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WORLD ENERGY DATA SYSTEM

WENDS

VOLUME XI
NUCLEAR FISSION PROGRAM SUMMARIES

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June 1979

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Argonne, Illinois 60439

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VOLUME XI
WENDS NUCLEAR FISSION PROGRAM SUMMARIES

TABLE OF CONTENTS

The World Energy Data System	v
Introduction to Nuclear Fission Program Summaries	ix
Program Summaries	
Argentina	AR
Brazil	BR
China	CH
France	FR
Germany (West)	GW
India	IN
Iran	IR
Israel	IS
Italy	IT
Japan	JA
Pakistan	PK
Peru	PE
Saudi Arabia	SA
South Africa	SF
Soviet Union	UR
Spain	SP
Taiwan	TW
United Kingdom	UK
Venezuela	VE

THE WORLD ENERGY DATA SYSTEM

The World Energy Data System (WENDS) is a managerial level information bank containing organized data on those countries and international organizations that may have critical impact on the world energy scene. The system was developed by the Office of Program Management Support at Argonne National Laboratory for the Office of International Affairs of the Department of Energy (DOE). The Office of International Affairs also provided funds for the collection of the following information:

- Country data which provides general background information on the economy, government, and energy orientation.
- Similar compilations of information concerning energy-related international organizations.
- Summaries of energy-related international agreements.

Nuclear fission information was collected for the Plans and Analysis Division, Office of Nuclear Energy Programs, DOE. It includes the following:

- Nuclear facility profiles which provide resumes of facts concerning specific installations.
- Nuclear program summaries,that is, overviews of the fission R&D programs in selected countries.

All the WENDS data contains references to enable verification and expansion of the information. Since all data sources are non-classified, complete information is not always available. The Office of Program Management Support at Argonne welcomes any information that will complete these synopses in future publications. Please address comments to:

WENDS
Office of Program Management Support
Building 362
Argonne National Laboratory
9700 South Cass Avenue
Argonne, IL 60439

This compendium of international energy-related information was compiled from a computerized database and is now available in a series of volumes. The total set of information is as follows:

Volume	Title	Contents
I	COUNTRY DATA Afghanistan, Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Bolivia, Brazil, Burma, Canada, China, Colombia	Review of background information for each country listed.
II	COUNTRY DATA Czechoslovakia, Denmark, Egypt, Finland, France, Germany (East), Germany (West), Greece, Guinea, India, Indonesia, Iran, Italy, Japan, Korea (South)	
III	COUNTRY DATA Libya, Luxembourg, Malaysia, Mexico, Netherlands, New Zealand, Niger, Nigeria, Norway, Pakistan, Peru, Philippines, Poland, Portugal	
IV	COUNTRY DATA Senegal, South Africa, Soviet Union, Spain, Sweden, Switzerland, Taiwan, Tanzania, Thailand, Turkey, United Kingdom, United States, Upper Volta, Venezuela, Yugoslavia	
V	INTERNATIONAL ORGANIZATION DATA Asian Development Bank, European Economic Community, Inter-American Development Bank, International Atomic Energy Agency, International Energy Agency, Nuclear Energy Agency, United Nations, World Bank	Review of backgound information for each international organization listed.

VI	INTERNATIONAL AGREEMENT PROFILES	Summaries of energy-related international agreements with indexes by country and by energy technology.
VII	NUCLEAR FACILITY PROFILES Algeria, Argentina, Australia, Austria, Belgium, Bolivia, Brazil, Bulgaria, Canada, Central African Republic, China	Fact sheets on nuclear facilities, with indexes by facility type and by country. Power reactors and U.S. installations excluded.
VIII	NUCLEAR FACILITY PROFILES Colombia, Czechoslovakia, Denmark, Egypt, Finland, France, Gabon, Germany (East), Germany (West), Greece, Greenland, Hungary	
IX	NUCLEAR FACILITY PROFILES India, Indonesia, Iran, Ireland, Israel, Italy, Japan, Korea (South), Madagascar, Mexico, Namibia, Netherlands, Niger, Norway, Pakistan, Peru, Philippines, Poland	
X	NUCLEAR FACILITY PROFILES Portugal, Puerto Rico, Romania, South Africa, Soviet Union, Spain, Sweden, Switzerland, Taiwan, Thailand, Turkey, United Kingdom, Venezuela, Vietnam, Yugoslavia, Zaire, Zambia	
XI	NUCLEAR FISSION PROGRAM SUMMARIES Argentina, Brazil, China, France, Germany (West), India, Iran, Israel, Italy, Japan, Peru, Pakistan, Saudi Arabia, South Africa, Spain, Taiwan, United Kingdom, Soviet Union, Venezuela	Overviews of fission R&D programs in 19 foreign countries.

INTRODUCTION TO

NUCLEAR FISSION PROGRAM SUMMARIES

ORIENTATION

WENDS has accumulated an organized collection of information on the nuclear fission programs in nineteen countries. Each synopsis of a program generally includes management and technical summaries, references and evaluative sources, and related notes. Because of the varying availability of unclassified data, all portions of a summary may not be present; also, within a summary page the amount of information varies.

ORGANIZATION

The nuclear fission program summaries are aggregated by country. The table of contents lists the nineteen countries. For each country there are summaries in many of the following areas:

- Fuel Supply
- Resource Recovery
- Enrichment
- Fuel Fabrication
- Light Water Reactors
- Heavy Water Reactors
- Gas Cooled Reactors
- Other Non-breeder Reactors
- Liquid Metal Fast Breeder Reactors (LMFBR)
- Other Breeder Reactors
- Research and Test Reactors
- Spent Fuel Processing
- Waste Management
- Safety and Environment

PROGRAM SUMMARY CONTENTS

Each program summary heading contains the State Department tags code for the country, the nuclear fission power area, the initials of the researcher, and the date of preparation of the information. Ideally, program summaries address the following:

- Management Summary
  - Objective
  - Milestones
  - Resources
  - Current status
  - Status source and date
  - Sponsors
  - Key contacts
  - R&D organizations
- Technical Summary
  - Scope
  - Approach
  - Problem areas
  - Benefits
  - Facilities
  - Significant parameters
- Key References
- Notes and Evaluations

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

AR: ARGENTINA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	2
Fuel Fabrication	4
Heavy Water Reactors (HWR)	5
Research and Test Reactors	7
Spent Fuel Processing	8

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Prospect for and develop domestic uranium resources for utilization in its nuclear power program.

MILESTONES

RESOURCES
Reserves of 22 thousand ST U308 under $15/lb proven, 48 thousand ST U308 reasonably assured (Note 1). Reserves at Sierra Pintada estimated at 12 thousand ST U308 (Note 2).

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Comision Nacional de Energia Atomica (CNEA)

KEY CONTACTS
J. Cosentino (CNEA)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Nuclear Mendoza (Government)		

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Sierra Pintada - Uranium is in a 20 x 80 km area, 20 meters deep. Considered to be the richest deposit in Argentina (Note 2).

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978, p. 5-17 DOE
2-Nuclear Engineering International, p. 4, May 1978

PROGRAM SUMMARY--AR NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Produce uranium for domestic uses.

MILESTONES
Production cf 70 ST U3O8/YR since late 1960s. When the Sierra Pintada mine goes to full production, output expected to rise to 900 ST U3O8/YR (early 1980s - Note 1).

RESOURCES

CURRENT STATUS
(1) Uranium mines: Salta, Malarque, Sierra de Pichinan (Note 1).
(2) Three pilot milling facilities in operation located at Planta Malarque, Don Otto, and Los Adobes (combined capacity is over 200 ST U3O8).
(3) The large commercial milling plant (600 ST U3O8) is under construction at Sierra Pintada (startup scheduled for 1979).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Comision Nacional de Energia Atomica (CNEA)

KEY CONTACTS
J. Cosentino, CNEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Nuclear Mendoza (Government)		

PROGRAM SUMMARY--AR NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
(1) Pilot milling facilities at Planta Malarque, Don Otto, and Los Adobes
(2) Commercial milling plant is under construction at Sierra Pintada

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--AR NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, p. 5-17, April 1978 WENDS
2-Nuclear Engineering International, p. 4, May 1978 DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish domestic capability to manufacture power reactor fuel.

MILESTONES
(1) Construction of a uranium fuel fabrication plant began in late 1975, with operation scheduled for 1977 (capacity 50 MTU/year).
(2) The capacity of this plant will be expanded to 250 MTU/year by 1981.
(3) A Zircaloy tubing plant is planned for operation in 1982-83.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CNEA

KEY CONTACTS
J. Cosentino, CNEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Step by step accumulation of manufacturing experience.

APPROACH
(1) Manufacturing of eleven sample fuel elements for Atucha 1 was planned in 1977 to gain experience.
(2) Fifty fuel elements will be fabricated in 1978, and 150 in 1979.

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMTERS

PROGRAM SUMMARY--AR NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE
2-Nucleonics Week, Vol 18, No. 16, p. 9, April 21, 1977 DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Install heavy water reactors to utilize domestic uranium resources without dependence on foreign enrichment services.
(2) Achieve self-sufficiency in the heavy water reactor fuel cycle and 80% sufficiency in reactor construction by 1985.

MILESTONES
(1) First nuclear plant (ATUCHA-I, 320 MWe PHWR, KWU) - comm. 1974
(2) Second nuclear plant (CORDOBA, a 600 MWe CANDU) is under construction - comm. 1981
(3) Four 600 MWe CANDUs during 1985 and 1990, and six 900 MWe CANDUs during 1992 and 2000 are under consideration, totalling 15 reactors, 9000 MWe by 2000 (Note 2).
(4) A 20-ton/year heavy water production facility using U.S. technology is planned for operation by 1984. This will be expanded to 250 tons/year later.

RESOURCES

CURRENT STATUS
(1) Decision to be made within 1978 by CNEA on ordering a third plant, ATUCHA II, a 600 MWe PHWR from KWU (W. Germany) which also supplied the first unit (ATUCHA I) - Cost $475M. KWU is prepared to supply this unit, although PHWRs not in its standard product line (Note 3). Bids for a CANDU were also received from a Canadian-Italian group (AECL, AMN, NIRA) - (Notes 4, 5).
(2) Plans for the fourth power plant at Mendoza have been completed by CNEA.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Comision Nacional de Energia Atomica (CNEA)

KEY CONTACTS
J. Cosentino, CNEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--AR NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
(1) During 1970-1975, 28 scientists and engineers were trained for a total of 270 man-months in the Federal Republic of Germany with respect to operation of ATUCHA I (Note 1).
(2) By 1985, government expects domestic industry to be able to provide 80% of the equipment and services for reactor construction.
(3) CNEA will install a small (1 ton/year) experimental heavy water plant in Atucha.

PROBLEM AREAS
(1) Argentina is not signatory to NPT.
(2) PHWR uses a pressure vessel - not a calandria pressure as a CANDU.

BENEFITS
Utilization of domestic uranium without dependence for enrichment services overseas.

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--AR NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Engineering International, Vol. 22, No. 260, p. 8, July 1977 DOE
2-Nuclear Engineering International, Vol. 22, No. 265, p. 6, December 1977 DOE
3-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-H. J. Lane, D. Nenturich, Successful Transfer of Nuclear Technology Through Scientific and Technological Cooperation, IAEA-CN-36/565, Proc. of International Conf., Salzburg, May 1977 DOE
2-Nuclear Engineering International, Vol. 22, No. 265, p. 6, December 1977 DOE
3-Nuclear News, June 1978, and Nuclear Engineering International, June 1978 DOE
4-Atomic Energy Clearing House, Vol. 24, No. 29, p. 115, July 17, 1978 DOE
5-Nuclear Engineering International, Vol. 23, No. 275, p. 6, August 1978 DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Conduct basic nuclear power technology research.

MILESTONES

RESOURCES

CURRENT STATUS
CNEA is building a 20 million volt particle accelerator.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CNEA

KEY CONTACTS
J. Cosentino, CNEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--AR NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS
Research reactor export to Peru reported

FACILITIES
CNEA has six research and test reactors
RA-1, Buenos Aires, 0.15 MWt, research tank (1958)
RA-0, Cordoba, --- , criticality experiment (1968)
RA-2, Buenos Aires, --- , criticality experiment (1958)
RA-3, Ezeiza, 8 MWt, tank (1970)
RA-4, Rosario, --- , solid, homogeneous (1966)
RA-5, --- , --- , criticality experiment (1975)

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--AR NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Engineering International, Vol. 22, No. 265, p. 6, December 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--AR NUCLEAR FISSION SPENT FUEL REPROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish basic know-how domestically.

MILESTONES
The lab-scale Ezeiza facility (research reactor metal fuel) was shutdown and reactivated in 1977. Facility probably can handle UO2 fuel (Note 1).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CNEA

KEY CONTACTS
J. Cosentino, CNEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--AR NUCLEAR FISSION SPENT FUEL REPROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Ezeiza--Lab-scale, research reactor metal fuel

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--AR NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. E. Gray et al., International Cooperation on Breeder Reactors, The Rockefeller Foundation, May 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

BR: BRAZIL

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	5
Fuel Fabrication	7
Light Water Reactors (LWR)	9
Gas Cooled Reactors (GCR)	11
Liquid Metal Fast Breeder Reactors (LMFBR)	12
Research and Test Reactors	14
Spent Fuel Processing	16
Safety and Environment	18

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Be at least self supporting and independent in supply of nuclear fuel.

MILESTONES
(1) The uranium ore for ANGRA Unit 1 and its reload cores will be supplied from indigenous uranium resources by 1981.
(2) Empresas Nucleares Brasilieros (Nuclebras), a government owned company, is constructing a mill to exploit the Pocos de Caldas deposit; uranium production is estimated to be 500 tonnes/year U3O8 (400 tonnes uranium) in 1979.

RESOURCES

CURRENT STATUS
(1) Nuclam (Nuclebras Auxiliar de Mineracoa SA) is exploring for uranium in Brazil.
(2) Resources

	Economically Recoverable	Total Resources
Uranium (1000 tonnes U3O8)	27.7	34.8
Thorium (1000 tonnes)	65.3	69.0

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government (Nuclebras)

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission (CNEN)

R&D ORGANIZATIONS LOCATION PROGRAM AREA

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Uranium self-sufficiency by 1985.

APPROACH
(1) Explore for uranium ore deposits.
(2) Mine uranium ore deposits.

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Uranium: Resources, Production and Demand, A Joint Report by the OECD Nuclear Energy Agency and the International Atomic Energy Agency, December 1977 DOE

2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 1, NAC C-7827 Prepared for U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Achieve self-sufficiency in the nuclear fuel cycle.
(2) Establish mining and milling industry to exploit indigenous resources.

MILESTONES
(1) A mine/pilot mill of 3 MTU/year uranium is currently operating at Pocos de Caldas (1974 operation).
(2) A 500 MTU/year mine/mill is being constructed at Pocos de Caldas and is scheduled for operation in 1979.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Brazil Government/Nuclebras

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--BR NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Build mines and mills for uranium recovery.

APPROACH
(1) Three MTU/year mine/mill pilot plant built in 1974.
(2) 500 MTU/year mine/mill plant scheduled for operation in 1979; this plant is being designed by STEC (PUK) of France; the Brazilian construction and project manager is Natron, Consultoria e Projetos.

PROBLEM AREAS

BENEFITS
Self-sufficiency

FACILITIES
Pocos de Caldas mine/mill located in the State of Minas Gerais

SIGNIFICANT PARAMETERS
Pocos de Caldas uranium recovery rate in 1979 - 500 MTU/year

PROGRAM SUMMARY--BR NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-Uranium Resources, Production and Demand; Prepared by OECD Nuclear Energy Agency and the International Atomic Energy Agency, December 1977 DOE
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Achieve self-sufficiency
(2) Export enrichment services to other countries

MILESTONES
Mid-1975 agreement with FRG for equipment and technology for nuclear reactors and fuel cycle industries; under this agreement, Nuclebras Enriquecimento Isotopico SA (NUCLEI) will build and operate in Brazil the first demonstration plant of the Becker jet nozzle enrichment process. This enrichment technology will then be developed to the commercial stage by the German firm Trenndiisen Enlwicklungsund Patentverwertungsgellschaft GmbH (NUSTEP).

RESOURCES

CURRENT STATUS
Operation of the pilot plant is scheduled for 1981 - it will be located at the Nuclear Technology Center (Sepetiba near Santa Cruz)

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
NUCLEI is a joint venture between Nuclebras (75%), STEAG (15%) and Interatom (10%)

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--BR NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Becker jet nozzle enrichment process

APPROACH
(1) Demonstrate process by building a pilot plant (250 thousand SWU/yr) in Brazil, planned for operation in 1981.
(2) Develop a commercial plant (1.0 to 5.0 million SWU/yr) based on success of pilot plant; NUSTEP (a West German firm) has the responsibility for this step.
(3) Pilot plant will have 600 stages with capacity between 180 to 250 thousand SWU/yr.

PROBLEM AREAS
Becker net jozzle process is in the development stage in W. Germany. The potential exists that this process may not prove to be technically or economically practical.

BENEFITS
(1) Self-sufficiency
(2) Brazil will be able to export surplus enrichment capacity to other countries
(3) A new enrichment process and technology will be established

FACILITIES
Pilot plant will be located at the Nuclear Technology Center (Sepetiba near Santa Cruz).

SIGNIFICANT PARAMETERS
Pilot plant capacity - 180 to 250 thousand SWU/yr.

PROGRAM SUMMARY--BR NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Achieve self-sufficiency in the nuclear fuel cycle by 1990.

MILESTONES
(1) Brazil's contract agreement with Germany provides for construction of a pilot fuel fabrication plant at Sepetiba using KWU technology. A small pilot plant, less than 10 MTU/yr, has been in operation which makes U3O8 pellets sheathed in aluminum. This plant also makes alloy fuel for a 5-MW swimming pool reactor and can also make UF4 from domestically supplied U3O8.
(2) The pilot plant at Sepetiba will be 50 MTU/yr which is sufficient to meet the annual reload requirements for the 625-MWe ANGRA-1.
(3) Sample fuel rods fabricated in Brazil have been irradiated in the German test reactor FRJ-2 in Julich.

RESOURCES

CURRENT STATUS
Sepetiba fuel fabrication plant is currently under construction.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Owners of Sepetiba pilot plant 70% Nuclebras (Brazil) and 30% KWU (W. Germany).

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission (CNEN)

R&D ORGANIZATIONS LOCATION PROGRAM AREA

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Fuel fabrication for Brazil nuclear reactors.

APPROACH
(1) Contract agreement in mid-1975 with West Germany to supply construction and technology for all fuel cycle needs.
(2) Test fuel rods and assembly fabricated in Brazil in German test reactors and commercial power plants to target burnup; post-exposure evaluation in Germany.
(3) Fuel fabrication plants will employ German technology.

PROBLEM AREAS

BENEFITS
Self-sufficiency

FACILITIES
Nuclei, located in Sepetiba, currently under construction, 50 MTU/yr

SIGNIFICANT PARAMETERS
Angra-1 reloads to be provided by KWU under all-purpose German-Brazilian contract (Note 1).

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-J. W. Dias et al.; German - Brazilian Cooperation on Fuel Radiation; IAEA-CN-36/85, Nuclear Power and its Fuel Cycle; Vol. 6, Proceedings of an International Conference in Salzburg, May 1977 DOE
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 5, September 1978 DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Build nuclear generating plants.
(2) Become self-sufficient in all aspects of the nuclear fuel cycle
(3) Encourage industry to scale up its technological and industrial capabilities to achieve self-sufficiency; to establish an in-house nuclear reactor supplier and manufacturer of heavy reactor components.

MILESTONES
(1) Contract with W. Germany for LWR technologies.
(2) Purchased one 626-MWe PWR from Westinghouse, currently under construction, scheduled for startup in 1979.
(3) Contract with Germany for two 1200-MWe reactors with an option for six additional plants. The agreement states that by 1990 the plant should contain 90% Brazilian-made components. Under the agreement a joint Brazilian-German company Nuclen (Nuclebras Engenharia, SA), 75% Nuclebras and 25% KWU, was set up to provide the design and construction of power stations.
(4) Another joint company, NUCLEN (Nuclebras Equipamentos Pesadus, SA), was formed to establish heavy industry for manufacturing of heavy nuclear components.

RESOURCES-Nuclebras and its subsidiaries staffed 915 high level professionals. Government Nuclear R&D budget for 1977 is $52.6 million.

CURRENT STATUS
(1) Angra dos Reis-1, a 626-MWe PWR, Westinghouse, startup 1979; Angra dos Reis-2 and 3, 1240-MWe PWRs, KWU startup in 1983 and 1984.
(2) Nuclei's current plant construction capacity is stated to be up to two 1200-MWe plants per year.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS-Nuclebras, KWU, Voest Alpine, GHH Sternrode

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Nuclear Energy Commission	Rio de Janeiro	Basic Nuclear Research Uranium Prospecting Reactor Site Selection Safety Evaluation Research reactor operation and fuel fabrication Nuclear Physics Radioisotope production/application

PROGRAM SUMMARY--BR NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Pressurized water reactor technology
(2) 10,000 MWe installed nuclear capacity by 1990

APPROACH
(1) Contract with Westinghouse for 626-MWe PWRs.
(2) Contract agreement in 1975 with Germany (FRG) for German LWR reactor technologies, construction, fuel cycle technologies.
(3) Universities and technical schools must train 450 engineers and 550 technicians per year to support nuclear power self-sufficiency programs; crash specialization programs have been developed in local schools to meet training needs; only when no industrial experience is provided, on-the-job training in foreign firms is considered.

PROBLEM AREAS
Unless major uranium reserves are discovered Brazil will be forced to shift its technological base to a different fuel cycle and/or reactor type. Brazil cannot be self-sufficient in fuel supply beyond 1990 with its current uranium reserves.

BENEFITS
Creation of domestic industry

FACILITIES

SIGNIFICANT PARAMETERS
(1) Brazil is seen to delay installation of Angra Units 4 and beyond (1200-MWe PWRs from KWU)-Note 1.
(2) Brazil refuses to sign the Non-Proliferation Treaty. At the Dutch Parliament's insistence Brazil has agreed that the enriched uranium from URENCO for Angra 2 and 3 will be subject to IAEA safeguards (Note 2).

PROGRAM SUMMARY--BR NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-R. N. Alves et al., Trained Manpower Resources in Brazil, IAEA-CN-36/423, Nuclear Power and its Fuel Cycle, Vol. 6, Proceedings of an International Conference in Salzburg, May 1977 DOE
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, August 24, 1978 DOE
2-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Brazil presently has no major gas cooled reactor program. However, Brazil has indigenous quantities of thorium which can be used in gas cooled reactors.

MILESTONES
The Institute of Atomic Energy at the University of Sao Paulo has signed an agreement with Gulf General Atomic to design and construct a 1/7 scale model of a prestressed concrete pressure vessel that is presently used in the HTGR.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
State of Sao Paulo

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
IEA	Sao Paulo	

PROGRAM SUMMARY--BR NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS
Develop know-how in design of prestressed concrete reactor vessels.

FACILITIES
IEA facility at University of Sao Paulo

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--BR NUCLEAR FISSION GCR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Pete Jude, NUS Corporation Extension Office, Brazil

PROGRAM SUMMARY--BR NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Initiate a liquid metal fast breeder reactor program. Brazil has indigenous quantities of thorium which can be used in breeder reactors.

MILESTONES
The Brazilian government has committed to construct a fast reactor research facility; a $2.5 million zero power fast test/experimental reactor has been ordered from France's TECHNICATOME.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Brazilian Government

KEY CONTACTS
Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Nuclebras		Reactor Nuclear fuel Uranium/thorium exploration Reactor technology with CNEN (National Nuclear Energy Commission) Radioisotope application with CNEN/scientific institutions/industry

PROGRAM SUMMARY--BR NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Fast breeder reactor research and development

APPROACH
Develop highly skilled personnel via technology acquisition.

PROBLEM AREAS

BENEFITS
Provide fuel for the thermal reactors when the indigenous uranium reserves run out.

FACILITIES

SIGNIFICANT PARAMETERS
Nuclebras conducts most of its research through three subsidiaries: IEN (Nuclear Engineering Institute); IRO (Radio-Protection and Dosimetry Institute); IPR (Radioactive Research Institute).

PROGRAM SUMMARY--BR NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

MILESTONES
(1) IEAR-1, pool reactor, operating since 1957
(2) Argonaut, Argonne National Laboratory design - teaching and research reactor, 10 KWth, 20% U235, operational in 1965
(3) Sublime, Triga Mark I - pulsed reactor, 100 KWth, operational in 1960

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
IEA, owner of IEAR-1; IEN, owner of Argonaut; Institute of Radioactive Research, owner of Sublime

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission (CNEN)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
IEAR-1	University City Sao Paulo	
ARGONAUT	University City Rio de Janeiro	
SUBLIME	Belo Horizonte	

PROGRAM SUMMARY--BR NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Train personnel to manage, control, and operate nuclear power plants and fuel cycle activities.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--BR NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 6, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Build and operate a spent fuel reprocessing plant to recover fissile material for use in its thermal reactors.
(2) Become self-sufficient in the nuclear fuel cycle.

MILESTONES
(1) Brazil's 1975 agreement with West Germany includes provisions for technology and technical assistance in the construction of a pilot reprocessing plant to be located at Sepetiba.
(2) A commercial reprocessing plant is planned for operation in 1990.

RESOURCES

CURRENT STATUS
Reprocessing plants are in the planning stage. However, Germany may proceed at a slow pace; see Problem Areas.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Brazil (Nuclebras)

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, National Nuclear Energy Commission (CNEN)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--BR NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Import a commercial spent fuel reprocessing plant from Germany.

APPROACH
(1) The pilot reprocessing plant will be of laboratory scale (approximately 5 kg/day); FRG will provide technology and technical assistance in construction.
(2) A commercial plant of 300 MTHM/yr is planned for 1990. It will probably use the technology of United Reprocessors, GmbH (FRG).

PROBLEM AREAS
The U.S. Government is attempting to pursuade West Germany not to sell Brazil the spent fuel reprocessing technology on non-proliferation grounds. W. Germany has stated its intention to honor the agreement with Brazil for a reprocessing facility. However, because of international pressure, W. Germany may proceed at a very slow pace (Note 1).

BENEFITS
Nuclear self-sufficiency

FACILITIES
Nuclei, reprocessing plant, located at Sepetiba (planned)

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--BR NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--BR NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-The Washington Post, Aug. 24, 1978 --

PROGRAM SUMMARY--BR NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Protect the public from harmful effects of nuclear power plants and other fuel cycle facilities.

MILESTONES
Brazilian Nuclear Energy Commission (CNEN) has the responsibility for regulation, standardization, licensing, planning, surveillance, nuclear research functions, and safeguards.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Brazilian Government

KEY CONTACTS
Prof. Hervasion Guimares de Carvalko, Chairman, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Nuclear Energy Commission (CNEC)	Rio de Janeiro, Brazil	Regulatory, standardization, licensing, planning, surveillance, nuclear research, and training.

PROGRAM SUMMARY--BR NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 1, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

CH: CHINA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	2
Enrichment Plants	3
Light Water Reactors (LWR)	4
Heavy Water Reactors (HWR)	6
Research and Test Reactors	7

PROGRAM SUMMARY--CH NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Recover indigenous uranium and thorium fuel material to support development of nuclear power plants.

MILESTONES
Uranium is believed to be mined and milled in inner China at four provinces: Szechwan, Tsinghai, Kuetchou, and Sinkiang. (For additional information see China Nuclear Fission LWR)

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--CH NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Mainland China Talking to French, Germans, About Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Recover uranium for its nuclear power program.

MILESTONES
Uranium is believed to be mined and milled in inner China at four provinces: Szechwan, Tsinghai, Kuetchou, and Sinkiang.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--CH NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-Mainland Chinese Talking to French, Germans, About Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Provide sufficient enrichment capability for its Nuclear Power Program.

MILESTONES
China has in operation a gaseous diffusion enrichment plant, completed at Lanchou in 1963. It is believed to have a capacity of 180,000 SWU/yr for production of military grade (94 pct U235) material.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--CH NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Uranium enrichment by gaseous diffusion process.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Enrichment plant at Lanchou-180,000 SWU/yr

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--CH NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-Mainland Chinese Talking to French, Germans, About Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) In the next eight years (China's eight-year plan) China plans to build two or three commercial nuclear power plants. China appears to be interested in pressurized water reactors of 600 to 900-MWe capacity.

(2) China plans to purchase the first two or three reactor plants; the long-range plan is to set up their own facilities to be able to build their own reactors and associated components.

MILESTONES

(1) China has been involved with nuclear technology over the last 19 years; this experience includes:
   Operating a 7-MW heavy water reactor, built near Peking with Soviet guidance (since mid-1958);
   Operating three other experimental reactors in Hasian, Chungking, and Shanyang between 1958 and 1960
   Construction of a plutonium production reactor in Paotou in 1963;
   Construction of two research reactors, one rated at 2 MW, located at the University of Peking, sometime after the Soviet Union's withdrawal of technical assistance in 1964.

(2) Atomic Energy Research Institute of the Academy of Science founded in 1958

RESOURCES

Atomic Energy Research Institute is staffed with about 1500 persons

CURRENT STATUS

(1) Currently, China has no commercial nuclear power plants and appears to be in a position similar to that of the United States at the start of its program in 1954.

(2) The maximum-size turbine produced in China today is rated 300 MWe.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) University of Peking	Peking	Research reactors
(2) Atomic Energy Research Institute of the Academy of Sciences (AERI)	Near Peking	Nuclear physics, reprocessing, research reactor fuels, plutonium and transuranic elements
(3) Tsin-Hua University	Peking	Engineering and Scientific Education

PROGRAM SUMMARY--CH NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS
China is not a signatory of the non-proliferation treaty, and a nuclear cooperative agreement with free world countries would require the negotiation of a multilateral safeguards agreement.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
China is exploring cooperative programs with Japan (Note 1).

PROGRAM SUMMARY--CH NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-Mainland Chinese Talking to French, Germans, About Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE
2-Octave J. DuTemple, ANS visit to China: Prelude to Cooperation; Nuclear News, Volume 21, number 9, Page 79, July 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 7, September 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
None indicated

MILESTONES
Operating a 7-MW heavy water reactor, built near Peking with Soviet guidance (since mid-1958).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
See China Nuclear Fission LWR		

PROGRAM SUMMARY--CH NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-Mainland Chinese Talking to French, Germans, About Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE

PROGRAM SUMMARY--CH NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Little public information was found on China research test reactors. However, research and test facilities do exist in China and it is believed they are used to gain experience, and provide a technical basis for commercial exploitation of nuclear power.

MILESTONES

(1) Operating a 7-MW heavy water reactor, built near Peking with Soviet guidance (since mid-1975)
(2) Operating three experimental reactors in Hsian, Chungking, and Shenyang between 1958 and 1960
(3) Construction of a plutonium production reactor in Paotou in 1963
(4) Construction of two research reactors, one rated at 2-MW and located at the University of Peking, sometime after the Soviet Union withdrawal of technical assistance in 1964

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government of China

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) University of Peking	Peking	Research reactors
(2) Atomic Energy Research Institute of the Academy of Science (AERI)	Near Peking	Nuclear physics, reprocessing, research reactor fuels, plutonium and transuranic elements.
(3) Tsin-Hau University	Peking	Engineering and Scientific Education

PROGRAM SUMMARY--CH NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Mainland Chinese Talking to French, Germans, about Nuclear Power, Nucleonics Week, Page 3, January 12, 1978 DOE

2-Octave J. DuTemple, ANS visit to China: Prelude to Cooperation, Nuclear News, Page 79, Volume 21, Number 9, July 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

FR: FRANCE

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	4
Enrichment Plants	6
Fuel Fabrication	9
Light Water Reactors (LWR)	11
Heavy Water Reactors (HWR)	14
Gas Cooled Reactors (GCR)	15
Other Non-Breeder Reactors	17
Liquid Metal Fast Breeder Reactors (LMFBR)	19
Other Breeder Reactors	22
Research and Test Reactors	23
Spent Fuel Processing	25
Waste Management	28
Safety and Environment	31

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE--Develop its significant domestic uranium resources to meet the demand in the national power reactor program and actively participate in overseas exploration and production ventures, mainly in the French-speaking community of Africa.

MILESTONES
(1) Prospecting began in 1946. Significant deposits found by 1955.
(2) Established charter for COGEMA to manage government sponsored uranium activities domestically and overseas (1976).
(3) Has control or access to over 200,000 ST U3O8 of reserves.
(4) Established goal to add 130,000 ST U3O8 to reserves by 1990.

RESOURCES
(1) Reasonably assured ST U3O8 - 48000 at $15/lb, 71000 at $30/lb; Estimated additional ST U3O8 - 33000 at $15/lb, 53000 at $30/lb (70 pct vein-type deposits, remainder in sedimentary formations organic silts, etc) - see Note 1.
(2) Uranium exploration costs by France -
Domestic - $87M (pre-1972), $160M (pre-1978)
Overseas - $58M (pre-1972), $193M (pre-1978)
(3) $4.3-6.5 M/YR government subsidy (1976)-ref. 2

CURRENT STATUS--Extensive exploration domestically and abroad.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS--Commissariat a l'Energie Atomique (CEA-Gov't)
Minatome - Private, equally owned by Companie Francaise des Petroles and Pechiney - Ugine Kuhlman

KEY CONTACTS--Mr. G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS LOCATION PROGRAM AREA

I. COGEMA (sub. CEA)
(1) Significant interests in uranium companies - CFMU, 12.8 pct, control by Imetal; COMUF, 15 pct (Gabon - U mine); SOMAIR, 33 pct (Niger - U mine); COMINAK, 34 pct (Niger - U mine); URCA, 16.5% (Central African Republic - U prospect); AMOK, 30 pct (Canada - Major U deposits).
(2) Exploration ventures - Niger (Imouratem, 35 pct; W. Afasto, 33 pct; East Afasto, 37.5 pct; Djado, 25 pct) - Gabon - Mauritania, 10 pct of Minatome operation -- Senegal - Canada, 100 pct of SERU which is exploring with Eldorado and James Bay Development Company - USA, 100 pct of FRAMCO - Australia, 100 pct of AFMECO - Indonesia, jointly with government's BATAN - Borneo - Brazil - Iran - Iraq.

II. Minatome-13 pct interest in Gabon uranium mines, 7.6 pct interest in Arlit (Niger), several joint ventures in Mauritania (with Marubeni and Nippon Mining) and in the USA (w/Cont. Oil)

III. Mokta-28 pct interest in Gabon uranium mines, 25 pct interest in AMOK (Cluff Lake, Canada). Active exploration programs - URANIA, 75 pct interest, in USA.

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Explore and determine domestic uranium resources
(2) Participate aggressively in overseas prospecting under sponsorship of the government and private industry

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

I. (1) Domestic resources -
63% in granite
37% in sedimentary formations

II. (1) COMUF reserves (Gabon) are 39000 ST UO8 (0.3-0.6 pct grade). Exploration costs through 1974 by CEA and COMUF were $16.5 million
(2) SOMAIR reserves (Niger) are 52000 ST U3O8 (about 0.3 pct grade)
(3) COMINAK reserves (Niger) are 50000 ST U3O8 (about 0.5 pct grade)
(4) URKA reserves (Nigeria) are 10500 ST U3O8 (1972)

III. Other R&D - Bureau of Geological Mineral Research, Orleans-Cedex

IV. France interested in acquiring about 1000 tonnes uranium a year from Australia in second half of 1980s (Note 2). Also, interest in purchasing uranium from Mexico on a technical assistance program (Note 3).

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-URANIUM - Resources, Production and Demand, a joint report by OECD/NEA and IAEA, December 1977 DOE
2-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978 WENDS

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Data from EPRI EA-725.
OECD/NEA & IAEA report of December 1977 gives the following (France)

Reasonably assured resource:	37000 tonnes U	(below $30/lb U3O8)
	14000 tonnes U	($30-50/lb U3O8)
Estimated add-on resources:	24100 tonnes U	(below $30/lb U3O8)
	20000 tonnes U	($30-50/lb U3O8)

2-Nuclear Engineering International, p. 9, September 1978 DOE

3-Nuclear Engineering International, p. 13, September 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish commercial uranium ore processing capability to meet its nuclear power program requirements.

MILESTONES
(1) Domestic uranium production to date has met national needs
(2) An 8000 ST U3O8/YR production capacity planned for 1985
(3) Uranium metal production (7000 MT, pre-1977)
(4) UF6 production (14000 MT, pre-1977)

RESOURCES
SOMAIR production (Niger) - $63M to date; COMINAK initial investment (1979 operation, 2600 ST U3O8/YR production).

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commisariat a l'Energie Atomique (CEA)
COMURHEX (29% COGEMA, 51% Pechiney-Kuhlman)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
COMURHEX	--	UF6 Production
COGEMA	Chatillon	Fuel Cycle
Fontenay-aux-Roses CEN	Chatillon	Ore processing
Pechiney Ugine Kuhlmann (PUK)	Overseas	Ore processing

PROGRAM SUMMARY--FR NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop and commercialize capability to purify uranium ore, UF4 for uranium metal, and UF6 for enrichment.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
I. (1) Three mills - L'Ecarpier (Vendee), Bessines (Limousin), St. Priest (Forez) of one million tonnes ore capacity (at 0.21 pct grade)
(2) Lodeve (Herault) ready to start operation - 550 ST U3O8/YR
(3) CFMU (Lozere) - 150 ST U3O8/YR

II. COMUF mill capacity (Gabon) - 1300 ST U3O8/YR (1977), 2000 ST U3O8/YR (1981)

III. COMURHEX, Malvesi; UF4, UO2 and metal production
COMURHEX, Pierrelatte; UF6 production (15000 MT/YR-1982)

SIGNIFICANT PARAMETERS
Production (ST U3O8/YR)-
Actual: 1600 in 1960s, 2080 in 1975
Planned: 3900 in 1980, 8500 in 1985
COMURHEX uses the standard ADU process
New technique of leaching by sulfuric acid pulping by PUK (Note 1)

PROGRAM SUMMARY--FR NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Compiled by K. M. Harmon, January 1978 DOE
2-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978 WENDS
3-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. Renaud, G. Boutonnet, New Techniques for the Treatment of Uranium Ores, IAEA-CN-36/256, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish uranium enrichment capacity to meet the needs of the domestic LWR program and for export initially under government sponsorship and lately under multinational technical and financial arrangements.

MILESTONES
(1) Diffusion enrichment activities at CEA for military purposes at Pierrelatte since 1953
(2) COGEMA took over CEA enrichment operations (1964)
(3) EURODIF group established in 1973 (COGEMA interest of 28+%)
(4) COREDIF group established in 1975 (COGEMA interest of 29%)
(5) R&D in alternative enrichment processes (chemical exchange - commercial in 1990s)

RESOURCES
Government R&D budget: 200 million francs (1977)

CURRENT STATUS
EURODIF (France, Spain, Belgium, Italy, Iran) - 10.8 million SWU/YR by 1982/Diffusion, capacity committed. COREDIF (France, Spain, Belgium, Italy, Iran) - 10.0 million SWU/YR by 1990/Diffusion (Note 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l'Energie Atomique (CEA)/COGEMA (CEA)/EURODIF/COREDIF

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
COGEMA	-	Gaseous diffusion
EURODIF	-	Gaseous diffusion
COREDIF	-	Gaseous diffusion
Saclay CEN	Saclay	Processes
Fonteneay-aux-Roses CEN	Fonteneay-aux-Roses	Processes

PROGRAM SUMMARY--FR NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop alternative uranium enrichment processes in addition to gaseous diffusion.
(2) Evaluate technical and economic feasibility of alternative processes.
(3) Adopt a process for commercialization domestically.

APPROACH
(1) Base new capacity through the 1980s on the domestically established gaseous diffusion process (Note 1).
(2) Develop and demonstrate the chemical exchange process. Seek international cooperation - talks with West Germany and USA (Note 7).

PROBLEM AREAS
COREDIF financing (Note 5)

BENEFITS
(1) Fuel supply self-sufficiency for the domestic LWR program
(2) Availability of enrichment services in support of LWR exports

FACILITIES
(1) COGEMA, Pierelatte (1964) - Diffusion process, 400000 SWU/YR for non-military uses.
(2) EURODIF, Tricastin - Diffusion process, 10.8 million SWU/YR (1979).

SIGNIFICANT PARAMETERS
(1) Country where COREDIF will build its diffusion plant has not been selected; initial capacity of 2-4 million SWU/YR by 1986.
(2) A chemical exchange demo plant (50-100000 SWU/YR) planned for 1983 (Notes 2, 4). The cost is expected to be $120-230,000 (Note 7).
(3) CEA studied and developed the following processes: gas centrifuge, chemical exchange, aerodynamic and selective photoexcitation.
(4) EURODIF plant (2.6 million SWU in first year) to begin production 1/79 (Note 6).
(5) The 10.8 million SWU/YR Tricastin plant is on schedule. Satisfactory startup results were obtained in its Annex-U testing (Note 7).

PROGRAM SUMMARY--FR NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-C. Frejacques et al., Developments on Uranium Enrichment Processes in France, IAEA-CN-36/257, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. F. Petit, Uranium Enrichment by the Gaseous Diffusion Process, IAEA-CN-36/223, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Nucleonics Week, December 8, 1977 DOE
3-J. J. Steyn, Worldwide Separative Work Supply/Demand, AIF Inter. Conf., New Orleans, Jan. 30, 1978 DOE
4-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Compiled by K. M. Harmon, January 1978 DOE
5-Nucleonics Week, February 6, 1978 DOE
6-Nucleonics Week, August 3, 1978 DOE
7-Nuclear Engineering International, p. 3, September 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish domestic self-sufficiency in support of the expanding and diversified power reactor program and the necessary capability to meet reactor export commitments.

MILESTONES
(1) CEA made MAGNOX fuel for gas reactors (early 1950s-)
(2) CEA made plutonium fuel for the fast breeders (Rapsodie, Phenix) and will make the plutonium for the Super-Phenix LMFBR (1972-)
(3) FBFC established to make LWR and LMFBR blanket UO2 fuel (Pechiney-Kulhman, FRAMATOME, Westinghouse, Creusot Loire); Production of 123 MT (LWR) in 1977, capacity of 1000 MTU/YR (1982) and 1400 MTU/YR (1984)
(4) ZIRCOTUBE established to make LWR ZR tubing for domestic needs (1982) - Note 1

RESOURCES
Government R&D of 13 million francs (1977)

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) Commissariat a l'Energie Atomique (CEA)/COGEMA
(2) Societe Franco-Belge de Fabrication du Combustible (FBFC)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Fontenay-aux-Roses CEN	Fontenay-aux-Roses	Plut. fuels
FBFC	--	UO2 fuels
Saclay CEN	Saclay	Fuels development
ZIRCOTUBE	--	Zr tubing

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Manufacture fuel for gas-reactors
(2) Manufacture UO2 fuel for LWRs
(3) Manufacture plutonium mixed oxide fuel for LMFBRs
(4) Manufacture fuel for research and test reactors

APPROACH
(1) Manufacture MAGNOX and plutonium fuels under CEA
(2) Manufacture LWR fuels in private industry (FBFC)
(3) Manufacture ZR tubing domestically

PROBLEM AREAS

BENEFITS
France/FRG/Japan, 5-yr agreement on plutonium fuel technology (6/78 - Note 2)

FACILITIES
(1) CEA-Cadarache-Thermal and fast reactor plutonium fuels, 10 MT/YR
(2) FBFC - Dessel (Belgium) - LWR UO2: No UF6 conv., 200 MTU/YR (1978), 400 MTU/YR (1985)
(3) FBFC - Romans (France) - LWR and LMFBR UO2: Integrated facility, 1978 Capacity: 600 MTU/YR (UF6 to UO2), 300 MTU/YR (UO2 fab)

SIGNIFICANT PARAMETERS
(1) ZIRCOTUBE (51% Pechiney-Kuhlmann, 49% FRAMATOME) to build a plant with 120 km ZR tubing/YR capacity in 1982. Construction - 1978. Initial production - 1980.
(2) Direct plutonium nitrate to PuO2 process at Fontenay-aux-Roses CEN.

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Fuel, May 1, 1978 DOE
2-Atoms in Japan, p. 25, June 1978

PROGRAM SUMMARY--FR NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and rely on domestic PWR manufacturing capability to meet its power generation needs in the next 10-15 years, before it is ready to commercialize the LMFBR, and support its aggressive reactor/complete fuel cycle export program.

MILESTONES
(1) Built a 310-MWe PWR (SENA) in Belgium in 1967 (France, Belgium)
(2) Large national program of LWR construction launched by Electricite de France (EdF 1969).
(3) FRAMATOME was established as the LWR manufacturer (1970-51% Creusot-Loire, 45% Westinghouse). CEA to acquire all non-French interest by 1982.
(4) Optimistically 35 GWe (including about 3.7 GWe non-LWR) - 18.7 pct of grid by 1985 (Note 4).
(5) About 69 GWe to be installed (LWR) by 1992.

RESOURCES
Government budget, 213 million francs (1977)

CURRENT STATUS
PWRs installed:
(1) Fussenheim 1 (Comm-11/77), 2 (Comm-2/78)--First two PWRs (890 MWe each).
(2) Bugey 2 (925 MWe PWR) connected to grid - third LWR (Note 3)

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
EdF, the state-owned electric utility, and FRAMATOME (Note 1)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) FRAMATOME/Creusot-Loire	Le Creusot	Pressure vessels
(2) FRAMATOME/Creusot-Loire	Chalon	Pressure vessels/ steam generators/ pressurizers
(3) Jeumont-Sebneiden	--	Coolant pumps/ control rods
(4) Technicatome (sub. CEA/EdF)	--	--

PROGRAM SUMMARY--FR NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Develop LWR design, safety and operational criteria based on proven technology in the USA.

APPROACH

(1) Determine BWR and PWR commercial feasibility - FRAMATOME, Westinghouse licensee (1958); Compagnie Generale d' Electricite, (GE licensee).
(2) PWR adopted as the LWR system.
(3) Domestic capability established progressively within FRAMATOME.

PROBLEM AREAS

(1) Steam turbine problems in Fessenheim--beginning to be solved (Note 4).
(2) Nuclear power program slippage - delays in site and construction permits due to pressures on government by the public and environmentalists. Only plants in construction stage at this time are expected to be operational in 1985 (Note 4).

BENEFITS

(1) Decrease oil imports-established as government policy.
(2) Utilize its significant uranium resources in support of the LWR program.
(3) Utilize its advanced industry for LWR fuel and reactor componen supply.
(4) Increase LWR exports by offering complete fuel cycle services (FRAMATOME-COGEMA collaboration).

FACILITIES

(1) Creusot-Loire plant at Le Creusot (1973, pressure vessels)
(2) Creusot-Loire plant at Chalon (steam generators)
(3) Creusot-Loire plant at Chalon (1976-pressure vessels, steam generators, pressurizers)

SIGNIFICANT PARAMETERS

(1) Creusot-Loire, 8 pressure vessels/YR capacity. Meets long-term demand.
(2) Dependence on international programs in LWR safety (e.g., LOCA) - computer code development emphasis domestically (Note 2).

PROGRAM SUMMARY--FR NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-D. Gaussot, Inception of the Light Water Reactor System in France and its Fuel Cycle, IAEA-CN-36/218, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-R. Brandt et al., What is Done in France with Respect to the Design, Manufacture, Management and Development of Nuclear Fuel, IAEA-CN-36/569, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. Pelce, French Studies of Blow-Down Accident in LWRs, IAEA-CN-36/229, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-Nuclear Engineering International, Vol. 23, No. 272, June 1978 DOE
4-Nucleonics Week, July 20, 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
No power reactor program. Research and Test Reactor activities only.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CEA

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--FR NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop a commercial gas-cooled reactor system.

MILESTONES
(1) Early domestic emphasis on the graphite-moderated, gas-cooled reactor (MAGNOX GCR) system (1950s-) by the government (CEA and EdF)
(2) Seven GCRs under operation by EdF--Marcoule G2, G3 (39 MWe each - 1956, 1960); Chinon 2, 3 (210 and 480 MWe - 1966, 1967); St. Laurent 1, 2 (487 and 515 MWe - 1969, 1971); Bugey 1 (540 MWe - 1972)
(3) HTGR fuel development and irradiations (1974)
(4) CEA/US DOE agreement on high temperature, gas reactor systems (under negotiation - 1978)

RESOURCES
Government budget of 77 million francs (1977)

CURRENT STATUS
No GCRs installed since 1972. The national reactor program has been redirected towards LWRs (short-term) and LMFBRs (long-term).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l'Energie Atomique (CEA),
Electricite de France (EdF)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Cadarache CEN/CEA/COGEMA	Cadarache	Fuels and reactor system
NOVATOME	-	HTGR
Atelier-Graphite	Marcoule	HTGR graphite

PROGRAM SUMMARY--FR NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Establish feasibility of the gas-cooled system for electric power production.

APPROACH
(1) MAGNOX GCR system development parallel to similar programs abroad (UK primary and USA) as an extension of weapons material production facilities
(2) HTGR fuel development parallel to US and other European programs recently

PROBLEM AREAS

BENEFITS

FACILITIES
MAGNOX fuel fabrication by Societe Industrielle de Combustibles Nucleaires (SICN):
(1) Annecy, metal fuel
(2) Romans, metal fuel (900 MTU/YR capacity - 1971). Originally owned by CERCA (50% Pechiney-Kuhlmann, 50% Creusot-Loire) which has been absorbed by FBFC, the LWR fuel manufacturer.

SIGNIFICANT PARAMETERS
HTGR program - Fab of enriched U and Thorium particle fuel, biso and triso. Irradiations in UKAEA's Dragon reactor and at the French Osiris and Pegase test reactors.

PROGRAM SUMMARY--FR NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-C. Moreau et al., Fabrication and Irradiation Performance of French HTGR Fuel, IAEA-CN-36/270, Proc. of Inter. Conf, Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER NON-BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish the feasibility of a heavy water-moderated reactor system as an alternative to the graphite-moderated, gas-cooled reactor system.

MILESTONES
(1) CEA/EdF built the EL-4 facility, a small gas-cooled, heavy water-moderated reactor in 1968 (GCHWR, 70 MWe).
(2) CEA has done considerable R&D on a small reactor system (100 MW, H20, low-enriched uranium) for urban heating. A prototype, THERMOS, planned for completion at Saclay in 1982-83 (Note 1).

RESOURCES

CURRENT STATUS
Low priority development program

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l'Energie Atomique (CEA) and Electricite de France (EdF)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Cadarache CEN	Cadarache	Reactor system and fuels development

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER NON-BREEDERS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
CERCA facility at Romans, 20 MTU/YR (1971)

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER NON-BREEDERS
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER NON-BREEDERS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, July 10, 1977 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Develop broad technology for commercialization of LMFBRs based on the Super-Phenix, a large, prototype, pool-type, sodium-cooled fast reactor which is being built under multi-national electric utility sponsorship.

MILESTONES

(1) Operation of Rapsodie Fortissimo, 1967 (0 MWe) at Cadarache
(2) Operation of Phenix, 1973 - Current (233 MWe-50 MWD/KG) at Marcoule
(3) Formation of NERSA in 1973 to build and operate the Super-Phenix
(4) Construction permit for Super Phenix, 5/1977 - (1200 MWe-70 MWD/KG) at Creys-Malville
(5) Super-Phenix comm operation in 1983 - Electricite de France (EdF)
(6) LMFBR commercialization - 8 large plants (1800 MWe each) by 2000

RESOURCES

(1) Government budget of $125 M (1977)
(2) Super Phenix capital cost of $1.4 Billion (1978 $)

CURRENT STATUS

(1) Phenix at full power again (6/78)--it was shutdown in 1976 (Note 7).
(2) Super-Phenix nuclear boiler to be supplied by NOVATOME (51% Creusot-Loire, 34% CEA) and NIRA (65% Finmeccanica-Italy); other components to be procured competitively from industry of participating countries.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

(1) Commissariat a l'Energie Atomique (CEA - Gov't)
(2) NESRA (51% EdF, France - 33% ENEL, Italy - 16% SBK, FRG) - Lyon France

KEY CONTACTS

G. Vendryes (CEA-Paris)/A. Heine (Cadarache)/P. Tanguy (Saclay)/Jean Megy, Head, Reactor Operations, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Cadarache CEN/CEA	Cadarache	Systems; Fuels; reprocessing
NOVATOME	--	Reactor components
Saclay CEN	Saclay	Physics

PROGRAM SUMMARY--FR NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop LMFBR design, safety and operational criteria
(2) Establish economics for commercialization of LMFBRs

APPROACH
(1) Establish LMFBR feasibility in a pilot plant (Rapsodie)
(2) Develop design and performance criteria in a demonstration plant (Phenix)
(3) Utilize the Phenix experience to design the first, commercial LMFBR (Super-Phenix) with only component-scale extrapolation
(4) Define LMFBR safety criteria (1973) - Notes 3, 4.
(5) Build the Super-Phenix to current safety criteria and connect it to the EdF grid

PROBLEM AREAS
(1) Faulty heat exchangers in Phenix (1976) required replacement (Note 7)
(2) Super-Phenix component contracting in multinational environment
(3) Redesign of the Super-Phenix primary sodium circuit planned to protect against full range of accident possibilities (Note 6)

BENEFITS
(1) Complete utilization of uranium resources
(2) Long-term energy self-sufficiency
(3) Utilization of domestic industry
(4) Utilization of domestic plant stockpiles from MAGNOX reprocessing
(5) Potential for becoming leading LMFBR exporter
(6) International agreements
  (a) CEA/CNEN(It); CEA/GFK & INTERATOM (FRG) and formation of SERENA; France/FRG/Japan
  (b) NOVATOME/NIRA; NOVATOME/INB (FRG, Belgium, Holland)
  (c) CEA/US DOE agreement on technology exchange (under negotiation)

FACILITIES
(1) EdF - Test Center at Les Renardieres (50-MW prototype steam generators)
(2) Cadarache - Plutonium fuel fabrication/CEA; capacity: 4.5 MT/YR (pre-1976), 10 MT/YR (1976)
(3) Veurey (SICN) and Romans (CERCA/FBFC) - Blanket UO2 fuel fab.
(4) Repro-Marcoule (10 kg/day), Cadarache (CYRANO-1968) - Note 5

SIGNIFICANT PARAMETERS
(1) Compared to Phenix, the Super-Phenix containment is designed to meet modern safety criteria and the heat exchangers incorporate the evaporator and super-heater in a single unit.
(2) Super-Phenix components to be assembled at site.
(3) Low breeding ratio in Super-Phenix (Note 7).
(4) Phenix steam generators contained ferritic steels (Note 7).
(5) Peak burn-up (MWD/T) achieved: Rapsodie (160000), Phenix (75000).
(6) Super-Phenix testing (mock-up experiments, control rod vibration, materials, pumps, steam generators).
(7) Rapsodie on closed cycle: burns the plutonium it produced following reprocessing and fabrication (Note 1).
(8) Good fuel performance in Phenix (Note 2).

PROGRAM SUMMARY--FR NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-G. Vendryes et al., Programme and Status of the Development of the Fast Breeder Reactor System in France, IAEA-CN-36/219, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. E. Gray et al., International Cooperation on Breeder Reactors, The Rockefeller Foundation, May 1978 DOE
3-Creys-Malville Nuclear Power Station, Nuclear Engineering International, pp. 43, June 1978 DOE
4-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. C. Mougniot et al., A Closed Fuel Cycle: Rapsodie, IAEA-CN-36/266, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-P. Delpeyroux et al., Characteristics and Behaviour of the Fuel in the Phenix Reactor, IAEA-CN-36/268, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-F. Cogne, Safety Requirements and Options for a Large Fast Neutron Reactor, IAEA-CN-36/230, Proc. of Inter. Conf., Salzburg, May 1977 DOE
4-J. Bailly, European In-Pile Investigations of Fast Breeder Reactor Safety, IAEA-CN-36/245, Proc. of Inter. Conf., Salzburg, May 1977 DOE
5-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management R&D, Compiled by K. M. Harmon, January 1978 DOE
6-Electric Light & Power, p. 3, May 1978 --
7-Nuclear Engineering International, June 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
None indicated (ref. 1).
France does not have the resources to pursue alternative technologies by itself. Its primary commitment is to its successful LMFBR technology.

MILESTONES
Modest evaluation of GCFRs and MSBRs.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--FR NUCLEAR FISSION OTHER BREEDERS
KEY REFERENCES DTG 15 SEP 78

1-J. E. Gray et al., International Cooperation on Breeder Reactors, The Rockefeller Foundation, May 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Install and operate many types of facilities in support of its nuclear reactor program and fuels and materials development.

MILESTONES
(1) 1948 - Installed first research facility, EL-1 (Nat U, D2O, tank)
(2) Twenty-eight major facilities installed by mid-1970's. They incorporate different types of uranium fuels and moderators including highly-enriched uranium, plutonium breeder fuels, uranium alloys, heavy water, etc.

RESOURCES

CURRENT STATUS
CEA capability to design, manufacture, construct, fuel, operate and maintain research reactor facilities.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l' Energie Atomique (CEA)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, CEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Cadarache CEN	Cadarache	Reactor technology
(2) Saclay CEN	Saclay	Reactor technology
(3) Technicatome	-	Small reactor technology

PROGRAM SUMMARY--FR NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Test various reactor types, fuels and materials

APPROACH
(1) Early emphasis on heavy water and graphite reactors
(2) Testing of highly enriched uranium and metallic fuels
(3) Testing of plutonium fuels in fast flux facilities
(4) Lately, emphasis on PWRs

PROBLEM AREAS

BENEFITS
Self-sufficiency in reactor and fuels development

FACILITIES
Profile of CEA facilities (see complete list in Ref. 1)

NAME/YEAR	LOCATION	TYPE
EL-1/1948	Fontenay	Nat U, D2O
EL-3/1957	Saclay	LEU, D2O (20 MWt)
Proserpire/1958	Saclay	H2O-plut solution
Melusine/1958	Grenoble	93% U-Al, H2O (8MWt)
Marius/1960	Marcoule	Nat U, graphite
Ulysse/1961	Saclay	90% U-Al, graphite, H2O
Pegase/1963	Cadarache	93% U, H2O, (35 MWt)
Cabri/1963	Cadarache	90% U, H2O, Transients
Harmonie/1965	Cadarache	93% U, Fast exper
Masurca/1966	Cadarache	MEU-Pu-Fe alloy, fast exper
Osiris/1966	Saclay	93% U, H2O (70 MWt)
Grenoble/1971 (Langevin Inst)	Grenoble	93% U, D2O, High flux (60 MWt)
Chaudiere/1975	Cadarache	PWR (100 MWt)

SIGNIFICANT PARAMETERS
Testing of HTGR fuels in Osiris and Pegase (Note 1)

PROGRAM SUMMARY--FR NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-C. Moreau et al., Fabrication and Irradiation Performance of French HTGR Fuel, IAEA-CN-36/270, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Attain large-scale commercial capability in support of domestic plutonium power reactor programs and provide export services.

MILESTONES
(1) GCR MAGNOX fuel repro at Marcoule (UP1 plant) since 1958 and at La Hague, UP2, since 1967
(2) La Hague, UP2, modification/expansion in 1976 for UO2 fuels
(3) La Hague established as LWR fuel repro center (1976)
(4) La Hague to reprocess 1600 MT from Japan in 1980-90s
(5) LMFBR fuel pilot repro at La Hague
(6) LMFBR repro plant (1983-84)

RESOURCES
Government budget of 115 million francs (1977)

CURRENT STATUS
(1) Domestic capability established on PUREX process.
(2) Large-scale commercial capacity under planning/construction (Notes 1, 2, 3).
(3) More R&D still required for industrial-stage LMFBR fuel reprocessing.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l' Energie Atomique (CEA)/COGEMA

KEY CONTACTS
(1) COGEMA: G. N. Besse, Gen. Mgr./J. Couture, Comm Repro/ P. Amaury, UP3 plant
(2) La Hague: Dr. Delauge, Director
(3) Marcoule: Chotin, Mgr.-Repro.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
COGEMA	Marcoule	MAGNOX fuel
COGEMA	La Hague	MAGNOX fuel LWR fuel LMFBR fuel

PROGRAM SUMMARY--FR NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Develop MAGNOX, LWR and LMFBR fuel reprocessing technology for industrial application.

APPROACH

(1) Utilize the conventional PUREX process
(2) Develop alternative processes especially for high activity fuels (e.g., LMFBR fuel)

PROBLEM AREAS

BENEFITS

(1) Utilization of plutonium in LMFBR program (Note 4)
(2) Complete fuel cycle services for export

FACILITIES

(1) Marcoule (1958) - GCR fuels, 1000 MT/YR capacity
(2) La Hague, UP2 plant - GCR fuels until 1981. UO_2 fuels since 1976; only UO_2 fuels post-1981 (800 MT/YR capacity in 1983)
(3) La Hague, UP3 plant (planned) - UO_2 fuels (800 MT/YR - 1985; 1600 MT/YR - 1989)
(4) La Hague, LMFBR fuel pilot repro facility (AT-1, 1966 - Rapsodie Fuel)

SIGNIFICANT PARAMETERS

(1) UO_2 repro campaigns at La Hague, UP2:
    14 tonnes, 1976, Muehleberg (Swiss)
    40 tonnes, 1977, Stade (German)
(2) COGEMA reprocessed 1705 tonnes spent fuel of the German DWK utility group (Note 6)
(3) COGEMA, BNFL (UK) and KEWA (FRG) - own United Reprocessors GmbH
(4) France, in a major policy reversal, cancelled contract to construct a repro plant in Pakistan (Note 5)
(5) Sweden may not reprocess fuel in France (Note 6)
(6) CEA and PUK developed a promising dryway separation process which is based on volatility of uranium and plutonium hexafluorides (ref. 1)

PROGRAM SUMMARY--FR NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-J. Sauteron et al., Technology of Reprocessing Fast Reactor Fuel, IAEA-CN-36/567, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, compiled by K. M. Harmon, January 1978 DOE
3-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-W. Haussermann et al., Demand and Supply Estimates for the Nuclear Fuel Cycle, IAEA-CN-36/493, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-G. K. Rossney, Status and Prospects for Reprocessing, IAEA-CN-36/56, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-J. Couture et al., Design, Construction, Operation and Maintenance of Reprocessing Plants: Experience Gained, IAEA-CN-36/224, Proc. of Inter. Conf., Salzburg, May 1977 DOE
4-J. Van Dievoet et al., Plutonium Use - Present Status and Prospects, IAEA-CN-36/477, Proc. of Inter. Conf., Salzburg, May 1977 DOE
5-The Washington Post, August 24, 1978 --
6-Nucleonics Week, Vol. 19, No. 34, August 25, 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop processes for immobilization/solidification/vitrification of wastes and install interim and permanent disposal facilities.

MILESTONES
(1) Gaseous (tritium, noble), low level liquid waste (LLLW), high level liquid waste (HLLW) and solid waste R&D began in the 1950s.
(2) HLLW vitrification (pot process-laboratory) demonstrated (1963)
(3) PIVER - HLLW vitrification pilot plant (oper. 1969)
(4) 1972 - Decision to build industrial HLLW vitrification plant at Marcoule (AVM, oper. 1978 - Note 4)
(5) LLLW bituminization process (1977)
(6) 1978 - Construction of the world's largest HLLW vitrification plant (AVH-La Hague) began
(7) 1985 - Operation of a pilot transuranic (TRU) waste repository

RESOURCES

CURRENT STATUS
(1) Waste treatment technology at large-scale, commercial level
(2) Interim engineered storage facilities available
(3) Promising geologic formations of various types identified
(4) Safety aspects under evaluation

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l' Energie Atomique (CEA)

KEY CONTACTS
G. Vendryes, Director, Fuel Cycle, Paris
Y. Sousselier, Coordinator, Waste Mgmt., Fontenay-aux-Roses
R. Bonniand, Head-Solidification, Marcoule
A. Barbreau, Geol. disposal, Saclay
Poincet, Director, SGN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) SGN/COGEMA	La Hague	Facility construction Non-HLLW operations HLLW vitrification.
(2) Fontenay-aux-Roses CEN	Fontenay-aux-Roses	HLLW, geologic disposal
(3) Cadarache CEN	Cadarache	Non-HLLW bitumin and immobilization
(4) Grenoble CEN	Grenoble	Non-HLLW immobil
(5) Marcoule Center	Marcoule	HLLW vitrification/ solidification
(6) Saclay CEN	Saclay	Non-HLLW solidification
(7) INFRATOME	-	Waste transport/bury

PROGRAM SUMMARY--FR NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Vitrification of HLLW, interim storage in concrete wells, and eventually isolation in geologic formations.
(2) Processing of LLLW and immobilization in bitumen or concrete.
(3) Development of processes for TRU partitioning.

APPROACH
(1) Establish base technology on worldwide proven processes (coop with Germany).
(2) Develop new process (direct bituminization, thermoset resins)
(3) Develop and demonstrate a continuous HLLW vitrification process.
(4) Identify geologic formations for technical/economic evaluation.
(5) Perform safety evaluations of waste products and storage facilities.

PROBLEM AREAS

BENEFITS
(1) Interim/permanent disposal of wastes from processing facilities.
(2) CEA/US DOE 10-year agreement (under negotiations - 12/1976)
(3) CEA/GFK (Germany) agreement

FACILITIES
Note 4
(1) PIVER - pilot, HLLW vitrification, pot system (Marcoule)
(2) AVM (Atelier de Vitrification de Marcoule) - continuous vitrification process of gas graphite HLLW; oper 6/78. Capacity - 50 cubic meters glass/YR (1979).
(3) AVG (Atelier de Vitrification de La Hague) - PWR HLLW; construction 1978- . Capacity - 700 cubic meters glass/YR.
(4) Cadarache bituminization cell (1977)
(5) Marcoule hot cell - VULCAIN - glass characterization
(6) Grenoble non-HLLW solidification pilot (1971)

SIGNIFICANT PARAMETERS
(1) AVM plant based on experience with PIVER, but continuous vitrification (rotary calciner with melting furnace) was adopted for better economics and reprocessing liquids handling (Note 4).
(2) Direct bituminization of non-HLLW demonstrated at Cadarache.
(3) Tritium and noble gas removal processes demonstrated.
(4) Non-HLLW embedding in thermosetting resins demonstrated.
(5) Geologic formations evaluated - salt rock, crystalline rock and granite.
(6) Reprocessing considered necessary for satisfactory storage of waste (Note 2).
(7) Development and tests by CEA and St. Gobain Techniques Nouvelles on tritium management (Note 1).
(8) Hot tests to begin at Marcoule AVM in June 78 (Note 3).
(9) Questions raised recently about devitrification of vitrified HLLW when stored in deep salt repository. Possibly, there are better alternatives to vitrification (Note 5).

PROGRAM SUMMARY--FR NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-A. Redon et al., Management of High-level Radioactive Waste (Fission Products), IAEA-CN-36/226, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management R&D, Vol. 2, Compiled by K. M. Harmon, January 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-L. Lolle et al., Tritium Formation and Elimination in Light Water Nuclear Plants, IAEA-CN-36/238, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-M. Boiteux, The French Electro-Nuclear Programme, IAEA-CN-36/217, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-Nucleonics Week, March 16, 1978 DOE
4-Nuclear Engineering International, June 1978, p. 63 DOE
5-Nucleonics Week, August 24, 1978 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION SAFETY & ENVIRONMENT MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Protect the public and the environment.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Commissariat a l' Energie Atomique (CEA) and Electricite de France (EdF)

KEY CONTACTS
(1) Mr. G. Vendryes, Director, Fuel Cycle, CEA
(2) Mr. J. P. LeNoc, EdF

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) EdF	-	Transport
(2) Institute de Protection et de Surete Nucleaire, Saclay CEN	Saclay	Nuclear Regulations
(3) Fontenay-aux-Roses CEN	Fontenay-aux-Roses	Waste disposal in geologic formations
(4) Cadarache CEN	Cadarache	Immobilized low-level waste
(5) Paris School of Mines	Paris	Geologic formations

PROGRAM SUMMARY--FR NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop safety criteria for new types of nuclear facilities.
(2) Develop and improve operating procedures for fuel cycle facilities.
(3) Evaluate environmental effects of nuclear facilities and modify/apply regulations as necessary.

APPROACH
(1) R&D by CEA on all aspects of safety of nuclear facilities (e.g., repro, waste disposal, etc.)
(2) Dependence on international programs regarding LWR safety
(3) Coordination of experimental and analytical effort, especially regarding breeder safety, with other European countries (Note 1)

PROBLEM AREAS

BENEFITS
(1) France/FRG/Japan, 5-YR agreement on fast reactor safety (6/78) - Note 5
(2) France/USA - LWR safety research agreement (1974-79)

FACILITIES

SIGNIFICANT PARAMETERS
(1) LMFBR in-pile tests: (i) Local blockages (Scarabee-CEA, DFR-UKAEA, Mol 7C-GFK and CEN Belge), (ii) loss of pumps leading to cooling failure or inlet blockage (Scarabee and Cabri-CEA, GFK) and (iii) reactivity excursions (Cabri and Viper-UKAEA)-Note 1
(2) Had good experience with breeders regarding radioactive releases (Note 3)
(3) Developed spent fuel handling and transport procedures
(4) Shipping cask of EdF weighs 100 tonnes, is capable of containing 12 PWR assemblies (Note 4)
(5) Performed tests on transport containers for spent fuel and plutonium (Note 2)

PROGRAM SUMMARY--FR NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-P. Candes, Development of the Radiological Safety Studies for French Reactors and their Sites, translation ANS-Trans-1030 (CEA-CONF-1877 in French), July 1975
2-C. Jouannaud et al., Safety and Protection Analysis of Reprocessing Plants, IAEA-CN-36/248, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-P. Candes, J. Pradel, Safety and Protection Aspects of the Management of High-Level Radioactive Wastes, IAEA-CN-36/231, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--FR NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. Bailly et al., European In-Pile Investigations of Fast Breeder Reactor Technology, IAEA-CN-36/245, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Y. Sousselier, Experience with the Use and Application of Regulations Governing the Transport of Irradiated Fuels and Plutonium, IAEA-CN-36/227, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-J. Megy et al., Phenix LMFBR Power Plant: Radioactive Effluent Releases and Operating Team Irradiation Results After Two Years of Industrial Operation, IAEA-CN-36/233, Proc. of Inter. Conf., Salzburg, May 1977 DOE
4-J. P. LeNoc, Irradiated Fuel Transport and Handling System for Electricite de Frances Nuclear Power Plants, IAEA-CN-36/240, Proc. of Inter. Conf., Salzburg, May 1977 DOE
5-Atoms in Japan, p. 25, June 1978

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

GW: GERMANY (WEST)

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	4
Fuel Fabrication	6
Light Water Reactors (LWR)	8
Heavy Water Reactors (HWR)	11
Gas Cooled Reactors (GCR)	12
Liquid Metal Fast Breeder Reactors (LMFBR)	14
Other Breeder Reactors	17
Research and Test Reactors	19
Spent Fuel Processing	22
Waste Management	24
Safety and Environment	26

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Explore for uranium ore deposits.
(2) Obtain at least 60% of FRG uranium requirements from deposits owned or jointly owned by German companies after the year 1980.

MILESTONES
(1) Urangesellschaft MBH (UG) active in exploration and development of uranium supplies (shareholders: 33.3% Metalgesblschaft AG, 33.3% Steag AG, 33.3% Veba AG).
(2) Uranerzbergbau (URZ) in uranium mine/exploration maintains 49% of Rabbit Lake Mine/Mill complex and a 10% share of Agnew Lake Mines all in Canada.
(3) Bilateral agreement in 1975 with Brazil for the possibility of German participation in uranium prospecting and mining. This agreement also contains guarantees by Brazil to supply natural uranium.

RESOURCES
Expenditures (million DM): 35 (1977), 30 (1978), 27 (1974), 5 (1980)

CURRENT STATUS
(1) Exploration for uranium deposits continuing.
(2) As U3O8 - 1180 tonnes possibly economically recoverable and 5910 tonnes total indigenous located in Black Forest. Recovery is not economically practical under present world conditions.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
URZ is a subsidiary of the German utility RWE. Costs for prospecting ventures are 20% mining industry, 20% electric utilities, and 50% German Government.

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Uranium exploration

APPROACH
(1) UG is exploring for economically viable uranium deposits in Australia, Canada, U.S., Brazil, Colombia, Indonesia, and Niger
(2) URZ is exploring for uranium ores.

PROBLEM AREAS
(1) Economically recoverable uranium is not an abundant resource.
(2) Uranium resources within West Germany are insignificant.

BENEFITS
(1) Obtain fuel supply for nuclear industry needs.
(2) Ensure adequate fuel supply for FRG's needs.

FACILITIES
Urangesellschaft (UG) owns 6.5% of Somair (Niger).
Uranerzbergbau (URZ) owns 49% Rabbit Lake Mine/Mill complex and 10% of Agnew Lake Mines all in Canada.

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Ministers for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 2, NAC C-7827, Prepared for U.S. Department of Energy, June 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and encourage uranium mines and mills.

MILESTONES
Private Industry - Uranerzbergbau (URZ) - owns 49% of Rabbit Lake Mine/Mill complex and 10% of Agnew Lake Mines all in Canada.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Uranerzbergbau

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
(1) Rabbit Lake Mine/Mill complex in Canada
(2) Agnew Lake Mines in Canada

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-Battelle Pacific Northwest Laboratories, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 2, PNL-2478, Jan 1978 DOE

2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Develop and build uranium enrichment industry to support LWR fuel cycle.
(2) Develop centrifuge enrichment process.

MILESTONES
(1) 1970 - Uran-Isotopentrennungs-GmbH (URANT) was formed as the West German partner (33-1/3%) of Urenco-Centec.
(2) Urenco has two enrichment centrifuge pilot plants at Almelo (Netherlands) and Capenhurst (UK). Plans are for a 0.2 million SWU per year demonstration plant at each site in 1978.
(3) Urenco is projecting a 2.5 and 10 million SWU/year in 1982 and 1985.
(4) The German partner in Centec (the centrifuge development organization) is Gesellschaft fur Nukleare Vergahrenstechnik (GNV).
(5) Agreement with Brazil (Nuclebras) for construction of demonstration 180,000 SWU/yr Becker separation nozzle enrichment process.

RESOURCES
Centrifuge enrichment requires a capital investment that is about the same as that for a diffusion plant. German Government has offered the industrial partners of URENCO grants of 700 million DM for construction of the first plant and as a guarantee to cover operating risks. Expenditures (million DM): 109 (1977), 111 (1978), 116 (1977), 120 (1980).

CURRENT STATUS
Gas centrifuge enrichment plants at Capenhurst (England) and Almelo (Holland) have reached the production stage and are presently providing uranium enrichment.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) United Kingdom
(2) Uran-Isotopentrennungs-GmbH (Uranit) - 1/3 owner of Urenco.
(3) Shareholders of Uranit are Farbwerke Hoechst AG, 20%; Gelensbear AG, 40%; Nukem GmbH, 40%.

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Centec	Germany	Centrifuge enrichment
Urenco	Headquarters in UK	Enrichment management

PROGRAM SUMMARY--GW NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop centrifuge enrichment.
(2) Develop new enrichment techniques.

APPROACH
(1) Two demonstration, 0.2 million SWU/yr, plants presently scheduled for 1978 (one at Capenhurst and the other at Almelo).
(2) Urant plans to build a plant at Gronau, Germany.
(3) FRG is assisting Brazil in their efforts to develop the Becker nozzle process. The Becker process was developed at Karlsruhe (KFK).

PROBLEM AREAS
Maintenance requirements for gas centrifuge enrichment are considered greater than for gas diffusion enrichment.

BENEFITS
(1) Gas centrifuge enrichment requires less power than diffusion enrichment.
(2) Gas centrifuge enrichment will provide West Germany with enrichment capability to support their nuclear power industry.
(3) Providing alternative technology for enrichment.

FACILITIES
Gronau, Germany (planned enrichment)

SIGNIFICANT PARAMETERS
FRG and France have begun preliminary talks on the French-developed chemical process for uranium enrichment (Note 1).

PROGRAM SUMMARY--GW NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Ministers for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977
2-Battelle Pacific Northwest Laboratories, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 2, PNL-2478, Jan 1978 DOE
3-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Provide fuel fabrication facilities for uranium oxide fuel elements for the present LWR designs.
(2) Develop fuel element technology for LMFBRs.
(3) Develop fuel element technology for the HTGR.

MILESTONES

(1) LWR fuel fabrication industry has matured to the point where no additional government support is required.
(2) LMFBR work emphasized U02 and Pu02 fuels which will also be tested in the SNR-300.
(3) HTGR fuel element projects are handled jointly by industry and KFA; studies are devoted to advancement of spherical fuel elements.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Fuel element fabrication - Reaktor-Brennelement Union GmbH (50% KWU, 30% NUKEM, 20% GE)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Julich Nuclear Research Center (KFA)	Julich	Nuclear Fuel Research

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

	LOCATION	TYPE	CAPACITY	YEAR	SHAREHOLDERS
Alkem	Wolfgang bei Hanau	Thermal and Fast Reactor Mixed Oxide Fuel Fabrication	50 MT/yr	1966	60% KWU 40% Nukem
Hobeg	Wolfgang bei Hanau	Spherical and Presmatic HTGR Fuel Fabrication	N/A	1972	100% Nukem
RBU-I	Wolfgang bei Hanau	LWR Fuel Fabrication, PWR Final Fuel Assembly	1000 MT/yr Powder 750 MT/yr Pellet 600 Assembly	1964	50% KWU 30% Nukem 20% GE
RBU-II	Grosswelzheim	BWR Final Fuel Assembly	150 Assembly Only	1966	50% KWU 30% Nukem 20% GE

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by The Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977

2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Develop and build nuclear power electric generation stations to reduce dependence on imported and indigenous fossil fuels.
(2) Develop nuclear power industry for export.
(3) Government position: nuclear power should be last resort.

MILESTONES
(1) 8167 MWe (5379 PWR, 2788 BWR) operating in 1978
(2) 19820 MWe by 1985
(3) 28510 MWe by 1991 (total firm and planned)
(4) Presently supplying nuclear power plants to six countries.
(5) Has a wide range of reactor vendors and pressure vessel/ steam generator support companies.
(6) Has developed major fuel fabrication industry for LWRs.
(7) Has nuclear material transportation capability.

RESOURCES
Over 100,000 scientists and engineers; extensive private industry; government nuclear energy budget - DM 460 million (1978).

CURRENT STATUS
(1) KWU offers both PWRs and BWRs but is currently refraining from expanding BWRs until good operating ability is shown.
(2) Present KWU capacity: 6 turnkey plants per year.
(3) FRG private industry manufactures fuel elements, reactor vessel pressurizers, and steam generators.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) Private industry
(2) Technical information exchange with GE and CE
(3) Nuclear power programs are administered through the Federal Ministry of Research and Technology (Bundesministering fur Forschung and Technologie)

KEY CONTACTS
W. S. Schmidtkuster - Federal Ministry for Science and Technology (BMFT), Bonn

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) KFK	Kernforschungszentrum Karlsruhe	R&D Nuclear Energy
(2) Nukem	Nukem GmbH	Nuclear Fuel Cycle
(3) KWU	Wiesenstr	Development and design of conventional power plants

PROGRAM SUMMARY--GW NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

(1) Kraftwek Union (KWU) is the major supplier of LWRs.
(2) KWU has orders for 34 units (25 PWRs and 9 BWRs) - nine operating, thirteen under construction, and twelve planned (as of 1978).
(3) KWU is exporting two 1300-MWe PWRs to Brazil, one BWR (692-MWe) to Australia, six 1300-MWe to Iran, one 445-MWe plant currently operating in the Netherlands, one 985-MWe PWR to Spain, one 920-MWe PWR to Switzerland.

APPROACH

(1) KWU was formed in 1969 through a merger. In 1970, the Westinghouse (PWR) license was terminated and a Combustion Engineering agreement for PWR exchange was made.
(2) BBR was formed in 1971 by the consortium with Babcock & Wilcox (BEW) and Brown, Boveri et Cie (BBC) to market the BEW PWR design.
(3) Reaktor Brennelement Union (RBU) manufactures fuel elements.

PROBLEM AREAS

The growth of the LWR industry is constrained pending resolution of the fuel cycle issues (waste disposal, reprocessing, Pu recycle).

Extreme difficulty in licensing is being experienced (Note 1).

BENEFITS

Substitution of nuclear based energy for critical fossil fuels.

FACILITIES

(1) Kraftwerk Union (KWU) - PWR and BWR vendor
(2) Babcock, Brown, Boveri et Cie (BBR) - PWR vendor
(3) Reaktor Brennelement Union - LWR fuel vendor
(4) Gutehoffnugshutte Sterkrade AG - pressure vessel vendor
(5) Deutsche Babcock & Wilcox - steam generator vendor
(6) Transnuklear GmbH - transportation of nuclear fuel
(7) Gesellschaft fur Nukleartransporte - Spent fuel transportation

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, PNL-2478, Jan 1978 DOE
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827, Prepared for U.S. Department of Energy, June 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 11, September 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Presently there is no commercial offering of heavy water reactors.

MILESTONES
(1) Siemens developed a 52-MWe prototype pressurized heavy water reactor (MZFR) which began operation in 1966.
(2) The Siemens HWR design was commercially tested when the ATUCHA-I reactor (365-MWe) began operation in Argentina in 1974.
(3) Siemens discontinued offering heavy water reactors.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Establish heavy water reactor technology.

APPROACH
(1) Develop pilot plant (52-MWe) - 1966 startup
(2) Commercial HWR (365-MWe) - 1974 startup in Argentina

PROBLEM AREAS
Supplies of heavy water may not be readily available.

BENEFITS
Natural uranium utilization directly - (needs no enrichment)

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC=7827, Prepared for the U.S. Department of Energy, June 1978 (Draft)

PROGRAM SUMMARY--GW NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Develop high temperature gas reactor industry.
(2) Employ high temperature reactors for industrial, high temperature process heat.

MILESTONES
(1) In 1956, Brown, Boveri et Cie (BBC) began development on HTGR which led to the construction of the AVR experimental reactor (15-MWe, operation in 1967).
(2) In 1971, a 300-MWe HTGR named THTR was contracted by BBC. In 1973, Gulf General Atomic (GA) acquired 45% of BBC which was named Hochtemperatur Reaktor GmbH (HRB). THTR is scheduled for operation in 1983.
(3) Nuclear Process Heat Prototype Plant (PNP)/coal gasification is in the conceptual design phase (1976). Reference plant plant design is scheduled for 1978. Detailed design phase of reference plant and operation of pilot plant after 1979.
(4) An order for the first HTR nuclear process heat facility is expected in the second half of the eighties.

RESOURCES
HTR Expenditures
(million DM): 34 (1977), 83 (1978), 124 (1979), 118 (1980)

CURRENT STATUS
(1) THTR under construction
(2) PNP project conceptual design

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) Hochtemperatur Reaktor GmbH (HRB) (55% BBC and 45% GA)
(2) KFA, GHT, HRB responsible for PNP pilot plant nuclear heat generator system
(3) Bergbauforschung responsible for water vapor gasification of PNP plant
(4) Rheinbraun responsible for hydrogenerating gasification of coal of the PNP plant

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Kernforschungsanlage Julich GmbH (KFA)	Julich	Nuclear Technology (HTGR) and general research

PROGRAM SUMMARY--GW NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
High temperature gas reactor development

APPROACH
(1) A 15-MWe AVR (Experimental test reactor) in 1967
(2) A 300-MWe THTR presently under construction
(3) Spherical fuel elements are being employed in the HTRs

PROBLEM AREAS
(1) HTGR high development and commercialization cost (approximately DM 10 billion) has reoriented the German HTR Program. The concept for further development of the HTR is based largely on the interest for process heat.
(2) FRG will rely on international cooperation to help reduce the financial burden imposed by the HTR and associated fuel cycle.
(3) Licensing delays the THTR 300 prototype (Note 1).

BENEFITS
(1) Nuclear process heat
(2) New reactor system
(3) Greater utilization of potential nuclear fuels (such as thorium)

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION GCR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, pp. 25-27, September 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Develop the LMFBR to increase the useful energy content in uranium and make FRG independent of imported primary energies for several hundred years.

MILESTONES

(1) SNR-300 (200 MWe) fast breeder reactor: construction began in 1973; completion scheduled for 1982.
(2) International cooperation with Belgium and the Netherlands for SNR-300.
(3) 20-MWe experimental nuclear power station, KNKI (Compact Sodium Cooled Nuclear Reactor) of GFK, 1973.

RESOURCES

(1) Funding of SNR-300 (million DM): 2519
(2) LMFBR expenditures (million DM): 359 (1977), 361 (1978), 350 (1979), 367 (1980)

CURRENT STATUS

Construction of the SNR-300 liquid metal fast breeder reactor is continuing

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

(1) SNR-300 -- Belgium, Netherlands, West Germany
(2) Schnell -- Bruter-Kernkraftwerksgesellschaft mbH (SBK) is the purchaser of SNR-300
(3) Internationale Natrium -- Brutreaktor-Baugesellschaft mbH (INB) is the builder of SNR-300

KEY CONTACTS

Dr. Hans Matthofer, Federal Minister for Research and Technology

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Gesellschaft fur Kernforschung (Gfk)	Karlsruhe	FBR Nuclear Technology and General Research
(2) Centre d' Etudes Nucleaires (CEN) Mol	Belgium	SNR Support and Research
(3) Nijverheidsorganisatie TNO, ECN Petten	Netherlands	SNR Support and Research

PROGRAM SUMMARY--GW NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop the liquid metal fast breeder reactor.

APPROACH
(1) Cooperation agreement with Belgium and Netherlands in the construction of the SNR-300
(2) KNK-I (compact sodium cooled nuclear reactor), 20-MWe, full power in 1973 - served to study sodium technology
(3) KNK-II will test a UO_2/PuO_2 core and is scheduled for late 1977 operation
(4) The KNK projects are to furnish additional experience for the SNR-300 project

PROBLEM AREAS
(1) Careful study of reactor safety and environmental impacts must be conducted with favorable outcome prior to their use for energy supply purposes.
(2) Commercialization of the LMFBR depends greatly on the development and availability of fuel cycle facilities
(3) The development cost for the LMFBR is high. Therefore, FRG seeks closer international cooperation.

BENEFITS
Liquid Metal Fast Breeder Reactors will provide additional nuclear fuels for thermal and fast reactors and therefore reduce the demand for and reliance on foreign uranium.

FACILITIES
(1) SNR-300 Located at KALKAR
(2) Nuclear Research Center at Karlsruhe (KFK) - Fast Breeder and nuclear research

SIGNIFICANT PARAMETERS
FRG/France/Japan, 5-year agreement on fast reactor safety (6/78) - Note 1.

PROGRAM SUMMARY--GW NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technologies, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977

2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Atoms in Japan, p. 25, June 1978

PROGRAM SUMMARY--GW NUCLEAR FISSION OTHER BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Perform research on the gas cooled fast breeder reactor.

MILESTONES
(1) Participation restricted to international projects (such as fuel elements and safety) handled within the framework of OECD-NEA.
(2) KFA and GfK are performing studies on the helium cooled gas breeder reactor.

RESOURCES
Expenditures (million DM): 10 (1977), 9 (1978), 8 (1979), 7 (1980)

CURRENT STATUS
Studies being performed.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
R&D Program of KFA and GfK

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION OTHER BREEDERS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Gas cooled breeder reactor

APPROACH
(1) The helium cooled fast breeder reactor is expected to have a high breeding ratio.
(2) The high temperature helium cooled reactor technology experience gained in the HTR program will aid in the development of the gas breeder reactor.

PROBLEM AREAS

BENEFITS
Alternative to the liquid metal fast breeder reactor

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION OTHER BREEDERS
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977

PROGRAM SUMMARY--GW NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Construct research and test reactors to support development in the various nuclear power programs.

MILESTONES
(1) Thirty-seven research and test reactors have been built and are currently operating in FRG. The test reactor types include research pool; Argonaut; Heavy Water-Research Tank; Solid Homogeneous; Heavy Water; critical experiment; Uranium Zirconium Hydride; Aquatic Homogeneous; HTGR highly enriched Uranium. The first research pool reactor was built in 1957.
(2) Government sponsored research is primarily aimed at LWR, HTR, and FBR reactor technologies and associated fuel cycles

RESOURCES
Government Research Program Fxpenditures (million DM): 1028 (1977), 1086 (1978), 1152 (1979), 1170 (1980)

CURRENT STATUS
Research continues on LWR, HTR, and FBR reactor technologies

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government and private industry

KEY CONTACTS
(1) Hans Matthofer - Federal Minister of Research and Technology
(2) Werner Maihofer - Minister of Interior

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Nuclear Research Center (Gfk)	Karlsruhe	Fast breeder, reactor safety, physical protection, reprocessing waste conditioning, final storage superconductors
(2) Nuclear Research Center (KFA)	Julich	High temperature reactors, new secondary energy systems
(3) Research Center at Geesthacht (GKSS)	Geesthacht	Nuclear safety, nuclear ship propulsion, offshore technology
(4) Research Center for Environmental Science (GSF)		Final storage of radioactive waste
(5) Society for Reactor Safety		Reactor safety R&D
(6) Hahn-Meitner Institute for Nuclear Research Berlin (HMI)	Berlin	Nuclear research in chemistry and physics

(7) For Private Industry Organizations see Notes and Evaluations

PROGRAM SUMMARY--GW NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
(1) LWR research in reactor safety, waste disposal, reprocessing, recycling, waste treatment, ultimate storage, and nuclear safeguards
(2) HTR development program
(3) FBR development program
(4) Nuclear ship propulsion

PROBLEM AREAS

BENEFITS

FACILITIES
(1) AVR and THTR - gas cooled reactors
(2) SNR-300 liquid metal fast breeder reactor
(3) N.S. OTTO HAHN commercial nuclear powered ship
(4) MZFR (Karlsruhe multipurpose research reactor)

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Private Industry Nuclear R&D

PRIVATE INDUSTRY	R&D PROGRAM
1. KWU (Kraflweck Union AG)	Development and design of nuclear and conventional power stations and steam and gas turbines
2. Interatom (Internationale Atomreaktorbau GmbH)	Development of sodium cooled fast breeder reactor
3. INB (Internationale Natrium-Brutreaktor Bau GmbH)	Overall development of LMFBR technology
4. NUKEM GmbH	Conversion of enriched uranium hexafluoride to oxide, production of MTR fuel plates and uranium elements, reprocessing of spent fuel
5. ALKEM GmbH	Development of production of plutonium fuel elements
6. RBG (Reaktorbrennelemente GmbH)	Conversion of uranium hexafluoride to uranium dioxide, production of uranium dioxide fuel elements

PROGRAM SUMMARY--GW NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop spent fuel reprocessing technology.

MILESTONES
(1) WAK, at Karlsruhe, a Government-financed pilot reprocessing plant, 35 MTHM/year, startup in 1971.
(2) United Reprocessors (UNIREP-UK, France, and FRG private industry). KEWA is the German participant. A commercial reprocessing plant operated by KEWA is currently scheduled to be operational in the late 1980's. Its capacity will be approximately 1500 MTHM/YR.
(3) Temporary storage capacity will be created after 1982 on the site of the waste management facility. Storage facility ultimate capacity should be about 3000 to 5000 MT.
(4) Several large utilities have established DWK, which is responsible for construction and startup of an industrial reprocessing plant.
(5) Karlsruhe Nuclear Research Center founded the Reprocessing and Waste Treatment Project in 1974 to solve problems relevant to safety to the extent these solutions are needed for construction and operation of large facilities.

RESOURCES

CURRENT STATUS
(1) WAK - Pilot reprocessing plant is operational
(2) KEWA - Commercial reprocessing plant is in the planning stage

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) WAK (20% Nukem, 20% Gelsenberg, 20% Bayer, 20% Hoescht, 20% DWK) operation funded by German Government
(2) KEWA commercial reprocessing plant - 100% DWK

KEY CONTACTS
Dr. Hagen, Director, Office of Nuclear Fuel Cycles No. 2, Federal Ministry of Science and Technology

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) WAK	Karlsruhe	Spent Fuel Reprocessing (Pilot research & development)
(2) KFK (Jupiter)		Reprocessing of AVR-HTR fuel elements

PROGRAM SUMMARY--GW NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Establish spent fuel reprocessing technical and safety criteria.

APPROACH
(1) WAK has obtained operating experience in reprocessing fuels from LWR power plants. It has confirmed the PUREX reprocessing process developed in the U.S.
(2) HTR reprocessing is limited to a small test facility at KFA (Jupiter). AVR fuel elements will be reprocessed there.
(3) Commercial LWR reprocessing plant of 1500 MTHM/yr is to be commissioned in late 1980s.

PROBLEM AREAS
(1) Presently the value of nuclear fuels recovered does not fully meet the expenses on the basis of current uranium and separative work prices.
(2) Component development and optimization for PUREX process is still required; improvement on instrumentation is required; minimization of work quantities is needed; development and testing of systems for retention of radioactive iodine, krypton, carbon, and hydrogen isotopes is required.

BENEFITS
Commercial reprocessing facilities will recover for subsequent use unspent uranium and bred plutonium in fuel elements, thus reducing the demand for foreign uranium and enrichment.

FACILITIES

SIGNIFICANT PARAMETERS
A titanium electrolytic mixer-settler developed by the Karlsruhe research establishment has been tested successfully for 1000 hours (Note 1).

PROGRAM SUMMARY--GW NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Publications Department, Bonn, Federal Republic of Germany, 1977
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 2, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 11, September 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop an integrated waste management system for the ultimate storage of radioactive fission products in one place.

MILESTONES
(1) Fourth Amendment to the Atomic Energy Act clearly defines responsibilities: Industry builds and operates the facilities for reprocessing, waste management, and temporary waste storage; the government operates the ultimate storage facility; the costs for implementing this concept will be borne by the utilities under the polluter pays principle.
(2) GSF has been carrying out an extensive research and test program on ultimate storage in the former salt mine ASSE-II since 1967.
(3) So far, solidified low and intermediate level wastes have been stored in containers within the ASSE-II salt mine for long time testing. Test storage in this mine of high level wastes will start toward the end of this decade.

RESOURCES
R&D work, relevant to safety, for pilot and test facilities is financed by government waste mangement budgets (million DM): 163 (1977), 188 (1978), 224 (1979), 251 (1980)

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government: Ministry of Research and Technology

KEY CONTACTS
Dr. Hagen, Director of Office of Nuclear Fuel Cycles No. 2, Federal Ministry of Science and Technology

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

(1) Waste management technology development.

(2) All R&D efforts in waste management and waste storage are conducted under international cooperation within the framework of EURATOM, OECD/NEA, OECD/IEA, IAEA, and bilateral agreements with other countries. This close cooperation ensures that the ultimate storage concepts in different countries satisfy common safety requirements.

APPROACH

(1) Reprocessing plants will allow radioactive waste to be converted into a form suitable for safe ultimate storage.

(2) R&D work in waste treatment is aimed at reducing waste volume and improve chemical and physical stability of end products. High level waste is embedded in vitrified substances.

(3) Suitable retention of radioactive gases such as iodine, krypton, and tritium is being developed.

PROBLEM AREAS

(1) For the HTGR, because of its self-contained fuel cycle, separate development work in the waste management field is required.

(2) For solid wastes of reprocessing plants the techniques of decontamination and compaction must be developed further.

(3) Environmental effects of long-term ultimate storage of radioactive waste products.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

Questions raised recently about devitrification of vitrified high-level waste when stored in deep salt repository. Possibly, there are better alternatives to vitrification (Note 1).

PROGRAM SUMMARY--GW NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977

PROGRAM SUMMARY--GW NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, August 24, 1978 DOE

PROGRAM SUMMARY--GW NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Establish strict safety standards and develop nuclear power plant designs that comply with these standards.

MILESTONES

(1) Safety standards constitute the basis for licensing decisions.
(2) Radiation exposure to public should be below the maximum permissible local levels.
(3) LWR safety research programs: Loss of coolant - emergency core cooling and containment; component safety; burst protection; and core meltdown.

RESOURCES

(1)	LWR safety expenditures (million DM):	75 (1977), 61 (1978), 60 (1979), 57 (1980)
(2)	LMFBR and HTGR safety expenditures (million DM):	9 (1977), 34 (1978), 41 (1979), 46 (1980)
(3)	Other safety related expenditures (million DM):	68 (1977), 67 (1978), 71 (1979), 78 (1980)

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS LOCATION PROGRAM AREA

PROGRAM SUMMARY--GW NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

Reactor safety research - additional projects:

(1) Quality Assurance Programs - early detection of incipient failures - methods for remote nondestructive testing.

(2) External impacts program - test and studies of explosions, plane crashes, earthquakes, and shockwaves on functional capability of safety systems.

(3) Fission product transport and radioactive exposure projects serve to develop techniques and equipment for transportation, repair, maintenance, and decommissioning work to minimize radiation exposure to personnel.

(4) Risk Reliability Project - quantitative analysis or risks brought about by operations of nuclear power plants.

(5) A decommissioned 100-Mth reactor (HDR) will be used to study the effects of loss-of-coolant accident on pressure vessel internals and the containment.

PROBLEMS

BENEFITS

(1) Assure that reactor plant designs are safe

(2) Provide safety guidelines for future generation plants

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--GW NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-Energy Research and Energy Technologies Program, 1977-1980, Published by the Federal Minister for Research and Technology, Press and Public Relations Department, Bonn, Federal Republic of Germany, 1977

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

IN: INDIA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	5
Fuel Fabrication	6
Light Water Reactors (LWR)	7
Heavy Water Reactors (HWR)	9
Liquid Metal Fast Breeder Reactors (LMFBR)	11
Other Breeder Reactors	12
Research and Test Reactors	14
Spent Fuel Processing	16
Waste Management	18
Safety and Environment	20

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Self-sufficiency is practically achieved in meeting the present needs.

MILESTONES
(1) Indian Rare Earth Ltd. formed 1965 for thorium recovery.
(2) Ministry of Energy established 1974, responsible for optimum development and utilization of energy resources.

RESOURCES
$33 million spent in the last quarter century, and the present annual expenditure for exploration is $3 to 4.5 million (Note 1).

CURRENT STATUS
(1) Uranium resources of 62,100 tonnes, of which 34,500 tonnes are economically recoverable. Thorium resources of 450,000 tonnes, of which 320,000 tonnes are economically recoverable.
(2) UCIL has a stockpile sufficient to cover 10 years' requirements for the CANDU reactors.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Uranium Corporation of India, Ltd. (UCIL)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Atomic Minerals Division, Dept. of Atomic Energy		Survey, prospect and explore

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Assure domestic uranium supply to meet the needs of the present CANDU reactors. Enriched uranium for BWRs is purchased from U.S.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
A mine/mill faciity at Jaduguda in Bihar provides natural uranium for CANDU reactors, 1100 MT/day ore, owned by UCIL, operational since 1967.

SIGNIFICANT PARAMETERS
1975-indigenous U3O8 supply of 29 tonnes, and imports from US of 49 tonnes.

A 3-pronged plan was unveiled by Prime Minister Desai for increasing uranium supply: examination of promising uranium findings on priority, intensification of exploration efforts and strengthening of instrumentation and analytical facilities (Note 2).

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Uranium-Resources, Production and Demand, OECD Nuclear Energy Agency and IAEA, December 1977 DOE
2-Nuclear Engineering International, p. 13, September 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To produce all the uranium for its present CANDU reactors.

MILESTONES

RESOURCES

CURRENT STATUS
(1) UCIL has a stockpile sufficient to cover 10 years' requirements for the CANDU reactors.
(2) India and Japan are in negotiation on thorium processing for reactor fuel (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Uranium Corporation of India, Ltd. (UCIL)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Domestic uranium production sufficient to supply all the operating CANDU reactors.

APPROACH

PROBLEM AREAS
Uranium mine production in 1975 and 1976 was curtailed due to limited access to favorable ore deposits. A new shaft (completed in 1977) should provide better access to the ore and improve production.

BENEFITS

FACILITIES
(1) A mine/mill facility at Jaduguda in Bihar provides natural uranium for CANDU reactors, 1100 MT/day ore, owned by UCIL, operational since 1967.
(2) Nuclear Fuel Complex (NFC) at Hyderabad, a completely integrated fuel fabrication center, has facility for uranium conversion.
(3) The Minerals Division of Indian Rare Earth Ltd. operates three mineral sand separation plants, two small plants at Manavalakurichi and one integrated plant at Chavara. These plants can treat 285,500 MT/yr of raw beach sand. The beach sand contains 97-99% monazite which has 9% thorium (Note 1).

SIGNIFICANT PARAMETERS
UCIL is expanding its mining operation at Narwapahar and Bhatin in the Singhblum district. No plan for new milling facilities announced.

PROGRAM SUMMARY--IN NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, October 1977 DOE
2-Nuclear Fuel, August 21, 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Low-level enrichment services would be required if India follows its present nuclear power program of deploying heavy water reactors.

MILESTONES

RESOURCES

CURRENT STATUS

(1) India is understood to have received an informal USSR offer on enrichment services (Note 1).
(2) The latest shipment of US enriched uranium, 7.6 tonnes, for Tarapur refueling was approved by US government, August 1978.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, July 20, 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To achieve self-sufficiency in fuel fabrication.

MILESTONES

RESOURCES

CURRENT STATUS
NFC uses GE technology in its BWR fuel fabrication process and AECL technology in its CANDU fuel fabrication.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Nuclear Fuel Complex (NFC) of the Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Self-sufficiency in fuel fabrication is practically achieved at Nuclear Fuel Complex. Other domestic industries supply a large portion of components and equipment for nuclear power plants.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Nuclear Fuel Complex at Hyderabad has seven individual plants for sequential processing of zircon sand, uranium ore concentrates and imported enriched UF6 into finished fuel assemblies, operational since 1971. Annual production 100 MT/yr CANDU fuel and 24 MT/yr BWR fuel.

SIGNIFICANT PARAMTERS

PROGRAM SUMMARY--IN NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Policy decision to shift from LWRs to CANDU reactors after the first two BWRs were built. No plan to promote further LWR technology.

MILESTONES
By 1979, nuclear power will account for 2.8% of the total power generated (Note 1).

RESOURCES
World Bank assisted in a number of power plant financing arrangements.

CURRENT STATUS
Two BWRs, 380 MWe total, in operation since 1969. Long-term contract with US for the supply of enriched UF6.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
No plan to build additional LWRs.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Tarapur 1 and 2, each 190-MWe net GE BWR, operational since November 1969.

SIGNIFICANT PARAMETERS
Nuclear Fuel Complex at Hyderabad capable of providing UF6 to UO2 conversion, pelletizing, zircaloy tubing production and rod and bundle fabrication. Annual production 24 MT/yr BWR fuel using GE fuel fabrication technology.

PROGRAM SUMMARY--IN NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

India has opted for CANDU-type reactors over LWRs because of greater efficiency in using uranium and the ability to use domestic natural uranium instead of enriched uranium which needs to be imported.

MILESTONES

(1) Pre-1977, capacity 200 MWe net, 1280 MWe projected for 1985 and 7780 MWe for 2000.
(2) Ministry of Energy established in 1974, responsible for optimum development and utilization of energy resources.

RESOURCES

World Bank assisted in financing a number of power plants in India.

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
One plant, 200 MWe, in operation and five new plants, totaling 1082 MWe, in construction or planning.

APPROACH
India chooses relatively small capacity HWRs to suit its small power grids and scattered load centers.

PROBLEM AREAS

BENEFITS

FACILITIES
Power plant description/status published annually (in April) by NUCLEAR ENGINEERING INTERNATIONAL and semi-annually (January and July) by NUCLEAR NEWS.

SIGNIFICANT PARAMETERS
(1) Domestic industry capable of providing 80% of plant components. Nuclear Fuel Complex at Hyderabad builds CANDU fuel, 100 MT/yr, using AECL fuel fabrication technology.
(2) Nangal Heavy Water Plant, 14 MT/yr, operational since 1967. Four more plants under construction, Baroda 67 MT/yr operational 1979, Tuticorin 71 MT/yr operational 1978, Kota 100 MT/yr operational 1980 and Talcher 62 MT/yr operational 1980.
(3) Bhabha Atomic Research Centre (BARC) developed a computer-based control system for operating and fueling machines for pressurized HWRs (Note 1).

PROGRAM SUMMARY--IN NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, December 1977 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Base the country's nuclear power program on thorium-fueled LMFBRs (Note 2).

MILESTONES
Note 2
(1) Determine feasibility of installing LMFBRs in early 1990s
(2) Have LMFBRs play dominant role by 2000

RESOURCES

CURRENT STATUS
The Reactor Research Center at Kalpakkam will soon have a testing LMFBR for developing thorium based technology.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Reactor Research Center at Kalpakkam

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
India is primarily interested in thorium-based breeder reactors.

APPROACH

PROBLEM AREAS

BENEFITS
Utilization of large domestic thorium resources (Note 2)

FACILITIES

SIGNIFICANT PARAMETERS
With French assistance, the Reactor Research Center at Kalpakkam will have a 10-MW plutonium-fueled, sodium-cooled fast breeder reactor primarily for developing thorium-based technology (Note 1) (Completion date unknown).

PROGRAM SUMMARY--IN NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE
2-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION OTHER BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
India has substantial thorium deposits and intends to exploit them fully in fast reactors.

MILESTONES

RESOURCES
Total research and development budget (1974-79) of $144 million, of which $66 million for developing breeder technology at the Kalpakkam Reactor Research Center.

CURRENT STATUS
Active research is conducted in developing a thorium based breeder reactor.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Madras Atomic Power Project (Note 2) of the Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Kalpakkam Reactor Research Center		breeder technology

PROGRAM SUMMARY--IN NUCLEAR FISSION OTHER BREEDERS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
To develop a thorium-based breeder reactor so as to utilize India's thorium resources.

APPROACH
India plans a three-step program (Note 3) to arrive ultimately at a Th-U233 nuclear power system:

1. Production of fissile plutonium in PHWRs fueled with natural uranium
2. Use of the plutonium in fast breeder reactors fueled either with natural uranium or with thorium, to produce either more Plutonium or U233 and
3. Establishment of a Th-U233 FBR system, fueled with thorium.

PROBLEM AREAS

BENEFITS
Utilization of the abundant thorium resources in India.

FACILITIES

SIGNIFICANT PARAMETERS

(1) A breeder reactor, 50 MWth, using domestic thorium is in development with French assistance (located at Kalpakkam, near Madras, estimated operation in 1980s-Note 2).
(2) Nuclear Fuel Complex is attempting to manufacture ThO_2 filled blanket fuel elements for the reactor (Note 1).

PROGRAM SUMMARY--IN NUCLEAR FISSION OTHER BREEDERS
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION OTHER BREEDERS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Vol. 2, Page 526, IAEA Salzburg Conference, May 1977 DOE
2-Nuclear Engineering International, October 1977 DOE
3-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 3, Battelle Pacific Northwest Laboratories, January 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To promote basic nuclear research and development of advanced reactor systems.

MILESTONES

RESOURCES
Total research and development budget (1974-79) was $144 million, of which $66 million for developing fast breeder technology at Kalpakkam Research Center.

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Kalpakkam Research Center		Nuclear Technology

PROGRAM SUMMARY--IN NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
India has four research reactors in operation and two in planning or construction.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

NAME	LOCATION	TYPE	MW(th)	YEAR
Apsara	Trombay	Research Pool	1	1956
Cirus	Trombay	Research Tank, heavy water	40	1960
Zerlina	Trombay	Critical Exp.	0	1961
Purnima	Trombay	Critical Exp.	0	1972
FBTR	Kalpakkam	FBR	50	under construction
Kalpakkum PFR	Kalpakkam	Pulsed fast, air cooled	0.03	planning

SIGNIFICANT PARAMETERS
India has capability to fabricate metallic uranium fuel for the Cirus heavy water research reactor.

PROGRAM SUMMARY--IN NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To recover fissile material from spent fuels.

MILESTONES
Trombay reprocessing plant, dedicated 1965.

RESOURCES

CURRENT STATUS
Two spent fuel processing plants in operation and a third in planning.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Tarapur Atomic Power Station (Note 3)/Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
India has a modest but solid program for spent fuel reprocessing.

APPROACH
High population density and limited transport facilities led to a national policy to set up small capacity fuel reprocessing, waste solidification, interim waste storage complexes at several locations rather than a centralized large capacity plant (Note 2).

PROBLEM AREAS

BENEFITS

FACILITIES
(1) TROMBAY plutonium plant, a pilot reprocessing facility, uses PUREX process to reprocess spent fuel from CIRUS and other research reactors, 100 MTU/yr, operational 1965, inactive at present, will be modernized and expanded.
(2) Power Reactor Fuel Reprocessing Plant at Tarapur, 150 MTU/yr of zircaloy clad oxide fuels, PUREX process, started operation in 1978 (Notes 2 and 3).
(3) A third reprocessing plant at Kalpakkam near Madras, 150 MTU/yr, of CANDU spent fuel and the fast breeder test reactor fuel (Note 1 and 4) is in planning.

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--IN NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827 ,International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Volume 3, page 571, IAEA Salzburg Conference, May 1977 DOE
2-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 3, Battelle Pacific Northwest Laboratories, January 1978 DOE
3-Nucleonics Week, April 20, 1978 DOE
4-Nuclear Engineering International, p. 13, September 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To dispose radioactive waste by safe and economical means.

MILESTONES

RESOURCES

CURRENT STATUS
Indian waste disposal practices at present are to:
(1) Discharge volatile radionuclides to the atmosphere
(2) Store HLLW concentrates in underground stainless steel tanks, pending future solidification
(3) Store fuel hulls in steel barrels in underground steel-lined concrete tile-holes
(4) Neutralize non-HLLW, incorporate in bitumen, and store in underground concrete trenches.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Bhabha Atomic Research Centre (BARC)/Department of Atomic Energy

KEY CONTACTS
N. S. Sunder Rajan, Project Engineer, BARC

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Bhabha Atomic Research Centre	Trombay	Waste treatment and isolation

PROGRAM SUMMARY--IN NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
A modest waste disposal program is in progress.

APPROACH
High population density and limited transport facilities led to a national policy to set up small capacity fuel reprocessing, waste solidification, interim waste storage complexes at several locations rather than a centralized large capacity plant.

PROBLEM AREAS

BENEFITS

FACILITIES
A HLLW solidification plant located at the Tarapur Atomic Power Station.

SIGNIFICANT PARAMETERS
The Engineering Services Group of BARC is responsible for planning, design, construction and operation of radioactive waste management systems (Note 1).

PROGRAM SUMMARY--IN NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management R&D, Vol. 3, compiled by K. M. Harmon, January 1978 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, page 77, Volume 4, IAEA Salzburg Conference, May 1977 DOE

PROGRAM SUMMARY--IN NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To monitor radioactive discharges into the environment and to protect the public.

MILESTONES
Radiation Protection Rules promulgated by the Department of Atomic Energy in 1971.

RESOURCES

CURRENT STATUS
The Health Physics Division of BARC operates environmental survey laboratories at each nuclear installation.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Bhabha Atomic Research Centre (BARC)/Department of Atomic Energy

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IN NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Volume 4, page 77, IAEA Salzburg Conference, May 1977 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

IR: IRAN

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	5
Fuel Fabrication	7
Light Water Reactors (LWR)	8
Liquid Metal Fast Breeder Reactors (LMFBR)	11
Research and Test Reactors	12
Spent Fuel Processing	14
Waste Management	16

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Iran has undertaken an ambitious uranium exploration program.

MILESTONES

RESOURCES

CURRENT STATUS
(1) Agreement reached between Iran and Australia on bilateral safeguards, pending ratification by both governments. The agreement paves the way for supplying 15,000 tonnes uranium from Australia to Iran (Note 2).
(2) AEOI is responsible for survey and exploration of uranium resources in Iran.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Secure foreign uranium supply and prospect indigenous uranium resources.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

(1) Under Iran's uranium exploration program, over 500,000 square kilometers are under active airborne survey for radiometry and gravimetry. Also extensive ground survey is being conducted. French, German, and Italian firms provided assistance (Note 1).

(2) Uranium deposits found near Yasd and Anarak, but grades not reported.

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, March 1978 DOE
2-Nucleonics Week, August 10, 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To develop indigenous uranium resources.

MILESTONES

RESOURCES

CURRENT STATUS
AEOI is responsible for exploiting uranium through extraction and purification processes.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
AEOI contracted a French firm for conversion process.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
A French company named Comurhex has a $6 million contract with AEOI for converting yellow cake concentrates to uranium hexafluoride (Note 1).

PROGRAM SUMMARY--IR NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, April 1977 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Iran has a major vested interest in participation in the EURODIF and COREDIF enrichment plants.

MILESTONES

RESOURCES

CURRENT STATUS
Participation in EURODIF and COREDIF with France, Spain, Belgium, and Italy (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Participation in joint enrichment ventures with other countries.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
(1) A joint company SOFIDIF, formed by AEOI and Cogema (a French nuclear fuel company), holds 25% interest in EURODIF; the participation is divided 10% AEOI and 15% Cogema.
(2) AEOI has a direct holding of 20% interest in COREDIF and through EURODIF an additional 5.1% in COREDIF (total 25.1%).

PROGRAM SUMMARY--IR NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. J. Steyn, Worldwide Separative Work Supply/Demand, AIF Inter. Conf., New Orleans, January 30, 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Iran possesses no nuclear vendors and none are planned.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Iran has an ambitious nuclear power program.

MILESTONES
Plans to install 40 GWe by 2000. Recent report (Note 3) indicates some curtailment may follow a current reassessment of the nation's nuclear power program.

RESOURCES
Financing of two Framatome reactors and associated fuel involved 40% direct payment from the government of Iran and 60% (approx. $1.6 billion) provided by a consortium of six French banks. The loaned funds were in the form of a six year credit with repayment to begin when the reactors start operation. Similar methods can be expected for future reactors. See significant parameters.

CURRENT STATUS
Eight nuclear power plants in various stages of construction or planning.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Ministry of Energy (Note 3)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Eight nuclear power plants in various stages of construction or planning.

APPROACH
(1) Iran will rely on nuclear power plants purchased abroad from experienced vendors. Likely such purchases will be influenced by political considerations rather than by competition among vendors.
(2) Plant siting, construction management, manpower and immediate energy requirements for rapid economic development (Note 1).

BENEFITS
Nuclear power will replace oil, when oil resources are depleted.

FACILITIES

NAME	TYPE	MWe	DATE
Bushehr-1	PWR	1240	Jan 1981
Bushehr-2	PWR	1240	Jan 1982
Ahvaz-1	PWR	925	Oct 1983
Ahvaz-2	PWR	925	Oct 1984
Isfahan-1	PWR	1300	1984
Isfahan-2	PWR	1300	1984
Iran-7	PWR	1300	1987
Iran-8	PWR	1300	1987

SIGNIFICANT PARAMETERS
(1) In addition to two PWRs (Ahvaz 1 and 2) supplied by Framatome, Iran is negotiating with France for six additional nuclear units. For financing, Iran proposes crude oil bartering (Note 1).
(2) A second preliminary nuclear plant site is being conducted by Switzerland's Motor Columbus in the east-central part of the country (Note 3).
(3) Iran may buy up to eight additional nuclear plants from the U.S. A preliminary agreement allowing the sale of U.S. reactors to Iran is expected to be approved soon by the Carter Administration (Note 4).
(4) France has agreed to sell four 1200 MWe plants valued at 4 billion dollars in return for Iranian crude oil (Note 4).

PROGRAM SUMMARY--IR NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, March 1978 DOE
2-Nucleonics Week, May 11, 1978 DOE
3-Nucleonics Week, August 24, 1978 DOE
4-Electric Light and Power, Vol. 56, No. 9, September 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Iran indicates interest in fast breeders.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Planning to set up training programs on fast breeder technology.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
A new nuclear technology center will be built near ISFAHAN.
Training in the center will include handling fast breeders.

PROGRAM SUMMARY--IR NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To promote pure and applied research and to train specialists.

MILESTONES

RESOURCES
$4 million for nuclear research in FY 1975-76.

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Tehran Nuclear Research Center	Tehran University	Nuclear physics, Radioisotopes, Electronics Applications of Radioactivity
Radioactive Materials Research Center		
Isfahan Nuclear Technology Center		Principal support for nuclear power programs. Technology development in all phases of nuclear fuel cycle

PROGRAM SUMMARY--IR NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Some pure and applied nuclear research is conducted at the Institute of Technology, University of Tehran.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

NAME	LOCATION	TYPE	MW(th)	DATE
UTRR	Tehran	Pool, 20% U, light water	5	1967
UTRR	Tehran	Solid homog.	5/10	In conversion

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--IR NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
No immediate need of fuel reprocessing. Joint venture with other countries may likely be the best choice in the future.

MILESTONES

RESOURCES

CURRENT STATUS
Negotiations on Iran-U.S. bilateral agreement have been completed. U.S. promises Iran most favored nation treatment regarding spent fuel reprocessing (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
No specific fuel reprocessing plan is reported.

APPROACH
Iran has abandoned plans for a domestic reprocessing facility in favor of making bilateral and multilateral reprocessing agreements.

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Iran will not need reprocessing until about 1990 (Note 1).

PROGRAM SUMMARY--IR NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7327, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, January 12, 1978 DOE
2-Nucleonics Week, July 20, 1978 DOE

PROGRAM SUMMARY--IR NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Assistance appears to be obtained from U.K. for waste management.

MILESTONES

RESOURCES

CURRENT STATUS
AEOI reportedly signed a contract with UKAEA on waste management programs. Details unknown.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Organization of Iran (AEOI)

KEY CONTACTS
Dr. Akbar Etemad, President, and technical contact, M. Sarram, both of AEOI.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IR NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Engineering International, March 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

IS: ISRAEL

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Fuel Fabrication	2
Light Water Reactors (LWR)	3
Heavy Water Reactors (HWR)	5
Research and Test Reactors	6
Safety and Environment	8

PROGRAM SUMMARY--IS NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Israel has no known uranium deposits but it could produce low grade uranium from phosphates.

MILESTONES
Israel has developed a process for producing uranium from domestic phosphate resources (Note 1).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IS NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

There is no known fuel fabrication capability in Israel. However, fuel fabrication plant bids have been requested in parallel with the evaluation of nuclear power plant orders abroad.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IS NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 3, NAC C-7827, Prepared for the U.S. Dept. of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Israel has no known plans for developing indigenous commercial nuclear reactor supply capability and will rely on import from experienced vendors abroad.

(2) In the mid-1980s nuclear power is expected to become available for electric power generation and water desalination.

MILESTONES

(1) The Israeli Electric Power Corporation obtained government approval late in 1976 to pursue a nuclear power program and an agreement was signed with the USA allowing for the delivery of two reactors with a total capacity of 1970 MWe.

(2) Either a 645 or a 945-MWe nuclear plant (PWR or BWR) is planned for operation by 1985. The plant will also be used for desalination.

(3) The Israeli Electric Power Corporation is exclusively responsible for the nuclear power program.

RESOURCES

CURRENT STATUS

Israel has spent $10 million already and plans to spend another $4 million on site work at Nitzamin, 32 km south of Tel Aviv. The U.S. refuses to help provide aid for the $1.3 billion project (two 970-MWe LWRs). Problems: Israel is not signatory to the Non-Proliferation Treaty, Mid-East politics. Israel may turn to France or Germany for LWRs. The earliest that the plant can produce power is 1989 (Notes 1, 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Israeli Atomic Energy Commission

KEY CONTACTS

Ariel Amiad - Director General, Israeli Electric Power Corporation
Moshe Nelken - Director of Research and Development, Israeli Electric Power Corporation

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Israeli Atomic Energy Commission	Tel Aviv	Advises government on long-term policies and priorities in advancement of nuclear R&D

PROGRAM SUMMARY--IS NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Nuclear power plant for electricity and water desalination

APPROACH
(1) Turbine condenser waste heat to be used to evaporate water in a horizontal aluminum tube falling film evaporator.
(2) A 10 million gallon/day desalination plant for adaption to a nuclear plant is now being designed.

PROBLEM AREAS
Possibility for radioactive contamination carried over by the steam exhausted from the nuclear power plant turbine to the desalination plant.

BENEFITS
(1) Nuclear power plant reduces demand for imported and domestic fossil fuel.
(2) Nuclear power provides a source of energy for generating potable water for arid regions.

FACILITIES

SIGNIFICANT PARAMETERS
Israel 1 (to be built) - 645 or 945-MWe LWR
Water desalination - 50 to 100 million gallons per day

PROGRAM SUMMARY--IS NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-J. Ador et al., Near Term Feasibility of Nuclear Reactors for Seawater Desalting: Coupling of Standard Condensing Nuclear Power Stations of Low Grade Heat Multi-effect Distillation Plant; IAEA-CN-36/52, Nuclear Power and its Fuel Cycle, Vol. 6, Proceedings of an International Conference in Salzburg, dated May 1977 DOE

2-M. Nelken et al., Small System Expansion with Large Nuclear Generating Units - Technical Feasibility and Economic Soundness; IAEA-CN-36/191, Nuclear Power and its Fuel Cycle, Vol. 6, Proceedings of an International Conference in Salzburg, May 1977 DOE

3-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 3, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, August 17, 1978 DOE
2-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Israel has a heavy water test reactor only.

MILESTONES
IRR-2, natural uranium/heavy water, 26 MW(th), operating.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government of Israel

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IS NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
IRR-2, located in Negev, Israel, owned by the Government (French reactor).

SIGNIFICANT PARAMETERS
IRR-2: 26 MW(th), natural uranium, heavy water moderated.

PROGRAM SUMMARY--IS NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 3, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Currently Israel has two research test reactors.

MILESTONES
(1) IRR-1, pool-type reactor, 5 MW(th), 1960
(2) IRR-2, natural uranium and heavy water, 26 MW(th)

RESOURCES

CURRENT STATUS
IRR-1 and IRR-2 are both operating.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
SRE - owner of IRR-1; Israel Government owner of IRR-2

KEY CONTACTS
Amos Horev, Professor, Israel Institute of Technology (TECHNION)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Negev Nuclear Research Center (IRR-2)	Negev	Government Nuclear Research
(2) Soreq Nuclear Research Center (IRR-1)	Soreq	Research Reactor, Principal Research Organization of Israel Atomic Energy Commission
(3) Israel Institute of Technology	--	Nuclear Physics, Particle Physics
(4) Weizman Institute of Science	--	Nuclear Research, Isotope Research
(5) The Hebrew University Jerusalem	--	Nuclear Research

PROGRAM SUMMARY--IS NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS
Israel will not sign the NPT and has resisted international inspection of its Dimona research reactor and laboratory (Note 1).

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
PROGRAM SUMMARY--IS NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 3, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--IS NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

MILESTONES

(1) The Israeli Atomic Energy Commission, set up in 1952, is responsible for government policies and priorities in advancement of nuclear research and development. It supervises implementation of policies approved by government, including licensing of nuclear power facilities.
(2) An advisory committee on Nuclear Safety (ACKS) established by special ordinance.
(3) Safety at Work Ordinance enacted in 1970.
(4) The IAEC gives operation approval and license, and the Licensing Division for Inspection and Operation is responsible for the operation of the nuclear power plant.

RESOURCES
Government of Israel

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS LOCATION PROGRAM AREA

PROGRAM SUMMARY--IS NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Vol. 3, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

WENDS PROGRAM SUMMARIES FOR NUCLEAR FISSION

IT: ITALY

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	4
Fuel Fabrication	6
Light Water Reactors (LWR)	7
Heavy Water Reactors (HWR)	9
Gas Cooled Reactors (GCR)	11
Liquid Metal Fast Breeder Reactors (LMFBR)	12
Research and Test Reactors	14
Spent Fuel Processing	16
Waste Management	18
Safety and Environment	20

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop domestic uranium resources to supplement uranium imports.

MILESTONES
(1) Domestic uranium prospecting began in 1954 and first cycle of exploratory work completed in 1962 (Note 1).
(2) Exploratory activities resumed in 1975 using modern exploration techniques (Note 1).

RESOURCES

CURRENT STATUS
(1) Domestic resources of 2600 tonnes U3O8, 1420 tonnes economically recoverable.
(2) Agip Minerarie owns 6.5% of Somair uranium and milling facility in Niger (operation in 1972).
(3) Agip Minerarie signed a contract in 1975 with Madawasca Mines of Canada for uranium supply (Note 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Agip Minerarie, a member of the state-owned Ente Nazionale Idrocarburi (ENI)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Joint ventures with other countries plus a small domestic program.

APPROACH

PROBLEM AREAS
Uranium resources in Italy are insignificant.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
(1) ENI has been given a conditional go-ahead in developing U3O8 deposits near Novazza (Note 4), estimated deposit of 1200 tonnes with average grade of 0.09% U. Mine capacity of 120 tonnes per year (Note 1).
(2) In addition to 6.5% ownership of Somair in Niger, Italy has several overseas exploration projects including participation in Ngalia joint venture with Australia, exploration permit in Zambia, part ownership of uranium exploration in Somalia and joint ventures in US (Note 2).

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-URANIUM-Resources, Production and Demand, OECD and IAEA, December 1977 DOE
2-EPRI EA-725 Project 883, Foreign Uranium Supply, by N. Barrie McLeod and Julian J. Steyn, NUS CORPORATION, April 1978 WENDS
3-Nuclear Fuel, May 29, 1978 DOE
4-Nuclear Fuel, June 26, 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To develop domestic uranium supply to supplement imports.

MILESTONES

RESOURCES

CURRENT STATUS
A mill of 150 MTU per year capacity is in planning and will be built at Bergamo in Northern Italy

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Agip Minerarie, one member of the state-owned Ente Nazionale Idrocarburi (ENI).

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IT NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Depend on Eurodif and Coredif for enrichment services in the early 1980s. Near-term enrichment contracted with USA and USSR.

MILESTONES
Italian Group for Uranium Enrichment (GIAU) was set up in 1967 with participation of government agencies and industrial groups to sponsor R&D programs of gaseous diffusion, ultra-centrifuges and laser photo-excitation (Note 1).

RESOURCES

CURRENT STATUS
Agip Nucleare and CNEN each hold 12.5% interest in Eurodif and through Eurodif a 6.4% interest in Coredif, both in France.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
National Committee for Nuclear Energy (CNEN)

KEY CONTACTS
Prof. E. Clemental, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Saluggia Laboratory		Uranium enrichment

PROGRAM SUMMARY--IT NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Participation in Eurodif and Coredif for long-term enrichment services.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Separative work demand is projected at 2200 t/a in the early 1990s and onward (Note 1).

PROGRAM SUMMARY--IT NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Vol. 3, pages 5 to 17, IAEA Salzburg Conference, May 1977 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Supply components and equipment for domestic reactors and for export.

MILESTONES

RESOURCES

CURRENT STATUS
Italy has capability of manufacturing fuel assemblies and pressure vessels.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CNEN

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
CNEN	Cassacia	Fuel Develop.

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Fuel fabrication and equipment manufacture.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
(1) CNEN has a small (pilot) mixed oxide fabrication facility for LWR and FBR fuels at Cassacia research center
(2) Breda Termomeccanica builds pressure vessels, 4 to 6 vessels per year. On-site welding required.

SIGNIFICANT PARAMETERS
(1) Agip Nucleare and French CEA formed a joint company Societa Fabricationi (SF) to fabricate fuel for the Super Phenix FBR of France.
(2) Terni capable of manufacturing small sized pressure vessels (e.g., Garigliano BWR) and parts of large pressure vessels.

PROGRAM SUMMARY--IT NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Import large LWRs from the USA and develop domestic manufacturing capability under licensee agreements with foreign manufacturers.

MILESTONES
Pre-1977 LWR installed capacity of 392 MWe (242 MWe PWR and 150 MWe BWR), 3166 MWe projected for 1985 and 29100 MWe for 2000.

RESOURCES
$19.8 million in 1977. Financing of power plants has been through loans contracted with Export-Import Bank through Instiuto Mobiliare Italiano and the European Investment Bank.

CURRENT STATUS
Revised version of National Energy Plan (issued December 1977 by Interministerial Committee for Economic Planning) includes construction of 12 LWRs, 1000 MW each, and 2 CANDU type reactors, 600 MW each. Estimated total cost $6.36 billion (Note 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) AMN Impianti Termici e Nucleari SpA (AMN)-GE licensee. Renewal is unlikely when license expires in 1982 (Note 4).
(2) Societa Impianti Generazione Energia Nucleare SpA (SIGEN), a joint venture of Fiat and Breda Termomeccanica-Westinghouse licensee.
(3) Societa per Impresa Nucleari (SPIN) with US participants (B&W and Stone and Webster).

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
NUCLITAL Consortium (set up by CNEN and AMN)		BWR technology
CNEN and SIGEN (Note 2)		PWR technology

PROGRAM SUMMARY--IT NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Four power reactors in operation and another five in planning or construction.

APPROACH
(1) Acquisition of data, codes and knowledge for designing core and fuel elements and for designing, building and qualifying nuclear components and systems.
(2) Study and experiment with recycling systems, develop components, design steam generators and analyze radioactive discharges.

PROBLEM AREAS
(1) Difficulty in finding adequate power plant sites (Note 1)
(2) Financing (Note 1)

BENEFITS
Less dependence on imported oil.

FACILITIES
Power plant description/status published annually (in April) by NUCLEAR ENGINEERING INTERNATIONAL and semi-annually (January and July) by NUCLEAR NEWS.

SIGNIFICANT PARAMETERS
(1) Fabricazioni Nucleari (FN) at Bosco Marengo fabricates BWR fuel, 150-200 MT/year, operational since 1974.
(2) COREN at Saluggia assembles PWR fuel, 60 MT/year, operational since 1968.
(3) Italy and the European Economic Community utilize ESSOR reactor as a test facility for LWR fuel behavior study under nominal, transient and accident conditions (Note 2).

PROGRAM SUMMARY--IT NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Vol. 1, pages 155 to 173, IAEA Salzburg Conference, May 1977 DOE
2-Nuclear Power and Its Fuel Cycle, Vol. 2, page 494, IAEA Salzburg Conference, May 1977 DOE
3-Nucleonics Week, January 5, 1978 DOE
4-Nucleonics Week, January 19, 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To enhance the utilization of natural uranium.

MILESTONES

RESOURCES

CURRENT STATUS
(1) NIRA is constructing a 40-MWe heavy water moderated, natural uranium fueled demonstration reactor (CIRENE). NIRA holds a license for CANDU reactors from AECL of Canada.
(2) Revised version of National Energy Plan issued in December, 1977 by Interministerial Committee for Economic Planning) includes construction of two CANDU type reactors (Note 3), 600 MW each (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Nucleare Italiana Reattori Avanzati (NIRA), a joint venture of Agip Nucleare and AMN.

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
CNEN	Saluggia	HWR technology

PROGRAM SUMMARY--IT NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
One demonstration reactor in construction and two power reactors in planning.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
CNEN has a pilot line in Saluggia for fabricating the first CIRENE Core (Note 1).

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--IT NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Power and Its Fuel Cycle, Vol. 3, pages 3 to 17, IAEA Salzburg Conference, May 1977 DOE
2-Nucleonics Week, January 5, 1978 DOE
3-Nuclear News, March 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Not clear if Italy will promote further GCR technology.

MILESTONES

RESOURCES

CURRENT STATUS
Latina MAGNOX reactor, 160 MWe, operational since January 1964.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Electric Energy Agency (ENEL), the state electricity producer

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IT NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
One reactor in operation and another one of joint undertaking with other countries in construction.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Latina reactor of MAGNOX type, 160 MWe, operational since January 1964. Reactor vendor TNPE, utility ENEL.

SIGNIFICANT PARAMETERS
Fuel assemblies for Latina MAGNOX reactor were assembled by Combustibili Nucleari SpA in Rotondella (Matera), 30 MT/year, operational since 1969.

PROGRAM SUMMARY--IT NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop economically competitive LMFBR to be deployed commercially in the 1980s. Italy is committed to breeder development.

MILESTONES

RESOURCES
$67.4 million 1977 and $630 million 1978 to 1985

CURRENT STATUS
(1) Design of LMFBR test reactor PEC began in early 1970s (Note 3), 140 MWth prototype, for testing fast reactor fuel elements.
(2) Cooperation with France and West Germany in LMFBR development (Notes 2 and 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
National Committee for Nuclear Energy (CNEN)

KEY CONTACTS
Prof. E. Clemental, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Nucleare Italiana Reattori Avanzati (NIRA)		Development of advanced fast breeder

PROGRAM SUMMARY--IT NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
One test reactor and one power reactor both in construction.

APPROACH
Although PEC-related effort continues, the main emphasis is directed toward international cooperation on breeder development (Note 3). The Italian Parliament approved on October 5, 1977, continued research and development in the framework of existing international agreements (Note 1).

PROBLEM AREAS

BENEFITS
Dependence on breeders for long-term power supply is imperative for lack of uranium resources.

FACILITIES

SIGNIFICANT PARAMETERS
(1) Construction of the PEC test reactor by Nucleare Italiana Reattori Avanzati (NIRA).
(2) Ente Nazionale per l'Energia Elettrica (ENEL) is participating in the construction of the large LMFBR demonstration plant at Creys-Malville, France (1200 MWe, Super Phenix) and West Germany (SNR-300) (Notes 2 and 3).

PROGRAM SUMMARY--IT NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, November 1977 DOE
2-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, K. M. Harmon, Battelle Pacific Northwest Laboratories, January 1978 DOE
3-International Cooperation on Breeder Reactors, The Rockefeller Foundation, May 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To promote basic research on nuclear technology.

MILESTONES

RESOURCES

CURRENT STATUS
Italy has capability to design and construct research reactors and fabricate the required fuels.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
National Committee for Nuclear Energy (CNEN)

KEY CONTACTS
Prof. E. Clemental, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IT NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Fourteen research and test reactors in operation.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

NAME	TYPE	MW(th)	DATE
ISPRA-I	tank,20%U, D20	5	1959-1974
ECO	tank,nat.U, D2O,organic	0	1965-1972
ESSOR	tank,nat.U, D2O,organic	40	1967
RANA	pool,20%U,H2O	0	1961
RITMO	pool,90%U,H2O	0	1965
TAPIRO	fast,93.5%U,He	0	1971
RC-1	solid homog.	1	1960
ROSPO	tank,89.9%U	0	1963
TRIGA-II	solid homog.	0	1960
RB-1	graphite,20%U	0	1962
RB-2	graphite,20%U	0	1963
Avogadro	pool,90%U-AL,H2O	7	1959-1973
Galileo Galelei	pool,89.9%U-AL,H2O	5	1963
AGN 201-110	solid homog.	0	1960
Triga-II-Pavia	solid homog.	0.25	1965
L-54	aqu. homog.	0	1960
PEC	FBR	140	1978
CIRENE	nat. U	128.5	--
RB-3	tank,D2O	0	1971

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--IT NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop capability for domestic spent fuel in 10-15 years (Note 2).

MILESTONES

RESOURCES

CURRENT STATUS
Two small reprocessing plants, EUREX and ITREC, in operation (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
CNEN

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) La Trisaia Nuclear Research Center		Reprocessing
(2) Saluggia Research Center		Reprocessing
(3) Military Center for Applied Nuclear Energy (LAMEN)		Reprocessing

PROGRAM SUMMARY--IT NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Two small scale reprocessing plants are in operation.

APPROACH
Whether Italy will develop its own commercial reprocessing plant or go into partnership with another European country is not certain (Note 2).

PROBLEM AREAS

BENEFITS

FACILITIES
(1) EUREX reprocessing plant at Saluggia research center, 0.03 MT/year (MTR-fuel) and 0.1 MT/year (LWR and MAGNOX fuel), operational since 1970, partly funded by EURATOM.
(2) ITREC reprocessing pilot plant owned by CNEN (Note 2), at Trisaia Nuclear Center, completed in 1968, 15 Kg/day of ThO_2 and UO_2 fuels (Note 1).

SIGNIFICANT PARAMETERS
Agip Nucleare plans to develop data from the two existing plants to be used for designing the next generation of commercial plants (Note 2). Projected capacity of 1000-1500 tonnes per year, operational in late 1980s (Note 1). Implementation of this plan is not certain.

PROGRAM SUMMARY--IT NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-PNL-2478, International Source Book - A Compendium of World Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, K. M. Harmon, Battelle Pacific Northwest Laboratories, January 1978 DOE
2-Nucleonics Week, July 27, 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To dispose nuclear wastes by safe and economical means.

MILESTONES

RESOURCES

CURRENT STATUS
Experimental work on waste disposal is in progress.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
National Committee for Nuclear Energy (CNEN)

KEY CONTACTS
Prof. E. Clemental, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Trisaia Nuclear Research Center		Treatment of solid and liquid wastes (Note 1)

PROGRAM SUMMARY--IT NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Small-scale waste disposal methods are planned or in experimentation.

APPROACH

Agip Nucleare and CNEN have set up a working group to study waste-disposal and plan to build a vitrification and calcination plant to experiment with non-radioactive materials first. Experience from the first step would enable Italy to build a test plant to condition the small amounts of nuclear wastes in the next few years. Final disposal of the conditioned waste will probably be in thick clay beds (Note 2).

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

(1) CEC nuclear research center at Ispra has two major waste management projects, one on evaluation of long-term hazard of radioactive waste disposal and the other on chemical separation and nuclear transmutation of actinides.

(2) CNEN is studying the properties of plastic argillaceous sediments in the Trisaia area as a possible site for geologic disposal of radioactive wastes.

PROGRAM SUMMARY--IT NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-PNL-2478, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, K. M. Harmon, Battelle Pacific Northwest Laboratories, January 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-N72-20734, Disposal of the Radioactive Wastes at Trisaia Nuclear Research Center, February 1973 DOE

2-Nucleonics Week, July 27, 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To monitor radioactivity in environment and to protect the public.

MILESTONES
Laws passed in 1962 and 1975 assigned protection and safety tasks to CNEN.

RESOURCES

CURRENT STATUS
Environmental radioactivity data regularly collected through a nationwide monitoring network (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
National Committee for Nuclear Energy (CNEN)

KEY CONTACTS
Prof. E. Clemental, CNEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--IT NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--IT NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Prot-San 11/71, Data on Environmental Radioactivity Collected in Italy (January-December 1970), CNEN, October 1971. DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

JA: JAPAN

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	4
Enrichment Plants	6
Fuel Fabrication	8
Light Water Reactors (LWR)	10
Heavy Water Reactors (HWR)	12
Gas Cooled Reactors (GCR)	14
Liquid Metal Fast Breeder Reactors (LMFBR)	16
Research and Test Reactors	19
Spent Fuel Processing	21
Waste Management	24
Safety and Environment	27

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Import uranium from overseas while extensively participating in overseas uranium projects to meet its long-term uranium needs.

MILESTONES
(1) Domestic uranium exploration began in 1954-56.
(2) Domestic resources are insignificant (9000 tonnes U3O8 proven, 0.053 grade, 4000 tonnes at 0.1 grade).
(3) Aggressive overseas ventures underway.

RESOURCES
Note 2
(1) Exploration expenditures domestically - $10.6M (pre-1972) about $3M (1972-1976)
(2) Exploration expenditures abroad
pre-1972: $0.41M (PNC) $7.9M (private)
1977: $8.0M (PNC) $16.0M (private)
(3) About $0.6 Billion, FY1978-87 (Note 4)

CURRENT STATUS
(1) Uranium is imported from Canada, S. Africa and Namibia, France, UK, Australia, and USA (3.3 pct only from USA). Total commitment of 135,000 ST U3O8 (As of Jan. 1975).
(2) Japanese companies are engaged in uranium development activities overseas (Niger, Algeria). OURD will start U3O8 production in Niger in 1979/80 (2000 MTU/year).
(3) Japan to specify to Australia its uranium needs in August 1978 talks in Tokyo.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) Direct Sponsors are PNC and Metal Mining Corporation
(2) Private industries (electric power companies, mining companies and trading companies)

KEY CONTACTS
Mr. M. Segawa, President (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) PNC	Tokyo/Ningyo Toge	Prospecting in Tono area (1978)
(2) Geological Survey of Japan	--	Surveying
(3) Metal Mining Corporation	Tokyo	Surveying

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Secure uranium supply from overseas.

APPROACH
(1) Distribute uranium importing sources
(2) Accelerate overseas development
(3) Long-term purchase contracts

PROBLEM AREAS
(1) Japan has to rely on overseas uranium supply.
(2) Uncertainties exist in uranium exporting policy of resource countries for overseas mines in which Japan participates in development/production.

BENEFITS
Nuclear power viability (interim)

FACILITIES
PNC-Ningyo Tohge uranium production.

SIGNIFICANT PARAMETERS
(1) Overseas Uranium Exploration ventures (Note 3)
PNC - Discovery in Kelowna, B.C. Canada; Exploration in Niger
International Resources Development Co. - Exploration in Niger
OURD - 25 pct ownership of Akouta deposit, plus other properties in Niger
Tokyo Uranium Development Co. - 20 pct ownership of exploration venture in Mauritania
Mitsui - Joint venture with Denison Mines in Elliot Lake, Canada
Mitsubishi and PNC - Exploration ventures in Western USA
Japan Petroleum Trading Co. - Joint Ownership of Azelik deposit in Niger
(2) Program to extract uranium from sea water began in 1975 (Note 1).
(3) PNC set up subsidiaries in Australia and Canada, and it is trying to increase its FY 1979 overseas budget by 32% to $24.4 million (Note 5).

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Atomic Power Pocket Book, Japan Atomic Industrial Forum, November 1977 (In Japanese)

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-M. Kanno, Extraction of Uranium from Sea-Water, IAEA-CN-36/161, Proc. of Inter Conf., Salzburg, May 1977 DOE
2-Uranium: Resources, Production and Demand, A joint report by OECD/NEA and IAEA, December 1977 DOE
3-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978, p. 5-15 WENDS
4-Atoms in Japan, p.20, July 1978
5-Nuclear Fuel, September 4, 1978 DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop uranium mining and milling processes for export to uranium producers overseas as part of its international uranium supply ventures.

MILESTONES
(1) The Ningyo-Tohge uranium (pilot) refining facility was established (1964).
(2) The direct ore to UF4 or UF6 processing technology was developed (PNC process).
(3) PNC to build a uranium refining plant (200 MT/yr) at Ningyo-Tohge to produce UF6 for domestic enrichment (Note 3).

RESOURCES
$4.1M (1976), $8.3M (1977)

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
PNC/STA

KEY CONTACTS
Mr. M. Segawa, President (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
PNC	Ningyo-Tohge	Uranium refining
Research Development Corp. (RDCJ) (Government of Japan)	Tokyo	Low-grade uranium leaching
Mitsubishi Rayon Co.	Tokyo	Low-grade uranium leaching

PROGRAM SUMMARY--JA NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
PNC -- Ningyo-Tohge mine and pilot milling plant (1964)

SIGNIFICANT PARAMETERS
PNC process - Direct ore to UF4 or UF6 conversion (bypasses U3O8 step).

Continuous absorbent leaching technique developed for low-grade uranium ores (Note 1).

IRSA (sub. of Tokyo-based Arabian Oil Co.) to produce 1500 tonnes/yr yellow cake starting in 1983 from low-grade ore in Niger (Note 2).

PROGRAM SUMMARY--JA NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, Vol. 3, June 1978 (Draft). DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Fuel, June 27, 1977 DOE
2-Nuclear Fuel, May 29, 1978 DOE
3-Atoms in Japan, p. 27, June 1978

PROGRAM SUMMARY--JA NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop domestic enrichment capability to increase security of supply of enriched uranium and reduce foreign exchange outflow while depending on overseas supply.

MILESTONES
(1) PNC performed evaluation of diffusion and centrifuge technology in 1970-1972.
(2) Adopted centrifuge technology in 1973.
(3) Built a small experimental cascade facility (operated since 1974).
(4) Is constructing a pilot facility of 50 tSWU/y (1977, operation in 1980).
(5) A demonstration plant will be constructed in early 1980s.
(6) The demonstration plant is expected to be expanded to a few thousand tonnes SWU (industrial plant) in late 1980s.
(7) Is negotiating to build enrichment facilities in Australia.

RESOURCES
$27.7 M (1976), $32.8 M (1977)/About $1.5 Billion (FY 1978-87)-Note 4

CURRENT STATUS
(1) Tokai-Mura facility operating since 1974.
(2) The 500 thousand SWU/YR demonstration centrifuge facility is under construction at Ningyo (10 thousand machines).
(3) Japan-Australia negotiations stalled because of US anti-proliferation position.
(4) R&D on enrichment by ion-exchange chromatography by Asabi Chemical Industry Co. Lab-tests reported to justify the needs for future extensive R&D, and STA may appropriate expanded budget.

SOURCE: NUS Corporation DATE: 15 SEPT 1978

SPONSORS
Science & Technology Agency (STA)/PNC

KEY CONTACTS
Mr. M. Segawa, President (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
PNC	Tokyo/Tokai-Mura	Centrifuge R&D Plant Operation

PROGRAM SUMMARY--JA NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Design, build and operate two centrifuge cascades.
(2) Build and operate a pilot plant in 1980.
(3) Build and operate a large demo plant in mid-1980s.
(4) Expand the demo plant to industrial plant in late 1980s.

APPROACH
(1) Buy enriched uranium as UF6 from US stockpile (equivalent to 12 million lb U3O8) - discussion with DOE currently (Note 3) Enriched UF6 from US stockpile negotiating points - lending to a international nuclear fuel bank, yen/$ exchange rate for transaction, sale commercial terms and conditions, UF6 storage (Note 2).

PROBLEM AREAS

BENEFITS

FACILITIES
PNC-Small pilot centrifuge facility at Tokai-Mura (50 thousand SWU/YR)

SIGNIFICANT PARAMETERS
Tokai-Mura has performed satisfactorily (Note 2). C-I cascade (180 machines) produced slightly enriched uranium/operation 1974. C-II cascade (247 machines) produced 1.5E uranium/operation 1976.

PROGRAM SUMMARY--JA NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-T. Watanabe, T. Murase, Uranium Enrichment by Centifugation in Japan, IAEA-CN-36/160, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-T. Aouchi et al., Research on the Economic Evaluation of Uranium Enrichment by Gaseous Diffusion in Japan, IAEA-CN-36/552, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-NAC C-7827, International Data Collection and Analysis, Draft Vol. 3, June 1978 DOE
4-The Japan Economic Journal, Aug. 1, 1978

PROGRAM SUMMARY--JA NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, Vol. 23, No. 272, p. 5 (5 78) DOE
2-Nuclear Engineering International, Vol. 23, No. 273, p. 12 (6/78) DOE
3-Nucleonics Week, July 13, 1978 DOE
4-Atoms in Japan, P. 20, July 1978

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Import LWR fuel fabrication technology from abroad under agreements, develop domestic industry to meet its demand and utilize plutonium oxide fuel to decrease its uranium requirements.

MILESTONES

RESOURCES

CURRENT STATUS

(1) Plutonium MOX fuel fabrication capacity (MT/YR) (Note 1)
Thermal-10 in 1976, 50 (pilot) in 1983, 200 (production) in 1988.
Fast - 2 in 1976, 10 (pilot) in 1983, 50 (production) in 1988.
(2) All PWR fuel is supplied by MNF, except Westinghouse supplies fuel for first cores of its reactors.
(3) All BWR fuel is supplied by JNF in a captive market.
(4) NFI is trying to break the monopolies held by MNF and JNF.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

I. LWR fuel vendors
(1) Mitsubishi Nuclear Fuel Co., Ltd. (MNF)
(2) Sumitomo Metal Mining Co., Ltd. (SMM)
(3) Japan Nuclear Fuel Co., Ltd. (JNF)
(4) Nuclear Fuel Industries, Ltd. (NFI)

II. Science and Technology Agency (STA)--Advanced reactor system fuels (Gov't)

CONTACTS

Mr. T. Muto, Manager, Plutonium Fuels Div., Tokai, PNC

R&D ORGANIZATIONS		LOCATION	PROGRAM AREA
I.	(1) MNF (W. Lic.)	Tokai-Mura	UF6 to UO2, Fuel fab
	(2) SMM	Tokai-Mura	UF6 to UO2
	(3) JNF (GE Lic.)	Kanagawa	Fuel fab
	(4) NFI	Tokai-Mura	Fuel fab
II.	(1) PNC	Tokai-Nura	Plutonium fuel fab
	(2) JAERI	Oarai	Plutonium fuel research

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
(1) Use plutonium in thermal reactors (1991-2000)
(2) Use plutonium in breeders (1990-)

PROBLEM AREAS
Proliferation aspects associated with the use of plutonium.

BENEFITS
Participation in INFCE

FACILITIES
I. (1) SMM - UF6 conv, Tokai-Mura (1 MT/day 1973)
(2) MNF - UF6 conv and Fuel fab, Tokai-Mura (420 MT/yr, LWR, 1972)
(3) JNF - Fuel fab, Kanagawa (490 MT/yr, LWR, 1972)
(4) NFI - Fuel fab, Tokai-Mura (100 MT/yr, LWR, 1978)
II. (1) PNC - Plutonium Fuel Development Facility (PFDF, 1965) and Plutonium Fuel Fabrication Facility (PFFF, 1971).
(2) JAERI - Hot laboratory (Tokai)
(3) JAERI - Plutonium fuel research laboratory (Oarai)

SIGNIFICANT PARAMETERS
(1) SMM uses the ADU process for UF6 conversion to UO2. It plans to build a new 340 MT/yr plant at Tokai-Mura (oper in 1979).
(2) JNF capacity of 490 MT/yr is adequate until the early 1980s. Plant constructed so capacity could be increased by 50 pct.
(3) The MNF facility is the only completely integrated fab plant in Japan.
(4) NFI fabricated and irradiated successfully test assemblies in domestic BWRs and PWRs. It expects to receive about 1/3 of the domestic market (long-term).

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-T. Muto et al., Status of the Development of Mixed-Oxide Fuels in the Power Reactor and Nuclear Fuel Development Corporation (PNC), IAEA-CN-36/553, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Atomic Power Pocket-Book, JAIF, Nov. 77 (In Japanese)
3-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-T. Amanuma, K. Uematsu, Plutonium Utilization in Thermal and Fast Reactors in Japan, IAEA-CN-36/162, Proc. of Inter. Conf. Salzburg, May 1977 DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Import large LWRs from the USA first and establish domestic reactor manufacturing capability under license agreement to build follow-on plants to same specifications. Standardize large LWRs to Japanese environment.

MILESTONES

(1) Pre-1977 LWR installed capacity of about 6.9 GWe (3.7 GWe PWRs, 3.2 GWe BWRs)
(2) 1985-Projected LWR installed capacity of 30 GWe
(3) 2000-Projected LWR installed capacity of 98 GWe

RESOURCES

$150M (1977) for power reactor development

CURRENT STATUS

The first standardized PWR design has been approved for construction.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

LWR domestic manufacturers
(1) Mitsubishi Heavy Industries Co., Ltd. (MHI) - Westinghouse licensee
(2) Hitachi, Ltd.-General Electric licensee, B&W (UK) agreement
(3) Tokyo Shibaura Electric Co., Ltd. (Toshiba) - General Electric, AEG and Brown-Boveri licensee
(4) MITI-Gov't

KEY CONTACTS

Mr. E. Munakata, President (JAERI)
Mr. M. Segawa, President (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) JAERI/Oarai	Oarai-Machi	Reactor Technology Materials & Components Testing
(2) PNC	Oarai-Machi	Reactor Engineering
(3) National Research Institute for Metals	Meguro-Ku	Materials

PROGRAM SUMMARY--JA NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Import US LWRs
(2) Import LWR manufacturing capability
(3) Establish domestic LWR manufacturing capability, and standardization
(4) Manufacture domestically all LWRs needed by utilities

APPROACH
Japan did not have domestic R&D capability in late 1950s and it decided to first import LWRs from the USA and then develop LWR manufacturing capability through licensing agreements with General Electric and Westinghouse.

PROBLEM AREAS
(1) Public acceptance
(2) Low plant capacity factor (55.2% through 1976)
(3) Assurance of construction sites
(4) Reprocessing of spent fuels

BENEFITS
Timely utilization of imported LWRs as energy source while not overburdening domestic industry and government outlays. Step-by-step development of domestic manufacturing capability.

FACILITIES
Power plant description/status published annually (April) by NUCLEAR ENGINEERING INTERNATIONAL and semiannually (July, January) by NUCLEAR NEWS.

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--JA NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-S. Aoki et al., Safety Aspects and Operating Experience of LWR Plants in Japan, IAEA-CN-36/544, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Atomic Power Pocket Book, JAIF, Nov. 1977
3-NAC C-7827, International Data Collection and Analysis, Vol. 3, June 1978 (Draft) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Develop an advanced thermal reactor (ATR) system to utilize the plutonium from the LWRs in the interim period (1985-2000) before ultimately using it in fast breeders.

MILESTONES

(1) FUGEN, a prototype 160 MWe ATR (Heavy water moderated-boiling water cooled) is in final construction stage at Tsuruga. Startup scheduled for 1978 (Note 2).
(2) Planning underway regarding the installation of a CANDU HWR plant (two 600 MWe reactors).

RESOURCES

(1) A 600-MWe CANDU to cost $800-$1000 million (Note 4).
(2) About $1.5 Billion on ATR (FY78-87) (Note 5).

CURRENT STATUS

(1) There is a 50-50 chance that a CANDU plant will be purchased.
(2) Electric Power Development Co. signed a CAN $1.8M agreement with AECL (Canada) covering CANDU plant engineering (Note 3).
(3) Electric Power Development Co. sought $13.5 million for FY-79 R&D on CANDU ($5.8 million on safety, $9.5 million on environmental) (Note 6).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Science & Technology Agency (STA)/PNC
Electric Power Development Co., a semi-government company controlled by Ministry of International Trade and Industry

KEY CONTACTS

Mr. M. Segawa, President (PNC)
Mr. S. Shima, FUGEN Project (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
PNC	Tokyo	ATR

PROGRAM SUMMARY--JA NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
Use a prototype ATR as a first step to commercialization
(1) 1978- ATR Prototype operation
(2) 1985-1990 One 1000 MWe ATR introduced per year
(3) -2000 ATR deployment equivalent to 10 pct of gen capacity

PROBLEM AREAS
(1) Proliferation aspects of plutonium
(2) Timing of FBR commercialization

BENEFITS
(1) Early utilization of LWR-produced plutonium to reduce U3O8 requirements
(2) Nuclear power program diversity
(3) A 100% domestic technology

FACILITIES
Oarai Engineering Center (PNC) - Support test facilities for FUGEN

SIGNIFICANT PARAMETERS
As of 3/1977, over 10 tonnes of plutonium MOX fuel had been fabricated for FUGEN at the Plutonium Fuel Development Laboratory (PNC).

PROGRAM SUMMARY--JA NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-T. Amanuma, K. Uematsu, Plutonium Utilization in Thermal and Fast Reactors in Japan, IAEA-CN-36/162, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE
3-Nucleonics Week, July 13, 1978 DOE
4-The Energy Daily, July 13, 1978 DOE
5-Atoms in Japan, p. 20, July 1978
6-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Develop multipurpose HTGR technology for industrial power generation.
(2) Develop base technology through international cooperation.

MILESTONES
(1) Imported a 160 MWe GCR (Magnox) plant from UK (comm in 7/66) - the first commercial nuclear reactor in Japan.
(2) JAERI has underway a design study for a 50 MWT experimental reactor (VHTR).
(3) Fabrication experiments for VHTR particle fuel since 1972.
(4) Process evaluation studies began on the head-end process for VHTR fuel reprocessing.

RESOURCES
$1.9M (1976), $4.0M (1977)--Multi-purpose HTGR. R&D, FY1978-87 ($1.0 Billion) (Note 2)

CURRENT STATUS
Cooperation agreement between Japanese industry and GHT (Bensberg, West Germany) reached on HTR R&D (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Science & Technology Agency (STA)

KEY CONTACTS
Mr. Munakata, JAERI

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
JAERI	Tokai-Mura	Multi-purpose HTGR

PROGRAM SUMMARY--JA NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
Conceptual design work for multi-purpose HTR. This high temperature reactor (1000 degrees F, 50 MWt, thorium fuel) should be operating by 1985 (Note 3).

PROBLEM AREAS
Funding

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Experimental work is being done on coated particle fuels, graphite materials, heat-resisting metals and heat-transfer (JAERI).

PROGRAM SUMMARY--JA NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-S. Nomura et al, Status of VHTR Fuel Research in Japan, IAEA-CN-36/168, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-Nuclear Engineering International, p. 10, September 1978. DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION GCR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, Vol. 23, No. 273, p. 7 (7/78). DOE
2-Atoms in Japan, p. 20, July 1978.

PROGRAM SUMMARY--JA NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE--Develop base LMFBR technology under government financial support and direction primarily. Starting with an experimental LMFBR, Japan plans to build a medium-size prototype LMFBR to demonstrate breeder safety, reliability and economics for eventual deployment of large, commercial LMFBRs beginning in 1995.

MILESTONES
(1) JOYO, the experimental LMFBR (50 MWt) went critical (4/77)
(2) Several key facilities installed
(3) Functional and nuclear tests successfully completed
(4) Construction of the prototype MONJU (300 MWe) to start in 1978
(5) JOYO to be modified to 100 MWt in 1980 for use as irradiation facility
(6) Five large, commercial LMFBRs (loop type--1000 MWe or more each) to be deployed between 1995-2000. Only LMFBRs to be deployed after 2000.

RESOURCES--$500 Million spent through 1976 on fast breeders. $89 Million (1977). R&D, FY 1978-87 ($7.0 Billion) (Note 3).

CURRENT STATUS
(1) JOYO reached 50 MWt level. All tests proceeding smoothly (Note 4).
(2) Japan negotiating with USSR for possible breeder cooperation (Note 4).
(3) Japan-U.S. (DOE) information exchange agreement (3/4/69-3/4/79)
(4) More than one tonne plutonium fuel fabricated for the program at the PNC Plutonium Fuel Development Program (3/77).
(5) MONJU design incorporates PuO_2-UO_2 fuel in SS cladding for the core; depleted UO_2 in blankets.
(6) Five-year agreement of cooperation (physics, safety, plut. fuels) between Japan (PNC), W. Germany (KFK, INTERATOM), and France (CEA)--Tokyo, 6/21/78 (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) PNC/STA-Gov't
(2) Fast Breeder Reactor Engineering Office (FBEO) - Private (Hitachi, Toshiba, Fuji Electric Co., MHI)

KEY CONTACTS
(1) Mr. Segawa, President, (PNC)
(2) Mr. T. Takaichi, General Manager (FBEO)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) PNC	Tokyo/Oarai	Reactor Technology-Fuels, Materials, Components
(2) JAERI	Tokyo	Critical facility
(3) FBEO	Tokyo	MONJU design engineering

PROGRAM SUMMARY--JA NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Established LMFBR design and safety criteria.

APPROACH
(1) Use small prototypes and pilot plant facilities to carry out detailed performance and process evaluations on which to base the design of a demonstration LMFBR.
(2) Cooperate with the USA, UK, France, and Germany in component testing and prototypical fuels.

PROBLEM AREAS
Fusion is the only potential alternative energy source to meet future demand.
International concern over safeguards and nuclear weapons proliferation.
Public acceptance of LMFBRs, i.e., safety, environmental impact and waste handling and disposal.

BENEFITS
(1) Elimination of need for uranium imports and enrichment
(2) Utilization of the plutonium from the LWRs
(3) Adequate energy supply for centuries
(4) Japan cooperation with KFK (W. Germany) since 1971. New agreement (PNC-KFK/INTERATOM/CEA) to involve the Netherlands and Belgium in partnership with W. Germany, and Italy (CNEN) in partnership with France (Note 2).

FACILITIES
(1) Oarai Engineering Center (PNC) - Sodium boiling, component testing, steam generator development, instrumentation, materials development, post-irradiation testing facilities, etc.
(2) Tokai Research Establishment (JAERI) - Critical facilities, hot laboratory, development of advanced reactors.

SIGNIFICANT PARAMETERS
(1) Post-irradiation testing at OEC confirmed JOYO 50 MWD/kg design
(2) JOYO expected to achieve breeding ratio of 1.2 at 50 MWt.
(3) JOYO critical tests completed by JAERI.
(4) MONJU critical tests completed in 1973 at Zebra (Co-oper UKAEA)
(5) Steam generator (50 MWt size) completed in 1975 by OEC.
(6) In-core irradiations completed or under way at GETR (US), Rapsodie and Phenix (France).
(7) Physics and testing of advanced carbide fuels for commercial LMFBRs under way at JAERI with involvement of universities and industry.
(8) Sodium and component technology R&D continuing.
(9) Out-of-pile experiments have been conducted to evaluate local faults in fuel subassemblies and steam generators (Note 1).

PROGRAM SUMMARY--JA NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-T. Amanuma, K. Uematsu, Plutonium Utilization in Thermal and Fast Reactors in Japan, IAEA-CN-36/162, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-T. Suita, A. Oyama, Status and Programme of Fast Breeder Reactor Development in Japan, IAEA-CN-36/164, Proc. of Inter. Conf., Salzburg, May 1977. DOE
3-J. E. Gray et al, International Cooperation on Breeder Reactors, the Rockefeller Foundation, May 1978. DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Y. Kikuchi et al., Evaluation of Local Accidents in Fast Breeder Reactors, IAEA-CN-36/551, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-Atoms in Japan, p. 25, June 1978
3-Atoms in Japan, p. 20, July 1978
4-Nuclear Engineering International, Vol. 23, No. 273, p. 7 (7/78) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Support power reactor and fuel development activities.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Hitachi		Design/construction
Toshiba		Design/construction
JAERI		Design/construction
Nippon Atomic		Design/construction
Mitsubishi		Fuel fab
Sumitomo		Fuel fab
Furukawa		Fuel fab
PNC		Fuel fab

PROGRAM SUMMARY--JA NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
Operation of a materials test reactor by JAERI at Oarai (50 Mwt - JMTR).

PROBLEM AREAS

BENEFITS

FACILITIES
NFI fuel fabrication at Kanagawa and Osaka (60 MT/YR -early 1960s)

SIGNIFICANT PARAMETERS
List of Research and Test Reactors (Note 1)

NAME	LOCATION	OWNER	TYPE	MW(th)
JRR-2/1960	Tokai	JAERI	HW	10
SHCA/1961	Tokai	JAERI	Tank	0
AHCF/1961	Tokai	Aerojet	Critical	0
UTR-10/1961	Higashi	Kinki	Critical	0
HTR/1961	Kawasaki	Tokyo Atomic	Argonaut	0.10
Triga-II/1961	Yokosuka	Rikkyo	Pool	0.10
TTR/1962	Kawasaki	Toshiba	U-Zr	0.10
TCA/1962	Tokai	JAERI	Pool	0
JRR-3/1962	Tokai	JAERI	Critical	10
OCF/1962	Kawasaki	Hitachi	HW	0
TRIGA-II/1963	Kawasaki	Gotoh	Critical	10
NCA/1963	Kawasaki	Nippon	U-Zr	0
KUR/1963	Kumatori	Government	Critical	5
JRR-4/1965	Tokai	JAERI	Tank	2.50
JMTRC/1965	Oarai	JAERI	Pool	0
SCA/1966	Tokai	-	Pool	0.10
FCA/1967	Tokai	-	Tank	0
JMTR/1968	Oarai	JAERI	Critical	50
DCA/1969	Tokai	-	Critical	0
YAYOI/1971	Tokai		Fast	0
KUCA	Kumatori		Critical	0
NSRR	Tokai	-	U-Zr	0.3

PROGRAM SUMMARY--JA NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827 Vol. 3, June 1978 (Draft) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Ship and reprocess LWR spent fuel overseas on large scale while developing domestic capability over the next 15 years based on foreign proven technology.

MILESTONES
(1) PNC built a small pilot plant (purex-0.7 MTU/D) with assistance from the French SGN (1974) (Note 4).
(2) Plans to build a commercial size plant (5 MTU/D) with sponsorship from government, utilities and LWR manufacturers-construction to begin 1987 (Note 6). The second commercial size plant (5 MTU/D) in 1993.
(3) Projected commercial LWR fuel reprocessing capacity - 170 T/yr (1980 - 1985) 1370 T/yr (1990) 2570 T/yr (1995).
(4) Under contracts it will reprocess 1600 MTU at BNFL-Windscale and another 1600 MTU at COGEMA-La Hague (Note 5).
(5) INFCE participation (1977-).

RESOURCES
Transport of 3200 MTU spent fuel to Europe to cost 200 million British pounds. BNFL reprocessing of 1600 MTU spent fuel to cost 300 million British pounds (Note 7).
R&D, FY1967-77 ($0.25 Billion), FY 1978-87 ($0.35 Billion) (Note 9).

CURRENT STATUS
(1) PNC pilot plant successfully operated for the limited period of two years as agreed with USA.
(2) Amendment to the law was sent to the Congress, which would enable private sectors establish an organization to plan and construct/operate the commercial reprocessing plant (Spring 1979).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
(1) PNC
(2) Federation of Electric Power Companies (FEPC) - Private

KEY CONTACTS
Mr. K. Nakamura, Director, PNC
Mr. S. Tamiya, Senior Advisor, FEPC

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
PNC	Tokyo/Tokai-Mura	Purex

PROGRAM SUMMARY--JA NUCLEAR FISSION SPENT FUEL REPROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop technology under government sponsorship
(2) Transfer demonstrated technology to the private sector

APPROACH
Design, build, and operate conventional PUREX repro plants.

PROBLEM AREAS
(1) Government permission, MB-10, required under Japan-US bilateral agreement to ship fuel to Europe
(2) Tokai-Mura pilot plant limited to 99 tonnes in the next two years by the Japan-US agreement (late 1977)
(3) International non-proliferation political climate
(4) