermal sites.
Follow through on utilization of solar energy, starting with the provisions of the Solar Heating and Cooling Demonstration Act and proceeding with studies for electricity generation from solar power.
Put a lot more work into development of fuel cells, both large ones for power generation at central plants and small ones for electricity generation on single-home basis.

Until the above questions receive satisfactory answers, we urge that the MOX program not be implemented. It is certainly NOT insignificant."

Response:

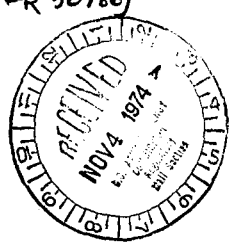
A well-balanced national energy program certainly must include all of the programs mentioned in this comment. However, due to technological uncertainties, inherent limitations (rivers only have so much flow, geothermal reservoirs are limited) and continued growth in energy demand, other sources of power will be needed. Some of this power will come from nuclear power plants. The purpose of GESMO is to assess the differences in the impacts environmentally and economically due to the introduction of recycle plutonium as MOX fuel into LWR's. Also an issue that is examined is: What should be done with the spent fuel from LWR nuclear plants? After examining the various alternatives, it appears that recycle makes nuclear power less costly than nuclear power with no recycle, conserves resources and could possibly reduce the overall environmental impact. See CHAPTER XI, Section 4.0.

Comment Letter No. 37

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

Carolina Power & Light Company

November 1, 1974



Mr. S. H. Smiley
Deputy Director for Fuels and Materials
Directorate of Licensing-Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

THE GENERIC ENVIRONMENTAL STATEMENT ON THE USE OF RECYCLE PLUTONIUM IN MIXED OXIDE FUEL IN LWRs (GESMO, WASH-1327)

Dear Mr. Smiley:

The draft Generic Environmental Statement, Mixed Oxide fuel (GESMO), has been thoroughly reviewed within Carolina Power & Light Company because of our strong interest in the recycle of plutonium. Your staff has presented extensive analyses in the draft GESMO which provide an effective focal point for contribution by industrial, governmental, and other organizations in resolving the plutonium recycle issues.

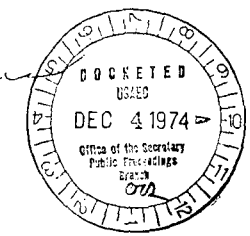
Included as enclosures are both general and specific comments which may be useful in developing the final GESMO. Although these CP&L comments pertain to a broad variety of the issues related to plutonium recycle, cost-benefit evaluation is most frequently emphasized.

The GESMO has effectively utilized cost-benefit evaluation for many of the factors which must be considered in recycling plutonium. However, we suggest that even greater emphasis on cost-benefit evaluation is appropriate. The scope of the social issues, together with the number and complexity of the technical issues contribute to an overall representation of the problem which is somewhat confusing. Cost-benefit evaluation should represent the quantifying central structure of the total analysis to mitigate the confusion. The effects of the risk and environmental factors which are not readily expressed in dollars, can be quantified by evaluation of the cost or benefit to obtain acceptable levels of risk or environmental commitment. Although this cost-benefit emphasis does not contribute to the solution of unresolved social and technical issues, it does provide a clearly recognizable single basis for evaluating the total impact of these uncertainties.

The task you have undertaken is absolutely necessary at this time, and the Carolina Power & Light Company is glad for this opportunity to participate. The comments contained in Enclosures 1 and 2 to this letter are offered as constructive assistance. Please contact me with any questions you may have.

Very truly yours,

J. A. Jones
Executive Vice President



JAJ/jc
Enclosures

Raleigh, N. C. • P. O. Box 1551 • Raleigh, N. C. 27602

5-37.1

Enclosure 1

GENERAL COMMENTS ON WASH-1327 (GESMO)
CAROLINA POWER & LIGHT COMPANY

I. Scope

GESMO may have an impact on the nuclear industry and on the nation's resource conservation far beyond that envisaged in its present scope. A decision not to recycle plutonium in LWRs would certainly be associated with the potentially negative effects of plutonium on the public health and safety. Such a negative decision would also reduce public acceptance of breeder reactors because of their even stronger dependence on plutonium. A decision not to recycle plutonium in LWRs would probably cripple the breeder program. Because GESMO has been generated in an industry atmosphere which assumes the breeder will be developed, a positive decision on mixed-oxides (MOX) in LWRs will have little effect. Nevertheless, GESMO must consider the consequences of either a positive or a negative decision and establish a basis for accounting for the full cost-benefit impact of a negative decision.

The decision whether to recycle plutonium in LWRs should be based on the basic issues of direct importance to our society, rather than on technical details. The single question to be answered is "What is the cost-benefit choice for present and future generations concerning MOX in LWRs?" Detailed technical considerations are not central to the decision to be made here but should be considered from two viewpoints only: (1) credibility of pertinent technology, and (2) estimated cost to be utilized in the cost-benefit evaluations. The first should provide perspective in evaluating the uncertainty of the second. Sensitivity studies should be provided on significant issues to further quantify uncertainties.

II. Cost-Benefit

The GESMO report provides the AEC an opportunity for responsible leadership by rigorously adhering to the cost-benefit evaluation basis provided in enabling legislation. Such a sound basis for evaluation and decision-making will assist our society in avoiding excessive commitment of resources to the reduction of risks to infinitesimal levels and will withstand the vagaries of public opinion as various causes in turn become popular.

Actual cost-benefit margins should be provided in dollars as well as in percent. In addition to quantifying cost-benefit relationships, such margins provide perspective and guidance in consideration of the costs of additional procedures, facilities, and equipment which may be required as plutonium recycling technology develops. Such analyses will inform the industry of the practical limits of additional expenditures which may be associated with plutonium recycling.

III. Format

The GESMO report gives the overall impression of being repetitive and therefore unnecessarily voluminous. It is recognized that the authors have been careful to repeat material wherever it is pertinent, in order that each section of the report might constitute an independent whole. However, this report could be more easily comprehended if basic tables, figures, and analyses were provided in only one location. Other discussions and summaries should reference these data in detail so that each statement can readily be checked against its substantiating analyses. The present format also requires substantial searching and checking of repeated versions of the same materials to identify differences between the versions and to establish, if possible, the location of the complete presentation of the data. Some of the space saved by eliminating repetition could be used to present summaries and conclusions in a more objective format to avoid any impression of bias.

Principles for determining the significance of individual aspects of the evaluation should be established on a generic basis and applied rigorously throughout the report. For instance, one rule might state that any aspect of the problem which changes the cost of the base case by less than one percent, including uncertainties, can be disregarded. It will then be necessary to demonstrate that a particular effect is less than one percent before it can be declared to be "insignificant." We suggest a completely comprehensive set of such groundrules should be prominently described in the report.

IV. Safeguards

It is the responsibility of the AEC to force those considering plutonium recycling to evaluate the needs for additional safeguards within a total perspective of risks to our society from saboteurs and bombers. This industry cannot allow scare tactics to cause our society to waste a disproportionate share of its resources in insignificant reduction of this one particular type of risk when thousands of other comparable risks, not associated with nuclear power, are not dealt with similarly.

Preliminary qualitative assessments of several of the proposed concepts for improving safeguards are offered as follows:

1) Through integrated facilities, the minimization of safeguard risks in transporting Plutonium between reprocessing and MOX fabrication plants are most evident. It should be recognized, however, that reprocessing and MOX fabrication services provided to customers are generally considered totally separable from the standpoint of both the purchaser and the supplier of the service. A very high degree of maturity in this industry must exist prior to deriving any significant benefits from this concept. Even then there will be older facilities which will not be coupled and therefore not provide this form of additional safeguard protection.

2) Numerous improvements are mentioned related to personnel security, many of which offer the potential of very positive benefits. Changes which may be implemented in this area should be made only as required to meet the fundamental safeguards objectives set forth and only when necessary to meet our expanding needs. Overreaction in this area has the potential of weakening the overall protective system.

3) The use of radioactive spikes in plutonium for safeguards strengthening will certainly fail all forms of accurate cost-benefit analyses.

In summary, GESMO offers numerous constructive alternatives for improving and strengthening existing special nuclear materials safeguards. The principal weakness lies in the failure to justify or have sufficient supporting documentation elsewhere justifying the need for safeguard changes. The final statement should contain very precise justification for the upgrading of our current safeguard objectives. Additionally, new safeguard concepts to be implemented should likewise be justified individually on a cost-benefit basis.

V. General Credibility

The GESMO Report should create a general impression of strict objectivity. The AEC is fully discharging its duties as protector of the public interest with regard to nuclear power, and this fact should not be undermined.

It is quite obvious, however, that the writers of GESMO have tried to make convincing arguments for the recycling of plutonium in LWRs. In spite of the fact that we here at CP&L agree with this conclusion, we believe such an impression of bias will prove to be detrimental to an early positive ruling on plutonium recycle.

This document must be edited from the viewpoint of those who oppose plutonium recycling. The document must avoid statements which can be shown to be biased under cross-examination at the subsequent hearings. Many examples of this bias have been identified in the draft; however, only a few are presented below for illustration.

1) The draft GESMO has too lightly dismissed several negative factors regarding plutonium recycling. For example: the potential effects of plutonium ingestion deserve a more

comprehensive, objective discussion of the well documented pathways and effects on man in order to improve the credibility of the report; and the potential additional occupational hazard to utility plant personnel must be addressed in terms of potential changes in equipment and procedures to reduce the additional hazard to insignificance.

2) The last of the fourth paragraph on page S-2 states that "Accidents at the mixed oxide fuel fabrication plant, a facility that does not occur in the UO_2 fuel cycle, are similar in consequence to accidents at UO_2 fuel cycle facilities as follows:

(1) Criticality accidents - UO_2 fuel fabrication facilities

(2) Fires and explosions involving plutonium - fuel reprocessing plants."

Because there is no basis for assuming comparable levels of automation and shielding in comparing a MOX fuel fabrication plant and a spent fuel reprocessing plant, one could easily interpret item (2) as an attempt to unfairly minimize the effect of a factor unfavorable to plutonium recycle by oversimplification.

3) The third sentence of the first paragraph of page S-42 states "The impact of plutonium recycle in light water reactors on the handling and shipping of significant quantities of strategic SNM (Special Nuclear Material) has been assessed and it is judged that the introduction of plutonium recycle into a situation already dominated by other strategic SNM would not in itself significantly affect the required safeguards measures." Although this conclusion may be accurate, most readers expect

additional measures to guard against theft of plutonium fuels to be required at commercial nuclear power plants. On the surface this seems a major increase in impact for a potentially large number of facilities. If the conclusion is reached because the changes at nuclear plants are judged to be relatively minor and inexpensive, then this simple explanation should be included in all descriptions. Otherwise, many readers will interpret this conclusion as biased minimization of an additional negative effect of plutonium recycle.

4) The first sentence of the last paragraph of page S-46 states "In the spent fuel reprocessing plants increased, but low, emissions of transuranium isotopes would accompany the implementation of plutonium recycle." Here an impression of bias has been conveyed by choice of words. The "but low" in this sentence appears as too much protesting about how insignificant the effects of plutonium recycle are. A sentence quantifying the low level of emissions from reprocessing plants with UO_2 cycle, followed by a second sentence quantifying the magnitude or percentage of increase to be caused by MOX would present the same facts with a degree of objectivity which could be defended and probably would not be challenged.

5) The sixth and seventh sentences in the second paragraph of page S-61 state "Since this (enriching) plant would be required in the early 1980's if plutonium were not recycled, it would probably be based on gaseous diffusion technology. This plant would probably use the gas centrifuge technology under either of the plutonium recycle alternatives since more time would be available for development of the new technique." This conclusion clearly reflects substantial bias in favor of plutonium recycle since it is highly speculative to conclude now that gas centrifuge technology will reach commercial practicality within precisely the span of time required to provide this presumed advantage to the MOX fuel cycle. At best these facts should be presented as a trend which could result in such an advantage.

The credibility of this report could also be improved through provision of sensitivity studies of the major data analyses. Because many projections are required to evaluate plutonium recycling in the year 1990, the reader is continually made aware that uncertainties exist. These uncertainties could be brought into perspective through appropriate sensitivity studies.

Enclosure 2

SPECIFIC COMMENTS ON WASH-1327 (GESMO)
CAROLINA POWER & LIGHT COMPANY

Page S-7, item 6

The safeguards concept of "spiked" plutonium should be eliminated from consideration because it only trades one risk for another and is not consistent with the concept of "as low as practical" occupational radiation exposure.

Page S-12, Section II.1

Does the AEC intend to issue regulatory information with respect to the use of mixed oxide in the already acceptable LWR designs under the IAC or will the use of mixed oxide be considered as new core design requiring major hardware changes in existing LWRs in light of the FAC?

Page S-22, Figure S-1

Projections for nuclear power are highly optimistic and inconsistent with recent industry and AEC estimates.

Page S-21, second paragraph

This paragraph should be modified to avoid the implication that operation in accordance with Technical Specifications is unique to use of recycled plutonium.

Page S-29, Table S-6

The units of the liquid radiological effluents have not been specified.

Page S-36, last line of fourth paragraph

Modify to read ". . . genetic defects from all causes expected in 1990. . ."

Page S-42, second paragraph

"Storage at reactor sites" is considered as an "area of greatest difference between the present uranium fuel cycle for LWRs and the LWR mixed oxide fuel cycle, where additional safeguards measures must be considered . . ." A similar statement on page S-6 does not include these reactor sites. We recommend use of the version on page S-42 as most responsive to potential safeguards concerns.

Page S-43, Table S-10, footnote

A description of the LWRs considered here as noncommercial should be included for clarity.

Page I-14, third paragraph, last sentence

Reads, "At most, some additional control rods and rod drive mechanisms may be necessary in some reactors" [for utilization of MOX]. The "at most" is a misleading oversimplification.

Page I-15, Table I-2

The "Decay Heat Characteristics of Irradiated Plutonium" should be added to this table.

Page II-12, Figure II-4

Figure II-4 should be updated to show the effect of the energy crises.

Page II-19, top of page

The first equation is erroneously repeated.

Page II-24, third paragraph, line 6

Should read, ". . . plutonium-containing fuel rods would have a greater power density than uranium-only rods of equivalent fissile material concentration." One cannot conclude the power density would be twice as high.

Page II-59, sixth paragraph

We do not believe that the statement "Plutonium utilization in BWRs appears economically less attractive than in PWR's . . ." can be substantiated.

Page II-59, tenth paragraph

The statement, ". . . it is of interest to blend the plutonium with uranium from gas-cooled reactors or PWR's . . ." is speculative and does not contribute to the objectives of GESMO.

Page II-63, first paragraph, last line, and Page IV G-31, Table IV G-6

Recent data investigated by CP&L indicates shipping of spent mixed-oxide fuel may not be different from spent uranium fuel since measured differences in decay heat seem insignificant. This issue should be clearly described as unresolved.

Page III-3, Table III-1

Plutonium storage data is incomplete.

Pages III-8, 9, Figures III-4A and III-4B

Should include plutonium storage facilities.

Page IVA-12, Section C

The words "accident," "severe accident" and "extremely severe accident" are used without defining the scope and consequences of each.

Page IVC-25, second paragraph

Accident classes should be identified as Condition II, III, or IV to be consistent with ANSI 18 standards and SARs.

Page IVC-26, Table IVC-2

Same as above.

Page IVC-32, third paragraph, second line

The thermal flux in a mixed oxide fuel assembly would not be reduced to "only half." This is only approximate because the higher self-shielding of plutonium should be considered.

Page IVC-38, fifth paragraph

The fuel element self-shielding effect should also be addressed. Self-shielding should be identified as being the reason for the behavior described on page IVC-49, third paragraph.

Page IVC-56, first paragraph

Should conclude here that the coolant requirements for spent fuel pools will not change from UO_2 storage to MOX storage.

Page IVD-3, second paragraph

"All plutonium contaminated wastes leaving the facility are solids, or have been incorporated into a solid matrix (concreted)." Alternatives to concrete matrix are being allowed as per WASH-1539.

Page IVD-30, Table IVD-7

Sanitary effluents in Tables IVD-7 and IVD-5 are not consistent.

Page IVD-38, Table IVD-11

The basis of the 80,000 rem/yr. is very unclear and requires further review and clarification. The value should possibly be 8000 rem/yr.

Page IVG-5, fifth paragraph

The 17% increase in vehicle-miles does not consider the highly probable changes in transportation criteria which will arise due to regulatory/intervenor pressures. A sensitivity analysis should be performed.

Page IVG-5, seventh paragraph

Definition of accident severity is required to appreciate the probability of the events.

Page IVG-6, Figure IVG-1

Potential storage/transportation of 10 nanocurie/gm low level waste from reactor operations should be indicated.

Page IVG-9, second paragraph

The reference to "serious" and "catastrophic" consequences is very unclear. Definition and limits of such terms are required.

Page IIVG-16, Table IV G-5

Transport Group III, ^{131}Ir should be ^{131}I.

Page IVG-19, Section e., third paragraph

It is noted that an open trailer with cask is under the same criteria. Closed trucks are not mandatory.

Page IVG-22, first and second paragraphs

It should be stated that the mileage is round-trip. Further, no mention of rail mileage is made. Is this included in these estimates? It is unclear if the 200 truck shipments refer to strictly radwaste and fuel related shipments.

Page IVG-22, paragraph n.

It is noted that various states have formed groups and programs to address post-accident actions - e.g., Southern Interstate Nuclear Board.

Page IVG-52, Table IV G-12

Should include comparable values for UO_2.

Page IVH-5, fourth paragraph

1. The rationale for the 10 nanocurie limit should be given. Reference Appendix B WASH-1539.

2. Why amend 10CFR20 to require disposal at federal burial grounds of fuel bundle hulls?

Page V-7, paragraph 4

Object to federally operated nuclear security system.

Page V-7, paragraph 6

"Spiked" plutonium makes plutonium recycle undesirable from the standpoint of storage and inspection of new fuel both in manufacturing plant and in power plant.

Page V-7

It is suggested that regulatory guides on plutonium utilization be separated for the various facilities such as power plants, manufacturing facilities, reprocessing plants, etc., to promote clarity of applicability.

Page V-16, paragraph (4)

The term "escort car" should be clarified. Does it mean escorting automobile or adjacent railcar?

Page V-16, paragraph (6)

AEC notification is usually placed on a time frame such as immediately by telephone, within 24 hours, etc.

Page V-17, paragraph b.

Material Balance Area (MBA) should be functionally defined.

Page V-26, second line

Storage of plutonium in vaults or vault type rooms will be difficult to provide at existing plants like H. B. Robinson or Brunswick.

Page V-44, Section q., H.2.9

The use of spiked plutonium seems contrary to the philosophy of ALAP inplant exposure (Regulatory Guide 8.8).

NRC Staff Response to Specific Comments on Health, Safety and Environment, by J. A. Jones

1. Comment:

"The GESMO has effectively utilized cost-benefit evaluation for many of the factors which must be considered in recycling plutonium. However, we suggest that even greater emphasis on cost-benefit evaluation is appropriate. The scope of the social issues, together with the number and complexity of the technical issues, contribute to an overall representation of the problem which is somewhat confusing. Cost-benefit evaluation should represent the quantifying central structure of the total analysis to mitigate the confusion. The effects of the risk and environmental factors which are not readily expressed in dollars can be quantified by evaluation of the cost or benefit to obtain acceptable levels of risk or environmental commitment. Although this cost-benefit emphasis does not contribute to the solution of unresolved social and technical issues, it does provide a clearly recognizable single basis for evaluating the total impact of these uncertainties."

Response:

In the assessments of final GESMO, it was determined that all impacts were below acceptable risk levels as defined by regulations 10 CFR 20 on radiological releases and 10 CFR 50, Appendix I, for design objectives and limiting conditions for LWR operations. GESMO addresses the differential impacts on the environment and the cost-benefit as related to the three fuel cycle options of no recycle, recycle of uraium only, and the recycle of uranium and plutonium. The socio-economics is more site oriented and would be considered in the licensing of each fuel cycle facility on a case-by-case basis.

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2. Comment:

"A decision not to recycle plutonium in LWR's would probably cripple the breeder program. Because GESMO has been generated in an industry atmosphere which assumes the breeder will be developed, a positive decision on mixed-oxides (MOX) in LWRs will have little effect. Nevertheless, GESMO must consider the consequences of either a positive or a negative decision and establish a basis for accounting for the full cost-benefit impact of a negative decision.

"The decision whether to recycle plutonium in LWRs should be based on the basic issues of direct importance to our society, rather than on technical details. The single question to be answered is "What is the cost-benefit choice for present and future generations concerning MOX in LWR's?" Detailed technical considerations are not central to the decision to be made here but should be considered from two viewpoints only: (1) credibility of pertinent technology, and (2) estimated cost to be utilized in the cost-benefit evaluations. The first should provide perspective in evaluating the uncertainly of the second. Sensitivity studies should be provided on significant issues to further quantify uncertainties."

Response:

To insure that no credits are taken for advanced and unproven technologies, economic advantages are deliberately excluded. This comment is valid in pointing out that Pu recycle, as it could be developed for the LWR industry, would have no major benefits for the later advent of a FBR industry.

Thus the analysis performed in CHAPTER XI in final GESMO is based on only plutonium recycle in LWR's, and the advent of the FBR is not an issue and does not influence the results. This effect and other sensitivity analyses are included in CHAPTER XI, Section 3.0.

3. Comment:

"Actual cost-benefit margins should be provided in dollars as well as in percent. In addition to quantifying cost-benefit relationships, such margins provide perspective and guidance in consideration of the costs of additional procedures, facilities, and equipment which may be required as plutonium recycling technology develops. Such analyses will inform the industry of the practical limits of additional expenditures which may be associated with plutonium recycling."

Response:

In final GESMO, the economic as well as the environmental costs of the implementation of plutonium recycle have been quantified in absolute as well as relative terms. A cost-benefit ratio, per se, is presented only for the radiological environmental costs, and the economic benefits of prompt recycle as related to the no recycle option. A complete coverage of the above is included in CHAPTERS VIII and XI, covering the sensitivities of delays in the implementation for the period 1975 through 2000.

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4. Comment:

"The GESMO report gives the overall impression of being repetitive and therefore unnecessarily voluminous. It is recognized that the authors have been careful to repeat material wherever it is pertinent, in order that each section of the report might constitute an independent whole. However, this report could be more easily comprehended if basis tables, figures, and analyses were provided in only one location. Other discussions and summaries should reference these data in detail so that each statement can readily be checked against its substantiating analyses. The present format also requires substantial searching and checking of repeated versions of the same materials to identify differences between the versions and to establish, if possible, the location of the complete presentation of the data. Some of the space saved by eliminating repetition could be used to present summaries and conclusions in a more objective format to avoid any impression of bias."

Response:

This final GESMO is a generic statement which must serve the entire LWR industry. It has been prepared to relate to all of the components of the Pu recycle industry. To accommodate wide coverage and varied interests, GESMO is structured to provide independent complete environmental assessments of the many steps of the final cycle detailed in CHAPTER IV. The individual summaries and overall summary and conclusions in the final GESMO have been recast to provide independent overviews with some repetition of basis tables and figures but augmented with cross references to the detailed text sections.

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5. Comment:

"Principles for determining the significance of individual aspects of the evaluation should be established on a generic basis and applied rigorously throughout the report. For instance, one rule might state that any aspect of the problem which changes the cost of the base case by less than one percent, including uncertainties, can be disregarded. It will then be necessary to demonstrate that a particular effect is less than one percent before it can be declared to be "insignificant." We suggest a completely comprehensive set of such ground rules should be prominently described in the report."

Response:

The ground rules for the evaluation of Pu recycle have been described in some detail in CHAPTER VIII, Section 5 of final GESMO. The uncertainties have also been explored, and their effects are discussed in CHAPTER XI, Section 3.

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6. Comment:

"It is quite obvious, however, that the writers of GESMO have tried to make convincing arguments for the recycling of plutonium in LWRs. In spite of the fact that we here at CP&L agree with this conclusion, we believe such an impression of bias will prove to be detrimental to an early positive ruling on plutonium recycle.

"This document must be edited from the viewpoint of those who oppose plutonium recycling. The document must avoid statements which can be shown to be biased under cross-examination at the subsequent hearings. Many examples of this bias have been identified in the draft; however, only a few are presented below for illustration."

Response:

This comment relating to the need to maintain objectivity in the assessment of plutonium recycle to avoid an impression of bias for a positive ruling has been given consideration in the text of final GESMO. The text has been expanded and provides more extensive coverage of the potential risks as well as benefits. Refer to specific responses to Comments 7, 8, and 12 of this Comment Letter No. 37.

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7. Comment:

"The draft GESMO has too lightly dismissed several negative factors regarding plutonium recycling. For example: the potential effects of plutonium ingestion deserve a more comprehensive, objective discussion of the well documented pathways and effects on man in order to improve the credibility of the report; and the potential additional occupational hazard to utility plant personnel must be addressed in terms of potential changes in equipment and procedures to reduce the additional hazard to insignificance."

Response:

Overemphasis of the inferior pathway of plutonium intake, ingestion, is difficult to justify. CHAPTER IV, Section J, Appendix C, reviews the considerable knowledge about plutonium metabolism that prevails.

Although the penetrating radiation from unirradiated MOX fuel is somewhat greater than that from fresh UO_2 fuel, the additional exposure entailed in the manual steps of loading an LWR is expected to be so inconsequential compared to normal exposures at an LWR, that additional mechanization should be unwarranted. Measures to cope with Pu in irradiated fuel need not be different for MOX than for UO_2 fuel.

8. Comment:

"The last of the fourth paragraph on page S-2 states that 'Accidents at the mixed oxide fuel fabrication plant, a facility that does not occur in the UO_2 fuel cycle, are similar in consequence to accidents at UO_2 fuel cycle facilities as follows:

(1) Criticality accidents - UO_2 fuel fabrication facilities

(2) Fires and explosions involving plutonium - fuel reprocessing plants.'

"Because there is no basis for assuming comparable levels of automation and shielding in comparing a MOX fuel fabrication plant and a spent fuel reprocessing plant, one could easily interpret item (2) as an attempt to unfarily minimize the effect of a factor unfavorable to plutonium recycle by oversimplification.

Response:

The final GESMO text has been changed to clarify the point that calculations show that radioactive releases resulting from upper limit accidents at MOX fuel fabrication plants are the same order of magnitude as those resulting from those accidents at reprocessing and UO_2 fuel fabrication plants. See CHAPTER IV, Section D-5.0 and Section E, paragraph 3.5.

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9. Comment:

4) "The first sentence of the last paragraph of page S-46 states 'In the spent fuel reprocessing plants increased, but low, emissions of transuranium isotopes would accompany the implementation of plutonium recycle.' Here an impression of bias has been conveyed by choice of words. The 'but low' in this sentence appears as too much protesting about how insignificant the effects of plutonium recycle are. A sentence quantifying the low level of emissions from reprocessing plants with UO_2 cycle, followed by a second sentence quantifying the magnitude or percentage of increase to be caused by MOX would present the same facts with a degree of objectivity which could be defended and probably would not be challenged."

Response:

The referenced paragraph in the draft GESMO pertains, for the most part, to releases of tritium and ^{85}Kr.

The above comment refers to the summary statement. The level of emissions from reprocessing plants which compare the UO_2 cycle with the changes due to the implementation of Pu recycle, are presented in detail in CHAPTER IV, Section E.

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10. Comment:

"The sixth and seventh sentences in the second paragraph of page S-61 state 'Since this (enriching) plant would be required in the early 1980's if plutonium were not recycled, it would probably be based on gaseous diffusion technology. This plant would probably use the gas centrifuge technology under either of the plutonium recycle alternatives since more time would be available for development of the new technique.' This conclusion clearly reflects substantial bias in favor of plutonium recycle since it is highly speculative to conclude now that gas centrifuge technology will reach commercial practicality within precisely the span of time required to provide this presumed advantage to the MOX fuel cycle. At best these facts should be presented as a trend which could result in such an advantage."

10. Comment (Cont'd)

Response:

In view of the existing reprocessing industry, this final statement considered the earliest possible date for spent fuel reprocessing was 1978 with widescale Pu recycle to start in 1981 as a bounding case for assessments of impacts from 1975 to year 2000. Based on mid-1976 realistic evaluation of industry progress there could be a delay in the implementation or Pu recycle to about 1981. In the 26-year period of study in final GESMO, the impacts on the overall LWR industry due to this delay are considered comparatively minor. Refer to the sensitivity studies on delays in CHAPTER XI, Section 3.0. With this schedule it has been assumed for assessment of the impacts on the environment that the next new enrichment plant will be gaseous diffusion and any follow on plants the gas centrifuge type. In addition, a comparative assessment of environmental impacts was made on the basis that all future enrichment plants would be gas centrifuge. Refer to CHAPTER IV, Section F, paragraph 4.3 and Appendix A.

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11. Comment:

"The credibility of this report could also be improved through provision of sensitivity studies of the major data analyses. Because many projections are required to evaluate plutonium recycling in the year 1990, the reader is continually made aware that uncertainties exist. These uncertainties could be brought into perspective through appropriate sensitivity studies."

Response:

The recommended studies have been performed and are discussed in this final GESMO. See CHAPTER XI, Section 3.0.

NOTE: Specific comments relating to editorial and clarfication items have been incorporated in the text. Response to selected comments follow:

12. Comment:

"Page S-12, Section II.1. Does the AEC intend to issue regulatory information with respect ot the use of mixed oxide in the already acceptable LWR designs under the IAC or will the use of mixed oxide be considered as new core design requiring major hardware changes in existing LWRs in light of the FAC?"

Response:

The use of recycle plutoium in the manner described (Refer to CHAPTER IV, Section C) will not cause fuel rod peak clad temperatures to increase at a faster rate following the design basis loss of coolant accidents and because of this no major hardware changes in existing LWR's to further improve emergency core cooling are warranted or contemplated.

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13. Comment:

"Page S-21 second paragraph. This paragraph should be modified to avoid the implication that operation in accordance with Technical Specifications is unique to use of recycled plutonium."

Response:

In final GESMO, the implication that the Technical Specifications are unique to the use of MOX in LWR's has been removed. Refer to CHAPTER IV, Section C-1.0 and Section C-4.0 for detailed discussions on the use of recycle Pu in LWR fuels.

14. Comment:

"Page II-59, sixth paragraph. We do not believe that the statement 'Plutonium utilization in BWRs appears economically less attractive than in PWRs...' can be substantiated.

"Page II-59, tenth paragraph. The statement '... it is of interest to blend the plutonium with uranium from gas-cooled reactors or PWR's ...' is speculative and does not contribute to the objectives of GESMO."

Response:

These statements are direct quotes from the conclusions reached by the Belgians in their Pu recycle program. A change to their conclusions would not be appropriate. The reference quoted is included in the final statement in CHAPTER II, paragraph 3.1.7.

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15. Comment:

"Page II-63, first paragraph, last line and Page IV G-31, Table IV G-6. Recent data investigated by CP&L indicates shipping of spent mixed-oxide fuel may not be different from spent uranium fuel since measured differences in decay heat seem insignificant. This issue should be clearly described as unresolved."

Response:

Based on the calculations used in final GESMO, there will be some higher heat generation in MOX spent fuel shipments. For more details on the comparisons of heat release from spent fuels refer to CHAPTER IV, Section G, paragraph 3.4, which shows differentials between the three options, no recycle, uranium recycle only, and uranium and Pu recycle.

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16. Comment:

"Page IVC-25, second paragraph. Accident classes should be identified as Condition II, III, or IV to be consistent with ANSI 18 standards and SARs.

"Page IVC-26, Table IV-2. Same as above."

Response:

Postulated accidents and occurrences are further classified in final GESMO in Table IV C-38. CHAPTER IV, Section C, paragraph 5.4.

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17. Comment:

"Page IVC-32, third paragraph, second line. The thermal flux in a mixed oxide fuel assembly would not be reduced to 'only half'. Ths is only approximate because the higher self-shielding of plutonium should be considered."

Response:

This portion of the draft GESMO has been changed. In the final GESMO the wording has been changed from "only" to approximately." Refer to CHAPTER IV, Section C, paragraph 3.3.4.

18. Comment:

"Page IVC-38, fifth paragraph. The fuel element self-shielding effect should also be addressed. Self-shielding should be identified as being the reason for the behavior described on page IVC-49, third paragraph."

Response:

The necessity for incorporating self-shielding effects in the fuel rod cross section calculations is discussed in the final GESMO and accounts for the nonuniform power production and resultant temperature profile that is noted in the comment. Refer to CHAPTER IV, Section C, paragraph 3.3.7.

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19. Comment:

"Page IVC-56, first paragraph. Should conclude here that the coolant requirements for spent fuel pools will not change from UO_2 storage to MOX storage."

Response:

Because of the calculated increased actinides for the model 1.15 SGR in contrast to the uranium-only core, the longer-term spent fuel storage cooling requirements may be slightly higher, but in general will be within spent fuel pool capabilities. See CHAPTER IV, Section C, paragraph 4.3.2.

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20. Comment:

"Page IVD-3, second paragraph. 'All plutonium contaminated wastes leaving the facility are solids, or have been incorporated into a solid matrix (concreted)'. Alternatives to concrete matrix are being allowed as per WASH-1530."

Response:

The final GESMO text has been modifed to state that present technology for processing liquid waste considers the incorporation of waste into a solid material -- (using either cement or an equivalent solidification agent. See CHAPTER IV, Section D, paragraph 1.5. Also see CHAPTER IV, Section for the deposition of transuranic wastes in Federal repository.

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21. Comment:

"Page IVD-38, Table IVD-11. The basis of the 80,000 rem/yr. is very unclear and requires further review and clarification. The value should possibly be 8000 rem/yr."

Response:

This number was in error in the draft GESMO. The basis was the population within 50 miles of the plant (8 million) multiplied by the average annual natural U.S. background radiation of 100 mrem (.1 rem/yr) to total 800,000 person rem/year. The basis for population dose has been changed in the final GESMO, however, to include the entire population of the United States (250 million). See CHAPTER IV, Section D paragraph 4.3.3.

22. Comment:

"Page IVG-5, fifth paragraph. The 17% increase in vehicle-miles does not consider the highly probable changes in transportation critera which will arise due to regulatory/interventor pressures. A sensitivity analysis should be performed."

Response:

It is not expected that the vehicle-miles would increase due to regulatory/intervenor pressures over the mileage already assumed in this section. The radiological impact and environmental effect due to transportation are sufficiently small (less) when compared to average natural background radiation and total United States truck mileage as to not warrant additional study. Refer to CHAPTER IV, Section G, Tables IV G-1 and IV G-2.

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23. Comment:

"Page IVG-9, second paragraph. The reference to 'serious' and 'catastrophic' consequences is very unclear. Definition and limits of such terms are required.

Response:

In final GESMO this statement has been clarified to indicate "serious" with regard to property damage, but not judged catastrophic since no deaths would be expected. See CHAPTER IV, Section G.

---

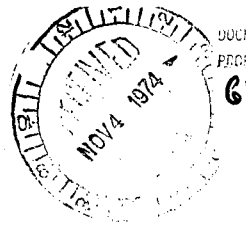
24. Comment:

"Page IVG-22, first and second paragraphs. It should be stated that the mileage is round-trip. Further, no mention of rail mileage is made. Is this included in these estimates? It is unclear if the 200 truck shipments refer to strictly radwaste and fuel related shipments."

Response:

In final GESMO, CHAPTER IV, Section G, Tables IV G-1 and IV G-2 have been updated to show shipments of fuel materials and waste material by rail and truck for comparative purposes. The shipments are roundtrips and refer to the radioactive materials listed for the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium. Rail shipments were not considered a factor in the traffic and weight discussion.

Comment Letter No. 38



DOCKET NUMBER
PROPOSED RULE PR Misc Notice (39 FR 36786) 12-11-74
GESMD

Consumers Power Company

R. A. Lamley
Vice President

General Offices: 212 West Michigan Avenue, Jackson, Michigan 49201 • Area Code 517 788-1270

November 1, 1974

US Atomic Energy Commission
Washington DC 20545

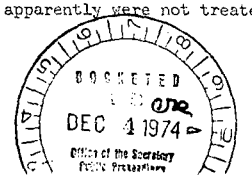
Gentlemen: Attention: Deputy Director for Fuels & Materials,
Directorate of Licensing - Regulation

We are taking this opportunity to offer our comments to the Commission on its Generic Impact Statement Mixed Oxide Fuel (GESMO).

Consumers Power believes that treating the environmental effects of plutonium recycle in a generic proceeding will allow a more detailed examination of plutonium recycle, than if plutonium recycle were independently considered in individual licensing proceedings.

Consumers Power feels that the GESMO treatment of plutonium safeguards is incomplete. First, plutonium recycle significantly reduces the amount of plutonium which would otherwise have to be stored. Secondly, we feel that plutonium in a reactor core is more secure than either plutonium nitrate or oxide stored at a vault-type storage facility. Thirdly, the plutonium recycle is in essence similar to spiking alternative suggested.

For a given reactor, plutonium recycling between 1975 and 1990 will reduce the amount of plutonium available from that reactor by a factor of approximately six due to the consumption of recycle plutonium. Without plutonium recycle, the self-generated plutonium would have to be stored. With recycle, plutonium will not have to be stored because at any given time the majority of it will be in the reactor core with the remainder being processed. Storage in a reactor core is significantly more secure than in any conceivable type facility. In a reactor core, the plutonium is not divertable due to high radiation levels. Further, the difficulty in removing it from the plant site and reprocessing it to a reusable form is prohibitive. In a vault-type facility, while diversion may be difficult to conceive, if access is gained to the material, it is in a useful form. Additionally, less plutonium is available in a self-generation recycle scheme due to consumption. Finally, recycle reduces the fissile to fertile isotope ratio which lowers the quality of plutonium from a weapons standpoint. This, in effect, is a form of spiking as described in alternate 6. We believe that these advantages significantly off-set the transportation risk. The benefits stated above apparently were not treated in (GESMO).



5-38.1

Additionally, Consumers Power feels that alternatives 1 & 2 have not been properly treated from a cost benefit standpoint. Alternative 1 provides for prompt reprocessing of the spent fuel and storing the plutonium for future use while alternative 2 provides for storage of the spent fuel for later reprocessing and recycling.

Consumers Power Company believes that a comparison of forecasted production and consumption rates in 1990 shows that it will be virtually impossible to utilize a significant amount of the plutonium that was generated and stored prior to 1990 unless significant redesign of reactors takes place. It is impossible to recycle quantities of plutonium in current light water reactors that are significantly greater than self-generation quantities. We believe that contrary to the last paragraph on Page IIX-37 that a significant amount of the loss of use of plutonium estimated to be worth 840 million dollars can never be recovered. We believe that this conclusion is valid irregardless of whether alternative 1 or 2 is selected.

While a small fraction of the plutonium generated might also be used in the initial loading of mixed oxide fuel cores in the 1990's, Consumers Power believes this would not represent a significant fraction of the plutonium previously generated and stored.

These comments are predicated on our knowledge of the present designs of light water reactors and their capability with regard to plutonium recycle. Although it is possible that a redesign of existing plants could be undertaken to enhance this capability, if such redesign is postulated GESMO should be amended to take into account the capital investment associated with a redesign and modification effort for current reactors and the cost of replacement power associated therewith.

Yours very truly,

R. A. Lamley

RAL/db

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By R. D. Lamley - Consumers Power Co.

1. Comment:

"For a given reactor, plutonium recycling between 1975 and 1990 will reduce the amount of plutonium available from that reactor by a factor of approximately six due to the consumption of recycle plutonium. Without plutonium recycle, the self-generated plutonium would have to be stored. With recycle, plutonium will not have to be stored because at any given time the majority of it will be in the reactor core with the remainder being processed. Storage in a reactor core is significantly more secure than in any conceivable type facility. In a reactor core, the plutonium is not divertable due to high radiation levels. Further, the difficulty in removing it from the plant site and reprocessing it to a reusable form is prohibitive. In a vault-type facility, while diversion may be difficult to conceive, if access is gained to the material, it is in a useful form. Additionally, less plutonium is available in a self-generation recycle scheme due to consumption. Finally, recycle reduces the fissile to fertile isotope ratio which lowers the quality of plutonium from a weapons standpoint. This, in effect, is a form of spiking as described in alternative 6. We believe that these advantages significantly offset the transportation risk. The benefits stated above apparently were not treated in (GESMO)."

Response:

This comment includes several valid points relating to the consumption of plutonium in LWR's with the Pu recycle mode of operation for the production of energy and reducing inventories of Pu to theft or sabotage or both. In the draft GESMO two fuel cycles were assessed--with Pu recycle and without Pu recycle. The without Pu recycle was a uranium recycle considering reprocessing of spent fuels and storage of plutonium. In final GESMO the third fuel cycle option is included--no recycle or the throw away fuel cycle. The quantities of self generated Pu utilized and stored are covered in detail in CHAPTER IV, Section I, Plutonium Storage. In CHAPTER III, Projected Pu Recycle Industry, a comparison is made of the three fuel cycle options, no recycle, uranium recycle only, and uranium and Pu recycle in terms of quantities of materials in process and storage, including plutonium. CHAPTER IV, Section C-4.0 provides comparative data of core inventories for LWR's operating with UO_2 fuel only and those operating with MOX fuels--the GESMO 1.15 SGR model at equilibrium. Table IV C-1 shows the changes in fertile and fissle plutonium after several years of recycle.

A supplement to the draft GESMO statement reviews the safeguards aspects of Pu recycle using the prompt recycle condition of Alternative 3 as compared to the throw away fuel cycle, no recycle, as the bounding analyses for safeguards considerations.

---

2. Comment:

"Additionally, Consumers Power feels that alternatives 1 & 2 have not been properly treated from a cost benefit standpoint. Alternative 1 provides for prompt reprocessing of the spent fuel and storing the plutonium for future use, while alternative 2 provides for storage of the spent fuel for later reprocessing and recycling."

Response:

The basis for this comment on the cost-benefit analysis of Alternatives 1 and 2 is developed in Comment 3 below. The response to comment 3 shows that the plutonium can be effectively utilized in the delayed recycle alternates.

---

3. Comment

"Consumers Power Company believes that a comparison of forecasted production and consumption rates in 1990 shows that it will be virtually impossible to utilize a significant amount of the plutonium that was generated and stored prior to 1990 unless significant redesign of reactors takes place. It is impossible to recycle quantities of plutonium in current light water reactors that are significantly greater than self-generation quantities. We believe that contrary to the last paragraph on Page IIX-37 that a significant amount of the loss of use of use of plutonium estimated to be worth 840 million dollars can never be recovered. We believe that this conclusion is valid irregardless of whether alternative 1 or 2 is selected.

"While a small fraction of the plutonium generated might also be used in the initial loading of mixed fuel cores in the 1990's Consumers Power believes this would not represent a significant fraction of the plutonium previously generated and stored."

Response:

In final GESMO, Alternative 3 prompt reprocessing of spent fuel about 1978 and recycle of Pu as fuel in LWR's about 1981 was used as the base case for analyses. With the delays indicated in the reprocessing and MOX fuel fabrication industry, it is postulated that recycled Pu could be delayed until 1983. In final GESMO, it was postulated that all the plutonium generated in the study period 1975 through 2000 would be recycled in LWR's.

The environmental and economic impacts of delays have been factored into the sensitivity analyses included in CHAPTERS VIII and XI. The evaluations were made over the 26-year period through 2000 and it was determined that with several years delay in reprocessing and MOX fabrication for Pu recycle the overall industry economic penalties would be small and the prompt reprocessing, Alternative 3, could be considered as a bounding condition for the analyses.

---

4. Comment:

"These comments are predicated on our knowledge of the present designs of light water reactors and their capability with regard to plutonium recycle. Although it is possible that a redesign of existing plants could be undertaken to enhance this capability, if such redesign is postulated GESMO should be amended to take into account the capital investment associated with a redesign and modification effort for current reactors and the cost of replacement power associated therewith."

Response:

Redesign of LWR's to be able to accept MOX fuel up to 1.15 self generation is not contemplated. Refer to CHAPTER IV, Sections C-3.0 and 4.0. The 1.15 SGR model chosen for assessments of environmental and economic impacts was chosen in light of a survey of industry plans indicated that currently designed LWR's would be operated up to self generation or slightly over self generation quantities of Pu.

Comment Letter No. 39

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

FREIHOFER, COOK, HECHT, OOSTERHOUSE & DEBOER, P. C.
ATTORNEYS AT LAW
850 UNION BANK BUILDING
GRAND RAPIDS, MICHIGAN 49502
TELEPHONE (616) 454-9321

WALTER B. FREIHOFER
GEORGE R. COOK
DAVID W. HECHT
DONALD F. OOSTERHOUSE
ROBERT J. DEBOER
BRUCE A. BARNHART
GLEN V. BORRE
ROBERT P. COOPER
PHILIP M. IDEMA
PETER W. STEKETEE
PETER R. TOLLEY
JAMES E. McCOBB
GEORGE E. PAWLOWSKI
WILLIAM J. FISHER, III
JAMES B. FLICKINGER
JANET T. NEFF
STUART F. CHENEY
MARK H. VERWYS

OF COUNSEL:
FRED N. SEARL
EDWARD C. McCOBB

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DEC 4 1974
Office of the Secretary
Docketing & Service
Branch

RECEIVED
NOV 5 1974
U.S. Atomic Energy Commission
Public Document Room

October 30, 1974

U.S. Atomic Energy Commission
Att: Deputy Director for Fuels and Materials
Directorate of Licensing-Regulation
Washington, D.C. 20545

Re: Generic Environmental Impact Statement on Plutonium Recycling (GESMO)

Dear Sirs:

This letter relates to the Commission's draft generic environmental statement on the use of mixed oxide fuel (GESMO) and to the notice of availability of the draft statement dated August 15, 1974.

This letter is being submitted to you on behalf of West Michigan Environmental Action Council, Inc., 822 Cherry Street, S.E., Grand Rapids, Michigan 49506, which this firm represents in a lawsuit entitled West Michigan Environmental Action Council, Inc. -v- AEC, et al., United States District Court, Western District of Michigan, Southern Division, File No. G 58-73 CA. We also represent West Michigan Environmental Action Council, Inc., in In the Matter of Consumers Power Company (Big Rock Point Plant), Docket No. 50-155, relating to the proposed use of mixed oxide fuel by Consumers Power Company at its Big Rock Point nuclear plant. WMEAC is also concerned with the Hot Particle proceedings initiated by the Natural Resources Defense Council, Inc., and with the generic proceedings relating to GESMO.

The purpose of this letter is to notify you that WMEAC is relying, for its comments on the draft GESMO, on the comments which you either have or will be receiving from the Natural Resources Defense Council, Inc.

Very truly yours,

FREIHOFER, COOK, HECHT,
OOSTERHOUSE & DE BOER, P.C.

Peter W. Steketee

PWS/jmc
cc: Tony Roisman
Gus Speth

5-39.1

NRC Staff Response to Specific Comments on Health, Safety and Environment by P. W. Steketee

1. Comment:

The purpose of this letter is to notify you that WMEAC is relying for its comments on the draft GESMO, on the comments which you either have or will be receiving from the Natural Resources Defense Council, Inc."

Response:

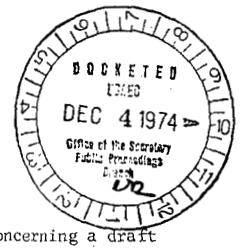
See responses to comments by Natural Resources Defense Council, Inc., Comment Letter No. 25.

Misc Letter 3HK-001861
GESMO

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S. COAST GUARD (G-WS/73)
400 SEVENTH STREET SW.
WASHINGTON, D.C. 20590
PHONE: 426-2262

4 NOV 1974



Mr. S. H. Smiley
Deputy Director for
Fuels and Materials
Directorate of Licensing
Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

This is in response to your letter of 23 August 1974 concerning a draft generic environmental statement on Mixed Oxide Fuel.

The concerned operating administrations and staff of the Department of Transportation have reviewed the material submitted. The Federal Highway Administration commented as follows:

"The Light Water Cooled Reactor (LWR) program is already underway and so the EIS covers just the impacts of recycling plutonium, the alternate to which is to not recycle plutonium. The environmental benefits result from not mining for the uranium which is replaced by the recycled plutonium. The environmental cost results mostly from the radiation effluent at the Mixed Oxide Plant (mixed oxide refers to the fact that Uranium Oxide, UO_2, and Plutonium Oxide, PuO_2, is mixed in the plant), the impact of transporting the Plutonium and the possibility of sabotage or theft during transportation. (PuO_2 can be made into a bomb fairly easily but UO_2 in concentration that run-reactors cannot be made into a bomb).

"There is one comment considered to be major and several considered to be minor.

"Major: The capital investment in recycling plutonium from the LWR will make it more desirable to proceed with the Liquid Metal Fast Breeder Reactor (LMFBR). This is roughly equivalent to the segmentation problem of some Federal Highway Administration EIS's. The issue is not addressed in the GESMO document, indeed Pg S-6 and various pages throughout assume the implementation of the LMFBR indicating that recycling plutonium is not a logical terminal.

"Minor: 1. Pg. S-12 - The EIS is quite conclusive.

2. Pg. S-44 - Misspelled word 3rd line from the bottom.

3. II-4-EIS states 'The amount of energy needed to produce a dollar's worth of Gross National Product has been decreasing.' This statement is misleading (or false).

4. Chap. II-32 indicates that plutonium is not concentrated in the higher trophic levels. EIS should say whether the transplutonium actinides have this property.

5. Chap. I A-2 and Chap. IV C-24 show slightly different by-products of first generation UO_2 fuel. A breakdown of the by-products of plutonium fission would be useful to compare with the by-products of uranium fission given in Chap. I A-2.

6. Chap. IV pages C-31 and C-50 hints that the efficiency and capacity of a plant might differ with different fuel use. This point should be made explicitly.

7. Chap. IV C-72 uses the word 'ethnic' strangely.

8. Chap. IV D-36 should state if HF, NO_x and NH_3 are the only significant chemical effluents that come from the Mixed Oxide Fuel Fabrication Plants.

9. Chap. IV F-36-Is it true that all gas-diffusion plants will be run by coal-fired electricity?

10. Chap. IV in general assumes that the 'Spiked plutonium' anti-theft measure mentioned throughout the EIS will not take place. Chap. V-44 does indicate that 'Spiked plutonium' use would change all the tables in Chapter IV. If 'Spiked plutonium' is a serious consideration, then it should be so treated in Chapter IV.

11. Chap. VII-7-The EIS shows AEC's measures to mitigate construction pollution are the same as ours.

12. Chap. XI-55 line 3 refers to 'paragraph-10' should be 'pg 10 of this chapter."

The Department of Transportation has no other comments to offer nor do we have any objection to this project. The concerns of the Federal Highway Administration, however, should be addressed in the final statement.

The opportunity to review this draft statement is appreciated.

Sincerely,

W. E. Caldwell

W. E. CALDWELL
Captain, U.S. Coast Guard
Deputy Chief, Office of Marine
Environment and Systems
By direction of the Commandant

NRC Staff Response to Specific Comments on Health, Safety and Environment by W. E. Caldwell - DOT-US Coast Guard

1. Comment:

"Major: The capital investment in recycling plutonium from the LWR will make it more desirable to proceed with the Liquid Metal Fast Breeder Reactor (LMFBR). This is roughly equivalent to the segmentation problem of some Federal Highway Administration EIS's. The issue is not addressed in the GESMO document, indeed Pg S-6 and various pages throughout assume the implementation of the LMFBR indicating that recycling plutonium is not a logical terminal."

Response:

In the draft statement, the LMFBR was assumed to be introduced about 1990 but no credit was taken in the analyses for benefits from the utilization of the recovered Pu in the LMFBR's. In this final GESMO, the analyses are centered about an LWR industry where all the plutonium recovered from spent LWR fuels is recycled to LWR's. However, other analyses are included to show that the economic benefits of plutonium recycle in LWR's are unchanged in the 26-year period 1975-2000 by the introduction of LMFBR's. Those benefits are not contingent upon the introduction of LMFBR's nor will benefits of an LMFBR industry, if it occurs in or soon after this period, be substantially different whether or not plutonium is recycled in LWR's, even though plutonium recycle would provide valuable experience applicable to an LMFBR fuel cycle.

Although Pu recycle in LWR's cannot be said to be unrelated to LMFBR's, the two are not inextricably intertwined nor does the existence of either one depend upon the existence of the other. The issue at hand is not Pu recycle per se, rather it is Pu recycle in LWR's and that is the issue which the final GESMO addresses.

---

2. Comment:

"3. II-4-EIS states, 'The amount of energy needed to produce a dollar's worth of Gross National Product has been decreasing.' This statement is misleading (or false)."

Response:

This statement has been deleted in the revisions to this section in final GESMO.

This comment is well taken. In the recasting of CHAPTER II in this final statement, reference to the "worth" of GNP was not considered pertinent to the revised text.

---

3. Comment:

"4. Chap. II-32 indicates that plutonium is not concentrated in the higher trophic levels. EIS should say whether the transplutonium actinides have this property."

Response:

In revising CHAPTER II for final GESMO and eliminating duplications of material cov[illegible] in more detail in other chapters, this section was deleted. The information

3. Comment (Cont'd)

on transplutonium actinides is covered in CHAPTER IV, Section J.

---

4. Comment:

"5. Chap. I A-2 and Chap. IV C-24 show slightly different byproducts of first generation UO_2 fuel. A breakdown of the byproducts of plutonium fission would be useful to compare with the byproducts of uranium fission given in Chap. I A-2."

Response:

The average composition of the recovered plutonium will differ depending upon the irradiation history of the fuel element, whether the fuel element was initially fueled with only slightly enriched uranium or with a mixture of PuO_2 and UO_2, and the amounts of plutonium isotopes in the pre-irradiated fuel mixture.

The referenced tables are presented to illustrate the variation in the isotopic composition of plutonium. Table IV C-1 is representative of fuel assemblies that were irradiated for periods less than the 275000 MWD/MT design objective assumed for Tables IV C-9 and IV C-12, for which selected fission products are shown.

The plutonium composition on page I(A)-2 of the draft GESMO was obtained from Table IV C-7 or IV C-12 in the final GESMO and is therefore consistent with calculations related to 1.15 SGR equilibrium conditions. Table IV C-1 in final GESMO represents the average composition of plutonium from all LWR's in the years 1975, 1980, and 1985, i.e., the values on page I(A)-2 represented the plutonium composition in spent fuel at the time it is removed from the core. Table IV C-1 values allow for variation in plutonium composition with fuel depletion, core design variations, and radioactive decay. Refer to CHAPTER IV, Sections C-2.0 and C-4.0.

---

5. Comment:

"6. Chap. IV, pages C-31 and C-50, hint that the efficiency and capacity of a plant might differ with different fuel use. This point should be made explicitly."

Response:

Page IV C-31 of the draft GESMO deals primarily with rod-to-rod power peaking, and the figure on page IV C-50 of the draft illustrates internal fuel rod temperatures.

The non-uniform power generation within the MOX rod in contrast to the uranium-only fuel rod (more of the MOX rod power is generated near the surface of the rod) results in lower central or peak fuel temperatures for the conditions assumed. Plant capacity and efficiency are not involved. Refer to final GESMO CHAPTER IV, Section C, paragraph 4.1.2.

---

6. Comment:

"8. Chap. IV D-36 should state if HF, NO_X, and NH_3 are the only significant chemical effluents that come from the Mixed Oxide Fuel Fabrication Plants."

6. Comment (Cont'd)

Response:

The text of final GESMO has been modified to clarify the fact that HF, NO_X, and NH_3 are the only significant chemical releases that could cause unacceptable atmospheric pollution if not controlled. Refer to CHAPTER IV, Section D, paragraph 2.3.2.

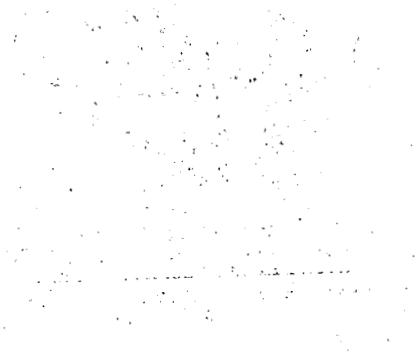
---

7. Comment:

"9. Chap. IV F-36 - Is it true that all gas-diffusion plants will be run by coal-fired electricity?"

Response:

The power generating system producing the electricity consumed by the present enrichment industry is primarily fossil fueled. It has been estimated in this final GESMO that after the period 1975 through 2000 approximately 40% of the power needed by the enrichment industry will be supplied by nuclear reactors. Refer to CHAPTER IV, Section F, paragraph 4.4.1.



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AZ-18

COVER SHEET for FEDERAL GRANT APPLICATION/AWARD NOTIFICATION
ARIZONA

1. APPLICATION DATE (yr mo day): 19 ___ ___ ___
2. FEDERAL EMPLOYER I.D. No.:

PART 1

3. APPLICANT — Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS — Street or P. O. Box: NONE
5. CITY: WASHINGTON
6. COUNTY:
7. STATE: DC
8. ZIP CODE: 20545
9. PROG. NO. /FEDERAL AGENCY: 24999 Atomic Energy Commissic
10. TYPE OF ACTION: a [X] New c [ ] Modification; b [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 [ ] Increase Grant; [ ] Decrease Grant; 12 [ ] Increase Duration; [ ] Decrease Duration; 13 a [ ] Other Scope Change; b [ ] Cancellation
14a. EXISTING FED GRANT ID
14b. EXISTING CLEARINGHOUSE
15. REQUESTED FUND START: 19 ___ ___ ___
16. FUNDS DURATION: ___ (Months)
17. EST. PROJECT START: 19 ___ ___ ___
18. EST. PROJECT DURATION: ___ (Months)
19. APPLICANT TYPE — Enter Letter [J]: A. State; B. Interstate; C. City; D. COG; E. County; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other
FUNDS REQUESTED (For Changes Show Only Amt. of Inc.(+) or Dec.(-))
20a. FEDERAL GRANT $ 1 .00
20b. FEDERAL LOAN $ .00
21. STATE $ .00
22. LOCAL $ .00
23. OTHER $ .00
24. TOTAL (20,21,22,23) $ 1 .00
25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)
26. PROJECT ABSTRACT (60 Characters Per Line — 5 Lines). Attach 1–2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.
27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA
28. CONGRESSIONAL DISTRICT — Of Applicant [ ] [ ] Districts Impacted By Project
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No — If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide
31. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b ADDRESS — Street or P. O. Box: WASHINGTON D.C. 20545
c TELEPHONE NO.

ITEMS 32-38 TO BE COMPLETED BY CLEARINGHOUSE

32. CLEARINGHOUSE ID: 200 — MULTIPLE CLEARINGHOUSE: [X] 201 202 203 204 205 206
33. a ACTION BASED ON REVIEW OF: a [ ] Notification b [ ] Application
33. b ACTION TAKEN: a [ ] With Comment c [ ] Waived b [X] Without Comment d [ ] Unfavorable
34. STATE APPLICATION IDENTIFIER (SAI): A Z 7 4 8 0 1 0 0 6 0 (State Number)
35. CLEARINGHOUSE IMPACT CODE — STATE WIDE: [X] Yes [ ] No; County/City/Reg Area
36. STATE PLAN REQUIRED: [ ] Yes [X] No
37. RECEIVING DATE AT CLEARINGHOUSE: 19 74 09 18
38. FINAL CLEARINGHOUSE ACTION DATE: 19 74 10 28 BY

ITEMS 39-42 TO BE COMPLETED BY APPLICANT AFTER RECEIPT OF CLEARINGHOUSE ACTION

PART 3

39. CERTIFICATION: The applicant certifies that to the best of his knowledge and belief the above data are true and correct and filing of this form has been duly authorized by the governing body of the applicant.
40. a NAME (Print or Type) | b TITLE | c SIGNATURE of Authorized Representative | d TELEPHONE NUMBER
41. DATE MAILED TO FEDERAL/STATE AGENCY: 19 ___ ___ ___
42. NAME OF FEDERAL / STATE AGENCY TO WHICH THIS APPLICATION SUBMITTED

ITEMS 43-51 TO BE COMPLETED BY FEDERAL OFFICE EVALUATING AND/OR COMPLETING APPLICATION

PART 4

43. GRANT APPLICATION ID (Assigned by Federal Agency)
44. GRANTOR AGENCY
45. ORGANIZATIONAL UNIT
46. ADMINISTERING OFFICE
47. ADDRESS — Street or P. O. Box
48. CITY
49. STATE
50. ZIP CODE
51. TELEPHONE NUMBER
52. Application Rec'd. (yr mo day): 19 ___ ___ ___
53. a Exp. Action Taken (yr mo day): 19 ___ ___ ___
53. b Action Taken: a [ ] Approved b [ ] Disapproved c [ ] Withdrawn
53. c OR Date Action Taken (yr mo day)
53. d Date to Applicant (yr mo day): 19 ___ ___ ___
REVISIONS: Amended Applic. Received (yr mo day): 19 ___ ___ ___
REVISIONS: Rev. Grantor Action Taken (yr mo day): 19 ___ ___ ___
54. Exp. Action Revised As Of (yr mo day): 19 ___ ___ ___
REVISIONS: Date Revised Action Rec'd. by Applicant (yr mo day): 19 ___ ___ ___

ITEMS 55-64 TO BE COMPLETED BY THE FEDERAL OFFICE AWARDING AND/OR COMPLETING APPLICATION

PART 5

FINAL ACTION — 55. a [ ] Awarded b [ ] Rejected c [ ] Withdrawn
FINAL DATES (yr mo day)
56. FUNDS AVAILABLE: 19 ___ ___ ___
57. ENDING DATE: 19 ___ ___ ___
58. FEDERAL GRANT ID
59. FEDERAL FUND ACCOUNT NUMBER
FUNDS APPROVED (For Changes Show Only Amt. of Inc. (+) or Dec. (-))
60. FEDERAL AMOUNT (IF Y ___ funds) $ .00
61. STATE SHARE $ .00
62. LOCAL SHARE $ .00
63. OTHER $ .00
64. TOTAL (60, 61, 62, 63) $ .00
65. MULTIPLE PROGRAM-LINK

PART 6

66. REMARKS
DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMD

DOCKETED USAEC DEC 4 1974
Office of the Secretary

7/74

INSTRUCTIONS FOR COMPLETING FORM 140

These instructions are designed to assist in completing the APPLICANT portions of the Form 1F. These portions are PART 1 and PART 3 and are SHADED IN P. DE.

PART 1

BOX NO	TITLE	INSTRUCTION	EXAMPLE
1	APPLICATION DATE	Date application is sent to the Clearinghouse.	yr mo day 73 01 02
2	FEDERAL EMPLOYER I.D.	This number is assigned to business entities by IRS. It has 9 digits. If you do not have an I.D. or need assistance in locating it, contact the Clearinghouse.	496-62-4684
3	APPLICANT	Use capital letters. MAXIMUM 40 CHARACTERS (including spaces). If necessary, abbreviate	STATE HEALTH DEPT US FOREST SERVICE
4	ADDRESS	Use capital letters. MAXIMUM 24 CHARACTERS (including spaces).	1916 WOODSTOCK AVE
5	CITY	Use capital letters. MAXIMUM 15 CHARACTERS (including spaces).	PHOENIX
6	COUNTY	Use capital letters. MAXIMUM 15 CHARACTERS (including spaces).	PIMA
7	STATE	Use capital letters. MAXIMUM 2 CHARACTERS Arizona . . . . . AZ California . . . . . CA Hawaii . . . . . HI Nevada . . . . . NV Guam . . . . . GU American Samoa . . . AM Trust Territories . . . TT	AZ
8	ZIP CODE	Enter your zip code	44001
9	PROG. NO.	Obtain this number from the Catalog of Federal Domestic Assistance. Do not include decimal point.	13.400 (13400)
10	TYPE OF ACTION	Enter X in the appropriate box.	
11, 12, 13	TYPE OF CHANGE	Complete only if you have checked box 10b or 10c.	
14a	EXISTING FED. GRANT I.D.	If you have checked item 10b or 10c and have had previous correspondence with a Federal Agency concerning your present grant, enter this number.	OEO-CA-004-1401
14b	EXISTING CLEARINGHOUSE I.D.	If you have checked item 10b or 10c and have submitted your project to the Clearinghouse previously, enter the State Application Identifier already assigned.	74-10-0011
15	REQUESTED FUND START	Enter appropriate date.	
16	FUNDS START	Enter appropriate date.	
17	EST. PROJECT START	Enter appropriate date.	
18	EST. PROJECT DURATION	Enter appropriate date.	
19	APPLICANT TYPE	Enter the appropriate letter in the box provided. Federal agencies see letter J.	
20, 21, 22, 23, 24	FUNDS REQUESTED	Enter appropriate amounts. If no funding involved, enter 0.	
25	BRIEF TITLE OF APPLICANT PROJECT	Use capital letters. MAXIMUM 90 CHARACTERS (including spaces).	CONSTRUCTION OF NEW HOUSING
26	DESCRIPTION OF APPLICANT'S PROJECT	Use capital letters. MAXIMUM 300 CHARACTERS (including spaces). 60 CHARACTERS PER LINE 4 LINES	
27	AREA OF IMPACT	Use capital letters. Enter City, County, etc.	RENO, NEVADA
28	CONGRESSIONAL DISTRICT	MAXIMUM 2 NUMERALS	
29	ENVIRONMENTAL ASSESSMENT	Enter an X in appropriate box. If X is in YES - attach a copy.	
30	CLEARINGHOUSE(S) TO WHICH SUBMITTED	Enter an X in the appropriate box.	
31a 31b 31c	CONTACT PERSON ADDRESS TELEPHONE	Enter this information for the person who has the most complete information regarding the proposal who can be contacted if necessary. Do not give the name of the administrator (for example, mayor) with general responsibility for the project.	

PART 3

The original of Form 140 will be returned to you by the State Clearinghouse and as well as each one sent to the area-wide Clearinghouses. EACH COPY MUST BE INCLUDED IN THE APPLICATION PACKET. COMPLETED PART 3 on the ORIGINAL and forward it attached to the application to the funding Agency.

BOX NO.	TITLE	INSTRUCTION	EXAMPLE
39	CERTIFICATION	Enter an X in the appropriate box if you have not heard from the Clearinghouse within 10 days.	
40a 40b 40c 40d	NAME TITLE SIGNATURE TELEPHONE NO.	Complete this information for the person with responsibility for the proposal. THIS IS THE PERSON WHO SIGNS GRANT APPLICATIONS FOR OUR AGENCY.	
41	DATE MAILED TO FEDERAL AGENCY	Enter appropriate date	
42	NAME OF FEDERAL AGENCY TO WHICH THIS APPLICATION IS SUBMITTED	Enter the abbreviation as listed on attached sheet.	

ARIZONA

1. APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
2 FEDERAL EMPLOYER ID NO.
CITY: WASHINGTON
5. COUNTY
6. STATE: DC
8. ZIP CODE: 20545
9. PHONE NO. /FEDERAL AGENCY: 24999 Atomic Energy Commissior

3. TYPE OF ACTION: a. [X] New c. [ ] Modification b. [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked)
11. a. [ ] Increased Dollars b. [ ] Decreased Dollars
12. a. [ ] Increased Duration b. [ ] Decreased Duration
13. a. [ ] Other Scope Change b. [ ] Cancellation
14a. EXISTING FEDERAL ID NO.
14b. EXISTING CFA PROGRAM NO.

15. REQUESTED FUND START: 19__ (yr mo)
16. FUNDS DURATION: ____ (Months)
17. EST. PROJECT START: 19__ (yr mo)
18. EST. PROJECT DURATION: ____ (Months)

19. APPLICANT TYPE — Enter Letter [J]
A. State F. School District
B. Interstate G. Community Action Agency
C. COG H. Sponsored Organization
D. County I. Indian
E. City J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Increase or Dec.)
20a. FEDERAL GRANT $ 1
20b. FEDERAL LOAN $ .00
21. STATE $ .00
22. LOCAL $ .00
23. OTHER $ .00
24. TOTAL (20,21,22,23) $ 1 .00

25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

26. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines). Attach 1–2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.)
STATEWIDE, ARIZONA

28. CONGRESSIONAL DISTRICT Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a. [ ] State b. [X] Area Wide

31. a. NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c. TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO: Office of Economic Planning
and Development, 3rd Floor
1624 West Adams Street
Phoenix, Arizona 85007

State Application Identifier (SAI)
State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Harry Higgins
Date: 10-25-74
Title: Plng. Dir.
Telephone: 271-5005

SEP 10 A.M. ARIZONA

1. APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
2 FEDERAL EMPLOYER ID NO.
CITY: WASHINGTON
5. COUNTY
6. STATE: DC
8. ZIP CODE: 20545
9. PHONE NO. /FEDERAL AGENCY: 24999 Atomic Energy Commissior

3. TYPE OF ACTION: a. [X] New c. [ ] Modification b. [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked)
11. a. [ ] Increased Dollars b. [ ] Decreased Dollars
12. a. [ ] Increased Duration b. [ ] Decreased Duration
13. a. [ ] Other Scope Change b. [ ] Cancellation
14a. EXISTING FEDERAL ID NO.
14b. EXISTING CFA PROGRAM NO.

15. REQUESTED FUND START: 19__ (yr mo)
16. FUNDS DURATION: ____ (Months)
17. EST. PROJECT START: 19__ (yr mo)
18. EST. PROJECT DURATION: ____ (Months)

19. APPLICANT TYPE — Enter Letter [J]
A. State F. School District
B. Interstate G. Community Action Agency
C. COG H. Sponsored Organization
D. County I. Indian
E. City J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Increase or Dec.)
20a. FEDERAL GRANT $ 1
20b. FEDERAL LOAN $ .00
21. STATE $ .00
22. LOCAL $ .00
23. OTHER $ .00
24. TOTAL (20,21,22,23) $ 1 .00

25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

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27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.)
STATEWIDE, ARIZONA

28. CONGRESSIONAL DISTRICT Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a. [ ] State b. [X] Area Wide

31. a. NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c. TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO: Mr. John P. Dickinson
Dept. of Economic Security
Post Office Box 6123
Phoenix, Arizona 85005

State Application Identifier (SAI)
State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

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[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Nancy B. Hahn
Date: 9/26/74
Title: Chairman
Telephone: 271-5784

COVER SHEET for FEDERAL GRANT APPLICATION/AWARD NOTIFICATION

ARIZONA

1 APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
c. CITY: WASHINGTON
b. COUNTY:
7 STATE: DC
8. ZIP CODE: 20545
14. PROG. NO. /FEDERAL AGENCY: 24999 Atomic Energy Commission

6. TYPE OF ACTION: a. [X] New c. [ ] Modification b. [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 a. [ ] Increased Dollars b. [ ] Decreased Dollars; 12 a. [ ] Increased Duration b. [ ] Decreased Duration; 13 a. [ ] Other Scope Change b. [ ] Cancellation
14a. EXISTING FED. GRANT NO.
14b. EXISTING FED. APPLICATION NO.

5. REQUESTED FUND START: 19___ (yr mo)
6. FUNDS DURATION: ___(Months)
7. EST. PROJECT START: 19___ (yr mo)
8. EST. PROJECT DURATION: ___(Months)

10. APPLICANT TYPE — Enter Letter [J]
A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc. (+) or Dec. (-))
20a. FEDERAL GRANT / 19 ___ .00
20b. FEDERAL LOAN / 19 ___ .00
21. STATE / 19 ___ .00
22. LOCAL / 19 ___ .00
23. OTHER / 19 ___ .00
24. TOTAL (20,21,22,23) / 19 1 .00

9. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

16. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines) Attach 1–2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

17. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

18. CONGRESSIONAL DISTRICT — Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a. [X] State b. [X] Area Wide

11. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c. TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO: Mr. John Jett, Director
Mineral Resources Department
Fairgrounds, Mineral Building
1826 West McDowell Road
Phoenix, Arizona 85007

State Application Identifier (SAI): State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

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[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: John W Jett
Title: D. Director
Date: Sept. 19 1974
Telephone: 271-3995

ARIZONA

1 APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
c. CITY: WASHINGTON
b. COUNTY:
7 STATE: DC
8. ZIP CODE: 20545
14. PROG. NO. /FEDERAL AGENCY: 24999 Atomic Energy Commission

6. TYPE OF ACTION: a. [X] New c. [ ] Modification b. [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 a. [ ] Increased Dollars b. [ ] Decreased Dollars; 12 a. [ ] Increased Duration b. [ ] Decreased Duration; 13 a. [ ] Other Scope Change b. [ ] Cancellation
14a. EXISTING FED. GRANT NO.
14b. EXISTING FED. APPLICATION NO.

5. REQUESTED FUND START: 19___ (yr mo)
6. FUNDS DURATION: ___(Months)
7. EST. PROJECT START: 19___ (yr mo)
8. EST. PROJECT DURATION: ___(Months)

10. APPLICANT TYPE — Enter Letter [J]
A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc. (+) or Dec. (-))
20a. FEDERAL GRANT / 19 ___ .00
20b. FEDERAL LOAN / 19 ___ .00
21. STATE / 19 ___ .00
22. LOCAL / 19 ___ .00
23. OTHER / 19 ___ .00
24. TOTAL (20,21,22,23) / 19 1 .00

9. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

16. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines) Attach 1–2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

17. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

18. CONGRESSIONAL DISTRICT — Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a. [X] State b. [X] Area Wide

11. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c. TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO: Mr. James Vercellino, Dir.
Department of Aeronautics
3000 Sky Harbor Boulevard
Phoenix, AZ 85034

State Application Identifier (SAI): State AZ Number 74-80-0060

From: Constance LaMonica

RECEIVED
SEP 18 1974
DEPT. OF TRANSPORTATION
AERONAUTICS DIV.

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: James Vercellino
Title: Asst. Dir.
Date: 9-20-74
Telephone: 271-4049

COVER SHEET for FEDERAL GRANT APPLICATION/AWARD NOTIFICATION

ARIZONA

1 APPLICATION DATE: yr mo day 19 ___ ___ ___

2 FEDERAL EMPLOYER ID NO.

1 APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION

4. ADDRESS – Street or P. O. Box: NONE

5. CITY: WASHINGTON

6. COUNTY:

7 STATE: DC

8. ZIP CODE: 20545

9. PHONE NO. /FEDERAL AGENCY: 24999 Atomic Energy Commissior

0. TYPE OF ACTION: a [X] New c [ ] Modification; b [ ] Continuation

11. TYPE OF CHANGE (Complete if 10b or 10c was checked): a [ ] Increased Dollars; b [ ] Decreased Dollars; 12: a [ ] Increased Duration; b [ ] Decreased Duration; 13: a [ ] Other Scope Change; b [ ] Cancellation

10a. EXISTING CFDA NUMBER (If any):

5. REQUESTED FUND START: yr mo 19 ___ ___

6. FUNDS DURATION: ___ (Months)

7. EST. PROJECT START: yr mo 19 ___ ___

8. EST. PROJECT DURATION: ___ (Months)

19. APPLICANT TYPE: Enter Letter [J]

A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc (+) or Dec (-)):

20a. FEDERAL GRANT $ 1 .00

20b. FEDERAL LOAN $ .00

21. STATE $ .00

22. LOCAL $ .00

23. OTHER $ .00

24. TOTAL (20,21,22,23) $ 1 .00

5. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

6. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines). Attach 1–2 Page Project Summary For Review.

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7. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

8. CONGRESSIONAL DISTRICT Of Applicant / Districts Impacted By Project: [ ] [ ]

29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No. If Yes, Attach.

30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide

15. NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS

16. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545

c TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

Dr. James Schoenwetter
Center for Environmental Studies
Department of Anthropology
Arizona State University
Tempe, AZ 85281

State Application Identifier (SAI)

State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
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[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Following cursory review I found no major areas which might lead to an adverse impact on the environment

Reviewer's Signature: John W McAleer

Title: Assistant Prj (Widen Eng.)

Date: 15 Oct 74

Telephone: 965 6469

ARIZONA

1 APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION

4. ADDRESS – Street or P. O. Box: NONE

5. CITY: WASHINGTON

6. COUNTY:

7 STATE: DC

8. ZIP CODE: 20545

9. PHONE NO. /FEDERAL AGENCY: 24999 Atomic Energy Commissior

0. TYPE OF ACTION: a [X] New c [ ] Modification; b [ ] Continuation

11. TYPE OF CHANGE (Complete if 10b or 10c was checked): a [ ] Increased Dollars; b [ ] Decreased Dollars; 12: a [ ] Increased Duration; b [ ] Decreased Duration; 13: a [ ] Other Scope Change; b [ ] Cancellation

10a. EXISTING CFDA NUMBER (If any):

5. REQUESTED FUND START: 19 ___

6. FUNDS DURATION: ___ (Months)

7. EST. PROJECT START: 19 ___

8. EST. PROJECT DURATION: ___ (Months)

19. APPLICANT TYPE: Enter Letter [J]

A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc (+) or Dec (-)):

20a. FEDERAL GRANT $ 1 .00

20b. FEDERAL LOAN $ .00

21. STATE $ .00

22. LOCAL $ .00

23. OTHER $ .00

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7. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

8. CONGRESSIONAL DISTRICT Of Applicant / Districts Impacted By Project: [ ] [ ]

29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No. If Yes, Attach.

30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide

15. NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS

16. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545

c TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

Dr. Mr. Wm. N. Price, State Hwy. E
Environmental Planning Divisic
Department of Highways
206 South 17th Avenue
Phoenix, Arizona 85007

State Application Identifier (SAI)

State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

RECEIVED
SEP 29 1974
ARIZONA DEPT. OF TRANSPORTATION
HIGHWAYS DIV.
ENVIRONMENTAL PLANNING SERVICES

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Marion G Jones

Title: Manager

Date: 10/03/74

Telephone: 261-7767

ARIZONA

3. APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
5. CITY: WASHINGTON
6. COUNTY:
7. STATE: DC
8. ZIP CODE: 20545
9. PHONE NO. IF FEDERAL AGENCY: 24999 Atomic Energy Commissior
2 FEDERAL EMPLOYER ID NO.

10. TYPE OF ACTION: a [X] New c [ ] Modification b [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 a [ ] Increased Dollars b [ ] Decreased Dollars; 12 a [ ] Increased Duration b [ ] Decreased Duration; 13 a [ ] Other Screne Change b [ ] Cancellation
14a. EXISTING FEDERAL ID
14b. EXISTING CLEARINGHOUSE ID

15. REQUESTED FUND START: 19__ (yr mo)
16. FUNDS DURATION: ___(Months)
17. EST. PROJECT START: 19__ (yr mo)
18. EST. PROJECT DURATION: ___(Months)

19. APPLICANT TYPE — Enter Letter [J]
A. State F. School District
B. Interstate G. Community Action Agency
C. COG H. Sponsored Organization
D. County I. Indian
E. City J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc. (+) or Dec. (-))
20a. FEDERAL GRANT $ 1
20b. FEDERAL LOAN $
21. STATE $
22. LOCAL $
23. OTHER $
24. TOTAL (20,21,22,23) $ 1

25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

26. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines) Attach 1–2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

28. CONGRESSIONAL DISTRICT — Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No — If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide

31. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO:
Dr. James L. Schamadan, Dir.
Department of Health Services
1740 West Adams Street
Phoenix, Arizona 85007

State Application Identifier (SAI): State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:
(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

SEP 1974 RECEIVED Division of Air Pollution Control

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[ ] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary) State Application Identifier 74-80-0060

Chapter IV, Section C, Paragraph 5.b. is inadequate because the radiological effects of normal reactor operation in desert areas are not discussed.

Reviewer's Signature: James D. Goff
Title: JAMES D. GOFF, P.E. ASSISTANT DIRECTOR DIVISION OF ENVIRONMENTAL HEALTH SERVICES
Date: SEP 27 1974
Telephone:

ARIZONA

3. APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
5. CITY: WASHINGTON
6. COUNTY:
7. STATE: DC
8. ZIP CODE: 20545
9. PHONE NO. IF FEDERAL AGENCY: 24999 Atomic Energy Commissior
2 FEDERAL EMPLOYER ID NO.

