ASSISTANT TO THE SECRETARY OF DEFENSE
3050 DEFENSE PENTAGON
WASHINGTON, DC 20301-3050

OSD1.950909.013

ATOMIC ENERGY

MAY 0 9 1994

Ruth Faden, PhD., MPH
Chair
Advisory Committee on
Human Radiation Experiments
1726 M Street, N.W.
Suite 600
Washington, DC 20036

Dear Dr. Faden: Ruth

Thank you for your recent letter and the appreciation that you expressed concerning my presentation at the Advisory Committee's opening session on April 22, 1994. As you are aware, the presentation summarized the Department of Defense's (DoD's) extensive efforts to discover and document the extent of its participation in human radiation experimentation. However, from another perspective, it also reflected the Department's strong commitment to this task, and the dedication of those personnel, at numerous bases and installations throughout the Nation, who diligently made the search. Therefore, I am grateful for having the opportunity to appear before the Committee and represent the Department and its dedicated professionals. I also wish to express my appreciation for the kindness and consideration shown me by the Committee.

The Department is eager to be of assistance to the Committee and its staff, and to provide you with the information available on the topics identified in your letter. Since January 1994 our efforts have been directed towards achieving the initial requirements established in the guidance promulgated by the Interagency Working Group. As such, information on some subjects of interest to the Committee may not be as extensive as in other areas. However, as we continue our search efforts, the Committee's interest will be incorporated, which will further aid us in focusing our efforts.

Regarding your letter, in addition to the four boxes of material provided to the Committee on 29 April 1994, I have enclosed additional material to address specific requests. A description of this material and its relation to your requests is enclosed. As additional information is found concerning these areas, it will also be forwarded for the Committee's review.

I hope that this information will assist the Committee in its tasks. The DoD is committed to achieving a full accounting of its involvement in human radiation experiments and welcomes the Committee's efforts in helping us to attain this goal.

On a personal note, I would like to commend you on the leadership and expertise that you, and the Committee, bring to this effort. I look forward to working with you.

Sincerely,

Gordon K. Soper
Principal

Enclosure

1. Ethical Standards and Regulations

Tab A -- Memorandum for the Secretaries of the Military Departments from the Secretary of Defense, dated 26 February 1953, Subject: Use of Human Volunteers in Experimental Research. The Memorandum established DoD policy for the use of DoD volunteer personnel in experimental research in the fields of atomic, biological, and/or chemical warfare.

Tab B -- Department of the Army Memorandum, dated 7 January 1994, Subject: Historical Perspective on Informed Consent, with attached information paper. The information paper traces the evolution of the Army's policy on informed consent and human use review. A chronology is also included.

Tab C -- Department of the Air Force Memorandum, dated 10 January 1994, Subject: History and Current Practice of Informed Consent in Clinical Practice and Clinical Research - INFORMATION MEMORANDUM. The memorandum is a chronology that traces the evolution of consent standards for human subjects from the 1940's to the present. It also incorporates the development of Air Force regulations relative to the subject.

The Department of the Navy also researched its regulatory history for instructions governing human use. In a report on its review of human radiation experiments dated 28 February 1994 the Navy stated, "The Navy Manual of the Medical Department in 1951 provided formal guidance for conducting experiments using human use test subjects. Further guidance was issued in DoD and BUMED [Bureau of Medicine] instructions in 1964, 1982, 1983, 1984, 1988 and 1989."

2. Plutonium Injection, Green Run and Cincinnati Experiments.

The available information was provided to the Committee staff on 29 April 1994. Our office has no information on plutonium injections (these experiments fall under the purview of the Department of Energy). Also, the material received from the University of Cincinnati contained duplicate copies of the same documents. To ensure the integrity of our search and that the Advisory Committee received a complete set, the documents were reproduced as is, with no attempt to remove duplicates.

Tab D -- Additional information on the Green Run experiments received after 29 April 1994.

3. Document Search

Tab E -- Secretary of Defense Memorandum, dated 7 January 1994, Subject: DoD Human Radiation Research Review. The memorandum published general record retention and search guidance.

Tab F -- Department of Defense Memorandum, dated January 31, 1994, Subject: Locating Records of DoD Human Radiation Experiments. This memorandum provides the Department's components and agencies detailed guidance by which to conduct their document search. It also established reporting suspenses and formats in which the reports were to be rendered.

Tab G -- Briefing vu-graphs, *Department of Defense Human Radiation Experiments Review*. The vu-graphs are copies of those that were used to brief the Committee on 22 April 1994 and contain information on the scope of the research effort and resources employed.

Additional information on search techniques and resources are in the Phase I and Phase II reports contained in the boxes provided to the Committee staff on 29 April 1994.

C O P Y

SECRETARY OF DEFENSE
Washington

26 Feb 1953

MEMORANDUM FOR THE SECRETARY OF THE ARMY
SECRETARY OF THE NAVY
SECRETARY OF THE AIR FORCE

SUBJECT: Use of Human Volunteers in Experimental Research

1. Based upon a recommendation of the Armed Forces Medical Policy Council, that human subjects be employed, under recognized safeguards, as the only feasible means for realistic evaluation and/or development of effective preventive measures of defense against atomic, biological or chemical agents, the policy set forth below will govern the use of human volunteers by the Department of Defense in experimental research in the fields of atomic, biological and/or chemical warfare.

2. By reason of the basic medical responsibility in connection with the development of defense of all types against atomic, biological and/or chemical warfare agents, Armed Services personnel and/or civilians on duty at installations engaged in such research shall be permitted to actively participate in all phases of the program, such participation shall be subject to the following conditions:

a. The voluntary consent of the human subject is absolutely essential.

(1) This means that the person involved should have legal capacity to give consent; should be so situated as to be able to exercise free power of choice, without the intervention of any element of force, fraud, deceit, duress, over-reaching, or other ulterior form of constraint or coercion; and should have sufficient knowledge and comprehension of the elements of the subject matter involved as to enable him to make an understanding and enlightened decision. This latter element requires that before the acceptance of an affirmative decision by the experimental subject there should be made known to him the nature, duration, and purpose of the experiment; the method and means by

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Downgraded to
UNCLASSIFIED 22 Aug 75
per S. Clements
DDR&E OSD(PA)

which it is to be conducted; all inconveniences and hazards reasonably to be expected; and the effects upon his health or person which may possibly come from his participation in the experiment.

(2) The concept of the human subject shall be in writing, his signature shall be affixed to a written instument setting forth substantially the aforementioned requirements and shall be signed in the presence of at least one witness who shall attest to such signature in writing.

(a) In experiments where personnel from more than one Service are involved the Secretary of the Service which is exercising primary responsibility for conducting the experiment is designated to prepare such an instrument and coordinate it for use by all the Services having human volunteers involved in the experiment.

(3) The duty and responsibility for ascertaining the quality of the consent rests upon each individual who initiates, directs or engages in the experiment. It is a personal duty and responsibility which may not be delegated to another with impunity.

b. The experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods or means of study, and not random and unnecessary in nature.

c. The number of volunteers used shall be kept at a minimum consistent with item b., above.

d. The experiment should be so designed and based on the results of animal experimentation and a knowledge of the natural history of the disease or other problem under study that the anticipated results will justify the performance of the experiment.

e. The experiment should be so conducted as to avoid all unnecessary physical and mental suffering and injury.

f. No experiment should be conducted where there is an a priori reason to believe that death or disabling injury will occur.

g. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.

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C O P Y

h. Proper preparation should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability, or death.

i. The experiment should be conducted only by scientifi cally qualified persons. The highest degree of skill and care should be required through all stages of the experiment of those who conduct or engage in the experiment.

j. During the course of the experiment the human subjec should be at liberty to bring the experiment to an end if he has reached the physical or mental state where continuation of the experiment seems to him to be impossible.

k. During the course of the experiment the scientist in charge must be prepared to terminate the experiment at any stage if he has probable cause to believe, in the exercise of the good faith, superior skill and careful judgment required of him that continuation of the experiment is likely to result in injury, di ability, or death to the experimental subject.

l. The established policy, which prohibits the use of prisoners of war in human experimentation, is continued and they will not be used under any circumstances.

3. The Secretaries of the Army, Navy and Air Force are authorized to conduct experiments in connection with the develop of defenses of all types against atomic, biological and/or chemi warfare agents involving the use of human subjects within the limits prescribed above.

4. In each instance in which an experiment is proposed pursuant to this memorandum, the nature and purpose of the proposed experiment and the name of the person who will be in charge of such experiment shall be submitted for approval to the Secretary of the military department in which the proposed experiment is t be conducted. No such experiment shall be undertaken until such Secretary has approved in writing the experiment proposed, the person who will be in charge of conducting it, as well as inform the Secretary of Defense.

5. The addresses will be responsible for insuring compliance with the provisions of this memorandum within their respective Services.

/signed/
C.E. WILSON

Copies furnished:
Joint Chiefs of Staff
Research and Development Board

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22 Aug 75

DEPARTMENT OF THE ARMY
OFFICE OF THE SURGEON GENERAL
5109 LEESBURG PIKE
FALLS CHURCH, VA 22041-3258

REPLY TO ATTENTION OF

18 Jan 93 PHM

~~16 Jan 93~~

S: 14 ~~Jan~~ 94

7 JAN 94

SGPS-PSP (40-5)

MEMORANDUM THRU Commander, U.S. Army Medical Research and Development Command, Fort Detrick, MD 21702-5000

FOR Deputy Chief of Staff, Regulatory Compliance and Quality (SGRD-RCQ, ATTN: MAJ Vander Hamm), Medical Research and Development Command, Fort Detrick, MD 21702-5000

SUBJECT: Historical Perspective on Informed Consent

1. Reference telephone conversation between COL Erdtmann, SGPS-PSP, and MAJ Vander Hamm, SGRD-RCQ, 04 Jan 94.

2. Recent revelations by the Department of Energy of "experiments" during the 1940s and 1950s involving exposure of human subjects to radioactive materials without their consent has caused the Department of Defense to begin scrutinizing its own procedures during that time. Request you provide a two- to five-page information paper describing:

a. the evolution of informed consent procedures used by the Army, from immediately after World War II up to the present, and

b. the procedures which the U.S. Medical Research and Development Command (MRDC) has used, over time, to archive records of studies, consent forms, and volunteer data bases.

3. We appreciate the difficulty you may encounter in trying to accomplish these tasks. An accurate portrayal of the "standards-of-practice then" versus the "standards-of-practice now," however, will contribute significantly to the American people being able to put the conduct of Army experiments in proper perspective.

4. Request the information paper be provided by 14 Jan 94.

5. POC is COL Peter H. Myers, OTSG Radiological Hygiene Consultant, Commercial 703-756-0132 (DSN 289-); (FAX -0140).

FOR THE SURGEON GENERAL:

Col, MC

for ROBERT G. CLAYPOOL
Brigadier General, MC
Director, Professional Services

Deputy Director, Professional

The first formal authority to recruit and use volunteer subjects in chemical warfare experiments occurred in 1942 when the Acting Secretary of War approved a request to use enlisted men for testing for mustard type agents (3,6). The initial statutory authority for the Secretary of the Army to conduct research and development was the Organization of the Army Act of 10 July 1950, Section 104 974 Statute 322; 5 USC 235a) (3). These actions were followed by the establishment of the Armed Forces Medical Policy Council. In 1953, the Secretary of Defense promulgated a policy governing medical experiments which also authorized research with voluntary, written, informed consent, involving defense against atomic, biological and/or chemical weapons.

The Army Chief of Staff published an implementing memorandum in 1953, which directed that proposals using volunteers for atomic, chemical, and biological warfare research be reviewed by The Surgeon General and approved by the Secretary of the Army (3,7). Chemical weapons defense research was conducted at Edgewood Arsenal, both by the Services and under contract. Most of this research was carried out in secrecy to protect national security interests. In 1959, this research was presented by Major General Creasy, former Chief Chemical Officer, U.S. Army, to the House Committee on Science and Astronautics, and also on several later occasions to other Congressional committees (2,4). Documents for these years indicate that tests for mustard gas, phosgene, and other chemical agents were conducted with volunteer employees of Edgewood Arsenal and military volunteers from several Army bases to include Navy and Air Force personnel (3,5).

In 1962, the thalidomide incident prompted the Federal Government to revise the Food, Drug and Cosmetic Act, increasing the role of the Food and Drug Administration (FDA) in new drug approvals. This action prompted the establishment in 1964 of DoD Instruction 5030.29, Investigational Use of Drugs by the DoD, and a Memorandum of Understanding (MOU) between the Department of Defense (DoD) and the FDA. This MOU requires the FDA to maintain staff with appropriate security clearances to allow their review of classified materials involving human subjects drug and vaccine research. Also, at this time The Army Investigational Drug Review Board was established to evaluate the scientific aspects of new drug research protocols.

The first Army Regulation to regulate the use of human research volunteers, AR 70-25, was published in 1962. This AR placed responsibility for research involving life sciences under the Army Research Office, Office of Research and Development. Revisions to this regulation in 1974 placed the responsibility for approval of all Army research involving human subjects, except for nuclear and chemical agent studies, with The Surgeon General. Also in 1974, with the issuance of OTSG Memorandum No. 10-7, the Human Use Review Board Office was established under the supervision of the Assistant Surgeon General for Research and Development.

The Human Use Review Office was charged with administering and coordinating the activities of the Army Investigational Drug Review Board, the U.S. Army Medical Research and Development Command (USAMRDC) Contract Review Board, and the Surgeon General's Human Use Committee and Clinical Investigation Committee to ensure the uniform application of ethical standards for human research studies conducted within or sponsored by the AMEDD and other Army agencies (1). In 1975, The Human Subjects Research Review Board (HSRRB) was established, replacing the three boards/committees mentioned above. Also in 1975, the Secretary of the Army ordered all human testing involving chemical agents at Edgewood Arsenal to stop. In 1978, the U.S. Army Health Care Studies and Clinical Studies Investigational Activity was established to administer the review of clinical investigation protocols for Health Services Command (HSC). Since that time, all organizations in the Army that conduct clinical investigations or research, development, test and evaluation studies are required to have their own Human Use Committee or to utilize the HSRRB or its Subcommittee for protocol review.

ARMY POLICY ON INFORMED CONSENT

Several events occurred in the civilian and Federal communities which contributed to the content of the Army's informed consent policy. In the summer of 1972, the Tuskegee Syphilis Study, conducted by the Public Health Service filled the American media reports. In October 1972, Congress passed Public Law #92-570, which required the military to obtain informed consent. This was followed in 1974 by the passage of the National Research Act (Pub. L. 93-348) which established the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. This Commission published The Belmont Report in 1978.

In 1981, the President's Commission on Ethical Problems in Medical and Behavior Research, along with the 1981 Health and Human Services regulations for the Protection of Human Subjects, 45 CFR 46, helped to further develop Army and DoD informed consent policy. The DoD Directive 3216.2, Protection of Human Subjects in DoD-Supported Research, published in 1983, further explicated the tenets of informed consent policy.

In 1990, an amendment to 21 CFR.50.23 was published in the Federal Register following petitioning of the FDA by the USAMRDC on behalf of the DoD. This interim ruling provided for an FDA-approved waiver of informed consent for the use of specific investigational drugs and vaccines during Operation Desert Shield/Desert Storm. In these situations and at the request of the Assistant Secretary of Defense for Health Affairs, the Commissioner of the FDA may determine that obtaining informed consent is not feasible. In this ruling, the FDA required the investigational drugs be used for treatment and not for research and required that appropriate information about these investigational substances be provided.

INFORMATION PAPER

DEVELOPMENT OF HUMAN USE REVIEW AND INFORMED CONSENT PROCEDURES WITHIN THE DEPARTMENT OF THE ARMY

INFORMED CONSENT: OVERVIEW

The Army's participation in human subjects research has included significant attention to human use review and informed consent procedures. The 1947 Nuremburg Code serves as the legal and ethical foundation for the conduct of human subjects research

INFORMED CONSENT: DOCUMENTATION

The history of the Army Medical Department (AMEDD) contains numerous examples of the use of written informed consent, particularly MAJ Walter Reed's yellow fever studies at the turn of the century. However, in general, both AMEDD and non-AMEDD written informed consent documents from the 50s and 60s were limited in scope, focusing on informing subjects they were volunteering for a research protocol with a certain test article, that there were risks, that participation was voluntary, and that a decision to participate should be made without coercion or duress. These early consent forms often did not explain in detail the actual procedural involvement of the subject, the known risks, the plan for the provision of medical care for injuries sustained as a result of participation in the research, and whom to contact for questions.

The major complicating factor for non-AMEDD researchers in following a legally and ethically balanced informed consent process was the onset of the Cold War, with its requirements for secrecy and the fear of attack by enemies with unconventional warfare capabilities. Protocols often were classified as secret and thus, full disclosure of details of the research to participants was not permitted. In addition, findings to date indicate that a number of non-AMEDD entities (e.g., the Army Chemical Corps, Army Intelligence Board, and the Army's Chemical Warfare Laboratories) consistently failed to obtain the Army Surgeon General's approval of testing and evaluation protocols and failed to follow the then-current Department of Defense regulations on human subjects research (1, 2, 3).

HUMAN USE REVIEW PROCEDURES

A global fear of the potential for use of chemical agents began during World War I. Both sides employed large numbers of chemical agents causing more than one million casualties, 90,000 of whom died (4). On 28 June 1918, the President of the United States directed the organization of the Chemical Warfare Service (CWS), National Army, under the Secretary of War, General Order No. 62 (3). In 1922, the CWS created a Medical Research Division to conduct research directed at providing defense against chemical agents via General Order No. 15 (3).

In 1991, DoD and all other Federal agencies adopted 32 CFR 219, which is Part A of the Health and Human Services 45 CFR46, as the Common Federal Rule for the protection of human subjects. This action paved the way for establishment of a consistent and unified approach to human subject research policy making.

In 1993 the Human Use Review Office was reorganized within the U.S. Army Medical Research and Development Command (USAMRDC) as the Human Use Review and Regulatory Affairs Division (HURRAD), Office of the Deputy Chief of Staff for Regulatory Compliance and Quality, HQ, USAMRDC. The Division continues to perform a wide range of functional responsibilities for the Command, OTSG, and DoD while interfacing directly with the Animal Use and Quality Assurance divisions on matters of regulatory compliance.

The Army supports the creation and review of Federal policy for the protection of human subjects through service on the Human Subjects Research Subcommittee, Committee on Life Sciences, and Health Federal Coordinating Council on Science, Engineering and Technology (FCCSET).

SUMMARY

A review of the history of the Army's involvement in human subjects research has included significant attention to human use review and informed consent policy and procedures. Actions to date demonstrate the evolutionary nature of these areas. Human subjects research and the concept of informed consent continue to evolve and change in response to the nature of science and a growing awareness of and support for the rights of human subject research participants.

Prepared by: COL Galante/MAJ Vander Hamm, SGRD-RCQ

KEY EVENTS/ACTIONS IN THE DEVELOPMENT OF HUMAN USE REVIEW AND INFORMED CONSENT PROCEDURES

YEAR	EVENT
1900	MAJ Walter Reed's Yellow Fever Studies
1918	Chemical Warfare Service (CWS) established under the Secretary of War
1922	Medical Research Division established in CWS
1942	Acting Secretary of War issued authority to recruit and use human subjects in chemical warfare research
1947	Nurenburg Code established
1950	Authority for the Secretary of the Army to conduct research and development codified (Organization of the Army Act of 1950, 5 U.S.C. 235a)
	Armed Forced Medical Policy Council created
1953	Secretary of Defense issued policy statement on medical experiments. Policy authorized conduct of research involving defense against atomic, biological, and/or chemical weapons; Required voluntary, written informed consent.
	Army Chief of Staff issued memorandum requiring all atomic, biological, and chemical research using human volunteers be reviewed by TSG and approved by the Secretary of the Army
1958	U.S. Army Medical Research and Development Command (USAMRDC) established
1959	Information on Edgewood Arsenal chemical weapons defense research presented to Congress
1962	DoD I 5030.29, Investigational Use of Drugs by DoD published
	MOU established between DoD and FDA on investigational drug and vaccine research
	Army Investigational Drug Review Board established

KEY EVENTS/ACTIONS IN THE DEVELOPMENT OF HUMAN USE REVIEW AND INFORMED CONSENT PROCEDURES

YEAR	EVENT
1962	AR 70-25, Use of Volunteers as Subjects of Research, published
1972	Tuskegee Syphilis Study made public
1973	OTSG Memorandum 10-7 published; established the Human Use Review Office, under the Assistant Surgeon General for Research and Development (Commander, USAMRDC). Office assumed responsibility to ensure the uniform application of ethical standards for human subjects research conducted within or sponsored by the AMEDD/other Army agencies
1974	AR 70-25 revised; placed responsibility for all Army research involving human subjects (except nuclear and chemical studies) with TSG
	National Research Act (PL 93-348) enacted; established the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research
1975	Army appeared before Congress to report on LSD studies conducted by the Chemical Corps
	Human Subjects Research Review Board (HSRRB) established; replaced the USAMRDC Contract Review Board, TSG's Human Use Committee, and the Clinical Investigation Committee.
1978	Belmont Report published by the 1974 National Commission
1981	President's Commission on Ethical Problems in Medical and Behavioral Research created; promoted support for Health & Human Services regulation 45 CFR 46
1983	DoD D 3216.2, Protection of Human Subjects in DoD-Sponsored Research became effective
1990	Amendment of 21 CFR 50.23 published; permits the FDA to approve DoD requests for waivers of informed consent for certain investigational drugs (combat/threat)

KEY EVENTS/ACTIONS IN THE DEVELOPMENT OF HUMAN USE REVIEW AND INFORMED CONSENT PROCEDURES

YEAR	EVENT
1991	32 CFR 219 adopted by DoD; regulation is Part A of 45 CFR 46; established as the CFR for all Federal agencies
1993	Human Use Review Office reorganized within the HQ, USAMRDC as the Human Use Review and Regulatory Affairs Division, Office of the Deputy Chief of Staff for Regulatory Compliance and Quality
	U.S. Army Health Care Studies and Clinical Investigation Activity reorganized, moved from HSC to the AMEDD C&S, and renamed the Clinical Investigation Regulatory Office

NUREMBERG CODE

1. The voluntary consent of the human subject is absolutely essential.

This means that the person involved should have legal capacity to give consent; should be so situated as to be able to exercise free power of choice, without the intervention of any element of force, fraud, deceit, duress, over-reaching, or other ulterior form of constraint or coercion; and should have sufficient knowledge and comprehension of the elements of the subject matter involved as to enable him to make an understanding and enlightened decision. This latter element requires that before the acceptance of an affirmative decision by the experimental subject there should be made known to him the nature, duration, and purpose of the experiment; the method and means by which it is to be conducted; all inconveniences and hazards reasonably to be expected; and the effects upon his health or person which may possibly come from his participation in the experiment.

The duty and responsibility for ascertaining the quality of the consent rests upon each individual who initiates, directs, or engages in the experiment. It is a personal duty and responsibility which may not be delegated to another with impunity.

2. The experiment should be such as to yield fruitful results for the good of society, unprocurable by other methods or means of study, and not random and unnecessary in nature.

3. The experiment should be so designed and based on the results of animal experimentation and a knowledge of the natural history of the disease or other problem under study that the anticipated results will justify the performance of the experiment.

4. The experiment should be so conducted as to avoid all unnecessary, physical and mental suffering and injury.

5. No experiment should be conducted where there is an a priori reason to believe that death or disabling injury will occur; except, perhaps, in those experiments where the experimental physicians also serve as subjects.

6. The degree of risk to be taken should never exceed that determined by the humanitarian importance of the problem to be solved by the experiment.

7. Proper preparations should be made and adequate facilities provided to protect the experimental subject against even remote possibilities of injury, disability, or death.

Encl 1

8. The experiment should be conducted only by scientifically qualified persons. The highest degree of skill and care should be required through all stages of the experiment of those who conduct or engage in the experiment.

9. During the course of the experiment the human subject should be at liberty to bring the experiment to an end if he has reached the physical or mental state where continuation of the experiment seems to him to be impossible.

10. During the course of the experiment the scientist in charge must be prepared to terminate the experiment at any stage, if he has probable cause to believe, in the exercise of the good faith, superior skill, and careful judgment required of him that a continuation of the experiment is likely to result in injury, disability, or death.

REFERENCES:

1. Prepared statement, Lieutenant General Richard R. Taylor, M.D., The Surgeon General, Before the Subcommittee on Administrative Practice and Procedure of the Judiciary Committee and the Subcommittee on Health of the Labor and Public Welfare Committee, United States Senate, First Session, 94th, Congress, 10 September 1975

2. Prepared statement, Charles D. Ablard, General Counsel, Dept of the Army, Before the Subcommittee on Administrative Practice and Procedure of the Judiciary Committee and the Subcommittee on Health of the Labor and Public Welfare Committee, United States Senate, First Session, 94th, Congress, 10 September 1975

3. Research Report Concerning the Use of Volunteers in Chemical Agent Research, prepared by Colonel James R. Taylor and Major William N. Johnson, Inspectors General, Office of The Inspector General, HQ, Department of the Army, pursuant to the Vice Chief of Staff Letter of Instruction, dated 21 July 1975

4. House Report No. 815, by The Committee on Science and Astronautics, House of Representatives, 86th Congress, 1959

5. Chemical Research and Development Laboratory Special Publication 2-51, Evaluation of Medical Research Volunteer Program, published in 1962

6. Office, Chief, Chemical Warfare Service Officer, Order No. 48, dated 3 July 1943.

7. Chief of Staff Memorandum through Assistant Chief of Staff, G-4, for Chief Chemical Officer and The Surgeon General, subject: Use of Volunteers in Research, dated 30 June 1953 (CS:385)

10 Jan 94

MEMORANDUM FOR AFMOA/SGP
AF/SG
IN TURN

FROM: AFMOA/SGPT

SUBJECT: History and Current Practice of Informed Consent in Clinical Practice and Clinical Research - INFORMATION MEMORANDUM

Current consent standards primarily emerged in response to unnecessary and dangerous research conducted during World War II. Following is a chronology of consent standards for human subjects:

- The Nuremberg Code was developed for the Nuremberg Military Tribunal following World War II. It states that "the voluntary consent of the human subject is absolutely essential."

- AFR 80-22, Research and Development, Clinical Research, 11 Jul 52 (superseded by AFR 169-6, 10 Apr 63), did not address the issue of consent.

- DDR&E OSD(PA) Memorandum for the Secretaries of the Army, Navy and Air Force, Subject: Use of Human Volunteers in Experimental Research, 26 Feb 53, required that informed consent be in written format.

- AFR 169-6, Clinical Investigation and Human Test Subjects in the Medical Service, 10 Apr 63 (canceled AFR 80-22), did not address informed consent.

- DoDI 5030.29, Investigational Use of Drugs by the DoD, 12 May 64, provided for the protection of humans involved in research under DoD sponsorship whether it involved investigational drugs or other hazards. It did not address informed consent.

- Declaration of Helsinki: Recommendations Guiding Medical Doctors in Biomedical Research Involving Human Subjects, 1964, was developed by the World Medical Association in Helsinki, Finland. The recommendations are similar to the code; however, it further distinguishes therapeutic from nontherapeutic research.

- AFR 169-8, Use of Volunteers in Aerospace Research, 8 Oct 65, stated that informed consent is absolutely essential (may be explained orally) and required the volunteer to sign an abbreviated consent document acknowledging having been apprised of the risks.

- AFR 80-33, Use of Volunteers in Aerospace Research, 28 Aug 69, required a written informed consent document and the subject's signature.

- Public Law 92-570, Oct 72, Congress required the military to obtain the informed consent of subjects involved in experimentations.

- National Institutes of Health Policies for the Protection of Human Subjects In the United States, 30 May 74, was converted into formal regulations, promulgated by the Department of Health, Education and Welfare (DHEW) and applied only to DHEW.

- The Belmont Report, 30 Sep 78, resulted from the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, established in 1974. The commission met from 1974 to 1978 and issued recommendations identifying the basic ethical principles that should underlie the conduct of biomedical and behavioral research involving human subjects, including the right of self determination and the need for informed consent.

- Title 45, Code of Federal Regulations, Part 46, Protection of Human Subjects, 16 Jan 81, promulgated by the Department of Health and Human Services (formerly DHEW), applied to DHHS and organizations receiving DHHS funds. Provided basic elements of the informed consent document (ICD), required a written consent form and signature of the subject or the subject's legally authorized representative.

- Public Law 10 USC 980, Department of Defense Authorization Act, 1985, restricted DoD research to subjects whose informed consent is obtained in advance; or, who will receive direct benefit and the subject's legal representative provides informed consent in advance.

- Federal Policy for the Protection of Human Subjects, 18 Jun 91 (revision of 45 CFR 46), was promulgated by the 16 federal agencies that conduct support, or otherwise regulate human subjects research. It was developed to create uniform standards within these agencies. It requires the use of written informed consent, approved by the institutional review board (IRB), signed by the subject, and a copy provided to the subject.

To ensure compliance with federal policy, the IRB reviews and approves research protocols and ICDs prior to initiation of the study, and monitors all aspects of the project until completion or termination. Additionally, the Air Force requires approval by the MTF or laboratory commander. The Surgeon General's Clinical Investigation Committee or the Air Force Human Use Committee must approve the protocol if it has been determined that the subjects will be exposed to greater than minimal risk.

RECOMMENDATION: None, for information only.

GERALD J. MERRITT, Colonel, USAF, BSC
Chief, Clin Investigations & Life Sci Div
Air Force Medical Operations Agency
Office of the Surgeon General

26 Feb 53, DDR&E (SD(PA) Memorandum for the Secretaries of the Army, Navy and Air Force, Subject: Use of Human Volunteers in Experimental Research
1964, Memorandum of Understanding Between the FDA and the DoD Concerning Investigational Use of Drugs by the DoD

19 Aug 74, AFR 169-8, Use of Human Test Subjects in the Medical Service (implemented DoDI 5030.29, 12 May 64; was canceled 1 Feb 78)

11 Jul 92, AFR 80-22, Clinical Research

10 Apr 63, AFR 169-6, Clinical Investigation and Human Test Subjects in the Medical Service (revised 23 Apr 68, 26 Aug 71, 19 Aug 74, 13 Sep 76, 4 Nov 77, 12 Feb 79, 15 Jul 85, and 9 Jul 90)

Paper

EXPERIMENTAL RELEASE OF ^{131}I: THE GREEN RUN

Maurice A. Robkin*

Abstract—In December 1949, a large amount of ^{131}I was released to the air at Hanford during the dissolving of irradiated uranium fuel for a classified military experiment called the "Green Run." Reports of the release have varied from about 0.15–0.3 PBq. Using, as a guide, the reported measurements of ^{133}Xe released during the experiment, the amount of ^{131}I released has been reanalyzed. The results indicate that about 0.40 ± 0.12 PBq (11 ± 3 kCi) was released, somewhat larger than the largest previous estimates.

Health Phys. 62(6):487–495; 1992

Key words: ^{131}I; contamination, environmental; emissions, atmospheric; radioactivity

INTRODUCTION

DURING its operations from 1944 to the present, the Hanford nuclear facilities released radionuclides to the environment. The releases were much larger in the early days before the development of control equipment and restrictive regulatory limits. These releases resulted in radiation doses to the surrounding populations. An extensive study of these doses is currently under way. This study, called the Hanford Environmental Dose Reconstruction Project (HEDRP), is being carried out by the Pacific Northwest Laboratories under the direction of a Technical Steering Panel (TSP). The study, which began in 1988, is a successor to the Hanford Health Effects Study carried out by the state of Washington and is the result of intense public interest and concern about the releases.

One of the singular events in the history of the Hanford releases, the Green Run experiment, occurred in December 1949. The experiment was part of the development of a monitoring methodology for intelligence efforts regarding the emerging Soviet nuclear program. The complete details of the experiment remain classified. A declassified description of the experiment has been released (Jenne and Healy 1950).

Declassified reports dealing with or mentioning the Green Run show considerable disagreement in the release amount (Jenne and Healy 1950; Paas and Singlevich 1950; Singlevich 1950; Roberts 1958; Anderson 1974). The values have ranged from 0.15 PBq (4,000 Ci) (Singlevich 1950) to 0.30 PBq (7,780 Ci) (Jenne and Healy 1950). There have been expressions of concern by various members of the public and by representatives of the states of Washington and Oregon about these disagreements.

It is important for the HEDRP that source terms be determined as accurately as possible. Although the earlier estimates indicated that the Green Run release represented less than 2% of the total ^{131}I releases from the Hanford facility, a defensible value is required for the HEDRP dosimetry. The purpose of the present study is to provide as good an estimate of the release from the Green Run experiment as is possible from the information contained in the historical record.

THE GREEN RUN

Examination of the *100 Areas Monthly Report* for November 1949 (Barnard 1949), the *P Division Monthly Report* for November 1949 (Lee 1949), and the *Daily Operating Conditions Report for the 100 Areas* (Anonymous 1950) indicates that the "F" Reactor supplied the irradiated fuel for the Green Run Experiment. The reactor outage began at 3 a.m. and reached nominal zero power at 4:50 a.m. on 16 November 1949. Fuel was removed (pushed) from the reactor on 17 November 1949 (Jenne and Healy 1950).

Approximately 1;000 of the discharged irradiated fuel slugs (two tons) were made available for the Green Run experiment. The radioactivity in the slugs was allowed to decay for only about 2 wk. The decay time was much shorter than usual to ensure that there would be sufficient ^{131}I ($T_{½}$ = 8.04 d) available for the experiment.

On 1 December 1949 these slugs were put into a clean dissolver at the reprocessing plant. The aluminum jackets were dissolved on the graveyard shift of 2 December (12 midnight to 8 a.m.). The dissolving of the declad and rinsed uranium slugs began at 8 p.m. that same day. The plant filters were bypassed to allow all of the evolved iodine to escape.

When a reactor is shut down in a normal way, the control rods are driven into the core. The neutron flux decreases quickly as the reactor goes highly subcritical. There is initially about 6.5% residual power that will slowly decrease with the decay of fission products. For a reactor that has been operating for a long time, the

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initial shutdown fission product power will decrease to about 1% of the full reactor power in a little over 3 h. The actual neutronic shutdown of the "F" reactor can be taken at 3 a.m. on 16 November 1949. The cooling time to the start of dissolving is 401 h measured from 3 a.m. on 16 November 1949 to 8 p.m. on 2 December 1949.

Not all of the ^{133}Xe and ^{131}I were discharged at the same time. The discharge of the xenon was spread out from the start of dissolving over 750 min while the iodine was emitted from about 50 to about 970 min after the start of the dissolving (Jenne and Healy 1950). Jenne and Healy (1950) give the time history of the evolution of these isotopes as the dissolving proceeded. The iodine release rate as a function of time is very symmetric around the midpoint of the discharge. The xenon release rate is nonsymmetric having a very rapid rise to a maximum at about 2.5 h after the start of dissolving followed by an extended decrease over a period of about 10 h (Jenne and Healy 1950). Using a discharge-rate- and decay-weighted average time-to-release gives average values of 4.8 h and 8 h for the average additional cooling from the start of dissolving for xenon and iodine, respectively. The total cooling times for these two isotopes are then 406 h for ^{133}Xe and 409 h for ^{131}I with an uncertainty of not more than 2 h.

The ^{133}Xe available for release from the dissolved fuel comes from the ^{133}Xe in the fuel at the time of reactor shutdown plus the ^{133}Xe produced by the decay of the 21-h ^{133}I in the fuel at shutdown. About 2.5% of the xenon activity comes from ^{131}Xe that was produced in the fuel during the cooling period from the decay of ^{131}I, and its contribution to the ion chamber current in the Jenne and Healy (1950) measurement is accounted for.

The ^{131}I available for release during dissolving comes from ^{131}I in the fuel at reactor shutdown plus the decay of the 1.35-d ^{131m}Te in the fuel at shutdown. The contribution from the reservoir isotopes amounts to about 15% additional for xenon and about 5% additional for iodine over the activities that would be present at dissolving from just the ^{133}Xe and ^{131}I inventory at reactor shutdown.

In this paper, the estimate of the amount of 8.04-d ^{131}I released from the fuel is based on the amount of 5.243-d ^{133}Xe released during dissolving as reported by Jenne and Healy (1950). All of the contributing isotopes were at radioactive equilibrium at the time the reactor was shut down for fuel discharge. The Bateman (1910) equations were solved for the equilibrium activities and for the activities of ^{133}Xe and ^{131}I in the fuel at that time of dissolving.

At the time of the Green Run experiment, the reactor fuel was made up of solid slugs of uranium metal clad in aluminum. The average specific power density in F reactors was about 1.1 MW Mg^{-1} (1 MW ton^{-1}) (Lockwood 1958). It is assumed that at this power density there is little migration of fission products within the uranium metal and only the fission products formed in the uranium that was actually dissolved are available for release. The amount of iodine discharged from the plant stack is proportional to the assumed value of the fraction evolved from the process solutions.

As part of the experiment, samples were taken of the gases and vapors that escaped from the dissolver and were carried up the stack of the reprocessing plant. A pump pulled about 0.472 L s^{-1} (0.5 cfm) through a sampling line at the 15.24-m (50-ft) level of the stack into the analysis building. The gas stream was passed through a scrubber solution and expelled out the building stack. Samples of the gas stream were collected about every 15 min into evacuated 1-L spherical flasks ("boiling flasks") containing an iodine scrubber solution (Jenne and Healy 1950).

After standing several days, the scrubber solution removed all of the iodine from the sample. After this time, each scrubber flask was connected to an evacuated 1-L spherical ionization chamber made from a boiling flask and the xenon was allowed to divide between the two flasks. The ion chamber was carefully bled to equilibrium with the atmosphere (Jenne and Healy 1950). The ionization current generated in the ion chamber was measured by a vibrating reed electrometer. Jenne and Healy quote Thorburn (1950) who describes the chamber as operated at 90 V in an air-conditioned room maintained between 22–24°C and 50% relative humidity. Thorburn (1950) reported constant ionization current per unit activity above 67.5 volts.

Jenne and Healy (1950) expressed the release rate of xenon as curies per minute by converting the chamber ion current to flask activity by use of a calibration factor (0.115 fA Bq^{-1}) (4.25 pA μCi^{-1}). The derived their calibration factor by assuming that: 1) the average specific ionization of beta particles was 120 ion pairs (ip) per centimeter (ip cm^{-1}); 2) the average path length in the ion chamber was 6 cm; and 3) the ionization from gamma rays was negligible. The results of the ion chamber measurement were reported as the activity discharge rate of ^{133}Xe assuming that: 4) the half-life of ^{133}Xe was 5.4 d and 5) that the flow rate up the stack was 11.8 m^3 s^{-1} (25,000 cfm).

The first assumption appears to be based on applying to the entire ^{133}Xe beta spectrum the specific ionization for an electron whose energy is equal to the average beta energy and assuming that the specific ionization was constant throughout the path of the electrons. Using the average energy of the main beta to determine the energy deposition is not adequate for the following reasons: 1) the specific ionization is not linearly proportional to the electron energy; 2) the average energy of conversion and Auger electrons is about one-third that of the beta particles; and 3) the fractional energy deposition of the lower energy discrete electrons is much greater than for the beta particles; more than one-half of the energy deposition from ^{133}Xe in the

chamber comes from conversion and Auger electrons that Jenne and Healy (1950) did not take into account.

The second assumption is incorrect. The average uncollided path length to the wall in a spherical volume of radius, R, for the particles emitted uniformly within the volume by an isotropic emitter is $0.75R$ (Lind 1928). For a 1-L spherical volume, $R = 6.2$ cm, and the average path length is 4.65 cm.

The third assumption is correct.

The fourth assumption is slightly higher than the current value of 5.243 d (Walker et al. 1989). For a standing time in the collection flask of as much as 5 d, the difference in the reported discharge rate of ^{133}Xe would be <2%.

Even in 1949, air flow rates could be accurately measured, so the fifth assumption is probably reasonable and good to within a few percent.

Thorburn (1950) reported ion chamber backgrounds on the order of 2–5 fA for a 2-L chamber. The 1-L chamber used in the Jenne and Healy experiment would have about one-half this background. For the smallest xenon release rate measured by Jenne and Healy (about 200 MBq s^{-1}), their calibration factor and assumed stack air-flow rate implies a chamber current of about 1 pA, at least 400 times the background.

Measurement of the iodine in the scrubber solution gave a value 2 orders of magnitude lower than expected (Jenne and Healy 1950). They discarded the results and took samples of the condensate in the sampling line. Based on these samples, Jenne and Healy (1950) reported a release of 0.29 PBq of ^{131}I. No description of the analytical methodology was given. Because Jenne and Healy's lack of methodological detail for obtaining the reported iodine release, this analysis was based on the release of ^{133}Xe.

METHODOLOGY

General overview

Two models to calculate the energy deposition in a spherical ion chamber were examined. The first was exponential attenuation for the beta particles and the transmission probability model of Kobetich and Katz (1969) for the discrete energy conversion and Auger electrons. The second was based entirely on the Kobetich and Katz model. Evaluation of the two approaches for beta particles was made by comparing the calculated calibration factors with experimental values for a set of ion chamber measurements of ^{85}Kr in air. ^{85}Kr decays by beta emission with negligible production of conversion or Auger electrons (ICRP 1983). Gamma rays and x rays deposit negligible energy in the ion chambers and were ignored.

The measured calibration factors for spherical ion chambers containing ^{85}Kr in air were kindly provided by the Victoreen Instrument Co.[†] The Victoreen data are shown in Table 1. Details of the exponential model and the Kobetich and Katz model are given in the Appendix (see also Table 2).

Table 1. Experimental calibration factors for spherical ion chambers[a].

Volume (mL)	nA × mL × μCi^{-1} (reported)	pA μCi^{-1} (equivalent)	aA Bq^{-1} (equivalent)
282	1.00	3.55	96.0
524	2.28	4.35	118
1020	5.44	5.33	144

[a] Data from Ulman;[†] values ± 20%.

Model choices

The agreement with the Victoreen experiment was much better using the exponential model for the absorption of the beta particles. This model was used in calculating the contribution of the continuous spectrum beta particles to the calibration factor for ^{133}Xe. The exponential model does not apply to electrons emitted with discrete energies. For the discrete energy conversion and Auger electrons emitted in the decay of ^{133}Xe, absorption fractions were calculated based on the Kobetich and Katz (K-K) transmission probability model. The energy deposition from gamma rays and x rays is very small and was neglected.

Evans (1955) shows that the exponential attenuation model holds well in the energy range from 100–3000 keV. A numerical evaluation of the K-K model was made by comparing the absorption fractions in a 6.2-cm air-filled spherical ion chamber for both allowed and first-forbidden spectrum betas with maximum energies from 100–700 keV. The results showed that the ratio of the absorption fraction from the adjusted exponential model to that given by the K-K model using a first-forbidden spectrum starts out at about 1.3 at the highest energy and decreases rapidly with decreasing energy. At the lowest energy, the ratio had fallen to about 0.75. When an allowed beta spectrum was used in the K-K model, the ratio decreased from 1.1 at the highest energy to about 0.7 at the lowest energy with a minimum (0.65) at 200 keV. An approximate average for the ratio for beta spectra of 100–200 keV maximum energy is 0.7. Further details of this calculation are given in the following uncertainty section.

There are large numbers of electrons emitted in these lower-energy spectra with energies similar to those of all of the discrete electrons emitted by ^{131}Xe and ^{133}Xe. As a result, there is considerable uncertainty in the absorption fractions calculated by the K-K model. For the discrete electrons, their energy depositions were calculated using the K-K model, summed and multiplied by 0.7. The scaled energy deposition was used with a large associated uncertainty. The details of the energy absorption calculation are described in the Appendix.

[†] Personal communication (1990), Ulman, R. Measured calibration factors for spherical ion chambers containing ^{85}Kr in air. Victoreen, Inc., 10101 Woodland Avenue, Cleveland, OH 44104.

Table 2. Experimental and theoretical absorption fractions, f, for ^{85}Kr in Victoreen air-filled ion chambers.

Volume (mL)	Radius (cm)	m	f_e[a]	f_{KK}[b]	f_e[c]	f_e/f_c	f_e/f_{KK}	k[d]
282	4.07	0.130	0.0912	0.0614	0.0820	0.899	1.32	15.3
524	5.00	0.160	0.110	0.0745	0.100	0.909	1.33	15.5
1020	6.25	0.200	0.135	0.0915	0.123	0.911	1.33	15.5

[a] Exponential attenuation model.
[b] Kobetich and Katz attenuation model.
[c] Calculated from Victoreen data.
[d] Adjusted value of coefficient.

DATA FOR ^{133}Xe

The 1-L ion chamber sphere had a radius of 6.2 cm. Assuming that the measurements were carried out at 22°C and 1 atm pressure, the density of air in the ion chamber was 0.0012 g cm^{-3}.

The average energy to produce an ion pair in air is taken as 33.85 ± 0.15 eV (ICRU 1979). The charged particles emitted in the decay of ^{133}Xe are given in ICRP Publication No. 38 (ICRP 1983).

ABSORPTION FRACTIONS FOR ^{133}Xe PARTICLES

The absorption fraction for each of the emitted particles from ^{133}Xe and ^{131}Xe was calculated based on the methods described above. For each kind of energetic electron emitted, the energy deposited in the ion chamber is given by the product of $f \times y \times E$ where f is the absorption fraction of the electron, y is the yield in particles per decay, and E is either the average beta energy or the energy of the conversion of Auger electron. Summing these products over all of the emitted discrete energy particles, decreasing the sum to 70% of the calculated value, and combining the result with energy deposition from the beta particles, gives an energy deposition of 44.8 keV per decay.

THE CALIBRATION FACTOR FOR ^{133}Xe

The corrected calibration factor for ^{133}Xe in a spherical ion chamber can now be calculated:

$$I = \frac{q}{w}\,\delta E, \qquad (1)$$

where $q = 1.602 \times 10^{-19}$ C ip^{-1}. For $w = 33.85$ eV ip^{-1}, and $\delta E = 44.8$ keV per decay, the calibration factor to be used for the present analysis becomes: $I = 0.21$ fA Bq^{-1} (7.8 pA μCi^{-1}).

XENON AND IODINE RELEASE

Jenne and Healy (1950) reported their measurements of the xenon discharged up the plant stack in Ci min^{-1} of ^{133}Xe based on their calibration factor of 4.25 pA Ci^{-1} (0.115 fA Bq^{-1}). Fig. 1 is taken directly from their report and shows their data as they presented them, including the curve. They reported that the area under the curve was about 20,000 Ci (740 TBq). To examine that value for this paper, the indicated data points were read from the curve as data pairs of time and activity discharge rate. These activities were transformed to their natural logarithms. The resulting values are shown in Fig. 2.

To obtain the total release, the release rate was integrated over the release interval. Note that there appear to be four distinct time intervals in each of which the logarithms of the discharge rates vary linearly with the time. Total dissolution time was taken to be 750 min (12.5 h) representing the interval between the very small xenon discharge rates at each end of the dissolution process.

The logarithms of the data in each region were fit by linear regression to a straight line using the computer code SYSTAT (Wilkenson 1990). The results are shown in Table 3. In each time interval, the release rate is given by:

$$\text{Rate} = \exp(A + B\,T). \qquad (2)$$

The total amount released is estimated by integration of eqn (2) over all four time-intervals to give:

$$\text{Release (Ci)} = 750 \sum_{i=1}^{4} \frac{e^{A_i}}{B_i}\left(e^{B_i T_{i2}} - e^{B_i T_{i1}}\right), \qquad (3)$$

where T_{i1} and T_{i2} are the times at the beginning and end of the ith time interval, respectively. Evaluation of eqn (3) with the parameters of Table 3 gives a total ^{133}Xe release of 29,000 Ci (1.07 PBq). The uncertainty in this estimate is discussed in a later section.

The ^{131}I release, A131, is given by:

$$\text{A131} = Xe\,\frac{CF_{JH}}{CF_R}\,\frac{AI}{AX}\,f_r, \qquad (4)$$

where Xe is the activity of ^{133}Xe measured by Jenne and Healy (1950), CF_{JH} is the calibration factor used by Jenne and Healy, CF_R is the calibration factor used in this paper, AX is the ^{133}Xe activity, AI is the ^{131}I activity contained in the dissolved fuel at the mean time of dissolution, and f_r is the fraction of iodine released from the process solutions.

The data shown in Fig. 1 are based on ion current readings. Jenne and Healy reported the activity release rate from the ion current based on their value for the

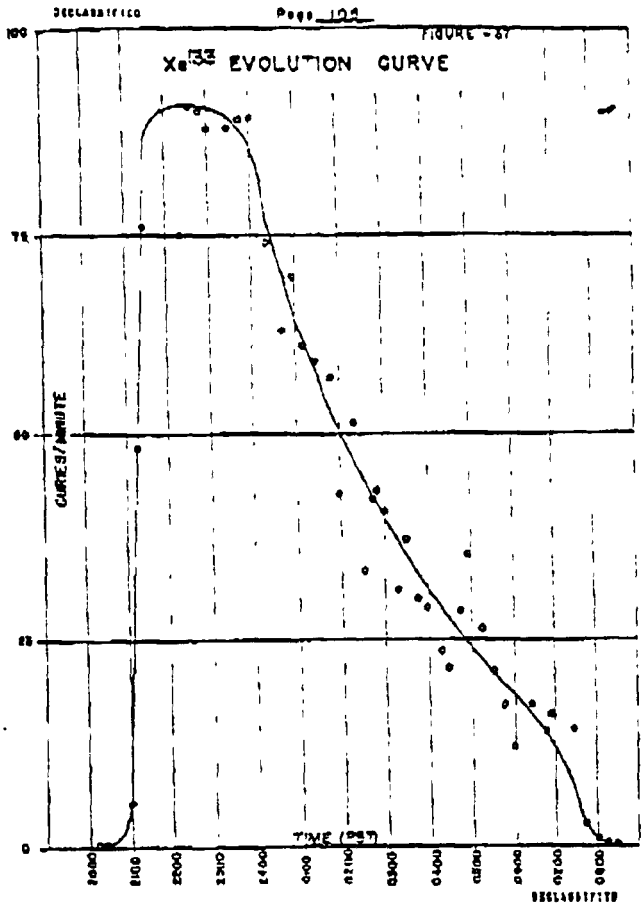

Fig. 1. Jenne and Healy (1950) data for ^{133}Xe release during the Green Run. PST = Pacific standard time.

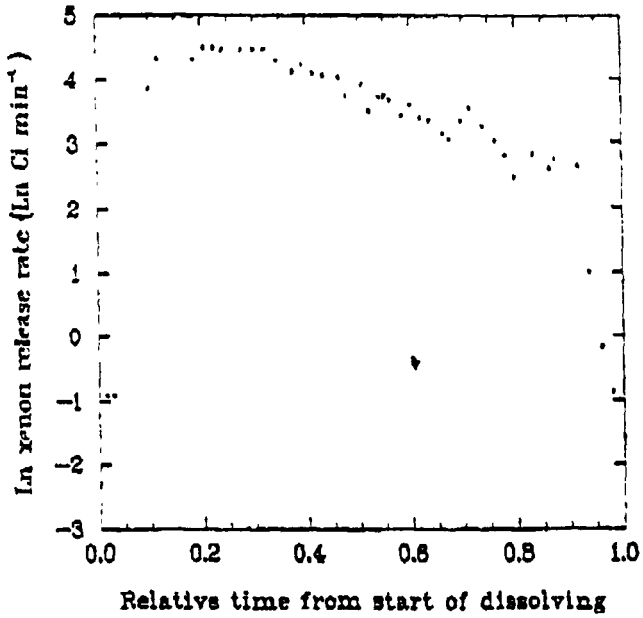

Fig. 2. Natural logarithm (Ln) of Jenne and Healy (1950) data for ^{133}Xe release during the Green Run vs. relative time. Relative time is unity at 750 min after the start of fuel dissolution. Linear regression fits were made in the intervals 0–0.117, 0.117–0.320, 0.320–0.917, and 0.917–1.

stack flow rate (25,000 cfm, 11.8 m^3 s^{-1}) and their calibration factor (4.25 pA μCi^{-1}, 0.115 fA Bq^{-1}). For a given ion current, the estimate of the amount of activity released is inversely proportional to the calibration factor. For a calibration factor of 7.8 pA μCi^{-1} (0.21 fA Bq^{-1}), the estimate of a release of 29,000 Ci (1.07 PBq) of ^{133}Xe obtained from the Jenne and Healy data becomes:

$$\text{Release} = (4.25/7.8)\ 29{,}000\ \text{Ci}$$
$$= 16{,}000\ \text{Ci}\ (0.6\ \text{PBq}).$$

The solution to the Bateman (1910) equations gave the activities in the dissolved fuel at the effective time of release as the following (F is the fission rate in the dissolved fuel while it was irradiated in the reactor): $8.63 \times 10^{-3}F$ Bq for the 5.243-d ^{133}Xe, $2.17 \times 10^{-4}F$ Bq for the 11.9-d ^{131m}Xe, $1.56 \times 10^{-5}F$ for the 2.19-d ^{133m}Xe, and $6.91 \times 10^{-3}F$ for the 8.04-d ^{131}I. These values account for the contributions to xenon and iodine from the equilibrium activities at reactor shutdown of ^{133}Xe and ^{131}I as well as the equilibrium activities of ^{133}I and ^{131m}Te. These activities were then decayed to the effective time of release. The parameters for the Bateman equations were taken from Crouch (1977) for fission yields, from the General Electric Chart of the Nuclides (Walker et al. 1989) for decay energy (Q) values, from ICRP Publication No. 38 (ICRP 1983) for the particle energies and yields and from Sarantites et al. (1965) for the ratio of the independent fission yield ratios of the ^{131}Te isomers. The ratio of the activity of ^{131}I to that of ^{133}Xe at their effective times of release was calculated to be 0.8.

Estimates of the fraction of the radioiodine contained in the dissolved fuel released from the dissolver solution vary from about 65% to about 90% (Dreher 1945; PNL 1991; Jenne and Healy 1950). Kirkendall (1952a, b) reported measuring a release fraction of 85% during the actual dissolving step. Of the remaining 15%, he reports that approximately 5% is evolved during later processing. The Kirkendall reports are the only ones found of actual measurements of the iodine release fraction. Work (1946) reports that about 5% of the iodine released by fuel processing dissolves into the stack drainage and is recovered at the bottom of the stack. Starting from 90% of iodine released from the process solutions, the fraction emitted from the stack would then be 85%. For this paper, the release fraction was taken to be 85% ± 15%.

On this basis, the central estimate of the amount of ^{131}I released is 0.40 PBq (11,000 Ci). This value is somewhat larger than the estimate made by Jenne and Healy (1950) of 0.29 PBq (7,780 Ci) based on their

Table 3. Regression analysis of ^{133}Xe release[b]: Ln rate = A + B T[a].

T[a]	A[b,c]	B[b,c]	R[d]
0–0.117	−2.28 ± 0.31	56.7 ± 4.2	0.989
0.117–0.320	4.25 ± 0.08	0.826 ± 0.333	0.711
0.320–0.917	5.40 ± 0.11	−3.15 ± 0.18	0.960
0.917–1.0	47.21 ± 5.2	−49.0 ± 5.5	0.982

[a] T is unity at 750 min after start of dissolving.
[b] Regression coefficients for Ln-transformed Jenne and Healy (1950) data with SYSTAT code (Wilkenson 1990).
[c] Dimensions of regression coefficients are Ln(Ci min^{-1}). To convert regression coefficients A and B to SI units [Ln(Bq s^{-1})], add 20.24 to A. B remains unchanged.
[d] R = correlation coefficient.

analysis of the condensate in the sampling line from the plant stack to the laboratory building.

UNCERTAINTY

None of the parameters used in this analysis are known exactly. For most of them, the uncertainty in the values is given in the literature as a standard deviation. For some, the error is due to lack of exact knowledge and may be either positive or negative. In this work, these errors are treated as random with an expected value of zero. For some, the error is bias due to model errors, but the dominant contributors to the uncertainty are random errors.

Bias errors

Using the Kobetich and Katz model for the discrete energy particles gives an unknown bias for their absorption fractions in the Jenne chamber. The observed variation in the ratio of the beta absorption fractions based on the exponential model to those based on the K-K model suggests that the K-K-derived absorption fractions for the discrete energy particles may be too large, but the amount of the overestimate is unknown.

For the case of an allowed beta spectrum with maximum energy of 100 keV (average 26 keV), the exponential model gives an average absorption fraction of about 0.6 while the K-K method gives a value of about 0.85; a ratio of about 0.7. For a maximum beta energy of 200 keV (average 55 keV), the values are 0.38 and 0.58, respectively. The ratio is still about 0.7. Taking an uncertainty of 25% around a ratio of 0.7 gives a reasonable range for the ratio. To adjust the apparent overestimate in the energy absorption of the discrete electrons given by the K-K model, the absorption was scaled by 0.7 ± 25%. The uncertainty spans the estimates for the absorption fraction given by the exponential model for betas in the energy range from 0–200 keV. The central value is consistent with the absorption fraction calculated with the exponential model for a beta spectrum with average energy of 55 or 26 keV. In order to estimate the uncertainty of the ^{131}I release, the uncertainty in the absorption fraction was combined with the other errors as though they all were random and independent.

The contribution to the fissions by plutonium has been neglected. This neglects the differences in the fission yields for ^{133}Xe and ^{131}I from plutonium fissions. The fuel for the Green Run experiment was discharged at about 400 MWd Mg^{-1} (Barnard 1949). At this exposure, the contribution to the total fissions from plutonium is very small.

Random errors

The estimate of the release of ^{131}Xe involves a sequence of connected functions. The error associated with each of these steps is propagated assuming that the various physical parameters are independent.

The quantity, Q, that is functionally dependent on other parameters in the sense of $Q = Q(x_1, x_2, ----, x_n)$ has a variance that can be estimated by (Bowen and Bennett 1988):

$$\sigma_Q^2 = \sum_{i=1}^{N} \left[\left(\frac{\partial Q}{\partial x_i} \right)^2 \cdot \sigma_{x_i}^2 \right]. \quad (5)$$

Each of the x_i parameters in Q may, itself, be functionally dependent on other parameters with a variance estimated in the same way as that for Q.

Numerical values

The counting errors in the Jenne and Healy measurements were small. That is, if one uses their calibration factor the assumed values for the average energy expended per ion pair and the specific ionization of the beta particles, then the number of ion pairs that they observed was large and Poisson counting error very small.

The values obtained by reading the data points as given in the Jenne and Healy graph have a random error that was assumed to include the random experimental error in the Jenne and Healy data. These errors are reflected in the variances in the fitted values for the linear regression on the log transformed release values. It is these variances that are included in the variance propagated to the final result.

The uncertainties in the fission product chain yields were taken from Crouch (1977). No data were available for the errors in the fractional yields of isotopes in a mass chain. The parameters for the particles emitted by ^{85}Kr, ^{131}Xe, and ^{133}Xe were taken from ICRP Publication No. 38 (ICRP 1983), but this reference does not give the associated errors. The coefficients of variation (COV) for the yields and energies of the particles emitted from ^{85}Kr and ^{133}Xe were taken from the National Nuclear Data Tables (NNDT 1991). These two isotopes are the major contributors to the energy depositions considered.

^{131}Te is only a small contributor to the ^{131}I activity at the time the fuel was dissolved and its contribution to the overall error is ignored. ^{133}I contributes about 16% and ^{133m}Xe contributes about 3% to the ^{133}Xe

Table 4. Victoreen ion chambers parameter values.

Parameter	Reported value	Reported standard deviation	Reference
Victoreen chambers			
Volume	282 mL	—	Ulman 1990
Calibration	96 aA Bq^{-1}	20%	Ulman 1990
Volume	524 mL	—	Ulman 1990
Calibration	118 aA Bq^{-1}	20%	Ulman 1990
Volume	1020 mL	—	Ulman 1990
Calibration	144 aA Bq^{-1}	20%	Ulman 1990
Jenne chamber	1000 mL	—	Jenne and Healy 1950
W	33.85 eV ip^{-1}	0.15 eV ip^{-1}	ICRU 1979
K [from eqn (A7)]	15.4	3.4	This paper
Air density	1.2 mg mL^{-1}	3%	Assumed
^{85}Kr decays			
Half-life	10.72 y	0.19%	NNDT 1991
$\beta 1$ energy — max	687.4 keV[a]	3.0 keV[a]	NNDT 1991
ave	251.4 keV	0.8 keV	NNDT 1991
yield	99.563%	0.010%	NNDT 1991
$\beta 2$ energy — max	170.4 keV[a]	5 keV[a]	NNDT 1991
ave	46.6 keV	1.4 keV	NNDT 1991
yield	0.437%	0.010%	NNDT 1991

[a] Calculated from Q value and decay scheme.

inventory at the time the fuel was dissolved. Their contribution to the overall uncertainty is also small. The ratio of the ^{131}I to the ^{133}Xe activities at the time of fuel dissolving gives one of the scale factors for converting the observed (Jenne and Healy 1950) xenon release to the corresponding iodine release. The contributions to the relative error in the overall predicted value of iodine release from the relative errors in these activities are small compared to the those of the uncertainties in the iodine release fraction, the calibration factor, and the regression fit to the experimental xenon release data. Thus, the uncertainty in the iodine-to-xenon activity ratio is adequately calculated using only the values for the relative errors in the overall mass chain yields.

The regression on the experimental xenon release data and the integral of the release rate gave a result with a COV of 10%. The assumed COV of the iodine release fraction is nearly 20% (0.85 ± 0.15). The uncertainty in the calibration factor arises from the uncertainties in the calibration factors reported in the Victoreen data,* in the air density in the ion chambers, and in the fit to the constant in the exponential model. The Victoreen data were reported with an uncertainty of 20%. The air temperature and pressure were assumed to be at 22 ± 3°C and 101.1 ± 3.4 kPa, respectively. The resulting COV of the calibration factor was 14.5%. The regression on the experimental xenon release data gave a COV of 10% for the total xenon release. The ratio of the 131 to 133 chain yields, which were decayed to the time of dissolving, has a COV of about 3% based on the data from the National Nuclear Data Tables (NNDT 1991). A COV of 10% was assigned to the iodine-to-xenon activity ratio to encompass all of the uncertainties in the parameters that make up that ratio. Based on these uncertainties, the net COV of the iodine release was calculated to be 27%. The value is rounded off to 30%.

CONCLUSIONS

The amount of ^{131}I released to the atmosphere during the Green Run experiment is calculated to be 0.40 PBq ± 30% (11 kCi ± 30%). This result is based on a number of improvements over the analysis used by Jenne and Healy (1950), who reported a release value of 0.29 PBq (7,780 Ci) based on measuring the sampling line condensate. The difference between the Jenne and Healy value and the value calculated in this paper is not statistically significant. Without further experimental evidence to test the model used in this analysis and more information about the analytical procedure used by Jenne and Healy, the similarity in the values should be considered fortuitous.

Acknowledgement(s)—The author is grateful to Mr. Robert Ulman of the Victoreen Instrument Company for kindly making available the data for the ion chamber calibration factors. He is also grateful for the helpful comments of Drs. Hans Bichsel, David Bodansky, Bernard Shleien, John Till, and Gerald van Belle.

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APPENDIX

The exponential model

It has been observed (Evans 1955) that beta particles with a continuous energy spectrum appear to attenuate exponentially through matter. For attenuation in aluminum, a reasonable fit to the mass absorption coefficient ($cm^2\ g^{-1}$) for a beta spectrum with maximum energy, E, in MeV is given by (Evans 1955):

$$\frac{\mu}{\rho} = \frac{K}{E^{1.14}} = \frac{17}{E^{1.14}}\ cm^2 g^{-1}, \qquad (A1)$$

where E is the end-point energy of the beta spectrum in MeV. It is assumed that the ion chambers were operated at 22°C and 1 atm pressure. For any reasonable range of temperature and pressure, the density of the air in the chambers will not vary by more than about 3%. The assumed density was 1.2 mg mL^{-1}. The maximum beta energy for ^{85}Kr is 0.6874 MeV (Walker 1989). Assuming simple density scaling, the linear beta attenuation coefficient calculated for air with eqn (A1) is 0.031 cm^{-1}.

Consider beta particles emitted isotropically from an arbitrary radial point within the spherical volume into a unit solid angle in an arbitrary direction. The shape of the energy spectrum remains nearly constant throughout the absorption (Evans 1955). Thus, the amount of energy deposited by the betas before they escape is proportional to the fraction of the particles that do not strike the wall averaged over the entire volume of the ion chamber. Treating the betas as exponentially attenuating, we can use the expression of Price et al. (1957) for the current, j ($cm^2\ s^{-1}$)$^{-1}$, at the surface of an absorbing sphere. The absorption fraction, f, is then the complement of the ratio of the total leakage, $4\pi R^2 j$, to the total source in the sphere:

$$f = 1 - \frac{3}{4m}\left[1 - \frac{1}{2m^2} + \left(\frac{1}{m} + \frac{1}{2m^2}\right) e^{-2m}\right], \qquad (A2)$$

where m is the optical distance from the center to the surface of the sphere, μR.

The Kobetich and Katz model

Kobetich and Katz (1969) give an empirical equation for the characteristic distance of an electron of

kinetic energy, T, in a medium of atomic number, Z. Their eqn (4) is:

$$R = AT\left(1 - \frac{B}{1 + CT}\right), \qquad \text{(A3)}$$

where
$A = (0.81\ Z^{-0.38} + 0.18) \times 10^{-3}$ g (cm^2 keV)$^{-1}$
$B = 0.21\ Z^{-0.055} + 0.78$
$C = (1.1\ Z^{0.29} + 0.21) \times 10^{-3}$ keV^{-1}.
Eqn (A3) can be inverted to give the residual energy corresponding to a given residual distance:

$$T = \frac{-[A(1 - B) - CR] \pm \{[A(1 - B) - CR]^2 + 4ACR\}^{1/2}}{2AC}. \qquad \text{(A4)}$$

^{85}Kr has a first-forbidden-unique beta decay whose energy spectrum is given by (Siegbahn 1955):

$$\frac{dn}{dw} = K(w_0 - w)^2 w^2 [(w^2 - 1) + (w_0 - w)^2][\alpha(Z) + \beta(Z)\sqrt{w - 1}], \qquad \text{(A5)}$$

where $\alpha(Z)$ and $\beta(Z)$ are given by Schenter and Vogel (1983):

$\alpha(Z) = -0.811 + 4.46 \times 10^{-2}\ Z + 1.08 \times 10^{-4}\ Z^2$, and $\beta(Z) = 0.673 - 1.82 \times 10^{-2}\ Z + 6.38 \times 10^{-5}\ Z^2$, for $T < 1.2\ mc^2$; or $\alpha(Z) = -8.46 \times 10^{-2} + 2.48 \times 10^{-2}\ Z + 2.37 \times 10^{-4}\ Z^2$ and $\beta(Z) = 1.15 \times 10^{-2} + 3.58 \times 10^{-4}\ Z - 6.17 \times 10^{-5}\ Z^2$, for $T \geq 1.2\ mc^2$, and where w is the total relative beta energy $(1 + T\ (mc^2)^{-1})$ and K is a normalization constant.

For each beta of kinetic energy, T, in the beta spectrum of ^{85}Kr, emitted at the radial point, r, into the unit of solid angle defined by $d\Omega = 2\pi \sin \Theta\ d\Theta$, eqn (A4) is applied to find the residual range: $R(\text{residual}) = R(T) - d(r,\Theta)$, where the distance to the wall is given by:

$$d(r, \theta) \doteq r \cos\theta + [R^2 - (r \sin \theta)^2]^{1/2}. \qquad \text{(A6)}$$

The energy corresponding to this residual range, $E(\text{residual})$, is weighted by the probability of reaching the wall and subtracted from T. The difference is the amount of energy that the particular beta particle deposited in the ion chamber before it struck the wall. These energy depositions in the spherical ion chamber are numerically integrated by Simpson's rule over all energies of the beta spectrum for all angles and radii. The ratio of this energy deposition to the total energy emitted as beta kinetic energy in the ion chamber by the ^{85}Kr is the average absorption fraction.

Testing the models

The Victoreen data for the ion chamber measurements of ^{85}Kr were used to test eqn (A2). More than 99.5% of the decays of ^{85}Kr are by a beta with $E_0 = 0.6874$ MeV (from Q value and decay scheme) and $E_{av} = 0.2514$ MeV (ICRP 1983). There is a very small amount of energy produced by a low probability decay of a much softer beta. With the absorption fraction computed with eqn (A2), the average exponential model absorption fractions calculated for the three Victoreen ion chambers are compared with the absorption fractions, f_v, corresponding to the experimental data assuming the average energy to produce an ion pair is 33.85 ± 0.15 eV (ICRU 1979).

The Kobetich and Katz model was programmed in QuickBasic[1] and the absorption fractions for the three Victoreen ion chamber measurements of ^{85}Kr were calculated. The 170-keV (max) beta of ^{85}Kr is emitted with an intensity of 0.437% and is ignored.

The results of these calculations are shown in Table 2. As can be seen, the exponential model gives an absorption fraction, f_v, about 10% higher than f_v, for each of the volumes while the Kobetich and Katz model values for f_{KK} are 33% lower. Thus, the exponential model seems to be the better representation for the absorption fraction of beta particles.

The parameters for the attenuation coefficient in eqn (A1) were obtained by fitting observed data on beta absorption in aluminum (Evans 1955). For absorption in air, one might consider either a different constant or a different exponent on the energy term. For low-Z materials, the energy dependence is relatively constant in Z (Evans 1955). What might be expected to change in the stopping power are the terms characteristic of the material such as mass, electron density, and atomic weight. The constant term can be considered to capture the characteristics of the absorber material.

The mean free path, m_v, was evaluated for each ion chamber volume by numerically inverting eqn (A2) to find the value for m that yields the observed absorption fraction, f_v. An adjusted value for the constant, K, in eqn (A1), is then found as shown in eqn (A7):

$$K = \frac{m_v \times E^{1.14}}{R \times \rho}. \qquad \text{(A7)}$$

These results are also shown in Table 2. The average value for K from the three measurements is 15.4. This value was used in the exponential model for evaluating the fraction of the ^{133}Xe betas absorbed in the Jenne and Healy ion chamber.

[1] QuickBasic V. 4.5 —Programming in BASIC, Microsoft Corporation, 1 Microsoft Way, Redmond, WA 98052-6399.

United States General Accounting Office

GAO

Fact Sheet for the Chairman, Committee on Governmental Affairs, U.S. Senate

ember 1993

NUCLEAR HEALTH AND SAFETY

Examples of Post World War II Radiation Releases at U.S. Nuclear Sites

OSD CASE # 9350-A

GAO/RCED-94-51FS

United States
General Accounting Office
Washington, D.C. 20548

Resources, Community, and
Economic Development Division

B-253483

November 24, 1993

The Honorable John Glenn
Chairman, Committee on
Governmental Affairs
United States Senate

Dear Mr. Chairman:

In response to your request, this fact sheet provides information on several planned radioactive releases that were conducted at U.S. nuclear sites in the post World War II years, including a release at Hanford, Washington, in December 1949. The Hanford event, referred to as the Green Run test, has been the subject of public attention in the Pacific Northwest since the late 1980s. Public concern has been heightened by the longtime secrecy surrounding the event and the fact that some test details still remain classified. As agreed with your office, we are presenting information on (1) the Green Run test and (2) several other tests at U.S. sites in the late 1940s and early 1950s that involved radioactive releases.[1]

In summary, the Green Run test was an atmospheric radioactivity monitoring experiment conducted by the military and the former Atomic Energy Commission (AEC). A premise of the test was that aerial monitoring and sampling of a radioactive cloud, even far from the source, could give evidence of nuclear materials. Conducted on December 2-3, 1949, the test released a recorded total of almost 28,000 curies of radioactive material from a special spent fuel reprocessing operation into the atmosphere over southeast Washington and Oregon.[2] (See fig. 1.1.)

For the test, some of the plant's usual radiation safety procedures were intentionally relaxed, resulting in a larger than normal radioactive release. Test participants did not consider the test to be unsafe at the time, and the radiation doses that the off-site populace might have received as a result of the test were not estimated at the time (based on the historical test documentation available to us). However, according to the AEC, in some locations, the release exceeded then-existing local Hanford limits for deposition in vegetation and animal tissue, and it may not have been permissible under today's more stringent safety standards for U.S. nuclear sites. Presently, to better understand the health effects of the test and

[1]An identically titled classified version of this fact sheet (C-GAO/RCED-93-1FS) was issued to you on June 30, 1993.

[2]A curie is a basic unit of radioactivity that is equal to 3.7×10^{10} radioactive disintegrations per second.

other Hanford iodine releases during the middle to late 1940s, a study of historical Hanford doses is under way, directed by the Centers for Disease Control.

In addition, we documented 12 other planned radioactive releases that occurred at three U.S. nuclear sites during [redacted] These releases, or tests, were part of the U.S. nuclear weapons research and development effort, and they were conducted by the military and the AEC. The releases were of two types, radiation warfare tests[3] and atmospheric radiation-tracking tests. The radiation warfare tests were conducted at the AEC's Oak Ridge, Tennessee, site and the military's Dugway, Utah, site in order to develop an air-dropped radioactive munition. The atmospheric radiation-tracking tests were conducted at the AEC's Los Alamos, New Mexico, site in order to analyze the diffusion of radioactive gases and fallout effects. Two of the Los Alamos tests—conducted in 1950, involving [redacted]—resulted in the detection of atmospheric radiation off-site over populated areas. We found no documentation of potential health effects from these tests.

To develop this fact sheet, we used diverse sources of information because of the lack of complete, definitive government records on radiation releases at nuclear sites. As a result, our results are based on—and limited to—available information drawn from government and private archives, agencies' files, and interviews with knowledgeable individuals. Other releases not documented in this fact sheet may have occurred at U.S. nuclear sites in the post World War II years.

We discussed information in this fact sheet with officials of the Department of Energy's Divisions of History and Air, Water, and Radiation, who generally agreed with the facts as presented. On the basis of their suggestions, minor technical changes were made where appropriate. However, as requested, we did not obtain written agency comments on this fact sheet.

As arranged with your office, unless you publicly release its contents earlier, we plan no further distribution of this fact sheet until 30 days after the date of this letter. At that time, we will send copies of this fact sheet to the Secretaries of Defense and Energy. We will make copies available to others on request.

[3]The term radiation warfare has different meanings, but in this fact sheet it refers to the use of non-bomb radioactive agents for offensive military purposes.

Please call me at (202) 512-3841 if you or your staff have any questions. Major contributors to this fact sheet are listed in appendix II.

Sincerely yours,

Victor S. Rezendes
Director, Energy and Science Issues

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Abbreviations

AEC	Atomic Energy Commission
DOE	Department of Energy

The Green Run Test and Its Safety and Health Implications

Details of the Green Run test and its historical context indicate that it was an atomic energy intelligence collection experiment. The test occurred during a period of heightened interest in Soviet nuclear capabilities, shortly after the first Soviet nuclear bomb detonation. The test was not considered unsafe at the time, when radiation protection standards were generally less stringent than they are today. However, at some locations, the release [redacted] and it may not have been permissible under today's nuclear safety standards. Presently, potential health effects from the test and other iodine releases at Hanford during the 1940s are being addressed in an ongoing dose reconstruction study.

A classified report on the test was issued in May 1950 by the former Atomic Energy Commission (AEC), but the report remained classified in its entirety—and the test remained undisclosed—for almost four decades. Details of the test and concerns about its potential health and safety effects first surfaced in the latter part of the 1980s. When references to the test appeared in other AEC documents that were declassified over the years, several Green Run-related Freedom of Information Act requests and appeals were filed. As a result, the test report was largely declassified in 1989. (Several passages in the report remain classified by determination of the Air Force, on the basis that further declassification of the report could compromise Air Force missions and thereby damage the national security.)

Test Purpose and Historical Context

The Green Run test was a special test of detectability as well as a research experiment into the atmospheric diffusion of radioactive gases. As such, it was related to postwar classified AEC/military research into the nature and effects of radioactive fallout and bomb debris.

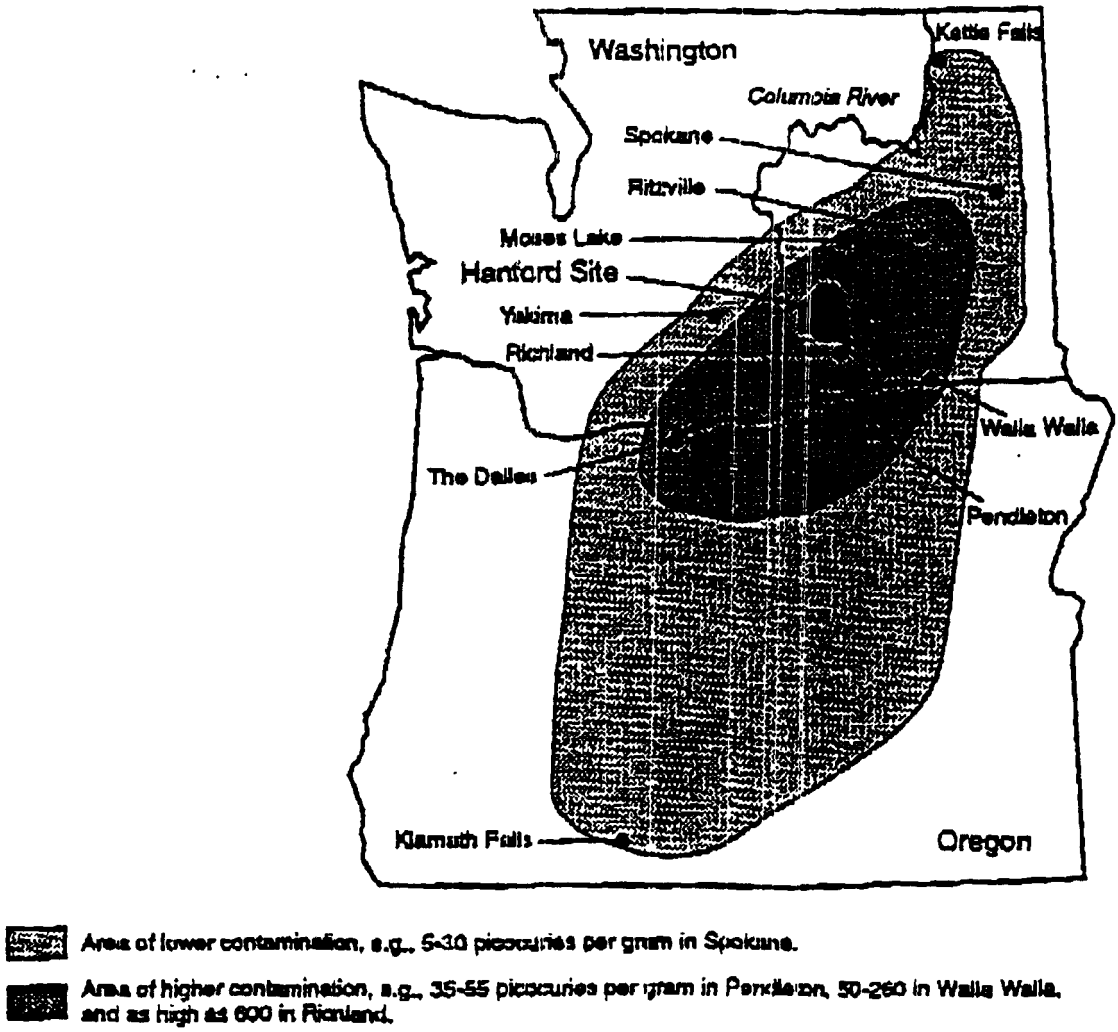
Test Purpose

The Green Run test was conducted at Hanford, Washington, on December 2-3, 1949, by the AEC and the Air Force. The test took place in a postwar climate of U.S. concern about Soviet nuclear capabilities following the first detected explosion of a Soviet nuclear weapon in August 1949. According to a test participant, a premise of the test was that aerial monitoring and sampling of a radioactive cloud, even long distances from the source, could give evidence of nuclear materials. The diffusion of the released gases was to be monitored in order to develop air, ground, and aquatic methods of collecting data on nuclear operations and weapons

tests. The radioactive cloud was generated by a special spent fuel reprocessing operation.

For the test, the plant's radiation emission control procedures were intentionally relaxed. The spent fuel used in the test was aged about 16 days instead of the usual longer period of up to 90 or more days, which accounts for the term "green" run (i.e., the test involved the reprocessing of "green" fuel). In addition, the plant's off-gas water scrubbers—used to minimize the release of radioactive off-gases from the stack—were not operated. According to the test report issued in May 1950, as a result of these steps, the test released about 27,800 curies of radioactive production off-gases, including about 7,800 curies of iodine and about 20,000 curies of less hazardous xenon, into the atmosphere in southeast Washington and Oregon. The total recorded iodine release was about twice the almost 4,000 curies predicted in pretest calculations. During the test, despite unexpected adverse weather patterns that developed and limited the range of diffusion, the radioactive cloud was detected by an aircraft over 100 miles northeast of the site. After the test, radioactive iodine was found on vegetation over large areas of southeast Washington and Oregon, as shown in figure 1.1.

Figure 1.1: Areas Where Radioactive Iodine Was Found on Vegetation Following the Green Run Test



Source: Hanford Environmental Dose Reconstruction Project Fact Sheet, Mar. 1992.

Historical Context

As a research experiment into atmospheric diffusion, the test was related to postwar classified AEC/military research into the nature and effects of radioactive fallout and bomb debris. Such research began as early as the Operation Crossroads test series in the Pacific Ocean in 1946—during which, fallout was monitored aerially by the Air Force and on the surface by naval vessels—and continued throughout succeeding

atmospheric-testing series. Effective instrumentation was an important aspect of research into radioactive effects, and at the time of the Green Run event the AEC and the military services were conducting several field instrument development programs to support their nuclear weapons research efforts. According to a test participant, the test was also generally related to research into the safety and health effects of nuclear detonations and nuclear production operations.

The Green Run test was preceded by other aerial radiation-monitoring tests that involved routine production releases of radioactive materials. The test was a follow-up to a series of aerial-monitoring tests conducted by the Air Force and the AEC during November 1948 to March 1949 at Oak Ridge, Tennessee, and at Hanford. For these tests, no special releases were conducted. The tests involved monitoring off-gases from routine production operations. At Oak Ridge, during 20 overflights by a C-47 aircraft between November 1948 and February 1949, reactor and separations off-gases were tracked up to 17 miles downwind. At Hanford in March, during three similar overflights, routine separations off-gases (with stack scrubbers in operation) were detectable for less than 2 miles—results considered so disappointing that further Hanford overflights were discontinued. In a report on the test series, the authors concluded that further use of similar Hanford operations as a source for aerial tracking was not practicable. Logically, the Green Run test—with Hanford scrubbers not operating—provided the needed stronger source.[1]

In addition, according to a former AEC official, monitoring overflights for the purpose of cloud tracking were conducted wherever sources of atmospheric radiation could be found in the United States, and probably at most or all AEC nuclear production sites. Routine close-in monitoring overflights at AEC sites began in the early 1950s and developed into a regular monitoring program having, among other things, environmental, safety, and security and safeguards purposes. Also, aerial radiation monitoring by Air Force aircraft was practiced in conjunction with the many nuclear bomb tests conducted at the Nevada Test Site and in the Pacific Ocean during the late 1940s and throughout the 1950s. For example, according to one source, during Operation Sandstone in the Pacific in April-May 1948, a fallout-tracking test called Operation

[1]Also in 1949, at an undetermined time before July 28, aerial monitoring tests of routine production effluents were conducted at the Harshaw Uranium Refining Plant in Cleveland, Ohio. Overflights detected particles, likely uranyl fluoride, 1,150 yards downwind from the source in concentrations of 0.71 micrograms per cubic meter. Also in 1949, on an undetermined date, aerial effluent monitoring of the Mallinckrodt Uranium Refining Plant in St. Louis, Missouri, detected uranium concentrations of 0.4 micrograms per cubic meter in the atmosphere 3,000 feet downwind from the plant.

Fitzwilliam monitored radioactive fallout gases for several thousand miles at levels many times above background levels.

Safety and Health Implications

Some routine Hanford radiation safety procedures were intentionally relaxed for test purposes. Specifically, in order to calibrate means of detecting Soviet production from Hanford plant operations, the cooling period for Hanford spent fuel was shortened from 90 or more days to only 16 days to simulate presumably less efficient or careful Soviet operations, and separations off-gas scrubbers were not operated. Furthermore, while the release was conducted on a weekend, which may have limited the number of workers on-site, the off-site populace was not forewarned of the event or made aware of it for several decades.

The test was also conducted despite less-than-optimal weather conditions, which limited the test results and may have exposed greater-than-expected numbers of the population to the radioactive cloud. Prevailing wind patterns prior to the test had been inopportune, and wind shifts during the test caused the emission of gases close to the ground, including directional shifts over populated areas in southeast Washington and greater-than-expected deposition at the Hanford site. Because of shifting winds, long-distance tracking of the cloud for several hundred miles was not possible. Two AEC contractor officials responsible for conducting the test differ in their recall of who decided that the weather for the test was acceptable. According to one, AEC contractor officials judged the weather to be acceptable. According to the other, the AEC did not wish to proceed, but the Air Force made the decision to conduct the test.[2] The recorded total release of iodine 131—about 7,800 curies—was about 2 times the predicted quantity. However, the accuracy of the recorded amounts has been questioned, and they have been recalculated.[3]

According to officials conducting the test, the amount of the release was not considered unsafe at the time. While the release was extremely concentrated, since it occurred over a 12-hour period, regulatory limits on the amount of such emissions did not exist at the time. In fact, the release was a small fraction of the total releases that occurred during wartime and immediate postwar Hanford operations, before radioactive iodine removal

[2]The AEC's Hanford contractor, General Electric Company, had a Health Instruments Division with the day-to-day authority to decide when reactor fuel could be processed.

[3]In June 1992, in the journal Health Physics, Maurice Robkin, a participant in the Hanford Dose Reconstruction Project, estimated the amount of iodine released to be about 11,000 curies, well over twice the predicted quantity. He calculated the release of xenon to be about 16,000 curies, for a total of about 27,000 curies.

systems were installed. For example, during 1945, production releases estimated at over 45,000 curies of iodine per month occurred at Hanford. By one estimate, the Green Run test accounted for about 1.1 percent of the total radioactive iodine released during 1944-49.

Test participants said the release was considered to be well within the standards of the time for human exposure to radiation.[4] In some locations, the release reportedly exceeded then-existing local Hanford limits for radioactive deposition in animal tissue and vegetation. According to the test report, the release resulted in iodine deposition in animal thyroids up to 80 times above the limit of 4 microcuries per kilogram of tissue. The then-existing local Hanford tolerance for continuous deposition on vegetation—9 microcuries per kilogram—was temporarily exceeded in the areas of Yakima, The Dalles, Spokane, and Blue Mountains. Based on post-test documentation available to us, radiation doses that the off-site population might have received as a result of the test were not estimated at the time.

In regard to today's more stringent radiation standards, which are not directly comparable to those of the 1940s, it has not been determined whether the test exceeded present limits for off-site radiation doses and emissions.[5] The effects of the Green Run release and other postwar Hanford radioactive iodine releases that may have had effects on the off-site population are being addressed in an ongoing dose reconstruction study, directed by the Centers for Disease Control, focusing on Hanford operations and releases from the site's beginning in 1944.[6] In regard to deposition standards that exist today, post-test deposition on vegetation in Richland, Walla Walla, and Pendleton reached levels above the threshold of 50 picocuries per gram listed in recent Environmental Protection Agency guidance for the interdiction of foodstuffs, applicable to accidents

[4]At about the time of the test, the National Committee on Radiation Protection—whose recommendations the AEC followed—recommended (but did not immediately publish) a public external dose limit corresponding to about 1.5 rem (roentgen equivalent man) annually, or 10 percent of its recommended worker limit of about 15 rem annually. We were unable to document a then-existing specific limit for internal radioactive iodine doses. Rem is a measure of the dose of any ionizing radiation to body tissues in terms of its estimated biological effect relative to a dose of 1 roentgen of X-rays.

[5]Per 40 C.F.R. 61.92, applicable to the Department of Energy under departmental order 5400.5, air pathway radiation doses to the off-site populace are limited to 0.01 rem annually.

[6]Preliminary dose estimates from the study indicate that, during 1945-47, when routine Hanford iodine releases were conducted that totaled up to several dozen times more than the Green Run release, doses exceeding present limits may have been received by downwind infants through the air-pasture-cow-milk-thyroid pathway. According to DOE, at the time, scientists had not identified this as a pathway for significant doses of radioactive iodine to individuals.

or other mishaps at both /civilian and Department of Energy (DOE) nuclear plants.[7]

Furthermore, if proposed today, the test (including procedures that intentionally increased the amount of the release) might not be permissible under the principle of limiting radiation effects from nuclear production operations to levels "as low as reasonably achievable" (10 C.F.R. 20.1, and DOE Order 5400.5). This principle was not operative in 1949, at the time of the Green Run test. In addition, if proposed today, such a test would appear to be imprudent from the point of view of operational safety procedures. DOE has categorized the test as one of the 14 most significant safety-related incidents in Hanford's history.

Our work did not document that the test was intended to be a radiation warfare experiment or a field test of radiobiological effects on humans. In particular, we examined still-classified passages in the Green Run test report and found that they did not refer to any such intentions or operations.

[7]EPA Manual For Protective Actions for Nuclear Incidents, No. 520/1-75-001-A, Jan. 1990.

etails of Other Releases

In addition to the Green Run test, we documented 12 other planned radioactive releases that occurred during post World War II nuclear weapons-related tests conducted at three U.S. sites: Oak Ridge, Tennessee, Los Alamos, New Mexico, and Dugway, Utah. Eight of the releases were conducted as part of the U.S. radiation warfare program. Four others were related to atmospheric radiation-tracking research. Like the Green Run test, none of these releases were accidental, and none resulted from routine production operations at nuclear sites.[1]

eleases During the adiation Warfare rogram, 1948-52

We documented eight planned radiation releases conducted during the postwar U.S. radiation warfare program. Two of these releases occurred at the AEC's Oak Ridge site, and six others at the U.S. Army's Dugway, Utah, test site. The releases were conducted as part of a research program conducted by a joint AEC-military panel on radiation warfare. Specific program participants (and roles) included the AEC (study and production of radioactive sources, study of biomedical effects), top military leadership (dissemination methods and protection measures), the Armed Forces Special Weapons Project (coordination and evaluation of the program), the Air Force (aerial delivery of device), and the Army (design, selection, testing of tactical device). Field testing of a radiation warfare device continued through at least 1952, as discussed below. The program appears to have ended in 1954 because it was not considered a high military priority.

Early on, the limitations of the concept of an offensive radiation warfare device were seen. For example, problems were seen related to preparing sufficient quantities of a suitable radioisotope for use in an offensive device. In some respects, chemical and biological weapons were perceived to be potentially as effective as a radioactive device, and logistically more convenient. During the program, the idea of using an air-dropped, cluster-type radiation warfare munition for tactical area exclusion (up to 25 square miles) was pursued, with the Army being the principal proponent.

Concurrently in the early 1950s, another logistically simpler kind of radiation warfare was foreseen. There was growing knowledge of fallout effects from so-called "dirty" atomic bombs, which advanced their potential for area exclusion and further limited the perceived need for a

[1]These events were classified at the time of their occurrence over four decades ago. We were unable to document some event details, including in some cases the radionuclide involved and the extent of atmospheric diffusion during the release.

non-bomb radiation warfare device.[2] Such "dirty" fallout effects were first witnessed at an underwater detonation during Operation Crossroads in 1946, and they were further studied through surface and cratering tests at the Nevada Test Site. For example, November 1951 ground-level detonations in the Buster-Jangle test series were conducted in Nevada to determine the military effects of atomic blasts. The enormous potential of "dirty" fallout came to be recognized after the Bravo detonation in the Operation Castle test series in the Pacific in 1954.

Oak Ridge Releases

In 1948, as directed by a newly formed AEC-military joint panel on radiation warfare, two radiation warfare field experiments were conducted by the AEC's Oak Ridge office. Both tests involved gamma radiation released from non-bomb point sources at or near ground level. The first test, on or before July 23, 1948, concerned the effectiveness of scattered radiation from a single gamma-emitting source—metallic lanthanum. Oak Ridge was assigned to prepare the single source (1,000 curies in strength) and place it near the ground in a 700-yard-long field. Radiation readings were to be taken at several distances up to 1,000 feet from the source, and at 3-, 6-, and 12-foot altitudes. (We were unable to document specific test results.)

The second test was conducted on an undetermined date in July 1948 following the first test. The second test concerned the effectiveness of gamma-emitting sources distributed uniformly over an area. One thousand separate small sources were to be prepared, consisting of metallic tantalum rods or wires in suitable containers, each of a uniform strength of 300 curies (a total of 300 kilocuries for the test). The overall grid pattern area was to be 300 yards on a side or greater and was to be varied for different measurements. (We were unable to document specific test results.)

Dugway Releases

During 1949-52, the military conducted six tests of radiation warfare ballistic dispersal devices containing radioactive agents at the U.S. Army's Dugway, Utah, site. The principal agencies involved in the tests were the Army Chemical Corps, the AEC, and the Air Force. The tests were conducted concurrently with four series of non-radioactive drop tests over Great Salt Lake to test the dispersion of various types of spheres to be used in a cluster munition. The spheres for the drop tests carried

[2]According to a former Hanford official, "dirty" atomic bombs were exploded at or near the surface to propel large amounts of dust particles into the atmosphere.

fluorescein dyes whose patterns in the water were photographed and analyzed.

The first and second live tests were conducted on October 22 and November 30, 1949, and their specific purpose was to obtain information about the uniformity of ballistic dispersal from an air-dropped device over an approximately 1-square-mile area. For both tests, 300 curies of tantalum 182 particles were prepared by the AEC's Oak Ridge office. For the first test, the particles were charged to a strength of 260 curies, and for the second test, to 1,506 curies. The particles were loaded into a 2,000-pound cluster device for each test. The devices were dropped by the Air Force from an altitude of about 15,000 feet, bursting at about 1,300 feet, resulting in dispersal areas about 50 percent greater than anticipated. For the first test, a 0.6-square-mile area was covered, with annular (circular) effects noted. The mean radius of contamination was 500 yards, with the main area of contamination being within a circle 200 yards in diameter. For the second test, contamination covered a 0.8-square-mile area, with a less pronounced annular effect because some of the tantalum particles were smaller than those used in the first test.

Four additional test events were conducted during 1950-52, for which detailed documentation is unavailable:[3]

- During September 1950, two tests of a 2,000-pound ballistic dispersal device were conducted.
- In November 1951, an undetermined number of drop tests from various altitudes were conducted using spheres filled with a radioactive agent with various physical characteristics.
- In May 1952, a further series of drop tests was conducted.

[3]We were unable to document other details of these tests, including the specific radioactive agent used. However, by 1952, the radiation warfare program had turned from tantalum and protactinium to zirconium-niobium as the radioactive agent under primary consideration. In addition, the program in 1952 projected a single-aircraft delivery capability of up to 15 megacuries, dispersed over 3 to 4 square miles, or 10 square miles using four aircraft.

The 1951 and 1952 tests resulted in primary radioactive patterns 250 yards in diameter, with contamination well beyond this distance. The series were conducted during periods of calm winds.[4]

In conjunction with radiation warfare tests at Dugway, monitoring instruments easily detected a ground tantalum source of a few thousand curies at an altitude of 6,000 feet. We found no documentation of whether the Dugway releases were detected off-site.

Releases During Atmospheric Radiation- Tracking Tests at Los Alamos, 1950

We documented a total of four atmospheric tracking tests conducted in 1950 at Los Alamos. In March and April of that year, the Air Force Laboratory, Cambridge, Massachusetts, and Los Alamos Laboratory exploded three simulated nuclear devices at the Los Alamos site, resulting in atmospheric fallout. The purposes of the detonations were to (1) study implosion dynamics and track a radioactively gaseous cloud as long as possible, (2) study the rate at which the ionization produced by the radioactive matter decreased and diffused, and (3) analyze the fallout of radioactive material from the cloud. The tests were conducted on March 24 and 29, and April 6, involving small simulated bombs containing unstated types and amounts of nuclear materials, presumably radioactive lanthanum 140 in kilocurie amounts. Resulting radioactive clouds were tracked downwind by a B-17 aircraft carrying an experimental ionization-measuring apparatus. On July 19, another radiation detection test was conducted near Los Alamos using an unidentified 400-curie radioactive source. The source was detected overhead and a few miles distant.

Fallout from the March 24 and April 6 tests went off-site over sparsely populated areas. The cloud from the March 24 test was tracked as far as the small town of Watrous, New Mexico, about 70 miles east of Los Alamos. The cloud from the March 29 test was tracked westward for an unstated distance. Information was not available concerning whether it went off-site. The cloud from the April 6 test was tracked northward for

[4]We also documented plans for two further tests (though we could not document that the events occurred) as follows: Mass drops of spheres containing a radioactive agent were planned for October-November 1952. Two clusters of 263 spheres each (each sphere containing 0.8 pounds of tantalum oxide pellets at a strength of 15 curies per pound, for a total of about 6,300 curies in the clusters) were to be prepared at Oak Ridge for air drops together from 30,000 feet. Another mass drop was planned for 1953, upon completion of an integrated munition system with ground-handling equipment at Dugway. For the test, six clusters of 263 spheres each were to be dropped, with planned centers of impact of the sphere groups to be 500 to 750 yards apart. Each sphere was to contain 0.8 pounds of tantalum oxide, at a strength of 75 curies per pound (about 95,000 total curies).

about 10 miles. Information was not available concerning whether the radiation from the July 19 test was detected off-site. We found no documentation of potential health effects from the four tests.

)bjectives, Scope, and Methodology

As requested by the Chairman, Senate Committee on Governmental Affairs, we developed information on (1) the Green Run test, including test details and potential health effects, and on (2) several other tests at U.S. nuclear sites in the late 1940s and early 1950s that involved radioactive releases. We focused on releases related to special tests conducted at nuclear sites rather than on accidental releases or routine, continuous releases related to sites' ongoing nuclear production operations. In addition, our scope did not include nuclear bomb detonations—hundreds of which were conducted in Nevada and in the Pacific Ocean during the 1950s and 1960s.

Our scope and methodology included interviewing knowledgeable sources and examining pertinent unclassified and classified documents. We interviewed active and former Department of Energy (DOE), Atomic Energy Commission (AEC), and Department of Defense personnel as well as nongovernment sources with knowledge of matters related to the request, including several Green Run test participants. We examined documents in DOE, Air Force, and Defense Nuclear Agency archives, as well as the National Archives and archives of the Massachusetts Institute of Technology. Our results are based on diverse sources of information and are limited by their dependence on necessarily selective records examinations, owing to a lack of complete, definitive AEC or U.S. military documentation of the radiation events that occurred at U.S. nuclear sites in the postwar years. As a result, other planned radioactive releases not documented in this fact sheet may have occurred at AEC and other U.S. nuclear sites during those years.

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THE SECRETARY OF DEFENSE

WASHINGTON, DC 20301-1000

07 JAN 1996

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDER SECRETARIES OF DEFENSE
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING
ASSISTANT SECRETARIES OF DEFENSE
COMPTROLLER
GENERAL COUNSEL
DIRECTOR, OPERATIONAL TEST AND EVALUATION
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR OF ADMINISTRATION AND MANAGEMENT
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: DoD Human Radiation Research Review

I have appointed Dr. Harold P. Smith, Assistant to the Secretary of Defense (Atomic Energy), as the DoD-wide focal point for the compilation and review of all Defense Department data or information related to ionizing radiation research with human subjects. He will work with the Interagency Working Group on this issue and coordinate our efforts with those of the other relevant agencies. I want to move quickly and thoroughly on this matter -- it should be given high priority.

The ATSD(AE) will chair a DoD working group to structure the process for data collection and analysis and development of a DoD overall plan of action. He will also be responsible for determining the outside organizations with which the Department has worked that might have such records, and the best way to preserve those records and obtain them for review. This ATSD(AE) led effort will be under the overall guidance of John Deutch, who is the senior department official responsible for this matter.

I request you take immediate steps to ensure that any documents or records in your office related to human ionizing radiation research are retained and not destroyed. This includes all letters, memoranda, reports, logs, handwritten notes, written procedures, and all other writings, as well as photographs, maps, and machine-readable materials. Your search should include all file indices of records retired to the Federal Records Center at Suitland, MD, or a search of those files at Suitland as appropriate. Please advise all persons responsible for routine document disposal procedures of the need to preserve these records.

Veterans who participated in atmospheric nuclear testing and the occupation of Hiroshima and Nagasaki are already included in the national Nuclear Test Personnel Review (NTPR) program and are not part of this effort.

Inquiries regarding this matter should be directed to Dr. Gordon K. Soper, Principal Deputy, ATSD(AE), (703) 697-5161.

Les Aspin.

ASSISTANT TO THE SECRETARY OF DEFENSE
3050 DEFENSE PENTAGON
WASHINGTON, DC 20301-3050

ATOMIC ENERGY

January 31, 1994

MEMORANDUM FOR SECRETARIES OF THE MILITARY DEPARTMENTS
CHAIRMAN OF THE JOINT CHIEFS OF STAFF
UNDERSECRETARIES OF DEFENSE
DIRECTOR, DEFENSE RESEARCH AND ENGINEERING
ASSISTANT SECRETARIES OF DEFENSE
COMPTROLLER
GENERAL COUNSEL
DIRECTOR, OPERATIONAL TEST AND EVALUATION
ASSISTANTS TO THE SECRETARY OF DEFENSE
DIRECTOR OF ADMINISTRATION AND MANAGEMENT
DIRECTORS OF THE DEFENSE AGENCIES

SUBJECT: Locating Records of DoD Human Radiation Experiments

On January 7, 1994, Secretary Aspin informed you that he had appointed me as the DoD-wide focal point for the review of human radiation experiments, and noted the high priority this task will require. He also directed that no records of human radiation experiments be destroyed. Based on the recommendations of the DoD working group, which I chair, this memorandum provides specific procedures for locating records of DoD human radiation experiments.

In the coming months, we will have requirements to carry out a number of important tasks, including: retrieval and inventory of all records of DoD human radiation experiments; provision of information to the Advisory Committee on Human Radiation Experiments, established by the President January 18; notification to subjects or next-of-kin of human radiation experiments; response to inquiries from citizens to the Department of Energy telephone hotline; release of information to the public; and others. To carry out these tasks, a Command Center has been established and other ground work begun. We are now ready to proceed with the formal information gathering process. Our objective in this is to "just get the facts" and our strategy is to fully arm the Command Center with as many of the facts as possible in order to minimize repeated queries to the field.

With this as the guide, I request from each addressee, by February 14, 1994, an initial report, and by February 28, a complete report, each consisting of two parts. Part I is the identification of DoD organizations under the authority of each addressee that, based on their missions and activities, might have conducted or sponsored human radiation experiments, together with an identification of the archives or records centers where records concerning such experiments might exist and a description of the steps taken to search those records. This information is needed both to document the completeness of the search and to establish a data

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base for resolving inquiries received through the Energy Department's hotline. Part II is an identification of each possible human radiation experiment and the location of records regarding each such experiment. Guidance will later be provided, after consultation with the Human Radiation Interagency Working Group, concerning procedures for actual retrieval of the records. At present, the requirement is only to identify them in the requested reports and to assure their preservation.

The attached guidance provides a definition of the scope of the records search, the requested format for the reports, and other specifics.

Inquiries regarding this matter should be directed to Dr. Gordon K. Soper, Principal Deputy, ATSD(AE), at (703) 697-5161. Thank you for your attention to this important matter.

Harold P. Smith, Jr.

SPECIFIC DIRECTION FOR LOCATING RECORDS OF DOD HUMAN RADIATION EXPERIMENTS

A. Scope of Records Search.

1. Definition of "human radiation experiments".

The Interagency Working Group has adopted the following definition of "human radiation experiments:"

(1) Experiments on individuals involving intentional exposure to ionizing radiation. This category does not include common and routine clinical practices, such as established diagnosis and treatment methods, involving incidental exposures to ionizing radiation.

(2) Experiments involving intentional environmental releases of radiation that (A) were designed to test human health effects of ionizing radiation; or (B) were designed to test the extent of human exposure to ionizing radiation.

2. Other specific experiments.

The Interagency Working Group has also identified several specific experiments for inclusion within the scope of the records search. They are:

(1) The experiment into the atmospheric diffusion of radioactive gases and test of detectability, commonly referred to as "the Green Run test," by the former Atomic Energy Commission (AEC) and the Air Force in December 1949 in Hanford, Washington;

(2) Two radiation warfare field experiments conducted at the AEC's Oak Ridge office in 1948 involving gamma radiation released from non-bomb point sources at or near ground level;

(3) Six tests conducted during 1949-1952 of radiation warfare ballistic dispersal devices containing radioactive agents at the U.S. Army's Dugway, Utah site;

(4) Four atmospheric radiation tracking tests in 1950 at Los Alamos, New Mexico; and

(5) Any other similar human radiation experiments that may later be identified by the Interagency Working Group.

3. Dates of experiments.

For purposes of the identification process, the scope of the search includes all human

radiation experiments conducted from 1944 to present. However, experiments conducted after May 20, 1974 (the date of issuance of the Department of Health, Education and Welfare Regulations for the Protection of Human Subjects, 45 CFR Part 46), must be clearly identified as having occurred after that date. This is because records retrieval requirements with respect to experiments conducted after May 20, 1974, will probably be different than requirements regarding experiments from 1944 until May 20, 1974. The differences in requirements will be explained when guidance on records retrieval procedures is provided.

4. Radiation exposure from atmospheric nuclear tests and Hiroshima and Nagasaki occupation excluded from scope.

Former military personnel exposed to ionizing radiation incident to the atmospheric nuclear test program and/or the occupation of Hiroshima and Nagasaki are covered by the existing Nuclear Test Personnel Review (NTPR) program and by existing compensation mechanisms. They are not included in the scope of this records identification process.

B. Component Search Coordinator.

Each DoD component requested to submit a report must identify an individual in the component as the component's coordinator for the effort to locate records of human radiation experiments. This individual will be responsible for the accuracy and completeness of the required reports, and will serve as the contact person for the Command Center. Each report must identify the name, title, address, telephone number, and telefax number of the reporting organization's search coordinator.

C. Identification of Organizations that Might Have Conducted or Sponsored Human Radiation Experiments.

Part I of the requested report requires the identification of DoD organizations that might have conducted or sponsored by contract or grant human radiation experiments. Guidelines for this task include the following.

1. Include predecessor organizations. Each organization identified as one that might have conducted or sponsored human radiation experiments must consider, if the organization is new since 1944, the activities of any predecessor organization.

2. Identify archives. Each organization identified as one that might have conducted or sponsored human radiation experiments must identify archives or records centers where records of such experiments, if conducted, might be located. This must include any archives where such records of any predecessor organizations might be located.

D. Document Search Activities by Each Organization That Might Have Conducted or Sponsored Human Radiation Experiments.

Also under Part I of the requested report, each organization identified as one that might have conducted or sponsored human radiation experiments must, for itself and for any predecessor organization, document that it attempted to determine whether it has conducted or sponsored any such experiments. Specific methods for searching may vary based on organization practices and records systems. Methods might include: search for all published and unpublished reports of research findings; review of the organization's contracts and/or grants records; queries to current or former employees with knowledge of historical activities. Each step of the process should be documented and described in Part I of the organization's report. In addition, each organization must maintain a complete file of all relevant memoranda, meeting notes, electronic mail messages, notes of telephone conversations and all other materials that document the search activities of the organization.

E. Identification of Specific Experiments Possibly Within the Scope of the Search.

As described further below, Part II of the requested report identifies specific experiments possibly within the scope of the search and begins the reporting of key facts regarding the experiments. Guidelines regarding this part of the process follow.

1. Err on the side of inclusion.

For purposes of this initial identification of possible experiments, organizations submitting reports should err on the side of inclusion. Reported activities that are outside the scope of the records search can then be excluded prior to actual records retrieval. (Knowledge of related activities, although outside the scope, will help the Command Center deal with inquiries expected from the public through the Energy Department hotline.)

2. Experiments conducted or sponsored by a DoD organization.

Experiments to be included in the identification process are all those conducted by a DoD organization, or predecessor organization, or sponsored in whole or in part by a DoD organization or predecessor organization through a contract or grant. For this purpose, a "contract" should be understood as including any cooperative agreement, memorandum of understanding, or other similar document establishing an agreement between a DoD organization and another party concerning a human radiation experiment.

3. Identify lead agency when more than one is involved.

In cases in which more than one DoD organization was involved, or an agency outside

DoD was involved, it is important to identify which agency should be considered the lead agency. This will help avoid duplication of effort in records retrieval activities. If it is not clear which organization was the lead agency, respective activities of the involved agencies should be described so that an appropriate assignment of lead responsibility for records retrieval activities can be made.

F. Identification of Records Regarding Possible Human Radiation Experiments.

Part II of the requested report also identifies existing records pertaining to the possible human radiation experiments that have been identified. Guidelines regarding this part of the process follow.

1. Definition of "records".

"Records" includes a wide range of materials, including reports, letters, memoranda, notes, drafts, logs, handwritten notes, written procedures, medical records, and any other writings and documents, as well as photographs, charts, drawings, machine readable materials, video tape, audio tape, computerized information, and any other source of physically retrievable information.

2. Focus on existing records.

The effort to locate records is restricted to records that currently exist. In the event of an experiment for which some or all records that may have at one time existed cannot now be found, the task of locating records does not require an effort to recreate records regarding individual experiments. If there is a need to reconstruct additional information regarding particular experiments, that will be undertaken separately, pursuant to instructions governing such a task.

3. Prepare to submit records.

Pending further guidance on records retrieval procedures, DoD organizations should make initial preparations for submission of documents to a central repository. These initial preparations include identification of any classification issues that need to be considered, determinations regarding the existence of any other records relating to the experiment, organization of the records, and steps to assure the safekeeping of the records. It is anticipated that when records retrieval procedures are established, the organization will be requested to make two copies of the records, one for submission and one for retention by the organization for purposes of any necessary follow-up activities, and to return the original documents to the proper archives or records repository. However, pending instructions on records retrieval procedures, records are not to be forwarded to the Command Center or other repository. Rather, the records must be maintained by the organization in the original records series in accordance with the organization's established records management system.

G. Preservation of Records.

As instructed in Secretary Aspin's January 7 memorandum, each organization must assure that records relating to human radiation research are preserved and not destroyed. Persons responsible for routine records disposal procedures must be advised of the need to preserve these records.

H. Classification and Declassification Issues.

1. Policy of maximum declassification.

The Interagency Working Group has established the policy that agencies should, upon locating records of human radiation experiments within the scope of this records search, review the records for national security classification and should declassify such records as soon as practicable and to the maximum extent possible.

2. Classification review procedures.

Classified information must be reviewed by the appropriate classification authorities before it can be declassified. Consult DoD Directive 5200.1-R, Chapter III, for guidance on declassification procedures. If there are documents within DoD's possession for which another agency is the original classification authority, that agency must make the determination to declassify the information. Every effort should be made to expedite this declassification process.

I. Contractor and Grantee Records.

When an organization determines that records of a human radiation experiment may be in the possession of a contractor or grantee of the organization, the organization must document the nature of those records and make plans to pursue retrieval. The organization should attempt to find the governing contract or grant documents pertaining to the research project or program involved and should obtain the assistance of the organization's Staff Judge Advocate or legal counsel to determine rights and obligations pursuant to the governing documents. These activities should proceed on an expedited basis.

J. Restrictions on the Release of Records.

1. Release of records outside Freedom of Information Act channels.

Because there may be personal privacy, security classification, or other restrictions on the release of records of human radiation experiments, it is essential that DoD organizations not

release records to the public, unless the release has been approved by the Command Center.

2. Freedom of Information Act procedures.

Guidance will be provided in the very near future through Freedom of Information Act (FOIA) office channels regarding the handling of FOIA requests pertaining to human radiation experiments.

K. Format for Part I of Report.

The following format will assist in the compilation of the information requested. In any case in which the reporting organization has no information to report, a negative report is required.

1. Identify each organization that, based on mission or activities, might have conducted or sponsored human radiation experiments. Give name and location(s) of the organization and name(s) and location(s) of any predecessor organizations that might have conducted or sponsored such experiments.

2. For each organization identified in item 1, identify the location(s) of records of the organization where records of human radiation experiments, if conducted or sponsored, might be located (or have been located).

3. For each organization identified in item 1 and each records repository identified in item 2, describe in detail the efforts undertaken to determine if records exist of human radiation experiments. List all files and file systems searched and all individuals consulted.

4. Based on the results of the search described in item 3, state whether any records of possible human radiation experiments were found, and, if so, identify the experiments.

L. Format for Part II of Report.

For each possible human radiation experiment identified in item 4 of Part I, provide as much of the following information as is presently possible. Start each separate experiment on a separate page.

1. Identify the possible human radiation experiment.

2. State where and when it took place.

3. Identify the primary researcher(s).

4. Identify the organizations and entities involved in the experiment. Include all DoD organizations, any other federal agency involved in conducting or sponsoring the project, and any contractors, grantees, or other parties. Identify the DoD organization and/or the other agency that was the lead agency.

5. Indicate the number of human subjects of the experiment. Indicate any available information on known characteristics of the class of subjects, such as: active duty members, researchers, a racial or ethnic group, prisoners, institutionalized persons, medical patients, children, pregnant women. Indicate whether available information includes names or other identifying information concerning the subjects.

6. Summarize the experiment, including an identification of the purpose of the experiment and the nature of the use of ionizing radiation. As examples of the types of information that would be helpful, if available information permits, preliminarily classify the possible human radiation experiment into one of the following categories. (Note that these categories are solely for the purpose of obtaining preliminary information about the experiment that may facilitate organization of the records retrieval process. These are not official classifications for any purpose. In addition, not all of these categories are necessarily within the actual scope of the records search activity, but might be involved in the initial identification because of the guidance to err on the side of inclusion of all possible human radiation experiments.)

(a) Clear purpose radiation research -- the purpose of the experiment was to test the human health effects of ionizing radiation. Example: subjects exposed to radiation for the purpose of measuring adverse reactions.

(b) Therapeutic research involving radiation -- the purpose of the experiment was to test the safety and efficacy of using ionizing radiation to diagnose or treat a disease or medical condition. Example: clinical research on bone marrow transplantation.

(c) Other research -- the experiment was for another purpose (i.e., other than categories (a) or (b)), but in the course of the research project, ionizing radiation was used in accordance with a routine, diagnostic procedure. Example: research of effects of dental coating to prevent cavities, monitored through periodic dental X-rays.

(d) Treatment use of radiation -- the use of radiation was for a medical treatment purpose, not a research purpose, but data were maintained on results or side effects. Example: radiation used as cancer treatment, with data reported on side effects.

(e) Unknown/uncertain -- available information does not indicate classification into a category.

7. Identify the location(s) of records regarding this experiment. Indicate whether any records are in the possession of a contractor or grantee, and, if so, what action will be initiated to

retrieve them. Indicate the name of the individual responsible for the maintenance of the records.

8. Indicate the estimated nature and quantity of the records.

9. Indicate whether the records are classified, and, if so, what action has been or will be initiated to consider the classification.

M. Initial and Follow-Up Reports.

The initial report on locating records of human radiation experiments is due February 14. It is anticipated that the identification of organizations that might have conducted or sponsored human radiation experiments (Part I of the report) will be complete or substantially complete by that date. It is also expected that the identification of all specific experiments possibly within the scope of the search will not be complete, but that Part II of the February 14 report will be an interim report. A complete report, consisting of both Parts, is due February 28. Any reporting organization that is unable to give a complete report by February 28 must nonetheless report by that date and provide the necessary supplements as soon thereafter as possible. Even after an organization provides its complete report, if any new information is discovered regarding the matters covered in the reports submitted, the organization has a duty to supplement its reports to assure their completeness and accuracy.

N. Resolution of Questions.

Every effort should be made to avoid the need to repeat any of the steps involved in the records location task. Therefore, organizations should be encouraged to resolve any questions or uncertainties at the earliest possible time. This should be done through the organization's chain of authority and up to the Command Center.

O. Command Center Address and Telephone.

The address and telephone number of the Command Center, to which the requested reports are to be sent and to which inquiries may be made, are:

DoD Radiation Experiments Command Center
1211 S. Fern St., Room 217
Arlington, Va. 22202

Telephone: (703) 602-1365