10. TYPE OF ACTION: a [X] New c [ ] Modification b [ ] Continuation
TYPE OF CHANGE (Complete if 10b or 10c was checked): 11 a [ ] Increased Dollars b [ ] Decreased Dollars; 12 a [ ] Increased Duration b [ ] Decreased Duration; 13 a [ ] Other Screne Change b [ ] Cancellation
14a. EXISTING FEDERAL ID
14b. EXISTING CLEARINGHOUSE ID

15. REQUESTED FUND START: 19__ (yr mo)
16. FUNDS DURATION: ___(Months)
17. EST. PROJECT START: 19__ (yr mo)
18. EST. PROJECT DURATION: ___(Months)

19. APPLICANT TYPE — Enter Letter [J]
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C. COG H. Sponsored Organization
D. County I. Indian
E. City J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc. (+) or Dec. (-))
20a. FEDERAL GRANT $ 1
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21. STATE $
22. LOCAL $
23. OTHER $
24. TOTAL (20,21,22,23) $ 1

25. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

26. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines) Attach 1–2 Page Project Summary For Review.
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27. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.): STATEWIDE, ARIZONA

28. CONGRESSIONAL DISTRICT — Of Applicant [ ] Districts Impacted By Project [ ]
29. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No — If Yes, Attach.
30. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a [X] State b [X] Area Wide

31. a NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

TO:
Mr. Edward Johnson
Arizona Atomic Commission
1601 West Jefferson Street
Phoenix, Arizona 85007

State Application Identifier (SAI): State AZ Number 74-80-0060

From: Constance LaMonica

This project is referred to you for review and comment. Please evaluate as to:
(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[ ] No comment on this project
[X] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Donald C. Gilbert
Title: Executive Director, AAEC
Date: October 16, 1974
Telephone: 271-4845

ARIZONA

APPLICANT – Organizational Unit: U S ATOMIC ENERGY COMMISSION
4. ADDRESS – Street or P. O. Box: NONE
CITY: WASHINGTON
6. COUNTY:
7. STATE: DC
8. ZIP CODE: 20545
9. PHONE NO. (FEDERAL AGENCY): 24999 Atomic Energy Commissio
2 FEDERAL EMPLOYER ID NO.

3. TYPE OF ACTION: a. [X] New c. [ ] Modification b. [ ] Continuation
11. TYPE OF CHANGE (Complete if 10b or 10c is checked): a. [ ] Increased Dollars b. [ ] Decreased Dollars; 12. a. [ ] Increased Duration b. [ ] Decreased Duration; 13. a. [ ] Other Scope Change b. [ ] Cancellation
10a. EXISTING CLEARINGHOUSE ID:

5. REQUESTED FUND START: 19__ __ (yr mo)
6. FUNDS DURATION: ____ (Months)
7. EST. PROJECT START: 19__ __ (yr mo)
8. EST. PROJECT DURATION: ____ (Months)

10. APPLICANT TYPE — Enter Letter [J]
A. State; B. Interstate; C. COG; D. County; E. City; F. School District; G. Community Action Agency; H. Sponsored Organization; I. Indian; J. Other

FUNDS REQUESTED (For Changes Show Only Amt. of Inc.(+) or Dec.(-))
20a. FEDERAL GRANT $ 1 .00
20b. FEDERAL LOAN $ .00
21. STATE $ .00
22. LOCAL $ .00
23. OTHER $ .00
24. TOTAL (20,21,22,23) $ 1 .00

5. BRIEF TITLE OF APPLICANT'S PROJECT: DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (RECYCLE PLUTONIUM IN LIGHT WATER COOLED REACTORS)

6. PROJECT ABSTRACT (60 Characters Per Line – 5 Lines) Attach 1 - 2 Page Project Summary For Review.
DRAFT ENVIRONMENTAL STATEMENT. WIDE SCALE RECYCLE OF PLUTONIUM IN LIGHT WATER COOLED, MODERATED NUCLEAR POWER REACTORS WILL SIGNIFICANTLY AFFECT QUALITY OF HUMAN ENVIRONMENT AND AFFECT ALL STEPS IN OVERALL LWR FUEL CYCLE FROM URANIUM MINING THRU REACTOR OPERATION TO REPROCESSING SPENT FUEL.

7. AREA OF PROJECT IMPACT (Indicate City, County, State, etc.)
STATEWIDE, ARIZONA

8. CONGRESSIONAL DISTRICT: Of Applicant [ ] Districts Impacted By Project [ ]
9. Environmental Assessment Required By State/Federal Agency? [X] Yes [ ] No — If Yes, Attach.
10. CLEARINGHOUSE(S) TO WHICH SUBMITTED: a. [X] State b. [X] Area Wide

11. a. NAME OF CONTACT PERSON: DEPUTY DIRECTOR FOR FUELS AND MATERIALS
b. ADDRESS – Street or P. O. Box: WASHINGTON D.C. 20545
c. TELEPHONE NO.

BALANCE OF FORM TO BE COMPLETED BY REVIEWING AGENCY

Mr. Bill Wade, Exec. Dir.
Northern AZ Council of Gov'ts
P.O. Box 57
Flagstaff, AZ 86001

State Application Identifier (SAI): State AZ Number 74-80-0060

attn: Constance LaMonica

A project is referred to you for review and comment. Please evaluate as to:

(1) the program's effect upon the plans and programs of your agency
(2) the importance of its contribution to State and/or areawide goals and objectives
(3) its accord with any applicable law, order or regulation with which you are familiar
(4) additional considerations

Please return this form to the clearinghouse no later than 15 working days from the date noted above. Please contact the clearinghouse if you need further information or additional time for review.

[ ] Respond to Applicant
[X] Respond to State Clearinghouse

[X] No comment on this project
[ ] Proposal is supported as written
[ ] Comments as indicated below

Comments: (Use additional sheets if necessary)

Reviewer's Signature: Russell F. Clark
Title: A-95 Coordinator
Date: 9-26-74
Telephone: 774-1895

NRC Staff Response To Specific Comments
On Health, Safety, & Environment By
State of Arizona

1. Comment:

"CHAPTER IV, Section C, paragraph 5.b is inadequate because the radiological effects of normal reactor operation in desert areas are not discussed."

Response:

Since GESMO is a generalized environmental statement, certain assumptions concerning characteristics of a hypothetical facility's environment had to be made. A river site was chosen since all major radionuclide pathways to man and many radionuclide pathways to biota other than man exist at such sites. Thus, doses to man and doses to biota other than man were calculated for a hypothetical river site. Those doses are presented in the final GESMO to serve as a basis for comparing relative radiological environmental impacts of reactor facilities with and without utilizing Pu recycle. Other hypothetical sites, such as a desert area site, have a smaller number of radionuclide pathways to man and to biota other than man and therefore, would not serve as a good basis for comparison.

The licensing of an individual reactor would evaluate site specific characteristics.

Comment Letter No. 42

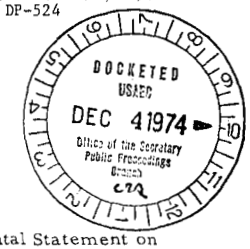
DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
( ) SMD

C-E Power Systems
Combustion Engineering, Inc
1000 Prospect Hill Road
Windsor, Connecticut 06095

Tel. 203/688-1911
Telex 9-9297

POWER SYSTEMS

October 30, 1974
DP-524



U. S. Atomic Energy Commission
Washington DC 20545

Attention: Deputy Director for Fuels & Materials
Directorate of Licensing

Gentlemen:

We have reviewed the draft report, "The Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in LWR's (GESMO), "WASH 1327, and applaud the efforts which have gone into producing this impressive and constructive document. The work which has gone into GESMO should be instrumental in insuring the timely utilization of this important energy resource. Our comments on this report and suggestions for clarification or correction of information are submitted below:

A. While the use of 115% SGR is probably a reasonable assumption for the study and one consistent with most expectations for the near term usage of plutonium in recycle cores, the 115% SGR level, if interpreted as a limit, may adversely affect utilities which may find it necessary or desirable to recycle plutonium at higher levels in specific plants. Although GESMO notes that the 115% SGR assumption affects only the reactor aspects of the fuel cycle and identifies no reactor or safety problem associated with higher loadings, the 115% SGR level appears, particularly in the summaries, to be treated as a limit. Even though the environmental impact analysis was performed using this assumption of 115% SGR, there appears to be no analysis in GESMO which should preclude the use of higher levels of plutonium utilization. We believe that it is proper to determine limits of plutonium utilization at the time of license application, where the level of recycle justified by past experience and reactor design can be evaluated, rather than impose limitations based upon arbitrary assumptions of the 115% SGR model.

   In order to correct the impression that the 115% SGR model imposes a limitation to the level of recycle, a more detailed discussion of the implications of this model should be included in the summary. This discussion should clearly identify that none of the analyses performed for GESMO preclude higher levels of utilization, nor has any consideration been identified

which precludes the safe operation at higher plutonium loadings. References to "recycle limitations imposed by the model 1.15 SGR", or "is justified up to 1.15 SGR" should be eliminated (pages S-4, S-12, S-20, I-14, IV-A-2, IV-A-10, IV-B-7, IV-C-59).

B. GESMO places emphasis on material safeguards and appears to endorse the concept of locating plutonium fuel fabrication plants next to reprocessing plants in order to minimize the shipment of pure plutonium and thereby reduce the safeguards problem. If the industry were to move in that direction, the fabrication plants of the vendors could be so fragmented that the through-put per plant of plutonium rods would be very small, and fabrication prices would consequently be very high. In order to avoid this problem, one would have to make arrangements to consolidate fabrication facilities at each reprocessing plant into one facility that would service all fuel vendors.

   The problem of safeguards is, of course, of concern to the entire nuclear industry and consequently deserves discussion in GESMO. Safeguards are, however, currently under separate AEC evaluation where careful consideration of impacts and alternatives will be made. We feel that the prominence given to the concept of collocation of reprocessing and fabrication plants could make difficult the acceptance of alternate solutions, and that GESMO should avoid giving the impression of endorsing any particular concept. Also, GESMO does not adequately discuss the safeguards problems associated with a failure to recycle plutonium. If fuel is reprocessed and the plutonium stored, many of the safeguards problems are similar to the recycle case, with additional concerns with respect to the large quantities of plutonium in storage.

C. Assumptions employed in the cost-benefit analysis have generally been chosen to minimize the economic benefits of plutonium recycle, and consequently the case for recycle is perhaps not as positive as it might have been. For example, we estimate that the costs of ore in 1990 will be higher than those employed in GESMO, and similar comments might be made for plutonium storage costs. While we recognize the benefits of a generally conservative analysis, the conclusions of the cost-benefit analysis might well change if various cost components come under question.

   Industry support of plutonium recycle is based upon the conviction that plutonium recycle will be economically feasible and we believe that a reasonable combination of cost components will show this to be the case; this conclusion, however, might not be reached if very pessimistic assumptions

are employed for all cost components. In order to avoid criticism of the cost benefit analysis, it may be desirable to identify the range of costs associated with each component, and perform the cost benefit analysis using carefully documented and referenced "best estimate" values.

D. The discussion of plutonium recycle experience presented in Section II. C, and also discussed in Section IV. C. 3 and page S-19 of the summary, neglects to mention the plutonium recycle irradiation demonstration in the Obrigheim reactor. This demonstration began in 1972 with the insertion of a single demonstration assembly, and eight additional mixed-oxide assemblies were added during the September 1973 refueling. The 1618 mixed-oxide rods which were under irradiation during 1973-1974 represent roughly one-third of the total number of rods fabricated and irradiated in LWR's in the U.S. and Europe, and more than twice the number in any previous demonstration. As a result of a cooperative agreement with KWU, CE has complete access to this experimental program. In addition to the Obrigheim demonstration, there have been two CE/KWU programs to determine the irradiation performance and densification properties of mixed-oxides in the MZFR, and a program to dynamically measure fuel properties, including densification, will begin shortly in the Halden reactor.

E. Detailed corrections to salient typographical or minor technical areas are included as an attachment to this letter.

Combustion Engineering believes that GESMO is an important step in establishing the mixed-oxide fuel cycle and a source of information and guidelines which will prove helpful in licensing plutonium recycle cores. However, we believe that several major issues require clarification or modification. In particular, the relationship and ramifications of various assumptions employed in GESMO on the licensing process must be clarified so that the nuclear industry is not unduly hampered or restricted by the conclusions of this report.

Very truly yours

COMBUSTION ENGINEERING, INC.

F. Stern

F. M. Stern
Vice President - Projects

COMBUSTION ENGINEERING, INC.

DETAILED COMMENTS AND CORRECTIONS TO GESMO

1. Tables S-3 and S-11: The sign of the change in wholebody radiation exposure for Alternate 2 should be negative.

2. Table S-12: The reduction in transportation costs for Alternatives 2 and 6 should be identical. These values do not appear to agree with those given in Table IV-G-1. The values given for plutonium storage differ widely from those given in IV-I-3.

3. Tables S-14, S-15: No capital cost is shown for plutonium transportation for Alternative 4 (upgraded safeguards program). Transportation costs should be equal to or greater than those of Alternatives 1 and 3. Similar comments apply to plutonium transportation charges shown in Table S-15.

4. Page I-14: While Pu contents are generally expected to be less than 5 w/o, this value might be exceeded, particularly for high-enrichment zones where the loading might be as high as 7 - 8% for plutonium with a low fissile fraction; fissile plutonium contents are, however, expected to be less than 5 w/o.

5. Page II-3 - Par 4: Last sentence, should read as follows: "For greater safety in transporting plutonium the AEC has proposed a regulation requiring all shipments of plutonium to be in solid nonrespirable form."

6. Page II-64: This page emphasizes the magnitude of the plutonium contaminated process-material waste problem. It should be followed by a strong recommendation for an energetic industry-AEC program directed at waste decontamination and volume reduction.

7. Page IV-C-13: The statement "For the large PWR's 264 fuel rods are assembled into a bundle . . . about 8-1/2" on a side". This is true only of a particular design of a particular vendor, and should be so represented, as should figures IV C-8 through 13.

8. Table IV J-2: The occupational dose commitment given for plutonium storage shows a factor of 30 higher with recycle than for UO_2 fuel. This seems unlikely in view of the order of magnitude reduction in the quantity of stored plutonium (IV-I. 3) realized with recycle. Similar comments apply to Table IV J-18.

9. Page VIII-48: Under the discussion of uranium value, it is concluded that the value increase (with time) is adequate to cover the carrying charges." The sentence should read ". . . is not adequate . . ."

2.

10. Chapter XI: Projections of ore costs employed are thought to be 50 to 100% low (consequently underestimating the economic benefits of recycle). The GESMO projections appear to be based on the cost of mining ore and neglect costs of exploration and profits. While these assumptions result in a conservative cost-benefit analysis, some note of potential greater economic benefits might be made.

NRC Staff Response to Specific Comments on Health, Safety and Environment by Combustion Engineering Co.

1. Comment:

"While the use of 115% SGR is probably a reasonable assumption for the study and one consistent with most expectations for the near term usage of plutonium in recycle cores, the 115% SGR level, if interpreted as a limit, may adversely affect utilities which may find it necessary or desirable to recycle plutonium at higher levels in specific plants. Although GESMO notes that the 115% SGR assumption affects only the reactor aspects of the fuel cycle and identifies no reactor or safety problem associated with higher loadings, the 115% SGR level appears, particularly in the summaries, to be treated as a limit. Even though the environmental impact analysis was performed using this assumption of 115% SGR, there appears to be no analysis in GESMO which should preclude the use of higher levels of plutonium utilization. We believe that it is proper to determine limits of plutonium utilization at the time of license application where the level of recycle justified by past experience and reactor design can be evaluated, rather than impose limitations based upon arbitrary assumptions of the 115% SGR model.

"In order to correct the impression that the 1.15% SGR model imposes a limitation to the level of recycle, a more detailed discussion of the implications of this model should be included in the summary. This discussion should clearly identify that none of the analyses performed for GESMO preclude higher levels of utilization nor has any consideration been identified which precludes the safe operation at higher plutonium loadings. Reference to 'recycle limitations imposed by the model 1.15 SGR,' or 'is justified up to 1.15 SGR' should be eliminated (pages S-4, S-20, I-14, IV-A-2, IV-A-10, IV-B-7, IV-C-59)."

Response:

For the purposes of this statement, an LWR is considered to be a 1.15 SGR when the amount of plutonium that has been charged to the reactor is less than 1.8 weight percent of the total heavy metal (plutonium and uranium) in the fabricated core. This value was used as the basis for the environmental calculations and safety evaluation because it is judged to adequately characterize industry's plans for recycling and it does not represent a safety limit. However, in the proposed rule-making action, 1.15 SGR would constitute a limit insofar as requests to use mixed oxide fuel. Applications for license modifications to use Pu in quantities less than 1.15 SGR would not require the preparation of a supporting environmental impact statement. Levels of plutonium utilization greater than 1.15 SGR would be considered on a case-by-case basis, and additional evaluation beyond that presented in GESMO would be required. Refer to CHAPTER IV, Section C, paragraph 4.

---

2. Comment:

"Assumptions employed in the cost-benefit analysis have generally been chosen to minimize the economic benefits of plutonium recycle, and consequently the case for recycle is perhaps not as positive as it might have been. For example, we estimate that the costs of ore in 1990 will be higher than those employed in GESMO, and similar comments might be made for plutonium storage costs. While we recognize the benefits of a generally conservative analysis, the conclusions of the cost-benefit analysis might well change if various cost components come under question."

Response:

All cost figures in final GESMO have been updated to reflect the best current estimates. See CHAPTER XI, Section 2.0. The effects of these revised cost estimates have been studied parametrically in CHAPTER XI, Section 3.0.

3. Comment:

"Industry support of plutonium recycle is based upon the conviction that plutonium recycle will be economically feasible and we believe that a reasonable combination of cost components will show this to be the case; this conclusion, however, might not be reached if very pessimistic assumptions are employed for all cost components. In order to avoid criticism of the cost benefit analysis, it may be desirable to identify the range of costs associated with each component, and perform the cost benefit analysis using carefully documented and referenced 'best estimate' values."

Response:

A range of costs have been identified in final GESMO and the best estimates are now documented. Furthermore, parametric studies were performed using a range of estimates see CHAPTER XI, Section 3.0.

---

4. Comment:

"The discussion of plutonium recycle experience presented in Section II.C, and also discussed in Section IV. C.3 and page S-19 of the summary, neglects to mention the plutonium recycle irradiation demonstration in the Obrigheim reactor. This demonstration began in 1972 with the insertion of a single demonstration assembly. Eight additional mixed-oxide assemblies were added during the September 1973 refueling. The 1618 mixed-oxide rods that were under irradiation during 1973-1974 represent roughly one-third of the total number of rods fabricated and irradiated in LWR's in the U.S. and Europe and more than twice the number in any previous demonstration. As a result of a cooperative agreement with KWU, CE has complete access to this experimental program. In addition to the Obrigheim demonstration, there have been two CE/KWU programs to determine the irradiation performance and densification properties of mixed-oxides in the MZFR, and a program to dynamically measure fuel properties, including densification, will begin shortly in the Halden reactor."

Response:

Additional information has been included in final GESMO, in CHAPTER II, paragraph 3.1.9, to cover Obrigheim reactor irradiations of mixed oxide fuel rods.

Note: Staff Responses To Detailed Comments Relating To Clarity And Corrections Have Been Included In The Text - The Following Are Responses To Specific Comments

5. Comment:

"2. Table S-12: The reduction in transportation costs for Alternatives 2 and 6 should be identical. These values do not appear to agree with those given in Table IV-G-1. The values given for plutonium storage differ widely from those given in IV-I-3."

Response:

In draft GESMO, the notations with and without plutonium recycle were used. The "without" designation is for the recycle of uranium only.

In final GESMO, all three fuel cycle options are assessed: no recycle, recycle of uranium only, and recycle of uranium and plutonium.

The revised Table IV-G-1 now includes the comparative data on transportation for all three options.

6. Comment:

"Tables S-14, S-15; No capital cost is shown for plutonium transportation for Alternative 4 (upgraded safeguards program). Transportation costs should be equal to or greater than those of Alternatives 1 and 3. Similar comments apply to plutonium transportation charges shown in Table S-15."

Response:

In draft GESMO in Alternative 4, consideration was given to integrated fuel cycle facilities which would reduce transportation mileage and costs. In the final GESMO, Alternative 4, which considered prompt Pu recycle with upgraded safeguards, has been deleted as a separate alternative. In the safeguards consideration, one level of safeguards will be provided for all Alternatives (1, 2, 3, and 5) wherein strategic special nuclear materials (SSNM) are handled.

---

7. Comment:

"4. Page I-14: While Pu contents are generally expected to be less than 5 w/o, this value might be exceeded, particularly for high-enrichment zones where the loading might be as high as 7 - 8% for plutonium with a low fissile fraction; fissile plutonium contents are, however, expected to be less than 5 w/o."

Response:

This comment is correct. An adequate statement is that the average fissile plutonium, Pu_f, contents of MOX fuel assemblies are expected to be less than 5% of the total uranium plus plutonium. Final GESMO is based on this premise.

---

8. Comment:

"Page II-3 - Par 4: Last sentence, should read as follows: 'For greater safety in transporting plutonium the AEC has proposed a regulation requiring all shipments of plutonium to be in solid nonrespirable form."

Response:

The suggested change is incorrect. Paragraph 71.42(a) of 10 CFR Part 71 states that plutonium in excess of twenty (20) curies per package shall be shipped as a solid, not all shipments. It is contemplated that most plutonium shipment will be in solid form.

---

9. Comment:

"Page. II-64: This page emphasizes the magnitude of the plutonium contaminated process material waste problem. It should be followed by a strong recommendation for an energetic industry-AEC program directed at waste decontamination and volume reduction."

Response:

The revised text in the final GESMO CHAPTER II, Paragraph 3.5, includes a brief review of the considerations of the emphasis of conversion of the high level wastes to solid form in preparation for possible geologic disposal and refers to CHAPTER

9. Comment (Cont'd)

IV, Section H, for a detailed assessment of the overall radioactive waste management program for the three fuel cycle options: no recycle, recycling of uranium only, and Pu and uranium recycle.

---

10. Comment:

"7. Page IV-C-13: The statement 'For the large PWR's 264 fuel rods are assembled into a bundle ... about 8-1/2" on a side.' This is true only of a particular design of a particular vendor, and should be so represented, as should figures IV C-8 through 13."

Response:

As recommended in this comment, the referenced statement has been changed in the final GESMO to emphasize that the figures related to one type of large PWR. See CHAPTER IV, Section C, paragraph 1.2.

---

11. Comment:

"8. Table IV J-2: The occupational dose commitment given for plutonium storage shows a factor of 30 higher with recycle than for UO_2 fuel. This seems unlikely in view of the order of magnitude reduction in the quantity of stored plutonium (IV-I.3) realized with recycle. Similar comments apply to Table IV J-8."

Response:

In a plutonium recycle industry, the recovered plutonium is moved in and out of storage at the storage facility and the MOX fuel fabrication plant resulting in a larger dose commitment than that received in the UO_2 only recycle industry where the recovered plutonium is only placed in the storage/disposal repository.

---

12. Comment:

"10. Chapter XI: Projections of ore costs employed are thought to be 50 to 100% low (consequently underestimating the economic benefits of recycle). The GESMO projections appear to be based on the costs of mining ore and neglect costs of exploration and profits. While these assumptions result in a conservative cost-benefit analysis, some note of potential greater economic benefits might be made."

Response:

The market place model employed in this final GESMO is described in CHAPTER XI, Appendix A. The rate of usage of the resources does affect the market price. Additionally, the model uses an "estimated cost of recovery" instead of the "forward cost" concept, thus an estimate of the market price is generated. Because of the possible uncertainties in such an exercise, the effects of uncertainties are examined by parameterizing the price of U_3O_8 and looking at the effect on incentives to recycle. See CHAPTER XI, Section 3.0.

Comment Letter No. 43

DOCKET NUMBER
PROPOSED RULE PR. Misc Not (39 FR 30186)
GESMO

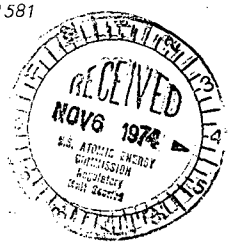
Telephone 617 366-9011
TWX
710-390-0739

WYR 74-33

YANKEE ATOMIC ELECTRIC COMPANY

20 Turnpike Road Westborough, Massachusetts 01581

October 31, 1974



U. S. Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing

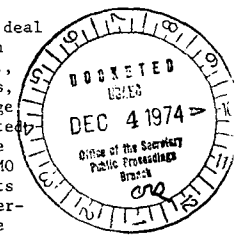
RE: Comments on Generic Environmental Statement - Mixed Oxide Fuel (GESMO), WASH-1327

Dear Sir:

A review of GESMO by personnel at Yankee Atomic Electric Company has resulted in the following comments.

1. GENERAL COMMENTS

We agree with the general conclusion of GESMO that plutonium recycle should be initiated in commercial power reactors. We specifically support the conditional conclusion summarized on page S-12 that "the utilization of plutonium resources as recycle fuel in the light-water reactors should be approved." However, we would offer as a critical review, the following general comments regarding the content of the report.



1.1 It is our feeling that part of GESMO should specifically deal with assessing the effect of the uncertainties present in several important parameters. Many such parameters (i.e., Projected nuclear capacity, and split between LWRs, HTGRs, and LMFBRs, fabrication costs of mixed oxide fuel in large scale plants, safeguards costs, etc.) can only be estimated at the present time. Since the general conclusion of the report is dependent on these estimates, we feel that GESMO should provide a clearer picture of the sensitivity of its conclusions to the uncertainties implicit in the six alternatives analyzed. We are particularly concerned with the effect of a delay in fuel reprocessing capabilities and mixed oxide fuel fabrication facilities.

1.2 In our opinion, GESMO does not adequately discuss the larger calculational uncertainties (both in the spectrum and spatial calculation) associated with the more complicated neutronic

behavior of mixed oxide fuel. That is, numerous general statements are made which seem to indicate that the neutronic calculations of mixed oxide cores are as accurate as required. While we certainly agree that they are sufficiently accurate to allow one to design a mixed oxide core, we feel it should be noted that possible additional uncertainties in the power distribution and rod worth calculations for such cores may result in additional restrictions initially being applied to the operation of a recycle reactor. Such restrictions could conceivably result in a power limitation for certain reactors and this possibility is not addressed in GESMO.

We feel that any curtailment of future research and code development which might stem from GESMO's broad positive statements as to the present neutronic calculational ability for mixed oxide cores would be unwise and would be an unfortunate result of what is otherwise a generally good assessment of plutonium utilization in LWRs.

1.3 We feel that GESMO should specifically state that if there were only plutonium recycle, the upgraded strategic SNM safeguards requirements would still be required. However, on page S-58 an argument is made which appears in several other places within GESMO. The argument is that "Since plutonium recycle in LWRs utilized generally less than one-half of the strategic special nuclear material projected for the total nuclear industry, except for a brief period around 1985 when plutonium recycle would account for roughly one-half of the strategic SNM, the various alternatives for plutonium disposition do not themselves control the overall strategic SNM safeguard requirements. Therefore, choice for plutonium disposition will have only a slight effect upon the AEC's need to upgrade safeguards programs."

If the intent of these statements is to point out that strategic SNM safeguard requirements will be required regardless of whether or not plutonium recycle is implemented, then we would agree. The fact remains, however, if there were only plutonium recycle the upgraded strategic SNM safeguards requirements would still be required.

1.4 Although we agree with the conclusion that there does not appear to be any safeguards related rationale sufficient to delay the use of plutonium in mixed oxide fuel for light water reactors subject to the condition that necessary additional safeguards requirements are decided upon in a timely manner, we feel that this conclusion is the most controversial issue in GESMO.

We find it extremely important that the commission indicate that its objective in "achieving a level of protection against such acts to insure against significant increase in the overall risk of death, injury, or property damage to the public from other causes beyond the control of the individual ...would not be fully met for plutonium recycle by current safeguards measures." The implication to the reader is that the safeguard systems presently utilized are, in fact, inadequate for plutonium recycle. This underlines the significance of the statement then made in GESMO report that "the indications at this time point to the decisions on upgrading (safeguards) within about one year after issuance of the final GESMO statement." The important point is that regardless of the impact or the amount of SNM material required by the introduction of HTGRs and FBRs by the turn of the century, additional necessary safeguards requirements will be required on a timely basis for the plutonium recycle program and that these requirements should be developed immediately.

2. COMMENTS ON FORMAT

2.1 Volume 1 contains a good summary of the information presented in GESMO, but it is often difficult to locate the detailed discussions in the later volumes which are related to the general statements and tables in Volume 1. To clarify these statements and tables it is recommended that Chapter and section numbers of the applicable detailed discussions be added to Volume 1.

2.2 Numerous general statements are made in GESMO which should be further clarified by placing them in context. For example, it is stated that the immediate recycling of plutonium would reduce the requirements for uranium by about 10% around 1990. It would be beneficial to add what fraction of the total benefit (in dollars) this reduction represents. This type of clarification would make GESMO much easier to understand and it would strengthen many of the arguments presented.

2.3 We feel that paragraph designators should identify the main section and subsections that contain a specific paragraph. To facilitate this identification, we recommend that a paragraph designated "(c)" be more completely designated (using a straight numbering system) as, for example, "1.2.1.3", thus allowing the reader to easily identify the main section and subsections that contain the paragraph.

3. SPECIFIC COMMENTS

3.1 **Page IV-C-2**, First Paragraph, Second Sentence
This sentence, beginning "The spent uranium fuel ..." is an incomplete sentence.

3.2 GESMO contains numerous, normally *obvious*, typographical errors which we hope will be corrected before the issuance of the final report.

3.3 The *minimization* or elimination of Pu shipping between reprocessing and mixed oxide fabrication would be very impractical in that it would force a utility to use the reprocessor or his nearest neighbor for MOX fabrication. The use of "spiked" Pu in mixed oxide fabrication would unnecessarily complicate fabrication and QA of mixed oxide fuel. Other safeguards measures should be adequate.

Very truly yours,

YANKEE ATOMIC ELECTRIC COMPANY

D. E. Vandenburgh
Vice President

DEV/ah

NRC Staff Response To Specific Comments
On Health, Safety & Environment By D.E. Vandenburg

1. Comment:

"It is our feeling that part of GESMO should specifically deal with assessing the effect of the uncertainties present in several important parameters. Many such parameters (i.e., Projected nuclear capacity, and spilt between LWRs, HTGRs, and LMFBRs, fabrication costs of mixed oxide fuel in large scale plants, safeguards costs, etc.) can only be estimated at the present time. Since the general conclusion of the report is dependent on these estimates, we feel that GESMO should provide a clearer picture of the sensitivity of its conclusions to the uncertainties implicit in the six alternatives analyzed. We are particularly concerned with the effect of a delay in fuel reprocessing capabilities and mixed oxide fuel fabrication facilities."

Response:

In final GESMO, the full impacts of the implementation of Pu recycle in LWR's have been integrated over a 26-year period from 1975 through 2000. Only the LWR industry growth has been considered.

The LWR industry fuel cycle material flows used were based on ERDA 1975 nuclear energy projections, low growth modified to be without the FBR and without the HTGR industries. The energy allocated to the HTGR's was considered made up by fossil fuel.

Sensitivity studies of the uncertainties and the impacts of delays in the implementation of spent fuels reprocessing and MOX fuel fabrication and related fuel cycle activities have been included in the final draft indicating the differentials in the economics and environmental impacts for three fuel cycles: no recycle, recycle of uranium only, and recycle of uranium and plutonium.

---

2. Comment:

"1.2. In our opinion, GESMO does not adequately discuss the larger calculational uncertainties (both in the spectrum and spatial calculation) associated with the more complicated neutronic behavior of mixed oxide fuel. That is, numerous general statements are made which seem to indicate that the neutronic calculations of mixed oxide cores are as accurate as required. While we certainly agree that they are sufficiently accurate to allow one to design a mixed oxide core, we feel it should be noted that possible additional uncertainties in the power distribution and rod worth calculations for such cores may result in additional restrictions intially being applied to the operation of a recycle reactor. Such restrictions could conceivably result in a power limitation for certain reactors and this possibility is not addressed in GESMO."

Response:

It is agreed that "Calculational Methods on Adequacy of Data" is somewhat abbreviated in the draft GESMO. This section has been rewritten and expanded in the final GESMO. One reason for the brevity of the section is the availability of comprehensive literature surveys and critiques on the subject. Although the position that the state of the art is such that cores with mixed oxide loadings can be safely designed, it is agreed that considerably more research and methods development is desirable to reduce any uncertainties in performance, economics, and the conservative allowances that must now be made in safety related features. Refer to CHAPTER IV, Section C, paragraph 3.3.

---

3. Comment:

"2.1. Volume 1 contains a good summary of the information presented in GESMO, but is often difficult to locate the detailed discussions in the later volumes which are related to the general statements and tables in Volume 1. To clarify these statements and tables it is recommended that chapter and section numbers of the applicable detailed discussions be added to Volume 1."

Response:

The data presented in Summary and Conclusions, Volume 1 has been provided with suitable references to guide the reader to the detailed text in the other volumes of the impact statement. Volume 1 also includes a composite Table of Contents and lists of Tables and Figures of all volumes of GESMO health, safety, and environmental issues.

---

4. Comment:

"2.2. Numerous general statements are made in GESMO which should be further clarified by placing them in context. For example, it is stated that the immediate recycling of plutonium would reduce the requirements for uranium by about 10% around 1990. It would be beneficial to add what fraction of the total benefit (in dollars) this reduction represents. This type of clarification would make GESMO much easier to understand and it would strengthen many of the arguments presented."

Response:

Wherever possible the bases for general statements used in final GESMO have been indicated directly in the text, by references or footnotes.

CHAPTER VIII, Alternatives, and CHAPTER XI, Cost-Benefits, have been expanded to provide detailed assessments of effects on the fuel cycle due to recycle in terms of environmental impacts and costs.

Discussions of the effect of the fuel cycle options and alternatives for Pu recycle on costs are presented in detail in CHAPTER XI. The Summary and Conclusions, final GESMO, Volume 1, provides an overview of the cost-benefits.

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230

Misc Notice (39FR30186)
GESMO

November 1, 1974

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DOCKETED
USAEC
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Office of the Secretary
Public Proceedings
Branch

Mr. S.H. Smiley
Deputy Director
for Fuels and Materials
Directorate of Licensing
Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Smiley:

The draft environmental impact statement for "Generic Environmental Statement Mixed Oxide Fuel," which accompanied your letter of August 23, 1974, has been received by the Department of Commerce for review and comment.

The statement has been reviewed and the following comments are offered for your consideration.

Because of the generic nature of this environmental statement, it is not possible to assess the radiological dose impact to the general public on a case-by-case, site-by-site basis. However, it does appear that the substitution of mixed oxide for enriched uranium as a reactor fuel will result in a net decrease (considering the entire process) of radioactive effluents released to the atmosphere. If this is true, a net decrease of radiological exposure to the general public would be expected.

Although the report states on page IV C-101 that "The assumptions used in calculations are conservative in the estimation of dilutions to the atmosphere," we feel the final version of the report should specifically indicate what these assumptions are. At the very least, the average annual relative concentrations (chi/Q) should be listed in conjunction with tables IV C-21 through 26.

Given its toxicity and long half-life (24,360 years), plutonium 239 is given special emphasis. The effects of plutonium on

humans and terrestrial animals are discussed extensively. On the other hand, plutonium in the aquatic environment is touched upon only briefly. Plutonium concentration factors are given only for freshwater fish (C.F.=3) and plants (C.F.=300) (Page IV C-99, Table IV C-19).

This statement does not consider the marine environment because it demonstrates a very small impact of changing from uranium oxide fuel in the immediate vicinity of a nuclear installation on a river. Concentration factors for marine organisms may be greater than those for freshwater organisms. Furthermore, the dose calculations (Tables IV C-21 to IV C-34) are for the year 2000. Continued introduction of small amounts of waste radioisotopes will add to the total environmental inventory of plutonium, which will ultimately reside mainly in the bottom sediments of rivers and the oceans.

More meaningful data are available on the uptake of "fallout: plutonium by benthic marine organisms, which had concentration factors as high as 400 in soft shell clams and 100,000 in sargasso weed (Noshkin et al., 1971).1/ Plutonium in particulate in water becomes associated closely with bottom sediments. Therefore, it is important to consider benthic organisms when determining the possible effects of plutonium in the aquatic environment. Additionally, the question of exposure involving the marine environment and marine food resources should be addressed in the document.

While we agree that a total defense of nuclear power would be unreasonable to expect in this document, we do feel that further discussion of the relation of the use of mixed-oxide fuel to the Breeder Reactor program is appropriate. In particular, the entire logic of the breeder reactor concept rests upon the assumption that plutonium bred in these breeder reactors will be used as nuclear fuel. Thus assuming the continued viability of

1/ Noshkin, Victor E., Vaughan T. Bowen, Kai M. Wong, and John C. Burke. 1971. Plutonium in North Atlantic Ocean organisms; ecological relationships, pp. 681-688 in: Radionuclides in Ecosystems, D.J. Nelson (ed). CONF-710501, U.S. Atomic Energy Commission, Oak Ridge National Laboratory and the Ecological Society of America.

the breeder reactor program, many of the environmental and NMS safeguards questions will eventually have to be faced. It is primarily a question of timing.

We agree with the conclusion that the most important questions regarding use of mixed-oxide fuels relate to special nuclear materials safeguards considerations. With respect to safeguards we have the following comments:

(a) The situation now is not the same as it will be with mixed-oxide fuel usage. At present no fuel reprocessing facilities are in operation and all of the currently produced plutonium is tied up in spent fuel elements which are highly radioactive and not easily subject to diversion. With fuel reprocessing, and no use of plutonium in mixed-oxide fuel, the plutonium once separated needs receive relatively little handling. With mixed-oxide fuel the plutonium will be subject to considerable further processing and handling while in a form where prevention of theft or diversion is much more difficult. The draft statement recognizes these problems. On page S-45 the draft document states, "It is judged that this objective will not be fully met for Pu cycle by current safeguards measures; however, the Commission has carefully reviewed present development programs and also has identified other concepts which could significantly improve safeguards." Recognition that the present SNM materials safeguards situation is not now satisfactory is also apparent in the conclusions section of the draft document, page S-12.

(b) With regard to international safeguards questions the situation seems particularly disturbing. For example, reference 26, page V-53, "The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons," International Atomic Energy Agency document INFCIRC/153; May 1971, deals primarily with SNM accountability measures. Therefore, reliable and accurate measurements are an essential part of implementation of this document. Internationally accepted

means to provide physical protection of nuclear material are much less developed than within the United States; however, internationally, the problem is much more complex.

(3) With regard to environmental questions, most aspects of the use of mixed-oxide fuels will not differ appreciably from the present situation with enriched uranium fuels and then generally in favor of mixed-oxide fuels. The two exceptions to this are:

(a) the increased handling of plutonium in the mixed-oxide fuel case with its attendent risk of increased exposure,

(b) the significantly increased transuranium actinide content of spent fuel when plutonium recycle is employed.

With regard to (a), the largest concern appears to be "The Hot Particle Hypothesis," discussed in Chapter IV, Section J, Appendix D of the draft statement. The draft statement does not draw conclusions regarding this question because sufficient information is probably not available. Additional studies of this question should be encouraged as part of the decision to approve the use of mixed-oxide fuels.

Thank you for giving us the opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving a copy of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By S.R. Galler-U.S. Dept. of Commerce

1. Comment:

"Although the report states on page IV C-101 that 'The assumptions used in calculations are conservative in the estimation of dilutions to the atmosphere,' we feel the final version of the report should specifically indicate what these assumptions are. At the very least, the average annual relative concentrations (chi/Q) should be listed in conjunction with tables IV C-21 through 26."

Response:

The section of draft GESMO referenced in this comment has been revised extensively. X/Q values are listed as suggested. Refer to CHAPTER IV, Section C, paragraph 5.2.

---

2. Comment:

"Given its toxicity and long half-life (24,360 years), plutonium 239 is given special emphasis. The effects of plutonium on humans and terrestrial animals are discussed extensively. On the other hand, plutonium in the aquatic environment is touched upon only briefly. Plutonium concentration factors are given only for freshwater fish (C.F. =3) and plants (C.F. =300) (Page IV C-99, Table IV C-19)."

Response:

It is recognized that various organisms may concentrate Pu to an extent greater than the values used for the GESMO analyses. These bioaccumulation values are taken as representative average values for comparison of various calculated dose scenarios.

Certainly it is further recognized that bioaccumulation factors vary, to sometimes large extents, among and within species based on a variety of physical and biological environmental parameters.

The consideration of individual species with large bioaccumulation factors is left to the analyses of specific cases where site specific parameters will be examined.

For addition data on plutonium in aquatic environment refer to the response to Comment 3 which follows.

---

3. Comment:

"This statement does not consider the marine environment because it demonstrates a very small impact of changing from uranium oxide fuel in the immediate vicinity of a nuclear installation on a river. Concentration factors for marine organisms may be greater than those for freshwater organisms. Furthermore, the dose calculations (Tables IV C-21 to IV C-34) are for the year 2000. Continued introduction of small amounts of waste radioisotopes will add to the total environmental inventory of plutonium, which will ultimately reside mainly in the bottom sediments of rivers and the oceans.

Comment: (Cont'd)

"More meaningful data are available on the uptake of "fallout: plutonium by benthic marine organisms, which had concentration factors as high as 400 in soft shell clams and 100,000 in sargasso weed (Noshkin et al, 1971). 1/ Plutonium in particulate in water becomes associated closely with bottom sediments. Therefore, it is important to consider benthic organisms when determining the possible effects of plutonium in the aquatic environment. Additionally, the question of exposure involving the marine environment and marine food resources should be addressed in the document."

Response:

The GESMO has as its objective the comparison of the impacts of various LWR operation, fuel production, and waste management scenarios. Doses to humans and to a limited number of terrestrial and aquatic species from the radioactive effluents produced in these scenarios were chosen as an appropriate basis of comparison.

The doses to humans from Pu in liquid effluents calculated for the facilities considered in the GESMO are of the order of tenths of millirem per year. These calculations are sufficiently conservative so that doses to aquatic organisms, marine organisms, and humans are small, even in light of bioaccumulation phenomena.

It is recognized that there may well be impacts on marine biota. However, these effects are expected to be even lower than those for the aquatic environment. In general, bioaccumulation factors in the marine environment are lower than those for the aquatic environment (also see response to Comment 2 of this comment letter No. 44).

It is felt that sufficient basis has been established for comparison of the previously mentioned scenarios.

---

4. Comment:

"While we agree that a total defense of nuclear power would be unreasonable to expect in this document, we do feel that further discussion of the relation of the use of mixed oxide fuel to the Breeder Reactor program is appropriate. In particular, the entire logic of the breeder reactor concept rests upon the assumption that plutonium bred in these breeder reactors will be used as nuclear fuel. Thus assuming the continued viability of means to provide physical protection of nuclear material are much less developed than within the United States; however, internationally, the problem is much more complex."

Response:

It is true that recycle of Pu as fuel in LWR's could be the forerunner to many factors in the development of handling procedures and safeguarding considerations for plutonium and utilization in the FBR. But, the GESMO mission is to analyze the differential impacts on the environment and economics of the LWR industry in the conversion from an all UO_2 fuel to one using UO_2 and MOX fuel. Economics are briefly reviewed in XII.

---

5. Comment:

"(3) With regard to environmental questions, most aspects of the use of mixed-oxide fuels will not differ appreciably from the present situation with enriched uranium fuels and then generally in favor of mixed-fuels. The two exceptions to this are:

(a) the increased handling of plutonium in the mixed-oxide fuel case with its attendent risk of increased exposure,

(b) the significantly increased transuranium actinide content of spent fuel when plutonium recycle is employed.

"With regard to (a), the largest concern appears to be 'The Hot Particle Hypotheses," discussed in Chapter IV, Section J, Appendix D of the draft statement. The draft statement does not draw conclusions regarding this question because sufficient information is probably not available. Additional studies of this question should be encouraged as part of the decision to approve the use of mixed-oxide fuels."

Response:

Point (a) and (b) above have been recognized in the analyses of the fuel cycle calculations when comparing the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium. For a summary of dose assessments see CHAPTER IV, Section J. For impacts of the environment and economics, refer to CHAPTERS VIII and XI.

For a full discussion on the hot particle hypothesis, petition, and denial, see CHAPTER IV, Section J, Appendix D.

Comment Letter No. 45

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

THOMAS O'BRIEN
DIRECTOR

The Commonwealth of Massachusetts
Executive Office for Administration and Finance
Office of State Planning and Management
Leverett Saltonstall Building, Room 909
100 Cambridge Street, Boston 02202

AREA CODE 617
727-5065

November 1, 1974

RECEIVED
NOV 7 1974

Mr. S. H. Smiley
Director of Fuels and Materials
Directorate of Licensing Regulation
U.S. Atomic Energy Commission
Washington, D.C. 20545

RE: A-95 Review of the Draft Environmental Impact Statement on the Use of Mixed Oxide Fuel in Nuclear Power Reactors
State Clearinghouse Identifier 74080548

Dear Mr. Smiley:

The State Clearinghouse in accordance with the provisions of OMB Circular A-95 and the National Environmental Policy Act has reviewed the above cited draft EIS.

Comments were requested from the Departments of Public Utilities, Public Health and Natural Resources, and the Executive Offices of Environmental Affairs, Public Safety and Transportation and Construction. The Department of Public Safety has supported the statement without further comment. The Department of Public Health has submitted the following comment:

> "This proposal is acceptable to DPH because it provides control over extremely hazardous material. This Division will require prior notification of shipment of such material within the Commonwealth in a manner and format that will be prescribed."

We are confident that the above comments will be given appropriate consideration in the development of the final Environmental Impact Statement. Any further comments we may receive will be forwarded for your information.

Sincerely,

Thomas O'Brien

DOCKETED
USAEC
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Office of the Secretary
Public Proceedings
Branch

cc: Mr. John Collins, DPH

TO'B/PS/h

5-45.1

NRC Staff Response to Specific Comments on Health, Safety and Environment by Tom O'Brien, State of Massachusetts

1. Comment:

"This proposal is acceptable to DPH because it provides control over extremely hazardous material. This Division will require prior notification of shipment of such material within the Commonwealth in a manner and format that will be prescribed."

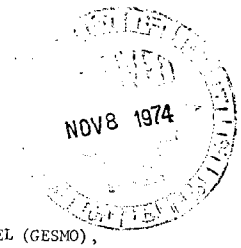
Response:

The purpose of GESMO is to assess the impacts of the environment due to the implementation of plutonium recycle. In GESMO, three fuel cycle options are compared: no recycle, recycle of uranium only, and uranium and plutonium recycle. The requirements as to handling, notification of shipments, etc., come under regulations promulgated by DOT and licensing of the transport carriers by the NRC. Refer to CHAPTER IV, Section G.

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

ADVISORY COMMITTEE ON REACTOR SAFEGUARDS
UNITED STATES ATOMIC ENERGY COMMISSION
WASHINGTON, D.C. 20545

November 6, 1974

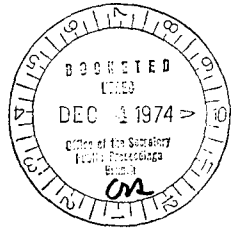


S. H. Smiley
Deputy Director for Fuels and Materials
Directorate of Licensing

DRAFT GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL (GESMO), WASH-1327

Attached for your consideration are comments on Volume 1 of the subject statement compiled from recommendations received from members of and consultants to the Environmental Subcommittee.

R. F. Fraley
Executive Secretary



Attachment

Comments of Environmental Subcommittee on Subj. Rept. (Vol. 1)

COMMENTS PREPARED BY MEMBERS OF AND CONSULTANTS TO THE ACRS ENVIRONMENTAL SUBCOMMITTEE

ON VOLUME 1 OF

"GENERIC ENVIRONMENTAL STATEMENT MIXED OXIDE FUEL"
(WASH-1327, AUGUST, 1974)

General Comments

1. Overall, this appears to be a comprehensive set of documents and provides better treatment to most topics than previous efforts such as the environmental statements on the LMFBR and the Uranium Fuel Cycle. In general, the GESMO report has adequate scope and coverage.

2. A major omission in the report is consideration of the health hazards of radionuclides, such as ^{241}Pu and ^{239}Pu. We believe a detailed assessment would show these to be the principal risks, rather than ^{239}Pu, during the lifetime of a nuclear plant.

3. Much of the report is based on projections as to how efficient some process under development will operate. This is particularly true for various waste management methods, waste incineration procedures, chemical separation factors and the like. We believe the report should be based on firm data only, not conjecture.

4. The use of units in the documents needs more attention. Is the unit, "MT," meant to represent "metric tons"? What it really means is "megatons." This is reinforced by your use of "MCi" to represent "megacuries."

Detailed Comments

Volume 1

Page	Comment
S-1	Line 22: We suggest the phrase, "including reactors," be deleted.
S-2	Lines 7 & 8: We suggest the last sentence be changed to read: "However, this estimated reduction in dose is not judged to be significant in light of the probable errors or uncertainties in the many assumptions that were used in performing the calculations.
S-2	Second paragraph: We suggest the paragraph be deleted since the cancer estimate was based on the following approach: $\text{Cancers/yr} = \pm\, m \times 10^{-4}$ $= (3000 \pm > 3000)(10^{-4})$ $= 0.27$ cancers/yr. The coefficient used to obtain the cancer risk (0.27) is all right but it should be noted that the genetic risk (0.18) was obtained by applying the coefficient which applies only to the first generation. Thus, it may grossly underestimate the long range genetic risk.
S-2	Third paragraph: Does the conclusion reached here take into consideration the fact that the transplutonium element inventory in the 1.15 SGR would be nearly 30 times that in the U-fueled LWR?

Page	Comment
S-2	Fourth paragraph, first line: In light of our later commentary on the hazards of the several plutonium isotopes, we are not convinced that the consequences of an accident are not increased. This is particularly true when new types of facilities (mixed fuel fabrication plant) are being added and when we have in many operations (including transportation) transuranium isotopes that are much more hazardous than ^{239}Pu.
S-3	Table S-1: The "50 years dose commitment" needs greater explanation. We assume the values are the 50 year dose commitments from one year of operation (1990 to 1991). Should not the title of the Table state: 1) Values are for one year of operation; 2) They apply only to the U. S. nuclear industry?
S-3	Table S-1: The last footnote should be expanded to read: "**Dose commitment ---- population or the genetically significant component of dose commitment."
S-4	Third paragraph: The "SGR" is designated in various places in Volume 1 as standing for "Self Generating," "Generator," and "Generation Reactor." These should all be made the same. We do not understand what is meant by the 115% or the 1.15 SGR. Initially, it appeared to mean a 115% increase in the ^{239}Pu ^{241}Pu in the reactor above the average amount at equilibrium in the usual LWR. This needs to be clarified.

Page	Comment
S-4	Fourth paragraph: We do not understand the second sentence in this paragraph unless it is true that the SGR has less uranium than the U-fueled reactor by an amount equal to two times the $^{238, 239, 241, 242, 243, 236}$Pu plus 29 times all the transplutonium elements plus the change in Np concentrations in the U-fueled reactor. In other words, $\Delta U_1 = 2\ Pu_1 + 29\ A_1 + (Np_2 - Np_1)$ in which ΔU_1 = reduction in U in the SGR below that in the U-fueled reactor; Pu_1 = Pu in the U-fueled reactor; A_1 = transplutonium elements in the U-fueled reactor; $Np_2 - Np_1$ = reduction of Np in the SGR. Is this, in fact, the case? It would help us understand what the changes are in converting to the SGR if a table were given showing under equilibrium conditions the Kg of each of the actinide radionuclides for the SGR and the conventional U-fueled reactor.
S-6	Second Paragraph (after line 10): Should not a fourth item be added? For example, "Shipment of Mixed Oxide Fuel Elements from the Reactor to the Reprocessing Plant."

Page	Comment
S-9	Table S-3: It is surprising to note that the values given are known to three significant figures. We also doubt that there would be a 21% increase in population whole body exposure in Case 2. This is undoubtedly a typographical error.
S-10	Lines 4 - 6: We question whether what this paragraph says could be substantiated. Third paragraph, line 10 on the page: Should this read "1955"? Line 26: Should read, "^{241}Pu" rather than "^{241}:u." Also, we calculate 16.3% instead of 15%.
S-10	It would help if in this section a good specific description could be given of the buildup of plutonium in successive stages of SGR operation, starting with the Pu discharged in the first cycle (given as 6.7 to 6.9 g per kg spent fuel). With the first recycle, some fraction of the reinserted material burns out and about another 6.7 to 6.9 g per kg spent fuel is formed. It is obvious that if about half of what is put in burns out each cycle then steady state is reached when burn-out equals growth, or input equals twice growth. However, an explicit description, plus graph or table of the successive changes would help visualization of the SGR made and the final steady state. It is recognized that the document does give changes in isotopic composition, percentages of MOX fuel in successive reloads, changes

Page	Comment
S-10	in fission products and transuranics, etc., but the simple successive input and output of Pu would clarify the changes.
S-12	Item 2: Should this read, ". . . loadings not to exceed 1.15" rather than "of up to"?
	Item 3: The word "strategic" has a typo.
S-13	Last paragraph: The value of 50,000 Kg of ^{239}Pu and ^{241}Pu available per year in 1990 seems too small. It would correspond to the Pu in only 90 LWRs of 1,000 MWe while the estimated number of LWRs at this time will be about 400.
S-15	Again this paragraph states that the ratio: $\frac{(^{241}Pu)(100)}{^{241}Pu + ^{239}Pu} = 15\%$. We calculated this to be 16.3%.
S-15	Last two paragraphs: Although the statements in these paragraphs are correct, there is no mention here or elsewhere in the text of several interesting observations. For example, the principal health hazard of the actinides during the lifetime of the plant is from ^{241}Pu. For example:

Page S-15 Comment

In Discharged Fuel (Kg/y):

TYPE REACTOR	^{238}Pu	^{239}Pu	^{240}Pu	^{241}Pu	^{242}Pu
1000 MWe-UO_2 Reactor	4.36	144	59	28	9.5
1000 MWe-PuO_2+UO_2 Reactor	27.7	488	457	280	204
Mass Increase (fraction)	6.4	3.4	7.7	10	21

In Discharged Fuel (Ci/y):

1000 MWe-UO_2 Reactor	7.35×10^4	8.85×10^3	1.3×10^4	3.19×10^6	37
1000 MWe-PuO_2+UO_2 Reactor	4.84×10^5	0.30×10^5	1.04×10^5	3.14×10^7	795
Mass Increase (fraction)	6.6	3.4	8	10	21

NOTE: Data in above Tables from T. H. Pigford, University of California.

From the above it is seen that the principal risks from the actinides in either the UO_2 or the UO_2+PuO_2 reactors are from the ^{241}Pu and ^{238}Pu and not from ^{239}Pu and the other plutonium isotopes. Casual inspection of this data above and the use of the factor - H (from the enclosed reprint) suggest the risk of ^{241}Pu and ^{238}Pu relative to that for ^{239}Pu in the UO_2 reactors and (UO_2+PuO_2) reactors as follows:

Page

Comment

S-15

$$\left(\frac{\text{Risk of } {}^{241}\text{Pu}}{\text{Risk of } {}^{239}\text{Pu}}\right)_{UO_2 \text{ Reactor}} = \frac{3.19\times10^{6}\times3}{8.85\times10^{3}\times1} = 1081$$

$$\left(\frac{\text{Risk of } {}^{241}\text{Pu}}{\text{Risk of } {}^{239}\text{Pu}}\right)_{UO_2+PuO_2 \text{ Reactor}} = \frac{3.14\times10^{7}\times3}{0.3\times10^{5}\times1} = 3140$$

$$\left(\frac{\text{Risk of } {}^{238}\text{Pu}}{\text{Risk of } {}^{239}\text{Pu}}\right)_{UO_2 \text{ Reactor}} = \frac{7.35\times10^{4}\times150}{8.85\times10^{3}\times1} = 1246$$

$$\left(\frac{\text{Risk of } {}^{238}\text{Pu}}{\text{Risk of } {}^{239}\text{Pu}}\right)_{UO_2+PuO_2 \text{ Reactor}} = \frac{4.84\times10^{5}\times150}{0.3\times10^{5}\times1} = 2420$$

$$\left(\frac{\text{Risk of } {}^{241}\text{Pu}}{\text{Risk of } {}^{238}\text{Pu}}\right)_{UO_2+PuO_2 \text{ Reactor}} = \frac{3140}{2420} = 1.3$$

In summary, the risks of ^{241}Pu and ^{238}Pu are about the same but are 3 orders of magnitude greater than those of ^{239}Pu. The risks of ^{241}Pu and ^{238}Pu are 2 to 3 times greater in the UO_2+PuO_2 reactors than in the UO_2 reactors. The values of H in the enclosed reprint were not developed for this application but indicate the approximate relative risks per curie (i.e., relative to ^{226}Ra).

S-16 Middle of page: Here is an example of the use of confusing units. The "MWd" apparently stands for megawatt days and the "MT" stands for metric tons.

Page

Comment

S-17 Part 2 on "Radiobiological Characteristics of Plutonium": A major item which should be referenced here is the report being prepared for issuance by NCRP on the plutonium "hot particle" problem. Although we realize this report was not available at the time of the writing of the initial WASH-1327 draft, it should be completed in time to be referenced in the final document. Since an independent statement by the NCRP on this subject would considerably enhance the position of the AEC on the matter of the hazard of "hot particles," we are sure you will want to reference the NCRP report as soon as it becomes official.

Third paragraph from bottom of page: We suggest deleting reference to lymph nodes from the first sentence or to offer some explanation. The ICRP no longer considers the lymph nodes the critical tissue in comparison with bone, liver, and lung in the case of Pu.

S-18 Here, there are two conclusions that are difficult to sustain. The fact that Pu in people from fallout is low does not really indicate that the passage from soil to man "is hardly to be expected." One needs considerably more analyses. The fact that there has been no consistently measurable plutonium concentration in people at Palomares could also reflect the lack of serious attempts to measure it. In this same regard, a review of previous

Page	Comment
S-18	studies (Price, K. R., Journal of Environmental Quality 2:62-66 (1973)) indicates that although plants have a very low uptake of ^{239}Pu, this uptake tends to increase with successive crops. Because of the 24,400 year half-life of ^{239}Pu, even a slight increase in uptake in successive crops could indicate a significant long term food chain hazard. Also, many previous experiments have used $Pu(NO_3)_4$ in solution, which is tightly bound to soil, while colloidal PuO_2, which is the chemical form most likely to result under accident conditions, is less bound. Other work relevant to this subject is being conducted at Harvard University by William V. Lipton, a doctoral candidate. The studies have involved the use of Early Alaska peas grown in sand contaminated with colloidal, hydrated PuO_2. Included in the studies have been variations in colloid sizes and in the depths of placement of the Pu in the sand. In addition, DTPA, a chelating agent, was applied to some of the plants. So far, there have been two important observations: a. Diethylenetriamine pentaacetic acid (DTPA) at 100 ppm (dry sand weight) tends to increase plant uptake by a factor of ten or more. Since chelating agents are produced by plant growth and decay, and are often used in fertilizers, this observation may be of importance.

Page	Comment
S-18	b. The observed concentration factors for all the samples, both chelated and unchelated, were significantly greater than values in the published literature. Most of the chelated samples had concentration factors on the order of 10^{-1}, while most of the unchelated samples had concentration factors on the order of 10^{-2}.
S-19	Lines 2 and 3: This sentence could be interpreted to mean that there was inadequate feedwater control only at the higher burnup. What you really mean, we presume, is that there was inadequate feedwater control throughout the reactor operation and it resulted in earlier than normal fuel rod defects. Second paragraph: Why were the experiments conducted at such low levels of burnup? It is at 35,000 MWd/MT and above that one would be concerned.
S-21	Lines 4-6: We believe care should be taken to include the assumptions made in the various calculations as to the amounts of Pu, etc., in the core of a 1.15 SGR and a LWR.
S-25	Figure S-4 (also Figure S-5 on page S-26): It is puzzling that the input of fuel assemblies to the reactor (13,800 MTU) is much greater than the output (8800 MTM). Is there an error here or should there be an explanation of some type?
S-27	The headings for columns 5 and 6 might be better understood if they read: "Number of Facilities."

Page	Comment
S-30	Footnote No. 3: Were assessments made for the situation in which Kr-85 and H-3 were not released to the environment?
S-31	Table S-7: The "50 year annual dose commitment to the world population" needs to be defined. Are these values the 50 year dose commitments to the world's population in 1990 for 1 year of exposure? Are these values known to three significant figures? Could not the occupational dose for the UO_2+PuO_2 reactors be reduced through proper shielding and working procedures?
S-34	Second paragraph: Is the 0.002 Ci alpha that quantity released per year from the reprocessing of fuel from about 400 UO_2+PuO_2 reactors in 1990? If this is the case, it assumes a decontamination factor of better than 10^{13} for the transuranics. Is this realistic? Middle paragraph: What justification do you have for saying "advanced reprocessing plants" are not expected to release radioactivity in liquid effluents"? Are there data to support this statement? Last two lines: How can you say that Pu contaminated wastes in storage have no environmental impact?

Page	Comment
S-35	Line 5: The incinerator you describe is only now being planned and much more research is needed. Is not this statement a little premature? Should you not wait until at least one plant has been designed and proven capable of operation?
S-36	Fourth paragraph: Again, a calculation is given which is based on numbers which are highly questionable.
S-38	Table S-8: The Table heading should be reworded. It is not clear now what is meant.
S-41	Line 7: If the decay time were much greater than a year, the major contributor to dose would be ^{242}Cm instead of ^{244}Cm. Also, under certain conditions, ^{238}Pu and ^{241}Pu might be major contributors to the population dose.
S-42	Middle of page: We suggest the the list include, "Shipment of Fuel from Reactor to Reprocessing Plant."
S-44	Three lines from bottom: There is a typo in the word, "implement."
S-46	Fourth paragraph, line 3: Here a promise is given for ALAP values for applications other than LWRs. When will these data be available?
S-47	Second paragraph: The first sentence is missing some words -- we cannot understand it. Third paragraph: Are the quoted separation factors attainable on a routine basis within current economics? Has a safe method for 600 year storage been developed? This appears to be based largely on plans not yet proven.

Page	Comment
S-49	First paragraph: Will a discussion of the use of Pu in HTGRs be the subject of future reports? We realize this document is restricted to LWRs.
S-52	Table S-11: The accuracy of the calculations does not appear to support the listing of values such a "-0.6%." Also, the problem of the "+21%" for whole body exposures for Case 2 appears here again.

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Attachment:

Copy, "Relative Hazard of the Various Radioactive Materials" by Karl Z. Morgan, W. S. Snyder and M. R. Ford (Health Physics, Pergamon Press 1964, Vol. 10, pp 151-169)

Health Physics Pergamon Press 1964. Vol 10, pp. 151-169. Printed in Northern Ireland

RELATIVE HAZARD OF THE VARIOUS RADIOACTIVE MATERIALS*

KARL Z. MORGAN, W. S. SNYDER and M. R. FORD
Health Physics Division, Oak Ridge National Laboratory,† Oak Ridge, Tennessee

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Abstract—An equation is given for the relative hazard, *H*, of various radionuclides under uniform working conditions. *H* is defined as the ratio of the average $\mu c/cm^3$ inhaled in the working area to the maximum permissible concentration, MPC, of the radionuclide for occupational exposure. The variation of *H* is discussed in relation to such parameters as radioactive and biological half lives of the radionuclides, fractional retention, dilution factors, specific activity, energy, RBE, relative damage factor, a, mass of the critical organ and the maximum permissible dose to the critical organ. Comparisons are made with values of *H* obtained by Hatch and other investigators. The values of *H* obtained by this method appear to be consistent with estimates from operational experience. A table of values of specific activity, $(MPC)_e$ and relative hazard, *H*, are given for the radionuclides listed in ICRP Publication No. 2, plus values for a number of additional transuranic elements not previously listed by the ICRP.

INTRODUCTION

At the first conference on the Peaceful Uses of Atomic Energy,[1] formulae were given for determining the relative hazard, *H*, of work with the various radionuclides. It was pointed out that *H* could be expressed as,

$$H = \frac{P}{\text{MPI}} \qquad (1)$$

in which *P* was the probability of taking a certain quantity of the radionuclide into the body and MPI was the maximum permissible daily intake into the body given in μc/day. It was assumed that the dust loading of air in areas where work was being done with radioactive material would not exceed the dust loading in the air of the average city. Drinker and Hatch[2] had shown that this corresponds to 0.1–1 mg/m^3 or 1–10 mg of dust inhaled per 8-hr work day. It was noted also at that time that the average shipment of radionuclides from Oak Ridge National Laboratory was 100 mc (excluding the large radiotherapy sources of Co^{60}); so, for convenience, it was assumed that the average accident involved work with 100 mc. The relative hazard associated with work involving 100 mc of various radionuclides was given by the equation,

$$H = \frac{10}{(\text{MPI}) \times (\text{mg}/100\ \text{mc})} = \frac{0.1}{(\text{MPC})_e \times D \times (\text{mg/mc})} \qquad (2)$$

in which $(MPC)_e$ = maximum permissible concentration ($\mu c/cm^3$) in the medium (air, water, food), *D* = daily intake of medium (cm^3/day), 10/(mg/100 mc) or 0.1/(mg/mc), was the probability, *P*, of inhalation of a given quantity of the radionuclide so that when mg/mc < 0.1, *P* was set equal to 1. Similar assumptions were made relative to the contamination of a wound, and values of *H* were found for all the radionuclides for which MPC values had been published at that time by the ICRP and the NCRP.

More recently, a number of investigators have attempted to develop mathematical relationships which can be used to determine the relative

* Portions of this paper were presented at the Annual Health Physics Society Meeting, Chicago, Illinois, June 10-15, 1962

† Operated by Union Carbide Nuclear Company for the U.S. Atomic Energy Commission.

hazard, H, of radionuclides. Perhaps, the most successful effort was by DUHAMEL and LAVIE,[3] who suggested the relation,

$$H = \frac{1}{\sqrt{(\mathrm{MPC})_a \times (\mathrm{MPC})_c}} \qquad (3)$$

where $(\mathrm{MPC})_a$ = maximum permissible concentration of the material in $\mu g/cm^3$ and $(\mathrm{MPC})_c$ = maximum permissible concentration of the material in $\mu c/cm^3$.* This equation can be written in the form,

$$H = \frac{\sqrt{c/g}}{(\mathrm{MPC})_c} \qquad (4)$$

in which c/g is the specific activity of the radionuclide in c/g.

HEURISTIC INTERPRETATION OF THE RELATIVE HAZARD FORMULA

In this paper, equation 2 of MORGAN *et al.*[2] has been related as,

$$H = C \times \mathrm{Min}\,(A \times c/g,\ 2.9 \times 10^{-10})/(\mathrm{MPC})_c \qquad (5)$$

in which the dimensionless index H is the relative hazard from work with a given number C of c of a radioactive material. The symbol Min (x, y) denotes the smaller of x and y. Thus, Min $(A \times c/g,\ 2.9 \times 10^{-10}) = A \times c/g$ if $A \times c/g < 2.9 \times 10^{-10}$ but Min $(A \times c/g,\ 2.9 \times 10^{-10}) = 2.9 \times 10^{-10}$ if $A \times c/g > 2.9 \times 10^{-10}$. This equation is derived below as the ratio of the amount (μc) of the radionuclide taken into the body per cm^3 of inhaled air in the work area during a hypothetical incident to the maximum permissible concentration $(\mathrm{MPC})_c$ of the radionuclide in air ($\mu c/cm^3$) for occupational exposure. The constant, A, is equal to the dust loading in the air ($\mu g/cm^3$) divided by the dilution factors $(b + 1)(d + 1)$. It is given by the equation,

$$A = \frac{10^{-4}}{(d + 1)(b + 1)} \qquad (6)$$

* Strictly, symbols $(\mathrm{MPC})_{a,g}$ and $(\mathrm{MPC})_{a,c}$ denoting the maximum permissible concentration in air in $\mu g/cm^3$ and $\mu c/cm^3$, respectively, should be used but since only $(\mathrm{MPC})_a$ values are used throughout this paper, the subscript "a" is omitted in order to simplify the notation.

in which the dust loading is assumed to be at a constant (or average) level of 10^{-4} $\mu g/cm^3$; b is the chemical dilution of the radioelement by stable isotopes of the radioelement or by other inert material (i.e. the chemical dilution of the radionuclide by stable material in the mixture and escaping into the work area); d is the dilution of the escaping radioactive mixture by airborne floor dust. The function Min $(A \times c/g,\ 2.9 \times 10^{-10})$ imposes a restriction on the air activity ($\mu c/cm^3$) in conformity with the assumption that the air activity in the working area will not be permitted appreciably above 10 times the MPC for Ra^{226} or above the MPC for Sr^{90}.

For convenience in this comparison, Ra^{226} is taken as the reference standard, i.e. the relative hazard, H, in equation 5 is set equal to 1 for Ra^{226}. This is done because for many years Ra^{226} has been the standard of comparison for determining the MPC values for bone-seeking radionuclides and it is the only radionuclide for which man has had over 40 years of recorded exposure history and, in some cases, a rather extensive evaluation of the consequent damage. When equation 5 is normalized to Ra^{226} for which $(\mathrm{MPC})_c = 2.9 \times 10^{-11}$ $\mu c/cm^3$ for occupational exposure (40 hr/week and for which the specific activity $c/g = 0.981$, the constant $A = 2.9 \times 10^{-11}$ and the constant dilution factors $(b + 1)(d + 1) = 3.43 \times 10^6$. If equation (5) had been normalized to Pu^{239}, $(b + 1)(d + 1)$ would have been equal to 5.56×10^6. Thus, in view of the fact that the limited accuracy of the biological data used in the Internal Dose Handbooks of NCRP and ICRP has not warranted the listing of MPC values of radionuclides to more than one significant figure, both isotopes —Ra^{226} and Pu^{239}—may be considered as reference standards for which H is equal to 1.

Equation (5) is intended to represent the hazard of rather routine day-to-day work with a radioactive material. It is not intended to represent the hazard of a major explosion or of a large, sudden release of radioactive material into the environment, although with certain additional assumptions relative to the amount of energy dissipated in an explosion and the amount of material released, equation (5) might be appropriately modified and extended to include such events. This equation is intended to express the hazard of routine work with any

radionuclide in reference to similar work with Ra^{226} using comparable facilities and procedures. Values of H obtained from equation (5) are intended to indicate the level of precautionary measures that should be taken for work with a radionuclide: for example, the type of chemical hood needed, the air changes required, the filters that are recommended in the ventilation system, the kinds of covering that are appropriate for the floor and table tops, the safety measures that should be enforced, etc.

DERIVATION OF THE RELATIVE HAZARD FORMULA

In deriving equation (5), six assumptions are made as follows:

(1) The relative hazard, H, is proportional to the ratio of the intake by the worker to the $(\mathrm{MPC})_c$ of the radionuclide or since the intake is assumed to be proportional to the average concentration in laboratory air, H is the ratio of the $\mu c/cm^3$ of laboratory air to the $(\mathrm{MPC})_c$ of the radionuclide. Thus,

$$H = \frac{\mu c/cm^3}{(\mathrm{MPC})_c} \qquad (7)$$

The symbol $(\mathrm{MPC})_c$ will be used to denote the maximum permissible concentration in air for occupational exposure (40 hr/week) in units of $\mu c/cm^3$ of air.

(2) The relative hazard $H = 1$ for Ra^{226} under standard conditions of dilution specified below.

(3) The activity ($\mu c/cm^3$) in the laboratory air is monitored continuously or rather frequently and is not permitted to exceed for significant periods 10 times the MPC for Ra^{226} (2.36×10^{-10} $\mu c/cm^3$) or, what is essentially the same value, the MPC for Sr^{90} (2.89×10^{-10} $\mu c/cm^3$). This is a level that is easily monitored by fixed or portable air monitoring equipment and it is assumed that should such a level be exceeded, remedial measures would be taken immediately to restore better working conditions. From this assumption,

$$H \leq \frac{10(\mathrm{MPC})_c Ra^{226}}{(\mathrm{MPC})_c} \quad \text{or} \quad \frac{2.36 \times 10^{-10}}{(\mathrm{MPC})_c}$$

and $$H \leq \frac{(\mathrm{MPC})_c Sr^{90}}{(\mathrm{MPC})_c} \quad \text{or} \quad \frac{2.89 \times 10^{-10}}{(\mathrm{MPC})_c} \qquad (8)$$

(4) The loading of dust and airborne escaping material in the laboratory air is constant at the value 10^{-4} $\mu g/cm^3$. That is,

$$(\mu g)_D/cm^3 = (\mu g)_F/cm^3 + (\mu g)_E/cm^3 + (\mu g)_R/cm^3 = 10^{-4} \qquad (9)$$

in which $(\mu g)_D/cm^3$ = μg of dust and airborne material/cm^3 of laboratory air, $(\mu g)_F/cm^3$ = μg of floor dust (lint, smoke, sand, etc.)/cm^3 of laboratory air, $(\mu g)_E/cm^3$ = μg of inert material escaping with radionuclide/cm^3 of laboratory air, and $(\mu g)_R/cm^3$ = μg of undiluted radionuclide/cm^3 of laboratory air.

(5) It is assumed that the material as it escapes initially into the laboratory is a representative sample of the mixture before it escaped, i.e. the ratio of radioactive material to inert material in the escaping air equals the ratio of these materials in the original mixture or compound. Thus the chemical and isotopic dilution factor is $(b + 1)$ in which,

$$(b + 1) = \frac{(\mu g)_E/cm^3 + (\mu g)_R/cm^3}{(\mu g)_R/cm^3} \qquad (10)$$

This assumption may not be correct in cases where there can be fractionation of certain of the chemicals as they escape. Therefore, where specific data are available, a correction for this fractionation should be applied to the value of b in obtaining H for a particular chemical operation.

(6) The amount of floor dust $(\mu g)_F/cm^3$ that becomes airborne is a constant multiple d of the amount of airborne material escaping into the laboratory for a given operation involving work with radionuclides for which the ratio of mass to activity is high, i.e. $c/g)_R \leq 10$ $\mu c/\mu g$. This assumption states that when the work involves 0.1 or more grams of radionuclide per c, the ratio of $\mu g/cm^3$ of floor dust becoming airborne to the $\mu g/cm^3$ of escaping material is relatively constant. Thus the dust dilution factor is $(d + 1)$ in which,

$$(d + 1) = \frac{(\mu g)_E/cm^3 + (\mu g)_R/cm^3 + (\mu g)_R/cm^3}{(\mu g)_E/cm^3 + (\mu g)_R/cm^3} = \frac{(\mu g)_D/cm^3}{(\mu g)_E/cm^3 + (\mu g)_R/cm^3} \qquad (11)$$

The total dilution factor $(b + 1)(d + 1)$ is

$$(b+1)(d+1) = \frac{(\mu g)_A/\text{cm}^3 - (\mu g)_B/\text{cm}^3 + (\mu g)_B/\text{cm}^3}{(\mu g)_A/\text{cm}^3} = \frac{(\mu g)_B/\text{cm}^3}{(\mu g)_A/\text{cm}^3} + \frac{10^{-4}}{(\mu g)_A/\text{cm}^3} \quad (12)$$

From equations (7)–(12), the general equation for H can be written as

$$H = \frac{\mu c/\text{cm}^3}{(\text{MPC})_c} = \frac{(\mu g)_A/\text{cm}^3 \times (c/g)}{(\text{MPC})_c} = \frac{10^{-4}(c/g)}{(b+1)(d+1)(\text{MPC})_c}$$

$$\text{but} \leq \frac{2.9 \times 10^{-10}}{(\text{MPC})_c} \quad (13)$$

In any case, it is assumed the concentration in the air being breathed will not rise above 2.9×10^{-10} $\mu c/\text{cm}^3$ because of remedial measures, including a possible alarm followed by the use of masks, the evacuation of personnel, etc. The formulae for H can be combined into a single formula by the use of mathematical symbol $\text{Min}(x, y)$ = the smaller of x and y. Using this symbol, equation (13) can be written as

$$H = \frac{\text{Min}\left(\frac{10^{-4}(c/g)}{(b+1)(d+1)}, 2.9 \times 10^{-10}\right)}{(\text{MPC})_c} \quad (13a)$$

If H is normalized to equal 1 for the case of 1 c of Ra^{226}, then

$$H = 1 = \frac{10^{-4} \times 0.961}{(b+1)(d+1) \times 2.90 \times 10^{-11}}$$

$$\text{or} \quad (b+1)(d+1) = 3.43 \times 10^{5} \quad (14)$$

If, as a first approximation, the values of b and d for Ra^{226} are applied to work with other radionuclides in finding the relative hazard, H, then

$$H = \frac{2.92 \times 10^{-11}(c/g)}{(\text{MPC})_c} \quad \text{but} \quad H \leq \frac{2.9 \times 10^{-10}}{(\text{MPC})_c} \quad (15)$$

Using the same notation as in equation (13a), these formulae can be combined to give

$$H = \frac{\text{Min}(2.92 \times 10^{-11}(c/g), 2.9 \times 10^{-10})}{(\text{MPC})_c} = \frac{2.9 \times 10^{-11}\,\text{Min}(c/g, 10)}{(\text{MPC})_c} \quad (15a)$$

This equation is the same as equation (5) if $A = 2.92 \times 10^{11}$. It can also be written as

$$H = \frac{2.92 \times 10^{-11} \phi(c/g)}{(\text{MPC})_c} \quad (15b)$$

where the function $\phi(c/g) = c/g$ if $c/g \leq 10$ and $\phi(c/g) = 10$ if $c/g \geq 10$.

DISCUSSION OF THE FORMULA

The value of b is determined by the chemistry of the operation and the isotopic dilution and d is related to the amount of floor dust permitted in the working area, the size distribution of the dust particles and the air flow pattern which, in turn, determines the effective dilution of the radioactive material from the time it escapes into the working area until it is inhaled. It is of interest to note that the relative hazard H can be decreased directly by increases in the chemical and isotopic dilution factor, the dust dilution factor, or a combination of these factors. Experimental values of this product $(b + 1)(d + 1)$ were not available to the writers for different chemical and engineering operations with the various radionuclides; so, in this paper, it was set equal to 3.43×10^5 for each of the radionuclides. Values of the product can and should be determined experimentally for many types of operations with various chemical compounds and physical forms of the radioisotopes and for various working conditions. When such experimental data become available, more realistic and directly applicable values of H can be determined – values that are applicable to the many chemical and physical forms of the radionuclides and to the various working conditions (i.e. values that are applicable to the equipment used, types of enclosure, dust level, etc.). However, in calculating such values of H, it must be kept in mind that the MPC values for radionuclides now available in the ICRP[3] and NCRP[5] publications are applicable only to the more common soluble and insoluble chemical forms of the radi-elements and specific values of MPC must also be determined eventually for each chemical and physical form of the radionuclides in order to obtain the most reliable and applicable values of H from equation (13).

The boundary conditions imposed by equations (5) or (15) are tantamount to assuming the intake in μc is proportional to the concentration of activity in the air provided this activity does not exceed 2.9×10^{-10} and, under the assumption that the total load of airborne material does not exceed 10^{-4} $\mu g/\text{cm}^3$, and for the dilution factors given, this will be realized if the specific activity does not exceed 10. For radionuclides of high specific activity, i.e. $c/g > 10$, the intake is assumed to be limited by an alarm or other monitoring device and subsequent action. This, of course, does not specify the specific activity of an individual dust particle since many dust particles would be relatively uncontaminated while others would have a specific activity much greater than that of the average. It is to be noted that when the dilution factor has a different value than that assumed here, the cut-off point in equation (15b) which limits the concentration of the radionuclide in the intake air to not more than 2.9×10^{-10} $\mu c/\text{cm}^3$ will be different.

The value of 10^{-4} $\mu g/\text{cm}^3$ (or 0.1 mg/m^3) used in this paper for the average dust loading in the air of the work area is probably not an unrealistic value, although there may be considerable variation in this value due to the differences in support of adequate measures for radiation protection to be found among the various organizations working with radionuclides. In general, however, the common use of good air filtering systems in laboratories and production facilities where work is done with radioactive materials tends to keep the dust load of the air within an order of magnitude of this value. D. M. Davis and W. D. Cottrell[6] made measurements from a number of dust samples collected in the isotope work areas of Oak Ridge National Laboratory and obtained a minimum value of 0.27×10^{-4} $\mu g/\text{cm}^3$, a maximum value of 1.8×10^{-4} $\mu g/\text{cm}^3$ or an average value of 0.86×10^{-4} $\mu g/\text{cm}^3$. The assumption that the air which is breathed in the working area has an average value of 100 per cent of the MPC, in the case of Ra^{226}, or that $H = 1$ for Ra^{226}, is an arbitrary choice used only for convenient reference. The use of the same value of the product $(b + 1)(d + 1)$ in the calculation of all values of H in this paper was an expediency dictated by the lack of experimental data. When experimental values of the chemical, isotopic and dust dilution factors become available for the various physical and chemical forms of the radioisotopes and for various chemical and engineering operations, the values of H tabulated in this paper can be extended and improved by adjusting them appropriately. For the present, however, and until experimental data are available for such refinements in the calculations, the values of H given in this report should be considered primarily as the relative hazards (or risks) of occupational workers being exposed while conducting routine operations with one curie of the various radionuclides under operating conditions similar to those provided for Ra^{226}. Values of MPC (or $\mu c/\text{cm}^3$) rather than MPI (or μc/day) are used in equations given in this paper because of the convenience to the reader in applying values of MPC to be found in publications of ICRP[3] and NCRP.[5] Other than mentioned above, the authors know of no good basis for these assumptions except that they lead to values of H that agree with years of laboratory experience.

The preceding heuristic derivation of H assumed 1 c of activity to be present. When more than one curie of activity is involved in an operation, H increases proportionately according to equation (5). This assumption may be unjustified in some cases, and a closer investigation of this assumption might indicate that the cut-off value should vary somewhat according to the amount of activity involved. However, a large variation in amount of activity will often require changes in the equipment and procedures which might affect the value of the dilution factors or make the operation not comparable with the previous operation. It would seem that the use of the curie amount as a multiplicative factor is probably conservative so far as the use of large activities is concerned. All the illustrative graphs and tables which follow are computed for the case of one curie of activity.

COMPARISON WITH OTHER RELATIVE HAZARD FORMULAE

In order to compare results, $\sqrt{c/g}$ from equation (4) of Duhamel and Lavi[3] and $\phi(c/g)$ from equation (15b) of this paper are plotted in Fig. 1. Also, values of H for typical radionuclides were determined by means of these two equations and plotted in this same figure. As would be expected, the two equations yield very

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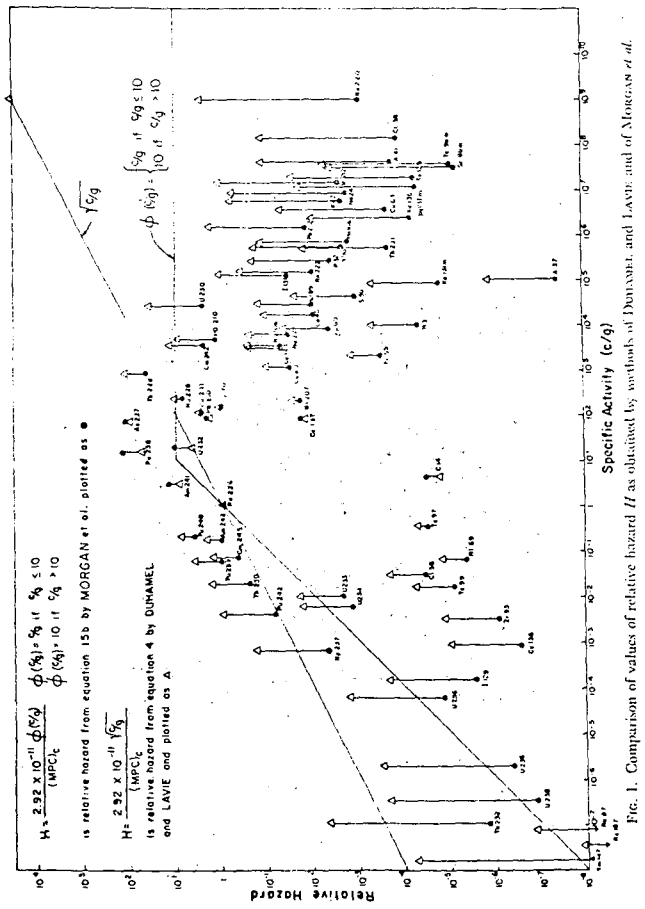

Fig. 1. Comparison of values of relative hazard H as obtained by methods of DUHAMEL and LAVIE and of MORGAN *et al.*

similar values (within an order of magnitude) in the range from $c/g = 10^{-2}$ to 10^4 but are divergent beyond these limits. Thus, the authors' method (equation (15b)) differs significantly from that of DUHAMEL and LAVIE in that long-lived radionuclides, i.e. $c/g < 10^{-2}$, and the short-lived radionuclides, i.e. $c/g > 10^4$, are considered to be less hazardous.

Some typical values of H obtained by the use of these two equations (i.e. equation (4) normalized by the constant $A = 2.92 \times 10^{-11}$ and equation (15b)) are plotted in Table 1 for ease of comparison. Both equations class Pu^{244}, Ac^{227}, $Cf^{254,250,249}$, Am^{242m} and Th^{228} as the most hazardous radionuclides. Also, both equations list radionuclides such as $Ra^{226,228}$, $Pu^{239,240,241}$, $Am^{241,243}$, $U^{220,222}$, Pb^{210}, Po^{210}, $Cm^{242,243}$, Sr^{90} and Th^{229} as very hazardous radionuclides. Both equations list radionuclides of extremely long half life such as In^{115}, Nd^{144}, Re^{187}, Rb^{87} as the least hazardous. Between these two extremes, the other radionuclides are classed by the two equations with varying degrees of intermediate hazard. There is, apparently, a weakness in the use of equation (4) in that H becomes too large as the half life of the radionuclide approaches zero.

Although it has not been possible to provide a strong theoretical basis, either for equation (4) or for equation (15b), a detailed comparison of the classification of various radionuclides obtained by the two equations with the classification arrived at through years of laboratory experience is useful in indicating the reliability of the two methods. This is the case because the only purpose in such equations is to provide a mathematical expression which can be shown to list the more common radionuclides in the known order of radiation hazard, as has been determined by experience, in the hope that this same equation may be relied upon as a guide to the relative hazard for work with a less common radionuclide where very little or no experience has been accumulated. Such classification of a radionuclide is required in order to determine the adequacy of health physics protective measures, waste disposal requirements, exempt quantities, shipping regulations, etc., for the various radioactive materials.

The greater the slope of the connecting lines plotted in Table 1, the greater the difference in relative hazard as determined by the two methods. In general, and as would be expected from values plotted in Fig. 1, the majority of values of H obtained from equation (15b) are less than those obtained from equation (4) when both equations are normalized by the same constant. However, this is considered to be of minor significance since the factor of primary interest is the ordering of the radionuclides and not the absolute magnitude of the relative hazard H. Table 2 provides, by the use of equations (4) and (15b), a comparison of the ordering of some of the more commonly used radionuclides and, in each case, this ordering is compared with that arrived at from laboratory experience. Perhaps such a comparison tends to justify the conclusion that equation (15b) furnishes a relatively reliable means of classifying the radionuclides in the order of increasing radiation hazard and that this classification, in general, is in agreement with laboratory and industrial experience with these radionuclides. Undoubtedly, this ordering could be improved upon if specific values of the chemical, isotopic and dust dilution factors, i.e. $(b + 1)(d + 1)$, were available for each chemical and engineering operation with the various radionuclides and if values of $(MPC)_e$ were available for specific chemical forms of the radionuclides.

The general value of $(MPC)_e$ may be obtained from the handbooks on internal dose of the ICRP[4] and NCRP[5] and substituted in equations (5) or (13a) to give the relation,

$$H = \frac{6.8 \times 10^{13} C T f_i (1 - e^{-0.693t/T}) \Sigma E(RBE) n \operatorname{Min}\left[\dfrac{10^{-4}(c/g)}{(b+1)(d+1)}, 2.9 \times 10^{-10}\right]}{mR} \tag{16}$$

in which f_i = fraction of the radioactive material inhaled that is deposited in the critical body organ, m = mass of critical body organ (g), t = period of occupational exposure (years), T = effective half life (years), R = maximum permissible dose rate (rem/year) delivered to the critical body organ, E = energy per disintegration (MeV) deposited in the critical body organ, RBE = relative biological effectiveness

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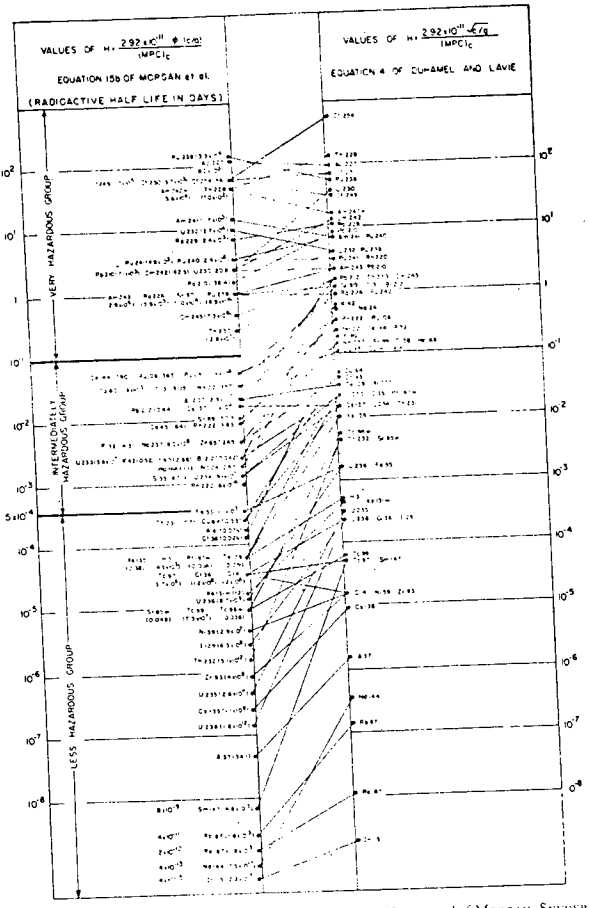

Table 1. *Comparison of values of H obtained by methods of* DUHAMEL *and* LAVIE *and of* MORGAN, SNYDER *and* FORD

Table 2. *Comparison of values of relative hazard obtained by method of* DUHAMEL *and* LAVIE *(equation* (4)*) and method of* MORGAN, SNYDER *and* FORD *(equation* (15b)*)*

Comparison	Comments
Ra^{226}, Sr^{90}, Pu^{239} and Po^{210} are considered to be very hazardous and of about equal hazard	Confirmed both by equation (4) and equation (15b)
Pu^{238}, Ac^{227}, $Cf^{254,250,249}$, Am^{242m} and Th^{228} are probably among the most hazardous radionuclides known	Confirmed both by equation (4) and equation (15b)
Radionuclides such as $Ra^{226,228}$, $Pu^{239,240,241}$, $Am^{241,243}$, $U^{230,232}$, Pb^{210}, Po^{210}, $Cm^{242,243}$, Sr^{90} and Th^{230} are very hazardous	Confirmed both by equation (4) and equation (15b)
Long-lived radionuclides such as Nd^{144}, Re^{187} and Rb^{87} are among the least hazardous radionuclides	Confirmed both by equation (4) and equation (15b)
I^{131} is probably about the same hazard as Co^{60} and much less hazardous than Ra^{226} or Sr^{90}	Confirmed by equation (15b) but equation (4) places I^{131} equally hazardous to Sr^{90} and Ra^{226} and much more hazardous than Co^{60}
Sr^{89} and Ca^{45} are probably more hazardous than P^{32}	Confirmed by equation (15b) but equation (4) places P^{32} more hazardous than Sr^{89} and Ca^{45}
U^{232} with a half life of 74 years is probably more hazardous than U^{230} with a half life of 21 days	Confirmed by equation (15b) but not confirmed by equation (4)
Th^{230} with a half life of 8×10^4 years is probably less hazardous than Sr^{90} and Ra^{226}	Confirmed by equation (15b) but not confirmed by equation (4)
Xe^{135} is probably much less hazardous than Cs^{137}, $U^{233,234}$	Confirmed by equation (15b) but not confirmed by equation (4)
H^3 and C^{14} are probably about equally hazardous	Confirmed by equation (15b) but not confirmed by equation (4)
Sm^{147} with a half life of 1.3×10^{11} years is probably much less hazardous than C^{14}	Confirmed by equation (15b) but not confirmed by equation (4)
H^3 is probably much more hazardous than U^{235} and Th^{232}	Confirmed by equation (15b) but not confirmed by equation (4)
C^{14} is probably more hazardous than U^{235} and U^{238}	Confirmed by equation (15b) but not confirmed by equation (4)
Na^{24} with a half life of 15 hours is probably less hazardous than Ca^{45}, Co^{60}, Cs^{137}, Np^{237} and Sr^{89}	Confirmed by equation (15b) but not confirmed by equation (4)
Rn^{222} is probably less hazardous than Sr^{89}, Co^{60}, Ru^{106} and Cs^{137}	Confirmed by equation (15b) but not confirmed by equation (4)
Rn^{220} is probably much less hazardous than Pu^{239}, Am^{243}, Pb^{210}, Sr^{90}, Ra^{226}, etc.	Confirmed by equation (15b) but not confirmed by equation (4)

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of the radiation, n = relative damage factor, $\text{Min}\left(\frac{10^{-4}(c/g)}{(b+1)(d+1)}, 2.9\times10^{-10}\right)$ has values as indicated for equation (5) and $10^{-4}/(b+1)(d+1)$ is a term that can be used if the chemical, isotopic and dust dilution factors are known (otherwise, it is set equal to 2.9×10^{-11}). Thus, it can be seen from equation (16) that, in general, and, as expected, the hazard H in the case of inhalation exposure increases directly with f_a, the fraction of the inhaled dust that arrives in the critical organ, with E, the energy delivered to the critical organ per disintegration, with the RBE of the radiation, and with n the relative damage factor. It decreases with m, the mass of the critical organ in which the radionuclide deposits and dilutes some or all of its energy of radioactive decay; it decreases with the constant dilution factors $b=1$, $d=1$, until the concentration of the air in the working area reaches a level of 2.9×10^{-10} $\mu c/cm^3$. A comparison of I^{131} which localizes primarily in the thyroid, with Pu^{239} which localizes primarily in the bone, and with H^3 which is rather uniformly distributed in the body, will illustrate the wide variation of these factors and the importance of them in determining the relative hazard H. Thus,

$$f_a\Sigma E(\text{RBE})n/mR = 0.23\times0.23(1)1/(20\times30) = 8.8\times10^{-5} \text{ for } I^{131};$$

$$f_a\Sigma E(\text{RBE})n/mR = 0.2\times5.4(10)5/(7\times10^3\times30) = 2.6\times10^{-4} \text{ for } Pu^{239} \text{ and}$$

$$f_a\Sigma E(\text{RBE})n/mR = 1\times0.006(1.7)1/(7\times10^3\times5) = 2.9\times10^{-8} \text{ for } H^3.$$

The variation of the relative hazard H with the effective half life, T, is somewhat involved because T is a function of the radioactive half life, T_r, and of the biological half life, T_b, as indicated by the equation,

$$T=\frac{T_rT_b}{T_r+T_b} \tag{17}$$

Also, T_r is present in the formulae through the specific activity,

$$c/g=\frac{3.56\times10^5}{WT_r}. \tag{18}$$

In this equation, T_r is the radioactive half life in years and W is the atomic weight of the radionuclide. If equations (17) and (18) are substituted in equation (16) and, if for convenience in observing the behavior of H with respect to T_b and T_r, the dilution factors are specified as previously, i.e. $(b-1)(d-1)=3.4\times10^6$, then equation (16) becomes,

$$H=\left[\frac{2\times10^3f_a\Sigma E(\text{RBE})n}{mR}\right]\times T\left(1-e^{\frac{-0.693t}{T}}\right)\phi c/g)$$

where the bracketed factors do not involve T_r. Neglecting the bracketed factors, for the purpose of this discussion, the formula for H becomes,

$$H=H_1=\frac{3.56\times10^5T_bX}{W(T_r+T_b)} \text{ when } c/g\lesssim10 \tag{19}$$

and

$$H=H_2=\frac{10T_rT_bX}{(T_r+T_b)} \text{ when } c/g>10 \tag{20}$$

in which X has the value,

$$X=(1-e^{-0.693t(T_r+T_b)/T_rT_b}) \tag{21}$$

In order to indicate the variation of H with T_r and T_b, the equations for H_1 and H_2 were plotted in Fig. 2 for various values of T_b and W and for an exposure period $t=50$ y, the occupational exposure period of the standard man. For a fixed value of T_b, the relative hazard is plotted as a function T_r; the curve continues to the cut-off value beyond which H decreases along the straight line. This cut-off value differs for different values of the atomic weight W. Table 3 summarizes some of the observations from Fig. 2. Here it is to be observed that for low values of T_b the maximum value of H increases rapidly with increasing values of T_b but for large values of T_b, it increases slowly with T_b and that $H(\max)$ is an insensitive function of W, i.e. $H(\max)$ decreases slowly with increasing W. The relative hazard H is always increased by an increase in T_b. The

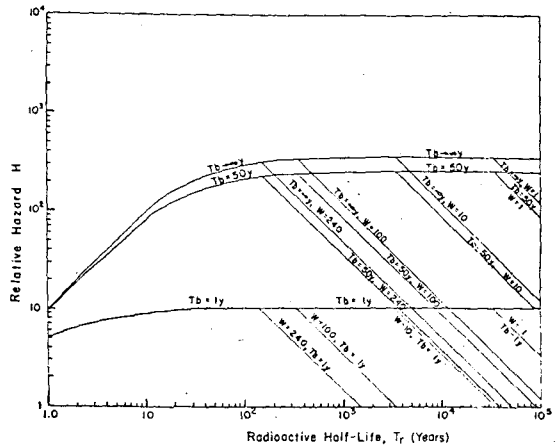


FIG. 2. Values of relative hazard H as a function of radioactive half life T_r for an occupational exposure period of 50 years and for various biological half lives T_b and atomic weights W.

value of T_r at which H is a maximum is independent of T_b but it decreases linearly with increasing W. Some of these changes seem to be in accord with what one would expect from an equation that is to indicate the relative hazard of a radionuclide. Thus, when T_b is shorter than the life span of man, H increases rapidly with T_b; but when T_b is much greater than the life span of man, there is little further increase of H with an increase of T_b. In other words, one would expect a large increase in the hazard if T_b were increased from 1 hr to 1 day to 1 year but would expect little increase in the hazard if T_b were increased from 1000 to 10,000 years. Also, the relative hazard H increases with increasing values of T_r when $c/g>10$ and this rate of increase with T_r approaches linearity when both c/g and T_b are large (i.e. c/g and $T_b\to\infty$). The relative hazard H reaches a maximum at the values of W and T_r corresponding to $c/g=10$. For values of $c/g<10$ and for a fixed value of W, the decrease in H is inversely proportional to T_r. Thus, transuranic radionuclides with atomic weights from 238 to 256 are most hazardous if their radioactive half lives are about 150 years or approximately twice the average life span of man and fission products having an atomic weight of about 100 would be most hazardous if their radioactive half lives were about five times the average life span of man.

An inspection of the twelve highest values of H for radionuclides obtained by means of equation (16) (see Table 6) reveals that ten of these twelve are transuranic elements and of these ten there are six with values of T_r that are within an order of magnitude of 150 y. All twelve of these radionuclides with highest values of H are "bone-seeking" radionuclides for which $n=5$ and nine of these decay primarily by α-emission for which (RBE) = 10. All twelve of these radionuclides with highest values of H are in the actinide group of elements for which a value of $T_b=200$ years is assigned. It

Table 3. Summary of maximum values of H and corresponding values of T_r (years) for various values of T_b (years) and W as plotted in Fig. 2

T_b(y)	Values of H (max) for $W = 240$	Corresponding values of T_r for H (max) and for $W = 240$	Values of H (max) for $W = 100$	Corresponding values of T_r for H (max) and for $W = 100$	Values of H (max) for $W = 10$	Corresponding values of T_r for H (max) and for $W = 10$	Values of H (max) for $W = 1$	Corresponding values of T_r for H (max) and for $W = 1$
1	10	148	10	356	10	3560	10	35,600
50	230	148	240	356	250	3560	250	35,600
∞	310	148	350	356	340	3560	350	35,600

will be noted also that most of the fission products have much shorter half lives and smaller values of H than the transuranic elements and, in general, the greater the half lives (i.e. both T_r and T_b) of the fission product, the greater the value of H.

Equation (15b) can be re-arranged in the forms,

$$(\mathrm{MPC})_c = \frac{2.92 \times 10^{-11}\phi(c/g)}{H} \qquad (22)$$

and

$$(\mathrm{MPC})_g = \frac{2.92 \times 10^{-11}\phi/(c/g)}{c/gH} \qquad (23)$$

in which $(\mathrm{MPC})_c$ and $(\mathrm{MPC})_g$ are the maximum permissible concentrations in the air in $\mu c/cm^3$ and $\mu g/cm^3$, respectively, for occupational exposure 40 hr/week. Values of $(\mathrm{MPC})_c$ and $(\mathrm{MPC})_g$ from equations (22) and (23) for $H = 1$, $H = 0.1$ and $H = 5 \times 10^{-4}$ are listed in Table 4 and plotted in Fig. 3. It is to be noted that in each case plots of $(\mathrm{MPC})_c$ and $(\mathrm{MPC})_g$ for a constant value of H form rectangles in which the base is 1/10 of the height. It is to be observed also that radionuclides such as Am^{243}, Pu^{239} and Sr^{90}, as well as Ra^{226}, fall approximately upon a line which is the locus of points for which $H = 1$ or for which the hazard is unity. Radionuclides falling within the rectangle for which $H = 1$ have a relative hazard greater than 1; radionuclides falling within the rectangle for which $H = 0.1$ have a relative hazard greater than 0.1 and radionuclides falling between rectangles for which $H = 0.1$ and 5×10^{-4} have relative hazards within this range, etc. Thus, equations (22) and (23) provide recipes such as plotted in Fig. 3 to furnish a convenient means of segregating the radionuclides into various relative hazard groups.

Table 4 indicates also for illustration the variation with specific activity ($\mu c/\mu g$) of (1) the $\mu g/\mu c$ of the radionuclide, (2) the factor ϕ (c/g), (3) the dilution factor, μg of dust/μg of radionuclide, (4) the average specific activity of the dust, $\mu c/\mu g$ of dust, (5) the average mass per unit activity of dust, μg dust/μc and (6) values of relative hazard H corresponding to a $(\mathrm{MPC})_c = 2.92 \times 10^{-10}$ $\mu c/cm^3$.

A close inspection of Fig. 3 indicates that the $(\mathrm{MPC})_c$ values for most of the uranium radioisotopes are very nearly the same. This suggests that it might be of interest to consider the resulting hazard for various mixtures of the uranium isotopes in order to illustrate further the influence of specific activity ($\mu c/\mu g$) or T_r on the relative hazard H. Table 5 summarizes values of mass per unit activity $\mu g/\mu c$ of isotopic mixtures of U^{235} and U^{230}, mass per unit activity $\mu g/\mu c$ of the airborne dust, $(\mathrm{MPC})_c$, $(\mathrm{MPC})_g$ and H for the various mixtures. These values of $(\mathrm{MPC})_c$ and $(\mathrm{MPC})_g$ are plotted in Fig. 3, forming a line—one that is almost horizontal—connecting the points for U^{235} and U^{230}. It is to be noted that as U^{235} is diluted with U^{230}, the mass of airborne dust per unit activity decreases linearly with the increase in

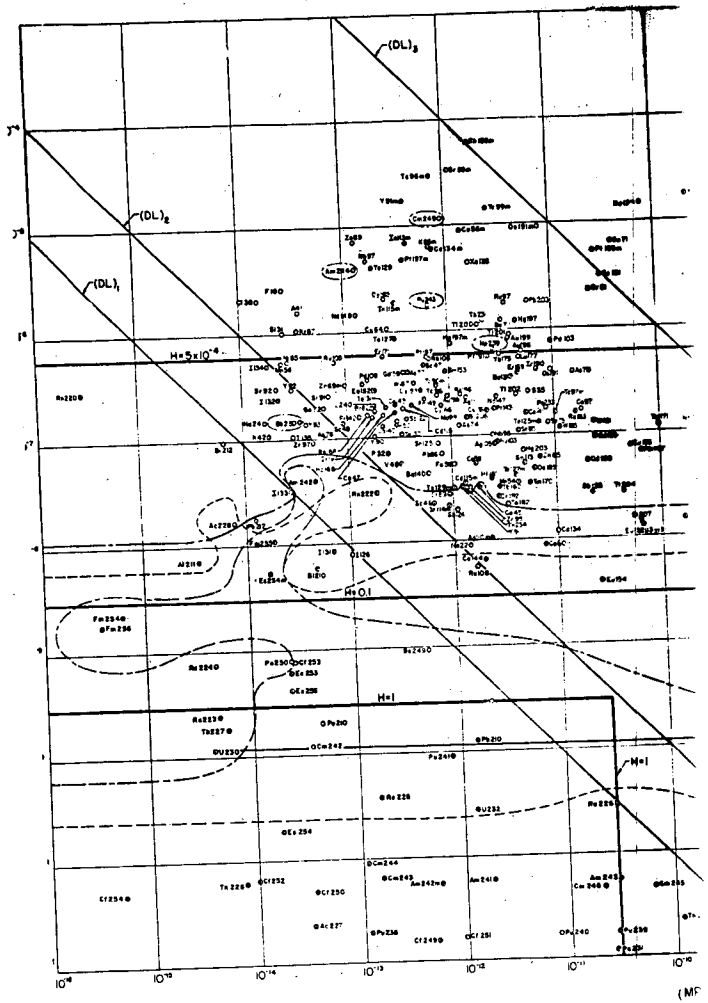
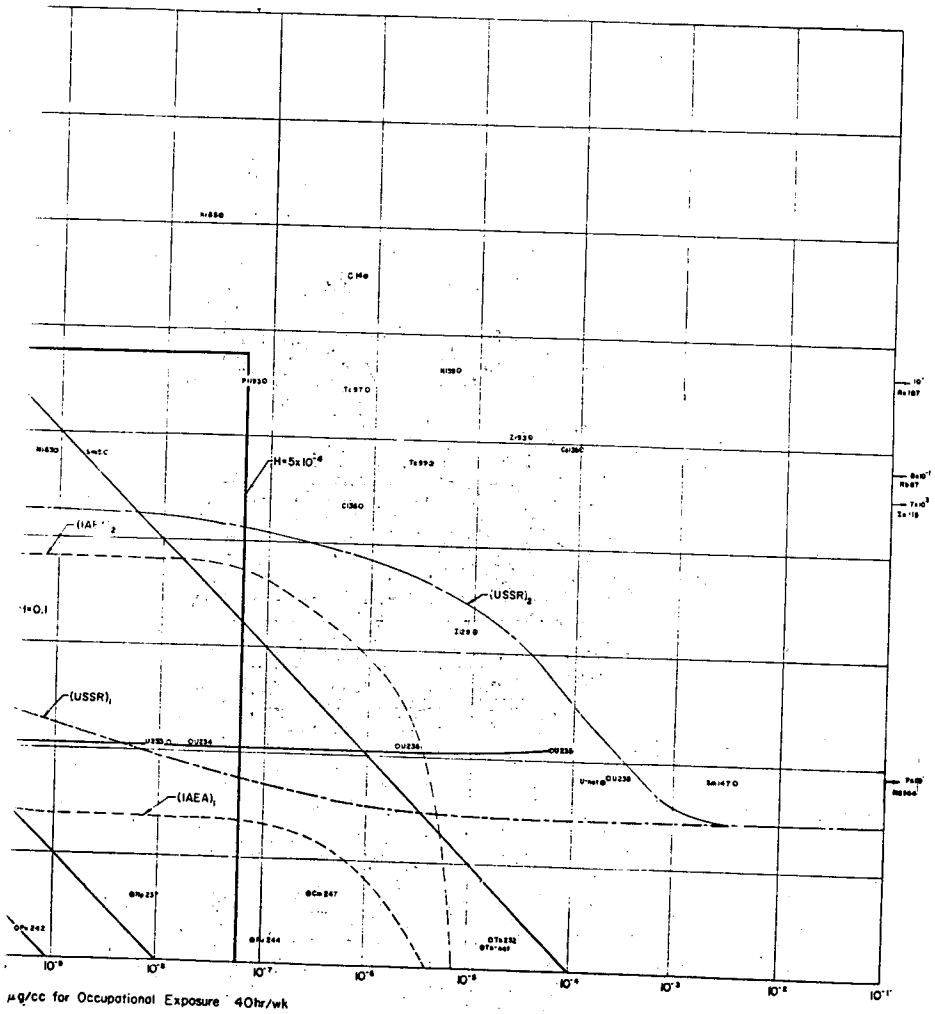


FIG. 3. Relative hazard grouping of the radionuclides as suggested by several authors. The rect
than 5×10^{-4} respectively as defined by the method of this paper. The triangles marked (DI
marked $(IAEA)_1$ and $(IAEA)_2$ enclose radionuclides of decreasing relative hazards as defined in



marked H = 1, H = 0.1 and H = 5×10^{-4} enclose radionuclides with relative hazards greater than 1, greater than 0.1 and greater
$_2$, and $(DL)_2$ enclose radionuclides of decreasing relative hazards as defined by the method of DUHAMEL and LAVIE. The irregular lines
$_7$ reports and the lines marked $(USSR)_1$ and $(USSR)_2$ enclose radionuclides of decreasing hazards as defined in USSR[8] reports.

Table 4. Illustrative examples indicating the relationship between the specific activity of the radionuclide, the specific activity of the dust and values of $(MPC)_a$ *and* $(MPC)_a$ *and H*

Specific activity of radionuclide (μc/μg)	Mass per unit of activity of radionuclide (μg/μc)	$\phi(c/k)$	Dilution factor (μg dust per μg of radionuclide)*	Average specific activity of dust in work area (μc/μg)*	Average mass per unit of activity of dust in work area (μg/μc)*	Values of $(MPC)_a$ and $(MPC)_a$ for the undiluted radionuclide if $H = 1$		$H = 0.1$		$H = 5 \times 10^{-4}$		Values of H corresponding to a constant value of $(MPC)_a = 2.9 \times 10^{-10}$ μc/cm³
						$(MPC)_a$ (μc/cm³)	$(MPC)_a$ (μg/cm³)	$(MPC)_a$ (μc/cm³)	$(MPC)_a$ (μg/cm³)	$(MPC)_a$ (μc/cm³)	$(MPC)_a$ (μg/cm³)	
1000	0.001	10	3.4×10^6	3×10^{-6}	3.4×10^5	3×10^{-10}	3×10^{-13}	3×10^{-11}	3×10^{-14}	6×10^{-10}	6×10^{-13}	1
100	0.01	10	3.4×10^7	3×10^{-6}	3.4×10^5	3×10^{-10}	3×10^{-13}	3×10^{-11}	3×10^{-14}	6×10^{-9}	6×10^{-12}	1
10	0.1	10	3.4×10^8	3×10^{-6}	3.4×10^5	3×10^{-10}	3×10^{-13}	3×10^{-11}	3×10^{-14}	6×10^{-8}	6×10^{-11}	1
1	1	10	3.4×10^9	3×10^{-7}	3.4×10^6	3×10^{-11}	3×10^{-14}	3×10^{-12}	3×10^{-15}	6×10^{-9}	6×10^{-12}	0.1
0.1	10	0.1	3.4×10^8	3×10^{-8}	3.4×10^7	3×10^{-12}	3×10^{-15}	3×10^{-13}	3×10^{-16}	6×10^{-10}	6×10^{-13}	10^{-2}
0.01	100	0.01	3.4×10^8	3×10^{-9}	3.4×10^8	3×10^{-13}	3×10^{-16}	3×10^{-14}	3×10^{-17}	6×10^{-11}	6×10^{-14}	10^{-3}
0.001	1000	0.001	3.4×10^8	3×10^{-10}	3.4×10^9	3×10^{-14}	3×10^{-17}	3×10^{-15}	3×10^{-18}	6×10^{-12}	6×10^{-15}	10^{-4}

* The constant dilution factors $(b + 1)/(d + 1)$ were set equal to 3.43×10^6 by normalizing the hazard H to 1 for Ra^{226} and assuming a constant dust loading of 10^{-4} μg/cm².

Table 5. Relative hazard, H, for a mixture of U^{230} and U^{235}

Radioactivity in mixture due to U^{235} (%)	Radioactivity in mixture due to U^{230} (%)	Mass per unit activity of isotope mixture ($\mu g/\mu c$)	Specific activity of isotope mixture ($\mu c/\mu g$)	Average mass per unit activity of dust in work area* ($\mu g/\mu c$)	$(MPC)_c$ ($\mu c/cm^3$)	$(MPC)_c$ ($\mu g/cm^3$)	H
100	0	4.68×10^3	2.14×10^{-4}	1.6×10^{12}	1.23×10^{-10}	5.99×10^{-7}	4.88×10^{-7}
10	90	4.68×10^3	2.14×10^{-4}	1.6×10^{11}	1.15×10^{-10}	5.38×10^{-6}	5.42×10^{-6}
10^{-1}	99.9	4.68×10^3	2.14×10^{-4}	1.6×10^{9}	1.14×10^{-10}	5.32×10^{-8}	5.48×10^{-4}
10^{-3}	99.999	4.68	2.14×10^{-4}	1.6×10^{7}	1.14×10^{-10}	5.32×10^{-10}	5.48×10^{-2}
2.14×10^{-5}	99.99—	0.1	10	3.4×10^{5}	1.14×10^{-10}	1.14×10^{-11}	2.56
10^{-7}	99.99—	5.05×10^{-4}	1.98×10^{3}	3.4×10^{3}	1.14×10^{-10}	5.76×10^{-14}	2.56
0	100	3.66×10^{-5}	2.73×10^{4}	3.4×10^{2}	1.14×10^{-10}	4.17×10^{-15}	2.56

* Assuming a constant dilution factor $k = 1$) $A = 1$, $= 3.43 \times 10^6$ or a total dilution factor of $3.43 \times 10^6 \times (c/g)/\phi(c/g)$

specific activity of the isotopic mixture and the relative hazard H increases almost linearly with the specific activity of the isotopic mixture until the specific activity of the isotopic mixture reaches 10 $\mu c/\mu g$. Therefore, the average mass of airborne dust per unit activity, remains constant at 3.4×10^5 $\mu g/\mu c$ and the relative hazard remains constant at the value of 2.56.

As stated above, many writers have listed the radionuclides into relative hazard groups, but it is the opinion of these writers that the method suggested by DUHAMEL and LAVIE[16] in 1959 is second in choice only to the method suggested by MORGAN, SNYDER and FORD[10] in 1956 and as further extended here. Thus, the purpose of the authors of this paper has been to establish a more detailed explanation and perhaps a better theoretical basis for the method suggested in 1956 and to compare the results of this method with those suggested by other writers. Whereas this method, as noted in Fig. 3, yields a series of rectangles with the base 1/10 of the height, the method of DUHAMEL and LAVIE yields a series of triangles with the base 1/3 of the height. The diagonals of these triangles are plotted in Fig. 3 by normalizing equation (4) so that $H = 1$ for Ra^{226}. It will be noted that the line $(DL)_1$, as well as the line marked $H = 1$, pass through the point for Ra^{226} and, by the method of DUHAMEL and LAVIE, radionuclides falling below the diagonal line marked $(DL)_1$ have a relative hazard >1. Radionuclides falling below the diagonal line marked $(DL)_2$ have a relative hazard >0.293 and were placed in the very hazardous group. Radionuclides falling between the diagonal lines $DL)_2$ and $DL)_3$ have a relative hazard between 0.293 and 2.93×10^{-3} and were placed in the intermediately hazardous group, and radionuclides falling above the line $(DL)_3$ have a relative hazard $<2.93 \times 10^{-3}$ and were placed in the less hazardous group. By the method of the present paper (by MORGAN, SNYDER and FORD), radionuclides falling within the rectangle marked $H = 0.1$ have a hazard ≥ 0.1 and were placed in the very hazardous groups; those falling between the rectangles marked $H = 0.1$ and $H = 5 \times 10^{-4}$ have a relative hazard between 0.1 and 5×10^{-4} and were placed in the intermediately hazardous group and radionuclides falling above the rectangle marked $H = 5 \times 10^{-4}$ have a relative hazard $<5 \times 10^{-4}$ and were placed in the less hazardous group. How many groups of radionuclides should be established and what boundaries of H should be selected for their demarcation depends upon the use that is to be made of these groups. The method suggested in this paper for obtaining H for the radionuclides and for various chemical forms and isotopic dilutions of the radionuclides permits any convenient grouping of the radionuclides in terms of the relative hazard. Some of the uses of these relative hazard groups are (1) to aid in the adoption of protective measures, (2) to determine laboratory facilities and equipment requirements, (3) to indicate the essential shipping regulations and (4) to aid in determining what

Table 6. Summary of values of specific activity, $(MPC)_c$ and relative hazard, H

Radionuclide	Critical body organ	Specific activity ($\mu c/\mu g$)	$(MPC)_c$ ($\mu c/cm^3$)	Relative hazard H
$_1H^3$	BT(S)	9.67×10^3	5.26×10^{-6}	5.56×10^{-5}
$_6C^{14}$	L(1)	3.48×10^2	1.20×10^{-6}	2.44×10^{-4}
$_9F^{18}$	Fat(S)	4.66	3.50×10^{-6}	3.88×10^{-5}
$_{11}Na^{22}$	UL(1)	9.32×10^7	2.57×10^{-8}	1.14×10^{-2}
$_{11}Na^{24}$	L(1)	6.24×10^5	8.91×10^{-9}	3.28×10^{-3}
$_{15}P^{32}$	LI(1)	8.64×10^5	1.43×10^{-7}	2.01×10^{-3}
$_{16}S^{35}$	UI(1)	3.03×10^2	7.01×10^{-8}	4.17×10^{-3}
$_{17}Cl^{36}$	B(S)	2.85	2.51×10^{-7}	2.91×10^{-2}
$_{17}Cl^{38}$	L(1)	4.28×10^3	2.28×10^{-8}	3.87×10^{-3}
$_{18}A^{37}$	ST(1)	3.02×10^5	2.01×10^{-6}	1.43×10^{-3}
$_{18}A^{41}$	SK(Su)	1.32×10^4	6.37×10^{-8}	4.59×10^{-3}
$_{19}K^{42}$	TB(Su)	1.01×10^5	1.58×10^{-6}	1.85×10^{-4}
$_{19}K^{43}$	LI(1)	4.18×10^4	1.08×10^{-7}	2.70×10^{-3}
$_{20}Ca^{45}$	B(S)	5.99×10^3	3.21×10^{-7}	9.09×10^{-3}
$_{20}Ca^{47}$	LI(1)	5.67×10^5	1.69×10^{-7}	1.72×10^{-2}
$_{21}Sc^{46}$	L(1)	3.34×10^3	2.22×10^{-8}	1.32×10^{-2}
$_{21}Sc^{47}$	LI(1)	8.11×10^4	4.67×10^{-7}	6.25×10^{-4}
$_{21}Sc^{48}$	LI(1)	1.30×10^5	1.40×10^{-8}	5.26×10^{-3}
$_{21}Sc^{49}$	L(1)	1.69	5.55×10^{-6}	1.30×10^{-1}
$_{23}V^{48}$	L(1)	9.19×10^4	2.25×10^{-6}	2.68×10^{-2}
$_{23}V^{49}$	L(1)	4.52×10^5	1.40×10^{-7}	8.33×10^{-3}
$_{25}Mn^{52}$	L(1)	8.06×10^4	3.50×10^{-8}	5.26×10^{-3}
$_{25}Mn^{54}$	LI(1)	2.12×10^3	8.76×10^{-8}	3.33×10^{-3}
$_{25}Mn^{56}$	LI(1)	2.16×10^5	5.26×10^{-8}	5.56×10^{-3}
$_{26}Fe^{59}$	SI(S)	4.91×10^3	1.61×10^{-7}	1.82×10^{-2}
$_{27}Co^{57}$	L(1)	8.47×10^5	8.76×10^{-6}	3.33×10^{-1}
$_{27}Co^{58}$	L(1)	5.93×10^5	5.40×10^{-8}	5.41×10^{-3}
$_{27}Co^{60}$	L(1)	3.12×10^4	1.14×10^{-8}	3.33×10^{-3}
$_{28}Ni^{59}$	L(S)	7.63×10^2	8.76×10^{-7}	4.77×10^{-2}
$_{28}Ni^{63}$	B(S)	7.13×10^3	6.42×10^{-7}	4.55×10^{-2}
$_{28}Ni^{65}$	UL(1)	1.83×10^7	5.26×10^{-7}	5.56×10^{-2}
$_{29}Cu^{64}$	LI(1)	3.95×10^6	1.05×10^{-6}	2.78×10^{-2}
$_{30}Zn^{65}$	L(1)	8.21×10^4	5.84×10^{-8}	5.00×10^{-3}
$_{30}Zn^{69m}$	L(1)	3.26×10^6	3.21×10^{-7}	9.09×10^{-4}
$_{30}Zn^{69}$	PK(S)	5.26×10^7	7.01×10^{-6}	4.17×10^{-5}
$_{31}Ga^{72}$	LI(1)	3.07×10^6	1.90×10^{-7}	1.54×10^{-3}
$_{32}Ge^{71}$	L(1)	1.53×10^6	6.42×10^{-6}	4.55×10^{-5}
$_{33}As^{73}$	L(1)	2.35×10^4	3.80×10^{-7}	7.69×10^{-3}
$_{33}As^{74}$	L(1)	1.00×10^5	1.26×10^{-7}	2.33×10^{-3}
$_{33}As^{76}$	LI(1)	1.55×10^6	9.93×10^{-8}	2.94×10^{-3}
$_{33}As^{77}$	LI(1)	1.01×10^6	4.09×10^{-7}	7.14×10^{-4}
$_{34}Se^{75}$	L(1)	1.37×10^3	1.23×10^{-7}	2.38×10^{-3}
$_{35}Br^{82}$	L(1)	1.06×10^6	1.90×10^{-7}	1.54×10^{-3}
$_{36}Kr^{85m}$	UE(Su)	8.53	6.13×10^{-6}	4.76×10^{-5}
$_{36}Kr^{85}$	UE(Su)	3.93×10^2	1.18×10^{-5}	2.47×10^{-3}
$_{36}Kr^{87}$	UE(Su)	2.74×10^5	1.01×10^{-6}	2.90×10^{-4}
$_{36}Rb^{86}$	L(1)	2.16×10^3	6.72×10^{-8}	4.35×10^{-3}
$_{37}Rb^{87}$	L(1)	8.51×10^0	6.54×10^{-5}	3.71×10^{-11}
$_{38}Sr^{85m}$	SI(1)	3.13×10^5	3.17×10^{-7}	8.40×10^{-4}
$_{38}Sr^{85}$	L(1)	2.36×10^3	1.05×10^{-7}	2.78×10^{-2}
$_{38}Sr^{89}$	B(S)	2.91×10^4	2.77×10^{-8}	1.05×10^{-2}
$_{38}Sr^{90}$	B(S)	1.45×10^2	2.89×10^{-10}	1.01
$_{38}Sr^{91}$	LI(1)	3.59×10^5	2.51×10^{-7}	1.16×10^{-3}
$_{38}Sr^{92}$	LI(1)	1.29×10^5	2.92×10^{-7}	1.00×10^{-3}
$_{39}Y^{90m}$	SI(1)	5.41×10^5	1.02×10^{-7}	2.86×10^{-3}
$_{39}Y^{90}$	L(1)	4.60×10^5	1.72×10^{-7}	1.69×10^{-3}
$_{39}Y^{91m}$	L(1)	2.47×10^3	3.21×10^{-8}	9.09×10^{-3}
$_{39}Y^{91}$	LI(1)	9.46×10^4	2.92×10^{-7}	1.00×10^{-3}
$_{39}Y^{92}$	LI(1)	3.34×10^5	1.37×10^{-7}	2.13×10^{-3}
$_{39}Y^{93}$	LI(1)	1.31×10^5	1.11×10^{-7}	2.63×10^{-3}
$_{40}Zr^{93}$	B(S)	3.51	3.21×10^{-6}	9.23×10^{-3}
$_{40}Zr^{95}$	L(1)	2.17	9.09×10^{-7}	9.09×10^{-3}
$_{40}Zr^{97}$	LI(1)	1.89×10^5	9.05×10^{-8}	3.23×10^{-3}
$_{41}Nb^{93m}$	B(S)	3.79	1.23×10^{-7}	2.38×10^{-3}
$_{41}Nb^{95}$	L(1)	3.92×10^4	9.93×10^{-8}	2.94×10^{-3}
$_{41}Nb^{97}$	LI(1)	2.64×10^7	4.67×10^{-6}	6.25×10^{-3}
$_{42}Mo^{99}$	LI(1)	4.73×10^5	2.01×10^{-7}	1.45×10^{-3}
$_{43}Tc^{96m}$	L(1)	3.77×10^7	2.92×10^{-5}	10×10^{-4}
$_{43}Tc^{96}$	LI(1)	3.16×10^5	2.42×10^{-7}	1.20×10^{-3}

5-46.16

Table 6 (cont'd)

Radionuclide	Critical body organ	Specific activity ($\mu c/\mu g$)	$(MPC)_e$ ($\mu c/cm^3$)	Relative hazard H
$^{43}Tc^{97m}$	L(I)	1.46×10^{1}	1.52×10^{-7}	1.92×10^{-3}
$^{43}Tc^{97}$	L(I)	3.64×10^{-1}	2.92×10^{-7}	3.64×10^{-3}
$^{43}Tc^{99m}$	ULI(I)	5.26×10^{6}	1.40×10^{-5}	2.08×10^{-5}
$^{43}Tc^{99}$	L(I)	1.80×10^{-2}	6.13×10^{-8}	8.60×10^{-6}
$^{44}Ru^{97}$	LLI(I)	4.80×10^{5}	1.78×10^{-6}	1.64×10^{-4}
$^{44}Ru^{103}$	L(I)	3.09×10^{1}	8.47×10^{-8}	3.45×10^{-3}
$^{44}Ru^{105}$	ULI(I)	6.52×10^{6}	5.26×10^{-7}	5.56×10^{-4}
$^{44}Ru^{106}$	L(I)	3.37×10^{3}	5.55×10^{-9}	5.26×10^{-2}
$^{45}Rh^{103m}$	ST(I)	3.34×10^{7}	6.13×10^{-5}	4.76×10^{-6}
$^{45}Rh^{105}$	LLI(I)	8.16×10^{5}	5.26×10^{-7}	5.56×10^{-4}
$^{46}Pd^{103}$	L(I)	7.46×10^{1}	7.48×10^{-7}	3.91×10^{-4}
$^{46}Pd^{109}$	LLI(I)	2.10×10^{6}	3.50×10^{-7}	8.33×10^{-4}
$^{47}Ag^{105}$	L(I)	3.11×10^{1}	8.18×10^{-8}	3.57×10^{-3}
$^{47}Ag^{110m}$	L(I)	4.39×10^{0}	1.02×10^{-8}	2.36×10^{-2}
$^{47}Ag^{111}$	LLI(I)	1.57×10^{5}	2.22×10^{-7}	1.32×10^{-3}
$^{48}Cd^{109}$	LIV(S)	2.52×10^{0}	5.26×10^{-8}	5.56×10^{-3}
$^{48}Cd^{115m}$	LIV(S)	2.64×10^{1}	3.50×10^{-8}	8.33×10^{-3}
$^{48}Cd^{115}$	LLI(I)	5.16×10^{5}	1.84×10^{-7}	1.59×10^{-3}
$^{49}In^{113m}$	ULI(I)	1.58×10^{7}	6.72×10^{-6}	4.35×10^{-5}
$^{49}In^{115m}$	L(I)	2.33×10^{1}	2.16×10^{-8}	1.35×10^{-2}
$^{49}In^{115m}$	ULI(I)	5.96×10^{6}	1.87×10^{-6}	1.56×10^{-1}
$^{49}In^{115}$	L(I)	5.16×10^{-12}	3.47×10^{-8}	4.33×10^{-15}
$^{50}Sn^{113}$	L(I)	1.03×10^{1}	5.26×10^{-8}	5.56×10^{-3}
$^{50}Sn^{125}$	L(I)	1.10×10^{0}	8.47×10^{-8}	3.45×10^{-3}
$^{51}Sb^{122}$	LLI(I)	3.82×10^{5}	1.46×10^{-7}	2.00×10^{-3}
$^{51}Sb^{124}$	L(I)	1.75×10^{1}	1.93×10^{-8}	1.52×10^{-2}
$^{51}Sb^{125}$	L(I)	1.19×10^{0}	2.66×10^{-8}	1.10×10^{-2}
$^{52}Te^{125m}$	L(I)	4.80×10^{1}	1.28×10^{-7}	2.27×10^{-3}
$^{52}Te^{127m}$	L(I)	9.81×10^{0}	4.09×10^{-8}	7.14×10^{-3}
$^{52}Te^{127}$	LLI(I)	2.64×10^{6}	8.53×10^{-7}	3.42×10^{-4}
$^{52}Te^{129m}$	L(I)	3.06×10^{1}	3.23×10^{-8}	9.09×10^{-3}
$^{52}Te^{129}$	ULI(I)	1.93×10^{7}	4.09×10^{-6}	7.14×10^{-5}
$^{52}Te^{131m}$	LLI(I)	7.96×10^{5}	1.90×10^{-7}	1.54×10^{-3}
$^{52}Te^{132}$	LLI(I)	3.09×10^{5}	1.05×10^{-7}	2.78×10^{-3}
$^{53}I^{126}$	TH(S)	7.77×10^{4}	7.88×10^{-9}	3.70×10^{-2}
$^{53}I^{129}$	TH(S)	1.61×10^{-4}	1.61×10^{-9}	2.92×10^{-6}
$^{53}I^{131}$	TH(S)	1.24×10^{5}	8.53×10^{-9}	3.42×10^{-2}
$^{53}I^{132}$	TH(S)	1.02×10^{7}	2.34×10^{-7}	1.25×10^{-3}
$^{53}I^{133}$	TH(S)	1.12×10^{6}	3.21×10^{-8}	9.09×10^{-3}
$^{53}I^{134}$	TH(S)	2.71×10^{7}	4.96×10^{-7}	5.88×10^{-4}
$^{53}I^{135}$	TH(S)	3.45×10^{6}	4.05×10^{-7}	2.78×10^{-3}
$^{54}Xe^{131m}$	TH(Sol)	8.31×10^{1}	1.75×10^{-5}	1.67×10^{-5}
$^{54}Xe^{133}$	TH(Sol)	1.86×10^{5}	1.49×10^{-5}	1.96×10^{-5}
$^{54}Xe^{135}$	TH(Sol)	2.54×10^{6}	4.38×10^{-6}	6.67×10^{-5}
$^{55}Cs^{131}$	L(I)	9.96×10^{1}	3.21×10^{-8}	9.09×10^{-3}
$^{55}Cs^{134m}$	LLI(I)	7.50×10^{6}	5.34×10^{-7}	5.00×10^{-5}
$^{55}Cs^{134}$	L(I)	1.15×10^{0}	1.17×10^{-8}	2.50×10^{-2}
$^{55}Cs^{135}$	L(I)	8.76×10^{-1}	9.05×10^{-9}	2.83×10^{-2}
$^{55}Cs^{136}$	L(I)	7.37×10^{1}	1.69×10^{-7}	1.72×10^{-3}
$^{55}Cs^{137}$	L(I)	8.64×10^{0}	1.86×10^{-8}	2.00×10^{-2}
$^{56}Ba^{131}$	L(I)	8.59×10^{1}	3.50×10^{-7}	8.33×10^{-4}
$^{56}Ba^{140}$	L(I)	7.29×10^{1}	4.38×10^{-8}	6.67×10^{-3}
$^{57}La^{140}$	LLI(I)	5.55×10^{5}	1.23×10^{-7}	2.38×10^{-3}
$^{58}Ce^{141}$	L(I)	2.89×10^{1}	1.58×10^{-7}	1.85×10^{-3}
$^{58}Ce^{143}$	LLI(I)	6.87×10^{5}	2.07×10^{-7}	1.41×10^{-3}
$^{58}Ce^{144}$	L(I)	3.12×10^{0}	6.42×10^{-9}	4.55×10^{-2}
$^{59}Pr^{142}$	LLI(I)	1.14×10^{6}	1.58×10^{-7}	1.85×10^{-3}
$^{59}Pr^{144}$	L(I)	6.66×10^{1}	1.78×10^{-7}	1.64×10^{-3}
$^{60}Nd^{141}$	B(S)	1.24×10^{-12}	8.18×10^{-11}	4.44×10^{-13}
$^{60}Nd^{147}$	L(I)	7.86×10^{1}	2.28×10^{-7}	1.28×10^{-3}
$^{60}Nd^{149}$	LLI(I)	1.05×10^{7}	1.46×10^{-6}	2.00×10^{-4}
$^{61}Pm^{147}$	B,S)	9.67×10^{2}	6.42×10^{-8}	4.55×10^{-3}
$^{61}Pm^{149}$	LLI(I)	3.98×10^{5}	2.25×10^{-7}	1.30×10^{-3}
$^{62}Sm^{147}$	B(S)	1.35×10^{-8}	7.01×10^{-11}	7.70×10^{-9}
$^{62}Sm^{151}$	B,S)	2.33×10^{1}	6.42×10^{-8}	4.55×10^{-3}
$^{62}Sm^{153}$	LLI(I)	4.35×10^{5}	4.09×10^{-7}	7.14×10^{-4}
$^{63}Eu^{152}$	LLI(I)	2.26×10^{0}	3.21×10^{-7}	9.09×10^{-4}
$^{63}Eu^{152}$	K(S)	1.83×10^{2}	1.23×10^{-8}	2.38×10^{-2}
$^{63}Eu^{154}$	K(S)	1.46×10^{2}	3.80×10^{-9}	7.69×10^{-2}
$^{63}Eu^{155}$	L(I)	1.36×10^{2}	7.30×10^{-8}	4.00×10^{-3}

Table 6 (cont'd)

Radionuclide	Critical body organ	Specific activity ($\mu c/\mu g$)	$(MPC)_e$ ($\mu c/cm^3$)	Relative hazard H
$^{64}Gd^{153}$	L(I)	3.61×10^{3}	9.05×10^{-8}	3.23×10^{-3}
$^{64}Gd^{159}$	LLI(I)	1.10×10^{6}	4.09×10^{-7}	7.14×10^{-4}
$^{65}Tb^{160}$	L(I)	1.12×10^{1}	3.21×10^{-8}	9.09×10^{-3}
$^{66}Dy^{165}$	ULI(I)	8.16×10^{6}	2.07×10^{-6}	1.41×10^{-4}
$^{66}Dy^{166}$	LLI(I)	2.31×10^{5}	1.96×10^{-7}	1.49×10^{-3}
$^{67}Ho^{166}$	LLI(I)	7.13×10^{5}	1.61×10^{-7}	1.82×10^{-3}
$^{68}Er^{169}$	L(I)	8.21×10^{1}	3.80×10^{-7}	7.69×10^{-4}
$^{68}Er^{171}$	ULI(I)	2.46×10^{6}	5.84×10^{-7}	5.00×10^{-4}
$^{69}Tm^{170}$	L(I)	6.04×10^{3}	3.45×10^{-8}	8.47×10^{-3}
$^{69}Tm^{171}$	B(S)	1.10×10^{3}	1.11×10^{-7}	2.63×10^{-3}
$^{70}Yb^{175}$	LLI(I)	1.82×10^{5}	5.84×10^{-7}	5.00×10^{-4}
$^{71}Lu^{177}$	LLI(I)	1.10×10^{5}	5.26×10^{-7}	5.56×10^{-4}
$^{72}Hf^{181}$	SP(S)	1.57×10^{1}	3.80×10^{-8}	7.69×10^{-3}
$^{73}Ta^{182}$	L(I)	6.40×10^{2}	2.19×10^{-8}	1.33×10^{-2}
$^{74}W^{181}$	L(I)	5.16×10^{2}	1.26×10^{-7}	2.33×10^{-3}
$^{74}W^{185}$	L(I)	9.53×10^{2}	1.41×10^{-7}	2.63×10^{-3}
$^{74}W^{187}$	LLI(I)	6.98×10^{5}	3.21×10^{-7}	9.09×10^{-4}
$^{75}Re^{183}$	L(I)	9.74×10^{2}	1.58×10^{-7}	1.85×10^{-3}
$^{75}Re^{186}$	LLI(I)	1.85×10^{5}	2.39×10^{-7}	1.22×10^{-3}
$^{75}Re^{187}$	L(I)	3.87×10^{-8}	4.96×10^{-7}	2.28×10^{-12}
$^{75}Re^{188}$	LLI(I)	9.81×10^{5}	1.61×10^{-7}	1.82×10^{-3}
$^{76}Os^{185}$	L(I)	7.41×10^{2}	4.67×10^{-8}	6.25×10^{-3}
$^{76}Os^{191m}$	L(I)	1.18×10^{6}	9.34×10^{-6}	3.12×10^{-5}
$^{76}Os^{191}$	L(I)	4.26×10^{1}	4.09×10^{-7}	7.14×10^{-4}
$^{76}Os^{193}$	LLI(I)	5.16×10^{5}	2.74×10^{-7}	1.06×10^{-3}
$^{77}Ir^{190}$	L(I)	5.72×10^{4}	4.09×10^{-7}	7.14×10^{-4}
$^{77}Ir^{192}$	L(I)	9.13×10^{0}	2.57×10^{-8}	1.14×10^{-2}
$^{77}Ir^{194}$	LLI(I)	8.53×10^{5}	1.55×10^{-7}	1.89×10^{-3}
$^{78}Pt^{191}$	LLI(I)	2.28×10^{5}	5.55×10^{-7}	5.26×10^{-4}
$^{78}Pt^{193m}$	LLI(I)	1.93×10^{5}	5.26×10^{-6}	5.56×10^{-5}
$^{78}Pt^{193}$	L(I)	3.76	3.21×10^{-7}	3.42×10^{-4}
$^{78}Pt^{197m}$	ULI(I)	1.19×10^{7}	4.67×10^{-6}	6.25×10^{-5}
$^{78}Pt^{197}$	LLI(I)	8.82×10^{5}	5.55×10^{-7}	5.26×10^{-4}
$^{79}Au^{196}$	L(I)	1.19×10^{6}	6.13×10^{-7}	4.76×10^{-4}
$^{79}Au^{198}$	LLI(I)	2.44×10^{5}	2.37×10^{-7}	1.23×10^{-3}
$^{79}Au^{199}$	LLI(I)	2.08×10^{5}	8.18×10^{-7}	3.57×10^{-4}
$^{80}Hg^{197m}$	K(S)	6.62×10^{5}	7.30×10^{-7}	4.00×10^{-4}
$^{80}Hg^{197}$	K(S)	2.45×10^{5}	1.17×10^{-6}	2.50×10^{-4}
$^{80}Hg^{203}$	K(S)	1.40×10^{1}	7.01×10^{-8}	4.17×10^{-3}
$^{81}Tl^{200}$	LLI(I)	5.77×10^{5}	1.14×10^{-6}	2.56×10^{-4}
$^{81}Tl^{201}$	LLI(I)	2.16×10^{5}	8.76×10^{-7}	3.33×10^{-4}
$^{81}Tl^{202}$	L(I)	5.39×10^{1}	2.39×10^{-7}	1.22×10^{-3}
$^{81}Tl^{204}$	L(I)	5.83×10^{2}	2.63×10^{-8}	1.11×10^{-2}
$^{82}Pb^{203}$	LLI(I)	2.96×10^{5}	1.81×10^{-6}	1.61×10^{-4}
$^{82}Pb^{210}$	K(S)	8.76×10^{1}	1.26×10^{-10}	2.33
$^{82}Pb^{212}$	K(S)	1.40×10^{6}	1.75×10^{-8}	1.67×10^{-2}
$^{83}Bi^{206}$	L(I)	9.89×10^{1}	1.46×10^{-7}	2.00×10^{-3}
$^{83}Bi^{207}$	L(I)	2.17×10^{2}	1.37×10^{-8}	2.13×10^{-2}
$^{83}Bi^{210}$	L(I)	1.24×10^{5}	5.84×10^{-9}	5.00×10^{-2}
$^{83}Bi^{212}$	K(S)	1.47×10^{7}	9.64×10^{-8}	3.03×10^{-3}
$^{84}Po^{210}$	L(I)	4.48×10^{3}	2.01×10^{-10}	1.45
$^{85}At^{211}$	TH(S)	2.06×10^{6}	7.01×10^{-9}	4.17×10^{-2}
$^{86}Rn^{220}$	L(S)	9.89×10^{8}	2.92×10^{-7}	1.00×10^{-3}
$^{86}Rn^{222}$	L(S)	1.54×10^{5}	2.92×10^{-8}	1.00×10^{-2}
$^{88}Ra^{223}$	L(I)	5.00×10^{1}	2.39×10^{-10}	1.22
$^{88}Ra^{224}$	L(I)	1.60×10^{5}	7.30×10^{-10}	4.00×10^{-1}
$^{88}Ra^{226}$	B(S)	9.81×10^{-1}	2.86×10^{-11}	1.00
$^{88}Ra^{228}$	L(I)	2.39×10^{2}	3.80×10^{-11}	7.69
$^{89}Ac^{227}$	B,S)	7.17×10^{1}	2.34×10^{-12}	1.25×10^{2}
$^{89}Ac^{228}$	L(I)	2.20×10^{6}	1.69×10^{-8}	1.72×10^{-2}
$^{90}Th^{227}$	L(I)	3.12×10^{1}	1.81×10^{-10}	1.61
$^{90}Th^{228}$	L(I)	8.16×10^{2}	6.13×10^{-12}	4.76×10^{1}
$^{90}Th^{230}$	B(S)	1.96×10^{-2}	2.25×10^{-12}	2.54×10^{-1}
$^{90}Th^{231}$	LLI(I)	5.28×10^{5}	1.20×10^{-6}	2.44×10^{-4}
$^{90}Th^{232}$	B(S)	1.11×10^{-7}	1.93×10^{-12}	1.68×10^{-6}
$^{90}Th^{234}$	L(I)	2.31×10^{4}	3.21×10^{-8}	9.09×10^{-3}
$^{90}Th\text{-nat}$	B(S)	1.11×10^{-7}	1.61×10^{-12}	2.01×10^{-6}
$^{91}Pa^{230}$	L(I)	3.21×10^{1}	7.88×10^{-10}	3.70×10^{-1}
$^{91}Pa^{231}$	B(S)	4.35×10^{-2}	1.14×10^{-12}	1.12
$^{91}Pa^{233}$	L(I)	2.05×10^{4}	1.75×10^{-7}	1.67×10^{-3}

Table 6 (contd)

Radionuclide	Critical body organ	Specific activity ($\mu c/\mu g$)	$(MPC)_e$ ($\mu c/cm^3$)	Relative hazard H	Radionuclide	Critical body organ	Specific activity ($\mu c/\mu g$)	$(MPC)_e$ ($\mu c/cm^3$)	Relative hazard H
$_{95}Am^{239}$	H.S.	2.73×10^{-3}	1.14×10^{-10}	2.56	$_{96}Cm^{242}$	LIV(S)	3.32×10^{-3}	1.20×10^{-10}	2.44
$_{95}Am^{240}$	LIV	2.08×10^{-3}	2.77×10^{-11}	1.05	$_{96}Cm^{243}$	H.S.	4.13×10^{-4}	6.32×10^{-12}	4.55×10^{0}
$_{95}Am^{241}$	LIV	3.43×10^{-3}	1.17×10^{-10}	2.38	$_{96}Cm^{244}$	H.S.	8.01×10^{-4}	9.05×10^{-12}	3.25×10^{0}
$_{95}Am^{242}$	LIV	9.55×10^{-3}	1.20×10^{-10}	1.49	$_{96}Cm^{245}$	H.S.	7.29×10^{-4}	4.67×10^{-12}	$4.5a \times 10^{0}$
$_{95}Am^{242m}$	LIV(S)	6.15×10^{-4}	1.28×10^{-11}	2.35	$_{96}Cm^{246}$	H.S.	2.23×10^{-4}	4.67×10^{-12}	1.38×10^{0}
$_{95}Am^{243}$	LIV	2.11×10^{-3}	1.28×10^{-10}	2.35	$_{96}Cm^{247}$	H.S.	1.60×10^{-4}	4.64×10^{-12}	1.01×10^{1}
$_{95}Am^{244}$	LIV	6.37×10^{-3}	1.26×10^{-10}	1.88	$_{96}Cm^{248}$	H.S.	3.09×10^{-5}	5.69×10^{-13}	1.59×10^{2}
$_{95}Am^{245}$	KI(S)	5.43×10^{-3}	7.30×10^{-11}	1.37	$_{96}Cm^{249}$	H.S.	1.19×10^{-3}	1.14×10^{-11}	2.56×10^{1}
$_{95}Am^{246}$	LI(LI)	9.19×10^{-3}	1.75×10^{-10}	1.07	$_{97}Bk^{249}$	H.S.	1.81×10^{-3}	9.34×10^{-12}	3.12×10^{1}
$_{96}Cm^{240}$	LI(LI)	3.30×10^{-3}	6.42×10^{-11}	1.50	$_{97}Bk^{250}$	H.S.	4.02×10^{-3}	1.46×10^{-10}	2.00×10^{1}
$_{95}Am^{242}$	H.S.	6.87×10^{-4}	4.00×10^{-12}	4.91	$_{98}Cf^{249}$	H.S.	3.09	1.58×10^{-12}	5.71×10^{1}
$_{95}Am^{239}$	LI(LI)	2.31×10^{-3}	6.54×10^{-11}	4.16	$_{98}Cf^{250}$	H.S.	1.41×10^{-4}	4.96×10^{-12}	5.83×10^{1}
$_{94}Pu^{238}$	H.S.	1.66×10^{-4}	1.03×10^{-12}	1.52	$_{98}Cf^{251}$	H.S.	1.79	1.66×10^{-12}	3.14×10^{1}
$_{94}Pu^{239}$	H.S.	6.15×10^{-6}	1.72×10^{-13}	1.04	$_{98}Cf^{252}$	H.S.	6.43×10^{-3}	6.32×10^{-12}	4.55×10^{1}
$_{94}Pu^{240}$	H.S.	2.27×10^{-4}	1.72×10^{-12}	3.83	$_{98}Cf^{253}$	LI	2.87×10^{-3}	7.65×10^{-12}	3.02×10^{1}
$_{94}Pu^{241}$	H.S.	1.12×10^{-3}	9.05×10^{-12}	3.23	$_{98}Cf^{254}$	LI	9.19×10^{-3}	4.91×10^{-12}	5.05×10^{1}
$_{94}Pu^{242}$	H.S.	3.85×10^{-5}	1.81×10^{-13}	6.21	$_{99}Es^{253}$	LI	2.58×10^{-3}	6.13×10^{-12}	4.76×10^{1}
$_{94}Pu^{243}$	LI(LI)	2.56×10^{-3}	1.75×10^{-11}	1.67	$_{99}Es^{254}$	LI(S)	3.21×10^{-3}	5.26×10^{-12}	5.56×10^{1}
$_{94}Pu^{244}$	H.S.	1.21×10^{-5}	1.61×10^{-13}	3.41	$_{99}Es^{255}$	H.S.	1.67×10^{-3}	1.90×10^{-11}	1.51×10^{1}
$_{94}Pu^{245}$	H.S.	3.18×10^{-3}	5.01×10^{-11}	1.59	$_{99}Es^{256}$	LI	1.71×10^{-3}	4.09×10^{-11}	7.11×10^{1}
$_{95}Am^{242m}$	H.S.	9.60×10^{-3}	5.55×10^{-11}	5.05	$_{100}Fm^{254}$	H.S.	3.67×10^{-2}	6.28×10^{-10}	4.65×10^{2}
$_{95}Am^{242}$	LIV(S)	1.96×10^{-2}	5.58×10^{-10}	7.52	$_{100}Fm^{255}$	H.S.	5.67×10^{-3}	1.08×10^{-10}	2.70×10^{2}
$_{95}Am^{243}$	H.S.	1.85×10^{-3}	5.55×10^{-11}	9.73	$_{100}Fm^{256}$	LI	1.63×10^{-3}	1.75×10^{-11}	1.67×10^{2}
$_{95}Am^{241}$	H.S.	1.27×10^{-3}	3.91×10^{-11}	7.11	$_{100}Fm^{257}$	LI			

SP = spleen.
ST = stomach.
TB = total body
TH = thyroid
ULI = upper large intestine
(I) = insoluble
(S) = soluble
(Sol) = solubility

• The correct values are given here, but values for Fm^{254} plotted in Fig. 3 are carbon-1 values which were revised after the manuscript had been prepared for publication.

quantities of a radionuclide can be considered as "exempt" from special regulations, etc.

A number of other groupings of radionuclides have been suggested but, for the most part, these have been suggested without offering any substantial theoretical basis and, in many cases, the groupings do not conform with laboratory experience regarding the relative hazard of these radionuclides. In Fig. 3, boundary lines are drawn to enclose radionuclides in the various hazard groups and, in some cases, it is noted that the lines are very irregular. For example, the radionuclides falling below the line marked $(IAEA)_1$ are listed by the International Atomic Energy Agency[7] as belonging in their Group I which is referred to as having "very high radiotoxicity." Radionuclides falling between the lines marked $(IAEA)_1$ and $(IAEA)_2$ are listed by IAEA as belonging within their Group II which is referred to as radionuclides of "high radiotoxicity." Those falling above the line marked $(IAEA)_2$ are listed by IAEA as belonging within their Group III which is referred to as radionuclides of moderate or low radiotoxicity. Likewise, radionuclides falling below the line marked $(USSR)_1$ are listed in the report of the Ministry of Health of the USSR[8] as belonging in the Group A of radionuclides of "especially high radiotoxicity" and those falling between the lines marked $(USSR)_1$ and $(USSR)_2$ are listed as belonging in Group B of radionuclides of "high radiotoxicity," etc. No effort has been made in constructing the boundary lines in Fig. 3 to include the groupings of radionuclides as suggested by all the various individuals and organizations but rather to give typical examples, indicating the wide variations between the methods suggested and to show some of the irregularities of other methods in comparison with the orderly arrangement provided by the method of this paper.

It should be pointed out that Fig. 3 and Table 6 include a number of transuranic radionuclides which have not been published in any previous grouping of radionuclides. These values of $(MPC)_e$ have been calculated using the methods given in ICRP[9] Publication No. 2, and they have now been adopted and will be published by ICRP[10] as officially recommended $(MPC)_e$ values. Table 6 summarizes values of critical body organ, specific activity, $(MPC)_e$ and H for the various radionuclides listed in ICRP Publication No. 2, as well as for the new group of transuranic elements in ICRP Publication No. 6.

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5-46.18

NRC Staff Response To Specific
Comments On Health, Safety & Environment
Advisory Committee On Reactor Safeguards
U.S. Atomic Energy Commission
By R.F.F. Farley

1. Comment:

"A major omission in the report is consideration of the health hazards of radionuclides, such as ^{241}Pu and ^{238}Pu. We believe a detailed assessment would show these to be the principal risks, rather than ^{239}Pu, during the lifetime of a nuclear plant."

Response:

In the final GESMO, the health effects of ^{238}Pu and ^{241}Pu are included in dose calculations. These represent important factors along with all other radionuclides which were considered, but are not the principal risks. See CHAPTER IV, Section J.

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2. Comment:

"Much of the report is based on projections as to how efficient some process under development will operate. This is particularly true for various waste management methods, waste incineration procedures, chemical separation factors and the like. We believe the report should be based on firm data only, not conjecture."

Response:

In the final GESMO, an effort has been made to utilize available data to the extent possible. Where it has been found necessary to project industry developments, such as the description of the model MOX fuel fabrication plant, these projections have been clearly identified. Where commercial size plant operating data is not available, maximum use is made of pilot plant data.

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3. Comment:

"Page S-2 Second paragraph: We suggest the paragraph be deleted since the cancer estimate was based on the following approach:

$$\text{Cancers/yr} = \Delta m \times 10^{-4}$$

$$= (3000 \pm > 3000) \quad (10^{-4})$$

$$= 0.27 \text{ cancers/yr.}$$

The coefficient used to obtain the cancer risk (0.27) is alright, but it should be noted that the genetic risk (0.18) was obtained by applying the coefficient which applies only to the first generation. Thus, it may grossly underestimate the long range genetic risk."

Response:

This paragraph does not appear in the final GESMO summary. The methods for estimation of health effects were revised and are discussed in CHAPTER IV, Section J, Appendix B.

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4. Comment:

"S-2 Third paragraph: Does the conclusion reached here take into consideration the fact that the transplutonium element inventory in the 1.15 SGR would be nearly 30 times that in the U-fueled LWR?"

Response:

There is a significant increase in the actinides for 1.15 SGR spent fuel assemblies as presented in Table IV C-12, CHAPTER IV, Section C, paragraph 4.3.2. The relative core inventories of the 54 most important radionuclides based on the Reactor Safety Study-WASH 14 -- (Core Melt Accident Analysis), are shown in Table IV C-13.

Radioactive halogen and noble gas isotopes constitute the principal consequences of design basis accidents. The use of MOX fuel does not significantly affect computed doses resulting from postulated design basis accidents. Refer to CHAPTER IV, Section C, paragraph 5.3.

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5. Comment:

"Page S-2 Fourth paragraph, first line: In light of our later commentary on the hazards of the several plutonium isotopes, we are not convinced that the consequences of an accident are not increased. This is particularly true when new types of facilities (mixed fuel fabrication plants) are being added and when we have in many operations (including transportation) transuranium isotopes that are much more hazardous than ^{239}Pu."

Response:

This comment relates to plutonium and other activites. Refer to response to comment Number 10 of this Comment Letter Number 46.

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6. Comment:

"S-4 Third paragraph: The 'SGR' is designed in various places in Volume 1 as standing for 'Self Generating,' 'Generator,' and 'Generation Reactor.' These should all be made the same."

"We do not understand what is meant by the 115% increase in the ^{239}Pu ^{241}Pu in the reactor above the average amount at equilibrium in the usual LWR. This needs to be clarified."

Response:

1.15 SGR - The amount of plutonium recycled in the reactor is approximately 15% more than the amount recovered from the spent fuel removed from the same reactor prior to reaching equilibrium conditions.

1.15 SGR is used to designate the model Reactor of GESMO. Refer to CHAPTER IV, Section C-4.0.

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7. Comment:

"S-4 Fourth paragraph: We do not understand the second sentence in this paragraph unless it is true that the SGR has less uranium than the U-fueled reactor by an amount equal to two times the $^{238\ 239\ 241\ 242\ 243\ 236}Pu$ plus 29 times all the transplutonium elements plus the change in Np concentrations in the U-fueled reactor. In other words,

$$\Delta U_1 = 2\ Pu_1 + 29\ A_1 + (Np_2 - Np_1)$$

in which ΔU_1 = reduction in U in the SGR below that in the U-fueled reactor:

Pu_1 = Pu in the U-fueled reactor;

A_1 = transplutonium elements in the U-fueled reactor;

$Np_2 - Np_1$ = reduction of Np in the SGR.

"Is this, in fact, the case?

"It would help us understand what the changes are in converting to the SGR if a table were given showing under equilibrium conditions the Kg of each of the actinide radionuclides for the SGR and the conventional U-fueled reactor."

Response:

In reply to the query in reference to ΔU_1, this is not the case. Significant nuclides for the spent fuel and core for the UO_2 fueled reactor and the GESMO model reactor are listed in Tables IV C-12 and IV C-13 of CHAPTER IV, Section C paragraphs 4.3.2 and 4.3.3.

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8. Comment:

"S-10. It would help if in this section a good specific description could be given of the buildup of plutonium in successive stages of SGR operation, starting with the Pu discharged in the first cycle (given as 6.7 to 6.9 g per kg spent fuel). With the first recycle, some fraction of the reinserted material burns out and about another 6.7 to 6.9 g per kg spent fuel is formed. It is obvious that if about half of what is put in burns out each cycle than steady state is reached when burn-out equals growth, or input equals twice growth. However, an explicit description, plus graph or table of the successive changes would help visualization of the SGR made the final steady state. It is recognized that the document does give changes in isotopic compositoin, percentages of MOX fuel in successive reloads, changes in fission products and transuranics, etc., but the simple successive input of Pu would clarify the changes."

Response:

The final GESMO contains an expanded discussion of the model 1.15 SGR including Tables IV C-9 and IV C-10 and Figure IV C-26 showing the build up of plutonium in successive stages of SGR operation. See CHAPTER IV, Section C, paragraph 4.2.

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9. Comment:

"S-13 Last paragraph: The value of 50,000Kg if ^{239}Pu and ^{241}Pu available per year in 1990 seems too small. It would correspond to the Pu in only 90 LWRs of [redacted] MWe while the estimated number of LWRs at this time will be about 400.

9. Comment (Cont'd)

Response:

In the draft GESMO the available fissile plutonium available is taken from the NUFUEL data in the Tables, CHAPTER III, Appendix A, Forecasts of Nuclear Capacity.

In final GESMO, the year 1990 as the mature industry for Pu recycle has been deleted. The environmental impacts and dose assessments have been integrated over a period of 26 years from 1975 through 2000. In CHAPTER I, Figures I-2, I-4 and I-7 show the fuel cycle requirements in year 2000 for three options: no recycle, recycle of uranium only, and uranium and plutonium recycle, respectively. The material flows are based on ERDA OPA projections, modified for low growth, without the breeder reactor.

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10. Comment:

"Page S-15, last two paragraphs: Although the statements in these paragraphs are correct, there is no mention here or elsewhere in the text of several interesting observations. For example, the principal health hazard of the actinides during the lifetime of the plant is from ^{241}Pu."

Response:

The health hazard of ^{241}Pu is considered in final GESMO along with other actinides. The dose commitments that are estimated present a balanced approach by including doses from all of the radionuclides encounted in the fuel cycle facilities. Refer to CHAPTER IV, Section J.

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11. Comment:

"S-17, Part 2 on 'Radiobiological Characteristics of Plutonium': A major item which should be referenced here is the report being prepared for issuance by NCRP on the plutonium 'hot particle' problem. Although we realize this report was not available at the time of writing of the initial WASH-1327 draft, it should be completed in time to be referenced in the final document. Since an independent statement by the NCRP on this subject would considerably enhance the position of the AEC on the matter of the hazard of 'hot particles' we are sure you will want to reference the NCRP report as soon as it becomes official."

Response:

The NRDC petition and the NRC denial of the hot particle hypothesis are included in CHAPTER IV, Section J, Appendix D.

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12. Comment:

"Page S-17, third paragraph from bottom of page: We suggest deleting reference to lymph nodes from the first sentence or to offer some explanation. The ICRP no longer considers the lymph nodes the critical tissue in comparison with bone, liver, and lung in the case of Pu."

Response:

The dose commitments for lung, bone, and liver were estimated in final GESMO. In Appendix C of CHAPTER IV, Section J, the observed behavior of plutonium in lymph nodes is stated. However, the dose commitments for lymph nodes were not estimated.

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13. Comment:

"Page S-18. Here, there are two conclusions that are difficult to sustain The fact that Pu in people from fallout is low does not really indicate that the passage from soil to man 'is hardly to be expected.' One needs considerably more analyses. The fact that there has been no consistently measurable plutonium concentration in people at Palomares could also reflect the lack of serious attempts to measure it."

Response:

Observations of fallout plutonium in food and plant uptake of transuranium elements from contaminated soils indicate the plant pathway contributes a small amount to the total dose from plutonium. A detailed discussion of plutonium in the environment is in CHAPTER IV, Section J, Appendix C.

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14. Comment:

"Page S-19. Lines 2 and 3: This sentence could be interpreted to mean that there was inadequate feedwater control only at the higher burnup. What you really mean, we presume, is that there was inadequate feedwater control throughout the reactor operation and it resulted in earlier than normal fuel rod defects."

Response:

In final GESMO, CHAPTER II, paragraph 3.12, the Saxton program is described. In the latter portion of this paragraph, under the information of core III demonstrations, the defects in some of the rods that were detected after the ~ 40,000 MWd/MTM burnup. The examination suggested a change in the core environment, such as water chemistry after the midlife shutdown.

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15. Comment:

"Second paragraph: Why were the experiments conducted at such low levels of burnup? It is at 35,000 MWd/MT and above that one would be concerned."

Response:

This comment relating to Volume 1 summary and conclusions is an overview of the data in CHAPTER II relating to recycle Pu experimentation and demonstration programs. As reported, the early tests were at low levels of burnup and the later demonstrations were at higher burnup levels.

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16. Comment:

"S-25, Figure S-4 (also Figure S-5, on page S-26): It is puzzling that the input of fuel assemblies to the reactor (13,800 MTU) is much greater than the output (8800 MTU). Is there an error here or should there be an explanation of some type?"

16. Comment (Cont'd)

Response:

In final GESMO flow diagrams with material flows are included in CHAPTER III Figure III-2 for no recycle; Figure III-3 for uranium recycle only; and Figure III-4 for uranium and plutonium recycle. The material quantities in these figures represent the cumulative production for the 26 year period 1975 through 2000. The flows of materials indicated, as in the case of the draft GESMO diagrams, are not intended to constitute a material balance.

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17. Comment:

"Page S-31, Table S-7: The '50 year annual dose commitment to the world population' needs to be defined. Are these values the 50 year dose commitments to the world's population in 1990 for 1 year of exposure? Are these values known to three significant figures? Could not the occupational dose for the UO_2 + PuO_2 reactors be reduced through proper shielding and working procedures?"

Response:

The 50 year annual dose commitment to the population is based on the final year of plant operation. In the final year, the accumulation of radionuclides in the environment and the releases from the plant are combined to result in the maximum dose. These values are not known to three significant figures, but the difference between fuel cycle options, in some cases are observable to the third or fourth significant figure. In the conclusions of final GESMO, for many of the environmental impacts, the differences are insignificant. As stated, occupational doses at reactors are reduced by shielding and administrative controls to keep occupational exposures within limits set for 10 CFR Part 20 and in addition attempt to reduce exposures to as low as reasonably achievable levels.

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18. Comment:

"Page S-34. Second paragraph: Is the 0.002 Ci alpha that quantity release per year from the reprocessing of fuel from about 400 UO_2 + PuO_2 reactors in 1990? If this is the case, it assumes a decontamination of better than 10^{13} for the transuranics. Is this realistic?"

Response:

The particulate release factors assumed in final GESMO for fuel reprocessing are between 2×10^{-9} and 5×10^{-9}. These release factors are expected to be conservative. The detailed discussion of particulate removal is in CHAPTER IV, Section E, paragraph 2.2.

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19. Comment:

"Middle paragraph: What justification do you have for saying 'advanced reprocessing plants' are not expected to release radioactivity in liquid effluents'? Are there data to support this statement?"

Response:

The Barnwell Nuclear Fuel Plant and the proposed Exxon facility will not add radionuclides to the liquid effluent. In general, low-level radioactive process condensate is evaporated with the overheads and released as a vapor to the atmosphere.

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20. Comment:

"Page S-34. Last two lines: How can you say that Pu contaminated wastes in storage have no environmental impact?"

Response:

The wording in draft GESMO should have been more appropriately worded -- no significant environmental impact. In final GESMO, any waste from reactors or any component of the fuel cycle containing significant plutonium contamination will be termed transuranic waste and will be solidified, encapsulated, and disposed of in a Federal geologic repository. Under this disposal concept, there indeed would be an insignificant environmental impact from these wastes.

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21. Comment:

"Page S-35. Line 5: The incinerator is only now being planned and much more research is needed. Is not this statement a little premature? Should you not wait until at least one plant has been designed and proven capable of operation?

Response:

The specifics of incinerator design and operating characteristics are beyond the scope of final GESMO. The inclusion of the incinerator concept in draft GESMO was to indicate the kinds of waste treatment processes being considered at that time.

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22. Comment:

"S-41, Line 7: If the decay time were much greater than a year, the major contriubtor to dose would be ^{242}Cm instead of ^{244}Cm. Also, under certain conditions, ^{238}Pu might be major contributors to the population dose."

Response:

Contrary to what is implied, since ^{242}Cm has a half-life of 162 days, its contribution to the dose commitment diminishes with time. Moreover, because the amount of plutonium in the waste normally is about 0.5% of that in the feed, the contribution to the dose commitment from plutonium isotopes is much less than the contributions from ^{106}Ru, ^{90}Sr, ^{242}Cm and ^{244}Cm. Only under a combination of extreme conditions, involving a very high loss to the high level waste, which would be cause for reprocessing curtailment would the plutonium isotopes be among the major contributors to the dose commitment.

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23. Comment:

"Fourth paragraph, line 3: Here a promise is given for ALAP values for applications other than LWRs. When will these data be available?"

Response:

A series of technical reports covering the findings of the NRC's ALARA studies are now being prepared and are scheduled for publication over the next two to three years.

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24. Comment:

"S-47, Second paragraph: The first sentence is missing some words -- cannot understand it.

"Third paragraph: Are the quoted separation factors attainable on a routine basis within current economics? Has a safe method for 600 year storage been developed? This appears to be based largely on plans not yet proven."

Response:

In the first sentence referred to in this comment, it was intended to indicate that most of the fission products, all of the transplutonium elements, and about 0.5% of the plutonium originally in the spent fuel will end up in the high level radioactive waste resulting from fuel reprocessing operations.

In general, the separation of small amounts of actinides from relatively large amounts of the lanthanide elements and other fission products in the high level radioactive waste is difficult and would be costly. Some plutonium in the waste is very difficult to extract because it has complexed with other materials in the waste or may have polymerized. Thus, the end result is likely to include two types of high level radioactive waste, both requiring long term storage. Moreover, considered in the context of the overall problem related to long term confinement of long life actinide waste, the separation of the actinides from the high level radioactive waste appears, at this time, to be nonproductive and the high level radioactive wastes can be safely contained in engineered geological formations. For a full discussion on waste management, refer to CHAPTER IV, Section H.

The approach mentioned in this paragraph describes an area that is being investigated. It was not the intent to indicate that this is current technology. The reference to the separation factors is offered to show what these factors must be to attain americium contents in the 10nCi/gm range after 600 years. The approach mentioned in the preceding paragraph of the draft GESMO was assumed as a basis for analysis.

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25. Comment:

"Page S-52. Table S-11: The accuracy of the calculations does not appear to support the listing of values such as '-0.6%.' Also, the problem of the '+21%' for whole body exposures for Case 2 appears here again."

Response:

For a discussion of accuracy of dose commitment in final GESMO, refer to the response to Comment Number 17 of this Comment Letter Number 46.

Comment Letter No. 47

-Misc Notice (39FR 30186)
GESMO

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

NOV 0 6 1974

Mr. S. H. Smiley
Deputy Director
for Fuel and Materials
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

This is in response to your letter dated August 23, 1974, requesting comments on the AEC Draft Environmental Statement, WASH-1327 (August 74), relating to the use of plutonium, created in light water reactors, as fuel for light water reactors. This recycling of plutonium for nuclear reactor use is contrasted to a spectrum of alternative ways of handling plutonium, including the storage of plutonium for ultimate disposal.

These comments by the Federal Power Commission's Bureau of Power staff are made in compliance with the National Environmental Policy Act of 1969 and the August 1, 1973, Guidelines of the Council on Environmental Quality, and are directed to the need for plutonium as a fuel for nuclear power reactors used for electric power generation by the electric utility industry.

In the preparation of these comments, the Bureau of Power staff has considered the AEC's Draft Environmental Statement; the AEC report, Nuclear Power Growth 1974-2000, WASH-1139(74); related reports made in accordance with the Commission's Statement on Reliability and Adequacy of Electric Service (Docket No. R-362); and related information from other FPC reports. The staff's evaluation of the need for plutonium recycling is based upon the long-term needs of the nuclear power industry as an increasingly important energy source for the electric power industry.

The Federal Power Commission staff has projected the installed electric generating capacity for 1980 and 1990 by energy source. The following table shows this and the 1973 installed capacity.

DEC 3 1974

Installed Electric Generating Capacity
Gigawatts

	Coal	Natural Gas	Oil	Hydro	Nuclear	Total 1/
1973	189 (44%)	85 (20%)	80 (19%)	54 (12%)	21 (5%)	429 (100%)
1980	265 (41%)	81 (13%)	120 (19%)	68 (10%)	110 (17%)	644 (100%)
1990	405 (33%)	85 (7%)	168 (14%)	82 (7%)	475 (39%)	1,215 (100%)

The breakdown assumes 20 percent and 30 percent reductions respectively, in the availability of natural gas for electric power generation from 1973 to 1980 and from 1980 to 1990, reflecting the deepening shortage of natural gas. It also assumes a 40 percent increase in coal consumption from 1973-1980 and from 1980-1990.

These projections were made prior to the proposal by the President in his address of October 8, 1974, before the Joint Session of Congress to set a target date of 1980 for eliminating oil-fired plants from the Nation's baseload electric capacity. All progress in this direction will accentuate the need for nuclear power.

For 1980 and 1990, the existing FPC staff projections of probable installed nuclear capacity are 110 and 475 gigawatts, respectively. The most recent AEC projections of probable nuclear capacity for these years are 102 and 475 gigawatts. 2/ The projected large increases in nuclear capacity will require correspondingly large increases in the amounts of uranium mined and enriched. By the end of 1990, the power industry's operating light water reactors will have produced approximately 346 metric tons of fissile plutonium. 3/ The fast breeder reactors planned for the mid-eighties and subsequent years will depend on the plutonium produced from the light water reactors. This will tend to lessen the amount of plutonium for eventual storage. Nevertheless, fast breeder reactors will produce more plutonium than they consume, so an increase in the inventory of plutonium is expected. Recycling of plutonium for limited use in light water reactors would conserve uranium resources, reduce separative work requirements, and reduce the problem of storage.

1/ Excludes pumped storage.

2/ "Nuclear Power Growth 1974-2000, "USAEC, Washington, D. C., February 1974 (WASH-1139), P. 8.

3/ AEC's Draft Environmental Statement, Volume 2, Chapter III, Appendix A.

The Bureau of Power staff concludes that the recycling of fissile plutonium for light water nuclear reactors will contribute to the reliability and adequacy of bulk electric power systems by augmenting the nuclear fuel supply for what is projected to be a major portion of the total installed electric generating capacity of the industry.

Very truly yours,

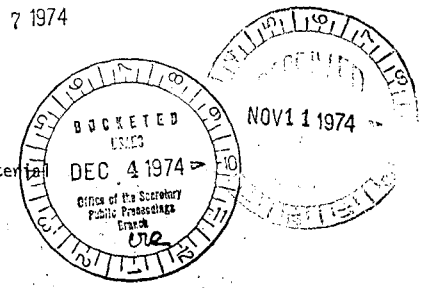
T. A. Phillips
Chief, Bureau of Power

Comment Letter No. 48

Misc Notice (39 FR 30186)
PROPOSED RULE - GESMO

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

NOV 7 1974



Mr. S. H. Smiley
Deputy Director for Fuel and Material
Directorate of Licensing
Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Smiley:

The opportunity to review and comment on the draft Generic Environmental Statement - Mixed Oxide Fuel - WASH-1327 (GESMO) is appreciated. The review of this report, with the exception of the safeguards problem and the introduction of the mixed oxide fuel fabrication facility into the reactor fuel cycle, does not show new problems introduced from the use of plutonium as a constituent of the mixed oxide fuel except in terms of quantities of plutonium and the transplutonium elements that are involved. From a health standpoint these increased quantities have a potential health impact, but do not present the need for technological concepts to control these hazards not currently under consideration or in use.

Based on information contained in the draft statement it appears that the more significant addition to the overall health problem presented by the addition of mixed oxide fuel fabrication facilities is one of increased occupational exposure and dose. It is noted that this occupational dose commitment might be reduced by extensive mechanization of the work involved in the mixed oxide fuel fabrication facility and this is being considered by industry in the design of proposed new plants. It recommended that such dose reduction methodology be pursued and encouraged as being in keeping with the announced "as low as practicable" policy of the AEC with regard to occupational exposures associated with the nuclear power industry fuel cycle.

The draft statement states "perhaps the greatest potential adverse impact of plutonium recycle involves the increased exposure of plutonium to theft or sabotage" and then goes on to note that this potential could be substantially reduced by certain modifications or additions to current security measures already in effect. This is without doubt a serious potential adverse impact of plutonium recycle and there is no question but that current security measures need to be upgraded and augmented to reduce this potential.

One of the proposed additional safeguards would be the use of "spiked" plutonium making it less susceptible to theft and more difficult to manufacture into a nuclear explosive because of the required elaborate handling procedures. This is undoubtedly true. However, it would appear to also present this same kind of problem with respect to the fabrication of fuel elements utilizing "spiked" plutonium unless the plutonium were first reprocessed to remove the spiking material. This is one of the considerations noted in the need to recycle plutonium following fuel reprocessing without a long delay-time in order to prevent the build-up of americium-241 from the decay of plutonium-241 because of the high gamma emission from the americium. The concept of minimizing or eliminating transportation of plutonium from reprocessing plants by locating mixed oxide fuel fabrication plants in close proximity to or immediately adjacent to processing plants in integrated fuel cycle facilities does have obvious advantages. It notes, however, that such a plan would require careful analysis of a number of social, economic, environmental, and political factors. One of these factors would certainly be the possibility of increases in the amount and concentrations of plutonium accumulating in the environment adjacent to such a combined facility. This would need consideration in siting. This is discussed further below.

The draft statement contains a discussion of waste disposal problems which would be worsened to some extent by the recycle of plutonium. This covers a good deal of discussion that was contained in the draft environmental impact statement, WASH-1539, on the storage and disposal of high-level waste and actinide-containing wastes. There appears to be some differences between the two discussions of this problem whereas in the WASH-1539 draft statement it is assumed that ultimate disposal of the wastes would be possible prior to the decay of waste, whereas this statement assumed that decay to the level of 10 nCi per gram would be necessary to permit unrestricted burial. This difference in thinking should be resolved in the final statements. Both statements discuss the fact that investigations are being carried out leading to the processing of the liquid high-level waste to remove transuranic elements prior to solidification. This course of investigations should be followed.

The draft statement notes that methods to reduce releases of tritium and krypton-85 from fuel reprocessing facilities by factors of 10 to 100 (90 to 99% retention) and their collection and storage are being investigated by AEC. It also states that this work is based on incentives not directly related to plutonium recycle as these effluents dominate population dose commitments from reprocessing plants in general. This is true and, this being the case, it is felt that such investigations should be continued and pursued as they are in keeping with the AEC's policy of reducing discharges to the environment to "as low as practicable" levels.

The report contains a discussion of the possible effect of concentrations of plutonium in the environment on uptake by foods and by inhalation from concentrations in the atmosphere. The statement is made that measurements of plutonium levels in persons exposed to fallout from past nuclear tests indicate a maximum plutonium concentration of 3×10^{-14} curies per gram in plumonary lymph nodes and 5×10^{-15} curies per gram in the lung. This statement is impossible to interpret because there is no indication whether these persons sampled were from the general population, thus, representing exposure to concentrations from the general dispersal of plutonium from worldwide fallout or whether they were individuals closer-in to test sites who may have actually been exposed to a relatively concentrated cloud from the weapons burst.

In the discussion of the predicted health effects due to the introduction of the MOX fuel cycle predictions are made, based on the world's population for 1990, that there would be a reduction in the population rem 50 year dose commitment of 1000 to whole body, 2500 to lungs, 3000 to skeletons, and 700 to the gonads of the reproducing portion of the population and that, based on BIER report data, these reductions in population exposure would diminish cancers in the world population by 0.27 of a cancer and genetic defects 0.18 of a defect. This does not seem to be an appropriate way to measure the population health impact from this program and it seems unlikely that the effluents from the industry in question would be dispersed worldwide as is the case with fallout from weapons testing, for example, but would rather be confined to a smaller geographic areas and smaller population groups. The decreased incidence in disease and defects based on population-rem might be the same numerically. However, the population at risk would be smaller and would likely have a higher decrease in rate of disease and defects, based on the effluent assumptions used.

Related to this is the fact that the draft statement does not contain a discussion of the plutonium and transplutonium isotope build-up in the environment immediately adjacent to these facilities over a prolonged period of time. It seems reasonable to expect that the areas receiving the maximum impact of discharges from individual plants or by integrated fuel cycle facilities, if this concept is adopted, would be relatively small, geographically speaking, and that these would be the critical areas insofar as human exposures to accumulated plutonium and transplutonium elements would be concerned.

In the discussion of the uptake of plutonium by plant life and reaching man through the plant cycle directly through food crops or indirectly through animals and more indirectly through milk, the question of uptake of plutonium deposited in bodies of water by seafoods has not been discussed. This might be especially important in the case of organisms such as shellfish which tend to concentrate certain radioactive elements.

The draft statement contains a commendable discussion of the hot particle problem with regard to the inhalation of air borne plutonium. It is noted that the draft report does use the prevailing position of the standards-setting bodies, i.e. that the diffused radiation of tissue should be used to calculate dose rather than dose to tissues immediately surrounding the hot particle. This is likely to be a continued point of controversy for some time to come and until a definitive body of data are available to prove one or the other of these theories. It is noted that the Natural Resources Defense Council, Inc. has filed a petition with the AEC requesting that a reduced limit be imposed on the concentration of plutonium in air for particles of a high specific activity and that this matter is being given careful consideration in a separate proceeding. It is assumed that this separate proceeding will be available for public and scientific evaluation.

Sincerely yours,

Charles Custard

Charles Custard
Office of Environmental Affairs

NRC Staff Response To Specific
Comments On Health, Safety, & Environment
By Charles Custard, U.S. Dept. of Health, Education & Welfare

1. Comment:

"Based on information contained in the draft statement it appears that the more significant addition to the overall health problem presented by the addition of mixed fuel fabrication facilities is now of increased occupational exposure and dose. It is noted that this occupational dose commitment might be reduced by extensive mechanization of the work involved in the mixed oxide fuel fabrication facility and this is being considered by industry in the design of proposed new plants. It recommended that such dose reduction methodology be pursued and encouraged as being in keeping with the announced 'as low as practicable' policy of the AEC with regard to occupational exposures associated with the nuclear power industry fuel cycle."

Response:

The incentive for mechanization of MOX fuel fabrication facilities is production efficiency and economics. There is an economic incentive to achieve close process control, reduce any radioactive release, and maintain maximum production yields in the manufacture of MOX fuels.

The reduction of dose resulting from mechanization is a secondary benefit. However, it is the intent of the NRC to encourage any action that promises to keep the levels of occupational exposures to "as low as reasonably achievable."

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2. Comment:

"The draft statement contains a discussion of waste disposal problems which would be worsened to some extent by the recycle of plutonium. This covers a good deal of discussion that was contained in the draft environmental impact statement, WASH-1539, on the storage and disposal of high-level waste and actinide-containing wastes. There appears to be some differences between the two discussions of this problem whereas in the WASH-1539 draft statement it is assumed that ultimate disposal of the wastes would be possible prior to the decay of waste, whereas this statement assumed that decay to the level of 10 nCi per gram would be necessary to permit unrestricted burial. This difference in thinking should be resolved in the final statements. Both statements discuss the fact that investigations are being carried out leading to the processing of the liquid high-level waste to remove transuranic elements prior to solidification. This course of investigations should be followed.

Response:

There appears to be some misunderstanding of the proposed 10 nCi/g cutoff for plutonium contaminated wastes. This is not a function of decay (the half life of ^{239}Pu is 24,000 years) but rather one of concentration. A concentration of 10 nCi/g of alpha emitting plutonium isotopes is roughly equivalent to concentrations of radium found in nature.

WASH-1539 has been withdrawn and a new environmental impact statement on waste management is being prepared by ERDA.

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3. Comment:

"The draft statement notes that methods to reduce releases of tritium and krypton-85 from fuel reprocessing facilities by factors of 10 to 100 (90 to 99% retention) and their collection and storage are being investigated by AEC. It also states that this work is based on incentives not directly related to plutonium recycle as these effluents dominate population dose commitments from reprocessing plants in general. This is true and, this being the case, it is felt that such investigations should be continued and pursued as they are in keeping with the AEC's policy of reducing discharges to the environment to 'as low as practicable' levels."

Response:

The development of the Purex process used by reprocessing plants has reached the stage where process variables are well understood. As suggested, the development efforts being conducted by ERDA now identified with this process are aimed at the reduction of radionuclides, such as ^{85}Kr and ^{3}H, in process effluents, pursuant to the aims of the policy of "as low as reasonably achievable."

For assessments of impacts from the release of ^{85}Kr and ^{3}H refer to CHAPTER IV, Section E, paragraphs 2.3 and 2.4.

---

4. Comment:

"The report contains a discussion of the possible effect of concentrations of plutonium in the environment on uptake by foods and by inhalation from concentrations in the atmosphere. This statement is made that measurements of plutonium levels in persons exposed to fallout from past nuclear tests indicate a maximum plutonium concentration of 3×10^{-14} curies per gram in plumonary lymph nodes and 5×10^{-15} curies per gram in the lung. This statement is impossible to interpret because there is no indication whether exposure persons sampled were from the general population, thus, representing exposed to concentrations from the general dispersal of plutonium from worldwide fallout or whether they were individuals, closer-in to the sites, who may have actually been exposed to a relatively concentrated cloud from the weapons burst.

"In the discussion of the uptake of plutonium by plant life and reaching man through the plant cycle directly through food crops or indirectly through animals and more directly through milk, the question of uptake of plutonium deposited in bodies of water by seafoods has not been discussed. This might be especially important in the case of organisms such as shellfish which tend to concentrate certain radioactive elements."

Response:

In final GESMO, the plutonium levels are discussed in the general population as determined from human autopsy data. The populations are from Colorado and New Mexico. Inhalation of plutonium based on air concentrations in New York City was estimated using ICRP models. The measured plutonium in human organs and estimated plutonium in the same organs are in general agreement.

The uptake of radionuclides by fish is considered in Appendix A of Section J, CHAPTER IV. Plutonium and other transuranium elements are included in the estimated dose from consumption of fish.

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5. Comments:

"In the discussion of the predicted health effects due to the introduction of the MOX fuel cycle predictions are made, based on the world's population for 1990, that there would be a reduction in the population rem 50 year dose commitment of 1000 to whole body, 2500 to lungs, 3000 to skeletons, and 700 to the gonads of the reproducing portion of the population and that, based on BIER report data, these reductions in population exposure would diminish cancers in the world population by 0.27 of a cancer and genetic defects 0.18 of a defect. This does not seem to be an appropriate way to measure the population health impact from this program and it seems unlikely that the effluents from the industry in question would be dispersed worldwide as is the case with fallout from weapons testing, for example, but would rather be confined to a smaller geographic area and smaller population groups. The decreased incidence in disease and defects based on population-rem might be the same numerically. However, the population at risk would be smaller and would likely have a higher decrease in rate of disease and defects, based on the effluent assumptions used."

Response:

Final GESMO contains estimates of health effects for each fuel cycle option. Estimates are made for both the United States and world population integrated over a 26-year period of fuel cycle operation from 1975 through 2000. The majority of the estimated health effects are in the U.S. population. The small numbers of health effects estimated for the world population are based on releases of ^{85}Kr, ^{14}C, and ^{3}H dispersed worldwide.

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6. Comment:

"The draft statement contains a commendable discussion of the hot particle problem with regard to the inhalation of air borne plutonium. It is noted that the draft report does use the prevailing position of the standards-setting bodies, i.e. that the diffused radiation of tissue should be used to calculate dose rather than dose to tissues immediately surrounding the hot particle. This is likely to be a continued point of controversy for some time to come and until a definitive body of data are available to prove one or the other of these theories. It is noted that the Natural Resources Defense Council, Inc. has filed a petition with the AEC requesting that a reduced limit be imposed on the concentration of plutonium in air for particles of a high specific activity and that this matter is being given careful consideration in a separate proceeding. It is assumed that this separate proceeding will be available for public and scientific evaluation."

Response:

The NRDC hot particle petition and the NRC denial are included in CHAPTER IV, Section J, Appendix D.

Comment Letter No. 49

EXXON NUCLEAR COMPANY, Inc.
2101 Horn Rapids Road, Richland, Washington 99352
PHONE: (509) 946-9621

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

NOV 11 1974

November 4, 1974

U. S. Atomic Energy Commission
Washington, D. C. 20545

Attention: Deputy Director for Fuels and Materials
Directorate of Licensing - Regulation

Subject: Comments on Draft Generic Environmental Statement Mixed Oxide Fuel, WASH-1327

DOCKETED
USAEC
DEC 4 1974
Office of the Secretary
Public Proceedings
Branch

Dear Sir:

Exxon Nuclear Company assisted in the preparation of the joint nuclear industry comments by the Atomic Industrial Forum and is in general agreement with that response. We are submitting this direct response in order to highlight certain key ideas which we believe need re-emphasis and added clarification.

First, we commend the Staff for a thorough first draft which was prepared on a short time schedule. The draft statement provides a valuable technical and economic source document on the entire subject of plutonium recycle. It covers the generic aspects of recycle which we judge to be important in a comprehensive environmental statement. We appreciate the opportunity to comment.

1. Cost-Benefit Analysis

We judge this section to be an important element of the statement. We recognize that the carrying out of a meaningful cost-benefit analysis on the subject of plutonium recycle does involve a complex of inter-relationships through all sectors of the nuclear fuel cycle. Commercial cause and effect, supply-demand balances and investment program alternatives are all variables in cost-benefit assessments. Although the Staff's analysis is based on a quite logical approach, we believe that the benefit derived through plutonium recycle most likely will exceed the costs by margins much larger than you show. The results of our analyses are discussed below.

The key fuel cycle economic factors in the C-B equation are the operating and capital costs associated with enrichment, fuel reprocessing, mixed oxide fuel fabrication, the cost of U_3O_8, and the cost of a truly satisfactory safeguards system. The latter cost can be folded into the others, as the Staff has done. Although projections of fuel cycle

costs are subject to large uncertainties (particularly in view of limited cost experience with commercial scale fuel reprocessing and plutonium fabrication plants designed to still emerging and as yet undefined standards), the Staff's estimates are out of date and are low by large amounts in our view and experiences. Using more recent estimates which we believe are more representative of future costs as we consider data in the public domain, we compute a differential annual cost penalty to the users of LWR-generated electrical energy if plutonium is not recycled of 0.8 mil/kwh, or twice that indicated in GESMO. The 0.8 mil/kwh differential amounts to a two-billion dollar cost penalty in 1990; if neither plutonium nor uranium is recycled, we compute the 1990 cost penalty to be likely in excess of 2.5 billion dollars.

We further emphasize that the economics of a single future year are not nearly representative of the overall magnitude of the potential cost savings due to plutonium recycle in LWR's, particularly for an early year like 1990. For example, for the 1980-2000 time period, our calculations indicate that the users of LWR-generated electrical energy will pay a cumulative penalty of nearly fifty billion dollars if plutonium is not used in light water reactors, and nearly sixty billion dollars if neither plutonium nor uranium is recycled. This cumulative penalty to society through the year 2000, which is in 1974 dollars, is more than the total capital investment needed to support the LWR fuel cycle.

2. Safeguards

An important quantity on the cost side of the C-B equation is the safeguards consideration. A strong national safeguards program appears to be inherent in the commercialization of plutonium. The Staff's discussion of safeguards needs to be strengthened, quantified in terms of risk and cost, and presented in a way so that the public can fully understand that the risks associated with plutonium as a commercial commodity are acceptable. Threat analyses, fault free analyses, deterrence, protection and response alternate studies all need prompt action. Such studies could focus down on a "design basis diversion," provide bases for meaningful safeguards alternates, quantify the risks and costs, and provide both the public and the nuclear industry the long-needed information upon which clear judgments and business decisions can be made and measure the impact of their not being made.

The list of possible safeguards improvements provided in GESMO may well become candidates for safeguard systems alternates. However,

until the studies recommended are done, these may be considered additional, escalating and ad hoc fixes without fully developed underlying bases.

It will be important that the nuclear fuel industry be permitted choices in arriving at acceptable safeguards positions. These choices should be from a set of possibly different (but equivalent in terms of protection) alternatives which can be administered in the national interests. To force colocation, for example, on all plutonium fuel suppliers and reprocessors, could cause unfair and unnecessary economic penalties to some which should be carefully evaluated. Sufficient alternatives should be available to permit the fuel supplier to make his decisions based on those economic factors best suited to his own situation and still end up with an overall safeguards risk which is within the envelope of those determined from the threat analyses, etc.

Further delays on arriving at a national policy on plutonium cannot be tolerated since industry decisions on new fuel facilities are needed today. Yet, to arrive at the answers suggested above within the needed time frame will be difficult. An effort, similar to that of the Rasmussen study, may be required. Action, involving other governmental agencies knowledgeable in threat situations and response systems, should be implemented at once to get the needed answers on an accelerated basis.

3. Other Considerations and Comments

Although necessary for a complete cost-benefit assessment, the details of costs and benefits presented in GESMO (many of them of small consequence) tend to mask the truly large benefits of plutonium recycle. For example, the contribution to energy self sufficiency needs more emphasis. The opportunity to utilize the fertile (U-238) portion of a valuable natural resource, uranium, should be stressed. This is particularly important at a time when limits to our finite natural resources are becoming visible.

Finally, without plutonium recycle in light water reactor systems, there may be no plutonium fuel based breeder systems for decades. The plutonium feed stock to start the breeders will not be available and the needed experience gained in handling large amounts of plutonium will not be available to provide the framework for licensing, public acceptance, and fast fuel production. Whether or not the breeder will be required should not be a factor in this justification, since the importance lies in the fact that no future energy source should be jeopardized by present actions in advance of full knowledge of whether or not future energy sources are viable candidates. On

this basis, four of the six alternates discussed in GESMO would no longer be considered viable options for the breeder concept.

The impact of plutonium recycle on the price elasticity of yellowcake in GESMO is assumed to be negligible. This conclusion must be challenged on the basis that the demands placed on U_3O_8 without plutonium recycle may well exceed the supply. Under such pressures, the price of yellowcake must certainly exceed by considerable margin the values projected in GESMO.

In this same vein, the omnipresent national goals of energy self-sufficiency and energy conservation become increasingly more important with continuing shifts in world monetary and political power. The need for an economical energy source that can be depended on for generations, compatible with our environment, is one of our highest national priorities. Plutonium recycle in light water reactors, under appropriate controls and safeguards, assists in the fulfillment of this energy need.

Alternate #6, storage of spent fuel with ultimate disposal may not be an acceptable form of waste disposal. Furthermore, the conclusion that no reprocessing results in no tritium or krypton releases is questioned. The reliability of spent fuel containment for these fission gases is time dependent and may require extensive additional engineered safety systems and facilities.

The discussions on transuranic wastes do not recognize that transuranic wastes generated by fuel reprocessing plants will include penetrating radiation. No acceptable disposal route for penetrating radiation transuranic waste is discussed.

Again, we appreciate this opportunity to review and comment on the draft statement. We hope our comments are helpful and that resolution on this important question will occur promptly.

Sincerely,

Roy Nilson
Manager, Quality Assurance
& Licensing Department

RN/psl

NRC Staff Response to Specific Comments on Health, Safety and Environment by Roy Nilson, EXXON Nuclear Co.

1. Comment:

"We judge this section to be an important element of the statement. We recognize that the carrying out of a meaningful cost-benefit analysis on the subject of plutonium recycle does involve a complex of inter-relationships through all sectors of the nuclear fuel cycle. Commercial cause and effect, supply-demand balances, and investment program alternatives are all variables in cost-benefit assessments. Although the Staff's analysis is based on a quite logical approach, we believe that the benefit derived through plutonium recycle most likely will exceed the costs by margins much larger than you show. The results of our analyses are discussed below.

"The key fuel cycle economic factors in the C-B equation are the operating and capital costs associated with enrichment, fuel reprocessing, mixed oxide fuel fabrication, the cost of U_3O_8, and the cost of a truly satisfactory safeguards system. The latter cost can be folded into the others, as the Staff has done. Although projections of fuel cycle costs are subject to large uncertainties (particularly in view of limited cost experience with commercial scale fuel reprocessing and plutonium fabrication plants designed to still emerging and as yet undefined standards), the Staff's estimates are out of date and are low by large amounts in our view and experiences. Using more recent estimates which we believe are more representative of future costs as we consider data in the public domain, we compute a differential annual cost penalty to the users of LWR-generated electrical energy if plutonium is not recycled of 0.8 mil/kwh, or twice that indicated by GESMO. The 0.8 mil/kwh differential amounts to a two-billion dollar cost penalty in 1990; if neither plutonium nor uranium is recycled, we compute the 1990 cost penalty to be likely in excess of 2.5 billion dollars."

Response:

Costs throughout final GESMO have been updated to reflect the best current estimates. As discussed in CHAPTER XI, Section 3.0, the value of Pu recycle is sensitive to the costs assumed. Included in the assessments are the economic impacts of delays in the implementation of Pu recycle. The effects of uncertainties in certain future costs are evaluated by parameterizing such costs over a range of values.

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2. Comment:

"We further emphasize that the economics of a single future year are not nearly representative of the overall magnitude of the potential cost savings due to plutonium recycle in LWR's, particularly for an early year like 1990. For example, for the 1980-2000 time period, our calculations indicate that the users of LWR-generated electrical energy will pay a cumulative penalty of nearly fifty billion dollars if plutonium is not used in light water reactors, and nearly sixty billion dollars if neither plutonium nor uranium is recycled. This cumulative penalty to society through the year 2000, which is in 1974 dollars, is more than the total capital investment needed to support the LWR fuel cycle."

Response:

In this final statement, the impacts are integrated for the period 1975-2000. The cumulative penalty for no recycle is calculated to be about 66% of that forecasted by Exxon. However, the difference is small relative to the uncertainties, and as discussed in CHAPTER XI, Section 3.0, the Exxon estimate of the penalty is within the range of possible values.

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3. Comment:

"Although necessary for a complete cost-benefit assessment, the details of costs and benefits presented in GESMO (many of them of small consequence) tend to mask the truly large benefits of plutonium recycle. For example, the contribution to energy self-sufficiency needs more emphasis. The opportunity to utilize the fertile (U-238) portion of a valuable natural resource, uranium, should be stressed. This is particularly important at a time when limits to our finite natural resources are becoming visible."

Response:

The questions of energy self-sufficiency balance of payments, national security, etc., were not addressed, although there are real benefits to be gained in all these areas from plutonium recycle. The quantification of these benefits is beyond the scope of this analysis, which deals with the differentials between a Pu recycle industry and the existing UO_2 fuel cycle industry. Comparisons have been included in final GESMO to show the differentials between the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium.

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4. Comment:

"Finally, without plutonium recycle in light water reactor systems, there may be no plutonium fuel based breeder systems for decades. The plutonium feed stock to start the breeders will not be available and the needed experience gained in handling large amounts of plutonium will not be available to provide the framework for licensing, public acceptance, and fast fuel production. Whether or not the breeder will be required should not be a factor in this justification, since the importance lies in the fact that no future energy source should be jeopardized by present actions in advance of full knowledge of whether or not future energy sources are viable candidates. On this basis, four of the six alternates discussed in GESMO would no longer be considered viable options for the breeder concept."

Response:

It is felt that the decision to recycle plutonium should be made independently from considerations of the breeder program. Hence, the economic impacts of no recycle on the breeder development are not considered appropriate for discussion in GESMO. This is discussed in some detail in CHAPTER XI, paragraph 3.9.

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5. Comment:

"The impact of plutonium recycle on the price elasticity of yellowcake in GESMO is assumed to be negligible. This conclusion must be challenged on the basis that the demands placed on U_3O_8 without plutonium recycle may well exceed the supply. Under such pressures, the price of yellowcake must certainly exceed by considerable margin the values projected in GESMO."

5. Comment (Cont'd)

Response:

The marketplace model employed in final GESMO is described in CHAPTER XI, Appendix A. The rate of usage of the resources does affect the market price. Additionally, the model uses an "estimted cost of recovery" instead of the "forward cost" concept, thus an estimate of the market price for yellowcake is generated. Because of the inherent uncertainties in such an exercise, the effects of the uncertainties are examined by parameterizing the price of U_3O_8 and looking at the effect on incentives to recycle. See CHAPTER XI, paragraph 3.1.

A price elasticity as such has not been derived nor invoked and the short term fluctuations were not examined. The market model does approximate this effect.

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6. Comment:

"Alternate #6, storage of spent fuel with ultimate disposal, may not be an acceptable form of waste disposal. Furthermore, the conclusion that no reprocessing results in no tritium or krypton releases is questioned. The reliability of spent fuel containment for these fission gases is time dependent and may require extensive additional engineered safety systems and facilities."

Response:

In final GESMO, comparisons have been made for the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium. The Alternative 6, no recycle or the throwaway cycle, is assessed in CHAPTER IV, Section H - Radioactive Waste Management. This alternative considers that the spent fuel would be encapsulated after a specified cooling time and then shipped to a Federal repository for storage/disposal.

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7. Comment:

"The discussions on transuranic wastes do not recognize that transuranic wastes generated by fuel reprocessing plants will include penetrating radiation. No acceptable disposal route for penetrating radiation transuranic waste is discussed."

Response:

In final GESMO, the transuranic wastes are considered in much the same fashion as high level wastes in that these wastes will be encapsulated and shipped to a Federal geologic repository for disposal. See CHAPTER IV, Section H.

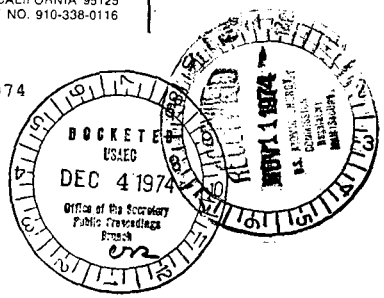
DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

GENERAL ELECTRIC

NUCLEAR ENERGY
DIVISION

GENERAL ELECTRIC COMPANY, 175 CURTNER AVENUE, SAN JOSE, CALIFORNIA 95125
Mail Code 273 Phone (408) 297-3000, TWX NO. 910-338-0116

November 11, 1974



Mr. S. H. Smiley
Deputy Director Fuels and Materials
Directorate of Licensing-Regulation
U. S. Atomic Energy Commission
Washington D. C. 20545

Subject: Revision of General Electric Comments on Generic Environmental Statement - Mixed Oxide Fuel

Dear Mr. Smiley:

By letter dated October 25, 1974, signed by G. J. Stathakis, Vice President and General Manager, the Nuclear Energy Division of General Electric Company provided comments on the Generic Environmental Statement - Mixed Oxide Fuel (GESMO). Review of the attachments to that letter reveals two items which should be revised.

The first item is on page 4 of Part A of the Attachment to that letter, the last paragraph of Section 7. The fourth sentence of Section 7 reads:

"The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude or more (depending on actual milk usage pathways)."

That sentence should be two sentences which read as follows:

"The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude. The iodine-milk pathway doses are overestimated by two orders of magnitude or more (depending on actual milk usage pathways)."

The second item appears on page 15 of Part B of the Attachment. In the

comment concerning page IV E-22, the word "arithmatic" should be corrected to read "arithmetic."

Accordingly, enclosed are corrected copies of page 4 of the Attachment-Part A, and page 15 of the Attachment-Part B to Mr. Stathakis' letter which should be substituted for pages of the same number previously submitted.

Very truly yours,

A. N. Tschaeche
Administrator-Licensing
M/C 273, Ext. 2235

enc.

General Electric's detailed comments on the various factors of conservatism are provided in the Attachment to this letter. It is concluded that GESMO overestimates doses from both the UO_2 and MO_2 reactor plants by significant factors. Doses from liquid effluents are overestimated by one to two orders of magnitude. The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude. The iodine-milk pathway doses are overestimated by two orders of magnitude or more (depending on actual milk usage pathways). We believe that these conservatisms, further detailed herein, should be removed from the GESMO document because such overstatement of impact is not in the best interest of the public, the industry, or the regulatory agencies.

8. Section B of Chapter 4 discusses mixed oxide fuel fabrication. The method used in the model analyzed includes only blending of plutonium oxide and uranium oxide powders. Other processes and shipping forms under development by the industry include alternatives such as co-precipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated waste generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described, and the risk to the environment may be not greater than that which is produced by a process which blends the plutonium and uranium oxide powders. Accordingly, the second paragraph on page IV D-3 should be revised to add the following statement:

> "Other processes and shipping forms under development by the industry include alternatives such as co-precipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated wastes generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described herein."

- nitrate conversion processes (filtrates and wash solutions)
- secondary cooling systems
- fire protection systems in plutonium processing areas (abnormal occurrences)
- scrub water or hot shower water from first aid facility (abnormal occurrences)."

Page IV D-18

Paragraph D.2.a - The first sentence after Table IV D-5 is: "Plutonium handling operations are carried out inside equipment located within process enclosures (glove boxes) ... ." Radiation from plutonium material will, in many cases, preclude operations within unshielded glove boxes. Therefore, shielded cells will be required. The sentence should be revised to read as follows:

> "Plutonium handling ... (e.g., glove boxes) ... ."

Page IV D-29

Paragraph D.2.c (2) - Calculations of the nonradiological process effluent emitted from the fabrication plant, set forth in D.2.c (2), page IV D-29, are not consistent with Table IV D-12 on page IV D-41. For example: 1.5 kg per year of fluoride ion translates to 20.5 grams per day, assuming 20% operation of the dirty scrap line. (1.5 kg/year = [4.1 grams/day] [20%] = 20.5 grams/day.) This does not check with the 0.1 gram per day set forth in the first line on page IV D-29. We believe these calculations should be reviewed and revised as appropriate.

Page IV E-22

Table E-8 - There appears to be an arithmetic error in the I-131 entry since 0.50 plus 0.50 does not equal 0.50.

NRC Staff Response to Specific Comments on Health, Safety and Environment by A. N. Tschaeche of General Electric

1. Comment:

"It is concluded that GESMO overestimates doses from both the UO_2 and MO_2 reactor plants by significant factors. Doses from liquid effluents are overestimated by one or two orders of magnitude. The noble gas radiation dose and the thyroid inhalation dose are overestimated by about one order of magnitude. The iodine-milk pathway doses are overestimated by two orders of magnitude or more (depending on actual milk usage pathways). We believe that these conservatisms, further detailed herein, should be removed from the GESMO document because such overstatement of impact is not in the best interest of the public, the industry, or the regulatory agencies."

Response:

The dose models used to estimate individual and population doses from UO_2 and MOX reactor plants are the same models used by the NRC staff for specific reactor plants and the associated licensing anlayses. These models are described in Regulatory Guide 1.109 and reflect the latest Commission guidance regarding realism in performing dose assessments, thus any conservatism in final Gesmo is realistic.

Individual and population dose values provided in the final GESMO are typical of values calculated for specific reactor facilities. Thus, the industry is being properly represented.

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2. Comment:

"Section B of Chapter 4 discusses mixed oxide fuel fabrication. The method used in the model analyzed includes only blending of plutonium oxide and uranium oxide powders. Other processes and shipping forms under development by the industry include alternatives such as coprecipitation of mixed oxide, pretreatment of feed material to achieve ceramic grade plutonium oxide, certain improved scrap reprocessing steps to minimize the amount of plutonium contaminated waste generated, and other solid form plutonium compounds for shipment. These processes do not represent environmental impacts substantially different from those described, and the risk to the environment may be not greater than that which is produced by a process which blends the plutonium and uranium oxide powders."

Response:

The summary of CHAPTER IV, Section D, of the final GESMO contains descriptions of several processes for the manufacture of MOX rods which could be used and would have essentially the same environmental impact. The two processes described in the text CHAPTER IV, Section D, paragraphs 1.3.1, 1.3.2 and 1.3.3 are now proven technology. The mechanical mixing process used in the statement was chosen because, at this time, it is the dominant method used. The environmental impact of processes under development could not be fully assessed until the processes are fully developed for commercial production.

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3. Comment:

"Page IV D-29, paragraph D.2.c(2) - Calculations of the nonradiological process effluent emitted from the fabrication plant, set forth in D.2.c(2), page IV D-29, are not consistent with Table IV D-12 on page IV D-41. For example: 1.5 kg per year of fluoride ion translates to 20.5 grams per day assuming 20% operation of the dirty scrap line. (1.5 kg/year = [4.1 grams per day] [20%] = 20.5 grams/day.) This does not check with the 0.1 gram per day set forth in the first line on page IV D-29. We belive these calculations should be reviewed and revised as appropriate."

Response:

This comment is valid and the values stated are inconsistent in the draft GESMO. Non-radiological-process effluent quantities have been recalculated. The corrected quantities appear in paragraph 2.3.2 and in Table IV D-1 of CHAPTER IV, Section D of the final GESMO.

Comment Letter No. 51

MEMO ROUTE SL (Form AEC-318 (Rev. 2) AECM 0240)	Signature if discussed	For concurrence	For action
	Note and return	For signature	For information

TO (Name and unit) Homer Lowenberg Assistant Director for Technical Support and Transportation, HQ	INITIALS	REMARKS We have reviewed Part IVH, Section 2, "Storage of Plutonium Contaminated Wastes," in the Document, "Generic Environmental Statement Mixed Oxide Fuel," WASH-1327. Our suggested changes are included. We are also forwarding a new photographic view (73-2695) of ITSA to be used for Figure IVH-13. Your photo is out-of-date. If you have any questions, please call.
	DATE	
TO (Name and unit)	INITIALS	
	DATE	
FROM (Name and unit) George Wehmann, Director Office of Waste Management ID	REMARKS IDAHO NATIONAL ENG'G LAB Idaho Operations Office 550 2nd St Idaho Falls, Idaho 83401	
PHONE NO. 1668	DATE 11/5/74	

USE OTHER SIDE FOR ADDITIONAL REMARKS

GPO : 1968 O—234-619

Monitoring wells are maintained at each burial site and are sampled periodically to determine if there has been any migration of radioactivity. In addition, air and vegetation samples are taken around the site and analyzed for radioactivity. Should any sample reveal an increase in the concentration of radioactive material in an aquifer above that measured prior to commencement of burial operations and it is determined that the radioactivity originated in the burial ground, its significance must be analyzed, corrective actions developed, as appropriate, and the entire matter reported. Corrective actions are subject to approval by the AEC or an agreement state and additional corrective measures may be required as necessary to protect public health and safety.

To date, there have been no reports of migration of radioactivity from commercial burial sites. In the unlikely event that there would be such a finding, several courses of action could be taken. These include: (1) a halt to burial operations, (2) removal of the radioactive material from the burial area in which the radioactivity originated, (3) grouting of the site from which the radioactivity originated, or (4) other such procedures which might be necessary, depending on the extent of migration of radioactivity from the site.

Environmental Effect of Accidents at Burial Grounds - There have been no accidents at burial grounds under Federal or State jurisdictions that resulted in offsite environmental effects. Some minor accidents have occurred involving materials not utilized in any fuel cycle.

Accidental opening of an other-than-high-level waste package prior to burial and release of the package contents could occur, however, at a commercial land burial facility. Normally, the scattered waste materials would be confined to the fenced facility and the impact on the environment would be negligible. However, even if it is assumed that as much as one-third of the waste contained in a 55-gallon drum is released to the unrestricted area, the effect on the environment would be insignificant. The volume of a 55-gallon drum is approximately 7.4 cubic feet. Using the assumption of a waste concentration of 0.03 Ci per cubic foot, (~1 μCi/ml), the total amount of radioactivity involved is about 200 millicuries. If the waste were uniformly dispersed over an area of one acre, the concentration of the radioactive material would be about 1.5 microcurie per square foot, approximately 20 times that in the outer 1 mm surface of uranium ore. Dispersion over a greater area would result in a proportionally lower concentration. The dispersed material would be in the vicinity of the site which is normally uninhabited and unused. The bulk of the scattered waste could easily be recovered. Radiation surveys could be made and the area decontaminated, if necessary.

(2) Storage of Plutonium-Contaminated Wastes

In accordance with proposed amendments of 10 CFR Part 20 wastes contaminated with plutonium or other transuranic long-lived alpha emitting radionuclides in concentrations exceeding

10 nanocuries per gram of waste will be transferred to the AEC for storage. The most probable way of providing this storage would be to store the commercial waste together with the AEC-generated plutonium waste at one of the large existing AEC sites. This action will be supported by an environmental statement to characterize the specific action proposed.

The volume of undissolved fuel element hulls and other fuel element parts and discarded equipment from the reprocessing plants in 1990 is estimated at 120,000 to 240,000 cubic feet. Since this waste contains activation products and small quantities of fission products, interim storage at the site of generation may be required to allow some decay of beta-gamma activity. This waste will also contain small amounts of plutonium greater than 10 nanocuries per gram, and therefore will require storage at Federal repositories. Alternatively, this waste may be stored at the RSSF for high-level wastes.

Much of the wastes received at the storage facility for plutonium-contaminated wastes will be combustible material. For the purposes of this environmental statement it is assumed that it will be desirable to incinerate this material whenever practicable, and that an incinerator will be operational sometime in the 1980's. Incineration will remove a potential fire hazard from the stored waste and will reduce the volume of wastes to be stored in the facility and later to be transferred to a permanent disposal facility, e.g., a geologic formation.

Site Considerations - Since the amendments of 10 CFR Part 20 to require the retrievable storage of plutonium-contaminated wastes are still in the proposal stage, a site has not been selected for a facility. A large, isolated arid land area would be suitable for this type of storage. Three AEC sites - the National Reactor Test Station (NRTS), the Hanford site, and the Nevada Test Site - have these characteristics. For the purposes of this environmental statement the NRTS is chosen as a reference site.[25]

NRTS was established in 1949 for building, testing, and operating various types of nuclear reactors, associated plants, and equipment. It is centered on a former Naval Proving Grounds which served the Pocatello (Idaho) Ordnance Depot, and is located along the western edge of the Upper Snake River, Lemhi, and Beaverhead-Centennial mountain ranges. The site area is 894 square miles with an average elevation of 5000 feet above sea level. A covered asphalt pad for plutonium waste storage is located in the southwest portion of the site, about 5 miles from U.S. Highway 20 which traverses the NRTS site.

The NRTS is a government reservation with access limited for reasons of safety and national security. There are no permanent onsite residents. The surrounding areas are sparsely populated, with the nearest populated areas (all small) located at Mud Lake and Terreton (29 miles northeast), Arco (19 miles west), Howe (15 miles north) and Atomic City (12 miles southeast). Most of the site work force live in the much larger communities of Idaho Falls, Blackfoot, and Pocatello, which are from 40 to 60 miles to the east or southeast.

Archeological surveys of the site started during 1967 and are continuing. Artifacts recovered from the NRTS thus far indicate a long period of occupation by man ranging from the time of the

mammoth hunters. Protection of these specific sites from relic hunters will be continued. Although no relics have been found in the vicinity of the covered pad for plutonium storage, standard site operating procedures provide that suitable precautions be taken if items of archeological interest are unearthed during construction of pits or trenches. The Experimental Breeder Reactor No. 1 (EBR-1), located in the southwest part of the NRTS, is listed in the National Register of Historic Places prepared by the National Park Service. Work is in progress to decommission the EBR-I as appropriate to allow the installation of public visitor sites.

The Snake River Plain consists of composite layers of interbedded volcanic rock and sedimentary material. The NRTS water table lies between 200 and 900 feet below ground level, and at the covered pad is about 500 feet below the ground surface. The direction of subsurface water flow is from recharge areas to the north and east toward the main part of the Snake River Plain to the south. The NRTS water supply is obtained from 24 production wells at a combined rate of about two billion gallons per year. Approximately 93 percent of the water used at the NRTS is eventually recharged to the Snake River Plain aquifer through deep wells and shallow pits or surface ponds.

The NRTS lies in a basin which has no surface outlet for its streams. The largest source of surface water at the NRTS, the Big Lost River (dry onsite during much of the year) flows in a northeasterly direction and sinks into the desert floor at the northern end of the NRTS. Two smaller streams (Birch Creek and the Little Lost River) flow onto the northern portion of the NRTS and also sink into the desert. The only other surface water onsite results from snowmelt during the spring.

Localized flooding and surface flow of water occasionally occur during periods of rain or snow when air temperatures are above freezing and the ground is deeply frozen. Drainage has been provided to carry water away from NRTS installations, including the covered pad, under such conditions.

The climate at the NRTS is arid to the point of assuming desert-like characteristics. The topographic features which affect the NRTS weather patterns are the northeast-southwest orientation of the plain and the mountain ranges to the north and west. The NRTS is relatively level and is bounded to the north and west by mountain ranges with elevations as high as 6000 feet above the plain. The predominant surface winds are southwesterly and northeasterly. Nearly all air masses entering the plain are forced to cross mountain barriers; thus, the air masses usually release moisture over the mountains and enter the plain dry, giving the region its desert-like characteristics with an average annual precipitation of 8.5 inches. The climate is cool, with the average maximum daily temperature ranging from 27°F during winter months to 87°F in summer. The average annual surface wind speed in the Central Facilities Area, just east of the covered pad, is 7.5 miles per hour, and hail of 1/2 inch or greater diameter occurs at a frequency of less than one per year. Since 1949, no confirmed tornadoes have occurred within

the present boundaries of the ~~NRTS~~ INEL. One tornado occurred 5 1/2 miles east of the east boundary in June 1967 and another occurred 1 mile east of the east boundary in July 1972, but neither caused any damage.

Until 1970, the region which includes the ~~NRTS~~ INEL was classified as Seismic Risk Zone 2 by the Pacific Coast Uniform Building Code. The new Uniform Building Code (UBC) of the International Conference of Building Officials, issued in 1970, reclassified the area into Zone 3. All new facilities are being designed accordingly. The Hebgen Lake earthquake (7.1 magnitude on the Richter Scale) occurred in 1968 at the extreme northeast corner of the Snake River plain. This is the greatest magnitude earthquake that has occurred in the eastern portion of the Snake River Plain during the period of recorded regional history (100 years).

The ecosystem of the ~~NRTS~~ INEL is typical of a semi-desert region. The covered pad area is also typical of the ~~NRTS~~ INEL; except that large mammals will be excluded by a ~~barbed wire~~ fence currently being built. The types of vegetation are limited, with the most prominent ground cover being a mixture of sagebrush, lanceleaf rabbitbrush, and a variety of grasses. This mixture covers practically all of the site.

The vegetation supports a variety of desert rodents. Chipmunks and ground squirrels inhabit the shrub areas. The mixed grasslands are inhabited mainly by mice. The herb drylands are preferred by kangaroo rats; the white-footed mouse and the jackrabbit are found in all site areas. The only large mammals seen commonly on the site are the coyote, bobcat, and pronghorn antelope. The last is migratory, wintering south and summering north of the site. Some migratory birds (doves, larks, and hawks) inhabit the site during summer. Other migrants, such as eagles (golden and, very rarely, the bald, which is an endangered species) and waterfowl pass through in the spring and fall.

Aquatic life is not significant on the site, since the major surface water flows are dry much of the year.

Of special ecological interest are the flats (playas) that are subjected periodically to flooding by the Big Lost River. These flats support a distinctive vegetation mixture composed almost solely of dense bluestem wheatgrass, and a small perennial herb, iva axillaris. These flats provide the most unique biota on the site. Sage grouse and pheasant are the only resident game birds; however, hunting is not permitted on the site.

Covered Pad Concept - This concept is the procedure developed and used at ~~NRTS~~ INEL for the storage of plutonium-contaminated wastes.[26] An asphalt pad about three inches thick is constructed on a four-inch gravel base. The surface of the pad is sloped toward the centerline and toward one end to provide for drainage of any moisture. ~~An earthen berm is placed along the high end and two sides, while the low end is left open for access by personnel and vehicles during the period of waste emplacement.~~ The pad has a surface area of about 2.5 acres, with approximate dimensions of 150 by 730 feet.

The earthen berm was used as a means of stockpiling the earth for covering the ~~first~~ first pad. It is not an integral design feature and is not a requirement

The plutonium wastes now being received at the ~~NRTS~~ INEL pad are packaged either in steel drums ~~(30 or 55 gallon)~~ 55 gallon (7.4 cubic ft.) or wooden crates, intended to meet retrievable storage requirements as well as other administrative and safety requirements. The steel drums are manufactured and loaded under a quality assurance program to minimize the possibility of leakage during handling and storage. ~~In some cases, the~~ drums have a rigid polyethylene liner. The crates are constructed of plywood and coated with a fire- and weather-resistant fiberglass-resin. Their dimensions are 4 feet by 4 feet by 7 feet.

The drums and crates containing plutonium waste are stacked on the pad in 80 x 150 foot sections called "cells". The sides of the cells are formed with the crates, and the drums are stacked within the crates in a five-high array with a layer of fire-retardant plywood and plastic sheeting separating each level. Each cell in the 730-foot length of the pad is separated from the adjacent cell by a 3-foot-thick soil firewall. As each cell is completed, it is covered with fire-retardant plywood and nylon-reinforced polyethylene before the final cover of two to three feet of soil is emplaced. (Figure IV H-13 is a view of the pad.

new photograph enclosed for substitution

Before any waste shipments are approved for receipt or storage on the pad, the necessary reviews and analyses are performed to assure that safety requirements are met. Each shipment must be accompanied by shipping forms identifying the content of each type of radioactive material in each container, and this information is placed in a computerized radioactive waste reporting system for the site. Even though the normal amounts of fissionable material in any one waste container are small, nuclear criticality safety requirements have been established for the arrays of containers and incoming shipment data is checked against these requirements. Penetrating radiation levels from containers are also checked, even though they are normally quite low. Monitoring for contamination is done frequently during the unloading and stacking of shipments, and air samples are taken continuously during ~~the~~ unloading operations

Each of the cells within the storage pad has moisture sampling pipes, and the later cells have access pipes for air sampling and temperature measurements. A sump at the low end of the pad collects all drainage and after rain or periods of snow melt, water samples are taken and analyzed for radioactivity. The pad is immediately adjacent to the conventional trench-and pit-type ~~burial ground~~, and four deep wells (about 650 feet) are provided in the general vicinity of this ~~burial ground~~ for sampling the underlying aquifer. In accordance with contamination of the aquifer by either waste disposal or storage has been detected.

The preceding description relates to the specific storage provided at the ~~NRTS~~ INEL for solid wastes contaminated with ^{239}Pu and similar radioactive materials. Some details (such as the exact dimensions of the asphalt pad and the orientation of water test wells relative to the pad and adjacent burial grounds) would not necessarily be the same at other AEC sites. The general technique, however, would be fully applicable.

If packages containing fuel rod hulls and hardware were to be stored in a covered pad, it would probably be desirable to locate their packages in the bottom layer(s), thus permitting the top

Delete this

this concept is not acceptable for this generic type of EIS. We do not want the concept developed in the Federal report

Figure IV H-56

In order to use PV-E cells, the concept of diffusion in general terms as apply to TRU waste with gamma activity

Eke. Wehmann

layers and soil layer to provide shielding for the beta-gamma activity associated with this waste. A remote crane with a shielded cab would be required for removal of the containers from the shipping cask and emplacement in the covered pad.

Storage at RSSF or Equivalent - The Retrievable Surface Storage Facility for solidified commercial high-level radioactive waste could be modified and expanded to accommodate commercial plutonium-contaminated waste. However, since most of such waste would not require the heat removal and gamma radiation shielding capabilities of the RSSF, joint storage would not be a necessity. The equivalent of the Plutonium wing of the RSSF could, in fact, be constructed at a completely different location as warranted by transportation logistics or other considerations, such as the availability of excess structures suitable for conversion to the purpose.

One concept for storage of plutonium-contaminated wastes would be a warehouse-type structure, upgraded to withstand tornadoes (or other high wind conditions) and earth shock as appropriate to the site, and containing contamination control features. A typical storage module for the waste would be 200 by 800 feet and would hold 13,500 storage units, each 4 feet by 4 feet by 6 feet high (a crate or set of palletized drums). Heavy walls and roof would provide the required protection against tornadoes and wind-projected missiles.

Forklifts would be used for material handling and other standard warehousing techniques would be used for maximum efficient operation of the facility. Personnel entry to filled storage areas would be permitted for inspection, and the shipment receiving and inspection station would also be provided with equipment for repackaging containers found to be defective either on receipt or on later inspection. The ventilation system for the entire structure would be monitored and discharged to atmosphere through high efficiency filters.

If land area were limited, a multiple-story structure would permit storage of a greater volume of waste. Such a facility would use the same operational features described above, but applied to each story. Because of the costs of tornado and earthquake resistance features, such a facility would probably have practical limits of two or three levels.

Still another approach would be to use a canyon-type building. Canyon is a term in the nuclear field for the type of massive reinforced-concrete structure used for processing irradiated fuel. A typical canyon consists of a long row of thick-walled cells in which remotely-controlled operations are conducted. Removable thick blocks forming the roofs of the cells permit access for maintenance by a remotely-operated bridge crane which can travel the full length of the cell row. Several of these structures at the AEC's Hanford site are no longer in use for their original purpose and might be converted for waste storage, using the bridge crane to stack closely packed units up to a height of 60 feet. Since the configuration of these canyon cells would not facilitate personnel inspection during storage, special arrangements would be needed for careful inspection and repackaging as necessary during transfer of stored waste from the facility. All of the canyons, of course, have monitored and filtered ventilation exhaust systems from their original usage.

Storage of fuel rod hulls and hardware could be readily accommodated with this concept. They could be stored in a canyon. Alternatively, the hulls could be compacted and encapsulated in a steel container of the same approximate size as the canisters used for solidified high-level waste, and stored with the high-level waste at the RSSF.

Conceptual Incinerator - An incinerator to reduce combustible volumes is assumed to be built and operated at the site for either of the concepts as discussed above. Since the incinerator has not yet been designed, a staff concept for the facility is presented here, with only those features described to assure safe operation and protection of public health and safety. The concept is based on the philosophy that the receipt and inspection of packages, the handling, the incineration and other operations would be performed in a facility with all the enclosures and multiple confinement and ventilation barriers inherent in any plutonium handling facility.

The building for the facility would be designed to withstand natural forces such as tornadoes, earthquakes and floods. A receiving area would contain a crane and other equipment for handling drums or other packages containing plutonium-contaminated combustible material and appropriate enclosures for examination and sorting of waste materials. The package would be opened in an enclosure to prevent spread of radioactive material and any non-combustible material would be removed and repackaged. The combustible material would be loosely placed in combustible bags, cartons or other packages and inserted through an air-lock into the combustion chamber of the incinerator. Packages containing non-combustible material would be removed from the area, and after examination for external contamination would be transferred to the retrievable storage area. The empty drum or other non-combustible package in which the waste was received would be resealed, checked for external contamination, and returned to the shipper for reuse.

The incinerator would be housed in an enclosure with viewing windows, gloved ports, and access panels for operation and maintenance. A control panel for control of the unit would be external to the enclosure. The incinerator system would be designed with a capacity to handle all combustible materials anticipated for receipt in the year 1990 with provision for expansion and/or the addition of parallel units as necessary to process increasing loads as they are required. Provision would be made for removal and packaging of ash for transfer to recover any usable plutonium values and then to long term storage at the retrievable storage facility. Provision would also be made for periodic clean-out of the combustion chamber.

Off-gases from the combustion chamber will pass through separators to remove gross particles, through scrubbers to remove noxious gases (fluorides, chlorides, SO_x, NO_x, etc.), through a series of HEPA filters for final clean-up of particulates and to a stack for discharge. Provision will be made for conversion of scrubber solutions to solids for storage. Building ventilation air will flow from non-contaminated areas through progressively more contaminated areas and through a filter system to the discharge stack.

Environmental Considerations of Storage of Transuranic Waste - The environmental effects of construction of the covered pad facility are noise and dust generated during excavation for the pad. Formation of the asphalt pad would produce small effects similar to those encountered in highway construction.

Extending the RSSF to store alpha wastes would have a marginal effect on construction of the facility.

The major impact of normal operation of the covered pad facility would be noise and dust generated in covering the stored packages. Operation of an alpha waste repository in conjunction with the RSSF would require a slight increase in power use for handling the drums to be stored, and for the operation of ventilation equipment.

The various forms of plutonium and other transuranium materials to be expected in most of the waste under discussion emit primarily non-penetrating radiation. The relatively low levels of the latter permit routine operations at the covered storage pad at NRTS (vehicle unloading, container inspection and stacking, installation of covering materials) to be carried out using conventional materials handling equipment and with the resultant exposures to personnel well within the occupational standards. Special handling procedures would be required if hulls were to be emplaced in the covered pad. The intensity of penetrating radiation through the earth side walls and top cover layer would be infinitesimally small at any point of public access. If stored at the RSSF most of the commercial plutonium waste would not require heat removal or shielding of penetrating radiation, and the component requiring shielding (hulls) could be handled quite comparably to the solidified encapsulated high-level waste. Similar contamination confinement and exhaust ventilation filtration would be provided for both portions of the RSSF.

Under normal operation it is estimated that the releases from the stack of the incinerator would be about 6 microgram of plutonium per year, assuming the annual throughput through the incinerator would be approximately 100 kilogram of plutonium in combustible wastes. The annual 50-year bone committment of an individual residing full time at a distance of 400 meters from a 23 foot stack would be less than 0.5 mrem for plutonium resulting from recycle operation. For the reference AEC sites, at which the nearest normal public access is at least 5 miles from the stack, the dose would be at least a factor of 10 less. The annual 50-year committment to other organs of the body, including whole body, would be less than the bone committment by a factor of 50 to 100. Exposures from non-recycle plutonium would be less than these values by a factor of about 2.

In 1990, about 30,000 drums (200,000 cubic feet) of plutonium-contaminated waste (excluding hulls) would be generated. Development of volume reduction methods may reduce this volume by a factor of 5-10. Based on the 30,000 drums, 1 to 1.5 acres of covered pad facility would be required in 1990. One estimate[7] is about 3 million cubic feet (400,000 drums) of commercially generated plutonium-contaminated wastes would be accumulated through 1990, requiring a pad of roughly 6 acres.

Using the estimates of waste generation summarized above, accumulated storage of plutonium-contaminated waste through 1990 would require about 1.7 typical storage modules of 200 by 800 feet located at the RSSF site. Requirements for 1990 generated waste would be about 1/4 storage module.

The above requirements are estimates based on plutonium recycle. Since alpha wastes produced at the reprocessing plants without recycle are 85 to 90 percent of those produced with recycle, and there would be no waste from mixed oxide plants if plutonium is not recycled, the requirements without recycle are about 70 percent of those estimated above. Another way of making the comparison is to note that plutonium recycle will result in the order of a 50 percent increase in the quantity of plutonium-contaminated wastes to be stored.

In either of the concepts considered here, air monitoring would be routine. Visible effects would be sample stations located at strategic points both on and off the AEC reservation, and appropriate sampling towers. Packages will be monitored for external contamination, radiation and inadvertent receipt of large quantities of plutonium prior to emplacement in the facility.

The facilities would be designed to avoid inadvertent release of radioactivity to ground waters. Nevertheless, ground water sampling will be performed to routinely check for possible radioactive releases.

Environmental Effects of Accidents at Transuranic Waste Storage Facilities - The most probable accident that might occur at an alpha waste storage facility would be the accidental opening of a drum after removal from the shipping container (overpack) and prior to placing the drum in storage. Contamination, if any, resulting from such incidents would normally be confined to the immediate vicinity. Most of the contents of a package would be readily identifiable, and could be picked up and repackaged without spread of contamination. The area would be surveyed, and any contamination removed. If the accidental opening were to occur over uncovered soil, it could be necessary to remove the top inch or so of soil and package it in drums which could then be stored in the repository. If the accident occurred on the asphalt pad or on the floor of a storage building at the RSSF, the contaminated surface could be removed and similarly packaged for storage.

If an accidentally opened package had not been packaged in accordance with regulations, it is possible, although of low probability, that a few grams of dust might be widely dispersed.

Assuming that as much as 100 grams of waste containing 50 micrograms of recycle plutonium per gram of waste were dispersed uniformly over an area of 1 acre, the average deposition would be about 0.1 microgram per square foot, equivalent to 0.08 alpha nanocuries per square centimeter or 1.5 total nanocuries (including beta curies from ^{241}Pu) per square centimeter. The 50-year dose commitment to an individual (a worker) standing for 10 minutes in this area at the time of the incident would be about 15 rem to the bone, and about 0.5 to 2 rem to the whole body, lung, liver and kidney. These exposures may be compared with the reference limit of 25 rem considered in evaluating site criteria for reactor accidents as described in 10 CFR Part 100. Exposure from non-recycle plutonium would be roughly one-half these doses. Since the reference repository site will be in a remote desert region (the reservation boundary 5 miles or more from the site), fall out of particles would be essentially complete before reaching the reservation boundary and the impact to the general population would be negligible. The area could be decontaminated by removing the top layer of soil and packaging it for storage.

The most serious credible accident at the incinerator facility would be a fire or explosion in the receiving enclosure. Fire suppression equipment would be expected to extinguish a fire quickly. Emergency manual fire extinguishing capability would prohibit a fire continuing for more than a few minutes. Since the enclosure air would be ventilated through a filter system plutonium release would be negligible, i.e., less than 1 microgram of plutonium. If the enclosure walls were penetrated and the filter system by-passed, conceivably 1 milligram of plutonium could be released. An individual 400 meters distant could receive under these condition a 50 year bone committment approaching 100 mrem. A member of the public at the reservation boundary (5 miles away at the reference sites) might receive a 50-year bone commitment of less than 5 mrem.

A nuclear criticality accident at the facility is extremely improbable. The density of plutonium in storage containers would be too low to permit assembly of a critical array. If a nuclear incident were to occur, it would have its greatest, although low probability, in connection with the incinerator. For the purposes of this statement it was assumed that the incinerator would be constructed of ceramic materials which would include neutron absorbers, e.g., boron. Plutonium density would normally be of low concentration in the ash, and flooding of the combustion chamber would be a necessary condition for criticality, even if sufficient plutonium were available for criticality. The only possibility for aqueous solution to flood the chamber would be a suck-back from the scrubber, and this would first have to flood particulate separators. Further, monitoring and operating procedures would be established to prevent the inadvertent accumulation of a critical mass in the combustion chamber.

G-59

Description of

EBR II Interim Underground Storage Area

High-Level-Activity Solid Wastes

These wastes, particularly those consisting of irradiated hardware and components of subassemblies that had been removed from the reactor, are sealed in steel cans and placed in the underground storage area at EBR-II. This is not properly a burial ground, since, if in the future it should become desirable to do so, it is possible to retrieve any individual can of scrap or waste; therefore, it is termed an "Interim Underground Storage Area." The following is a brief description of how these wastes have been handled.

The solid wastes consist of the following: stainless-steel scrap materials from the dismantling of the EBR-II fuel and blanket subassemblies; stainless-steel cladding scrap from the decanning of the fuel elements; used process materials from the fuel reprocessing step (zirconium oxide crucibles, fume traps, and graphite molds) and from the fuel refabrication step (graphite crucibles); and, discarded equipment items.

Some of the axial blanket elements obtained from the subassemblies contain depleted uranium, and the plutonium content of these blanket pins will be very low due to their relatively short irradiation time in the reactor. Therefore, these blanket elements are buried rather than sent to a plutonium recovery plant.

The equipment at the FCF for handling the wastes consists of the following: small waste container pails 10 in., 12 in., or 24 in. high by 10-1/4 in. inside diameter; a 6-ft high by 11 in. inside diameter waste container; many in-cell tools for handling and capping the waste

containers; and a waste handling coffin and trailer. The waste containers have crimp-on, lug-type lids with gaskets. Figure 4 shows the four sizes of waste containers. The three smaller containers fit inside of the 6-ft high can.

Figure 5 shows the insertion of a small waste pail into the 6-ft high can and the tool for remotely capping the cans.

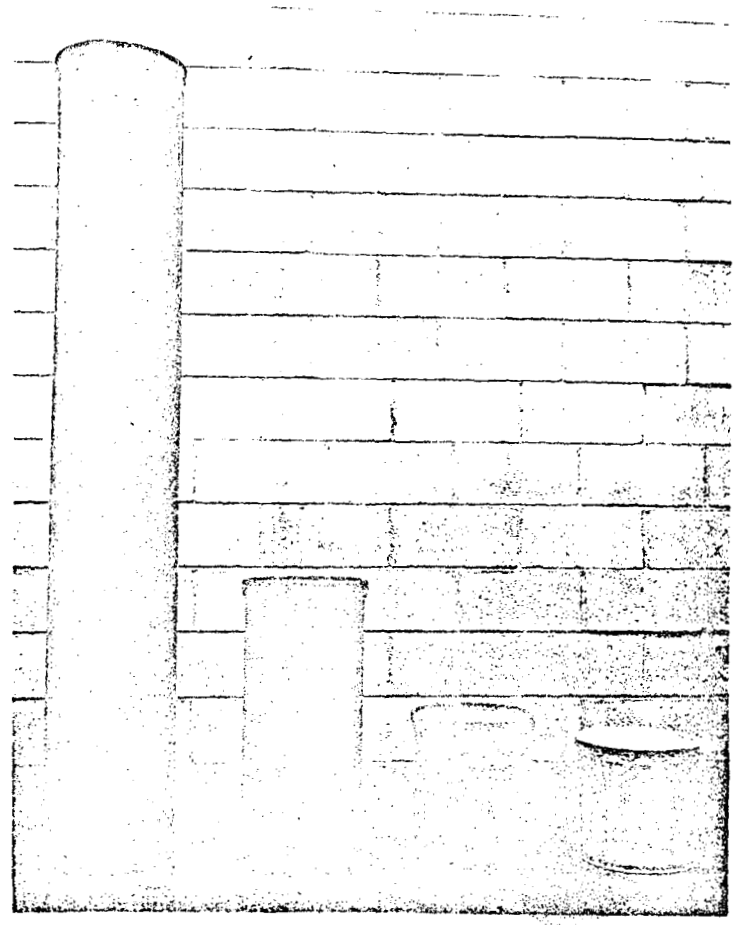
The 6-ft high waste cans are also used to accept the fuel subassembly hardware and blanket elements for burial disposal. These items range in length from 24 to 70 in.

The 6-ft high waste cans are used for transport of all waste pails to the burial ground. They are capped in the Air Cell and transferred one at a time to a waste handling coffin (Fig. 6). This coffin is a top-loading, bottom-dumping, vertical, shielded cylindrical container for handling one of the 6-ft high waste cans. The coffin provides 8-3/4 in. of lead shielding and has top and bottom shielding doors which are rolled out for the loading and unloading operations.

To transport the waste handling coffin from the FCF to the burial ground, a special lowboy trailer was built (Fig. 7). The trailer allows the coffin to be positioned over the burial hole for dumping, and the waste container to be dumped with a minimum amount of radiation hazard (Fig. 8). The trailer has a hydraulic system, with its own gasoline engine for operation, capable of leveling the trailer, manipulating the waste coffin to a desired height, and for lateral (up to 6-in.) adjustment. The trailer has a gravel hopper to back-fill the waste burial hole for shielding.

Burial Facility

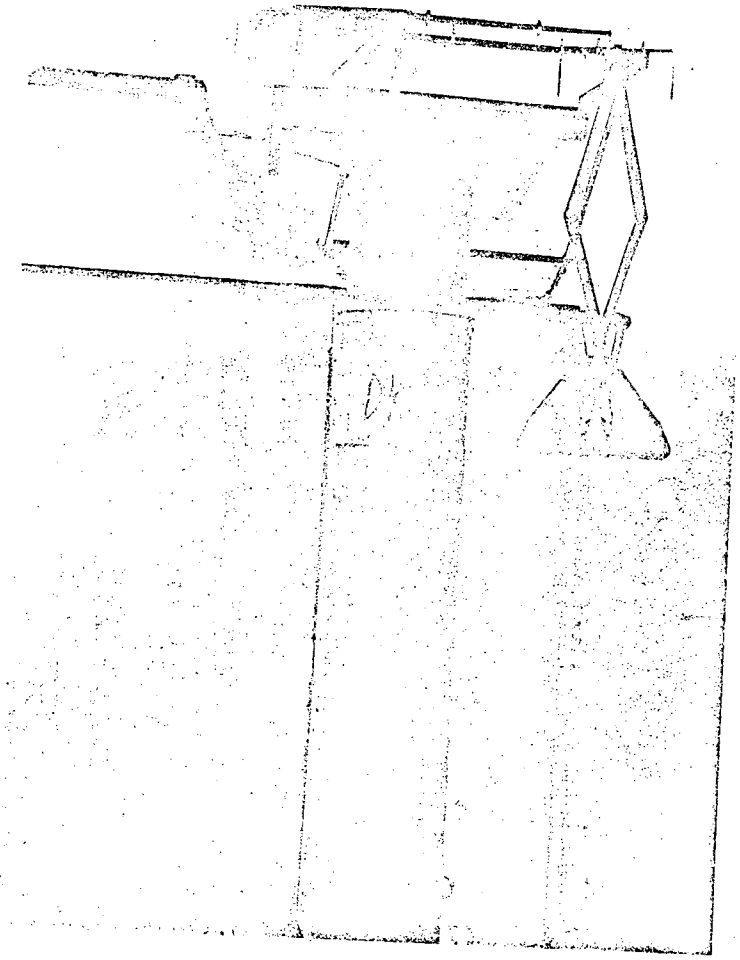
The waste burial facility is a controlled access, fenced area approximately one-half mile from the EBR-II complex. The area was selected and built up by banking the earth to a level several feet above the original



ANL Photo No. 103-H5112

Fig. 4

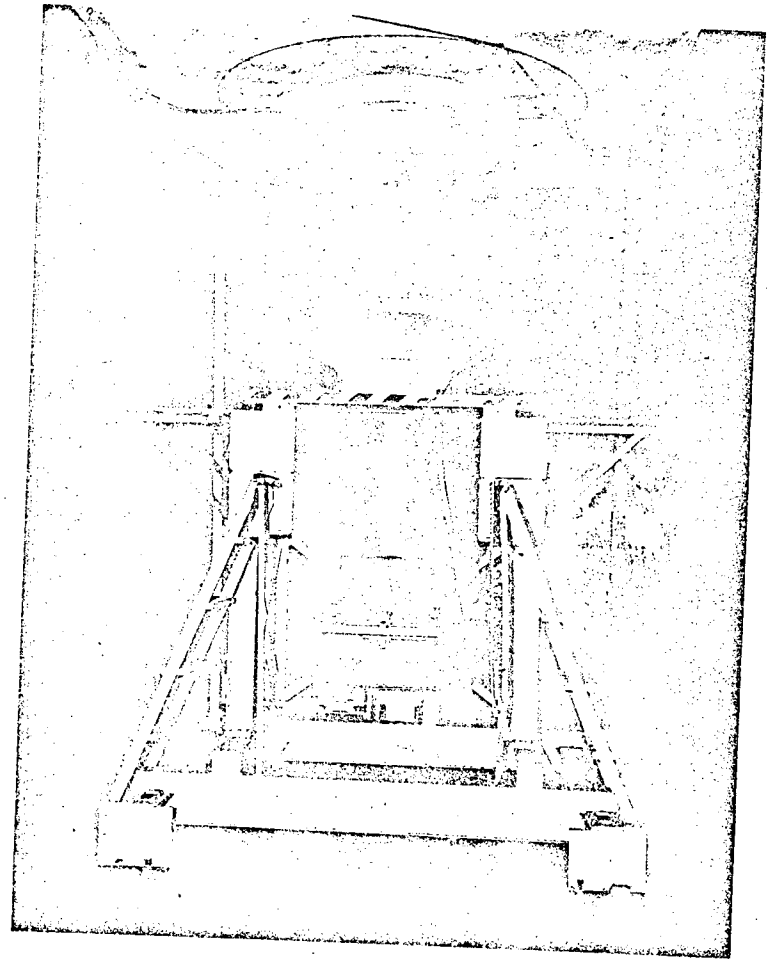
Four sizes of steel containers used for packaging of Fuel Cycle Facility solid wastes. The filled containers or pails are remotely capped (gasketed lug-lid) and closed.



ANL Photo No. 103-H5441

Fig. 5

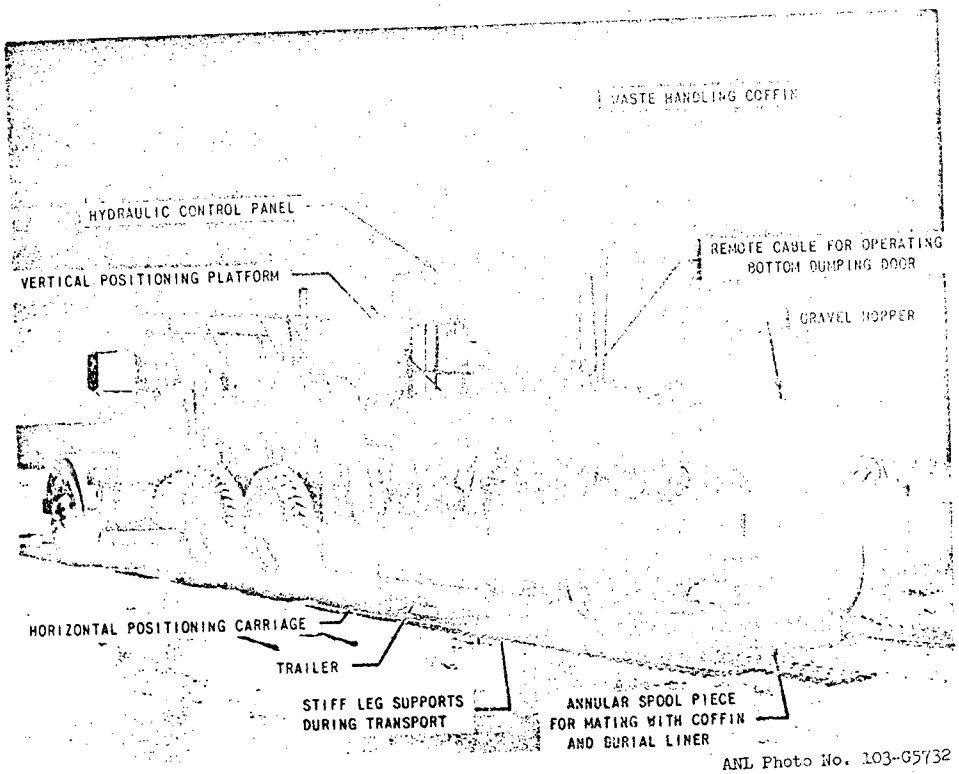
A small capped pail is shown ready for insertion into a 6' high container. The remotely operated crimping tool hanging at the right of the container, closes the lugs on the container lid.



ANL Photo No. 103-I5557

Fig. 6

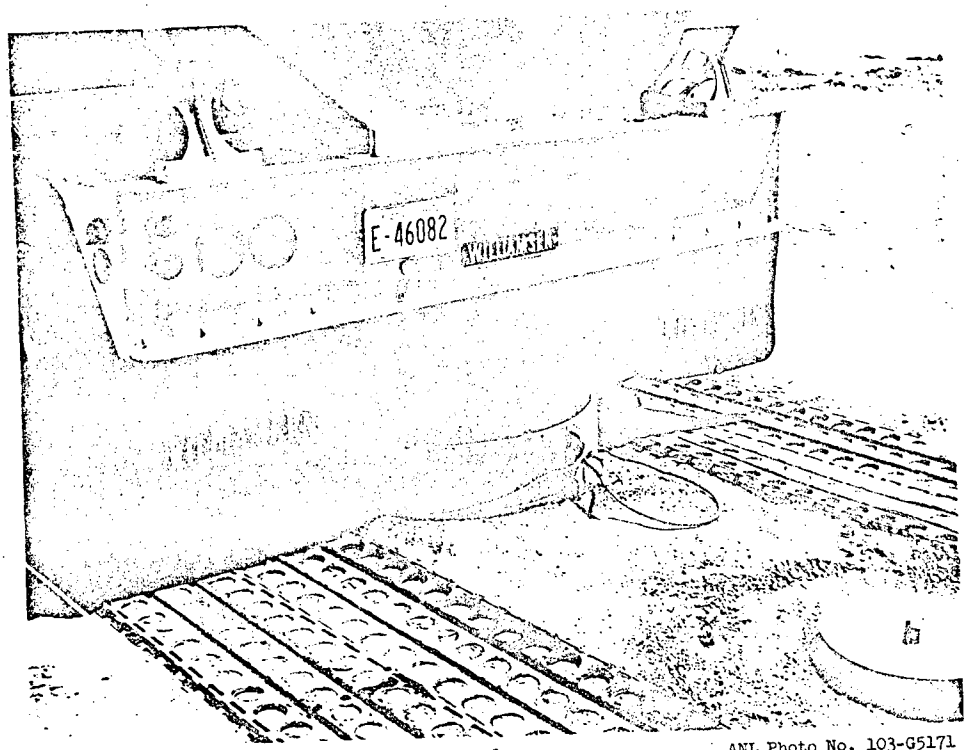
Waste-handling coffin is in loading position on passageway cart beneath penetration in air cell floor. Individual capped, 6' high containers are transferred out of the air cell into the coffin through this floor penetration.



ANL Photo No. 103-G5732

Fig. 7

Waste-handling coffin is shown on specially constructed lowboy trailer. The gravel hopper at back end of trailer, is located over annular shielded spool piece and lined burial hole.



ANL Photo No. 103-G5171

Fig. 8

Closeup view of lowboy trailer positioned over annular shielded spool piece and lined burial hole into which a capped 6' high container has been discharged, and gravel (from hopper on trailer) has been added to serve both as backfill and shielding for the burial hole. At lower right fore-

ground level to eliminate chances of flooding by surface runoff under any foreseeable conditions.

The area hydrology is such that the surface of much of the area is covered by waterborne and windborne top soil, under which there is a considerable depth of gravel, ranging in size from fine sand to 3 in. in diameter. At the several locations inspected to date, the gravel lies from approximately 1 ft to 50 ft under the top soil. Lava rock extends below this gravel layer and downward to a considerable depth, ranging at least to the water table. The lava rock is honey-combed with openings of about 1/8 in. in diameter. Frequently, large openings occur, and these range upwards to the size of tunnels, tubes, and caves.

Test borings were made within the burial ground area indicating that the depth of regolith varies from 11.8 ft to 23.6 ft, with an average depth of approximately 15 ft.

During foundation investigations of the EBR-II site, test borings were made to depths ranging from 6 ft to 90 ft. Ground water was not encountered in any of these exploratory borings. At the burial site, the water table is in excess of 600 ft below grade and the mean annual rainfall is less than 7 in., so that leaching by ground water is not considered a potential hazard. Since only solid wastes will be buried in the burial ground, the release of radioactivity to ground water could occur only during extremely unlikely major flooding of the area, and the leakage, rupture or failure of one of the steel liners. Even under such conditions, the contaminated water would have to percolate through the over 600-ft thick dirt layer and lava substrata before reaching ground water. Naturally occuring earth materials from localities near the National Reactor Testing Station have shown good ability to remove radioisotopes from solution.

It is assumed that all wastes will still be radioactive at the end

of five years, and therefore, high-integrity burial hole liners are used. If in the future it should become desirable to do so, these liners (complete with contained wastes) could be removed for burial elsewhere.

The burial site utilizes post-hole burial with a steel liner. The steel liners are fabricated of schedule 10 pipe (12 ft 4 in. long, 16 in. outside diameter with 1/4-in. thick wall); they are welded closed at the bottom end and provided with a top closure plate. The top plate is welded on after the 6-ft waste can has been deposited in the liner and has been covered with gravel to provide shielding. Temporary covers are present on each liner to prevent water from filling the steel liner prior to welding the permanent top closure plate. The holes are located on 6-ft centers at a distance of 12 ft between rows.

A shielded annular spool piece, used to enable the coffin to dump its waste without touching the ground, is maintained at the site and positioned over the hole designated for the next burial. Figures 7 and 8 show the coffin and trailer rig with the gravel hopper positioned over the annular spool piece and burial hole.

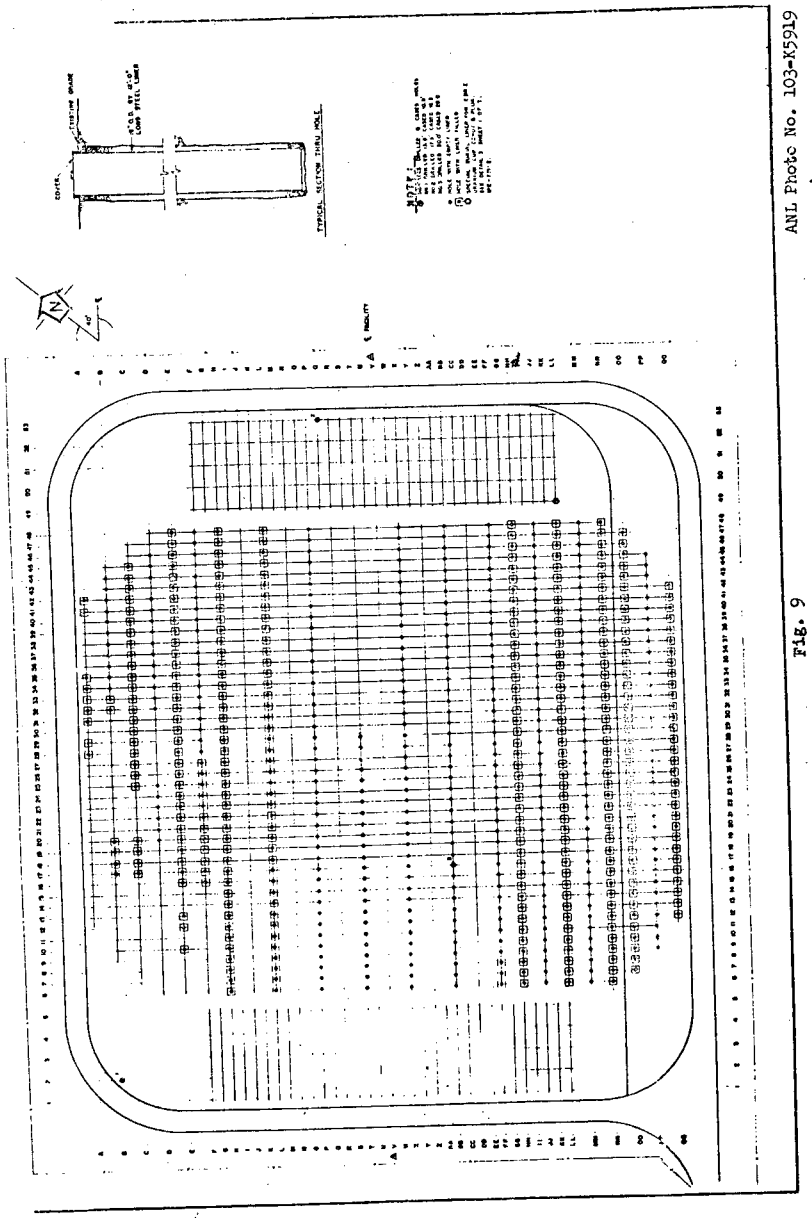
Figure 9 shows a sketch of a burial ground and steel liner.

Prior to the burial, the steel liner is checked to ascertain that the interior is dry because of the deleterious effect water might have on the waste containers and steel liner interior.

The actual dumping operation is carried out from the trailer hydraulic panel console by a remote door-opening cable device.

The average time required for a burial is about one hour from picking up the waste handling coffin with its waste can, driving to the burial ground, dropping the waste can into the burial hole, filling the remainder of the hole with gravel and returning the empty coffin to the FCF.

The Health Physics section has the responsibility of approving entry



ANL Photo No. 103-K5919

Fig. 9 Plan of waste burial facility, which is a controlled-access, fenced area. (410' x 370') Lined burial holes are located on 6' centers at a distance of 12' between rows. Burial holes used to date are shown.

to the burial ground, providing constant radiation monitoring protection functions during the burial operation, designating the hole location for each burial, maintaining official logs and records of the burial ground operations as necessary, and testing holes in the burial ground periodically for water seepage.

All waste containers, empty and full, are logged in and out of the process cells. Their whereabouts are also recorded at all times. The contents of each can is clearly recorded, and great care is exercised in the handling of waste materials that may contain significant quantities of iodine-131.

Inasmuch as iodine-131, which is trapped on the fume traps and melt-refining crucibles during reprocessing in the Argon Cell, may react with air or vaporize and thus allow the iodine-131 to be released to the atmosphere, all waste cans containing fume traps or crucibles from fresh irradiated-fuel-reprocessing runs are held in the Argon Cell for a minimum of 90 days after the date of completion of the reactor irradiation of the fuel used in the reprocessing runs, to allow sufficient decay of the iodine-131.

Occasionally, during operations, minor quantities of enriched uranium are obtained in a form not economically recoverable and are therefore included with the waste items which are scheduled for burial.

The cans containing stainless steel scrap vary in weight from 18 kg to 159 kg with an estimated activity level of from 1,500 to 58,000 curies and their radiation levels were estimated to be 95 to 200,000 R/hr at 1 ft (based on measurements at the top of the cask with the plug open and at the burial ground just prior to the gravel back-fill, then compared with previous calibration data obtained from measurements in a hot cell).

The containers filled with the processing scrap from the Argon Cell

averaged about 55 kg each and had an estimated activity content of 1,000 to 25,000 Ci each. The radiation levels of these waste cans were estimated to be 50 to 900,000 R/hr at 1 ft in air. These wide ranges of curie amounts and radiation levels are the result of the wide range of burnup levels (0.1 to 1.2 a/o) of the fuel which was sent to the FCF for processing.

At the time of burial, the cooling time for the isotopic wastes varied from 20 days to 90 days with isotope half-lives ranging from 8 days to 28 years.

Radiation measurements, taken at the burial ground after the disposal was made and the gravel shielding back-fill was placed, were less than 1 mR/hr at 6 in. from the top of the liner.

Comment Letter No. 52

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMO

NORMAN B. LIVERMORE, JR.
SECRETARY

Department of Conservation
Department of Fish and Game
Department of Navigation and Ocean Development
Department of Parks and Recreation
Department of Water Resources

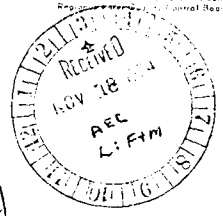
RONALD REAGAN
GOVERNOR OF
CALIFORNIA

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

Air Resources Board
Colorado River Board
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Lands Commission
State Reclamation Board
State Water Resources Control Board
Regional Water Quality Control Boards

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

NOV 13 1974



Mr. H. S. Smiley
Deputy Director for Fuels
and Materials
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

The State of California has reviewed the draft "Generic Environmental Statement -- Mixed Oxide Fuel (GESMO)" Volumes 1, 2, 3, and 4, dated August 1974, which was submitted to the Office of Planning and Research (State Clearinghouse) within the Governor's Office. This review fulfills the requirements under Part II of the U. S. Office of Management and Budget Circular A-95.

State agencies participating in the review were the Departments of Commerce, Conservation, Fish and Game, Food and Agriculture, Health, Navigation and Ocean Development, Parks and Recreation, Transportation, and Water Resources; Air Resources Board; California Coastal Zone Conservation Commission; and State Water Resources Control Board.

We do not have any comments on the draft statement. Thank you for the opportunity to review and comment upon the report.

Sincerely yours,

N. B. LIVERMORE, JR.
Secretary for Resources

By Paul L. Clifton

Air Mail
cc: Director of Management Systems
State Clearinghouse
1400 Tenth Street
Sacramento, California 95814 (SCH No. 74090920)

NORMAN B. LIVERMORE, JR.
SECRETARY

Department of Conservation
Department of Fish and Game
Department of Navigation and Ocean Development
Department of Parks and Recreation
Department of Water Resources

RONALD REAGAN
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THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

NOV 13 1974

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Secretary for Resources

By Paul L. Clifton

Air Mail
cc: Director of Management Systems
State Clearinghouse
1400 Tenth Street
Sacramento, California 95814 (SCH No. 74090920)

Comment Letter No. 53

DOCKET NUMBER
PROPOSED RULE PR. Misc Notice (39 FR 30186)
GESMD

RONALD W. PEDERSEN
FIRST DEPUTY COMMISSIONER

STATE OF NEW YORK
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
ALBANY

RECEIVED
NOV 18 1974
AEC
L: F+M

November 13, 1974

Dear Mr. Smiley:

The State of New York has completed its review of the "Draft Generic Environmental Statement on Mixed Oxide Fuel" by the Directorate of Licensing, United States Atomic Energy Commission.

In preparing the attached comments, we have taken into consideration the views of all appropriate State agencies including the New York State Atomic Energy Council. Many of the comments are detailed and directed to the specific points in the document with the intent of assisting the Commission in preparing the final statement.

It is felt that the environmental effects of reprocessing spent fuel have been underestimated in the GESMO report. The operation of the Nuclear Fuel Services reprocessing plant in New York State has resulted in discharges of radioactivity to Buttermilk Creek, the on-site creek, far in excess of the <0.1% of 10CFR20 limits referred to in the report.

The final statement should provide corrected environmental effects and additional economic details to allow a more accurate comparison of Alternative No. 2 (store spent fuel for later recovery of uranium and plutonium) with Alternative No. 4 (reprocessing spent fuel promptly, recycle plutonium in LWR's using upgraded safeguards program).

The attached comments are illustrative of our concerns and we request that they be given your utmost consideration. Thank you for the opportunity to review and comment upon this document.

Sincerely,

Enclosure

Mr. S. H. Smiley
Deputy Director for Fuels and Materials
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D. C. 20545

DOCKETED
USAEC
DEC 4 1974

State of New York
Comments on the
U.S. Atomic Energy Commission, August 1974,
Draft Generic Environmental Statement
Mixed Oxide Fuel (GESMO)

1) General Comment -- The radiological effluents at reprocessing plants cause the largest dose commitment from the nuclear fuel cycle to the offsite public. The report does not evaluate the reduction in exposure to radiation workers which can be accomplished by storage rather than reprocessing. Reduction of exposure to the public and radiation workers is in keeping with the "as low as practicable" philosophy.

2) General Comment -- The various alternates proposed consider the economic aspects of the nuclear industry as a whole. While overall, nuclear power may provide the lowest cost for power, the fuel reprocessing segment of the fuel cycle appears to have marginal economic basis. The economic aspects of this phase should be discussed separately and in more detail.

3) General Comment -- The impact of various incidents and accidents treated throughout the Generic Environmental Statement should be reconsidered using the probability values offered for such occurrences in the recent Rasmussen report. The development of another analysis using the probability values of this report may result in significantly different estimates of the potential impact of such occurrences.

4) P. S-10, the statement is made "Alternatives 2 and 6, which respectively, store spent fuel either temporarily or permanently require the maximum needs for natural resources, separative work and cost of materials and services, while decreasing radiological exposure and potential safeguards threats. Requirements for Alternatives 2 and 6 over the base case through 1955 (sic) are projected to be 195,000 tons of virgin U_3O_8. They would also, in effect, eliminate the reprocessing industry. The energy equivalent of these added requirements is 15 billion barrels of oil or 3 billion tons of coal." It is not shown how deferred reprocessing (stock piling of spent fuel for 40 years) is equivalent to permanent disposal. The deferred reprocessing would have the energy reserves available if their need is essential.

5) A statement on page S-11 reads "If plutonium were not recycled, it is conceivable that spent fuel would not be processed since the cost of reprocessing exceeds the current uranium values." This statement should be developed to include an appropriate analysis of light water fuel costs with and without credit being taken for the value of plutonium. The utility industry, in evaluating nuclear power costs at the bus bar,

usually includes some credit for the recovery of plutonium. The impact of not being able to recover plutonium for plutonium recycle or use in the breeder at some future date because of the delay of reprocessing facilities should be addressed more fully in alternatives 1, 3 and 4.

6) P. S-14, the statement is made "Plutonium recycle defers the time when new uranium enrichment capability will be needed, thus allowing additional time for new technology to be developed." The slippage in new plants coming on line and the decrease in predicted electrical demand may defer the time when new uranium enrichment will be needed. The report should discuss the urgency of the need for expanded enrichment capacity in more detail. It should also discuss whether and to what extent improved enrichment technology may eliminate or make uneconomical plutonium recycle.

7) P. S-14, the statement is made "Recovery and recycle of uranium are not now economically feasible unless plutonium is also recycled, since the cost of recovery exceeds the value of uranium." If plutonium is recycled, it is conceivable that spent uranium would not be. The report should determine whether plutonium recycle would be economically advantageous if spent uranium is not recycled.

8) P. S-28, the statement is made that "plutonium recycle in LWR's would eliminate the need for extensive plutonium storage facilities." Table S-6 indicates that the plutonium recycle fuel would create an additional 91,000 curies of alpha emitting actinides with an appreciable increase in americium-241 and curium. Thus plutonium storage may decrease but storage facilities will be required and perhaps increased for the additional actinides.

9) A statement on page S-37 is made that "the overall accident analysis source terms for model SCR reactors represent no significant change in exposure relative to UO_2 fueled LWR's." An increase in the thyroid dose source term of 10 to 14% is not considered to be insignificant.

10) P. IV C-66, Table IV C-6 includes ^{234}U and ^{236}U in reload fuel assemblies that in sum are greater than 10% of the ^{235}U. The source of these radionuclides should be clarified as ORNL 4451 dated July 1971 indicates charged fuel does not contain ^{234}U and ^{236}U.

11) In the accident analysis source terms section on page IVC-115, the information is given that the iodine thyroid source term may exhibit a 14% increase for plutonium recycle over uranium oxide cores with an average increase of 10% for the iodine thyroid dose source terms. However on page S-37, the accident analysis section indicates only an 8% increase in the thyroid dose source term. This apparent discrepancy should be rectified.

12) The Health Department, which has lead responsibility in emergency planning in New York State, notes that it would appear from the calculations of radiological consequences of postulated accidents found in Tables IVC-40 and IVJ-16 that elaborate offsite radiological response plans will not be required for LWR's whether or not plutonium recycle fuel is utilized. The maximum individual whole body dose at site boundary for all postulated accidents is 900 millirems for a large break, loss of coolant accident at a PWR and 29 millirems for a BWR.

13) P. IV E-5, the statement is made "At present it is planned that recovered uranium will be recycled to the reactor after re-enrichment in gaseous diffusion plant. Recovery of fissile material from spent fuel elements is economically advantageous if fissile material can be recycled." The ^{235}U content of high burnup fuel is about the same as virgin uranium. However, there is also considerable ^{234}U and ^{236}U as shown in Table IV C-7, p. IV C-67. The fission product content of separated uranium is not reported. The report should discuss the difficulties, if any, of re-enriching separated uranium. A discussion of what has been done with separated uranium to date should also be included.

14) Table IV E-3 lists the number of nuclear fuel reprocessing plants contemplated to be available in the United States through the year 2000. It is understood that the Midwest Fuel Recovery Plant, listed to be operational soon, may be abandoned by the General Electric Company for other than storage of spent fuel. The report should be updated to reflect this status.

15) P. IV E-9, Table IV E-5 lists the liquid wastes from NFS (the only reprocessing plant with operating experience) as follows: Tritium and ^{106}Ru controlled releases to creek; other isotopes <0.1% of 10CFR20 in on-site waters.

Comments on GESMO

In the new Safety Analysis Report for the expanded facility the applicant has requested (proposed tech specs p. V 1-16 SAR) permission for 10% of 10CFR20 at Cattaraugus Creek. In on-site waters the levels have exceeded 10CFR20 limits. It appears the radiological releases as a result of reprocessing at Nuclear Fuel Services have been grossly underestimated in this report.

16) P. XI-13, Table XI-6 gives the difference in fuel cost for various alternates considered. The largest difference of 0.5 mills in the various alternates is about 13% in fuel cost. However, fuel cost in the range of 3 to 4 mills is only a small part of generating cost for nuclear power. Jamesport Nuclear Plant projects generating cost of about 22 mills per kilowatt hour. The difference in various fuel alternates is only about 2% when generating cost are considered.

The difference in cost to consumer would probably be less than 1% for the various alternates considered if the generating, transmission and distribution costs are considered. This savings in cost may not justify the potential hazards of diversion or increased exposure to effluents from reprocessing.

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By R.W. Pedersen, State of N. Y.

1. Comment:

"It is felt that the environmental effects of reprocessing spent fuel have been underestimated in the GESMO report. The operation of the Nuclear Fuel Services reprocessing plant in New York State has resulted in discharges of radioactivity to Buttermilk Creek, the onsite creek, far in excess of the <0.1% of 10 CFR 20 limits referred to the report."

Response:

Past operating experience in one plant is not necessarily typical to the expected overall performance of other plants, which will differ significantly in the design and the types of installed effluent treatment systems. The NFS plant operated within the technical specifications of its license. The technical specifications, however, granted NFS an exemption under 10 CFR part 20.10(6) with respect to concentrations of radioactivity in Buttermilk Creek. In this regard, NFS made reasonable efforts to minimize the radioactivity contained in its effluents. Moreover, it is not likely that the radioactivity discharged to Buttermilk Creek resulted in the exposure of any individual to concentrations of radioactivity exceeding the limits specified in Appendix "B", Table 11, of 10 CFR Part 20. These and other factors are included in the NFS application for modification and plant expansion which is now being reviewed by NRC for complaiance with latest regulatory requirements.

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2. Comment:

"The radiological effluents at reprocessing plants cause the largest dose commitment from the nuclear fuel cycle to the offsite public. The report does not evaluate the reduction in exposure to radiation workers which can be accomplished by storage rather than reprocessing. Reduction of exposure to the public and radiation workers is in keeping with the 'as low as practicable' philosophy."

Response:

This revised final GESMO more clearly shows the changes in environmental effects and economics that might occur in relation to alternative assumptions regarding the prospective growth of the fuel cycle, including the disposal of spent fuel rather than reprocessing. Note that the reduction in exposure to workers and the reduction in dose commitments to the general public, related to no recycle versus the recovery of uranium and plutonium from spent fuel, are offset by environmental impacts associated with increased mining and milling operations, and the economics, related to the expenditure of valuable natural resources that could be conserved by reprocessing the spent fuel. For environmental and economics differentials of the three fuel cycle options (no recycle, recycle of uranium only, and uranium and plutonium recycle), see CHAPTERS VIII and XI.

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3. Comment:

"The various alternates proposed consider the economics aspects of the nuclear industry as a whole. While overall, nuclear power may provide the lowest cost for power, the fuel reprocessing segment of the fuel cycle appears to have marginal economic basis. The economic aspects of this phrase should be discussed separately and in more detail."

Response:

The GESMO mission is to assess the differential environmental and economic impacts due to the implementation of plutonium recycle. Alternative sources of power to nuclear energy are treated in other documents. The alternatives reviewed in final GESMO relate to the timing of Pu recycle with sensitivity analyses made to evaluate delays and impacts over a 26-year period through the year 2000. Comparisons are made between no recycle, recycle of uranium only, and recycle of uranium and plutonium. Refer to CHAPTERS VIII and XI.

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4. Comments:

"The impact of various incidents and accidents treated throughout the Generic Environmental Statement should be reconsidered using the probablity values offered for such occurrences in the recent Rasmussen report. The development of another analysis using the probability values of this report may result in significantly different estimates of the potential impact of such occurances."

Response:

The probability values used in the Rasmussen Report were developed specifically for a narrow application -- very severe type accidents that might occur in reactors. The treatment of accidents in a reactor loaded with MOX fuel is covered in CHAPTER IV, Section C, which states that, from an accidents standpoint in LWR's, the use of MOX fuel is no different than the use of UO_2 fuels. Studies similar to the Rasmussen report for fuel cycle facilities are being considered by the NRC. However, it is anticipated that the results of such studies will confirm the present methods of accident analyses, which are based on experience and engineering analyses of specific facilities.

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5. Comment:

"P. S-10. The statement is made 'Alternatives 2 and 6, which respectively store spent fuel either temporarily or permanently, require the maximum needs for natural resources, separative work, and cost of materials and services, while decreasing radiological exposure and potential safeguards threats. Requirements for Alternatives 2 and 6 over the base case through 1955 (sic) are projected to be 195,000 tons of virgin $U_3 O_8$. They would also, in effect, eliminate the reprocessing industry. The energy equivalent of these added requirements is 15 billion barrels of oil or 3 billion tons of coal.' It is not shown how deferred reprocessing (stockpiling of spent fuel for 40 years) is equivalent to permanent disposal. The deferred reprocessing would have the energy reserves available if their need is essential."

Response:

In final GESMO in CHAPTER XI, a full review is made of plutonium values for prompt Pu recycle vs delayed recycle. Alternative 2 considers that reprocessing would be delayed until some later date when plutonium values would be realized. Alternative 6 considers the spent fuel as high level waste that would be placed in permanent storage/disposal in a Federal geologic repository.

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6. Comment:

"A statement on page S-11 reads, 'If plutonium were not recycled, it is conceivable that spent fuel would not be presented since the cost of reprocessing exceeds the current uranium values.' This statement should be developed to include an appropriate analysis of light water fuel costs with and without credit being taken for the value of plutonium. The utility industry, in evaluating nuclear power costs at the bus bar, usually includes some credit for the recovery of plutonium. The impact of not being able to recover plutonium for plutonium recycle or use in the breeder at some future date because of the delay of reprocessing facilities should be addressed more fully in alternatives 1, 3, and 4."

Response:

In final GESMO, a detailed analysis has been made of reprocessing costs, with comparisons to fuel costs, over the full period 1975 through 2000. The basic analysis is for LWR's only with no credits taken for possible use of the recovered plutonium to fuel the early FBR's. In final GESMO Alternative 4, prompt recycle of plutonium in MOX fuels in LWR's, with upgraded safeguards, has been deleted. It is now considered that all safeguards considerations for the handling of strategic special nuclear materials are all to be the same. The safeguards issues are outlined in a draft supplement to the draft GESMO.

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7. Comment:

"P. S-14. The statement is made 'Plutonium recycle defers the time when new uranium enrichment capability will be needed, thus allowing additional time for new technology to be developed.' The slippage in new plants coming on line and the decrease in predicted electrical demand may defer the time when new uranium enrichment will be needed. The report should discuss the urgency of the need for expanded enrichment capacity in more detail. It should also discuss whether and to what extent improved enrichment technology may eliminate or make uneconomical plutonium recycle."

Response:

This statement in the draft GESMO was intended to indicate that the implementation of Pu recycle in 1975 would allow some flexibility in the schedule for the next enrichment plant based on nuclear energy growth projected in WASH-1139 (1974). Since that time, the nuclear energy growth projections have changed and indicate new time schedules for enrichment capacity requirements. A discussion of the urgency for expanded enrichment facilities is not within the scope of the final GESMO.

The objective of final GESMO is to assess the economic and environmental impacts of the various operating modes assuming that the projected industry requirements will be met. There is currently no information available to support the implication that improved enrichment technology would eliminate the need for plutonium recycle or make it uneconomical since the benefit of improved enrichment would be applied to each fuel cycle option and the differential between options could remain constant. The economics of various alternatives are reviewed in detail in CHAPTERS VIII and XI.

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8. Comment:

"P. S-14. The statement is made 'Recovery and recycle of uranium are not now economically feasible unless plutonium is also recycled, since the cost of recovery exceeds the value of uranium.' If plutonium is recycled, it is conceivable that spent uranium would not be. The report should determine whether plutonium recycle would be economically advantageous if spent uranium is not re[illegible].

8 Comment Cont'd

Response:

This statement on the economics of recycled uranium and plutonium values is covered in detail in final GESMO, CHAPTER XI. Included also is an evaluation of the penalties incurred in the ^{236}U build-up in the re-enrichment of recovered uranium. Since the process used for the recovery of plutonium also separates uranium, there would be an inherent advantage in using this uranium for recycle. In final GESMO, comparisons are made for three fuel cycle options: no recycle, recycle of uranium only and recycle of uranium and plutonium. Alternative 5, the recycle of uranium only, is described in CHAPTER VIII. This alternative appears to be the least attractive of all recycle options.

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9. Comment:

"P. S-28, the statement is made that 'plutonium recycle in LWR's would eliminate the need for extensive plutonium storage facilities.' Table S-6 indicates that the plutonium recycle fuel would create and additional 91,000 curies of alpha emitting actinides with an appreciable decrease but storage facilities will be required and perhaps increased for the additional actinides."

Response:

In the spent fuel reprocessing, the uranium and plutonium are separated and recovered from the process stream and the curium and americium remain in the high level waste. The additional nuclides referred to in the draft GESMO, Table S-6, represent less than 1% of the bulk being sent to waste storage tanks and can be readily accomodated without design changes in terms of configuration and size. Some change may be required to accomodate the heat content of the waste due to the nuclides.

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10. Comment:

"A statement on page S-37 is made that 'the overall accident analysis source terms for model SGR reactors represent no significant change in exposure relative to UO_2 fueled LWR's.' An increase in the thyroid dose source item of 10 to 14% is not considered to be insignificant."

Response:

The 10% number in the draft GESMO has been recalculated and found to be 3%. A 3 to 14% increase in the thyroid dose source term is considered insignificant since;

- The change is within the error bands of the basic input data used in the accident dose calculations.
- It does not introduce any new and substantially different requirements for protection against thyroid doses (i.e., engineered safeguards such as filter systems, exclusions boundaries, etc. do not change appreciably due to the predicted increases on the thyroid dose source terms).
- The 14% increase is the highest predicted increase representing only the portion of the mixed oxide fuel within the recycle core loadings. Only a fraction of any one core (i.e. 40% or less) would have the potential for this increase. Thus, on a total core basis, the effect of the increase amounts to only a few percent. Refer to CHAPTER IV, Section C, paragraph 5.3.

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11. Comment:

"P. IV C-66. Table IV C-6 includes ^{234}U and ^{236}U in reload fuel assemblies that in sum are greater than 10% of the ^{235}U. The source of these radionuclides should be clarified as ORNL 4451 dated July 1971 indicates charged fuel does not contain ^{234}U and ^{236}U."

Response:

The revised ^{234}U and ^{236}U values presented in Table IV C-11 of final GESMO, are based on Minor Isotopes Committee Report Draft - October 28, 1974 for BWR reload cores. See CHAPTER IV, Section C, paragraph 4.3.1.

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12. Comment:

"In the accident analysis source terms section on page IV-115, the information is given that the iodine thyroid source term may exhibit a 14% increase for plutonium recycle over uranium oxide cores with an average increase of 10% for the iodine thyroid dose source terms. However, on page S-37, the accident analysis section indicates only an 8% increase in the thyroid dose source term. This apparent discrepancy should be rectified."

Response:

The 8% increase in the thyroid dose cited on page S-37 in draft GESMO stems from an error that was corrected but apparently not changed on page S-37 in the summary. See CHAPTER IV, Section C, paragraphs 5.3 and 5.4 in final GESMO for the recalculated source terms used in the accident analysis. The corrected value for the average iodine dose increase is 3%.

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13. Comment:

"The Health Department, which has lead responsibility in emergency planning in New York State, notes that it would appear from the calculations of radiological consequences of postulated accidents found in Tables IV-40 and IVJ-16 that elaborate offsite radiological response plans will not be required for LWR's whether or not plutonium recycle fuel is utilized. The maximum individual whole body dose at site boundary for all postulated accidents is 900 millirems for a large break, loss of coolant accident at a PWR and 29 millirems for a BWR."

Response:

Each class of accidents in Tables IV C-39 and IV C-40 has a spectrum of consequences and probability of occurrences of those consequences. For development of emergency plans, extremely conservative assumptions are used for the purpose of calculating doses resulting from a hypothetical release of fission products from the fuel. From an environmental effects standpoint, realistically computed doses are calculated using best estimates for realistic fission product release and transport assumptions. Refer to CHAPTER IV, Section C, paragraph 5.4.

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14. Comment:

"P. IV E-5. Th statement is made, 'At present, it is planned that recovered uranium will be recycled to the reactor after re-enrichment in gaseous diffusion plant. Recovery of fissile material from spent fuel elements is economically advantageous if fissile material can be recycled.' The ^{235}U content of high burnup fuel is about the same as virgin uranium. However, there is also considerable ^{234}U and ^{236}U as shown in Table IV C-7, p. IV C-67. The fission product content of separated uranium is not reported. The report should discuss the difficulties, if any, of re-enriching separated uranium. A discussion of what has been done with separated uranium to date should also be included."

Response:

Only very small quantities of uranium separated from LWR spent fuel have been processed in enrichment facilities to date. However, a detailed discussion of the estimated effects of recycling uranium from spent reactor fuel on the performance of both the enrichment facility as well as the reactor has been presented in response to a similar comment. This detailed discussion, endorsed by NRC was submitted as testimony by A. de la Garza in response to contention 8.b in the Barnwell Nuclear Fuel Plant Hearing and concludes that, "there are no effects associated with uranium isotopic contaminants in recycled light water reactor fuels which would make the use of recycled fuel in the form of accepted UF_6 operationally unfeasible and economically undesirable at an enrichment plant producing fresh fuel for light reactors." A copy of this testimony is included in the response to Comment Letter 15, Comment 4.

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15. Comment:

"Table IV E-3 lists the number of nuclear fuel reprocessing plants contemplated to be available in the United States through the year 2000. It is understood that the Midwest Fuel Recovery Plant, listed to be operational soon, may be abandoned by the General Electric Company for other than storage of spent fuel. The report should be updated to reflect this status."

Response:

In final GESMO, Chapter IV, Section E, paragraph 1.1 has been updated to reflect the current status of the spent fuel reprocessing industry.

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16. Comment:

"P. IV E-9, Table IV E-5 lists the liquid wastes from NFS (the only reprocessing plant with operating experience) as follows: Tritium and ^{106}Ru controlled releases to creek; other isotopes <0.1% of 10CFR20 in onsite waters.

"In the new Safety Analysis Report for the expanded facility the applicant has requested (proposed tech specs p. V 1-16 SAR) permission for 10% of 10CFR20 at Cattaraugus Creek. In onsite waters the levels have exceeded 10CFR20 limits. It appears the radiological releases as a result of reprocessing at Nuclear Fuel Services have been grossly underestimated in this report."

Response:

The release to the Cattaraugus Creek of all radionuclides was controlled. In addition to ^{3}H and ^{106}Ru, other radionuclides discharged to Buttermilk Creek (onsite water) did exceed 10 CFR 20 limits. The releases to Cattaraugus Creek (offsite), except for ^{3}H and ^{106}Ru, were <0.1% of 10 CFR 20. In this context, that part of Table IV E-5 was in error.

The words in this comment within the parentheses are not completely accurate, i.e. NFS is not the only reprocessing plant with operating experience. Government plants using the Purex process have many years of reprocessing experience.

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17. Comment:

"P. XI-13, Table XI-6 gives the difference in fuel cost for various alternates considered. The largest difference of 0.5 mills in the various alternates is about 13% in fuel cost. However, fuel cost in the range of 3 to 4 mills is only a small part of generating cost for nuclear power. Jamesport Nuclear Plant projects generating cost of about 22 mills per kilowatt hour. The difference in various fuel alternates is only about 2% when generating cost are considered.

"The difference in cost to consumer would probably be less than 1% for the various alternates considered if the generating, transmission and distribution costs are considered. This savings in cost may not justify the potential hazards of diversion or increased exposure to effluents from reprocessing."

Response:

The amount of savings to the consumer is large and constant regardless of the basis of comparison. The analysis in this final GESMO indicates that the benefits (both economic and environmental) outweigh the costs of plutonium recycle by a considerable margin. See CHAPTER XI, Section 4.0.

The benefits and costs of plutonium recycle must be weighed on a consistent basis the only meaningful basis in the absolute costs and absolute benefits.

Comment Letter No. 54

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39FR 30186)

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

21 NOV 1974

DOCKETED USAEC DEC 4 1974 Office of the Secretary Public Proceedings Branch
RECEIVED NOV 22 1974

Dr. S. H. Smiley
Deputy Director for Fuels
and Materials
Directorate of Licensing
U.S. Atomic Energy Commission
Washington, D.C. 20545

Dear Dr. Smiley:

The Environmental Protection Agency has reviewed the draft Generic Environmental Statement Mixed Oxide Fuels for Recycle Plutonium in Light Water Cooled Reactors. Our detailed comments are enclosed.

We would like to thank you and your staff for the time spent in meeting with EPA staff members to discuss the issues raised during the review of GESMO. These meetings were helpful to EPA for the purposes of narrowing issues and hopefully prepared your staff for responding to our comments on GESMO. Recognizing the scope of the problems and the difficulty of addressing them at a level of detail not heretofore approached, we commend the AEC staff for earnestly attempting to present a fair picture of the plutonium recycle problem.

In its review, EPA has attempted to determine whether the information provided is complete and adequate to support the conclusions reached in the draft statement. The EPA comments do not, however, address the completeness or adequacy of the technical aspects of plutonium safeguards since this Agency does not have expertise for such a technical analysis and hopefully, such a detailed review will be made by those agencies of the U.S. Government having this expertise. Because of the extreme importance of adequate safeguards, our comments do reflect concern with the general and cost/benefit aspects of the safeguards program. The EPA review of the GESMO was also based on the premise that the program as proposed does not include the exportation of plutonium.

Until the information requested by EPA to be included in the final statement is available, no final judgment can be made on the environmental acceptability of this program. However, our preliminary findings are that the implementation of plutonium recycle on an industry-wide basis appears to be marginally acceptable from a cost/benefit balance. This analysis indicates that the timeliness of the program implementation does not appear to be critical. With the application of the revised cost/benefit analysis methodology that we recommend, the timeliness may be even less critical and the cost/benefit balance even more marginal. It also appears that the program could result in some environmental advantages. Within this perspective, the principal conclusions reached by EPA on the plutonium recycle program are as follows:

1. Before a full scale mixed oxide recycle program is implemented a commitment should be made to an acceptable safeguards program. Such commitment should include the completion of the necessary selection of a procedure, its development and the securing of regulatory or legislative approvals for its implementation, including funding mechanisms.

2. Before actual full-scale mixed oxide fabrication and fueling of light water reactors is commenced, the following should be accomplished:

(a) the safeguards program should be implemented;

(b) the waste disposal concerns about transuranic wastes identified in EPA's review of the draft statement, "Management of Commercial High-Level and Transuranium -- Contaminated Radioactive Waste," and the proposed rulemaking on transuranic waste should be resolved; and

(c) accident analysis of specific plutonium recycle reactor designs should be completed for each proposed application and deemed satisfactory.

Relative to the adequacy of the draft GESMO, EPA has commented on several subject areas. First, the methodology used to compare the costs of using recycled plutonium to the base case. Second, the role of population exposures from uranium processing and occupational exposures in the reported reduction of dose from use of mixed oxide fuels. Third, our review includes comments on the uncertainties of plutonium toxicity and pathways of radionuclides to man.

EPA is very much aware of the controversy that exists relative to transuranium uncertainties. We are attempting to resolve these through a program of information development and consideration of the need to establish generally applicable environmental standards for the transuranium elements. EPA has stated this intent and requested relevant information in a Federal Register Notice, Vol. 39, No. 185 - Monday, September 23, 1974. We are confident that any standards promulgated through this process will be implemented by the Commission. We feel that these parallel efforts of the EPA and the AEC will adequately protect the public health and safety and the environment.

Based on our reservations about safeguards and in accordance with EPA procedure, we have classified the project as ER (Environmental Reservations) and rated the draft statement as Category 2 (Insufficient Information). If you or your staff have any questions concerning our classification or comments, please do not hesitate to call on us.

Sincerely yours,

Sheldon Meyers

Sheldon Meyers
Director
Office of Federal Activities (A-104)

Enclosure

DOCKET NUMBER
PROPOSED RULE PR-Misc Notice (39 FR 30186)
GESMO

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I. INTRODUCTION AND CONCLUSIONS

The Environmental Protection Agency (EPA) has completed its review of the Generic Environmental Statement Mixed Oxide Fuel (GESMO) on Recycle Plutonium in Light Water Cooled Reactors issued on August 23, 1974. The conclusion stated by AEC based on their analysis is that the recycle of plutonium in light water reactors should be approved subject to continuation of detailed case-by-case licensing procedures and upgraded safeguards. Both environmental and economic factors were analyzed in GESMO by AEC.

In its review, EPA has attempted to determine whether the information provided is complete and adequate to support the conclusions reached in the draft statement. The EPA comments do not, however, address the completeness or adequacy of the technical aspects of plutonium safeguards since this Agency does not have expertise for such a technical analysis. We would expect that such a detailed review will be made by those agencies of the U.S. Government having this expertise. Because of the great importance of adequate safeguards, our comments do reflect concern with the general and cost/benefit aspects of the safeguards program. The EPA review of the GESMO was also based on the premise that the program as proposed does not include the exportation of plutonium. A decision to export plutonium and the related safeguards considerations should be a separate issue.

EPA has included comments on the cost/benefit analysis since it considers factors which are environmental and public health related, and since it is relevant to potential risks assumed. EPA reviewed the analysis from the standpoint of methodology, data utilized and the degree to which it presents an independent evaluation of program costs and benefits. Additionally, there have been cases within the nuclear industry where abandonment of economically marginal operations have left State and Federal governments with a legacy of environmental radiation problems. Example of these operations include abandoned uranium mill tailings and low-level waste storage sites. In order to assess the probability of similar occurrences in the future, EPA must evaluate the economic viability of proposed projects which could result in undesirable environmental legacies.

The implementation of plutonium recycle on an industry-wide basis appears at best to be marginally acceptable from a cost/ benefit balance. The AEC analysis indicates that the timeliness of the program implementation does not appear to be critical. With the application of the revised cost/benefit analysis methodology that we recommend, the timeliness may be even less critical and the cost/benefit balance even more marginal. It also appears that the program could result in some environmental advantages. Within this perspective, the principal conclusions reached by EPA on the GESMO program are as follows:

1. Before a mixed oxide recycle program is initiated, a commitment should be made to an acceptable safeguards program. Such a commitment should include the completion of the necessary selection of a procedure, its development, and the securing of regulatory or legislative approvals for its implementation including funding mechanisms.

2. Before actual full scale mixed oxide fabrication and fueling of light water reactors is commenced, the following should be accomplished:

(a) the safeguards program should be implemented or operational. (b) the waste disposal concerns about transuranium waste identified in EPA's current NEPA review of the draft statement, "Management of Commercial High-Level and Transuranium -- Contaminated Radioactive Waste," and the proposed rulemaking on transuranic waste should be resolved: and (c) accident analysis of specific plutonium recycle reactor designs should be completed for each proposed application and deemed satisfactory. These conclusions are not different in concept from AEC's approach, but rely on specific milestones as decision points as opposed to time intervals as specified by AEC.

Relative to the adequacy of the draft GESMO EIS, EPA makes the following additional comments:

1. The methodology used to compare the costs of using recycled plutonium to the base case of not recycling can be significantly improved. We recommend that a sensitivity analyses be performed to determine how sensitive the cost savings from recycling are to

changes in the growth of electrical energy demand, uranium availability, and changes in estimated capital costs of mixed oxide facilities and safeguards measures. The final statement should also expand the discussion of the economic timing of the commercialization of plutonium recycle. Application of improved cost/benefit methodology may indicate that the economic incentives for introduction of plutonium recycle may influence the time of introduction.

The cost benefit analysis should consider any inherent government subsidy of plutonium recycle. In particular, the safeguards proposals describe government actions which may involve direct or indirect government subsidies, such that a program that is marginally acceptable to society as a whole, might otherwise be unsually attractive to industry.

2. In the draft statement the increased population exposures from mixed oxide fuel processing are said to be offset by reduced exposures from mining and milling of uranium ore. It is not made clear the extent to which plutonium is or is not the dominant environmental consideration. The application of "As Low As Practicable" concepts to uranium processing are not included in the statement.

3. Occuptional exposures are not discussed in detail. Although these deficiencies may not be crucial for final conclusions regarding acceptability of plutonium recycle, it is possible the dose savings may not exceed the increased exposures from the rest of the mixed oxide cycle.

4. The values of radiation dose equivalents and population dose reported in GESMO were calculated using assumptions and a data base that were not included in the statement. To evaluate the adequacy of the transport of radionuclides in the environment, the assumptions and pathways used in these calculations should be included in the final statement.

II. PLUTONIUM CONSIDERATIONS

a. Radiation dose and Plutonium Toxicity

Basically two comparisions relative to radiation dose and health effects can be made between the MOX cycle and the base LWR case. One is for occupational exposure and the other for the general population. Neither of these discernments are clearly delineated.

In the case of occupational exposures it would be helpful to identify the types of workers at risk and the sources of information on their exposure. It is not clear in the EIS whether uranium miners were included and if so if their occupational hazards not due to radiation were considered as part of the health impact.

In the EIS, the increased occupational and population exposures from mixed oxide fuel processing are said to be offset by reduced exposures from mining and milling of uranium ore. Indeed an actual overall dose savings is indicated. However, it does not appear that the two cases were similarly treated. To the degree that the dose estimates for mining and milling were based on models which do not reflect the control technology forecast for the 1990's, and exposures from the mixed oxide cycle were evaluated on more realistic effluent releases (ALAP), it is possible that the dose savings shown in the EIS for reduced uranium processing may not balance so favorably the increased exposure from the rest of the MOX cycle. Therefore, the AEC should review the bases for the dose estimates from mining and milling to see if they are compatible with assumptions used to evaluate the dose from other sources of exposure.

Throughout the discussion on toxicity, dose and health effects, numerous points are in need of clarification or other resolution. These individual points are presented in the additional comments section. However, some issues so pervade the whole discussion that some remarks are appropriate at this point.

Primary among these is the manner of utilizing and extrapolating animal data to interpretation of effects on man. As precarious as this manner always is, the EIS seems to make it

even more so by implying a false sense of security in the stated conclusions. A prime example is the area of lung effects utilizing data from dogs and cats which have no common denominator for comparision with human lung effects. This general situation is compounded by a lack of information on experimental procedure, such as chemical form for experiments at high dose rates as a basis to infer effects on man at low dose rates.

Some other issues include the need to examine the potential effects of other transplutonium radionuclides in order to place them in perspective and premature biological conclusions such as assuming the gonads to not be a potential internal organ. These areas of ambiguity present a case which may well be misleading and this matter should be resolved in the final EIS. We feel that our detailed comments previously referred to along with the references we have presented should be of assistance in carrying this out. Although the results will probably not change conclusions relative to the program's acceptability they will certainly more clearly state the related impact and the degree of uncentainty associated with it.

b. Radionuclide Pathways in the Environment

The primary area of concern relative to environmental pathways is the direct inhalation interface involved with the resuspension of plutonium from soils. Several specific comments relative to the discussion of this are included in the additional comments. In general however, it is felt that this is an area where much more effort is required although it is realized it may be sometime before it is entirely resolved. The present sparsity of data is compounded by the fact that much of it is from desert test areas and may not be at all applicable to the urban and suburban areas of most concern. The program to determine this parameter is all the more critical due to the sensitivity of lung doses to the resuspension variables. We hope that a vigorous effort will be pursued and to the extent possible the planned program be described in the final EIS.

The other major comment on environmental impact assessment is that the pathways used are not described in enough detail to make an assessment of the thoroughness of the analysis. However, when comparing the dose per curie released used in this report with the dose per curie release from the EPA analysis of the uranium fuel cycle, similar results are obtained. Thus, it appears that the analysis of long-lived isotopes-particularly tritium, krypton-85,

iodine-129-did include the use of long-time -span pathways even though the report does not describe these pathways. However, the population dose commitment estimates presented in the draft statement do not appear to consider world population growth over the time period of the released radionuclides exist in the environment. We feel that calculations of population dose commitments which extend over many decades should take into consideration world population growth during that period.

Several sections of GESMO describe the expected radiation dose from transuranium elements. Information should be included in the final statement which should indicate the pathways for transport of transuranium elements to man. Any differences in chemical behavior assumed for elements other than plutonium should be included.

c. Safeguards

EPA does not have the expertise to evaluate the adequacy of safeguards programs. We do see the issue as a prime factor in the feasibility of a mixed oxide recycle program however, for this reason we do not feel that a commitment should be made to the program until an extensive set of safeguard measures are committed to and the necessary approvals are obtained for their implementation. We hope that other government agencies, such as Justice or Defense where an expertise exists will review these measures to assure their adequacy. As safeguards are such an integral part of the program we would expect that the incurred expense be fully reflected into the cost benefit evaluation. If the devised measures are to be carried out by Federal agencies this should be recognized as a form of government subsidy and either this fact reflected or some means of charging the industry should be arranged.

We are pleased to note that the GESMO includes a lengthy and comprehensive discussion of the safeguards problem; we believe the magnitude of the impact that could potentially derive from a failure of the safeguards system merits this attention. We also concur that continuing study and effort should be devoted to upgrading the safeguards provisions, as outlined in section V-H and elsewhere in Chapter V, and urge the AEC to follow through with their planning in this area.

It should be understood that EPA's comments are based on the premise of no U.S. export of plutonium. The consideration of such an action should be handled as a separate issue. Such a decision should not be taken lightly as it is apparent that a deficiency in safeguards provisions or a breakdown of safeguards in another nation to which we might export MOX fuel, or which moves to plutonium recycle on its own, could effectively negate the safeguards developed in this country. We recognize that such considerations are beyond the

stated scope of the AEC's safeguards objectives. However, we believe that discussions with other nations urging them to implement more stringent physical security measures, mentioned on p V-38, are a vital element in overall safeguards considerations. Effective accountability and physical security safeguards must exist in other countries which utilize plutonium and other SNM if this country's safeguards efforts are to have meaning.

The example calculation on p. V-48 quantifies the risk to selected individuals from a postulated dispersion of plutonium oxide; however, of more interest would be total risk in terms of deaths and cancers, assuming the dispersion occurred in a densely populated area. Also, it would be helpful in evaluating the magnitude of the risk to know what assumptions are used to perform the calculation. For example, is any credit given for evacuation of the affected area? What assumptions are made regarding resuspension? The final EIS should also indicate what kinds of cleanup operations would be required to restore the affected area to a habitable condition.

For the example calculation on p. V-49, of risk from uniformly dispersed plutonium oxide, the area chosen (1/4 acre) is so small that an "inhabitant" would have to be carefully defined. A large area would seem to be more appropriate, corresponding to something less than unity risk for the inhabitants developing bone cancer. Again, total risk should be given for a representative population density, and the bases for the calculation indicated.

III. WASTE MANAGEMENT

Definition of Wastes

The AEC has defined only three catagories of "other-than high-level" wastes; low-level beta-gamma waste, low-level plutonium bearing or alpha waste, and fuel cladding hulls. The present classification system for "other-than" waste, however, gives no indication of the activity, content, or hazard potential of the waste, except that it is not "high-level" waste. The lack of clear definitions for these wastes presents great difficulties for those who ship wastes, for those who receive wastes, and for EPA, particularly, in determining the potential health and environmental impact of the wastes, and we therefore, would like to see the AEC develop a more detailed, formal classification for "other-than" wastes.

Our concerns about the waste classification problem were discussed in EPA's comments on the LMFBR program draft environmental statement and will be discussed in more detail in comments on the Management of Commercial High Level and Transuranium - Contaminated Radioactive Waste draft environmental statement.

Predicated Volumes for "Other-Than" Wastes

There appears to be some discrepancies between the volumes of the "other-than" wastes currently being buried and the amounts predicted in the draft statement EPA has recently completed a preliminary assessment of commercial "other-than" waste volumes, activity, and space requirements(1). In particular the AEC estimates yearly and accumulated quantities of radioactive wastes buried appear to be somewhat underestimated when compared with the results of the EPA assessment. The AEC should re-evaluate their estimates based on the EPA information and other AEC information (2).

The AEC should be more explicit in the final statement concerning the methods used to estimate the volume of future "other-than" wastes from the MOX fuel cycle and how these predicted volumes fit into the total nuclear waste disposal picture. EPA feels that resolution of these points is essential to an evaluation of the environmental impact of the proposed MOX waste management program.

Segregation of Transuranic Contaminated Wastes

"Other-than" wastes from the MOX fuel cycle are expected to be richer in Pu and other alpha contaminants than wastes from the other fuel cycles. This will mean that significant quantities of MOX wastes, which would have been channeled into land burial at commercial burial grounds, would now be placed in interim storage and later transferred to a national repository for disposal or treatment. The economic impact of this policy change on the total costs of power production and on the operations of the commercial burial industry should be considered.

The final statement should indicate the technical arrangements that will be made to screen the "other-than" wastes for transuranium contamination and to prevent the accidental dilution of the transuranium - contaminated wastes to less than 10 nanocuries per gram.

Commercial Burial Grounds

Shallow land burial is the present and proposed method for disposing of the nontransuranic "other-than" wastes. The AEC should present or directly reference in the final statement the results of any studies which have been conducted at the commercial burial sites, subsequent to the beginning of burial operations which could corroborate or validate the conclusions reached in the original evaluation that buried radioactive waste will not migrate from the sites. Also any monitoring data or other evidence which confirms that the radioactive waste now buried has remained immobile at the place of burial should be submitted or directly referenced.

Interim Storage/Ultimate Disposal

While we have significant concerns about the proper execution of the interim engineered storage and ultimate disposal concepts for "high-level" waste we will not include detailed discussion of them in these comments.

We feel that, while they apply to the MOX program, they are more relevant to the draft environmental statement on the Management of Commercial High-Level and Transuranium-Contaminated Radioactive Waste.

Miscellaneous Comments on GESMO: The draft EIS indicated the maximum credible accident at any RSSF to be the rupture of a single cannister. However, since the AEC indicated the possibility of a loss-of-cooling accident, we feel that the environmental impact of this type of accident should be discussed in the same degree of detail as the single cannister accident. These analyses address the additional 30% heat loads and higher radiation levels affect safety margins, facility designs, or costs.

With the increase of total transuranics present in the high-level MOX wastes and the change in the mix of these transuranics, the final statement should discuss how this affects the time required to retain the wastes in some ultimate disposal site and which radionuclides are of primary concern after 10, 100, 1,000, 10,000, 100,000, and 1,000,000 years.

References

1. M. F. O'Connell and W. F. Holcomb, "A Summary of Low-Level Radioactive Wastes Buried at commercial Sites Betwen 1962-1973, with Projections to the Year 200", to be published in Radiation Data and Reports for December 1974.

2. U.S. AEC "The Nuclear Industry 1973, WASH 1174-73

IV. Safety

a. Reactor Plant

The discussion of the relationship of mixed oxide cores to reactor safety margins generally presented qualitative evaluations of the MOX to reactor kinetics and reactor control capabilities. In conclusion the AEC stated that there were no limitations in the use of MOX related to safety. In view of the fact that the draft statement did not consider specific or reference reactor designs, we believe some quantitative details should be presented in support of the conclusion that no safety limitations are necessary. This is particularly important since the MOX, as discussed in the draft statement statement will have both positive and negative impacts on the levels of margin relative to reactor safety. In order to better delineate the overall quantitative aspects of MOX on the level of the margin of safety, we recommend that the final statement assess the overall change in pertinent safety parameters, as itemized in the draft statement, for reference PWR and BWR core designs for several different MOX fuel loadings in the range under consideration. The resulting changes should then be compared, if possible, with the ranges of existing margins in light-water reactors. Although the reference core design may not necessarily be identical to designs or specific reactors, this analysis will enable a conclusion to be reached on quantitative analyses regarding the impact of MOX on safety margins and on the need for specific safety limitations. We assume that, before any operating nuclear plant is licensed to operate with recycle MOX, the AEC will perform detailed safety assessments of the specific core design and will issue an independent safety evaluation report of the results.

b. Transportation

The analysis of transportation accidents appears incomplete since no quantitative information is presented for either the probability of an accident in which radioactive materials are released or the conquences of such an accident. The primary reference used to support the AEC conclusion that the radiation risk is small is WASH-1238 which suffers from a similar lack of quantitative information. In particular, with regard to the probability of an accident involving a release there is no analysis relating the shipping container test conditions to the severity of the accident. Thus, the conclusion that the container should withstand a Category 3 (severe) accident without being breached is not substantiated. With regard to the consequences of an accident involving a release, no estimate of the radiation dose to emergency crews, controversy concerning the quantity of fission products, especially cesium, which may be released is made. An estimate of the external exposure to humans from released radioactive materials was made in WASH-1238. However, it appears the dose to humans from inhalation of the released material may be much greater than received externally.

A complete risk analysis for the shipment of plutonium in DOT approved containers has recently been completed by Battelle Northwest Laboratories (BNWL-1846). This analysis is an important first step in resolving the issues concerning radiation risk in the transportation of nuclear materials. While this study has not yet received the detailed scrutiny of the scientific community to determine its acceptability, it appears to be of sufficient quality to warrant inclusion of its findings in the final statement. A commitment to perform similar analyses for other shipping pathways should also be made in the final statement.

V. FUEL REPROCESSING, FUELS AND REACTOR

Fuel Reprocessing

The iodine-129 and -131 source terms for the model fuel reprocessing plant listed in table E-8 are not in agreement with present estimates by the Oak Ridge National Laboratory based on currently available technology. In the past many uncertainties have been associated with iodine source terms and control technology that will be utilized to obtain the release rates presented in the draft statement. Also the final statement should provide a separate listing in the tables of the doses (both individual and population) resulting from the projected radioiodine releases.

The draft statement does not present information on carbon-14 release rates from either reactors or fuel reprocessing plants.

Because of its long half-life and its persistence in the environment, carbon-14 which has been discharged from these facilities may result in a population dose commitment significantly greater than from either kryton-85 or tritium. Therefore, we feel that the final statement should present the following information on carbon-14:

a. release rates from both reactors and fuel reprocessing plant.

b. local doses and population dose commitments.

c. a discussion of control technology at both reactors and fuel reprocessing plants.

Fuels

The statement is made in several places in the draft EIS (e.g., on pages IV C-20 and IV C-58) that depleted uranium (diffusion plant tails) could be used instead of natural uranium as the diluent for blending with recycled plutonium during fabrication of MOX fuel. This implies a benefit owing to the reduced ore mining and milling requirements and utilization of existing stores of depleted uranium. Elsewhere, however (e.g., on pages I-14, II-44 and II-55) it is noted that natural uranium shows an economic advantage over depleted uranium. The conditions under which stores of depleted uranium might be used, even though such use is described as "uneconomic," should be discussed in the final EIS. If utilization of depleted uranium or tails is not reasonably anticipated the references to such possible use should be deleted.

Reactor

According to Chapter IV, page IV C-73 of GESMO, WASH-1258 (Final Environmental Statement Concerning Proposed Rule Making Action for Operation to Meet Criterion "As Low As Practicable") served as the basis for the source term calculations. However, comparision of the source term parameters in GESMO (Tables IV C-9 and IV C-10) with corresponding tables in WASH-1258 reveal certain discrepancies:

BWR Source Term Parameters

Parameter	Table IV C-9 GESMO	Table 2-1 WASH-1258
Reactor Cleanup Flow Rate	1.54×10^5 lb/hr	1.3×10^5 lb/hr
D. F., Clean Waste Demineralizer	10(10)	1(10)

PWR Source Term Parameters

Parameter	Table IV C-10 GESMO	Table 2-2 WASH-1258
Te Escape Rate Coefficient	1.0×10^{-11}/sec	1.0×10^{-9} /sec
Sr, Ba Escape Rate Coefficient	1.0×10^{-12} /sec	1.0×10^{-11} /sec
Weight of water in primary system	5.5×10^5 lb	5.0×10^5 lb
Weight of water in secondary system	3.7×10^6 lb	4.1×10^5 lb

In addition to these differences in basic source term parametric values, the waste treatment systems assumed for the GESMO model reactors are in may instances unlike those systems presented in WASH-1258. These discrepancies should be clarified with respect to the potential effects on environmental releases.

Table IV C-12 of GESMO has apparently excluded the BWR mechanical vacuum pump (at startup) source term, 2,300 Ci/yr of Xe-133, 350 Ci/yr of Xe-135, and radioiodine (unspecified).

Table IV C-21 and C-22 are apparently mixed-up. Table IV C-12 shows a higher noble gas source term for the UO fueled BWR but doses from this reactor (i.e., skin and total body doses) are lower than the corresponding doses from the mixed oxide fueled BWR. Similarly for radioiodine, a higher source term is listed for the mixed oxide fueled BWR but higher thyroid doses are listed for the UO fueled BWR. It is not clear whether this confusion may have filtered to Tables IV C-27 and IV C-28 for annual man-rem doses.

VI. BENEFIT/COST ANALYSIS

INTRODUCTION

EPA considers the benefit/cost study to be insufficient in detail and depth of analysis. In our opinion, the methodology used is incorrect for a number of reason, which will be discussed in the following sections. Even before correction of methodology the cost savings from plutonium recycle are small relative to nuclear electricity generation costs. There are indications that, if corrected procedures for the analysis were used, the cost savings from plutonium recycle may prove to be smaller than reported.

The debate over recycling revolves around the issues of increased environmental risks to man and the environment, which should be weighed against the benefits to be derived from producing somewhat cheaper power with plutonium recycling. Since risks are balanced against the cost advantages of plutonium recycling, the smaller the cost advantage, the smaller the risks that may be acceptable to society.

METHODOLOGY

The method of analysis employed in the AEC benefit/cost study does not provide the cummulative LWR fuel cycle industry cost figures for the years 1974 through 1995. Table XI-7 does supply cummulative figures for resource and service commitments, but this table is of limited usefulness since it does not include capital costs.

Instead the major thrust of the AEC benefit/cost study is a projection of the LWR fuel cycle industry under various alternatives at a "...mature operating level, about 1990..." The cost figures for this year are in Tables XI-4 through XI-6. AEC chose this year because they believe it represents an "...approximate average industry condition for the time span 1974 - 1995" (p.XI-3).

The methodology used for this AEC benefit/cost study is to measure the fuel cycle costs for a base case, labeled Alternative 1. This base case is then used as a standard of comparison for five alternative cases. The base case represents the reprocessing of the spent fuel and the storage of the plutonium for future use.

Although this methodology appears to be acceptable, since the LWR's will be operating in either case, it is reasonable to suspect that little reprocessing of spent fuel will occurr if plutonium recycle in LWR's is not permitted. With no plutonium recycle, it is likely that most of the spent fuel would be stored for some future use rather than reprocessed within a short time. Such a scenario could lead to significantly smaller impacts in both the reprocessing and transportation areas. We believe that AEC should present more evidence to justify this choice of the base case.

The five alternatives represent different dispositions of the plutonium and uranium contained in the spent fuel. Alternatives 3 and 4 represent plutonium recycling. The difference between these two is that Alternative 4 includes an upgraded safeguards program. The alternatives representing plutonium recycling are the only cases considered that result in lower fuel cycle costs below those for the base case. The AEC's recommended course of action is to proceed with plutonium recycling. Therefore, this discussion of the benefit/cost analysis will be directed towards plutonium recycling.

The benefits to be derived from plutonium recycling are defined as the cost savings gained from plutonium recycling. There are two categories of potential social costs associated with plutonium recycling: those that involve an impact upon the environment and those that have an effect on the level of safety.

Table XI-2 is a summary of the environmental factors for the alternative spent fuel dispositions. No attempt has been made to attach dollar values to these environmental factors. However, it is argued by the AEC that plutonium recycling reduces, to a small extent, the overall impact on the environment. The primary source of this reduction is a decrease in uranium mining, UF_6 conversion and uranium enrichment. In turn, this reduces the need for land and resource inputs, and results in diminished fossil fuel needs. There are some increases in environmental impacts but they are believed to be negligible in comparison to the reduced environmental factors.

The other potential social cost of plutonium reycling is increased safety hazards. Plutonium recycling expands the quantity of plutonium in use in the fuel cycle. This plutonium must be transported and

handled in the process of recycling and is therefore vulnerable to attempted acts of theft or sabotage. The upgraded safeguards program in Alternative 4 is directed towards that danger. Alternative 3 includes a safeguards program much like that for Alternative 1, but extended to take into account the increased quantities of plutonium present with plutonium recycling.

SENSITIVITY ANALYSIS OF SUPPLY AND DEMAND ASSUMPTIONS

Estimates of uranium resources are uncertain. If future nuclear fuel requirements can be met only by the mining of low grade ores, extraction costs will rise above today's level. Plutonium recycle has the potential for somewhat reducing future uranium requirements and costs. The primary source of reduction in costs is the reduction in extraction and enrichment costs, since plutonium can be used as a substitute for a portion of the uranium fuel.

AEC estimates of U. S. uranium resources are shown in Table XI-(A-2). Given the AEC estimates of uranium reserves, and the AEC's estimates of the need for uranium fuel under the different alternatives, the future price for U_3O_8 can also be estimated. These prices are shown for every five-year interval from 1975 through 1995 in Table XI-11. No attempt has been made to determine how sensitive the cost savings from plutonium recycle are to alternative assumptions for uranium reserves, potential changes in enrichment technology, rates of growth of electrical energy demand, rates of substitution of nuclear for fossil plants, or different mixes of nuclear reactors (e.g. HTGRs or HWRs). In our opinion, it seems reasonable to expect that the estimated cost savings shown in Table XI-11 could vary quite significantly if different assumptions were used.

The growth of nuclear power is obviously derived from the overall growth in demand for electrical energy. The overall electrical demand projection used in the AEC Draft statement is based upon Assumption Set D of the AEC projection, Nuclear Power Growth 1974-2000, WASH-1139 (74). That demand projection corresponds to an average annual growth of 6.2% for all electrical power and 21.5% for nuclear power over the period 1970-1995. Growth of electrical energy demand could be much lower (e.g. as low as 4%) as a result of the substantial price increases and

conservation efforts now in progress. There is also considerable uncertainty about the size of the nuclear share of electricity generation. This uncertainty arises from recent trends in capital construction costs and lower-than-expected reactor availability experience. The cost savings from Pu recycle can reasonably be assumed to be quite sensitive to these assumptions.

Table 1 shows the eight combinations that EPA considers essential for the sensitivity analysis. The first combination shown represents the case analyzed in the Draft EIS.

Two cases for the supply of U_3O_8 are of interest. The first is the same as projected in the Draft EIS and the second is a 100% increase in uranium resources. This increase would be an additional 100% of the U. S. uranium resources (both reasonably assured and estimated additional) corresponding to each price level as shown in Table XI-(A-2).

Two cases for the projected growth in nuclear power are proposed. The first would be the same as projected in the Draft EIS and the second would reflect an average annual growth rate of 4% in electrical power demand and 10% growth for installed nuclear power demand over the period 1974-1995. Two cases are proposed for capital construction costs. The first would be the same as projected in the Draft EIS and the second would represent a 100% increase in the capital equipment and construction costs of all facilities needed for plutonium recycle. This increase would allow for the uncertainties of present day capital construction costs.

TABLE 1

SENSITIVITY ANALYSIS

Uranium Supply	Growth in Nuclear Power Industry	Capital Costs
Same as Presented in the Draft EIS	Same as Projected in the Draft EIS	Same as Presented in the Draft EIS
		100% Greater than Presented
	Lower than Projected (4% growth in electrical power) (10% growth in nuclear power)	Same as Presented in the Draft EIS
		100% Greater than Presented
100% Larger than Estimated in the Draft EIS	Same as Projected in the Draft EIS	Same as Presented in the Draft EIS
		100% Greater than Presented
	Lower than Projected (4% growth in electrical power) (10% growth in nuclear power)	Same as Presented in the Draft EIS
		100% Greater than Presented

THE OPTIMAL DATE FOR FULL COMMERCIALIZATION

The EPA believes that the AEC methodology places too much emphasis on the date of introduction of plutonium recycle. There is often a great deal of difficulty in progressing from introduction to full commercialization. The time projections for full commercialization often miss by years. The EPA believes that a better concept to be used in considering the timing of a program is the date of "full commercialization." This is defined to be the time when commercial development has progressed to the point where the future expansion path of the industry can be reliably predicted. Once this point has been reached, there will be comparatively less doubt as to the date a fully developed industry will be achieved. AEC might wish to empirically define the point of full commercialization as the point when recycled plutonium accounts for more than X percentage of LWR fissile fuel.

If plutonium recycling is fully commercialized too early, the price of uranium will still be too low, decreasing the discounted present value of cost savings derived from plutonium recycle. Delay in the date will increase the discounted present value of cost savings. However, if plutonium recycle is fully commercialized too late, future cost savings will occur too far in the future and their discounted value will be smaller than if the date were moved earlier in time. Thus, the discounted present value of the cost savings from plutonium recycle will first rise and then fall as the date of full commercialization is moved outward in time. The optimal date for full commercialization is the date for which the present discounted value of cost savings is maximized.

The Final EIS should include calculations of the present discounted value of cost savings for each different date. These calculations should be performed not only for base case parametric conditions, but also for the other sensitivity cases identified in this review. In order not to bias the analysis against later full commercialization dates, it will probably be necessary to extend the ending period of the analysis past 1995.

COST SAVINGS AND THE CROSSOVER POINT

The EPA believes that early initiation of plutonium recycle requires the demonstration that the savings are significant in comparison to nuclear electrical generation costs and that they are realized early in the recycle program. Deferred initiation of plutonium recycle should be considered to be an alternative if the cost savings are not realized early in the fuel recycle program. The remainder of this section provides the framework for this argument.

First, it should be demonstrated that there are savings from plutonium recycle. They should be apparent from the analysis of the cumulative costs of operation for the period 1974-1995. These savings should be realized for the whole program, including reactor costs as well as fuel cycle costs. In addition, these savings should be large enough to warrant the additional risks inherent in plutonium recycle. As discussed elsewhere in this review, the draft EIS does not satisfactorily describe or quantify the costs of an adequate safeguards program. Some safeguards measures (e.g. spiked plutonium) may substantially increase the costs of plutonium recycle. These costs are difficult to predict, and could be considerably higher than the AEC presently estimates.

If analysis demonstrates that there are substantial savings from plutonium recycle, steps to proceed immediately are justified only if it is shown that the savings derived will begin soon after the program is implemented. In order to determine how soon plutonium recycle reaches this point, which can be termed the crossover point, an analysis of the costs of operation of each alternative, on a year by year basis is needed.

EPA considers the determination of the crossover point to be quite important. If this point will not be reached until many years in the future then there is less incentive to make a present commitment to the future use of plutonium recycle for routine fueling of LWR's. A more limited present commitment could be considered without foreclosing the future option of using routine plutonium recycling. The crossover point concept could be usefully incorporated into sensitivity analysis.

PRIORITY USE OF PLUTONIUM

AEC gives first priority to the production of the plutonium needed to fuel fast breeder reactors. Therefore, 26% of the plutonium produced in LWRs over the time span 1974-1995 is to be withheld from plutonium recycle for that purpose. The choice of the 26% figure is not explained or justified, except to state that there will be large quantities of plutonium left over after meeting the requirements for the first fuel loadings for the new breeder reactors. Since the savings from plutonium recycle is responsive to changes in the fuel cycle, EPA believes that the Final EIS should explain how the 26% figure was determined because there can obviously be important environmental consequences from saving different percentages of LWR-generated plutonium. The interrelationship between the fast breeder reactor program and plutonium recycle will be explored in the Appendix which describes a method that can be used to determine the appropriate amount of plutonium to be withheld from recycle for the fueling of fast breeder reactors.

THE ROLE OF THE HTGR

There is virtually no discussion of the role of the HTGR in the nuclear reactor field through 1995. Figure S-1 and Table VIII-2 shows that it is expected to make a relatively small contribution. An obvious question is whether or not the cost advantage to plutonium recycling is sensitive to the relative mix of LWRs and HTGRs. Some supplementary analysis could be usefully employed to pursue this question.

DISCOUNTING

No discounting has been used in assembling the data for Tables XI-4 through XI-7. Therefore, there is no adjustment for the fact that capital and operating expenditures take place at different times. For example, the capital in place in 1990 will be composed of a mix of capital of various ages. The accepted procedure for taking this into account is to use discount rates to evaluate time distributed costs and benefits in present value terms. This procedure is described in Circular A-94, Revised, issued by the Office of Management and Budget. This circular requires the use of a 10% discount rate.

It is impossible to determine with the present analysis precisely what discounting will do to the apparent cost savings gained from plutonium recycling, for the changes in the present value are functionally related to the time-distribution of expenditures. Time distributions of cost data are not provided in the Draft EIS. However, if the time distribution of expenditures is roughly the same for the alternative cases, it is to be expected that the use of discounting would reduce the absolute size of the cost savings that can be attributed to plutonium recycling. Table XI-6 shows the fuel cycle costs for the year 1990. There appears to be one billion dollar saved from plutonium recycling as compared to the base case. Since no discounting has been used, the corrected value of this cost savings cannot be determined.

The failure to discount to present value leads to even greater misconceptions when considering Table XI-7. This table is a tabulation of expenditures for resources and services for the period from 1974 through 1995. These expenditures do not represent any capital investment over this period, just the expenditures for resources and services incurred in operation each year. Since the costs of operation are not discounted for future years of operation, the contribution for those years in the distant future are much greater than they would be if evaluated in present value terms. With discounting, the differential costs for each alternative dispostion of plutonium would be reduced in a like manner, thus decreasing the magnitude of the apparent cost savings when plutonium is recycled.

Since no time-specific cost data is provided in the draft statement it is impossible to determine how much the cost savings claimed exceed those that would be incurred if evaluated in present value terms. In our opinion, they could be substantial. The nuclear power industry is projected to grow continuously through 1995, so that the total operating expenses for each of the six alternatives will be larger in the later years of the period evaluated. Therefore, these later years make the greatest contribution to the expenses recorded in this table. But the expenses for the later years are the ones that will be subject to the greatest discount. The present value of the cost savings may be greatly reduced from those recorded in the table.

SAFEGUARDS COSTS

The safeguards program is described in Chapter V of the Draft Statement and its costs are estimated in Chapters VIII and XI. A wide

variety of safeguards programs are discussed. Some have estimates of costs attached to them, others do not. The measures considered include the incorporation of integrated fuel cycle facilities which would reduce transportation requirements, a Federal security force that would not be restricted by state and local limitations and could respond on a nationwide basis if necessary, hardening of barriers against theft and sabotage, suggested protection of transportation functions, spiked plutonium, and a variety of other measures. Since the particular form of the safeguards program is not resolved in the Draft EIS, the costs of implementation cannot be determined with certainty. AEC states that the cost figures are to be used to "...give a perspective, a point of view and an order of magnitude for these costs." AEC maintains that these costs would be small enough that they would not be a significant economic consideration.[1] The remainder of this section and the next section of this EPA review demonstrate that the estimated costs of these safeguards programs are large enough to have an impact on the economics of plutonium recycling.

In the summary of Chapter XI, under the discussion of Materials and Plant Protection Considerations, p.XI-19, it is stated that although "...projected materials and plant protection costs in 1990 will be significantly higher for Alternative 4 than for the base case, the resultant effect on the overall economics of the fuel cycle is judged to be inconsequential." This statement is in reference to an upgraded safeguards program, estimated to cost 74 million dollars in 1990. This cost is indeed small when compared to the total fuel cycle costs. However, it is much larger in comparison to the costs savings incurred in 1990, representing approximately 6% of the cost savings attributable to plutonium recycling without safeguards (Table XI-6, Alternative 3). For this reason EPA suggests that the term "inconsequential" is not an appropriate descriptor of potential safeguards costs.

SPIKED PLUTONIUM

Spiked plutonium is discussed in various places in the draft environmental impact statement, but has not been included in estimated costs of materials and plant protection. Nowhere is its use explicitly

[1] See page VIII-75.

rejected. The reader is left with no definite indication whether spiked plutonium is considered to be a likely additional safeguard measure.

The cost of incorporating spiked plutonium is estimated to be 170 million dollars for the year 1990 and to be in the order of three billion dollars for the period through 1995.[2] By telephone inquiry, the EPA was informed that spiked plutonium was not included in the fuel cycle since its cost is small compared to total fuel cycle costs. However, comparing these costs to total fuel cycle costs is not relevant. Spiked plutonium costs are more appropriately compared to the savings associated with plutonium recycling. Inspection of Table XI-6 reveals that the inclusion of spiked plutonium as an additional safeguard will lower the cost advantage of Alternative 4 from 980 million dollars to 810 million dollars, a reduction of 17%. If spiked plutonium is some day determined to be a necessary safeguard measure, its use will significantly reduce the cost savings derived from plutonium recycling.[3]

STANDARDS FOR COMPARISON OF COST SAVINGS

In Table XI-6, AEC calculates the cost savings from Alternative 4 to be approximately one billion dollars as compared to the base case, for the year 1990. This cost savings results in a calcualted savings in "Total Operating mills/kwh" of 3.89-3.54=0.35 mills/kwh. These costs are not busbar costs, for they include only fuel cycle costs. Costs not contributed by the fuel cycle have not been included in Table XI-6. There is a question as to the appropriateness of not giving an estimate of the busbar costs. An uninformed reader of the Draft EIS might assume the reported costs represent the total costs of generating electricity, and arrive at the incorrect conclusion that the cost savings from plutonium recycle represent approximately a 10% savings (i.e. 0.35 mills/kwh saved from a base cost of 3.89 mills/kwh).

The 1974 busbar cost of generating electricity is approximately 16 mills/kwh. The cost savings for Alternative 4 as compared to Alternative 1 could then be calculated to be (3.89-3.54)/16 = .022 or approximately 2.2% of the total costs.[4]

When the savings for plutonium recycle are viewed as a component of total nuclear power generating costs, they are much smaller than they

[2] This estimate is found on page VIII-75. A contradictory estimate of its cost is found on page V-45. Inquiry of the AEC established that the correct figure is 170 million dollars.

[3] No discounting has been used here, because the necessary data is not available in the Draft EIS.

[4] No discounting has been used here, because the necessary data is not available. However, the use of discounting would not change these conclusions.

are when considered as a component of fuel cycle costs only. It is important to view the cost savings from this perspective. Should it become necessary to forego plutonium recycle someday, because of some environmental or safeguards problem, it is clear that the absence of plutonium recycle would have only a marginal impact on electricity costs. EPA recommends that AEC consider total LWR busbar costs to be the appropriate standard against which the cost savings from plutonium recycle be compared. This standard of comparison would be more meaningful to a reader of the final EIS. The Final EIS should at least include this kind of comparison, and it should be given equal prominence with the comparison to fuel cycle costs presented in the Draft EIS.

ONCLUSION

The methodology used to compare the costs of using recycled plutonium to the base case of not recycling can be significantly improved. There is considerable reason to believe that the cost savings from plutonium recycling may not be as large as shown in the Draft EIS. EPA recommends that all the calculated costs of alternative spent fuel dispositions be redone with all expenditures discounted to 1974 values. Discounting is the only way to bring expenditures that take place in different time periods into proper perspective.

It is further recommended that the capital and operating costs of reactors be included in the costs of six alternatives. This will make it possible to judge all cost savings in relationship to the total costs of using nuclear reactors to generate electricity.

EPA also recommends that the sensitivity analyses described in an earlier section of this review be incorporated into the benefit/cost study so that readers of the Final EIS will be able to determine how sensitive the cost savings from plutonium recycling are to changes in the growth of electrical energy demand, changes in the uranium resources, and changes in the estimated capital costs of mixed oxide facilities.

The EPA does not consider the analysis of fuel cycle costs for only one year, 1990, to be adequate for judging the merits of plutonium recycle. This would be true even if the analysis were methodologically correct. The cumulative costs for the years 1974 through 1995,

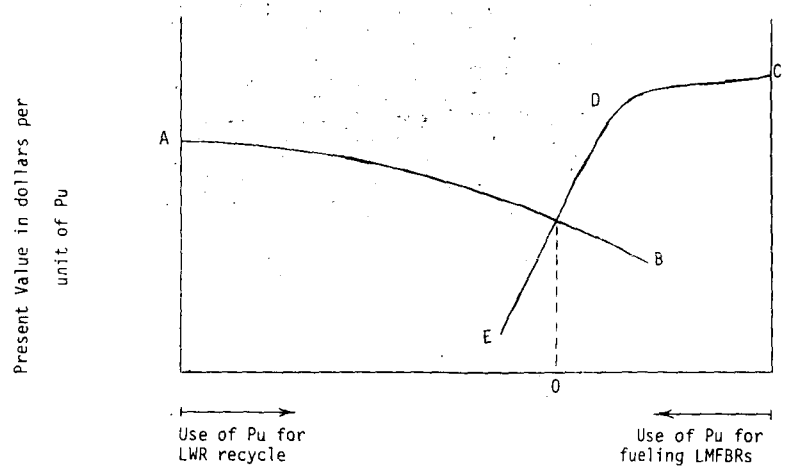
appropriately discounted, must be shown for each alternative. The information the AEC provides in Table XI-7 is not sufficient, for it does not include capital costs.

The Draft EIS does not adequately treat the subject of the economic timing of the commercialization of plutonium recycle. Timing is very important because new information is continually being developed in the areas of plutonium toxicity, the costs and feasibility of safeguards measures, and the magnitude of transportation hazards. Thus, the Final EIS should contain a thorough analysis of when the cost savings of plutonium recycle are expected to begin and how large they are likely to be. This information will be highly useful to interested groups and could be a valuable input to future public discussions about the timing of plutonium recycle.

APPENDIX

It is assumed here that uranium resources, the growth of the nuclear power industry, and the date of LMFBR introduction are all given. The horizontal axis in Figure 1 represents units of plutonium. The total horizontal dimension represents the total amount of plutonium generated from LWRs. Movement from left to right represents more use of plutonium for LWR recycle and less use for LMFBR fueling. Movement from right to left, on the other hand, represents more use of plutonium for LMFBRs at the expense of LWR recycle. Each point on the horizontal axis represents a different allocation of plutonium between plutonium recycle and fuel for LMFBRs. The verticle axis measures the present value of a unit of plutonium.

Figure 1



The line AB represents the preset value of plutonium used in LWR plutonium recycle, and is expressed in dollars per unit. The downward slope of the line reflects the fact that the present value of each additional unit of plutonium will decline as the amount of plutonium used in recycle increases for any given year. This is because plutonium replaces uranium as a fuel in LWRs and the higher cost uranium ores will be the first to be replaced by plutonium.

The line CDE represents the present value of plutonium used for fueling LMFBRs, and is expressed in dollars per unit. The downward slope of this line (moving from right to left) reflects the fact that the present value of each additional unit of plutonium will decline as the amount of plutonium reserved for fueling LMFBRs increases. The "kink" in the line is to indicate that there may be a minimum amount of plutonium needed to satisfy the rapid rates of LMFBR commercialization projected by the AEC.

Point "0," where the two lines cross, represents the optimal distribution of plutonium between plutonium recycle and fuel for LMFBRs.

EPA does not consider it unreasonable to ask that the above type of analysis be performed. The only significant obstacle to performing such an analysis would be the present uncertainty about the dates and rates of LMFBR introduction. This obstacle can be overcome by using the dates and rates specified in Table 10.4 in Volume III of the AEC Draft Environmental Impact Statement for the LMFBR Program (WASH-1535).

VII. ADDITIONAL COMMENTS

1. Tables IV C-12, IV C-21 and IV C-22 are not consistent; e.g., MOX skin doses are higher but for the mix of noble gases in effluents given, they should be lower. Also, while iodines in MOX gaseous effluents are shown higher, thyroid doses are lower.

2. Figure IV C-24 does not appear to be drawn correctly. The reduced central temperature in the MOX rod is stated to be a consequence of the higher neutron cross section of Pu, which causes a higher peripheral heat generation rate and lower central flux. This being the case, one would expect the termperature profile of the MOX to be higher in the periphery, reflecting the increased heat flux at that location.

3. No mention is made of the magnitude of possible tramp plutonium problems with MOX fuel. This should be addressed in the final statement.

4. Another possible alternative that should be considered relative to the timelessness of initiating a mixed oxide recycle program in LWRs is the diversion of surplus enriched weapons uranium to such utilization as naval reactors. While the diversion may be completely infeasible such a move make available present inventories of new uranium and enrichment capacity to LWRs alleviating short term shortage problems. Because of the interest in such trade offs, this alternative should be discussed in the final EIS.

5. Vol. 1, Pages S-38 to S-40: Table S-8
The titles of these two tables refer to two fuels being considered but only one set of numbers is given.

6. Vol. 2, Page II-29, last sentence of part b: This sentence is not totally true. Some plutonium has been left in wounds when surgery was expected to result in a worse situation than by leaving the plutonium there.

7. Vol. 2, Page II-29, part c: This part could be made specific for environmental radioactive material received into the body via inhalation or ingestion. Wound or injection entry is of little concern in the environment, but important for occupational workers.

8. Vol, 2. Page II-32, part j; and Vol. 3, Page IV. J (c)-1 last sentence: There are data available which suggest an increase with time in plant plutonium uptake from soil. (See J. Environ. Quality, Vol. 2, No. 1, 1973, and Health Physics Journal 19:487-491, 1970.) These data should be discussed here.

9. Vol. 3, Page IV. A-13, last sentence of second paragraph: the standard referred to in this sentence should be referenced or discussed. Such a standard has not been, to our knowledge, proposed by a recognized radiation standard setting group.

10. Vol. 3, Page IV. J. (A)-9: The numbers used in the population dose commitment equation cannot be considered conservative since higher P/A and lower deposition velocity values have been strongly suggested. Both of these trends would increase the dose.

11. Vol. 3, Page IV. J. (C-7, second paragraph: The ingestion pathway should not be dismissed as a potential pathway for exposure to actinides. If gut absorption increases and plant uptake increases (both are possibilities), then this pathway could be as important as important as the air pathway.

12. There is apparently a contradiction in philosophy concerning fission-gas-release in MOX fuels (p. IV C-51). Since this aspect is related to fuel rod performance (and safety) characteristics, the question of significant or insignificant increases in fission-gas-release should be resolved and included in the final statement.

13. p. IV J (A)-2 A semi-infinite cloud dose calculation was utilized in WASH-1327 to compute the dose due irradiation by nuclides in the atmosphere. A comparison of external gamma whole body dose calculations using finite and semi-infinite cloud dose models is presented in EPA-520/1-74-004(1). It is noted that at close distances to the facility stack a semi-infinite cloud assumption results in a very low ground level concentration and gross underestimates of dose since it ignores gamma rays emanating aloft. Therefore, a finite cloud rather than a seminfinite cloud dose model should be utilized to compute close in external doses from evaluated atmospheric emissions of radionuclides.

14. p. IV J (A)-2 A value of 7mg/cm was assumed for the density thickness of the dead layer of the outside of human skin in computing " the beta dose. New values of epidermal thickness are reported by Judi T. Whitton (2) and it is recommended that "for radiological protection purposes it is appropriate to replace the value of 7mg/cm , currently used for minimal epidermal thickness on all body sites, by a value of 4mg/cm for average epidermal thickness." We concur with the recommendation by Whitton.

15. In determining the dose rate from airborne beta radioactivity, it is stated that a graph (Fig. 7.5, Meteorology and Atomic Energy, 1968, p. 332) was utilized to determine the maximum beta rad dose versus maximum beta energy through a 7mg/cm absorber. Because of an error in the apparent absorption coefficient, the dose at a depth of 7mg/cm is low in Fig. 7.5 of Meteorology and Atomic Energy, 1968 (3). The depth dose values in Figure 7.5 utilizes results from equation 7.25c on p. 331 (3) which is in error by a factor of 2. The correct simplified expression for the apparent absorption coefficient obtained from Loevinger, et al. (4) is as follows:

$$v = \frac{18.6 \text{ cm}^2/\text{gm}}{(E - 0.036)\ 1.37}$$

where v = apparent absortion coefficient
E = maximum beta energy emitted

Therefore, the low beta depth dose values presented in WASH-1327 should be recomputed based on an average epidermal thickness of 4mg/cm and corrected apparent absorption coefficient values. The graph on p. 332 of Meteorology and Atomic Energy, 1968 (3) should not be utilized for depth dose values.

16. pp. IV J (A)-3-4 Since the INREM computer code was used to compute the 50-year dose commitment from the inhalation and ingestion of radionuclides, the pertinent assumptions utilized in this code should be presented in WASH-1327. The information presented in WASH-1327 regarding INREM is not complete enough to allow an evaluation of dose assessment

techniques to be made so conclusions cannot be reached regarding the validity of the presented dose commitment estimates in WASH-1327. A complete copy of the code with an explanatory text should be made available to all reviewers so that an evaluation of the INREM dose assessment techniques can be made.

17. pp. IV J (A) -7-8 In the analysis of the aeolian pathway, only the Pasquil D dispersion regime was considered in computing the generalized aeolian dilution factor values. Ignoring other representative dispersion regimes significantly underestimates the annual average χ/Q value for the 100 m chimney release at 500 meter downwind. More representative assumptions would result in a value of similar magnitude to those presented for downwind distances of 1, 1.3, and 2.5 kilometers. Reference 5 presents annual average χ/Q values at 500 meters for 25 LWR site regimes and an average value of 6.157×10 sec/m is reported for a 100 meter release hight. The 500 m value for the m chimney release in Table IV J-(A.1) should be modified to reflect more reasonable dispersion values and any dose calculations made using this dilution factor should be corrected since they underestimate the dose by approximately 10,000.

References for comments 14-17:

1. Martin, J. A., C. B. Nelson, and P. A. Cury, AIREM Program Manual- A Computer Code for Calculating Doses, Population Doses, and Ground Depositions Due to Atmospheric Emissions of Radionuclides, Office of Radiation Programs, U.S. Environmental Protection Agency, Washington, D.C., EPA-520/1-84-004 (May 1974).

2. Whitton, Judi T., "New Values for Epidermal Thickness and Their Importance, "Health Physics, Vol. 24, pp. 1-8 (January 1973).

3. Slade, D. H., ED., Meteorology and Atomic Energy 1968, U.S. Atomic Energy Commission/Division of Technical Information (July 1968).

4. Loevinger, R., E. M. Japha, and G. L. Brownell, "Discrete Radioisotope Sources," Chap. 16, Radiation Dosimetry, Academic Press Inc., New York (1956).

5. Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions for Operation to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents, Prepared by the Directorate of Regulatory Standards, U.S. Atomic Energy Commission, Vol. 1, p. 6B-32, Table 6B-2, WASH-1258 (July 1973).

18. Page IV H-2; lines 26 and 27

Indicate the basis for the waste generation rate of 4 x 10 ft per year and the burial ground acreage requirement. These values appear to be quite different from numbers obtained from WASH-1539 and ORNL TM-3965.

Page IV H-4; Accident and General Exposure Sections

Indicate or reference the basis used for the factor numbers and original dose numbers.

19. Page IV H-4; Accident and General Exposure Sections

Indicate or reference the basis used for the factor numbers and the original dose numbers.

20. Page IV H-7; Uranium Mills Section

Indicate the basis used for calculating the curie release.

21. Page IV H-10; line 20

Indicate basis for volume and radioactivity of waste generated in 1990.

22. Page IV H-32; lines 6 and 7

Indicate other kinds of low-level liquid wastes which will be produced and why they can't be cleaned up and recycled. In considering solidification indicate other alternatives which are available besides cementing.

23. Page IV H-39; lines 13-15

Could the radioactive liquid wastes be recycled? In considering solidification indicates other viable alternatives available besides cement.

24. Page IV H-40; lines 4-6

After the processing of the contaminated water for the removal of radioactivity indicate what is done with the processed water. Indicate what methods and limits will be used to distinguish between uncontaminated and contaminated water.

25. Page IV H-46; lines 14 and 15

Since the AEC is eliminating the routine use of surface and near surface techniques that depend on soil to remove radioactivity from liquid wastes (WASH-1202-73 p. 27) the statement concerning high absorptive capacity of the soil should be further clarified as perhaps a 3rd or 4th order protective device and not as a secondary backup as might be inferred.

26. Page IV H-51; line 25

Show the basis for the assumption of waste radioactivity concentration of 0.003 Ci per ft .

27. Dose calcuations for the dropping and rupture of a waste canister at the Retrievable Surface Storage Facility (RSSF) are made at a distance of 5 miles from the facility stack. This 5 mile distance is stated to be the closest assumed access for a member of the public. If this 5 mile exclusion distance is not a documented siting policy for the RSSF then dose calculations should be presented for distances closer to the facility stack. As a minimum, the reason for the use of the 5 mile exclusion distance should be presented.

28. It is not made clear in the EIS the extent to which plutonium is or is not the dominant environmental consideration. A thorough discussion of the sources, biological availability, and the metabolism of the transplutonic isotopes would be helpful for evaluation of the EIS. Durbin has presented data on the differences in metabolism of transplutonic elements (P. W. Durbin, Distribution of the Transuranic Elements in Mammals, Health Physics 8:665-671 1962). Additional information on distribution and metabolism variations both by isotopes and by species and age for plutonium and transplutonic isotopes can be found in the Proceedings of the Hanford Symposium on the Biological Implications of the Transuranium Elements Health Physics 22 #6, 1972. Implications of these differences should be included.

29. Page IV, J-2. Because only fatal cancers are enumerated in the EIS, the somatic health effects listed underestimate the projected impact by a factor of two. If the total cancer incidence, not just cancer fatalities were included in the EIS, an additional perspective would be provided.

30. Page IV, J-3, Table J-1, there is evidently a misprint. Appendix A to Chapter IV-F is limited to some effluent information pertinent to the uranium mining and/or milling industry; but it does not give the basis for the man-rem number listed in the succeeding Tables.

31. Page IV, J-7 c, second paragraph. Differences between the physical and chemical characteristics of Pu fallout and particulate Pu from mixed oxide fuels should be described so that the reader can judge the relevancy of fallout plutonium to the problem of interest here. Indeed it would be helpful to discuss the particulate nature of Pu in mixed oxide fuels early in the Chapter.

32. Page IV, J-7c, third paragraph. ICRP #6 page 8 would seem to contradict the conclusion that the absence of a consideration of hot particles is a satisfactory state of affairs to standard setting bodies. The Los Alamos reference offered for the assertion given in the EIS is inadequate support for this assertion in view of the statement by Sanders, Thompson and Bair in AEC Symposium Series 18, "Nonuniform irradiation of the lung from deposited radioactive particulates is clearly more carcinogenic than uniform exposure (on the basis of total lung dose), and alpha radiation is more carcinogenic than beta irradiation."

33. Page IV, J-8, second paragraph. This one sentence paragraph could mean that either the particulates in MO fuels are not subject

to accidental distribution or that no health consequences due to particulates would follow such an event. Either way, this important conclusion should be discussed in full with better documentation.

34. Page J-14, Table J-13. In view of the possibility (see earlier comment) that the increased dose from mixed oxide fuel fabrication and reprocessing does not out weigh the reduced dose from less mining use of the label of "Risk Reduction" may be premature.

35. Page IV, J(A)-2. From the text in "Meteorology and Atomic Energy" it would appear that the Fig. 7.5 (ibid) referred to here was based on an incorrect calculation of beta-ray attenuation in skin. The sensitivity of the results presented to this error should be evaluated or better yet use Martin Berger's more recent calcuations in Health Physics, Vol. 26, No. 1, January 1974,

36. Page IV, J(A)-3, second paragraph. Applicability of data from the "particular plot of ground" at ORNL to rest of the United States should be discussed in terms of soil characteristics, climate, cropping practices, etc., so that the importance of this study can be placed in perspective by the reader.

37. Page IV, J(A)3. The estimate of environmental concentrations of I-127 and H (water vapor) are quite critical to the final risk evaluations and should be documented in full. Variations in these parameters could affect large portions of the population, for example persons living in regions with iodine deficient soils. Perhaps those cases should be discussed also.

38. Page IV, J(A)-4d, first paragraph. The breathing rate used is for a "reference man." Consideration should be given to other members of the population also. Were women and children not considered?

39. Ibid, 1, fourth paragraph. That the range of resuspension varies between 10^{-2} - 10^{-13} should be referenced to the original source documents. It is not clear that this range is appropriate for plutonium in the environment or that 10^{-13} has been verified experimently.

40. Ibid, 1, last paragraph. Has the purported decrease of resuspension with time been observed in areas other than desert type such as used for bomb testing? Changes in the amount of resuspended plutonium in the vicinity of Rocky Flats, which is more likely to be similar to the problem of interest here, would help show the general applicability of these data. In addition, particulate resuspension in urban and suburban areas should also be considered in the EIS.

41. Page IV, J(A)-5, fifth paragraph. If the longest study of resuspension decreasing with time is, as reported in the EIS, eleven months, the 50 day half life used here corresponds to a reduction of about 30 in plutonium resuspension. The applicability of such data to a reduction of 100,000 (as is done in this EIS) should be justified by an appropriate analysis, since the magnitude of the lung doses is quite sensitive to the resuspension variables.

42. Page IV, J(8)-8. AEC reports documenting the k factors used to calculate dose are not described in the EIS. The selected conversion factors may be valid but there is no way of examining the underlying assumptions used in their development.

43. Page IV, J(B)-1, first paragraph. Animal experiments have identified the need to know the physical and chemical forms of the transuranics since any anticipated distribution is closely related to these questions. Animal experiments have also identified definite species differences which make extrapolation to man uncertain. As pointed out by Engel (S. Engel, Comparative Anatomy and Pulmonary Air-Cleansing Mechanisms in Man and Certain Experimental Animals, Health Physics 10:967-971, 1964): "I should like to stress that neither the lung of the dog nor cat are typical examples of the mammalian lung. In other words, if either animal is used for laboratory experiments, this fact must be borne in mind." Current studies on morphometrics of the lungs of experimental animals at Lovelace Foundation show definite differences between man and dogs, rats and hamsters. The differences include branching angles, branching angle as a factor of parent airway diameter and functional anatomy. (Respiratory Tract Deposition Models Project Staff Reports, Dec. 1972, March 1973, July 1973 and April 1974). Additional information on species age and isotope interrelationships can be found in the Handbook of Experimental Pharmacology XXXVI, Uranium•Plutonium•Transplutonic Elements, Springer-Verlog, New York, 1973. Particularly Chapter 10 (Distribution, Excretion and Effects of Plutonium asa Bone-Seeker) and Chapter 18 (Metabolism and Biological Effects of the Transplutonium Elements). Perhaps, the relevance of animal data to the problem of interest here should be critiqued so that the reader will not read too much into the reported results.

44. Page IV, J(B)-1, third paragraph. The body of data on distribution and retention of ^{239}Pu in man is severely restricted by the fact that only selected tissues have been analyzed and they may not be the appropriate ones. Transuranium Registry data show that any of a wide variety of tissues may have the highest organ concentration of plutonium and until sufficient data are obtained it

will be difficult to adequately assess the problem in man (United States Transuranium Registry Summary Report to June 30, 1974, HEHF #22, 1974).

45. Ibid, last sentence. Comparative pathology is not so far advanced that one can assume that pathological changes observed in animals are a true or adequate picture of the hazards to man from transuranics. For example the majority of lung malignancies reported in animals after plutonium inhalation are adenocarcinomas or other peripheral cancers. However as Kuschner points out:

> I feel very strongly that the term tumors of the lung is an unfortunate one. Even cancer of the lung is an unfortunate term. I think all of us here know that cancer is a disease of a tissue, not of an organ. There are particular determinants that relate to the production of a bronchogenic carcinoma that probably do not hold for tumors of more peripheral sites.
>
> I believe that we can study the mechanism of malignant transformation and the factors that relate to it in any part of the body and in any tissue. Perhaps peripheral lung tumors are a convenient method of doing this, but they don't relate to the immediate problem; that is, what are the particular factors that go into the induction of - and the pathogenesis of - bronchogenic carcinoma in humans.
>
> It is for this reason that I think the induction of pulmonary adenomas, or adenocarcinomas, is not pertinent to the lung tumor problem. They are pertinent to the tumor problem, but not to specific induction of the lung tumor that we are concerned with, bronchogenic carcinoma.
>
> I think it might be important, too, in regard to Dr. Sanders' presentation these Proceedings, pp. 285-3031, to point out that as far as I know the tumors produced by J. F. Park and by C. L. Yulie were all peripheral tumors of alveolar orgin. Some of the dosage inconsistencies between alpha and beta emitters which did produce bronchogenic carcinoma might perhaps be explained by the fact that we are dealing with a different tissue.

(S. Laskin, M. Kuscher and R. T. Drew, Studies in Pulmonary Carcinogenesis, pp 321-351 in Inhalation Carcinogenesis, AEC Symposium Series #18, 1970). Also a discussion of the comparative pathology of "lung tumors" is presented on pp 467-472 of the Panel Discussion in Morphology of Experimental Respiratory Carcinogenesis (AEC Symposium Series #21, 1970). The use of such data to evaluate health effects in humans should be fully explained.

Page IV, J(B)-2, third paragraph. The statement in the EIS that "Unfortunately no evaluation of economic cost that might be due to the linear assumptions, as compared to other assumptions, has yet been done" might be more appropriate in the cost-benefit section. The idea that the dose-risk relationships used to evaluate potential health impacts from nuclear energy should be subject to a cost benefit analysis has important public health policy implication and should either be explored further in a "generic" impact statement of this type or deleted.

46. Page IV, J(B)-4. The genetic effects calculations referred to in Table IV, J(B-1) and in the fourth paragraph are adequate for a population which replaces itself in a 50 year period, that is the replacement rate (birth rate) is 2% per year. If the birth rate is more than 2% per year or less than 2% per year these genetic risk estimates will proportionately increase and decrease accordingly. This should be stated.

47. Page IV, J-(B-4), second paragraph. Reference if any should be cited for the zero effects estimates and the value of the assumed threshold dose rate used here.

48. Page IV, J(C)-7, 2, first paragraph. The statement that the BEIR report calculates average dose and estimates tumor incidence on the basis of the uniformly irradiated lung is inaccurate. BEIR report lung tumor estimates are based on the radiation dose to cells of the bronchial epithelium and it is explicitly so stated. (BEIR, Summary of Risk Estimates for Bronchial Cancer, p. 150). The specific risk estimates are for irradiation of the basal cells of the bronchial epithelium as indicated in the BEIR report (p 148, p 154 BEIR Report). This EIS should be corrected to accurately reflect what the BEIR report says of the BEIR report is referenced.

49. Page IV, J(C)-8a. Since the sample size in the Las Alamos study referred to makes a negative finding almost inevitable, the probability of a type II statistical error, false negative, should be given to avoid possible erroneous conclusions. Rough calculations using values of 1 rad/year bone exposure and 8 rad/year lung exposure

(the approximate average annual dose rate for the maximum accumulated organ dose reported in A Twenty-Seven Year Study of Selected Los Alamos Plutonium Workers, LA-5148-MS, 1973) yield an annual dose estimate of 250 man rem in bone and 2000 man rem in lung for the 25 workers in the Los Alamos study.

Using BEIR report risk estimates there would be an annual risk of 8×10^{-2} lung cancers and 3×10^{-3} lung cancers in the workers. If the 1966-1968 Connecticut Tumor Registry mortality data are used the follow-up time required to observe a radiation related increase in mortality can be calculated.

To observe a difference in exposed and a normal populations at the 90% level a 33 year follow-up would be required in the lung cancer and a 667 year follow-up in the bone cancer evaluations. For a 95% level 53 years and 1098 years respectively would be required.

The follow-up time required would be further increased by the length of the latent period before induction of the cancer. If a 20 year latent period is used the difference between exposed and a normal population, if present, probably would not be identifiable until the year 2020, a period of time beyond the expected lives of those workers discussed in the Los Alamos Study.

The low relevance of negative findings in the Los Alamos Study population at the present time should be explained to put the information in perspective.

50. Page IV, J(C)-7. Several general questions concerning LA-5483, used here as part of the EIS should be answered before its applicability to human risk evaluation is accepted by the AEC.

Can "oat cell" carcinomas be produced in animals by irradiation with any radiation type or is it strictly a human cancer?

Have animals exposed to radiation, particularly external radiation, been adequately examined to insure that reported lung tumors are primaries, not secondaries to Harderian gland tumors (rodents) or mammary tumors (dogs and rodents)?

51. Page IV, J(C)-9, 4. The "animal data" comment concerning use of animal data for comparative pathology page IV, J(B)-11 also applies here. In addition, the admonitions of Bair (W.J. Bair, Inhalation of Radionuclides and Carcinogenesis, pp. 77-101 in Inhalation Carcinogenesis, AEC Symposium Series #18) might also be considered:

> The experimental animal studies have clearly demonstrated the carcinogenicity of radionuclides deposited in the lung. Though we are tempted to extrapolate these results to man, at least qualitatively, we are well advised to exercise caution, because radon and radon decay products have not induced lung cancer in experimental animals, yet are strongly suspect as being the cause of lung cancer in miners. Extrapolation of experimental animal data to man on a quantitative basis can be even more misleading because a common denominator for comparing radiation doses to lung tissue has not been identified. Thus, it is difficult to relate the doses estimated for the bronchial tissues of the uranium miners to the doses calculated for the experimental animals. It would seem urgent that the next generation of experiments be directed toward this problem. Factors which need evaluation are the relative susceptibilities of human and experimental animal tissues to radiation-induced cancer, the relative latent periods for the induction of cancer in man and other species, possible species differences in the rates of clearance and translocation of inhaled radionuclides, and a number of other factors which pertain to the still unknown mechanisms of tumor induction. A serious obstacle to evaluating results of animal experiments with inhaled radionuclides and extrapolating them to man is the difficulty in identifying the effective biological target tissue in the lung and measuring the radiation dose to that tissue.

That the state of the art has not advanced much beyond that point, should be made clear to the readers of the EIS.

52. Page IV, J(C)-10, third paragraph. Implying that plutonium deposition in lymph nodes only rarely induces tumors in lymphatic tissue is probably erroneous and/or specious. Bair et al (W. J. Bair, J. E. Ballou, J. F. Park and C. L. Sanders, Plutonium in Soft Tissues with Emphasis on the Respiratory Tract, pp 502-568 in Handbook of Experimental Pharmacology XXXVI. Uranium - Plutonium - Transplutonic Elements, Springer-Verlog, New York 1973) mention some reported malignant lymphomas and also the possibility that plutonium deposited in lymph nodes may cause thoracic sarcomas by irradiating local endothelial and mesothelial tissues.

Of the malignant lymphomas, two observed in dogs and several in rats after inhalation of plutonium were reported "..., but the incidence was probably not greater than in controls." In the two cases reported for dogs the pattern of lymph nodes involved was not readily relatable to the nodes with greatest plutonium deposition nor to natural lymph drainage patterns since one involved mandibular and mesenteric nodes the other all nodes and viscera (E. B. Howard, The Mophology of Experimental Lung Tumors in Beagle Dogs, pp 147-160 in Morphology of Experimental Respiratory Carcinogenesis, AEC Symposium Series #21, 1970). One lymphoma was reported in a dog after subcutaneous injection of plutonium oxide. However, in this case also the distribution of lymph nodes involved suggests the retrograde movement of plutonium in the lymphatic system would be needed. Since only the prescapular lymph node (not involved in the malignant lymphoma) appears to have been radioassayed it is difficult to tell if there was any plutonium in other nodes (J. L. Lebel, E. H. Bull, L. J. Johnson and R. L. Watters, Lymphosaicoma Associated with Nodal Concentration of Plutonium in Dogs: A Preliminary Report, Amer J. Vet. Res 31: 1513-1516, 1970). In studies done by Bistline (R. W. Bistline, Translocation Dynamics of 239-Plutonium, C00-1787-20, 1973) there is no indication of transfer of Pu from regional lymph nodes to contralateral nodes or visceral nodes. Further, Dagle (G. E. Dagle, - Lymph Node Clearance of Plutonium from Subcutaneous Wounds in Beagles, C00-1787-18, 1973) reporting on pathology of lymph nodes containing plutonium states:

"The eventual sequesting of plutonium in the scar tissue of lymph nodes probably alleviates the potential of the alpha radiation damaging the host. The alpha particles only penetrate soft tissues up to 50 and the presence for rather hypocellular scar tissue of this distance around the plutonium means that the alpha particles have ceased to come in contact with parenchymal cells. If parenchymal cells are no longer damaged directly by irradiation, there may be less chance of mutagenic or other action causing tumor induction.

The final lymphoma reported was seen in a pig following intradermal injection of plutonium. This lymphomas is also probably nonrelevant since the doses administered were split to between 18 and 152 separate injection sites (J. W. Cable, V. G. Horstman, W. J. Clarke and L. K. Bustad, Effects of Intradermal Injections of Plutonium in Swine, Health Physics 8:629-634, 1962) so that many regional lymph nodes would be involved and irradiated. However, the lymphosarcoma developed in a visceral node, the hepatic lymph node. Thus, there is no causality demonstrated in any lymphatic tumors associated with Pu. The observation of lymphoproliferative diseases

in occasional animals is not unexpected and should be placed in perspective if mentioned.

53. Page IV,J(C)-15. Inhalation studies in beagles are poor sources of data since the doses administered were so large that radiation fibrosis and edema were induced. These processes isolated that inhaled material and destroyed normal physiology and histology. As Howard reported (E. B. Howard, The Morphology of Experimental Lung Tumors in Beagle Dogs pp 147-160 in Morphology of Experimental Respiratory Carcinogenesis, AEC Symposium Series #21, 1970) in the beagles the following relationships were observed, an alveolar deposition of 0.1 μCi/g or more, associated with acute death, 1-12 months post exposure; 0.05 /g with subacute death, 1-5 years post exposure and only at doses of about 0.01 μCi/g is the delayed effect response observed. Bair etal (W. J. Bair, J. E. Ballou, J. F. Park and C. L. Sanders, Chapter 11 Plutonium in the Soft Tissues with Emphasis on the Respiratory Tract, pp 503-568 in Handbook of Experimental Pharmacology XXXVI, Uranium•Plutonium•Transplutonic Elements, Springer-Verlag, New York, 1973) report that 39% of the beagles died of lung neoplasia and 100% of those surviving more than 1600 days past exposure died of pulmonary neoplasia. There were two mortality curves extractable from the data, one for fibrosis (5-900 nCi/g deposited), the other for neoplasia (3-45 nCi/g deposited). The exposure levels for most of the beagles was too high to allow delayed effects-neoplasia-to develop Results are not at all representative of what might be expected at lower exposure levels. Current experiments using lower exposure levels may be more pertinent to expected population exposures. These facts should be made clear to the reader.

54. Page IV, J(C)-16, second paragraph. The assumption of relationship of lymphopenia, lymph node pathology, reduced immunocompetancy and pathogenesis of plutonium-induced lung tumors should be explained and justified.

55. Ibid, fourth paragraph. It is premature to state the gonads are not critical organs. Effects of plutonium on gonads have not been examined for below the level of acute effects. Studies on pre- and post-natal wastage, future reproductive capacity, teratogenesis or other congential effects on progeny have not been tested for. Ovcharenka (E. P. Ovcharenko, An Experimental Evaluation of the Effects of Transuranic Elements on Reproductive Ability, Health Physics 22:641, 1972) reported decreased viability, delayed physical development, disturbance of blood formation, change of radiosensitivity and depression of sex function in offspring of animals receiving ^{239}Pu or ^{241}Am and increased uterine death in

offspring of males, receiving the same isotopes, mated to normal females. These results imply direct effects on the gonads and/or the reproductive tract. The data on biological distribution and estimated dose provided by Fish etal (B. R. Fish, G. W. Keilholtz, W. S. Snyder and S. D. Swisher, Calculation of Doses of Accidentally Released Plutonium from an LMFBR, ORNL-NSIC-74, 1974) suggest that the impact of Pu on the ovaries may not be negligible. The need for further examination of the question should be considered.

56. Ibid, fifth paragraph. The experiments alluded to which are still in progress, while not showing increased mortality in neonates as stated here, have demonstrated an age-related difference in development of tumors and other age differences in response to plutonium insult which is not mentioned. (Seattle 1974, IRRS meeting.) Perhaps the EIS could be more inclusive in describing these studies.

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By Sheldon Meyers, U.S. EPA

1. Comment:

"Until the information requested by EPA to be included in the final statement is available, no final judgement can be made on the environmental acceptability of this program. However, our preliminary findings are that the implementation of plutonium recycle on an industry-wide basis appears to be marginally acceptable from a cost/benefit balance. This analysis indicates that the timeliness of the program implementation does not appear to be critical. With the application of the revised cost/benefit analysis methodology that we recommend, the timeliness may even be less critical and the cost/benefit balance even more marginal. It also appears that the program could result in some environmental advantages. Within this perspective, the principal conclusions reached by EPA on the plutonium recycle program are as follows:

1. Development and implementation of a safeguards program is needed.

2. Waste disposal issues need answers.

3. Accident analysis of Pu reactors is needed."

Response:

The revised cost-benefit analysis has been applied as recommended. The results indicate that plutonium recycle may be more advantageous than concluded in the draft GESMO. See CHAPTER XI, Section 3.0 and 4.0 for the sensitivity analyses presented to show the impacts of delays in the implementation of plutonium recycle.

The safeguards considerations are covered in a draft supplement to GESMO. LWR accident analyses and waste management are discussed in CHAPTER IV, Sections C and H, respectively.

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2. Comment:

"Before actual full-scale mixed oxide fabrication and fueling of light water reactors is commenced, the following should be accomplished:

(a) the safeguards program should be implemented;

(b) the waste disposal concerns about transuranic wastes identified in EPA's review of the draft statement, 'Management of Commercial High-Level and Transuranium--Contaminated Radioactive Waste,' and the proposed rulemaking on transuranic waste should be resolved;"

Response:

Safeguards considerations are assessed in the draft supplement to GESMO. The transuranic wastes will be handled in the same manner as high level wastes. The waste disposal plans for high level waste and for disposal of transuranic waste are discussed in CHAPTER IV, Section H, paragraphs 3.2 and 3.2.1.

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3. Comment:

"Before actual full-scale mixed oxide fabrication and fueling of light water reactors is commenced, the following should be accomplished:

3 Comment Cont'd

(c) accident analysis of specific plutonium recycle reactor designs should be completed for each proposed application and deemed satisfactory."

Response:

A number of revisions have been made to the reactor performance section of final GESMO to make the discussion more quantitative.

From the available information on mixed oxides and experience with plutonium fueled reactors, there is little question that a core utilizing Pu recycle fuel can be operated safely and in a manner approximating operation of a UO_2 core. This point is discussed in final GESMO, CHAPTER IV, Section C-3.0. A general or generic analysis is the objective of GESMO.

There are a number of design limits that would be reviewed on a case-by-case basis, such as fuel temperature limits, fuel rod stored energy, cladding strain limits, etc. These limits are dependent on plant design as well as on fuel type. These limits are reviewed carefully for any design change whether it be a change in cladding thickness, pellet density, or fuel composition. Based on the generic review of mixed oxide properties and fuel performance, it is concluded that safety analyses will be less dependent on plutonium content as compared with other design variables.

The Commission's regulations, as stated in Section 50.34 of 10 CFR Part 50, require that each applicant requesting a construction permit or operating license for a nuclear power plant or a fuel reprocessing plant provide an analysis and evaluation of the design and performance of the structures, systems, and components of the facility, with the objective of assessing the risk to public health and safety resulting from operation of the facility. These analyses include a determination of the margins of safety during normal operations and transient conditions anticipated during the life of the facility and the adequacy of structures, systems, and components provided for the prevention of accidents and the mitigation of the consequences of accidents. All applications to recycle plutonium in LWR's will be evaluated on a case-by-case basis to assure that associated risks to the public health and safety are acceptable. See CHAPTER IV, Sections C-2.0, C-3.0, and C-4.0.

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4. Comment:

"Basically, two comparisons relative to radiation dose and health effects can be made between the MOX cycle and the base LWR case. One is for occupational exposure and the other for the general population. Neither of these discernments are clearly delineated.

"In the case of occupational exposures it would be helpful to identify the types of workers at risk and the sources of information on their exposure. It is not clear in the EIS whether uranium miners were included and if so if their occupational hazards not due to radiation were considered as part of the health impact."

Response:

In final GESMO, animal data for interpretation of effects on man have not been used in the estimates of health risks. Animal data have been used in final GESMO to indicate the types of tumors that may occur. More recent data has been included in final GESMO than that used in the draft. Refer to CHAPTER IV, Section J, Appendices B & C.

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5. [redacted]nt:

"In the EIS, the increased occupational and population exposures from mixed oxide fuel processing are said to be offset by reduced exposures from mining and milling of uranium ore. Indeed an actual overall dose savings is indicated. However, it does not appear that the two cases were similarly treated. To the degree that the dose estimates for mining and milling were based on models which do not reflect the control technology forecast for the 1990's, and exposures from the mixed oxide cycle were evaluated on more realistic effluent releases (ALAP), it is possible that the dose savings shown in the EIS for reduced uranium processing may not balance so favorable the increases exposure from the rest of the MOX cycle. Therefore, the AEC should review the bases for the dose estimates from mining and milling to see if they are compatible with assumptions used to evaluate the dose from other sources of exposure."

Response:

For the final GESMO all the bases for estimating effluents along with conversions for each step in the supporting uranium fuel cycle were reviewed and estimates of dose commitments were recalculated using the most reliable procedures currently available for each of the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium.

Results of these estimates are summarized in CHAPTER IV, Section F and are discussed and presented in detail in CHAPTER IV, Section J.

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6. Comment:

"Throughout the discussion on toxity, dose, and health effects, numerous points are in need of clarification or other resolution. These individual points are presented in the additional comments section. However, some issues so pervade the whole discussion that some remarks are appropriate at this point.

"Primary among these is the manner of utilizing and extrapolating animal data to interpretation of effects on man. As precarious as this method always is, the EIS seems to make it even more so by implying a false sense of security in the stated conclusions. A prime example is the area of lung effects utilizing data from dogs and cats which have no common denominator for comparison with human lung effects. This general situation is compounded by a lack of information on experimental procedure, such as chemical form for experiments at high dose rates as a basis to infer effects on man at low dose rates."

Response:

In final GESMO, animal data for interpretation of effects on man have not been used in the estimates of health risks. Animal data have been used in final GESMO to indicate the types of tumors that may occur. More recent data has been included in final GESMO than that used in the draft.

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7. Comment:

"Some other issues include the need to examine the potential effects of other transplutonium radionuclides in order to place them in perspective and premature biological conclusions such as assuming the gonads to not be a potential internal organ. These areas of ambiguity present a case which may well be misleading and this matter should be resolved in the final EIS. We feel that our detailed comments previously referred to along with the references we have presented should be of assistance in carrying this out. Although the results will probably not change conclusions relative to the program's acceptability they will certainly more clearly state the related impact and the degree of uncertainty associated with it."

Response:

In final GESMO, attempts were made to address all radionuclides in a consistent manner. However, with the interest in plutonium specifically, Appendix C of CHAPTER IV, Section J, was added to amplify the discussions on plutonium.

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8. Comment:

"The primary area of concern relative to environmental pathways is the direct inhalation interface involved with the resuspension of plutonium from soils.

"...The other major comment of environmental impact assessment is that the pathways used are not described in enough detail to make an assessment of the thoroughness of the analysis. However, when comparing the dose per curie released used in this report with the dose per curie release from the EPA analysis of the uranium fuel cycle, similar results are obtained. Thus, it appears that the analysis of long-lived isotopes particularly tritium, krypton-85, and iodine-129 did include the use of long-time span pathways even though the report does not describe these pathways. However, the population dose commitment estimates presented in the draft statement do not appear to consider world population growth over the time period of the release radionuclides existing in the environment. We feel that calculations of population dose commitments which extend over many decades should take into consideration world population growth during that period."

Response:

The calculations of population dose commitments for the world population have been added to final GESMO. CHAPTER IV, Section E discusses the dose commitments from tritium, krypton-85, carbon-14, and iodine-129. All dose commitments presented in final GESMO are 50-year dose commitments.

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9. Comment:

"Several sections of GESMO describe the expected radiation dose from transuranium elements. Information should be included in the final statement which should indicate the pathways for transport of transuranium elements to man. Any difference in chemical behavior assumed for elements other than plutonium should be included."

Response:

The final GESMO, CHAPTER IV, Section J contains details of the radiological health assessments. The dose calculation methodology is included in Appendix A of CHAPTER IV, Section J. Aeolian, air-borne emission, pathway modeling for individual exposure included inhalation and radon-222 pathway. Hydrological (water-borne emission) pathway modeling for individual exposure included drinking water, eating

fish, irrigated vegetation, beef and milk, and external pathways. Population exposure pathway modeling is also described.

CHAPTER IV, Section J, Appendix C summarizes data on plutonium in the Environs and in Fauna.

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10. Comment:

Definition of Wastes

"The AEC has defined only three catagories of 'other-than high-level' wastes; low-level beta-gamma waste, low-level plutonium bearing or alpha waste, and fuel cladding hulls. The present classification system for 'other-than' waste, however, gives no indication of the activity, content, or hazard potential of the waste, except that it is not 'high-level' waste. The lack of clear definitions for these wastes presents great difficulties for those who ship wastes, for those who receive wastes, and for EPA, particularly in determining the potential health and environmental impact of the wastes, and we therefore, would like to see the AEC develop a more detailed, formal classification for 'other-than wastes..

"Our concerns about the waste classification problem were discussed in EPA's comments on the LMFBR program draft environmental statement and will be discussed in more detail in comments on the Management of Commercial High Level and Transuranium, Contaminated Radioactive Waste draft environmental statement."

Response:

In final GESMO the various categories of radioactive wastes are reviewed in CHAPTER IV, Section H-2.0, Radioactive Wastes from the LWR Industry.

Wastes containing radioactive isotopes are generated from all segments of the LWR industry. Wastes from the uranium feed chain contain only naturally occurring radioisotopes, but the wastes from other segments of the nuclear fuel cycle contain radionuclides produced by reactor operations. Wastes from present mining and milling operations contain naturally occurring concentrations of radioisotopes and are generally stored on the earth's surface at the mine or mill site. Those wastes that contain sufficiently low levels of reactor generated radioisotopes, or have concentrations of natural isotopes somewhat greater than those occurring naturally, are disposed of in licensed burial facilities. For this analysis, it is assumed that wastes containing significant amounts of transuranic radionuclides will be sent to Federal geologic repositories. Also, paragraph 2.1 summarizes the sources and types of waste generated by each segment of the LWR industry, and discusses the planned or projected method of disposal. The volumes of the various wastes generated by the LWR industry for each of the recycle options are estimated for the period 1975 through the year 2000.

Waste classification will be addressed in the environmental statements related to the management of post-fission radioactive wastes.

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11. Comment:

Predicated Volumes for 'Other-Than' Wastes

"There appear to be some discrepancies between the volumes of the 'other-than' wastes currently being buried and the amounts predicted in the draft statement EPA has recently completed a preliminary assessment of commercial 'other-than' waste volumes, activity, and space requirements(1). In particular the AEC estimates yearly and accumulated quantities of radioactive wastes buried appear to be somewhat underestimated when compared with the results of the EPA assessment. The AEC should re-evaluate their estimates based on the EPA information and other AEC information(2)."

Response:

Waste volumes for each of the fuel cycle operations with and without recycle have been recalculated for the final GESMO as indicated in CHAPTER IV, Section H. These calculations are based on the most current information available. Low level wastes that are disposed of by commercial burial come from many sources in addition to fuel cycle and reactor operations, e.g., hospitals, and biological laboratories. There is only a fractional correlation between the GESMO figures and the total wastes buried. The subject of commercial operation of waste burial grounds is currently being evaluated by the NRC.

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12. Comment:

"The AEC should be more explicit in the final statement concerning the methods used to estimate the volume of future 'other-than' wastes from the MOX fuel cycle and how these predicted volumes fit into the total nuclear waste disposal picture. EPA feels that resolution of these points is essential to an evaluation of the environmental impact of the proposed MOX waste management program."

Response:

Data on wastes generated are presently in the descriptions of each component of the final cycle presented in CHAPTER IV. The quantities used are based on actual operating experience from commercial plants. Where commercial size plant experience is not available, estimates have been made from extrapolations from pilot size plants, i.e., MOX fuel fabrication. The subject of waste management is specifically addressed in CHAPTER IV, Section H.

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13. Comment:

Segregation of Transuranic Contamination Wastes

"'Other-than' wastes from the MOX fuel cycle are expected to be richer in Pu and other alpha contaminants than wastes from the other fuel cycles. This will mean that significant quantities of MOX wastes, which would have been channeled into land burial at commercial burial grounds, would not be placed in interim storage and later transferred to a national repository for disposal or treatment. The economic impact of this policy change on the total costs of power production and on the operations of the commercial burial industry should be considered.

13 Comment Cont'd

"The final statement should indicate the technical arrangements that will be made to screen the 'other-than' wastes for transuranium contamination and to prevent the accidental dilution of the transuranium - contaminated wastes to less than 10 nanocuries per gram."

Response:

The costs of disposal of alpha wastes generated by MOX fuel cycle operations have been included in the cost estimates associated for each such operation.

The technical details for the implementation of a proposed 10 nCi/g limit have yet to be developed. At this time of writing, it is anticipated that a system based on the source of specific wastes will be employed by most MOX fuel cycle plants. The 10 nCi/g figure is not a regulation - merely proposed - and is now being reviewed by an NRC Task Force.

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14. Comment:

Commercial Burial Grounds

"Shallow land burial is the present and proposed method for disposing of the nontransuranic 'other-than' wastes. The AEC should present or directly reference in the final statement the results of any studies which have been conducted at the commercial burial sites, subsequent to the beginning of burial operations which could corroborate or validate the conclusions reached in the original evaluation that buried radioactive waste will not migrate from the sites. Also, any monitoring data or other evidence which confirms that the radioactive waste now buried has remained immobile at the place of burial should be submitted or directly referenced."

Response:

The subject of disposal of low level wastes by shallow land burial is much broader in scope than merely its application for non-alpha fuel cycle wastes. For this reason, and because of its focus on the recycle of uranium, the generic subject of low level waste disposal is beyond the scope of GESMO.

There is an on-going EPA-USGS-NRC study of the potential environmental effects of shallow land burial practices.

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15. Comment:

"The draft ETS indicated the maximum credible accident at any RSSF to be the rupture of a single canister. However, since the AEC indicated the possibility of a loss-of-cooling accident, we feel that the environmental impact of this type of accident should be discussed in the same degree of detail as the single canister accident. These analyses address the additional 30% heat loads and higher radiation levels affect safety margins, facility designs or costs."

Response:

Alternatives of the RSSF were modeled in the draft GESMO and the effects on the environment were assessed based on this concept of storage/disposal of radioactive wastes.

15 Comment Cont'd

With the engineering features incorporated into the designs of water pools for storage of spent fuels or waste canisters, with emergency power and water supply systems, and with the time element available to take corrective actions, a melt down from loss-of-cooling accident in a water storage basin is not judged to be credible.

In final GESMO the model radioactive waste management facility is the Federal geologic repository. Refer to CHAPTER IV, Section H, paragraph 3.2.

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16. Comment:

"With the increase of total transuranics present in the high level MOX wastes and the change in the mix of these transuranics, the final statement should discuss how this affects the time required to retain the wastes in some ultimate disposal site and which radionuclides are of primary concern after 10, 100, 1,000, 10,000, 100,000, and 1,000,000 years."

Response:

High-level wastes from MOX fuel reprocessing will contain more transuranics than the comparable wastes from UO_2 fuels. However, the quantity of such radionuclides present, within the ranges involved, does not significantly affect required retention times in a permanent waste repository. Transuranic wastes will be sent to a Federal geologic repository. For details on the fission product and transuranium element content of HLW, see CHAPTER IV, Section H.

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17. Comment:

Reactor Plant

"The discussion of the relationship of mixed oxide cores to reactor safety margins generally presented qualitative evaluations of the MOX to reactor kinetics and reactor control capabilities. In conclusion, the AEC stated that there were no limitations in the use of MOX related to safety. In view of the fact that the draft statement did not consider specific or reference reactor designs, we believe some quantitative details should be presented in support of the conclusion that no safety limitations are necessary. This is particularly important since the MOX, as discussed in the draft statement will have both positive and negative impacts on the levels of margin relative to reactor safety. In order to better delineate the overall quantitative aspects of MOX on the level of the margin of safety, we recommend that the final statement assess the overall change in pertinent safety parameters as itemized in the draft statement, for reference PWR and BWR core designs for several different MOX fuel loadings in the range under consideration. The resulting changes should then be compared, if possible, with the ranges of existing margins in light-water reactors. Although the reference core design may not necessarily be identical to designs or specific reactors, this analysis will enable a conclusion to be reached on quantitative analyses regarding the impact of MOX on safety margins and on the need for specific safety limitations. We assume that, before any operating nuclear plant is licensed to operate with recycle MOX, the AEC will perform detailed safety assessments of the specific core design and will issue an independent safety evaluation report of the results."

Response:

Refer to response to Comment 3 of this letter.

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18. Comment:

Transportation

"The analysis of transportation accidents appears incomplete since no quantitative information is presented for either the probability of an accident in which radioactive materials are released or the consequences of such an accident. The primary reference used to support the AEC conclusion that the radiation risk is small is WASH-1238 which suffers from a similar lack of quantitative information. In particular, with regard to the probability of an accident involving a release there is no analysis relating the shipping container test conditions to the severity of the accident. Thus, the conclusion that the container should withstand a Category 3 (severe) accident without being breached is not substained. With regard to the consequences of an accident involving a release, no estimate of the radiation dose to emergency crews, controversy concerning the quantity of fission products, especially cesium, which may be released is made. An estimate of the external exposure to humans from released radioactive materials was made in WASH-1238. However, it appears the dose to humans from inhalation of the released material may be much greater than received externally."

Response:

This comment has been covered in final GESMO as follows:

The discussion in CHAPTER IV, Section G-5.0, has been expanded to cover shipping container test conditions to accident severity and the substantiation of the claim that a package can withstand a severe accident without breachment.

The discussion in paragraphs 5.3.2 and 5.3.3 have been expanded to include a discussion of probabilities of release and a discussion of release fraction of fission products, especially cesium. Paragraph 5.3.5 has been added for a discussion of the radiological consequences of accidents. A comparison of the lung dose compared to external dose is also discussed in the new paragraph 5.3.5.

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19. Comment:

"A complete risk analysis for the shipment of plutonium in DOT approved containers has recently been completed by Battelle Northwest Laboratories (BNWL-1846). This analysis is an important first step in resolving the issues concerning radiation risk in the transportation of nuclear materials. While this study has not yet received the detailed scrutiny of the scientific community to determine its acceptability, it appears to be of sufficient quality to warrant inclusion of its findings in the final statement. A commitment to perform similar analysis for other shipping pathways should also be made in the final statement."

Response:

The Battelle document referred to in this comment has been referenced in the new discussion in CHAPTER IV, Section G-5.0. The final GESMO is not considered to be the appropriate vehicle for making a commitment to study other shipping pathways.

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20. Comment:

Fuel Reprocessing

"The iodine-129 and -131 source terms for the model fuel reprocessing plant listed in Table E-8 are not in agreement with present estimates by the Oak Ridge National Laboratory based on currently available technology. In the past, many uncertainties have been associated with iodine source terms and control technology that will be utilized to obtain the release rates presented in the draft statement. Also, the final statement should provide a separate listing in the tables of the doses (both individual and population) resulting from the projected radioiodine releases."

Response:

In final GESMO, for the purpose of this assessment, use was made of the conservative estimates of radioactive effluents projected by ORNL for the model fuel reprocessing plant. Conservative estimates were also used of the dose commitments to the thyroid of the maximally exposed hypothetical individual and to the population, if the reprocessing plant released that amount of iodine.

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21. Comment:

"The draft statement does not present information on carbon-14 release rates from either reactors or fuel reprocessing plants.

"Because of its long half-life and its persistence in the environment, carbon-14 which has been discharged from these facilities may result in a population dose commitment significantly greater than from either kryton-85 or tritium. Therefore, we feel that the final statement should present the following information on carbon-14:

a. release rates from both reactors and fuel reprocessing plant.

b. local doses and population dose commitments.

c. a discussion of control technology at both reactors and fuel reprocessing plants."

Response:

At the 13th AEC Air Cleaning Conference, Messrs P. J. Magno, C. B. Nelson and W. H. Ellett, Office of Radiation Programs, EPA, presented a paper titled "A Consideration of the Significance of Carbon-14 Discharges from the Nuclear Power Industry." Among other things, this paper presented an estimate of the amount of ^{14}C which might be produced in LWR fuel, and recommended that the amounts of ^{14}C discharged from the nuclear power industry be defined.

The release of ^{14}C from spent fuel reprocessing operations has not been measured nor confirmed. However, in final GESMO, for the purpose of this assessment, the assumption was made that ^{14}C is released quantitatively during the dissolution of irradiated LWR fuel and that the maximum amount of ^{14}C likely to be present in the irradiated LWR fuel is released to the atmosphere. The environmental effect is shown on CHAPTER IV, Section E, Tables IV E-9 through E-13.

At this time, it is not known whether the hypothesis related to the release of C during the dissolution of irradiated LWR fuel is real or imaginary, and as noted by P. J. Magno, et al, the amount of ^{14}C discharged needs to be defined, and then a decision can be made as to whether it would be practical to remove it from the offgas effluent from the reprocessing plant.

22. Comment:

"The statement is made in several places in the draft EIS (e.g., on pages IV C-20 and IV C-58) that depleted uranium (diffusion plant tails) could be used instead of natural uranium as the diluent for blending with recycled plutonium during fabrication of MOX fuel. This implies a benefit owing to the reduced ore mining and milling requirements and utilization of existing stores of depleted uranium. Elsewhere, however, (e.g., on pages I-14, II-44, and II-55) it is noted that natural uranium shows an economic advantage over depleted uranium. The conditions under which stores of depleted uranium might be used, even though such use is described as 'uneconomic,' should be discussed in the final EIS. If utilization of depleted uranium of tails is not reasonably anticipated, the references to such possible use should be deleted."

Response:

References to natural uranium vs.depleted uranium found on the pages in CHAPTER II represent conclusions reached as a result of the EEI/W and EEI/GE programs quoted in summarizing the work. In the final statement, the model fuel and model fabrication industry is based on the use of natural uranium for MOX fuel. The effects and resulting environmental impacts would be on the conservative side. The eventual use of uranium tails at say 0.3% ^{235}U or recycled uranium at say 0.8% ^{235}U would be dictated by the price levels of U_3O_8. This matter is reviewed in CHAPTER IV, Section D.

References to natural uranium, depleted uranium and uranium tailings in the reactor portion of GESMO are merely to identify various sources of nonenriched uranium that may be mixed with recycle plutonium. Plutonium recycle reduces, or in the case of all recycle plutonium fueled reactors, eliminates dependence on uranium enrichment facilities. Refer to CHAPTER IV, Section C, paragraph 4.

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23. Comment:

"According to CHAPTER IV, page IV C-73 of GESMO, WASH-1258 (Final Environmental Statement Concerning Proposed Rule Making Action for Operation to Meet Criterion "As Low As Practicable") served as the basis for the source term calculations. However, comparison of the source term parameters in GESMO (Tables IV C-9 and IV C-10) with corresponding tables in WASH-1258 reveal certain discrepancies:

"In addition to these differences in basic source term parametric values, the waste treatment systems assumed for the GESMO model reactors are in many instances unlike those systems presented in WASH-1258. These discrepancies should be clarified with respect to the potential effects on environmental releases."

Response:

In final GESMO, the annual releases of radioactive materials from reactors were calculated using GALE, the computer code and models and parameters given in NUREG-006 and -017, Calculation of Releases of Radioactive Materials. Refer to CHAPTER IV, Section C, paragraph 5.1.1.

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24. Comment:

"Table IV C-12 of GESMO has apparently excluded the BWR mechanical vacuum pump (at startup) source term, 2,300 Ci/yr of Xe-133, 350 Ci/yr of Xe-135, and radioiodine (unspecified)."

Response:

The source term for the BWR mechanical vacuum pump (at startup) has been included in final GESMO in Table IV C-14 of CHAPTER IV, Section C.

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25. Comment:

"Table IV C-21 and C-22 are apparently mixed-up. Table IV C-12 shows a higher noble gas source term for the UO fueled BWR but doses from this reactor (i.e., skin and total body doses) are lower than the corresponding doses from the mixed oxide fueled BWR. Similarly for radioiodine, a higher source term is listed for the mixed oxide fueled BWR but higher thyroid doses are listed for the UO fueled BWR. It is not clear whether this conclusion may have filtered to Tables IV C-27 and IV C-28 for annual man-rem doses."

Response:

The calculated annual releases of radioactive materials in gaseous effluents for the model 1000 MWe BWR have been updated in final GESMO, CHAPTER IV, Section C, Table IV C-17.

The updated annual individual doses from atmospheric releases, comparing GESMO model BWR with MOX fuel with the BWR with UO_2 fuel, are included in CHAPTER IV, Section C, Tables IV C-24 and C-25.

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26. Comment:

"EPA considers the benefit/cost study to be insufficient in detail and depth of analysis. In our opinion, the methodology used is incorrect for a number or reasons which will be discussed in the following sections. Even before correction of methodology the cost savings from plutonium recycle are small relative to nuclear electricity generation costs. There are indications that, if corrected procedures for the analysis were used, the cost savings from plutonium recycle may prove to be smaller than reported.

"The debate over recycling revolves around the issues of increased environmental risks to man and the environment, which should be weighed against the benefits to be derived from producing somewhat cheaper power with plutonium recycling. Since risks are balanced against the cost advantages of plutonium recycling, the smaller the cost advantage, the smaller the risks that may be acceptable to society."

Response:

In final GESMO, the cost benefit analysis methodology was modified as recommended and the cost savings of plutonium recycle actually increased over those previously reported. Other benefits of plutonium recycle include resource conservation and reduced environmental impacts resulting from mining, milling, and uranium conversion activities. These factors are also included in the cost-benefit analyses. For detailed analyses, see CHAPTER XI, Section 4.0.

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27. Comment:

METHODOLOGY

"The method of analysis employed in the AEC benefit/cost study does not provide the cumulative LWR fuel cycle industry cost figures for the years 1974 through 1995. Table XI-7 does supply cumulative figures for resources and service commitments, but this table is of limited usefulness since it does not include capital costs.

"Instead the major thrust of the AEC benefit/cost study is a projection of the LWR fuel cycle industry under various alternatives at a '...mature operating level, about 1990...' The cost figures for this year are in Tables XI-4 through XI-6. AEC chose this year because they believe it represents an '...approximate average industry condition for the time span 1974 - 1995' (p.XI-3).

"The methodology used for this AEC benefit/cost study is to measure the fuel cycle costs for a base case, labeled Alternative 1. This base case is then used as a standard of comparison for five alternative cases. The base case represents the reprocessing of the spent fuel and the storage of the plutonium for future use."

Response:

The cost-benefits assessed in final GESMO are now cumulative for the period 1975-2000. The alternatives presented in CHAPTER VIII consider the industry today and the projected industry through the year 2000. The reference or base case, Alternative 3, considers the earliest processing date ∿ 1978 and earliest possible Pu recycle date, 1981. Although it is felt that industry will most likely not be able to meet this goal, the sensitivity analyses included in the economic and environment impacts due to delays will bring out the differentials for each of the three fuel cycles considered; no recycle, recycle of uranium only, and recycle of uranium and plutonium. Refer to CHAPTER VIII, paragraph 4.2.1.

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28. Comment:

"Although this methodology appears to be acceptable, since the LWR's will be operating in either case, it is reasonable to suspect that little reprocessing of spent fuel will occur if plutonium recycle in LWR's is not permitted. With no plutonium recycle, it is likely that most of the spent fuel would be stored for some future use rather than reprocessed within a short time. Such a scenario could lead to significantly smaller impacts in both the reprocessing and transportation areas. We believe that AEC should present more evidence to justify this choice of the base case."

Response:

The base case now the reference case Alternative 3 in the final GESMO is chosen so that comparisons are made on a consistent basis. The differences between cases are the same regardless of which alternative is labeled as the reference case. For final GESMO, the reference case was selected so that alternatives to prompt, widescale recycle could be succinctly differentiated. Part of the comment implies that no recycle, Alternative 6, is more probable than Alternative 5, delayed recycle. While it is stated in the final GESMO that reprocessing without recycle is unlikely, the primary function of GESMO is to assess impacts of the various alternatives. Refer to the detailed discussions of alternatives in CHAPTER VIII, Section 4.0.

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29. Comment:

"Table XI-2 is a summary of the environmental factors for the alternative spent fuel dispositions. No attempt has been made to attach dollar values to these environmental factors. However, it is argued by the AEC that plutonium recycling reduces, to a small extent, the overall impact on the environment. The primary source of this reduction is a decrease in uranium mining, UF_6 conversion and uranium enrichment. In turn, this reduces the need for land and resource inputs, and results in diminished fossil fuel needs. There are some increases in environmental impacts, but they are believed to be negligible in comparison to the reduced environmental factors."

Response:

As discussed in CHAPTER XI, Section 4.0 in final GESMO, it is difficult to evaluate whether the environmental reductions from recycle are more or less important than the reduced dose commitment of the no recycle case. Ignoring any environmental improvements resulting from recycle, and using a $1,000 per person-rem cost, the cost benefit analysis shows that recycle is advantageous by a wide margin compared to no recycle.

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30. Comment:

Page 1 Introduction & Conclusions

"EPA has included comments on the cost benefit analysis since it considers factors which are environmental and public health related, and since it is relevant to potential risks assumed. EPA reviewed the analysis from the standpoint of methodology, data utilized and the degree to which it presents an independent evaluation of program costs and benefits. Additionally, there have been cases within the nuclear industry where abandonment of economically marginal operations have left State and Federal governments with a legacy of environmental radiation problems. Examples of these operations include abandoned uranium mill tailings and low-level waste storage sites. In order to assess the probability of similar occurrences in the future, EPA must evaluate the economic viability of proposed projects which could result in undesirable environmental legacies."

Response:

The provision for perpetual management and ultimate disposal of uranium mill tailings is the subject of an intensive joint study currently being conducted by USEPA, USERDA, and cognizant state agencies. USNRC now requires as a condition for licensing new mills or for renewing licenses of existing facilities, a commitment from the licensee to stabilize tailings areas against wind and water erosion and to provide adequate maintenance of these areas for an arbitrarily selected period of 50 years after the facility is shut down with the expectation that a satisfactory means for tailings management will be developed during this period. For additional data on tailings refer to CHAPTER IV, Section H, paragraph 3.1.1.2.

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31. Comment:

"In the draft statement the increased population exposures from mixed oxide fuel processing are said to be offset by reduced exposures from mining and milling of uranium ore. It is not made clear the extent to which plutonium is or is not the dominant environmental consideration. The application of 'As Low As Practicable' concepts to uranium processing are not included in the statement."

Response:

The contribution of plutonium (combined as transuranics) to the environmental dose commitment resulting from mixed oxide fuel processing is presented in Tables IV J-9 through IV J-12 of the GESMO draft statement. In the final GESMO, the contribution of the transuranics has been combined with that of uranium in Tables IV E-9 and IV E-10 of CHAPTER IV, Section E and indicates that the dose commitment attributable to the plutonium is only a small percentage of the total environmental dose commitment.

As indicated in CHAPTER IV, Section F, process modifications directed toward decreasing environmental impacts are expected in future milling operations. In view of the uncertainty of the extent to which the improvements would be implemented, credits for improvements were not included in this assessment.

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32. Comment:

"AEC estimates of U.S. uranium resources are shown in Table XI-(A-2). Given the AEC estimates of uranium reserves, and the AEC's estimates of the need for uranium fuel under the different alternatives, the future price for U_3O_8 can also be estimated. These prices are shown for every five-year interval from 1975 through 1995 in Table XI-11. No attempt has been made to determine how sensitive the cost savings from plutonium recycle are to alternative assumptions for uranium reserves, potential changes in enrichment technology, rates of growth of electrical energy demand, rates of substitution of nuclear for fossil plants, or different mixes of nuclear reactors (e.g., HTGR's or HWR's). In our opinion, it seems reasonable to expect that the estimated cost savings shown in Table XI-11 could vary quite significantly if different assumptions were used."

Response:

These concerns have been addressed in the final GESMO by means of parametric studies. No specific attempt was made to determine the effect of alternative assumptions about uranium resources. However, by inference from the parametric studies of U_3O_8 prices (CHAPTER XI, Section 3.0) and the price algorithm (CHAPTER XI, Appendix A) the effect of the disappearance of some large block of resources could be estimated. Instead, the best estimates available were used for the resources in the parametric studies which answers the question, "What is the effect of doubling the price of U_3O_8?", from whatever cause.

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33. Comment:

"The growth of nuclear power is obviously derived from the overall growth in demand for electrical energy. The overall electrical demand projection used in the AEC Draft statement is based upon Assumption Set D of the AEC projection, Nuclear Power Growth 1974-2000, WASH-1139 (74). That demand projection corresponds to an average annual growth of 6.2% for all electrical power and 21.5% for nuclear power over the period 1970-1995. Growth of electrical energy demand could be much lower (e.g., as low as 4%) as a result of the substantial price increases and conservation efforts now in progress. There is also considerable uncertainty about the size of the nuclear share of electricity generation. This uncertainty arises from recent trends in capital construction costs and lower-than-expected reactor availability experience. The cost savings from Pu recycle can reasonably be assumed to be quite sensitive to these assumptions."

Response:

A lower (WASH 1139-75 low case) nuclear energy growth rate has been used as a basis for environmental and economic analyses for final GESMO. The effects of growth were assessed in parametric sensitivity studies in CHAPTER XI, Section 3.0.

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34. Comment:

"The final EIS should include calculations of the present discounted value of cost savings for each different date. These calculations should be performed not only for base case parametric conditions, but also for the other sensitivity cases identified in this review. In order not to bias the analysis against later full commercialization dates, it will probably be necessary to extend the ending period of the analysis past 1995."

Response:

Analyses in CHAPTER XI, Sections 3.0 and 4.0 in final GESMO, use present value figures for the comparison of alternatives and discussion of parametric studies. Furthermore, the effects of different discount rates are evaluated. The period of analysis in this final statement is from 1975 through 2000.

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35. Comment:

"COST SAVINGS AND THE CROSSOVER POINT

The EPA believes that early initiation of plutonium recycle requires the demonstration that the savings are significant in comparison to nuclear electrical generation costs and that they are realized early in the recycle program. Deferred initiation of plutonium recycle should be considered to be an alternative if the cost savings are not realized early in the fuel recycle program. The remainder of this section provides the framework for this argument.

"First, it should be demonstrated that there are savings from plutonium recycle. They should be apparent from the analysis of the cumulative costs of operation for the period 1974-1995. These savings should be realized for the whole program, including reactor costs as well as fuel cycle costs. In addition, these

savings should be large enough to warrant the additional risks inherent in plutonium recycle. As discussed elsewhere in this review, the draft EIS does not satisfactorily describe or quantify the costs of an adequate safeguards program. Some safeguards measures (e.g., spiked plutonium) may substantially increase the costs of plutonium recycle. These costs are difficult to predict, and could be considerably higher than the AEC presently estimates."

Response:

The items noted have been addressed in final GESMO. It is the full treatment of those items over the period 1975 through 2000 that are the bases for the comparisons of the three fuel cycle options: no recycle, recycle of uranium only, and recycle of uranium and plutonium. All through CHAPTER IV, differentials have been indicated for those options for each fuel cycle component.

The various alternatives of plutonium recycle are reviewed in CHAPTER VIII and cost-benefits in CHAPTER XI. The safeguards considerations are included in the safeguards supplement.

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36. Comment:

"PRIORITY USE OF PLUTONIUM

AEC gives first priority to the production of the plutonium needed to fuel fast breeder reactors. Therefore, 26% of the plutonium produced in LWR's over the time span 1974-1995 is to be withheld from plutonium recycle for that purpose. The choice of the 26% figure is not explained or justified, except to state that there will be large quantities of plutonium left over after meeting the requirements for the first fuel loadings for the new breeder reactors. Since the savings from plutonium recycle is responsive to changes in the fuel cycle, EPA believes that the final EIS should explain how the 26% figure was determined because there can obviously be important environmental consequences from saving different percentages of LWR-generated plutonium. The interrelationship between the fast breeder reactor program and plutonium recycle will be explored in the Appendix which describes a method that can be used to determine the appropriate amount of plutonium to be withheld from recycle for the fueling of fast breeder reactors."

Response:

In the final GESMO, the central analyses have been performed on a "without" the FBR basis. Analyses were made on the premise that the economic savings afforded the LWR industry by Pu recycle should be independent of the presence or absence of the FBR and, consequently, of the rate of transfer of plutonium from the LWR cycle to the FBR cycle. Refer to CHAPTER XI, Section 3.10, Effect of the Breeder Reactor.

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37. Comment:

"THE ROLE OF THE HTGR

There is virtually no discussion of the role of the HTGR in the nuclear reactor field through 1995. Figure 5-1 and Table VIII-2 shows that it is expected to make a relatively small contribution. An obvious question is whether or not the cost advantage to plutonium recycling is sensitive to the relative mix of LWRs and HTGRs. Some supplementary analysis could be usefully employed to pursue this question."

Response:

Since the time of writing the draft GESMO and the EPA's letter, the only manufacturers of the HTGR have withdrawn from the market. The market share previously projected for HTGR has been added to fossil plants. This is discussed in CHAPTER VIII, paragraph 3.2.3.

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38. Comment:

"DISCOUNTING

No discounting has been used in assembling the data for tables XI-4 through XI7. Therefore, there is no adjustment for the fact that capital and operating expenditures take place at different times. For example, the capital in place in 1990 will be composed of a mix of capital of various ages. The accepted procedure for taking this into account is to use discount rates to evaluate time distributed costs and benefits in present value terms. This procedure is described in circular A-94, Revised, issued by the Office of Management and Budget. This circular requires the use of a 10% discount rate."

Response:

In final GESMO, CHAPTER XI, tables presenting costs for the alternatives include both undiscounted and discounted cost figures using a 10% discount rate. Sensitivity studies using 6% and 10% discount rates were performed. The results do not change the rankings of the alternatives, although lower rates increase the apparent benefit of recycle.

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39. Comment:

"Since no time-specific cost data is provided in the draft statement, it is impossible to determine how much the cost savings claimed exceed those that would be incurred if evaluated in present value terms. In our opinion, they could be substantial. The nuclear power industry is projected to grow continuously through 1995, so that the total operating expenses for each of the six alternatives will be larger in the later years of the period evaluated. Therefore, these later years make the greatest contribution to the expenses recorded in this table. But the expenses for the later years are the ones that will be subject to the greatest discount. The present value of the cost savings may be greatly reduced from those recorded in the table."

Response:

In final GESMO, time-specific cost data discounted appropriately are used for most comparisons in CHAPTER XI. Using this technically accurate approach does not materially change the conclusions of the draft GESMO.

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40. Comment:

"When the savings for plutonium recycle are viewed as a component of total nuclear Power generating costs, they are much smaller than they are when considered as a component of fuel cycle costs only. It is important to view the cost savings from this perspective. Should it become necessary to forego plutonium recycle someday, because of some environmental or safeguards problem, it is clear that the absence

of plutonium recycle would have only a marginal impact on electricity costs. EPA recommends that AEC consider total LWR busbar costs to be the appropriate standard against which the cost savings from plutonium recycle be compared. This standard of comparison would be more meaningful to a reader of the final EIS. The Final EIS should at least include this kind of comparison, and it should be given equal prominence with the comparison to fuel cycle costs presented in the Draft EIS."

Response:

Fuel cycle costs are the only factors being changed by the decision on Pu recycle. The absolute size of the savings or losses are the important considerations in evaluating the cost-benefits of recycle. By comparing the changes to the total nuclear power generating cost, a smaller percentage savings will be in evidence. By comparing the changes to the sales cost of the power, an even smaller percentage savings will be noted. The basis of comparison is considered immaterial in any case. The only meaningful analysis compares the absolute benefits to the absolute costs.

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41. Comment:

"The EPA does not consider the analysis of fuel cycle costs for only one year, 1990, to be adequate for judging the merits of plutonium recycle. This would be true even if the analysis were methodologically correct. The cumulative costs for the years 1974 through 1995, appropriately discounted, must be shown for each alternative. The information the AEC provides in Table XI-7 is not sufficient, for it does not include capital costs."

Response:

The discounted cumulative costs for years 1975 through 2000 are now provided in CHAPTER XI, Sections 2.0, 3.0, and 4.0 of this final GESMO. The costs as developed in CHAPTER XI, Section 2.0 include capital costs, operating costs, taxes and profit.

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42. Comment:

"The draft EIS does not adequately treat the subject of the economic timing of the commercialization of plutonium recycle. Timing is very important because new information is continually being developed in the areas of plutonium toxicity, the costs and feasibility of safeguards measures, and the magnitude of transportation hazards. Thus, the final EIS should contain a thorough analysis of when the cost savings of plutonium recycle are expected to begin and how large they are likely to be. This information will be highly useful to interested groups and could be a valuable input to future public discussions about the timing of plutonium recycle."

Response:

In final GESMO, evaluations have been made of the environmental and economic impacts of delays for various periods of reprocessing of spent fuel and implementation of Pu recycle. Refer to CHAPTERS VIII and XI. The analyses are made on both a total and discounted basis.

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43. Comment:

"Tables IV C-12, IV C-21 and IV C-22 are not consistent; e.g., MOX skin doses are higher but for the mix of noble gases in effluents given, they should be lower. Also, while iodines in MOX gaseous effluents are shown higher, thyroid doses are lower."

Response:

The dose values described in this comment have been recalculated for the final GESMO. The anomalies mentioned have been eliminated. See CHAPTER IV, Section C-5.0.

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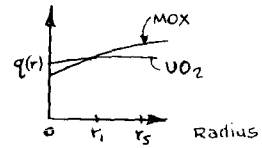
44. Comment:

"Figure IV C-24 does not appear to be drawn correctly. The reduced central temperature in the MOX rod is stated to be a consequence of the higher neutron cross section of Pu, which causes a higher peripheral heat generation rate and lower central flux. This being the case, one would expect the temperature profile of the MOX to be higher in the periphery, reflecting the increased heat flux at that location."

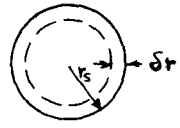
Response:

While it is true that curves of volumetric heat generation rates q(r) in W/Cm^3 would cross in order to produce the same total rod power for each fuel, it is not true that the temperature profiles should cross. The figure below shows qualitatively the volumetric heat generation



rates for MOX and UO_2 fuels. The area under these two curves, when normalized for radial coordinates, is the same since each fuel rod is assumed to produce the same power (same linear heat generation rate).

Consider the heat flux w(r) in W/cm^2 through a cylindrical wall at various values of the radius r. At the fuel



surface r_s the heat fluxes for the two fuels are the same,

$$w_u(r_s) = w_{Pu}(r_s),$$

44 Comment Cont'd

since the rod linear heat rates are the same. Moving in a small increment Δr it can be seen that the power generated in the shell corresponding to Δr is greater for MOX than UO_2

$$q_{Pu}(r) > q_u(r)$$

near the fuel surface. Now the total power in each fuel rod is the same, so the power generated inside the cylinder $r - \Delta r$ is lower for MOX than for UO_2. Consequently the heat flux through the cylinder wall at $r-\Delta r$ is smaller for MOX than for UO_2.

Continuing in this manner down to r_i, the crossover radius for $q_{Pu}(r)$ and $q_u(r)$, is expressed as

$$W_{Pu}(r) < W_u(r).$$

For radii smaller than r_i it is obvious that the heat generated within each cylinder is less for MOX than for UO_2, so that the inequality continues to hold for all smaller r except r=0. At r=0, of course,

$$W_{Pu}(o) \quad W_U(o) = 0.$$

Consequently, at any nonzero radius smaller than r_s,

$$W_{Pu}(r) < W_u(r).$$

Temperature gradient and heat flux are related by the thermal conductivity k;

$$w(r) = - k\, dT/dr.$$

If k is assumed to be independent of temperature and composition, then dT/dr is smaller for MOX fuels everywhere except at the centerline and surface, where it is the same for both UO_2 and MOX fuels. Since dT/dr for the UO_2 fuel is always larger than, or equal to, the temperature gradient in the MOX fuel, the uranium fuel temperature profile will always lie above the plutonium fuel profile, as it is drawn in Figure IV C-24.

In calculating temperatures for Figure IV C-24, k was assumed to be independent of composition, but a temperature dependent function was used (refer to Figure IV C-19 for the shape of this curve). Over much of the applicable temperature range, k decreases with increasing temperature. Consequently, the uranium case temperature calculation generally saw lower thermal conductivity values than the plutonium case. This tends to exaggerate the temperature enhancement of the UO_2 fuel profile and separate the two curves further. See CHAPTER IV, Section C, paragraph 3.4.1.

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45. Comment:

"No mention is made of the magnitude of possible tramp plutonium problems with MOX fuel. This should be addressed in the final statement."

Response:

State-of-the-art methods of contamination control in the fabrication of fuel rods containing mixed oxide fuels can provide fuels essentially free of external plutonium contamination.

45 Comment Cont'd

The presence of uranium on the exterior surfaces of reactor fuel rods and in corrosion products entering the primary coolant system has long been recognized as a potential problem and is given the generic name "tramp" uranium. "Tramp" uranium is considered to have two possible origins: (1) the presence of uranium contamination of fuel rod surfaces resulting from cross-contamination during fabrication and (2) the presence of uranium as a naturally occurring contaminant of metals.

Another possible mode of entry of uranium into the reactor coolant is the escape of uranium oxide particles from the fuel pellets through defects in the fuel cladding; however, operating experience with fuel with controlled fuel defects has shown that such escape is negligible.

Like most metals, the zirconium alloys used as the fuel cladding contain trace amounts of natural uranium. Typical analyses of Zircaloy-2 show natural uranium to be present in concentrations on the order of 3.5 and 5 ppm.*

In a light-water cooled reactor of the Oyster Creek size, the quantity of Zircaloy-2 cladding in the reactor core is about 5.5×10^4 lb (2.5×10^7g).** The specifications for nuclear grade Zircaloy require that the uranium content does not exceed 5 ppm. At the maximum 5 ppm, the uranium content of the Zircaloy-2 cladding should be less than 0.23 lb (130 g).

Fuel rod structural components are normally fabricated at a location physically separate from the final fuel assembly plant. In the process of loading fuel pellets into the fuel rod, only the rod tip is exposed to contamination in the loading zone. Upon completion of loading, a tip fixture is inserted, the rod tip is withdrawn from the contaminated loading zone and the tip area is decontaminated with chemicals or solvents prior to seal welding. Therefore, the only area of the fuel rod potentially contaminated is the tip fixture and the junction of the tip fixture and the fuel rod. Quality control procedures require that this area be carefully decontaminated prior to welding to assure a minimum of surface contamination.

In the assembly of mixed oxide fuel rods, the potential contaminants from the fuel pellet loading operation include plutonium. Manufacturing specifications for mixed oxide fuel rods require that each completed fuel rod be examined for surface plutonium contamination. Detection limits for removable alpha-emitting surface contaminants, e.g., plutonium, are on the order of 2 dis/min per square decimeter. Specifications for detection limits for "fixed" or imbedded alpha-emitting surface contaminants on experimental mixed oxide fuel rods call for rejection of rods with alpha-detection scintillation survey meter readings of greater than 50 counts per minute.*** Such a count rate corresponds to a uniformly distributed alpha emitting surface contamination on the order of 500 dis/min for the cylindrical area under inspection. If it is assumed that all alpha emitters detected are due to plutonium, then the plutonium contamination is not more than 2×10^{-5} μCi (500 dis/min= 2×10^{-5} μCi).

Since the only zone of the fuel rod exterior that has a potential for external plutonium contamination is the rod tip area and since the entire rod tip area can be scanned by the alpha contamination detector in a single 360° rotation of the rod, the limit of detection of Pu alpha surface contamination is on the order of 2×10^{-5} μCi per fuel rod.

A typical BWR may contain about 43,000 fuel rods in its core. At a plutonium contamination of $\leq 2 \times 10^{-5}$ μCi per rod, the potential inventory of tramp plutonium resulting from contamination during processing and fabrication is not more than 10 μCi in a complete core of mixed oxide fuel.

To place this amount of plutonium contamination in perspective, consider the irradiation history of the natural uranium contained in Zircaloy-2 cladding of a UO_2 fueled reactor. A typical reactor core contains approximately 130 g of normal uranium as a

naturally occurring contaminant of Zircaloy-2. R. Bellamy† has calculated that at an average neutron flux of 3 x 10^{13} n_{th}/cm^2 - sec, ^{239}Pu would be produced in the 130 g of normal uranium in the Zircaloy-2 at a rate of 170 μCi/day (6.2 x 10^{-2} Ci/yr) from the (n, γ) reaction of ^{238}U followed by two β decays. Therefore the quantity of ^{239}Pu produced in the cladding material from impurities in a uranium oxide fuel in one day is 17 times greater than the 10 μCi of tramp plutonium resulting from contamination of fuel rods during processing and fabrication of a complete core reload of mixed oxide fuel. This level of contamination is not of measurable significance with respect to determination of the radioactive liquid release source term for reactors employing mixed oxide fuels.

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*Cashin, W. M. (Ed) "Uranium Surface Contamination on Nuclear Reactor Fuel Elements," USAEC Report KAPL-2061, Knolls Atomic Power Laboratory. October 23, 1959.

**Oyster Creek Nuclear Power Plant, "Facility Description and Safety Analysis Report," Vol. 1, 1967.

***Saxton Quarterly Report for Period Ending December 31, 1964. Westinghouse Specifications #SAX-P003 and #SAX-P004, for manufacture of mixed oxide fuel rods for the SAXTON reactor, quoted in WCAP-3385-2, Westinghouse Corporation. January 1965.

†Bellamy, R. Internal memorandum to V. Benaroya, "Pu-239 Source in the Oyster Creek Reactor." Directorate of Licensing, USAEC, October 25, 1973.

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46. Comment:

"Another possible alternative that should be considered relative to the timeliness of initiating a mixed oxide recycle program in LWRs is the diversion of surplus enriched weapons uranium to such utilization as naval reactors. While the diversion may be completely infeasible such a move make available present inventories of new uranium and enrichment capacity to LWRs alleviating short term shortage problems. Because of the interest in such trade offs, this alternative should be discussed in the final EIS."

Response:

The availability of military enriched uranium is not an alternative that should be considered in the commercial LWR industry. Diversion of surplus enriched weapons uranium is not within the scope of GESMO.

The purpose of GESMO is to assess the differences in the LWR fuel cycle brought about by the implementation of Pu recycle by the replacement of part of the low enriched UO_2 fuel with MOX fuel. The alternatives considered are therefore related to the differential environmental and economic impact related to the timing of the implementation as well as to a throw away (no recycle) fuel cycle.

In this final GESMO the present status of the fuels reprocessing industry has been taken into consideration and the earliest possible timing for reprocessing is in 1978 and MOX utilization in 1981 (Alternative 3 in CHAPTER VIII, Section 4.0). A delay in the development of the Pu recycle industry appears possible and the sensitivity analyses included in Alternative 2 make the prompt reprocessing in Alternative 3 a bounding case. With this projected schedule and the LWR projections, the alleviation of a short term shortage of enrichment capacity is no longer tied to the Pu recycle decision.

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47. Comment:

"Vol. 2, Page II-29, last sentence of part b: This sentence is not totally true. Some plutonium has been left in wounds when surgery was expected to result in a worse situation than by leaving the plutonium there.

"Vol. 2, Page II-29, part c: This part could be made specific for environmental radioactive material received into the body via inhalation or ingestion. Wound or injection entry is of little concern in the environment, but important for occupational workers."

Response:

These comments are valid. Since CHAPTER II is an overview of the background of Pu experience, the reference listing has been expanded to include documents that contain in depth data and occupational histories of Pu workers. In addition, CHAPTER IV, Section J includes data on radiological impacts of plutonium.

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48. Comment:

"Vol. 2 Page II-32, part j; and Vol. 3 Page IV, J (c)-1 last sentence: There are data available which suggest an increase with time in plant plutonium uptake from soil. (See J. Environ. Quality, Vol. 2 No. 1, 1973, and Health Physics Journal 19:487 - 491, 1970.) These data should be discussed here."

Response:

Information was added to final GESMO to cover the increase in plutonium uptake with time. See CHAPTER II, paragraph 2.5.

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49. Comment:

"Vol. 3, Page IV. A-13, last sentence of second paragraph: the standard referred to in this sentence should be referenced or discussed. Such a standard has not been, to our knowledge, proposed by a recognized radiation standard setting group."

Response:

The reference to a standard for cumulative deposition of plutonium or other alpha emitters has been deleted from this portion of final GESMO. A discussion of ground contamination is included in CHAPTER IV, Section D, paragraph 4.3.4.

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50. Comment:

"Vol. 3 Page IV, J. (A)-9: The numbers used in the population dose commitment equation cannot be considered conservative since higher P/A and lower deposition velocity values have been strongly suggested. Both of these trends would increase the dose."

Response:

Higher P/A values would not affect the population doses from the food pathways because these doses are based on agricultural production and not population density. The food pathways provide most of the population dose, so higher P/A values would not

50 Comment Cont'd

significantly increase the population dose. The agricultural productivity values used in the analyses are conservative. The first component of population that occurs immediately after release from krypton-85, tritium, and carbon-14 is dependent on P/A. The second component resulting from exposure to these isotopes after their buildup in the atmosphere is not.

Deposition to velocities of about 1 cm/sec have been shown by model sensitivity analyses to yield the maximum population dose. For details of these analyses, see "The Effect of Deposition Velocities on Estimates of Environmental Transport and Population Doses" by Moore and Kaye in 1974, Health Physics Society Symposium on Population Exposures.

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51. Comment:

"Vol. 3, Page IV, J (C-7), second paragraph: The ingestion pathway should not be dismissed as a potential pathway for exposure to actinides. If gut absorption increases and plant uptake increases (both are possibilities), then this pathway could be as important as the air pathway."

Response:

The ingestion pathway for all radionuclides released from each facility was included in the dose calculations of final GESMO. A discussion of the pathways and the parameters for each radionuclide in the pathway is in Appendix A of CHAPTER IV, Section J. Pathways for the actinides are also included in the parameters. A specific discussion of plutonium pathway is included in Appendix C of CHAPTER IV, Section J.

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52. Comment:

"12. There is apparently a contradiction in philosophy concerning fission-gas-release in MOX fuels (p. IV C-51). Since this aspect is related to fuel rod performance (and safety) characteristics, the question of significant or insignificant increases in fission-gas-release should be resolved and included in the final statement."

Response:

The fission gas release paragraph has been revised in final GESMO to include new reference material and resolve the apparent contradiction. Refer to CHAPTER IV, Section C, paragraph 3.4.2.

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53. Comment:

"13. P. IV J (A)-2 semi-infinite cloud dose calculation was utilized in WASH-1327 to compute the dose due to irradiation by nuclides in the atmosphere. A comparison of external gamma whole body dose calculations using finite and semi-infinite cloud dose models is presented in EPA-520/1-74-004(1). It is noted that at close distances to the facility stack a semi-infinite cloud assumption results in a very low ground level concentration and gross underestimates of dose since it ignores gamma rays emanating aloft. Therefore, a finite cloud rather than a semi-infinite cloud dose model should be utilized to compute close in external doses from evaluated atmospheric emissions of radionuclides."

53 Comment Cont'd

Response:

The semi-infinite model underestimates the dose at distances close to a tall stack. Receptor location, site meteorology, effluent exit velocities, etc., parameters must be considered before generalizations can be made as to the uncertainty introduced by use of the semi-infinite or infinite cloud model. These are highly site-specific parameters and because the use of the semi-infinite model has been observed not to underestimate population dose, it has been used for dose commitment calculations. Reference is made to Regulatory Guide 1.109, Calculations of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I, March 1976.

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54. Comment:

"14. p. IV J (A)-2 A value of 7 mg/cm was assumed for the density thickness of the dead layer of the outside of human skin in computing 'the beta dose. New values of epidermal thickness are reported by Judi T. Whitton (2) and it is recommended that 'for radiological protection purposes it is appropriate to replace the value of 7 mg/cm, currently used for minimal epidermal thickness on all body sites, by a value of 4 mg/cm for average epidermal thickness.' We concur with the recommendation by Whitton."

Response:

NCRP and ICRP recommend the use of 7 mg/cm as the density thickness of the dead layer of the outside human skin for dose computations. NRC uses latest NCRP and ICRP recommendations in the final GESMO for dose modeling purposes. Any new recommendations made by NCRP and ICRP will be adapted in the NRC dose calculations.

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55. Comment:

"Therefore, the low beta depth dose values presented in WASH-1327 should be recomputed based on an average epidermal thickness of 4 mg/cm and corrected apparent absorption coefficient values. The graph on p. 332 of Meteorology and Atomic Energy, 1968 (3) should not be utilized for depth dose values."

Response:

Neither the graph on p. 332 nor the beta dose equations of Meteorology and Atomic Energy, 1968, have been utilized in the final GESMO. For details of the methodology used, see "Beta-Ray Dose in Tissue-Equivalent Material Immersed in a Radioactive Cloud," by Berger in the January 1974 Health Physics Journal.

The value of 7 mg/cm for density thickness of the dead layer of the outside of the human skin has been retained in the final GESMO. See response to Comment No. 54 of this Comment Letter 54.

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56. Comment:

"16. pp. IV J (A)-3-4 Since the INREM computer code was used to compute the 50-year dose commitment from the inhalation and ingestion of radionuclides, the pertinent assumptions utilized in this code should be presented in WASH-1327. The information presented in WASH-1327 regarding INREM is not complete enough to allow an evaluation of dose assessment techniques to be made so conclusions cannot be reached regarding the validity of the presented dose commitment estimates in WASH-1327. A complete copy of the code with an explanatory text should be made available to all reviewers so that an evaluation of the INREM dose assessment techniques can be made."

Response:

INREM is a published documented code. The final GESMO contains a detailed description of dose calculation methodology in CHAPTER IV, Section J, Appendix A. Twenty-four references are cited. Those references that may not be found in large public libraries have been placed in the NRC Public Document Room. Computer code INREM and EXREM Source and Data Base tapes may be obtained from the Radiation Shielding Information Center at Oak Ridge, Tennessee. INREM is described in ORNL-5003, available from National Technical Information Service (NTIS). EXREM is described in ORNL-TM-4322, also available from NTIS.

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57. Comment:

"The 500 m value for the chimney release in Table IV J-(A.1) should be modified to reflect more reasonable dispersion values and any dose calculations made using this dilution factor should be corrected since they underestimate the dose by approximately 10,000."

Response:

In final GESMO, dose calculations were not performed using the value for a distance of 500 m from a stack 100 m high. Calculations were based on 1300 m from release point with a χ/Q of 3.7×10^{8} sec per cubic meter. Refer to CHAPTER IV, Section J, Appendix A.

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58. Comment:

"Page IV H-7; Uranium Mills Section

Indicate the basis used for calculating the curie release."

Response:

The ORNL draft report, "Correlation of Radioactive Waste Treatment Costs and the Environmental Impact of Waste Effluents in the Nuclear Fuel Cycle for Use in Establishing 'As Low As Practicable' Guides" Part 3, Milling of Uranium Ores, was used as the basis for calculating the release of radioactive material from uranium mills.

The following assumptions were made:

a. Mill production about 1990 would be 50% from New Mexico and 50% from Wyoming.

b. 85% of mill production about 1990 would be from acid leach-solvent extraction mills and 15% from alkaline leach mills.

c. Radon-222 is in secular equilibrium with uranium in the ore and that 100% of this amount of radon is released in milling the ore.

The source terms given in Tables 4.6, 4.7, 4.8, and 4.9 of the ORNL report for Case 1 were adjusted on the basis of the above assumptions and the resultant values provided the bases for calculating the total release of radioactive material from uranium mills about 1990.

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59. Comment:

"Page IV H-32; lines 6 and 7: Indicate other kinds of low-level liquid wastes which will be produced and why they can't be cleaned up and recycled. In considering solidification indicate other alternatives which are available besides cementing."

Response:

This comment refers to the water basin waste storage concept that is not being considered in the waste management program in final GESMO.

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60. Comment:

"23. Page IV H-39; line 13-15. Could the radioactive liquid wastes be recycled? In considering solidification indicates other viable alternatives available besides cement."

Response:

In final GESMO the high level wastes and transuranic wastes are to be sent to a Federal geologic repository. Any wastes resulting from the handling of canisters or packages of transuranic waste would also be converted to solids for disposal. Refer to CHAPTER IV, Section H, paragraph 3.2.1.2.

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61. Comment:

"24. Page IV H-40; lines 4-6. After the processing of the contaminated water for the removal of radioactivity indicate what is done with the processed water. Indicate what methods and limits will be used to distinguish between uncontaminated and contaminated water."

Response:

Radioactive effluents are released from the plant when the radioactivity levels are as low as reasonably achievable (ALARA) as specified in 10 CFR Part 20. These ALARA levels are determined on a case by case basis at the present time. Decontamination or reduction of the radioactivity levels is accomplished by either evaporation or ion exchange The processed water, condensate from evaporation of contaminated water that is essentially at as low a level of radioactivity as can reasonably be achieved, will be released to the atmosphere as vapor. Refer to CHAPTER IV, Section H, paragraph 3.2.2.

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62. Comment:

"Page IV H-46; lines 14 and 15. Since the AEC is eliminating the routine use of surface and near surface techniques that depend on soil to remove radioactivity from liquid wastes (WASH-1202-73 p. 27) the statement concerning high absorptive capacity of the soil should be further clarified as perhaps a 3rd or 4th order protective device and not as a secondary backup as might be inferred."

Response:

The intent of this comment was to indicate that soil characteristics and site specific geology could provide an added measure of protection in case of inadvertent spills. In final GESMO, the nature of the wastes and the requirements for disposal of high level and transuranic waste in Federal geologic repositories and the handling of low level wastes are discussed in CHAPTER IV, Section H.

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63. Comment:

"Dose calculations for the dropping and rupture of a waste canister at the Retrievable Surface Storage Facility (RSSF) are made at a distance of 5 miles from the facility stack. This 5 mile distance is stated to be the closest assumed access for a member of the public. If this 5 mile exclusion distance is not a documented siting policy for the RSSF, then dose calculations should be presented for distances closes to the facility stack. As a minimum, the reason for the use of the 5 mile exclusion distance should be presented."

Response:

In final GESMO each model facility for the fuel cycle is based on best estimates. However, the 5 mile distance in the draft GESMO was used for modeling based on estimates of designs at hand for the RSSF. Exclusion boundaries will vary with each specific facility site and would be evaluated on a case-by-case basis.

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64. Comment:

"28. It is not made clear in the EIS the extent to which plutonium is or is not the dominant environmental consideration. A thorough discussion of the sources, biological availability, and the metabolism of the transplutonic isotopes would be helpful for evaluation of the EIS. Durbin has presented data on the differences in metabolism of transplutonic elements (P. W. Durbin, Distribution of the Transuranic Elements in Mammals, Health Physics 8:665-671 1962). Additional information on distribution and metabolism variations both by isotopes and by species and age for plutonium and transplutonic isotopes can be found in the Proceedings of the Hanford Symposium on the Biological Implications of the Transuranium Elements Health Physics 22 #6, 1972. Implications of these differences should be included."

Response:

The radiological and environmental health aspects of no recycle, uranium recycle only, or uranium and plutonium recycle were evaluated without giving dominant consideration to plutonium. However, because of the large amount of public interest in the radiobiology of plutonium, Appendix C was added to CHAPTER IV, Section J, to provide supplemental information for the reader. Appendix A of CHAPTER IV, Section J contains a detailed description of the dose calculation methodology used in the final GESMO.

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65. Comment:

"29. Page IV, J-2. Because only fatal cancers are enumerated in the EIS, the somatic health effects listed underestimate the projected impact by a factor of two. If the total cancer incidence, not just cancer fatalities were included in the EIS, an additional perspective would be provided."

Response:

The health effects discussed in final GESMO include nonfatal and fatal radiation induced injuries. Details concerning the incidence of each type of health effect and the source of the estimators are discussed in CHAPTER IV, Section J, Appendix B.

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66. Comment:

"30. Page IV, J-3, Table J-1, there is evidently a misprint. Appendix A to Chapter IV-F is limited to some effluent information pertinent to the uranium mining and/or milling industry; but it does not give the basis for the man-rem number listed in the succeeding Tables."

Response:

This discrepancy has been corrected in the revised CHAPTER IV, Section J, of the final GESMO.

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67. Comment:

"31. Page IV, J-7 c, second paragraph. Differences between the physical and chemical characteristics of Pu fallout and particulate Pu from mixed oxide fuels should be described so that the reader can judge the relevancy of fallout plutonium to the problem of interest here. Indeed, it would be helpful to discuss the particulate nature of Pu in mixed oxide fuels early in the Chapter."

Response:

While the particle size of plutonium from mixed oxide fuels is large at the source, filtration tends to reduce the aerodynamic mean activity diameter (AMAD) to about 0.3 micrometers.* In contrast, plutonium fallout was formed from vaporized metal condensed on dust particles and residues from weapons material in air. In both cases, the chemical form as oxide attaches to other larger particles in air, and once in the soil, attaches to soil particles.** As fallout the plutonium has been exposed a high-temperature oxidizing environment, while the traces of MOX fuels in effluents leave in an oxidized form. For estimates of pathways to man, the fallout plutonium is expected to behave similarly to plutonium from the fuel cycle, and the data from fallout plutonium thus is pertinent.

*Stafford, R. G., and Ettinger, H. J., "Filter Efficiency Versus Particle Size and Velocity," LA-4650 (April 1971).

**Whicker, F. W., Little, C. A. and Winsor, T. E., "Plutonium Behavior in the Terrestrial Environs of the Rocky Flats Installation." Symposium on Environmental Surveillance Around Nuclear Installations, November 5-9, 1973. IAEA-Warsaw, Poland.

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68. Comment:

(32) "Page IV, J-7c, third paragraph. ICRP #6 page 8 would seem to contradict the conclusion that the absence of a consideration of hot particles is a satisfactory state of affairs to standard setting bodies. The Los Alamos reference offered for the assertion given in the EIS is inadequate support for this assertion given in the statement by Sanders, Thompson and Bair in AEC Symposium Series 18, 'Nonuniform irradiation of the lung from deposited radioactive particulates is clearly more carcinogenic than uniform exposure (on the basis of total lung dose), and alpha radiation is more carcinogenic than beta irradiation.'

(33) "Page IV, J-8, second paragraph. This one sentence paragraph could mean that either the particulates in MO fuels are not subject to accidental distribution or that no health consequences due to particulates would follow such an event. Either way, this important conclusion should be discussed in full with better documentation."

Response:

Ref. 32: In final GESMO, CHAPTER IV, Section J, Appendix D contains the Federal Register Notice of the NRC denial of the NRDC petition for rulemaking on hot particles. Refer to this Appendix D for the NRC position on dose from insoluble alpha-emitting particles.

Ref. 33: The referenced paragraph does not appear in final GESMO. The conclusion given in the draft GESMO was based on an evaluation of the dose commitments from accidents given in other sections of CHAPTER IV. Refer to CHAPTER IV, Section J-5.0.

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69. Comment:

"Page IV, J(A)-2. From the text in 'Meteorology and Atomic Energy' it would appear that the Fig. 7.5 (ibid) referred to here was based on an incorrect calculation of beta-ray attenuation in skin. The sensitivity of the results presented to this error should be evaluated, or better yet, use Martin Berger's more recent calculations in Health Physics, Vol. 26, No. 1, January 1974."

Response:

This comment is similar to a previous EPA comment. Refer to the response to Comment Number 55 of this Comment Letter 54.

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70. Comment:

(36) "Page IV, J (A)-3, second paragraph. Applicability of data from the 'particular plot of ground' at ORNL to rest of the United States should be discussed in terms of soil characteristics, climate, cropping practices, etc., so that the importance of this study can be placed in perspective by the reader.

(37) "Page IV, J (A) 3. The estimate of environmental concentrations of I-127 and H (water vapor) are quite critical to the final risk evaluations and should be documented in full. Variations in these parameters could affect large portions of the population, for example, persons living in regions with iodine deficient soils. Perhaps those cases should be discussed also."

Response:

Ref. 36: More information is provided in the final GESMO concerning the irradiation by ground deposited nuclides pathway. In particular, no weathering or cropping is considered in calculating the dose commitment from ground plane irradiation.

69 Comment Cont'd

Ref. 37: Environmental concentrations of ^{127}I are not used in the methodology of the final GESMO.

The environmental concentrations of water vapor used in the final GESMO represent values considered by NRC to be an average applicable to the eastern United States where most of the people and nuclear facilities will be located. Thus, regional variations in water vapor concentration should not significantly affect the population dose estimates.

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71. Comment:

"Page IV, J (A)-4d, first paragraph. The breathing rate used is for a 'reference man.' Consideration should be given to other members of the population also. Were women and children not considered?"

Response:

In final GESMO, the sensitivity analyses performed show that the inclusion of sex and age breakdowns would not significantly change the population dose. Refer to CHAPTER IV, Section J.

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72. Comment:

"Ibid, 1, fourth paragraph. That the range of resuspension varies between 10^{-2} - 10^{-13} should be referenced to the original source documents. It is not clear that this range is appropriate for plutonium in the environment or that 10^{-13} has been verified experimentally.

"Ibid, 1, last paragraph. Has the purported decrease of resuspension with time been observed in areas other than desert type such as used for bomb testing? Changes in the amount of resuspended plutonium in the vicinity of Rocky Flats, which is more likely to be similar to the problem of interest here, would help show the general applicability of these data. In addition, particulate resuspension in urban and suburban areas should also be considered in the EIS."

Response:

Resuspension factors (k) ranging between 10^{-2} to 10^{-13} were referenced in draft GESMO to indicate the wide variation in the literature values. The analysis in draft GESMO made reference to resuspension factors for Rocky Flats in the fifth paragraph on Page IV, J (A) -5. In addition measured resuspension factors for ^{238}U were used for other areas, with differing climate, to establish the long-term value for the resuspension factor. A detailed discussion of resuspension is given in the final GESMO, CHAPTER IV, Section J, Appendix C.

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73. Comment:

"Page IV, J (A) -5, fifth paragraph. If the longest study of resuspension decreasing with time, is, as reported in the EIS, eleven months, the 50-day half-life used here corresponds to a reduction of about 30 in plutonium resuspension. The applicability of such data to a reduction of 100,000 (as is done in this EIS) should be justified by an appropriate analysis, since the magnitude of the lung dose is quite sensitive to the resuspension variables."

Response:

For data on resuspension, refer to NRC response to Comment Number 71 of this Comment Letter 54.

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74. Comment:

"Page IV, J (8) -8. AEC reports documenting the k factors used to calculate dose are not described in the EIS. The selected conversion factors may be valid, but there is no way of examining the underlying assumptions used in their development."

Response:

K factors (rem/ψ) are not used in the final GESMO. Refer to CHAPTER IV, Section J, Appendix A, for details of dose calculation methodology.

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75. Comment:

"Additional information on species age and isotope interrelationships can be found in the Handbook of Experimental Pharmacology XXXVI, Uranium Plutonium Transplutonic Elements, Springer-Verlog, New York, 1973. Particularly Chapter 10 (Distribution, Excretion and Effects of Plutonium as a Bone-Seeker) and Chapter 18 (Metabolism and Biological Effects of the Transplutonium Elements). Perhaps, the relevance of animal data to the problem of interest here should be critiqued so that the reader will not read too much into the reported results.

"Page IV, J (B)-1, third paragraph. The body of data on distribution and retention of ^{239}Pu in man is severely restricted by the fact that only selected tissues have been analyzed and they may not be the appropriate ones. Transuranium Registry data show that any of a wide variety of tissues may have the highest organ concentration of plutonium and until sufficient data are obtained it will be difficult to adequately assess the problem in man (United States Transuranium Registry Summary Report to June 30, 1974, HEHF #22, 1974)."

Response:

In the final GESMO in the discussion of the radiobiology of plutonium, an attempt was made to identify areas of uncertainty. Since the draft GESMO was prepared, additional human data and the result of animal experiments have been reported. The added information was considered in preparation of CHAPTER IV, Section J, Appendix C.

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76. Comment:

"Page IV, J (B) -2, third paragraph. The statement in the EIS that 'Unfortunately no evaluation of economic cost that might be due to the linear assumptions, as compared to other assumptions, has yet been done' might be more appropriate in the cost-benefit section. The idea that the dose-risk relationships used to evaluate potential health impacts from nuclear energy should be subject to a cost benefit analysis has important public health policy implication and should either be explored further in a 'generic' impact statement of this type or deleted."

Response:

Because the differentials of risks which are the matter of concern in this assessment are smaller than the uncertainties in their values, it is not essential to carry out the cost-benefit analysis of the impact of using the linear extrapolation of dose in this generic statement (GESMO).

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77. Comment:

"Page IV, J (B)-4. The genetic effects calculations referred to in Table IV, J (B-1) and in the fourth paragraph are adequate for a population which replaces itself in a 50 year period, that is the replacement rate (birth rate) is 2% per year. If the birth rate is more than 2% per year or less than 2% per year, these genetic risk estimates will proportionately increase and decrease accordingly. This should be stated.

"Page IV, J-(B-4), second paragraph. Reference, if any, should be cited for the zero effects estimates and the value of the assumed threshold dose rate used here."

Response:

Final GESMO includes revised risk estimates for the genetic effects calculations in CHAPTER IV, Section J, Appendix B. The birth rate over the period 1975 through 2000 is assumed to be constant. As stated in the comment, the genetic risk estimates will proportionately increase or decrease as the birth rate increases or decreases.

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78. Comment:

"48. Page IV, J(C)-7, 2, first paragraph. The statement that the BEIR report calculates average dose and estimates tumor incidence on the basis of the uniformly irradiated lung is inaccurate. BEIR report lung tumor estimates are based on the radiation dose to cells of the bronchial epithelium and it is explicitly so stated. (BEIR, Summary of Risk Estimates for Bronchial Cancer, p. 150). The specific risk estimates are for irradiation of the basal cells of the bronchial epithelium as indicated in the BEIR report (p 148, p 154 BEIR Report). This EIS should be corrected to accurately reflect what the BEIR report says if the BEIR report is referenced."

Response:

In final GESMO, in addition to the BEIR Report, new data published since the issuance of BEIR were considered in estimating risk of radiation injury. Risk estimates, from the Reactor Safety Study (WASH-1400), were used as well as the BEIR Report. The specific statement referenced in this comment has been deleted from the final GESMO.

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79. Comment:

"49. Page IV, J(C)-8a. Since the sample size in the Los Alamos study referred to makes a negative finding almost inevitable, the probability of a type II statistical error, false negative, should be given to avoid possible erroneous conclusions.

"...The low relevance of negative findings in the Los Alamos Study population at the present time should be explained to put the information in perspective."

Response:

The Los Alamos study of plutonium workers is discussed in CHAPTER IV, Section J, Appendix C. This study is continuing, but to date none of the medical findings in the group can be attributed to internally deposited plutonium. In view of the relatively small number of persons with sizable depositions, it seems unlikely that precise statistical estimates of the toxic effects will be made. This would not be true, however, if plutonium were markedly more toxic than is currently believed.

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80. Comment:

"50. Page IV, J(C)-7. Several general questions concerning LA-5483, used here as part of the EIS should be answered before its applicability to human risk evaluation is accepted by the AEC."

Response:

In final GESMO, the particle lung dose effects in Los Alamos report, LA-5483 - Hot Particle Lung Dose Effects, and other publications are discussed in the NRC denial of the NRDC petition for rulemaking, reprinted in CHAPTER IV, Section J, Appendix D.

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81. Comment:

"51. Page IV, J(C)-9, 4. The 'animal data' comment concerning use of animal data for comparative pathology, page IV, J(B)-11, also applies here. In addition, the admonitions of Bair (W. J. Bair, Inhalation of Radionuclides and Carcinogenesis, pp. 77-101 in Inhalation Carcinogenesis, AEC Symposium Series #18) might also be considered: ...That the state of the art has not advanced much beyond that point, should be made clear to the readers of the EIS."

Response:

The limitations of the use of animal data are fully realized. Animal data are included in final GESMO to indicate tumor types. Refer to previous response to Comment No. 6 of this Comment Letter No. 54.

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82. Comment:

"52. Page IV, J(C)-10, third paragraph. Implying that plutonium deposition in lymph nodes only rarely induces tumors in lymphatic tissue is probably erroneous and/or specious."

Response:

The final GESMO has been revised and the reference statement deleted. Refer to CHAPTER IV, Section J, Appendix C, paragraph 4.5, for a brief statement on plutonium in lymph nodes.

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83. Comment:

"53. Page IV-J(C)-15. Inhalation studies in beagles are poor sources of data since the doses administered were so large that radiation fibrosis and edema were induced...

"...The exposure levels for most of the beagles was too high to allow delayed effects-neoplasia-to develop results are not at all representative of what might be expected at lower exposure levels. Current experiments using lower exposure levels may be more pertinent to expected population exposures. These facts should be made clear to the reader."

Response:

As in the Draft GESMO, the cancer risk estimates for radiation in the final GESMO are not generally based on animal data. Animal data were included in the draft GESMO, and more recent data have been included in the final GESMO to indicate the tumor types that may occur.

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84. Comment:

"54. Page IV, J(C)-16, second paragraph. The assumption of relationship of lymphopenia, lymph node pathology, reduced immunocompetency and pathogenesis of plutonium-induced lung tumors should be explained and justified.

"55. Ibid, fourth paragraph. It is premature to state that gonads are not critical organs. Effects of plutonium on gonads have not been examined below the level of acute effects.

"56. Ibid, fifth paragraph. The experiments alluded to which are still in progress, while not showing increased mortality in neonates as stated here, have demonstrated an age-related difference in development of tumors and other age differences in response to plutonium insult which is not mentioned. (Seattle 1974, IRRS meeting.) Perhaps the EIS could be more inclusive in describing these studies."

Response:

The second paragraph, on Page IV J(C)-16 of draft GESMO, observes that the possibility of a relationship between the reduction of blood lymphocytes following deposition of plutonium in the lung, lymph node pathology decreased immunological capability, and the pathogenesis of plutonium-induced lung tumors cannot be ruled against. The statement is not an assumption.

Additionally, reviews of new data available since the publication of the draft GESMO do not appear to provide a basis for assuming that testes or ovaries should be considered critical organs. Additional data on plutonium transfer into neonates is included in CHAPTER IV, Section J, Appendix C. The additional data indicate that the placenta acts as an effective barrier to the transfer of plutonium.

-Misc Notice (39 FR 30186)
GESMO

United States Department of the Interior

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NOV 21 1974

Dear Mr. Smiley:

This is in response to your letter of August 23, 1974, requesting our comments on the Atomic Energy Commission's draft generic environmental statement on the use of Mixed Oxide Fuel in Light Water Reactors.

The statement represents a serious effort toward an identification and analysis of environmental impacts associated with recycle of plutonium in light water reactors. However, we are aware that, as stated in Vol. I, p. S-14, the statement considers the impact of modifications or changes to an existing mature industry. It does not consider the alternatives inherent in replacing that industry with other means of energy generation. Our comments have been made after reviewing the statement from this narrow perspective.

There are several topics in the statement which need expanded treatment. In particular, the environmental consequences of plutonium escaping to the atmosphere and the additional safety measures necessitated by the recycling of plutonium require more consideration. These concerns are presented according to the format of the statement or according to subject.

Consideration of Effects of Plutonium Recycle on Materials and Plant Protection (Safeguards)

The recycling of plutonium in light water reactors would cause plutonium oxide to be transported and used in a more widespread pattern across the country than occurs at this time. The concerns are that this material would have to be safeguarded from potential illegal uses or escape to the environment in many more localities and along more and longer routes of transport. Our particular concern is the potential escape of the plutonium to the environment which is predicated on its long term biologic hazard. We find it surprising that this hazard is so minimized in this report. The section on the radiobiologic characteristics

CONSERVE AMERICA'S ENERGY

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of plutonium in the Summary (p. S-17, 18) states, for example, that there are no reported cases of lung, lymphnode, liver or bone morbidity attributable to internal deposition of plutonium, but it does not mention that there is much evidence that inhaled plutonium will cause cancers and death of animals at relatively small doses. In our view, this section is very misleading and should be rewritten on more realistic terms in the final statement.

It is stated that "perhaps the greatest potential adverse impact of plutonium recycle involves the increased exposure of plutonium to theft or sabotage" (p. S-47). Plutonium recycle would constitute at least 50 percent of the projected utilization of strategic Special Nuclear Material (SNM) during some years in the 1980's (p. V-5), and if Liquid-Metal Fast Breeder Reactor (LMFBR) and High-Temperature Gas-Cooled Reactor (HTGR) programs do not develop as projected, then plutonium recycle would constitute a substantial fraction of the amount of plutonium handled. With all these programs in effect, there would be 25 times the strategic SNM in existence in 2000 as in 1975, and at that time 25 percent of the total would be in the LWR plutonium-recycle process, or an amount more than six times the total present in 1975. More significant than the total amounts of SNM expected to be in existence is the fact that all of the SNM involved in the plutonium-recycle process would be subject to significantly higher risk of diversion than the plutonium currently being held in storage after separation from reactor fuels, unless safeguards are significantly improved. It has been noted that the "transportation phase of any nuclear fuel cycle is probably the most vulnerable to overt theft or sabotage" (p. V-11), and that plutonium recycle would increase by 17 percent the vehicle miles involved in shipment of fuel materials and wastes (p. IV G-5).

It is stated that "plutonium recycle in LWR's utilizes generally less than one-half of the Strategic Special Nuclear Material projected for the total nuclear industry" and that "choice of plutonium disposition will have only a slight effect upon the AEC's need to upgrade safeguards programs" (p. S-58, paragraph 2). We do not agree that the amount of strategic SNM, but rather the accessibility of it, is the prime factor related to risk. Storage of the entire inventory in a single facility could be accomplished with little risk, whereas transport of a minute fraction of this could be hazardous. In other words, the choice of method of disposition appears to be very closely tied to the need for upgraded safeguards.

A firm commitment appears to be needed to situate mixed oxide fuel fabrication plants very close to or immediately adjacent to the fuel reprocessing plants. It is stated that "two large capacity reprocessing plants and at least one mixed oxide plant will be located in a relatively small triangle in southeastern U.S. -- thus the plutonium shipping distance should average no more than 300 miles and transit time about one and one-half days" (p. IV G-39). This sounds potentially risky in terms of possible diversion of plutonium oxide, since transit times greater than a few hours would appear to entail nearly equal risks, unless safeguards were significantly upgraded. In addition, a commitment is needed with regard to siting of the seven additional mixed oxide plants that are expected to be required about 1990.

In several places the overriding need for early approval of plutonium recycle is explained by the need to facilitate "projected phase-in of plutonium recycle" (for example, p. S-8, top). Because of this need it is apparently proposed that plutonium recycle be approved and that the necessary safeguards be implemented at a later date. Limits which would be placed on implementation of the recycle program prior to implementation of the safeguards program should be identified. The steps involved in the projected phase-in do not appear to have been clearly defined in the environmental statement.

It is stated on page S-6 that "safeguards measures are designed to deter, prevent, or respond to . . ." unauthorized possession of SNM or sabotage of nuclear facilities. The problem of detection might also be added, and further discussion of the problem of detection of losses of strategic SNM would be helpful. The fact that detection is a problem is confirmed by the statement on p. S-7 that "improved material accountability methods" is one of five major aspects of safeguards under study". The problem of detection appears to be of critical importance because failure to detect a loss would preclude any measures designed to respond to the loss and could have obvious serious consequences. Although this problem is partially discussed in connection with materials control and accounting systems, it would be helpful to discuss further the accuracy with which small thefts, diversions, or losses could be detected, and whether thefts could be differentiated from losses under all circumstances that might arise in connection with plutonium recycle operations.

With regard to radioactive solid waste disposal, the two major protective measures used are stated to be isolation and containment, and prime factors in isolation are stated to be distance, ion exchange capacity of the soil, and lack of water (p. IV H-6). In spite of AEC's frequent reference to ion exchange capacity of soil, we have found no quantitative data to indicate that such properties of soils beneath or around ground waste disposal sites have been measured. If ion exchange capacity of soil is relied upon for containment, then experiments should be conducted to determine these properties for specific soils or their constituents and relative to the specific ions that must be contained. Conditions under which the ions might be released should be defined. If such research has already been conducted, it should be referenced. Since this type of data has been requested previously for individual facilities, but not provided, it appears appropriate to include it in the generic environmental statement. It is noted that the proposed action would generate an additional 90 million curies of high-level transuranic actinide wastes such as americium and curium from fuel reprocessing about 1990, and 200 kg. of plutonium in wastes from mixed oxide fuel fabrication. It is also noted that the time period required for high-level waste storage, before decay of transuranics to concentrations allowing ultimate disposal by burial, would be about 250,000 years (p. S-47).

Higher heat would evidently be generated by high-level wastes from recycle plutonium reprocessing, requiring 30 years for a canister of waste to decay to 5 kilowatts as opposed to 6 years for waste from reprocessing enriched uranium oxide fuels (p. IV H-12). Therefore additional information on safety of cooling systems in the RSSF appears to be needed, including any requirement for wider spacing of canisters to compensate for the 5-fold increase in heat output. A safety margin of 10 hours before the basin water would begin to boil in the event of cooling-system failure has been given previously. The 5-fold increase in heat output of plutonium-recycle waste canisters would appear to reduce the margin of safety unless canister spacing were increased.

It is stated that "the technology and facilities established for management and disposal of radioactive waste from the LWR nuclear power industry without plutonium recycle will be directly applicable to the management of radioactive waste generated by LWR's with plutonium recycle" (p. IV H-21). However, a possible exception to this appears to be the 50-fold increase in helium accumulation in 10-year-old waste from plutonium recycle. Possible problems of excessive internal stresses in waste solidified as borosilicate glass were noted. The discussion of such stresses (p. IV H-20) suggests the possibility that the stresses might increase with time, as helium accumulates. However, no mention has been made of whether this might affect canister integrity or of anticipated effects after 100 years, 1,000 years, or 100,000 years. A discussion of the probable method and consequences of canister failures would be helpful; including an evaluation of whether rupture as a result of internal pressures is a credible event.

Alternative Dispositions of Plutonium and Cost Benefit Analysis

Alternative 4 clearly calls for "significantly upgraded materials and plant protection measures as might be judged to be consistent with AEC objectives " (p. S-8,#4). These objectives were previously identified as "achieving a level of protection against such acts to insure against significant increase in the overall risk of death, injury, or property damage" (p. S-6, last paragraph). It had also previously been stated unequivocally that "this objective will not be fully met for Pu recycle by current safeguards measures" (p. S-6, last 2 lines). What is clearly called for by these circumstances is significantly improved safeguards measures as a condition for approval of the use of plutonium as recycle fuel in the light water reactors. This appears to be what has been called for under Alternative 4, as quoted at the beginning of this paragraph.

However, instead of recommending such a condition for approval of plutonium recycle, three equivocal recommendations have been made with respect to the safeguards problem: (1) An "ongoing assessment of changing conditions which affect safeguards considerations" (p. S-12, #2a); (2) "decisions on upgrading within about one year after issuance of the final GESMO statement" (p. S-12, #2b), which is an unspecified future date; and (3) that "necessary additional safeguards measures should be promptly implemented" (p. S-12, #2c), in apparent reference to safeguards in addition to those which would be decided upon at an unspecified future date.

It is stated that Alternative 4, which we understand calls for significantly improved safeguards measures as a condition for use of recycle plutonium in LWR's, is favored. Nevertheless, what has actually been proposed appears to be the immediate approval of such use with conditions that apply only to unspecified future times. These times are referred to by "ongoing assessment," "decisions on upgrading" at a date likely to be 18 months in the future, and "prompt" implementation of additional safeguards. Consequently, we believe that the following minimum condition should be required prior to approval of the use of recycle plutonium in LWR's: That safeguards measures first be implemented to insure against significant increase in the risk of death, injury, or property damage to the public from causes beyond control of the individual resulting from theft or diversion of strategic special nuclear materials. In conclusion, we feel that Alternative 4, as defined in the environmental statement, should be implemented fully.

Clarification is needed on page S-11, paragraph 1, as it is not clear that Alternative 4 is being compared only to Alternative 3, with regard to safeguards. The statement might be amended to read ". . . decreases the potential safeguards threat by comparison with Alternative 3." Alternatively, the statement might read ". . . makes optimum use of natural energy sources, but increases the potential safeguards threat by comparison with all alternatives except Alternative 3."

It is stated on page S-8 (second paragraph from bottom) that for Alternative 3 the "safeguards threat - - is comparable to the base case" (or Alternative 1). This appears to be in error, because it had been concluded earlier that the safeguards threat arises mainly at three stages; namely, shipment of Pu to mixed oxide fabrication plants, operation of these plants, and shipment of mixed oxide fuel to LWR's. In Alternative 1, none of these stages exist, while in Alternative 3 all of them exist. The statement in question is incomprehensible because Alternative 1 (the base case) envisions "storing the plutonium for future use," but this use would presumably be at a time when better safeguards had been developed; hence risk would not be comparable to immediate use of the recycled plutonium, as evidently envisioned under Alternative 3.

Implementation of Plutonium Recycle in LWR's

The feasibility of designing fuel assemblies that are interchangeable is mentioned on page S-19. The need to use different control rods for mixed oxides and uranium fuels is also explained, but a statement to the effect that it would be impossible to operate the reactor with the wrong control rod is warranted.

The discussion on page S-20 about interchanging fuel assemblies in a Boiling Water Reactor (BWR) and Pressurized Water Reactor (PWR) does not address itself to the safe operation of an LWR. The statement should discuss interchanging fuel elements and control rods in an LWR more thoroughly.

Unavoidable Adverse Effects

From a metallurgical point of view, the summary discussion in Volume 1 on interchanging fuel elements should address itself to the problem of swelling and rupturing of cladding material. Volume 4 contains a statement on page VI-3 that, based on experience with UO_2 fuel rods, some clad defects will occur and small amounts of gaseous fission products will escape into the primary coolant and ultimately into the atmosphere. We hesitate to predict the degree of swelling in the mixed oxide fuel elements from the results of these experiments because of the greater neutron capture cross section of plutonium.

We would also like to bring the following more minor items to your attention:

1) The frequent use of the word "should" when predicting adverse environmental effects connotes doubt that the effects are fully understood. Three examples are given on page VI-5. The statement would be more acceptable if sentences such as the following could be worded more positively: "There would be some ground deposition of particulate plutonium compounds but this should not result in detectable changes in the terrestrial ecosystem".

2) Page S-2, paragraph 4, line 4 should possibly read "except as follows."

3) Page S-10, paragraph 3, line 4, 1955 should be 1995.

4) Page S-10, paragraph 4, 3 lines from bottom should be 241 Pu.

5) Page S-20, paragraph 2, line 1, TWR should be LWR.

6) Page S-6: The list of areas of greatest difference should have a fourth item, as on page S-42, "Storage at the reactor sites." The same comment applies to page S-57 and to page VI-9.

7) Table S-10, page S-43: A decrease in strategic SNM in commercial LWR Recycle in form of fissile Pu is shown from 1978 to 1979; the accuracy of the figures for 1978 and 1979 should be checked.

8) Table IV E-6; page IV E-13: Units of kilograms appears to be in error.

9) Table IV H-1, page IV H-3: The time period covered should be given. An error on the table is that high-level waste from fuel reprocessing is given as 2,710,000,000 curies without Pu recycle and 2,760,000,000 curies with recycle, but the difference is given as a decrease of 50 million curies.

10) Page IV I-8, paragraph b, lines 1-2: "decrease in the personnel" should apparently be "increase in the personnel."

11) Page V-46, line 13: "Uniformed" should be uninformed."

We hope these comments will be helpful to you in the preparation of the final statement.

Sincerely yours,

Stanley R. Bowman

Deputy Assistant Secretary of the Interior

Mr. S. H. Smiley
Deputy Director for
Fuels and Materials
Directorate of Licensing - Regulation
Atomic Energy Commission
Washington, D. C. 20545

NRC Staff Response To Specific Comments On Health, Safety & Environment By U. S. Dept Of The Interior

1. Comment:

"The section on the radiobiologic characteristics of plutonium in the Summary (p. S-17, 18) states, for example, that there are no reported cases of lung, lymphnode, liver or bone morbidity attributable to internal deposition of plutonium, but it does not mention that there is much evidence that inhaled plutonium will cause cancers and death of animals at relatively small doses. In our view, this section is very misleading and should be rewritten on more realistic terms in the final statement."

Response:

The perspective of this comment is in disagreement with the actual text. In both the draft and final GESMO summaries, the text presents factual data. In studies of the limited number of humans exposed to plutonium there are no reported cases of lung, lymphnode, liver, or bone morbidity attributable to internal deposition of plutonium. The induction of cancers in animals by inhaled plutonium is discussed in detail in CHAPTER IV, Section J, Appendix C. For detailed background and experience with Pu and MOX fuels, refer to CHAPTER II.

The summary contains only a small fraction of the information contained in the remaining volumes of GESMO. No intention of misleading the reader was intended in developing the summary of the draft GESMO or the final GESMO.

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2. Comment:

"With regard to radioactive solid waste disposal, the two major protective measures used are stated to be isolation and containment, and prime factors in isolation are stated to be distance, ion exchange capacity of the soil, and lack of water (p. IV II-6). In spite of AEC's frequent reference to ion exchange capacity of soil, we have found no quantitative data to indicate that such properties of soils beneath or around ground waste disposal sites have been measured. If ion exchange capacity of soil is relied upon for containment, then experiments should be conducted to determine these properties for specific soils or their constituents and relative to the specific ions that must be contained. Conditions under which the ions might be released should be defined."

Response:

Most commercial waste burial operations are State controlled and licensed. The conditions of such licenses are beyond the scope of GESMO. However, as a point of information, the Beatty, Nevada site which was originally licensed by the AEC, was carefully investigated. Cation exchange values ranged from 3.6 to 31.6 milli-equivalents per 100 grams. Similarily, one section of the West Valley, N.Y. site of the Nuclear Fuel Service Plant was originally licensed by the AEC to be used in support of plant operations. The extensive soil properties investigation for this site is documented in the NFS Safety Analysis Report, prepared as part of the license application. NRC is presently evaluating criteria for new and existing sites and providing a reference.

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3. Comment:

"Higher heat would evidently be generated by high-level wastes from recycle plutonium reprocessing, requiring 30 years for a canister of waste to decay to 5 kilowatts as opposed to 6 years for waste from reprocessing enriched uranium oxide fuels (p. IV H-12). Therefore, additional information on safety of cooling systems in the RSSF appears to be needed, including any requirement for wider spacing of canisters to compensate for the 5-fold increase in heat output. A safety margin of 10 hours before the basin water would begin to boil in the event of cooling-system failure has been given previously. The 5-fold increase in heat output of plutonium-recycle waste canister would appear to reduce the margin of safety unless canister spacing were increased."

Response:

Regardless of the source of high level wastes (HLW) from reprocessing spent reactor fuels, the solidified high level wastes sealed in canisters will be designed to meet the same requirements imposed by the disposal facilities. The HLW leaving the reprocessing plants will be collected from many campaigns of different discharges of irradiated fuels. Some of the spent fuel will have been first, second and third cycle MOX fuel and some from new reactors 1st, 2nd, and 3rd cycle UO_2 fuel with low burn up. GESMO assessments are generally based on an 11% MOX and 89% UO_2 fuel mix going through reprocessing. Refer to CHAPTER IV, Section E, paragraphs 1.2.1.3 and 1.2.2 for a detailed discussion of the fision product, transuranium element content, and the heat content of HLW.

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4. Comment:

"It is stated that 'the technology and facilities established for management and disposal of radioactive waste from the LWR nuclear power industry without plutonium recylce will be directly applicable to the management of radioactive waste generated by LWR's with plutonium recycle' (p. IV H-21). However, a possible exception to this appears to be the 50-fold increase in helium accumulation in 10-year-old waste from plutonium recycle. Possible problems of excessive internal stresses in waste solidified as borosilicate glass were noted. The discussion of such stresses (p. IV H-20) suggests the possibility that the stresses might increase with time, as helium accumulates. However, no mention has been made of whether this might affect canister integrity or of anticipated effects after 100 years, 1,000 years, or 100,000 years. A discussion of the probable method and consequences of canister failures would be helpful, including an evaluation of whether rupture as a result of internal pressures is a credible event."

Response:

The potential generation of helium in solidified wastes is one of a number of considerations that will have to be accommodated by a detailed design of waste storage confinement. For detailed information on this subject, see the report BNWL-2051, 'Radiation effects in Solidified High-Level Wastes - Part 2 - Helium Behavior' by R. P. Turcotte.

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5. Comment:

Implementation of Plutonium Recycle in LWR's

"The feasibility of designing fuel assemblies that are interchangeable is mentioned on page S-19. The need to use different control rods for mixed oxides and uranium fuels is also explained, but a statement to the effect that it would be impossible to operate the reactor with the wrong control rod is warranted.

"The discussion on page S-20 about interchanging fuel assemblies in a Boiling Water Reactor (BWR) and Pressurized Water Reactor (PWR) does not address itself to the safe operation of an LWR. The statement should discuss interchanging fuel elements and control rods in an LWR more thoroughly."

Response:

The discussions on pages S-19 and S-20 of the draft GESMO mention the use of fuel rod location schemes, not the use of different control rods (the same control rods would be used for UO_2 or mixed fuel). A more detailed discussion of core physics and LWR safety and performance is given in CHAPTER IV, Section C-3.0.

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6. Comment:

Unavoidable Adverse Effects

"From a metallurgical point of view, the summary discussion in Volume 1 on interchanging fuel elements should address itself to the problem of swelling and rupturing of cladding material. Volume 4 contains a statement on page VI-3 that, based on experience with UO_2 fuel rods, some clad defects will occur and small amounts of gaseous fission products will escape into the primary coolant and ultimately into the atmosphere. We hesitate to predict the degree of swelling in the mixed oxide fuel elements from the results of these experiments because of the greater neutron capture crosssection of plutonium."

Response:

A full discussion on experience to date with mixed oxide fuels in research reactors and power reactors is included in CHAPTER II, Background and Experience with Plutonium. The characteristics of MOX fuels are discussed in CHAPTER IV, Section C-3.0.

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7. Comment:

"The frequent use of the word 'should' when predicting adverse environmental effects connotes doubt that the effects are fully understood. Three examples are given on page VI-5. The statement would be more acceptable if sentences such as the following could be worded more positively" 'There would be some ground deposition of particulate plutonium compounds but this should not result in detectable changes in the terrestrial ecosystem."

7 Comment Cont'd

Response:

This comment is valid and is being implemented. The sentence wording has been revised in final GESMO, CHAPTER VI, paragraph 2.2, indicating that adverse environmental effects are not expected to result in detectable changes.

Similar changes have been made in other places as appropriate.

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8. Comment:

"Page S-6: The list of areas of greatest difference should have a fourth item, as on page S-42, 'Storage at the reactor sites.' The same comment applies to page S-57 and to page VI-9."

Response:

The difference in the requirements for safeguarding new and spent fuel at reactor sites and in spent fuel storage-only facilities are being assessed in the safeguards supplement to GESMO.

For the discussion on spent fuel storage, refer to CHAPTER IV, Section K, Extended Spent Fuel Storage.

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9. Comment:

"Table IV E-6; page IV E-13: Units of kilograms appears to be in error."

Response:

Table IV E-6 of draft GESMO contained several arithmetic errors. This table has been replaced by Table IV E-7, in this final GESMO, which shows the amounts of transuranium isotopes in the spent LWR fuels. In estimating the amounts of transuranium elements in the waste, the plutonium isotopes are reduced by a factor of 5×10^{-3} and multiplied by the number of tonnes of fuel reprocessed. See CHAPTER IV, Section E.

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10. Comment:

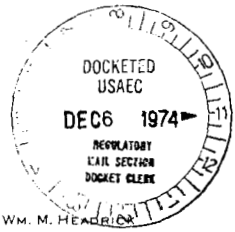
"Table IV H-1, page IV H-3: The time period covered should be given. An error on the table is that high-level waste from fuel reprocessing is given as 2,710,000,000 curies without Pu recycle and 2,760,000,000 curies with recycle, but the difference is given as a decrease of 50 million curies."

Response:

In final GESMO, CHAPTER IV, Section H has been revised indicating that the high level wastes and plutonium and transuranic wastes are to be disposed of in a Federal repository. The data presented in final GESMO is based on the types and quantities of wastes generated for the period 1975 through 2000. See CHAPTER IV, Section H-2.0.

DOCKET NUMBER
PROPOSED RULE PR-Miscellaneous (39 FR 30186)
GESMO

STATE OF MISSISSIPPI
OFFICE OF THE GOVERNOR



WILLIAM L. WALLER
GOVERNOR

WM. M. HEADRICK
COORDINATOR OF FEDERAL-STATE PROGRAMS

STATE CLEARINGHOUSE FOR FEDERAL PROGRAMS

TO: Mr. S. H. Smiley, Deputy Director
for Fuels and Materials
Directorate of Licensing - Regulation
United States Atomic Energy Commission
Washington, D. C. 20545

State Clearinghouse Number
74082601

Date: December 2, 1974

PROJECT DESCRIPTION: Generic Environmental Statement Mixed Oxide Fuel (Recycle Plutonium in Light Water - Cooled Reactors)

(x) 1. The State Clearinghouse has received notification of intent to apply for Federal assistance as described above.

(--) 2. The State Clearinghouse has reviewed the application(s) for Federal assistance described above.

(--) 3. After proper notification, no State agency has expressed an interest in conferring with the applicant(s) or commenting on the proposed project.

(--) 4. The proposed project is: ( ) consistent ( ) inconsistent with an applicable State plan for Mississippi.

(x) 5. Although there is no applicable State plan for Mississippi, the proposed project appears to be: (x) consistent ( ) inconsistent with present State goals and policies.

COMMENTS: The letter review of the Division of Radiological Health, forwarded to you under separate cover, will represent the comments of the State of Mississippi. No other State agency wishes to comment.

This notice constitutes FINAL STATE CLEARINGHOUSE REVIEW AND COMMENT. The requirements of U.S. Office of Management and Budget Circular No. A-95 have been met at the State level.

E. A. May, Jr.
Edward A. May, Jr.
Clearinghouse Director

SUITE 400, WATKINS BLDG. • 510 GEORGE STREET • JACKSON 39201 • (601) 354-7570

5-56.1

Comment Letter No. 57

Misc Notice (39FR 30186)
GE 10

North Carolina Department of Administration

OFFICE OF INTERGOVERNMENTAL RELATIONS

EDWIN DECKARD DIRECTOR

JAMES E. HOLSHOUSER, JR., GOVERNOR • BRUCE A. LENTZ, SECRETARY

November 25, 1974

DOCKETED USAEC DEC 9 1974

Mr. S. H. Smiley, Deputy Director
For Fuels and Materials
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

Generic Environmental Statement Mixed Oxide Fuel - GESMO - (Recycle Plutonium in Light Water-Cooled Reactors) Volumes I through IV

The above referenced environmental statement (four volumes) was reviewed by staff of The Department of Natural and Economic Resources. That office reported "no comment"; consequently, the State Clearinghouse has no substantive comment on the referenced environmental statement.

Sincerely,

Darryl M Bloom

Darryl M. Bloom (Mrs)
Clearinghouse Supervisor

DMB

pkd

116 WEST JONES STREET RALEIGH 27603 (919) 829-2594

5-57.1

Comment Letter No. 58

DOCKET
PROPOSED
GES

Misc Notice (39FR 30186)

BOSTON EDISON COMPANY
EXECUTIVE OFFICES
800 BOYLSTON STREET
BOSTON, MASSACHUSETTS 02199

NCIS M. STASZESKY
CUTIVE VICE PRESIDENT

DEC 9 - 1974
REGULATORY MAIL SECTION
DOCKET CLERK

December 3, 1974

MUNTZING
GOSSICK
KNUTH
Central Files

Honorable Melvin Price
Chairman
Joint Committee on Atomic Energy
H-403 Capitol Building
Washington, D. C. 20515

Dear Mr. Chairman:

I am writing to you with respect to the continuing delay in decision by the AEC with respect to plutonium recycle in fuel for the commercial light water reactors operating in the United States today. I am particularly concerned and motivated at this time because of the letter to AEC Chairman Dixy Lee Ray from Senators Mondale and Hart which urged AEC to postpone its plutonium recycle decision for "a few years."

A postponement of the AEC decision on plutonium recycle could be more damaging to commercial reactor operations than an adverse decision. With an adverse decision, plans and alternatives for the handling of spent fuel and development of more ore reserves and enrichment capacity can be pursued with clear direction. The reprocessing industry can be allowed to falter or proceed as a necessary step to ultimate disposal with definite guidance. However, a delay leaves the industry in limbo. Needed commitments will not be made and fuel may accumulate without adequate storage or treatment facilities. Current projects foretell of a storage squeeze without delays in development of the post reactor phase of the industry. The delays could be crushing. I think the interests of the industry require that a decision be made in a timely manner. Even an overly conservative decision is preferable to no decision at all at this time.

I urge that the Joint Committee and the AEC reach a decision on this question at the earliest possible moment.

Very truly yours,

Francis M. Staszesky

cc: Hon. Dixy Lee Ray
Hon. John O. Pastore
Mr. H. J. Larson
Mr. L. M. Muntzing
Mr. W. A. Anders

DEC 12 1974
paul

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By Boston Edison Co.

1. Comment:

"A postponement of the AEC decision on plutonium recycle could be more damaging to commercial reactor operations than an adverse decision. With an adverse decision, plans and alternatives for the handling of spent fuel and development of more ore reserves and enrichment capacity can be pursued with clear direction. The reprocessing industry can be allowed to falter or proceed as a necessary step to ultimate disposal with definite guidance. However, a delay leaves the industry in limbo. Needed commitments will not be made and fuel may accumulate without adequate storage or treatment facilities. Current projects foretell of a storage squeeze without delays in development of the post reactor phase of the industry. The delays could be crushing. I think the interests of the industry require that a decision be made in a timely manner. Even an overly conservative decision is preferable to no decision at all at this time."

Response:

The Commission has recognized the importance of a timely decision on Pu recycle and has taken steps to come to a decision on a timely basis. This final GESMO on the health, safety, and environmental issues of Pu recycle has been bifurcated from the safeguards issues and hearing will be held during the time that the safeguards, final cost-benefits, and final rules on recycle Pu are being prepared. A full review of the impacts on economics and the environment over a period of the years has been included in final GESMO. See CHAPTER VIII for the environemntal impacts for various alternates to prompt reprocessing of spent fuels and plutonium recycle. Also refer to CHAPTER XI for the sensitivity analysis of the economic impacts caused by the delays in Pu recycle.

Misc Notice (39FR30186)
GESMO

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE
32304
(904) 488-2371

Reubin O'D. Askew
GOVERNOR

L. K. Ireland, Jr.
SECRETARY OF ADMINISTRATION

Earl M. Starnes
STATE PLANNING DIRECTOR

December 6, 1974

DOCKETED USAEC DEC 16 1974 REGULATORY MAIL SECTION DOCKET CLERK

Mr. S. H. Smiley
Deputy Director for Fuels
and Materials
Directorate of Licensing
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Smiley:

Functioning as the state planning and development clearinghouse contemplated in U. S. Office of Management and Budget Circular A-95, we have reviewed the following draft environmental impact statement:

Generic Environmental Statement Mixed Oxide Fuel in
SAI: 75-0242E

During our review, we referred the draft environmental impact statement to the following agencies which we identified as interested: Board of Trustees of the Internal Improvement Trust Fund, Department of Health and Rehabilitative Services, Department of Natural Resources, Department of Pollution Control, Florida Energy Committee and Game and Fresh Water Fish Commission. Agencies were requested to review the statement and comment on possible effects that actions contemplated could have on matters of their concern. Letters of comment on the statement are enclosed from the Department of Health and Rehabilitative Service, Department of Natural Resources, Department of Pollution Control and Game and Fresh Water Fish Commission.

In accordance with the Council on Environmental Quality guidelines concerning statements on proposed federal actions affecting the environment as required by the National Environmental Policy Act of 1969, and U. S. Office of Management and Budget Circular A-95, this letter with attachments, should be appended to the final environmental impact statement on this project. Comments regarding this statement and project contained herein or attached hereto should be addressed in the final statement.

We request that you forward us ten (10) copies of the final environmental impact statement prepared on this project.

Sincerely,

Ed Maroney

E. E. Maroney, Chief
Bureau of Intergovernmental Relations

EM/tm

cc: Mr. Jay Landers
Mr. O. J. Keller
Mr. Harmon Shields
Mr. James Redman
Mr. H. E. Wallace
Mr. Marvin Yarosh

STATE OF FLORIDA

DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

Prior Notification and Review System

DIVISION OF ENVIRONMENTAL ENGINEERING
OCT 25 1974

O. J. KELLER
~~Emmett S. Roberts~~
Secretary

Date: October 22, 1974

MEMORANDUM

REF. NO: DHRS _____ SPDC (SAI) 75-0242

TITLE Generic Environmental Statement Mixed Oxide Fuel

APPLICANT U. S. Atomic Energy Commission

TO: Kenneth Ireland, Secretary
Department of Administration

Attn: ~~O. J. KELLER~~ E. E. Maroney, Chief
Bureau of Intergovernmental Relations

FROM: ~~Emmett S. Roberts~~, Secretary
Department of Health and Rehabilitative Services

By: Division of Planning and Evaluation

SUBJ: NOTIFICATION OF INTENT TO APPLY FOR FEDERAL FUNDS

The project identified above has been reviewed in accordance with O.M.B. Circular A-95. Action recommended:

☐ The project is consistent with the goals and objectives of the Department of Health and Rehabilitative Services. Favorable action is recommended.

☒ Substantive comments have been received and are summarized in the attached.

☐ Conference with applicant is requested.

☐ The project is not consistent with the goals and objectives of the Department of Health and Rehabilitative Services. Approval is not recommended for reasons described in the attached.

Attachment (s)

Title: Generic Environmental Statement Mixed Oxide Fuel

Reviewer's Comments:

Subject document (in four volumes) has been scanned in a cursory manner, due to the unrealistic time established for return of comment. This document is highly technical in nature and any effective review would require not less than one man-month of effort. Decisions proposed are of such importance to Florida that review in such a manner is at best careless, and, at worst, almost criminal in nature. The document should be reviewed by those with responsibility under Chapter 403 Florida Statutes, the Power Plant Siting Law.

In basic terms the document discusses the impact of utilizing the plutonium 239 produced in light water power reactors as a source of fissile material for new fuel, replacing in part the uranium 235 currently in use. Florida will have four operating nuclear powered electric generating plants in operation by the end of 1975.

Immediate results having an impact directly on Florida will include:

A. Increase in thyroid dose source term of 10-14 percent due to increased production of iodine 131 in the multiple oxide fuel. This will affect:

1. Siting of new power plants
2. Required exclusion and low population zones
3. Results of accidents and required emergency planning

B. Increased shipments of spent fuel (a 24 percent increase) and of high level waste.

C. Increased exposure to radiation during shipment. Dose to drivers, for example, for a typical trip to a fuel reprocessing plant would increase from 0.3 mrem to 56.0 mrem. Dose to population during shipment would also be increased.

Recommendation

D. Requirement for ; ity measures for new fuel a: l as spent fuel due to the presence of plutonium isotopes.

From a radiological health and safety viewpoint, the proposal would result in increased radiation dose at the fuel shipment and utilization end of the cycle (i.e., in Florida) with any population exposure reduction taking place at the mining and milling or uranium enrichment end of the cycle.

It is this reviewer's opinion that careful study should be given the proposal before Florida offers any positive comment.

William O. Lines

RECEIVED
OCT 22 1974
B. C. R. P.

STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE

32304

(904) 488-2371

Reubin O'D. Askew
GOVERNOR

Earl M. Starnes
STATE PLANNING DIRECTOR

L. K. Ireland, Jr.
SECRETARY OF ADMINISTRATION

TO: Mr. Harmon Shields, Ex. Dir.
Department of Natural Resources
Larson Building
Tallahassee, Florida 32304

DATE: SEP 1 3 1974

DUE DATE: OCT 4 1974

FROM: Bureau of Intergovernmental Relations

SUBJECT: SAI: 75 - 0242 F

Please review and comment to us on the above draft environmental impact statement, copy attached. In reviewing the statement, you should consider possible effects that actions contemplated could have on matters of concern to your agency.

If you feel that a conference is needed for discussion of the project or resolution of conflicts, or if you have questions concerning the statement, please call Mr. Estus Whitfield at (904) 488-2401. Please check the appropriate box below, attach any comments on your agency's stationery and return to IGR or telephone "no adverse comments" by the above due date.

On that date, we intend to consider all review comments received and develop a state position on the project. In both telephone and written correspondence please refer to the above SAI number.

Sincerely,

Earl Maroney

Chief
Bureau of Intergovernmental Relations

Enclosure cc: Mr. William Beckham

****

TO: Bureau of Intergovernmental Relations

FROM: Department of Natural Resources

SUBJECT: DEIS Review and Comments

☐ No Comments

☒ Comments Attached

OCT
SAI NO.

Reviewing Agency: Department of Natural Resources

Signature: James E. Smith Date: October 18, 1974

TITLE: Administrative Assistant

State of Florida

DEPARTMENT OF NATURAL RESOURCES

INTEROFFICE MEMORANDUM

September 26, 1974

TO: Jim Smith

FROM: Donald S. Kell

SUBJECT: SAI No. 75-0242E, Generic Environmental Statement, Mixed Oxide Fuels.

The conclusion of the AEC Environmental Statement is that the total impact from the nuclear fuel cycle (mining, milling, production, and use of the fuel materials) would be reduced if mixed oxide (MOX) fuel was used.

The information presented in the impressive, 4 volume statement is based upon actual operations or upon extrapolation from established developmental data or pilot operations, both entirely acceptable practices upon which the R and D technology of this century has been erected.

The safety record of electrical production by means of light water reactors (LWR's) has been laudable. Plutonium, moreover, is the most extensively studied of all elements with respect to behavior and properties.

Both the fission product inventory, and the consequences from any given accident would be essentially identical for either uranium oxide or MOX fuel cycles. The genetic risk from radiation dosage, already quite low, would be somewhat diminished by the use of the MOX fuel cycle.

An analysis of five additional alternatives to the use of MOX fuel indicates that the cost-benefit ratio would be highest when spent fuels were promptly reprocessed, with recycling of both uranium and plutonium in LWR's.

The storage of spent fuels would constitute an inane waste of plutonium as an appreciable but otherwise generally useless energy source. Not only would the recycling and reuse of plutonium (formed in the fuel during all normal operations) constitute increased efficiency of reactor operation, but uranium ore production and enrichment requirements could be reduced (together with concomitant negative impacts on land, water, and air resources) by some 10% by 1990, the equivalent saving of some 130,000 tons of U_3O_8, 10 billion barrels of oil, or 2 billion tons of coal. The recycling and use of plutonium in a MOX cycle would reduce the potential dangers of shipping and storing spent fuels as "radioactive wastes".

The fact that, as of 1972, only 1% of all energy consumed within the U. S. was produced from nuclear reactors (petroleum 46%, gas 32%, coal 17%,

hydro 4%, nuclear 1%=100%) is regrettable. The increased production of electricity by nuclear reactors has been too long delayed by the ulterior machinations of a highly vocal lobby of detractors.

When late developments in petroleum distribution and price are contrasted with the stable production and declining price of nuclear fuels; when the world's limited fossil fuel reserves are matched against the rate of their consumptive use (especially when they constitute a limited and basic raw material in the chemical industry); when the nation's goal of energy self-sufficiency is considered; when the cleanliness of operation of the nuclear power plant is contrasted with the typically dirty operation of the fossil fuel plant (especially now that emission standards have been relaxed with corresponding further degradation of regional air quality); when it is realized that neither fast breeder or fusion reactors will be in significant use by the centuries' end; and that tidal, geothermal, wind, and solar power productions are variously limited; the Division of Interior Resources staff highly supports the concept of the MOX cycle in LWR's.

The Staff furthermore, will be interested in reviewing the proposed regulations on the use of MOX fuels in LWR's when these are released. These regulations would apparently limit the amount of MOX fuels that could be used in LWR's without the preparation of an additional impact statement.

DSK:jip

STATE OF FLORI

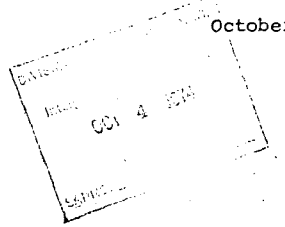
DEPARTMENT OF POLLUTION CONTROL

2562 EXECUTIVE CENTER CIRCLE, EAST
MONTGOMERY BUILDING, TALLAHASSEE, FLORIDA 32301

PETER P. BALJET
EXECUTIVE DIRECTOR

W. D. FREDERICK, JR.
CHAIRMAN

October 3, 1974



RE: SAI: 75-0242E
Generic Environmental Statement Mixed Oxide Fuel (Recycle Plutonium In Light Water - Cooled Reactors) Vols. I,II,III & IV U.S. Atomic Energy Commission

Mr. E. E. Maroney
Bureau of Intergovernmental Relations
Department of Administration
Division of State Planning
660 Apalachee Parkway
Tallahassee, Florida 32304

Dear Mr. Maroney:

The Department of Pollution Control has received the above referenced "Generic Environmental Statement". The Department has no comments at this time as this statement has been referred to the Department of Health and Rehabilitative Services for their through review and comments.

Sincerely,

Hamilton S. Oven

Hamilton S. Oven, Jr., P.E.

HSOJr/lbm

John R. Middlemas
BOARD MEMBER

Mark D. Hollis
BOARD MEMBER

Alice C. Wainwright
BOARD MEMBER

Y. E. Hall
BOARD MEMBER

5-59.5

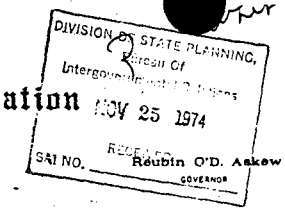
STATE OF FLORIDA

Department of Administration

Division of State Planning

660 Apalachee Parkway · IBM Building

TALLAHASSEE
32304
(904) 488-2371



Earl M. Starnes
STATE PLANNING DIRECTOR

L. K. Ireland, Jr.
SECRETARY OF ADMINISTRATION

TO: Mr. H. E. Wallace, Assistant Dir.
Game and Fresh Water Fish Commission
Bryant Building
Tallahassee, Florida 32304

DATE: SEP 1 3 1974

DUE DATE: ~~OCT 4 1974~~

FROM: Bureau of Intergovernmental Relations

SUBJECT: SAI: 75-0242 E

Please review and comment to us on the above draft environmental impact statement, copy attached. In reviewing the statement, you should consider possible effects that actions contemplated could have on matters of concern to your agency.

If you feel that a conference is needed for discussion of the project or resolution of conflicts, or if you have questions concerning the statement, please call Mr. Estus Whitfield at (904) 488-2401. Please check the appropriate box below, attach any comments on your agency's stationery and return to IGR or telephone "no adverse comments" by the above due date.

On that date, we intend to consider all review comments received and develop a state position on the project. In both telephone and written correspondence please refer to the above SAI number.

Sincerely,

Chief
Bureau of Intergovernmental Relations

Enclosure cc: Lt. Col. Robert Brantly

****

TO: Bureau of Intergovernmental Relations

FROM: Game and Fresh Water Fish Commission

SUBJECT: DEIS Review and Comments

[X] No Comments

[ ] Comments Attached

Reviewing Agency:

Signature: Date: 11/21/74

TITLE: Section Leader, Environmental Protection Section

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By E. E. Maroney - State Of Florida

1. Comment:

"Immediate results having an impact directly on Florida will include:

A. Increase in thyroid dose source term of 10-14 percent due to increased production of iodine 131 in the multiple oxide fuel. This will affect:

1. Siting of new power plants

2. Required exclusion and low population zones

3. Results of accidents and required emergency planning"

Response:

These statements are contrary to the GESMO conclusions and Tables IV C-13 and Tables IV C-35 and -36 of CHAPTER IV, Section C, paragraphs 5.3.1 and 5.4. The use of recycle plutonium in MOX fuels in LWR's does not significantly affect the computed doses from postulated accidents. The major differences in fission product yield for MOX fuel is a 5% increase in yield of ^{131}I. The conclusion of final GESMO is that the accident analyses source terms for Pu recycle reactors, typified by the SGR model, do not represent any significant increases over those used for UO_2 fueled reactors.

---

2. Comment:

"B. Increased shipments of spent fuel (a 24 percent increase) and of high-level waste.

C. Increased exposure to radiation during shipment. Dose to drivers for example, for a typical trip to a fuel reprocessing plant would increase from 0.3 mrem to 56.0 mrem. Dose to population during shipment would also be increased."

Response:

In final GESMO, it is estimated that the spent fuel shipments will increase about 20% due to plutonium recycle due to the higher heat loads. A lesser number of MOX fuel assemblies would be shipped per cask because of this higher heat output per assembly.

Radiation doses to transport vehicle drivers is expected to be about the same regardless of the fuel cycle option utilized, no recycle, recycle of uranium only or recycle of uranium and plutonium. For a more detailed discussion on transportation of radioactive materials refer to CHAPTER IV, Section 6.

---

3. Comment:

"From a radiological health and safety viewpoint, the proposal would result in increased radiation dose at the fuel shipment and utilization end of the cycle (i.e., in Florida) with any population exposure taking place at the mining and milling or uranium end of the cycle."

3 Comment Cont'd

Response:

Costs, benefits, and population exposure commitments for this generic statement were computed without assignment to a specific region or locale.

Local radiation impacts are considered in terms of maximum individual theoretical exposure for a neighboring inhabitant at each model facility and along transportation routes, and are found to be within the limits prescribed by standards. The majority of the person-rem from mining and milling accrues to populations hundreds of miles downwind where radon undergoes radioactive decay. The population exposure from tritium, ^{14}C, and ^{85}K which are released to the atmosphere is computed as being distributed to the world population.

Estimates of dose to the general population due to transportation of materials for the recycle option are slightly lower than the no recycle. The slight decrease comes about because fuel reprocessing concentrates the wastes so that fewer total shipments for the entire fuel cycle of radioactive materials are needed for recycle than for no recycle. Reductions in population exposure for recycle of uranium and plutonium are considered so small as to not be a factor on the decision.

Comment Letter No. 60

EXECUTIVE OFFICE OF THE PRESIDENT
COUNCIL ON ENVIRONMENTAL QUALITY
722 JACKSON PLACE, N. W.
WASHINGTON, D. C. 20006

PR. Misc Notice (39 FR 3012)
GESMO

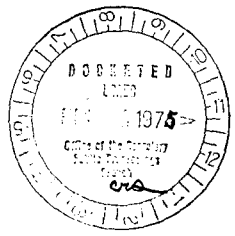
January 20, 1975

Dear Mr. Anders:

The Council on Environmental Quality has reviewed WASH-1327, the draft Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuels in Light Water Reactors (GESMO).

Although, in general, this draft is well done and reflects a high quality effort, the Council believes that it is incomplete because it fails to present a detailed and comprehensive analysis of the environmental impacts of potential diversion of special nuclear materials and of alternative safeguards programs to protect the public from such a threat. We understand that the Atomic Energy Commission (AEC) chose to give summary treatment to the diversion and safeguards issues in GESMO with the intention of dealing with these matters definitively in a separate future action. The purpose of this letter is to recommend that the Nuclear Regulatory Commission (NRC), as successor to the AEC, adopt an alternative course of action.

The potential impacts of the diversion and illicit use of special nuclear materials are well recognized. This threat is so grave that it could determine the acceptability of plutonium recycle as a viable component of this Nation's nuclear electric power system. Thus, we believe that the NRC, the Executive Branch, the Congress, and the American people should have the benefit of a full discussion of the



diversion and safeguards problem, its impacts, and potential mitigating measures, before any final decisions are made on plutonium recycle.

The National Environmental Policy Act requires that, in preparing an environmental impact statement, the agency develop and describe appropriate alternatives where unresolved conflicts exist. Alternative safeguards programs for dealing with the threat of diversion of special nuclear materials have not yet been developed. As such, the information necessary to make sound and reasoned decisions on plutonium recycle was not available for governmental and public consideration in the draft GESMO. Because of this, the Council believes that the draft environmental impact statement does not meet the requirements of the National Environmental Policy Act.

To bring the draft statement into conformance with NEPA we recommend the following:

- The NRC should identify alternative safeguard programs which could protect the public from the unauthorized use of special nuclear materials.

- The impacts - environmental, economic, social, legal and institutional - of each alternative safeguards program should be fully analyzed.

- The NRC should present these alternative safeguard programs, including its proposed, preferred alternative, in an addendum to the draft environmental impact statement (GESMO) which should be circulated for review and comment according to CEQ guidelines and existing NRC procedures for draft environmental impact statements.

- After considering the comments received on both the initial draft environmental impact statement and the addendum, the NRC should proceed with preparation of the final environmental impact statement.

- Only after these steps have been carried out should a final decision be made on whether to permit the commercial recycling of plutonium in light water reactors.

Because the NRC will be called upon to make decisions which are not directly related to the draft environmental impact statement in question, but which have clear implications for alternative safeguards programs, we are making the following additional recommendations:

- A decision on whether or not to permit construction of the mixed oxide fuel fabrication plant at Anderson, S.C. should be deferred until safeguards studies are completed, an acceptable safeguards program approved, and, in particular, the future role of integrated fuel cycle facilities (IFCF's) has been determined.

- During the period in which the safeguards issue is being resolved, the Commission should take care to avoid actions which would foreclose future options, such as IFCF's and power parks, or which would result in the unnecessary "grandfathering" of certain nuclear facilities.

The Council is prepared to discuss these matters with you in depth. If you, or members of your staff, have any question concerning our comments or recommendations, please do not hesitate to call on us.

Sincerely,

Russell W. Peterson

Russell W. Peterson
Chairman

Honorable William A. Anders
Chairman
Nuclear Regulatory Commission
Washington, D.C. 20545

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By Russell E. Peterson
Executive Office Of The President
Council On Environmental Quality

1. Comment:

"To bring the draft statement into conformance with NEPA, we recommend the following:

- The NRC should identify alternative safeguard programs which could protect the public from the unauthorized use of special nuclear materials.

- The impacts - environmental, economic, social, legal and institutional - of each alternative safeguards program should be fully analyzed.

- The NRC should present these alternatives safeguard programs, including its proposed, preferred alternative, in an addendum to the draft environmental impact statement (GESMO) which should be circulated for review and comment according to CEQ guidelines and existing NRC procedures for draft environmental impact statements."

Response:

The final GESMO will be published in 2 parts. The first will be an assessment of the health, safety, and environmental aspects of widescale use of recycle Pu in MOX fuels for LWR's.

The second part will be on the safeguards considerations of recycle Pu. A draft supplement statement on safeguards alternatives and preferred requirements will be issued for public comment. Then the final safeguards statement, with the recommended preferred alternative cost-benefit analysis and responses to the public comments will be published. The decision on the widescale use of recycle plutonium in the LWR industry will not be made until hearings are held on all the issues above as well as the necessary rule changes for the use MOX fuels in LWR's.

The final GESMO health, safety, and environmental assessments have changed from the draft in that environment and economic impacts have been integrated over a 26-year period from 1975 through 2000 and comparisons included for the three fuel cycle options: no recycle, recycle of uranium only, and uranium and plutonium recycle.

-Misc Notice (39 FR 30186)

GESMO

DOCKETED
JAN 29 1975

FEDERAL ENERGY ADMINISTRATION
WASHINGTON, D.C. 20461

24 JAN 1975

DOCKETED
USAEC
JAN 29 1975
REGULATORY
MAIL SECTION
DOCKET CLERK

Mr. S. H. Smiley
Deputy Director for
Fuels and Materials
Directorate of Licensing
Atomic Energy Commission
Washington, D.C. 20545

Dear Mr. Smiley:

The Federal Energy Administration has reviewed the Generic Environmental Statement - Mixed Oxide Fuel, WASH-1327 (GESMO). Your assessment considered six alternatives for the disposition of plutonium produced in light water reactors (LWR's) including several alternatives involving disposal of plutonium generated in light water reactors, and one case involving "the recycle of uranium and plutonium while providing for significantly upgraded protection measures as might be judged to be consistent with AEC objectives." Your analysis indicates that reusing plutonium generated in commercial reactors will lead to a reduction of 9% in the uranium required to meet energy needs by 1990, and a reduction of 11% in the enrichment capacity required to meet energy needs by 1990.

The FEA strongly supports the program to recycle plutonium in the Nation's commercial LWR's provided that sufficient actions are taken by the Nuclear Regulatory Commission (NRC) and the industry to assure that plutonium is adequately safeguarded from accidental or intentional diversion or release to the environment.

Studies performed by FEA regarding the development of energy resources in this country concluded that a substantial part of the Nation's energy needs must be met by nuclear power in the coming decades, if we are to maintain our position in the world as a leading industralized Nation. These studies

indicate that a key constraint in the growth of nuclear power may well be the availability of nuclear fuel resources and the facilities, such as fuel reprocessing plants which are necessary to utilize these resources effectively. It is also important to recognize that the alternative to plutonium recycle is storage and eventual disposal of large quantities of plutonium. This alternative has potential environmental and public health hazards although these potential impacts would be much lower than those associated with the proposed program.

However, we strongly believe that the plutonium recycle program should only be instituted if it incorporates adequate public health and environmental safeguards. In consideration of such safeguards, we note that WASH-1327 (p. S-7) states "studies on some of these [safeguards] aspects (Federal Security Force, threat analysis, personnel security clearances, strengthened physical protection measures at fixed-sites and in transportation, and improved material accountability methods) are underway and other studies (e.g., Integrated Fuel Cycle Facilities and "spiked" plutonium) are being initiated."

The FEA shares the Commission's "high degree of confidence" that through implementation of some combination of appropriate safeguards, commercial scale plutonium recycle in LWR's can be carried out in an acceptable manner. We believe such safeguards are within the reach of existing technology, and the cost of implementing them will be small relative to the gain which is achievable by use of plutonium recycling.

It is suggested in WASH-1327 that the Commission anticipates that the decisions on the necessary upgrading of safeguards will be made about one year after the final GESMO statement is issued. We recommend that the Commission accelerate the schedule so that safeguards can be implemented at least cost into the planning and construction of fuel recycle plants and other industrial ventures with minimum backfitting.

We suggest that the final GESMO statement be issued according to plan. However, it should clearly indicate that a supplement would follow which would discuss the safeguards programs and their relationship to the expected impacts on the human environment.

While we have not performed an analysis of the assumptions and calculations used by the AEC in the GESMO statements, we believe the potential benefit which can be accrued from recycle of plutonium may be greater than estimated in your report. The WASH-1327 estimate is based on a continuation of the present type of LWR's currently being used in commercial power stations. We are aware of federally sponsored programs to increase the utilization of nuclear fuel in LWR's, including the light-water breeder reactor development presently planned for the Shippingport Atomic Power Station next year. Although this program is focused on a reactor which uses thorium, we believe that the technology being developed is equally applicable to the uranium fuel cycle now being used in commercially operated nuclear power plants. This will result in even greater savings in uranium from the generation and recycle of plutonium.

When uranium becomes sufficiently scarce and prices sufficiently high, as expected in the next decade or so, the FEA believes that the market will call for the electric utility industry and their suppliers to introduce into commercial reactors the improvements necessary to achieve a greater utilization of uranium fuel by increasing the rate of conversion to plutonium. While the WASH-1327 analysis indicated a reduction of uranium needs by 1990 of 11% resulting from plutonium recycle, this reduction can and probably will be much greater in later years as more attention is given to higher conversion techniques. This conclusion lends support to the need for promptly taking those steps needed to initiate plutonium recycle in the nuclear power industry.

The FEA appreciates the opportunity to comment on this generic statement and hopes that these comments will be helpful in the development of plutonium recycle in commercial LWR's.

Sincerely,

Roger W. Sant
Assistant Administrator
Energy Conservation and Environment

NRC Staff Response To Specific Comments On Health, Safety & Environment By U.S. Federal Energy Administration

1. Comment:

"It is also important to recognize that the alternative to plutonium recycle is storage and eventual disposal of large quantities of plutonium. This alternative has potential environmental and public health hazards although these potential impacts would be much lower than those associated with the proposed program."

Response:

The alternatives of storage of fuel and disposal of large quantities of plutonium are evaluated in final GESMO. The impact of the no recycle or uranium only recycle options are assessed in the final GESMO together with the uranium and plutonium recycle option to determine differential impacts of the recylce options. Refer to CHAPTER IV, Section K for more specific details on the impacts of extended spent fuel storage and CHAPTER IV, Section H for the storage-disposal considerations for spent fuel.

---

2. Comment:

"We suggest that the final GESMO statement be issued according to plan. However, it should clearly indicate that a supplement would follow which would discuss the safeguards programs and their relationship to the expected impacts on the human environment."

Response:

The NRC has concluded that a draft supplement on safeguards consideration be prepared and issued for public comment. This portion of final GESMO assesses the health, safety, and environmental issues of the three cycle options, no recycle, the recycle of uranium only, and the recycle of uranium and plutonium.

---

3. Comment:

"While we have not performed an analysis of the assumptions and calculations used by the AEC in the GESMO statements, we believe the potential benefit which can be accrued from recycle of plutonium may be greater than estimated in your report. The WASH-1327 estimate is based on a continuation of the present type of LWR's currently being used in commercial power stations. We are aware of federally sponsored programs to increase the utilization of nuclear fuel in LWR's, including the light-water breeder development presently planned for the Shippingport Atomic Power Station next year."

Response:

It is true that the benefits of plutonium recycle could be greater with the development of other reactor technologies, however, the function of GESMO is to evaluate the costs and benefits of plutonium recycle in LWR's, both the BWR's and PWR's, which are expected to be the dominant source of nuclear power during the time frame considered. Refer to CHAPTER VIII for alternative considerations for recycling of uranium and plutonium in LWR's and CHAPTER XI for the cost-benefit sensitivity analyses provided to illustrate the influence of changes in any of the basic parameters.

---

4. Comment:

"While the WASH-1327 analysis indicated a reduction of uranium needs by 1990 of 11% resulting from plutonium recycle, this reduction can and probably will be much greater in later years as more attention is given to higher conversion techniques. This conclusion lends support to the need for promptly taking those steps needed to initiate plutonium recycle in the nuclear power industry."

Response:

In final GESMO assessment has been made, integrated over a 26-year period from 1975 through 2000. Differential impacts on the economics and environmental issues have been indicated for the three fuel cycle options, no recycle, recycle of uranium only, and uranium and plutonium recycle. The environmental impacts are summarized in CHAPTER VIII and the economics are detailed in CHAPTER XI.

-Misc Notice (39 FR 30186)

BESMO

'75 FEB 26 AM 8:11

BOARD MEMBERS
Lachlan L. Hyatt, Chairman
William M. Wilson, Vice-Chairman
I. DeQuincey Newman, Secretary
W. A. Barnette, Jr.
Leonard W. Douglas, M. D.
J. Lorin Mason, Jr., M. D.
Caroline G. Newhall

SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL

E. KENNETH AYCOCK, M.D., M.P.H., COMMISSIONER
J. MARION SIMS BUILDING — 2600 BULL STREET
COLUMBIA, SOUTH CAROLINA 29201

February 10, 1975

3-3-75, c.r2

Secretary of the Commission
United States Nuclear Regulatory Commission
Washington, D. C. 20545

Attention: Docketing and Service Section

Dear Sirs:

As indicated in our letter of January 16, 1975, in which the State of South Carolina requested party status in the upcoming public hearing on the generic environmental impact statement on the use of recycle plutonium, we are submitting comments regarding areas wherein we deem it essential for the Commission to address itself more fully and provide adjudicatory proceedings wherein actual controversy exists.

Having reviewed the document "WASH-1327" we find the following areas have been given inadequate treatment and require further attention before a decision to use recycle fuels is made:

1. As a result of our experience in the licensing proceedings involving the license applicant, Allied-General Nuclear Services, we have reason to suspect that the Commission's radionuclide effluent source terms have been significantly underestimated. Reference to the testimony given in transcript "Docket No. 50-332" will substantiate the Commission's own revision of source terms after the August, 1974, publication date of "WASH-1327".

   In the same proceeding evidence has been introduced that indicates that the Commission overlooked and did not evaluate the effect of the radionuclide C^{14}. The revision of iodine and other source terms indicate that the Commission needs to do the same with the "WASH-1327" evaluation.

   The issue involving Kr-85 removal is an open issue as indicated on Page IV E-15 of "WASH-1327". A policy decision to use recycle fuels will be incomplete until a cost-benefit analysis shows that Kr-85 removal is or is not warranted. Information exists that indicates to us that Kr-85 removal technology is available. It remains to be proven whether or not removal is "practicable", and it is our position that the burden of proof does not belong to those persons advocating installation of the equipment.

   The treatment afforded the "hot particle" plutonium concept in "WASH-1327" indicates that the issue is one of conflicting evidence. The fact that a separate proceeding is being held to evaluate this issue emphasizes that recycle fuels cannot be evaluated without a determination of this issue. We feel that due process would warrant inclusion of this issue in the public hearing.

2. The resolution of the high level waste problem presents two areas of concern and inquiry. Realizing that waste treatment presents a major adverse cost associated with the nuclear industry, we are not persuaded that the arbitrary cost of $30 per cubic foot for waste handling and care is adequate. The Commission should be more explicit in this evaluation. The idea of having future generations bear the total costs of perpetual maintenance of high level wastes is unacceptable. Present benefactors should equitably bear these costs.

   The summary treatment given to the idea of separating actinide wastes from shorter half-life materials is inadequate. The potential exists that such separation would result in less adverse impact in the future. The Commission should treat this more completely.

3. An item of miscellaneous nature which is of concern is the summary discussion given the potential for sabotaging spent fuel storage areas. Our concern rests with respect to the potential for saboteurs to penetrate the sheet metal enclosures of spent fuel storage areas and to thereafter impair the integrity of spent fuel stored in the pools. Contrary to the statement on Page V-11 of "WASH-1327" high levels of violence would not be required to effect such action.

   We have a concern also regarding the capability of effecting recovery from a transportation accident. Heavy fuel casks and potentially high radiation and contamination levels present foreseeable problems which we have not seen addressed.

   In the analysis of core performance with recycle fuels, there was no discussion of the ability to continue use of a recycle plutonium element throughout the normal three year cycle period. We note that distribution of plutonium elements is more restricted than uranium elements. With this restriction, will it be necessary to remove the fuel more frequently, thereby resulting in increased fabrication and reprocessing costs?

   Some questions exist with respect to the ability to use recycle uranium fuels. It is not understood whether there are restrictions or adversities associated with recycled uranium. The Commission should address these questions and present date from past experience if available.

4. Ultimately it would seem that the decision to recycle nuclear fuels would be arrived at after a thorough evaluation of costs and benefits. The step-by-step process that is currently being used in evaluation seems to extract maximum benefits in the present with the intent to pay the consequences at a later date. This process should cease, and a thorough costs-benefits analysis performed. Costs associated with Kr-85 removal equipment, high level waste treatment, adverse health effects, and others should be balanced against present reduced electrical rates benefits, etc. resulting from the use of nuclear power. Societal benefits of advanced technology, etc. should not be overlooked in the analysis, but we should be candid and indicate our attribution of offsetting consequences as the costs for such.

Indications are present throughout "WASH-1327" implying that the impact review will be limited to items directly associated with plutonium recycle. We would encourage the Commission to interpret these implications liberally. We think it illogical to segment various facets of the nuclear fuels cycle, and permit only a review of the segmented portion. The proposed hearing presents an opportunity to formulate an informed, intelligent policy to follow in the future, and an opportunity to adjudicate areas of controversy. Upon a final determination, the issues should become "res judicata" as to further licensing proceedings wherein the same issues arise.

We note in concluding that many of the comments submitted are the bases for items of contention in the Allied-General hearing currently in process. Our experience in this hearing indicates that these issues are not ones to be decided on an individual applicant basis. These issues vitally affect everyone, and public policy should dictate the direction to be followed.

The Commission may be reluctant to discuss some of the issues presented; however, it should be realized that many are recurrent in licensing proceedings. An adjudication on a national basis would prevent this recurrence. In this respect the State is a party to a present proceeding wherein these issues are being adjudicated. To preclude these issues or the State from an adjudication on a national basis would be to only make it necessary to continue the adjudication in the Allied-General hearing. We trust that the Commission will see it in the interests of all concerned to decide these issues on a one-time basis.

We continue to support the Commission's choice of public hearing format with the reservation that questionable issues be adjudicated. We look forward to continuing our relationship with the Commission in its effort to resolve an issue vital to each of us.

Very truly yours,

Lamar E. Priester, Jr., Ph. D.,
Deputy Commission for Environmental
Health and Safety

SB:HGS:bo

cc: Chairman William A. Anders
U. S. Nuclear Regulatory Commission
Washington, D. C. 20545

The Honorable James Edwards
Governor of South Carolina
COlumbia, South Carolina 29211

The Honorable Strom Thurmond
United States Senator
1310 Lady Street
Columbia, South Carolina 29201

The Honorable Butler Derrick
United States Representative
House Office Building
Washington, D. C. 20515

The Honorable Ernest F. Hollings
United States Senator
Senate Office Building
Washington, D. C. 20013

The Honorable Mendel Davis
United States Representative
House Office Building
Washington, D. C. 20515

The Honorable Floyd D. Spence
United States Representative
House Office Building
Washington, D. C. 20515

The Honorable George Busbee
Office of the Governor
State Capitol
Atlanta, Georgia 30304

Dr. William D. Rowe
Office of Radiation Programs
U. S. Environmental Protection Agency
Waterside Mall - 401 M. Street, S.W.
Washington, D. C. 20460

Mrs. Ruth S. Thomas
President, Environmentalists, Inc.
1339 Sinkler Road
Columbia, South Carolina 29206

Mr. Ed Carter
WIS-TV
1111 Bull Street
Columbia, South Carolina 29201

Mr. Charles Wickenburg
Associated Editor, Columbia State Newspaper
Stadium Road
Columbia, South Carolina 29201

Mr. Robert Hitt
Columbia Record
Stadium Road
Columbia, South Carolina 29201

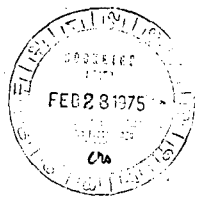
Mr. Robert L. Pendergraft
Assistant Attorney General
Environmental Protection Division
Office of the Attorney General
for the State of Texas
Austin, Texas 78711

Mr. William Willoughby
Chairman, S. C. Nuclear Advisory Council
S. C. Electric & Gas Company
P. O. Box 764
Columbia, South Carolina

Mr. Townsend M. Belser, Jr.
Attorney at Law
1213 Lady Street
P. O. Box 11600
Columbia, South Carolina 29211

Misc Notice (39 FR 30186)

GESMO



January 17, 1975

Secretary of the Commission
United States Atomic Energy Commission
Washington, D. C. 20545

Attention: Docketing and Service Section

Dear Sir:

The December 10, 1974, publication in the "Federal Register" regarding the Public Hearing on the generic environmental impact statement on the use of recycled plutonium as fuel in light water cooled nuclear reactors was not received by our agency and was only indirectly brought to our attention today. Our failure to receive notification was perhaps due to our not having commented upon the draft GESMO. At the time of receipt of the draft GESMO, our staff was and still continues to be involved in the Allied-General Nuclear Services hearing while conducting a regulatory program as an agreement state. Our limited staff is only now in the process of conducting its review of the draft GESMO. Upon conclusion of our review, it is still out intention to submit comments although perhaps redundant to those submitted by other parties.

Pursuant to the Commission's procedures for showing good cause fa. failure to comply with the published notice, we would request that the State of South Carolina be permitted to participate in the GESMO public hearing. At this time the State does not have any formulated items of contention; however, we would request that the State be permitted to enter evidence and interrogate witnesses concerning those items of contention reviewed during the hearing and affecting our State's interest.

It is our understanding that during the public hearing matters of procedure and hearing format will be determined. The State of South Carolina readily endorses the public hearing format in an effort to expedite the proceeding by formulating precise issues; however, should disputed factual issues present themselves, we would endorse an adjucatory proceeding to resolve these disputed issues. This would dispel reservations and promote public confidence in the nuclear industry.

As you are aware, the final decision regarding recycle fuel has a tremendous implication for affecting the State of South Carolina. The prospect of our State being the situs of reprocessing and recycle fuels fabrication for the immediate future is of great concern for many of our citizens. Due to this uniqueness and the proximity of major interested parties to our State, we would highly recommend holding the proposed hearing in Columbia, South Carolina. Our capital city affords ample accommodations in addition to the proximity of interested parties and affected industries. We can afford such accommodations as are required for conducting the hearing. We would welcome the opportunity to discuss these arrangements with you.

We feel that our State's interest is promoted by expediting the proposed proceedings, and encourage every effort to do so. We look forward to continuing our present friendly relationship with the Commission and its successor.

Very truly yours,

L. E. Priester, Jr., Ph. D.,
Deputy Commissioner for Environmental
Health and Safety

SB:bo

cc: Mr. William Willoughby, Chairman
Nuclear Advisory Council

Mr. Randolph R. Mahan
Assistant Attorney General

NRC Staff Response To Specific
Comments On Health, Safety & Environmental
By L. E. Priester - South Carolina Dept Of Health Envir. Control

1. Comment:

"As a result of our experience in the licensing procedure involving the license applicant, Allied-General Nuclear Services, we have reason to suspect that the Commission's radionuclide effluent source terms have been significantly underestimated. Reference to the testimony given in transcript 'Docket No. 50-322' will substantiate the Commission's own revision of source terms after the August, 1974 publication date of 'WASH-1327.'"

Response:

For the purpose of this assessment in final GESMO, the source terms have been revised in accordance with the conservative upper-level release estimates presented by testimony at the Barnwell Nuclear Fuel Plant hearing, Docket No. 50-332. It is noted, however, that the referenced testimony also stated that the release estimates, for the purpose of evaluating radiological effects, were conservative and that the actual releases of fission products and transuranic radionuclides were expected to be on the order of 10 to 100 times lower.

Population dose commitments are dominated by the release of ^{3}H, ^{14}C, and ^{85}Kr. CHAPTER IV, Section E, Tables IV E-9 through E-13, show the effect of radionuclide releases on dose commitment estimates. For the purpose of this assessment, the revised conservative source term estimates give reasonable assurance that the actual dose commitments to the population and to the maximally exposed individuals will be less than the projected values.

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2. Comment:

"In the same proceeding evidence has been introduced that indicates that the Commission overlooked and did not evaluate the effect of the radionuclide C^{14}. The revision of iodine and other source terms indicate that the Commission needs to do the same with the 'WASH-1327' evaluation."

Response:

The presence of significant amounts of ^{14}C in irradiated LWR fuel has not been confirmed. For the purpose of this assessment, however, we have evaluated the effect, if any, related to the hypothesis that ^{14}C is present in LWR fuel and that it is released quantitatively during the dissolution of the fuel. Note that this hypothesis has a significant impact on the population dose commitment estimates.

Iodine emissions from reprocessing plants used in final GESMO are consistent with data presented at the Barnwell Nuclear Plant hearing. Refer to Tables IV E-9 through E-13 in final GESMO, CHAPTER IV, Section E.

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3. Comment:

"The issue involving Kr-85 removal is an open issue as indicated on Page IV E-15 of 'WASH-1327'. A policy decision to use recycle fuels will be incomplete until a cost-benefit analysis shows that Kr-85 removal is or is not warranted. Information exists that indicates to us that Kr-85 removal technology is available. It remains to be proven whether or not removal is practicable, and it is our position that the burden of proof does not belong to those persons advocating installation of the equipment."

Response:

The benefit of recovering ^{85}Kr may be evaluated by comparing the maximum achievable dose reduction with the dose from natural background radiation. For example, the annualized cost of a system for recovering ^{85}Kr is estimated to exceed $2 million. For such an expenditure, the total body dose commitment would be reduced 0.005% to the U.S. population, or 0.0013% to the world population.

Taking into account the state of technology, and the economics of adding facilities for the recovery and disposal of ^{85}Kr, in relation to the negligible benefits to the population from the reduction of dose commitments already so small as to cause negligible risks to health, it has been concluded that it is not practicable at this time to require the addition of facilities for the recovery and disposal of ^{85}Kr.

---

4. Comment:

"The treatment afforded the 'hot particle plutonium concept in WASH-1327' indicates that the issue is one of conflicting evidence. The fact that a separate proceeding is being held to evaluate this issue emphasizes that recycle fuels cannot be evaluated without a determination of this issue. We feel that due process would warrant inclusion of this issue in the public hearing."

Response:

The NRDC petition and the NRC denial of the hot particle plutonium concept is covered in detail in final GESMO, CHAPTER IV, Section J, Appendix D.

---

5. Comment:

"The resolution of the high-level waste problem presents two areas of concern and inquiry. Realizing that waste treatment presents a major adverse cost associated with the nuclear industry, we are not persuaded that the arbitrary cost of $30 per cubic foot for waste handling and care is adequate. The Commission should be more explicit in this evaluation. The idea of having future generations bear the total costs of perpetual maintenance of high-level wastes is unacceptable. Present benefactors should equitably bear these costs.

"The summary treatment given to the idea of separating actinide wastes from shorter half-life materials is inadequate. The potential exists that such separation would result in less adverse impact in the future. The Commission should treat this more completely."

Response:

The NRC basically agrees that costs of waste disposal should be borne by the originator of such wastes. The subject of full cost recovery is included in 10 CFR Part 50, Appendix F.

The concept of partitioning of actinides from the shorter half-life radionuclides in high level wastes is not included in this generic statement and was the subject of a conference held in Seattle, Washington on June 8-10, 1976. Proceedings of this conference are reported in NR-CONF-001. It is anticipated that this subject will be covered in a separate study.

6. Comment:

"We have a concern also regarding the capability of effecting recovery from a transportation accident. Heavy fuel casks and potentially high radiation and contamination levels present foreseeable problems which we have not seen addressed."

Response:

Appropriate sections in the discussion of regulatory standards and requirements for recovery from an accidental release of radioactivity in the transportation system have been included in CHAPTER IV, Section G, Appendix A.

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7. Comment:

"In the analysis of core performance with recycle fuels, there was no discussion of the ability to continue use of a recycle plutonium element throughout the normal three-cycle period. We noted that distribution of plutonium elements is more restricted than uranium elements. With this restriction, will it be necessary to remove the fuel more frequently, thereby resulting in increased fabrication and reprocessing costs?

"Some questions exist with respect to the ability to use recycle uranium fuels. It is not understood whether there are restrictions or adversities associated with recycled uranium. The Commission should address these questions and present data from past experience if available."

Response:

Fuel shuffling between cycles should not be adversely restrictive with mixed oxide fuel in quantities less than 1.15 SGR. For BWR's each bundle is alike. The MOX rods are positioned at least 2 rows away from the control rod location with the UO_2 rods placed adjacent to the control rods. Bundle relocation for such rod arrangements within an assembly would not be affected. For PWR's, where it is expected that mixed oxide bundles would be located in unrodded locations, some constraints would be present. In those cases, however, the number of mixed oxide bundles (at 1.15 SGR) would be less than the number of unrodded locations so that premature discharge would not be expected.

The use of recycled uranium is also considered in final GESMO. See Table IV C-11. However, with regard to reactor operation, there are no new considerations to be accounted for. Refer to CHAPTER IV, Section C-1.0, C-2.0, and C-3.0 for general discussion on the 1.15 SGR and Section C-4.0 for specific discussion.

8. Comment:

"Ultimately it would seem that the decision to recycle nuclear fuels would be arrived at after a thorough evaluation of costs and benefits. The step-by-step process that is currently being used in evaluation seems to extract maximum benefits in the present with the intent to pay the consequences at a later date. This process should cease, and a thorough cost-benefits analysis performed. Costs associated with Kr-85 removal equipment, high-level waste treatment, adverse health effects, and others should be balanced against present reduced electrical rates benefits, etc. resulting from the use of nuclear power. Societal benefits of advanced technology, etc. should not be overlooked in the analysis, but we should be candid and indicate our attribution of offsetting consequences as the costs for such."

Response:

The analyses in the final GESMO have been performed in a rigorous economic fashion and includes the costs of all fuel cycle steps and has reduced these costs to present day values. The draft GESMO had a flaw in its omission to discount, in a similar fashion, the environmental costs; such an approach is not considered socially responsive. The final analyses tend to understate the benefits as compared to the costs. Refer to CHAPTER XI.

9. Comment:

"Indications are present throughout 'WASH-1327' implying that the impact review will be limited to items directly associated with plutonium recycle. We would encourage the Commission to interpret these implications liberally. We think it illogical to segment various facets of the nuclear fuels cycle, and permit only a review of the segmented portion. The proposed hearing presents an opportunity to formulate an informed, intelligent policy to follow in the future, and an opportunity to adjudicate areas of controversy. Upon a final determination, the issues should become 'res judicata' as to further licensing proceedings wherein the same issues arise.

"We note in concluding that many of the comments submitted are the bases for items of contention in the Allied-General hearing currently in process. Our experience in this hearing indicates that these issues are not ones to be decided on an individual applicant basis. These issues vitally affect everyone, and public policy should dictate the direction to be followed.

"The Commission may be reluctant to discuss some of the issues presented; however, it should be realized that many are recurrent in licensing proceedings. An adjudication on a national basis would prevent this recurrence. In this respect, the State is a party to a present proceeding wherein these issues are being adjudicated. To preclude these issues or the State from an adjudication on a national basis would be to only make it necessary to continue the adjudication in the Allied-General hearing. We trust that the Commission will see it in the interest of all concerned to decide these issues on a one-time basis."

Response:

The purpose of GESMO is to assess the differential impacts on the existing LWR industry due to the introduction of recycle Pu into MOX fuel as a replacement for a portion of the presently used ^{235}U in UO_2 fuels.

To properly assess the impacts it becomes necessary to review in depth, generically, the entire fuel cycle including the LWR's.

Should the Commission authorize the commercial use of recycle Pu in MOX fuel for LWR's this final generic statement as well as the final supplement on the safeguards considerations will serve as a basis for the rules on Pu recycle. Each reactor and Pu plant or facility of the supporting fuel cycle will, in addition, require licensing actions on a case-by-case basis. GESMO will provide support data for the environmental impact evaluations of the individual licensing actions.

Comment Letter No. 63

PROPOSED RULE PR - Misc Notice (39 FR 30186)
GESMO

BERLIN, ROISMAN AND KESSLER
1712 N STREET, NORTHWEST
WASHINGTON, D. C. 20036

EDWARD BERLIN
ANTHONY Z. ROISMAN
GLADYS KESSLER
DAVID R. CASHDAN
KARIN P. SHELDON
CLIFTON E. CURTIS
DAVID S. FLEISCHAKER (ADM. TEXAS)

AREA CODE 202
PHONE 833-9070

March 11, 1975

Howard J. Larson
Acting Director
Office of Nuclear Material
Safety and Safeguards
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Re: Draft General Environmental Statement
Mixed Oxide Fuels

Dear Mr. Larson:

Enclosed are the Natural Resources Defense Council Comments On Federal Agency Response To Draft GESMO. You will note on pages 3 and 5 specific requests are made for action in the immediate future.

Sincerely,

Anthony Z. Roisman

AZR/pq

CC: Howard Shapar, Esq.

PROPOSED RULE PR - Misc Notice (39 FR 30186)
GESMO

NATURAL RESOURCES DEFENSE COUNCIL

COMMENTS ON FEDERAL AGENCY RESPONSE TO

DRAFT GESMO

Anthony Z. Roisman, Esq.
BERLIN, ROISMAN, KESSLER
AND CASHDAN
1712 N Street, N. W.
Washington, D. C. 20036
(202) 833-9070

Counsel for Natural Resources
Defense Council

NATURAL RESOURCES DEFENSE COUNCIL
COMMENTS ON FEDERAL AGENCY RESPONSE TO
DRAFT GESMO

I. Adequacy of Safeguards Discussion

The virtually unanimous opinion of those agencies addressing the safeguards problems was the Draft GESMO did not adequately explore and discuss these problems.*/ The most authoritative statement was submitted by the Council on Environmental Quality which stated in a letter to Chairman Anders on January 20, 1975:

> Although, in general, this draft is well done and reflects a high quality effort, the Council believes that it is incomplete because it fails to present a detailed and comprehensive analysis of the environmental impacts of potential diversion of special nuclear materials and of alternative safeguards programs to protect the public from such a threat. We understand that the Atomic Energy Commission (AEC) chose to give summary treatment to the diversion and safeguards issues in GESMO with the intention of dealing with these matters definitively in a separate future action. The purpose of this letter is to recommend that the Nuclear Regulatory Commission (NRC), as successor to the AEC, adopt an alternative course of action.

*/ In our comments on the Draft GESMO we made this same point.

This view echoed the Department of the Interior which concluded in its statement:

> There are several topics in the statement which need expanded treatment. In particular, the environmental consequences of plutonium escaping to the atmosphere and the additional safety measures necessitated by the recycling of plutonium require more consideration.

In its comments the Environmental Protection Agency stated:

> Before a full scale mixed oxide recycle program is implemented a commitment should be made to an acceptable safeguards program. Such commitment should include the completion of the necessary selection of a procedure, its development and the securing of regulatory or legislative approvals for its implementation, including funding mechanisms.

These comments make clear the need for a substantial revision of the safeguards discussion in the Draft GESMO and its recirculation for comment. Safeguards is one of the most important issues in the plutonium recycle decision. A course of action which is adequate for safeguards may well involve economic, social and other costs which will make it unacceptable. In short, it is quite possible that the safeguard problems will ultimately be the basis for an adverse decision on plutonium recycle. This crucial role of safeguards underscores the necessity for a thorough discussion of the effectiveness of each possible safeguards solution and the full social, economic and other consequences of a such a solution. Unless this discussion is included no meaningful comments can be made on the draft statement.

The Council on Environmental Quality has suggested a useful and practical procedure to correct this deficiency in the Draft GESMO. By preparing an addendum to the Draft GESMO which identifies alternative safeguard programs and thoroughly analyzes the environmental, economic, social, legal and institutional impacts of each alternative and circulating this addendum according to the procedures required for draft impact statements, an expeditious review can be accomplished.

We are aware that substantial pressure is being applied to the NRC to either expedite the preparation of the final GESMO or authorize activities which implement or depend upon plutonium recycle. Obviously the latter course would be illegal and we are confident the NRC will adhere to the pledge made by the AEC*/ to postpone action on such proposed activities until after a decision has been reached on whether to have plutonium recycle. We believe that the GESMO review should not be expedited to the point that the quality of the review will suffer. However, one step which will expedite the review is for a decision to be made immediately to follow the course of action recommended by CEQ. In this regard we formally request that on or before March 31, a determination be made to prepare and issue the addendum to the Draft GESMO recommended by CEQ.

*/ Letter from Edson Case to Anthony Z. Roisman dated December 23, 1974.

II. Adequacy of Federal Agency Comments on Safeguards

In its comments on the Draft GESMO, EPA stated:

> EPA does not have the expertise to evaluate the adequacy of safeguards programs. We do see the issue as a prime factor in the feasibility of a mixed oxide recycle program however, for this reason we do not feel that a commitment should be made to the program until an extensive set of safeguard measures are committed to and the necessary approvals are obtained for their implementation. We hope that other government agencies, such as Justice or Defense where an expertise exists will review these measures to assure their adequacy.

To our knowledge neither of these agencies have provided comments. In addition no comments have been received from the Central Intelligence Agency, and the State Department (Arms Control and Disarmanent Agency).*/ It is inconceivable that an intelligent assessment can be made of the potential risk of domestic and foreign based terrorist and criminal activity against plutonium or of the measures needed to prevent such activity without the complete involvement of the Justice Department (FBI and Internal Security Division), the CIA, the Department of Defense (Defense Intelligence Agency) and the State Department (Arms Control and Disarmanent Agency). While the NRC can not compel these agencies to comment it can solicit the assistance of the President and the CEQ to bring pressure to bear to assure that these agencies do comment. Unless such comments are received and irrespective of whether the safeguards addendum is prepared and circulated, the final GESMO will not be legally or substantively defensible. We formally request that all efforts be made to assure

*/ Other important agencies from which comments were not received are the National Science Foundation and the Federal Energy Administration.

the receipt of detailed comments from the agencies we have noted and any others with special knowledge on domestic or foreign terrorist and criminal activity and methods to cope with such activity. We would like a response by April 4 of the specific steps that have been taken and will be taken to assure this invaluable input.

III. Hot Particles

A number of agencies while not necessarily agreeing with Drs. Tamplin and Cochran that plutonium standards thousands of times more restrictive than currently in effect should be applied to plutonium, nonetheless recognize that the hot particle issue is a major safety problem which is not resolved. In its comments the Commerce Department stated that the hot particle issue requires further study and that the studies should be completed and a definitive answer provided before a final decision is made on plutonium recycle:

> With regard to (a), the largest concern appears to be "The Hot Particle Hypothesis," discussed in Chapter IV, Section J, Appendix D of the draft statement. The draft statement does not draw conclusions regarding this question because sufficient information is probably not available. Additional studies of this question should be encouraged as part of the decision to approve the use of mixed-oxide fuels.

In its comments the Department of Health, Education and Welfare notes that the hot particle issue will continue to be a "point of controversy for some time to come and until a definitive body of data are available to prove one or the other of these theories".

NRDC believes that based on current data a definitive resolution can be made of the hot particle issue -- i.e. averaging the dose of a hot particle over the entire lung is not acceptable and plutonium release standards must be thousands of times more restrictive to adequately protect the public health and safety. However, if this view is not accepted, certainly it must be conceded that the issue is open and unresolved. It would be a flagrant violation of the mandate imposed upon the NRC to provide adequate protection for the public health and safety to approve plutonium recycle while this major safety problem is unresolved. */

Consistent with the uniform practice of the Commission the proper course to follow in the face of an unresolved safety problem is to bound the uncertainty and set conservative standards which encompass those bounds. The Draft GESMO assumes that the current plutonium standards are adequate in the face of substantial doubt and the opinion of knowledgeable federal agencies that the issue is open. Under these circumstances more stringent plutonium standards must be applied and the feasibility of plutonium recylce must be explored in light of the imposition of more stringent standards.

*/ In Power Reactor Development Company v. Electrical Union, 367 U.S. 396, 398, 407-08 (1961) the Court held that prior to authorizing operation of a nuclear facility the Commission must make a definitive finding of safety. Such a decision can not be made where there is an unresolved safety problem. Plutonium recycle involves at least the proposed operation of Barnwell, Nuclear Fuels Service and Big Rock in the immediate future.

We appreciate this opportunity to submit additional comments on the Draft GESMO.

Respectfully submitted,

Anthony Z. Roisman
BERLIN, ROISMAN, KESSLER & CASHDAN
1712 N Street, N.W.
Washington, D. C. 20036
(202) 833-9070

Counsel for Natural Resources
Defense Council

March 11, 1975

NRC Staff Response To Specific Comments On Health, Safety And Environment, By A. Z. Roisman

1. Comment:

"We believe that the GESMO review should not be expedited to the point that the quality of the review will suffer. However, one step which will expedite the review is for a decision to be made immediately to follow the course of action recommended by CEQ."

Response:

The Commission, in Federal Register Notice 40 FR 53056, dated November 14, 1975, indicated that a GESMO Draft Supplement on Safeguards, related to the implementation of Pu recycle in LWR's, would be issued for public comments, which would include overall cost-benefit analysis. This action which would precede a decision on widescale use of recycle Pu is responsive to CEQ comments. This final statement covers the health, safety, and environmental aspects of GESMO.

---

2. Comment:

"It is inconceivable that an intelligent assessment can be made of the potential risk of domestic and foreign based terrorist and criminal activity against plutonium or of the measures needed to prevent such activity without the complete involvement of the Justice Department (FBI and Internal Security Division), the CIA, the Department of Defense (Defense Intelligence Agency) and the State Department (Arms Control and Disarmament Agency). While the NRC can not compel these agencies to comment it can solicit the assistance of the President and the CEQ to bring pressure to bear to assure that these agencies do comment."

Response:

Comments on GESMO were solicited and received from the government agencies indicated. The comments are being taken into consideration in the GESMO - Draft Supplement on Safeguards issues and, as applicable, to the health, safety, and environmental issues.

---

3. Comment:

III. Hot Particles

"A number of agencies while not necessarily agreeing with Drs. Tamplin and Cochran that plutonium standards thousands of times more restrictive than currently in effect should be applied to plutonium, nonetheless recognize that the hot particle issue is a major safety problem which is not resolved. In its comments the Commerce Department stated that the hot particle issue requires further study and that the studies should be completed and a definitive answer provided before a final decision is made on plutonium recycle ..."

Response:

CHAPTER IV, Section J, Appendix D, of final GESMO contains the NRDC petition and the denial for rulemaking and the basis for the denial of the rulemaking on hot particles.

---

4. Comment:

"Consistent with the uniform practice of the Commission the proper course to follow in the face of an unresolved safety problem is to bound the uncertainty and set conservative standards which encompass those bounds. The Draft GESMO assumes that the current plutonium standards are adequate in the face of substantial doubt and the opinion of knowledgeable federal agencies that the issue is open. Under these circumstances more stringent plutonium standards must be applied and the feasibility of plutonium recycle must be explored in light of the imposition of more stringent standards."

Response:

This comment relates to the hot particle contention and safety aspects in possible near-term Pu recycle activities in reprocessing (AGNS and NFS) and in LWR's (Big Rock Point). CHAPTER IV, Section J, Appendix D of final GESMO contains the NRDC petition and the NRC denial for rulemaking on the hot particles.

The safety aspects of reprocessing MOX fuels are similar to the handling of UO_2 fuels and are covered in detail in the Safety Analysis Report submitted for licensing of each plant. Prior to the issuance of any license for plant operation, this report is reviewed in detail by the NRC staff and independently by the ACRS. Environmental effects of accidents in reprocessing plants with MOX fuels as compared to UO_2 fuels are reviewed in detail in CHAPTER IV, Section E, paragraph 3.5. Safety and accidents relating to LWR's fueled with MOX fuels in the 1.15 SGR mode are reviewed in detail in CHAPTER IV, Section C, paragraphs 5.3 and 5.4.

PR-Misc Notice (39 FR 30186)
GESMO

HUNTON, WILLIAMS, GAY & GIBSON
700 EAST MAIN STREET P.O. BOX 1535
RICHMOND, VIRGINIA 23212
TELEPHONE (804) 649-3661
CABLE HUNTWARD

WASHINGTON, D. C. OFFICE
1730 PENNSYLVANIA AVE. N.W.
SUITE 1060
TELEPHONE (202) 833-1600

March 25, 1975

FILE NO 300-039-2

3-31-75 ORS

The Honorable William A. Anders
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Generic Environmental Statement Mixed Oxide Fuel (GESMO)

Dear Chairman Anders:

On January 20, 1975, Chairman Peterson of the Council on Environmental Quality stated in a letter addressed to you that

> [T]he Council believes that [GESMO] is incomplete because it fails to present a detailed and comprehensive analysis of the environmental impacts of potential diversion of special nuclear materials and of alternative safeguards programs to protect the public from such a threat.

The letter stated CEQ's opinion that GESMO does not satisfy the requirements of the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 et. seq. (1970) and requested that there be "a full discussion of the diversion and safeguards problem, its impacts, and potential mitigating measures, before any final decisions are made on plutonium recycle." Chairman Peterson urged that in order to satisfy NEPA, NRC must first identify alternative safeguards programs and fully analyze the environmental, economic, social, and legal and institutional impacts of each alternative. He also asserted that the NRC must prepare and circulate an addendum to GESMO discussing the alternative safeguards programs, and should not produce the final GESMO or proceed with a decision on plutonium recycle until those procedural steps are taken. Your reply to Chairman Peterson on February 24

indicated that the Commission is considering CEQ's request. We understand that you still have this matter under consideration.

As lead counsel for the 15 electric utility systems that are participating jointly in the NRC's public hearings on GESMO,* I have been asked to comment on the CEQ request. It is clear to us that NRC's accession to this request would appreciably delay pilot work in the commercial utilization of lower cost recycle fuel. This would ultimately impose significant fuel costs on American consumers, and would increase pressures on uranium supplies. These tangible costs would not be offset by any appreciable benefits, since the amount of plutonium which would be utilized in the short term following an affirmative decision, pursuant to consideration of GESMO, to proceed with LWR recycle is minor in comparison with the size of existing plutonium uses for other purposes. Further, this costly alternative of a postponement of all consideration of GESMO until completion of the various inquiries recommended by CEQ is, in our view, not legally required.

Following the course of action recommended by the CEQ would entail considerable delay. In order to describe in full detail the possible alternative safeguards systems

* Baltimore Gas & Electric Company, Boston Edison Company, Consumers Power Company, Long Island Lighting Company, Pacific Gas & Electric Company, Philadelphia Electric Company, Public Service Electric & Gas Company, San Diego Gas & Electric Company, Southern California Edison Company, The Connecticut Light & Power Company, The Hartford Electric Light Company, The Northeast Nuclear Energy Company, Virginia Electric and Power Company, Western Massachusetts Electric Company, Yankee Atomic Electric Company.

and their environmental and social impacts, NRC would have to await the results of the studies now being performed on the safeguards issue. Since those studies are scheduled to be completed, at the earliest, toward the end of this year, drafting and circulating the GESMO amendment followed by hearings and issuance of the Final Environmental Statement would mean that, even with optimistic assumptions, no decision on plutonium recycle could be taken before late 1976 or early 1977.

NEPA does not require complete description of all possible environmental impacts in a generic environmental statement. Scientists' Institute for Public Information, Inc. v. AEC, 481 F.2d 1079 (D.C. Cir. 1973) indicates that a programmatic environmental statement such as GESMO need cover only reasonably foreseeable environmental impacts and point out what is unknown:

> The agency need not foresee the unforeseeable, but by the same token neither can it avoid drafting an impact statement simply because describing the environmental effects of and alternatives to particular agency action involves some degree of forecasting. And one of the functions of a NEPA statement is to indicate the extent to which environmental effects are essentially unknown. It must be remembered that the basic thrust of an agency's responsibilities under NEPA is to predict the environmental effects of proposed action before the action is taken and those effects fully known. Reasonable forecasting and speculation is thus implicit in NEPA . . . .

Id. at 1092. An Environmental Statement may leave for future description those impacts whose nature is presently indeterminate:

> [O]ne of the functions of an impact statement is to point up uncertainties where they exist. And whatever statement is drafted

> by the Commission can be amended to reflect newly obtained information as the program progresses.

Id. at 1098 (footnote omitted). See also Natural Resources Defense Council, Inc. v. Morton, 458 F.2d 827, 837 (D.C. Cir. 1972).

The plutonium recycle decision is a textbook case for the application of Scientists' Institute, for GESMO assesses "the environmental implications of research activities that have reached a stage of investment or commitment to implementation likely to restrict later alternatives," 481 F.2d at 1090 (quoting Council on Environmental Quality Memorandum to Federal Agencies on Procedures for Improving Environmental Impact Statements (May 16, 1972), 3 BNA Environment Reporter 82, 87 (1972)) (emphasis in original). Any unresolved safeguards issues may therefore be addressed in a later Environmental Statement addendum which is itself given the full NEPA circulation and comment treatment. Scientists' Institute does not require that all gaps in knowledge be filled in before a final GESMO is issued and a decision taken relying on it.

Furthermore, no appreciable risk to the public would be created by timely consideration and resolution of the plutonium recycle issue as long as the safeguards issues are settled before substantial amount of LWR recycle fuel comes into actual use. Only very small amounts of plutonium would be involved in the initial phases of LWR recycle. The conclusion to Chapter V of GESMO states that

> [T]here does not appear to be any safeguards related rationale sufficient to delay a decision to permit the use of plutonium in mixed oxide fuel for light water reactors . . . . During the decision and implementation period there will be very little plutonium being used

as mixed oxide fuel in LWR's; therefore, there will be essentially no perturbation to the safeguards situation from plutonium recycle.

GESMO at V-50, -51.

A decision to proceed now with plutonium recycle can be made without prejudice to the ability of the NRC to amend its policies at a later date, should new information develop from the safeguards studies which indicates that continuing to permit utilization of recycle fuel would be unwise. All who deal with the NRC are aware of its authority to revoke or modify licenses or to amend its regulations, for safety reasons. 42 U.S.C. §§ 2201(p), 2236, 2237 (1970). Thus a decision to proceed with plutonium recycle is not irrevocable legally, nor would it be practically irrevocable in the early years when the amount of plutonium involved will be small. On the other hand, the benefits which would accrue from allowing timely and orderly planning of fuel purchase and supply arrangements as well as providing for spent fuel storage facilities, if necessary, are considerable. The lead times involved in planning and construction of reprocessing and fabrication plants or of spent fuel storage facilities, should the decision be adverse, require early resolution of this issue. Before long, available in-plant storage for spent fuel assemblies will begin to run out, and alternate arrangements must be made. The costs of unnecessary short term arrangements or deratings or plant shutdowns due to lack of spent fuel storage space can be avoided by a timely decision. Delay of a year or two would thus impose excess costs, whatever the ultimate resolution of the basic issue. Furthermore, one of the surest ways to protect plutonium against theft is to load it in reactor cores, and

burning fissile plutonium in reactors helps dispose of that element.

In any event, adequate treatment, for present purposes, has been devoted to the safeguards issue, including the adverse environmental impacts of failure of whichever safeguards system is implemented, in GESMO Chapter V. This fifty-three page discussion includes sections on features and requirements of the AEC (now NRC) Materials and Plant Protection Program (MPPP) (Sections V-B and C); an assessment of the effectiveness of the MPPP and a description of provisions for upgrading the plan (Sections V-G and H); and an assessment of the environmental impact of failure of the safeguards system (Section V-I). Furthermore, effects due to safeguards are included in the cost-benefit analysis. See GESMO at V-49. NRC could thus, without undue risk to the public, proceed with plutonium recycle and consider and resolve remaining safeguards issues and assess more accurately various related environmental impacts at a later date.

Delay in implementing the plutonium recycle program does not serve the public interest since it would keep unavailable to utilities one principal means of cutting electrical generation costs and prevent greater utilization of available nuclear energy resources. Unnecessary deferral of decisions on which other subsequent decisions are dependent produces an impasse which increases long term costs and narrows the range of planning options for meeting the current energy crisis. For all these reasons we urge you not to accede to the CEQ request to delay the decision process until the current safeguards studies are fully completed, but rather

to proceed with that process forthwith, dealing with safeguards issues as they mature.

Yours truly,

George C. Freeman, Jr.

NRC Staff Response To Specific
Comments On Health, Safety & Environment
By Hunton, Williams, Gay & Gibson

1. Comment:

"Delay in implementing the plutonium recycle program does not serve the public interest since it would keep unavailable to utilities one principal means of cutting electrical generation costs and prevent greater utilization of available nuclear energy resources. Unnecessary deferral of decisions on which other subsequent decisions are dependent produces an impasse which increases long-term costs and narrows the range of planning options for meeting the current energy crisis. For all these reasons we urge you not to accede to the CEQ request to delay the decision process until the current safeguards studies are fully completed, but rather to proceed with that process forthwith, dealing with safeguards issues as they mature."

Response:

The purpose of final GESMO is to assess the impact on the environment due to implementation of Pu recycle in LWR's and not to be involved in procedural actions. However, it is noted here that the Commission in Federal Register Notice 40 FR 53056 dated November 14, 1975, indicated an expedited schedule for preparation of this final statement separating the health, safety, and environmental issues from safeguards considerations and provided for interim licensing. This action could provide for an earlier decision on Pu recycle by publishing and hearing the GESMO health, safety, and environmental issues in advance of the preparation and publication of the draft and final supplement on the safeguards consideration. The impacts on the economics because of delays in the implementation of Pu recycle are covered in detail in CHAPTER XI, Cost-Benefits.

Comment Letter No. 65

PP&L

TWO NORTH NINTH STREET, ALLENTOWN, PA. 18101 PHONE: (215) 821-5151

JOHN T. KAUFFMAN
Vice President, System Power & Engineering
821-5043

RELATED CORRESPONDENCE
DOCKET NUMBER
PROD. & UTIL. FAC. 50-201

'75 APR 1 PM 2:36

DOCKET NUMBER
PROPOSED RULE PR-Miscellaneous
GESMO (39 FR 30186)

OFFICE OF THE SECRETARY

DOCKETED
USNRC
APR 4 1975
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March 26, 1975

Mr. William A. Anders, Chairman
U.S. Nuclear Regulatory Commission
Washington, DC 20555

Dear Mr. Chairman:

It has been brought to my attention by Mr. Ralph Deuster, President of Nuclear Fuel Services, Inc. (NFS) that two major events have taken place recently which may seriously delay start-up of the NFS reprocessing plant and, in turn, have a serious detrimental effect on the supply of reload fuel for our Susquehanna Plant. These events are the letter of Mr. Edson Case of the NRC relating to the possibility that the NFS final environmental statement may not be issued until the GESMO action is completed and the letter by Mr. R. W. Peterson stating that the Council on Environmental Quality believes that the GESMO Draft Impact Statement does not meet the requirements of the National Environmental Policy Act.

We are not in a position to discuss the merits of these two actions, but we feel the issues should be attacked on an urgent basis and with consideration of the total impact on the U.S. Energy Supply. We have already seen NFS' projected operating date delayed by a year since we began negotiations with them last September (culminating in a contract signed in January). That delay, plus those which the above two letters might provoke, could prevent us from obtaining hoped for plutonium purchases in 1982 or recycle of our own plutonium in 1984.

We would then need additional U_3O_8 and enrichment with both the prices and sources uncertain. A negative ruling on plutonium recycle would also considerably increase our needs for U_3O_8 even though the need for additional enrichment would then be satisfied by the contingency plan in our enrichment contracts. These problems are recognized as common in the industry just as it is recognized that reasonable caution in the utilization of plutonium is necessary. We admit that readily acceptable solutions are hard to find and we assume you are already using all due effort to schedule the hearings and make the judgments necessary to get plutonium recycle approved and reprocessing plants licensed under proper conditions.

As one additional suggestion, we offer the concept of providing for plutonium safeguards by an adequate armed force both for transportation

To Exec. Dir. for Operations for reply. Send 3 cys of reply to Secy Mail Facility. Cy to O&SS. Note: See Secy ticket #75-2519, Rep. Yatron to Anders, dtd 3/31/75; also, Secy ticket #75-2147, Deuster to Anders (answered by EDO on 4/2/75) Suspense Date: 4/11/75

and for guarding the reprocessing plants and fabrication facilities. Right now, a large enough force could be dedicated so that it would be immediately clear to all that it would be adequate. As time went on, more detailed studies and hearings could perhaps justify a major reduction in the force. Meanwhile, the plants could be in operation and the resultant electrical energy available.

As another suggestion, we believe that reprocessing plants could be licensed without waiting for the GESMO decision. Although this would result in production of plutonium which could partially frustrate a negative decision on plutonium recycle, the plutonium would then be located only in a few, very easy to guard, plants. Also, a negative GESMO decision should be regarded as only a temporary situation because better safeguards technology or future acute need for plutonium could provide the impetus to reverse such a negative decision.

It is, of course, possible that without plutonium recycle some reprocessors would not want to go ahead with their plans. However, the way should be paved for reprocessing licenses on their own merits so that a significant amount of time could be saved if the reprocessor does decide to go ahead.

Thank you for your consideration in these matters.

Very truly yours,

John T. Kauffman

John T. Kauffman
Vice President - System Power & Engineering

NRC Staff Response To Specific Comments On Health, Safety And Environment, By John T. Kauffman, PP&L

1. Comment:

"As another suggestion, we believe that reprocessing plants could be licensed without waiting for the GESMO decision. Although this would result in production of plutonium which could partially frustrate a negative decision on plutonium recycle, the plutonium would then be located only in a few, very easy to guard, plants. Also, a negative GESMO decision should be regarded as only a temporary situation because better safeguards technology or future acute need for plutonium could provide the impetus to reverse such a negative decision.

"It is, of course, possible that without plutonium recycle some reprocessors would not want to go ahead with their plans. However, the way should be paved for reprocessing licenses on their own merits so that a significant amount of time could be saved if the reprocessor does decide to go ahead."

Response:

While the purpose of this document is to assess the impacts of Pu recycle on the LWR industry and not to be involved in licensing procedures, it is noted that the Commission, in Federal Register Notice 40, FR 53056, dated November 14, 1975, described the scope procedure and schedule for completing GESMO and allowed for interim licensing of certain facilities. The notice set forth the Commission's finding that before it can reach a decision on the widescale use of mixed oxide fuel, there must be a full assessment of safeguard issues. Toward that end, the Commission directed the staff to prepare a safeguards supplement to draft GESMO. The supplement covers an analysis of the alternate safeguards programs and recommendations of preferred safeguards considerations for widescale use of plutonium recycle. This bifurcation of GESMO allowing for an earlier publication and hearings for final GESMO on health, safety, and environmental issues could provide for an earlier decision on the implementation of Pu recycle.

Comment Letter No. 66

Houston Lighting & Power Company
Electric Tower
P.O. Box 1700
Houston, Texas 77001

(39 FR 30186)
(40 FR 20142)
Misc Notice
GESMO - Treatment of Safeguards & Deferral of Licensing Actions

May 14, 1975

Mr. William A. Anders, Chairman
Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Anders:

The Generic Environmental Statement on Mixed Oxide fuel (GESMO) was received and reviewed by Houston Lighting & Power Company in October, 1974. Due to our general concurrence with the conclusions drawn in GESMO, it was felt that it was not necessary to comment on this draft statement at that time. A number of recent events have caused us to reevaluate this position and as a result we would like to submit comments at this time.

In GESMO, the USAEC concluded that the utilization of plutonium resources as recycle fuel in light water reactors should be approved subject to the continuation of the licensing policies requiring detailed safety, safeguards and environmental reviews of each specific license application for such use of plutonium. In general Houston Lighting & Power concurs with these conclusions. It is believed that the AEC was correct in concluding that the implementation of plutonium recycle fuel has little, if any, adverse impact upon the environment.

In any such analysis, the potential environmental impact must be weighed against the benefits to the public. In the case of plutonium, there is the potential of reducing uranium requirements for HL&P from 15 to 50 or more percent, depending on the degree of use of such plutonium and the fuel cycle parameters. The net effect of this utilization would be to reduce the cost of electricity to the user as well as being environmentally beneficial by reducing the net uranium mining requirements per unit of time. This also

5/22 To EDO for direct reply. Send 3 cys of reply to Secy Mail Facility.
Cy of incoming to Chairman Anders

SUSPENSE DATE: 6/3/75.

has the beneficial result of more effectively utilizing our uranium resources for our energy needs, thereby extending the period of time this potentially low-cost source of energy may be used to satisfy the world's increasing energy needs.

Of related concern is the necessity of assuring effective safeguards to reasonably deter unauthorized diversion of this strategic material. Unquestionably, it is incumbent upon the regulatory agencies and users of this material to take all reasonable precautions to prevent such diversion in order to assure the adequate protection of the health and safety of the public. It is believed, however, as was concluded in GESMO, that adequate methods exist to ensure that the probability of diversion is sufficiently low.

In view of these considerations, Houston Lighting & Power urges:

1. that the NRC reconsider their decision to delay action on GESMO, and that the use of plutonium as a viable alternative for use in light water reactors be approved in a timely manner;

2. that the NRC concentrate on establishing realistic guidelines to be used to implement such security procedures as required to protect the health and safety of the public;

3. that ERDA assure implementation of these procedures on a timely basis;

4. that an active program for the continuing review and evaluation of these procedures be implemented to assure continued effectiveness; and

5. that the NRC act promptly and expeditiously on certain license applications and guidelines affecting fabrication,

reprocessing and shipment of mixed oxide fuels in order to assure timely implementation of plutonium recycle.

Very truly yours,

G. W. Oprea, Jr.
Executive Vice President

RPM:jak

cc: Dr. Robert G. Seamans (USERDA)

Comment Letter No. 67

Misc Notice (39 FR 30186)

GESMO.

DEPARTMENT OF STATE

Washington, D.C. 20520

May 27, 1975

Mr. Howard J. Larson
Acting Director
Office of Nuclear Material
Safety and Safeguards
Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Larson:

I am sorry to be so late in reply to your April 2 request.

Our main concern, of course, is that materials or weapons not fall into the hands of terrorists through any of the variety of means potentially available, (e.g., theft, diversion, armed attack, etc.). Any means of increasing the difficulty of terrorist groups obtaining materials or weapons would be applauded by the Working Group of the CCCT. While this office lacks expertise to judge the relative merits of the GESMO, other agencies represented on the Working Group with greater expertise were asked to comment. I attach the replies of ACDA, CIA, ERDA and DOD/ISA. Another office in the State Department (Politico-Military Affairs) was asked to comment but we have not received their reply to date.

Please let me know if I can be of any additional assistance.

Sincerely,

Jeffrey T. Browne
Staff Assistant for
Combatting Terrorism

Enclosures

UNITED STATES ARMS CONTROL AND DISARMAMENT AGENCY

April 15, 1975

MEMORANDUM

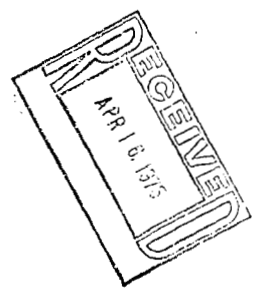
TO: S/CCT - Mr. Fearey

FROM: ACDA/D-CS - Robert H. Kupperman

SUBJECT: Environmental Impact Statement on Mixed Oxide Fuels

In response to your April 11, 1975 memorandum concerning the GESMO report and possible terrorism implications, I should only like to comment about the obvious: any technique that makes the diversion of reprocessed plutonium more expensive and difficult is a step in the right direction. Clearly, by mixing oxides of plutonium with oxides of uranium, we are adding far greater requirements for the amount of material that must be stolen by the terrorist, as well as difficulties in chemical separation.

I do not feel qualified to comment about the environmental effects, which is the main concern of the report. There are a number of other competitive ideas that include spiking of plutonium with nasty gamma emitters. There is much to resolve in this business. Not only are there terrorism implications but significant economic and technical problems drive the reactor and fuel cycle issues. I think our only hope is to keep the concerns of proliferation and terrorism a major policy constraint.



Comments on GESMO - WASH-1327 Aug 1974

Received From: Central Intelligence Agency, 29 July 1975

1. One area of primary concern to CIA is in the response and recovery program of the AEC in the event of theft of special nuclear material abroad. This is described briefly on page S-6 of the Summary and in more detail in Chapter V of Volume 4.* This latter reference specifies as follows:

> The AEC will immediately notify the Federal Bureau of Investigation (FBI) of any reported acts of theft or sabotage and of any attempts to carry out such acts. The FBI will notify other agencies (e.g., the CIA, the Customs Service, the Border Patrol, etc.), as needed, to aid in recovering the material and to apprehend those responsible for the theft or sabotage.

This topic has been discussed in other policy papers, and it is intended that the Agency be prepared to assist in the event the material is taken outside U.S. borders.

2. The effort to evaluate the capabilities and intentions of foreign terrorist groups, including any ventures into the nuclear field, is a continuing one in this Agency. Given the recent publicity on the relative ease of manufacturing a nuclear device on the basis of open literature, the question of measuring the capabilities of a given group is complicated by its very size. Since terrorists in many countries have been openly described as being between 20 and 35 years old and often well-educated, it must be presumed that some have had at least theoretical training in the physical sciences.

* GESMO
WASH 1327

Transmitted by
George Weisz

UNITED STATES
ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION
WASHINGTON, D.C. 20545

APR 30 1975

Mr. Robert A. Fearey
S/CCT
Department of State
Washington, D. C. 20520

Dear Mr. Fearey:

Thank you for forwarding to us the NRC's draft summary report entitled, "Generic Environmental Statement Mixed Oxide Fuel (Recycle Plutonium in Light Water-Cooled Reactors)." It is sometimes referred to as GESMO.

I discussed Volume 1, Summary and Conclusions, which was attached to your memorandum of April 11, 1975, within ERDA, including the Offices of the Assistant Administrator for Environment and Safety and the Assistant Administrator for Nuclear Energy. I was told that ERDA has made a decision to comment on the GESMO in its entirety. Consequently, the Assistant Administrator for National Security's comments on safeguards will be provided to the Nuclear Regulatory Commission in the context of the overall ERDA review of GESMO. The specific issues of terrorism and the adequacy of the safeguards proposed in GESMO are of course very important, and they have been and will be given considerable study by ERDA.

Sincerely,

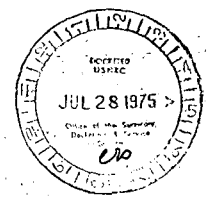
A. Bryan Siebert
Special Assistant to the
Deputy Assistant Administrator
for National Security

cc: J. L. Liverman, AES
R. D. Thorne, ADANE

JUN 9 1975

R.C. Youngdahl
Executive Vice President

Consumers Power Company



July 24, 1975

Secretary of the Commission
Att: Docketing and Service Section
United States Nuclear Regulatory Commission
Washington, DC 20555

On May 8, 1975 the Commission published for comment its provisional view that a cost-benefit analysis of alternative safeguards programs should be prepared and set forth in draft and final environmental impact statements prior to decision on wide-scale use of mixed-oxide fuels in light water nuclear power reactors. It was also the Commission's provisional view that the matter of deferral of future licensing actions related to the wide-scale use of mixed-oxide fuels should be addressed in individual licensing proceedings subject to the following guidelines:

> "(1) There should be no additional licenses granted for use of mixed-oxide fuel in light water nuclear power reactors except for experimental purposes; and
>
> (2) With respect to light water nuclear power reactor fuel cycle activities (activities other than nuclear power reactor construction and operation) which depend for their justification on wide-scale use of mixed-oxide fuel in light water nuclear power reactors, there should be no additional licenses granted which would foreclose future safeguards options or result in unnecessary 'grandfathering'. This would not preclude the granting of licenses for experimental and/or technical feasibility purposes."

Comments were solicited on (1) the relative merits of the NRC's provisional approach and the earlier AEC-DOL approach which would not have deferred action pending completion of the safeguards studies, (2) whether deferral of future licensing actions related to use of mixed-oxide fuels should be left for resolution in the individual licensing proceedings or addressed on a generic basis, and (3) appropriateness of the above-quoted guidelines.

7-28-75-02

The collective comments of Consumers Power Company and 14 other electric utilities are being submitted by Hunton, Williams, Gay & Gibson. In addition to those comments, the Company wishes to offer the following observations:

1. Deferral of action on wide-scale use of mixed-oxide fuel in light water reactors until the latter part of 1978 will have severe adverse economic impact.

Some of this impact will be unavoidable in any event, because of the current lack of reprocessing capability, because of lead time requirements, and the like. An early decision on plutonium recycle would lessen the adverse effect, however.

First of all, based on the amount of fissile plutonium expected to be produced in light water nuclear power reactors in the 1975 through 1978 period,[1] we estimate that the contemplated deferral would require expenditure of between $35,000,000 and $50,000,000 for additional plutonium storage. Amortization of this investment to storage revenues would add almost 70¢ per gram plutonium fissile per year to fuel cycle costs.

Second, if licensees are unable to use mixed-oxide fuel until mid-1978, they must burn additional enriched uranium instead. For Consumers Power Company's Big Rock Point and Palisades Plants alone, we estimate the additional cost of necessary enriched uranium at $6,000,000. Moreover, U_3O_8 production capability to meet probable commitments during the period is in short supply.[2]

Third, if the proposed deferral operates to defer spent fuel reprocessing capability, enriched uranium will not be utilized in a timely manner, resulting in added interest and storage costs. For Big Rock Point and Palisades alone, we estimate that more than 122,000 kilograms of enriched uranium, with a replacement value of more than $19,000,000, would be idled.

Fourth, since utilization of plutonium in reactor fuel is for the most part limited to self-generation quantities, deferral of utilization of plutonium for this purpose will mean that some plutonium must be stored indefinitely. By about June of 1978, it is estimated that a total of approximately 536 kilograms of fissile plutonium will have been accumulated from operation of Big Rock Point and Palisades. Of this amount, about 300 kilograms would be unusable in these reactors because scheduled discharges of uranium fuel containing self-generated quantities of plutonium will continue to add to inventory. Estimates of nationwide plutonium inventories held by other reactor operators

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1/ Nuclear Assurance Corporation Fuel-Trac Information Service, "World-Wide Reprocessing Status Report" May 30, 1975, estimates that firmly-planned U. S. reactors will produce 22,241 Kgs of fissile Pu in the period 1975 through 1978.

2/ See Atomic Industrial Forum, Inc, "The Nuclear Fuel Cycle: U. S. Capital and Capacity Requirements, 1975-1985," June 1975, pp 21-22, 26.

and assessments of the fuel cycle plans for such reactors and the operating schedules for the breeder reactor indicate that the usability (and hence the salability) of plutonium will be highly unlikely.

Fifth, to the extent the use of mixed-oxide fuel is deferred, the buildup of americium will affect the usability of the plutonium and increase the cost of its use because of additional handling, shielding and americium removal. The probable result is that such plutonium will not be used, based on our own experience that the handling and removal of americium costs approximately $2.00 per gram of plutonium.

Sixth, it is likely that manufacturers will not commence construction of additional mixed-oxide fabrication capacity until the rulemaking has been concluded. Based on lead times required for design, licensing and construction of such facilities, fabrication capability to meet annual production rates of plutonium could not be expected before the early 1980's, assuming the Commission's proposed deferral, adding substantially to total plutonium inventories and their associated economic impact. A similar conclusion can be drawn with respect to reprocessing capability. Also, such facilities as do exist are likely to remain idle or to operate at substantially reduced capacity, depending on the Commission's application of the proposed "experimental" exception to the deferral of mixed-oxide fuel use.

2. The proposed deferral of use of mixed-oxide fuel is unnecessary from a safeguards point of view.

The Hunton, Williams utility group proposal that conservative interim safeguards criteria be adopted (referencing the E. R. Johnson Associates, Inc. report "Estimated Cost of Improved Safeguards for Plutonium Used in the Commercial Nuclear Fuel Cycle," being submitted by the Atomic Industrial Forum), is workable and will satisfy NEPA, particularly if the amount of mixed-oxide fuel consumed prior to a generic plutonium recycle decision is limited to the productive capacity of already licensed mixed-oxide fuel fabrication plants.

3. NEPA does not require the Commission to defer its plutonium recycle assessment until all potential environmental impacts are known.

Perfect knowledge is not a requirement of NEPA:

> "The agency need not foresee the unforseeable [sic] but by the same token neither can it avoid drafting an impact statement because describing the environmental effects of and alternatives to particular agency action involves some degree of forecasting. And one of the functions of a NEPA statement is to indicate the extent to which environmental effects are essentially unknown. * * * [I]f the Commission makes a good faith effort in the survey to describe the reasonably foreseeable environmental impact of the program, alternatives to the program and their reasonably foreseeable environmental impact, and the irreversible and irretrievable commitment of resources the program involves, we see no reason why the survey will not fully satisfy the requirements of Section 102(c). * * *
>
> "Of course, some of the environmental impacts of the program are still shrouded in uncertainty. But one of the functions of an impact statement is to point up uncertainties where they exist. And whatever statement is drafted by the Commission can be amended to reflect newly obtained information as the program progresses." Scientists' Institute for Public Information, Inc. v Atomic Energy Commission, 481 F2d 1079, 1092, 1098 (DC Cir. 1973).

See also Natural Resources Defense Council v Morton, 458 F2d 827, 837 (DC Cir. 1972); Environmental Defense Fund, Inc. v Corps of Engineers, 342 F Supp 1211, 1217 (E.D. Ark.), aff'd 470 F2d 289 (8th Cir. 1972), cert. den. 412 US 931, 37 L Ed 2d 160 (1973).

4. Deferral of future licensing actions can and should be left for resolution in individual licensing proceedings.

Individual licensing proceedings may go forward prior to completion of generic rulemaking proceedings which may affect them. Union of Concerned Scientists v AEC, 499 F2d 1069 (DC Cir. 1974). Cf. American Commercial Lines, Inc. v Louisville & N.R.R.Co., 392 US 571 (1968); FCC v WJR Goodwill Station, 337 US 265, 93 L Ed 1353, 1358-59 (1949); Coastal Bend TV v FCC, 234 F2d 686 (DC Cir. 1956); Jicarilla Apache Tribe of Indians v Morton, 471 F2d 1275 (9th Cir. 1973).

Even if an individual licensing action can be characterized as part of a larger group of interrelated actions, it may proceed prior to the completion of an environmental impact statement covering the whole group of actions if, standing alone, it has independent utility and is susceptible of discrete environmental evaluation. Daly v Volpe, 514 F2d 1106 (9th Cir. 1975); Sierra Club v Stamm, 507 F2d 788 (10th Cir. 1974); Indian Lookout Alliance v Volpe, 484 F2d 11 (8th Cir. 1973); Committee to Stop Route 7 v Volpe, 346 F Supp 731 (D. Conn. 1972), aff'd per curiam sub nom. Citizens for Balanced Environment & Transportation, Inc. v Volpe, 503 F2d 601 (2d Cir. 1974).

An individual proposal need not preclude future alternatives, involve an irretrievable commitment of resources, or result in an increase in adverse environmental effects, at least if it relies largely on in-place production, processing and storage capability, and consideration is limited to the time period in which a complete, industry-wide assessment is likely to be completed. The NRC's "provisional view" is apparently based on CEQ's concern about the need to assess the safeguards implications of plutonium recycle prior to "final decisions" on plutonium recycle. But wide-scale use before 1978 is a virtual impossibility, considering the present and foreseeable lack of reprocessing capability. And even CEQ, by implication in its January 20, 1975 letter to the AEC, would permit mixed-oxide actions pending such "final decision" so long as they would neither foreclose safeguards alternatives nor result in unnecessary "grandfathering". The situation is readily distinguishable from the facts which led the DC Circuit Court of Appeals to prescribe a detailed "program" environmental impact statement in Scientists' Institute for Public Information Inc. v AEC, supra.

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

INTERNATIONAL SECURITY AFFAIRS

25 APR 1975

In reply refer to:
I-4477/75

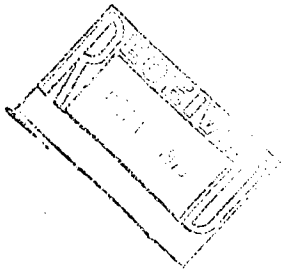
MEMORANDUM FOR MR. ROBERT A. FEAREY, CHAIRMAN OF THE COMMITTEE
TO COMBAT TERRORISM WORKING GROUP

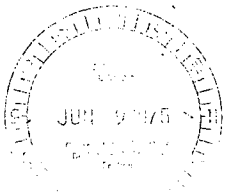
SUBJECT: Environmental Impact Statement on Mixed Oxide Fuels

REFERENCE: Your memorandum, subject as above, dated April 11, 1975

The draft summary report entitled: "Generic Environmental Statement Mixed Oxide Fuel" (WASH-1327) has been reviewed within the Department of Defense for terrorism implications. The discussion pertaining to theft and sabotage threats, as well as associated safeguards, is noted and considered adequate.

Dwayne S. Anderson
Deputy Director
Negotiations and Arms Control





5

Consumers Power Company's 75-MWt Big Rock Point Plant is a case in point. It has been previously licensed for utilization of a full core loading of mixed-oxide fuel,3/ a supply of plutonium oxide for such full core loading is likely to be available, the Company has contracted with a fabricator for fabrication of the mixed-oxide assemblies, fabrication of the next reloading of mixed-oxide fuel has been completed save for final assembly of the rods into 20 of the assemblies, safety analyses have been performed on the mixed-oxide fuel design, and the AEC Regulatory Staff has concluded that any incremental environmental effects of the use of such fuel would be insignificant. A suitably conservative safeguards plan for transportation and handling of the assemblies can surely be devised prior to completion of generic safeguards studies. This and similar limited uses should clearly be permitted even if a decision is made to defer a generic plutonium recycle decision until a safeguards analysis has been completed.

5. The NRC's proposed guideline concerning the granting of additional licenses for use of mixed-oxide fuels in LWR's should be revised or clarified to permit technical-feasibility or demonstration uses.

Technical feasibility or demonstration uses should be permitted and clearly excluded from the notion of "wide-scale" use of mixed-oxide fuels. In this way, the impending adverse economic and safeguards impacts of an increasing and substantial near-term plutonium inventory may be somewhat lessened at the same time "meaningful information . . . on the effects of application of the technology"4/ is being gained. Allowing such demonstration uses would also hasten the day when meaningful economic and technical information concerning the use of recycled mixed-oxide fuel becomes available for assessment.

R. C. Youngdahl
Executive Vice President

3/ The relevant license amendment is presently being challenged before an ASLB and in a Federal District Court.

4/ Scientists' Institute for Public Information, Inc v AEC, supra, 481 F2d at 1094.

NRC Staff Response to Specific
Comment on Health, Safety & Environment
By R. C. Youngdahl, Consumers Power Company

1. "Deferral of action on wide-scale use of mixed-oxide fuel in light water reactors until the latter part of 1978 will have severe adverse economic impact.

"Some of this impact will be unavoidable in any event, because of the current lack of reprocessing capability, because of lead time requirements, and the like. An early decision on plutonium recycle would lessen the adverse effect, however.

"First of all, based on the amount of fissile plutonium expected to be produced in light water nuclear power reactors in the 1975 through 1978 period,1/ we estimate that the contemplated deferral would require expenditure of between $35,000,000 and $50,000,000 for additional plutonium storage. Amortization of this investment to storage revenues would add almost 70¢ per gram plutonium fissile per year to fuel cycle costs.

"Second, if licensees are unable to use mixed-oxide fuel until mid-1978, they must burn additional enriched uranium instead. For Consumers Power Company's Big Rock Point and Palisades Plants alone, we estimate the additional cost of necessary enriched uranium at $6,000,000. Moreover, U_3O_8 production capability to meet probable commitments during the period is in short supply.2/

"Third, if the proposed deferral operates to defer spent fuel reprocessing capability, enriched uranium will not be utilized in a timely manner, resulting in added interest and storage costs. For Big Rock Point and Palisades alone, we estimate that more than 120,000 kilograms of enriched uranium, with a replacement value of more than $19,000,000, would be idled.

"Fourth, since utilization of plutonium in reactor fuel is for the most part limited to self-generation quantities, deferral of utilization of plutonium for this purpose will mean that some plutonium must be stored indefinitely. By about June of 1978, it is estimated that a total of approximately 536 kilograms of fissile plutonium will have been accumulated from operation of Big Rock Point and Palisades. Of this amount, about 300 kilograms would be unusable in these reactors because scheduled discharges of uranium fuel containing self-generated quantities of plutonium will continue to add to inventory. Estimates of nationwide plutonium inventories held by other reactor operators and assessments of the fuel cycle plans for such reactors and the operating schedules for the breeder reactor indicate that the usability (and hence the salability) of plutonium will be highly unlikely.

"Fifth, to the extent the use of mixed-oxide fuel is deferred, the buildup of americium will affect the usability of the plutonium and increase the cost of its use because of additional handling, shielding and americium removal. The probable result is that such plutonium will not be used, based on our own experience that the handling and removal of americium costs approximately $2.00 per gram of plutonium.

"Sixth, it is likely that manufacturers will not commence construction of additional mixed-oxide fabrication capacity until the rulemaking has been concluded. Based on lead times required for design, licensing and construction of such facilities, fabrication capability to meet annual production rates of plutonium could not be expected before the early 1980's assuming the Commission's proposed deferral, adding substantially to total plutonium inventories and their associated economic impact. A similar conclusion can be drawn with respect to reprocessing capability. Also, such facilities as do exist are likely to remain idle or to operate at substantially reduced capacity, depending on the Commission's application of the proposed 'experimental' exception to the deferral of mixed-oxide fuel use."

Response:

In final GESMO sensitivity analyses were made to show the economic impacts of delays in reprocessing of spent fuels and recycling of plutonium. Parametric studies are included to show the influence of growth rate in energy demands and the effects of uranium, separative work and MOX fuel fabrication costs. Refer to CHAPTER XI, Section 2.0 for the comparisons of the effects of alternative dispositions of plutonium on LWR fuel cycle operations. Economic comparisons and the alternatives to prompt recycle for three fuel cycle options, no recycle, recycle of uranium only and recycle of uranium and plutonium are included.

CHAPTER VIII includes a detailed description of the alternatives to prompt recycle and summarizes environmental impacts.

The full discussion and utilization of the plutonium generated in LWR's and a program for utilizing MOX fuel in LWR's is included in CHAPTER IV, Section C-4.0. The 1.15 SGR model reactor is also described in this part of final GESMO. Refer to CHAPTER IV, Section C, paragraph 4.1.2 for the basis for the GESMO model reactor, Figure IV C-26 for the MOX loading to approach equilibrium, and Table IV C-10 indicating the chronology of reactor reloads.

GESMO

THOMAS R. KENDALL, D. V. M.
1023 FULTON AVENUE
SACRAMENTO, CALIFORNIA 95825
TELEPHONE 483-2973

JULY 24, 1975

SECRETARY
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C.
20555

7-30-75 ERR

DEAR SIRS:

IN LIGHT OF THE KNOWN TOXICITY OF PLUTONIUM, I AM OPPOSED TO ITS USE AS A MIXED-OXIDE FUEL IN LIGHT WATER REACTORS. IF 3 MILLIONTHS OF A GRAM OF Pu_{239} WILL CAUSE CARCINOMAS OF THE LUNG IN 87% OF THE DOGS IN THE TESTS WE CAN NOT AFFORD TO HAVE PLUTONIUM IN THE ENVIORNMENT. IT IS UNFORTUNATE THAT PLUTONIUM INDUCED LUNG CANCER CAN NOT BE CLINICALLY DIFFERENTIATED FROM LUNG CANCER INDUCED BY CIGARETTE SMOKING. IT IS INVALID TO STATE THAT PLUTONIUM HAS NOT ALREADY CAUSED DEATH BECAUSE OF THIS FACT. THE DOGS IN THE RESEARCH STUDIES WERE ALL OLDER DOGS INDICATING THAT PLUTONIUM TAKES A WHILE TO INDUCE LUNG CARCINOMAS. TRANSPOSING THE

THOMAS R. KENDALL, D. V. M.
1023 FULTON AVENUE
SACRAMENTO, CALIFORNIA 95825
TELEPHONE 483-2973

CANINE DATA, A CANCER INCUBATION PERIOD OR LAG TIME FROM EXPOSURE TO CLINICAL CANCER DIAGNOSIS OF 20-30 YEARS. MOST MASSIVE GENERAL POPULATION EXPOSURES TO PLUTONIUM OCCURRED IN THE 1960's AS A RESULT OF ATMOSPHERIC NUCLEAR ARMS TESTING. THIS WOULD INDICATE WE COULD NOT EXPECT TO SEE WORLD WIDE PLUTONIUM INDUCED CARCINOMAS TILL THE 1980's - IF WE CAN AT THAT TIME DIFFERENTIATE THEM FROM OTHER LUNG CANCERS.

AS ANYONE IN THE MEDICAL PROFESSION KNOWS, A NEGATIVE LABORATORY FINDING DOES NOT MEAN THE TEST WON'T LATER PROVE TO BE POSITIVE. THIS SAME LOGIC CAN BE APPLIED TO PLUTONIUM TOXICITY IN PEOPLE. PLUTONIUM SHOULD NOT BE USED AS FUEL IN ANYTHING.

SINCERELY,
Thomas R. Kendall D.V.

5-68.1

NRC Staff Responses to Specific
Comments on Health, Safety & Environment
By Thomas P. Kendall

1. Comment:

"It is unfortunate that plutonium induced lung cancer can not be clinically differentiated from lung cancer induced by cigarette smoking. It is invalid to state that plutonium has not already caused death because of this fact.

"Most massive general population exposures to plutonium occurred in the 1960's as a result of atmospheric nuclear arms testing. This would indicate we could not expect to see world wide plutonium induced carcinomas till the 1980's--if we can at that time differentiate them from other lung cancers."

Response:

The Commission has consistently dealt with plutonium as a toxicant capable of inducing cancer and has imposed protective measures for working with or transporting the materials that are commensurate with its radiotoxicity. Refer to CHAPTER IV, Section J, Appendices B and C.

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2. Comment:

"In light of the known toxicity of plutonium, I am opposed to its use as a mixed oxide fuel in light water reactors. If 3 millionths of a gram of Pu_{239} will cause carcinomas of the lung in 97% of the dogs in the tested we can not afford to have plutonium in the environment."

Response:

The induction of lung cancers in dogs by inhaled plutonium has occurred at levels in excess of the present standards for lung burdens of plutonium. However, the analysis in final GESMO indicates that plutonium accounts for a very small fraction of the occupational and population exposure. The total exposures for no recycle, recycle of uranium only, or uranium and plutonium recycle result in about the same estimated risks. Refer to CHAPTER IV, Section C, Appendix C.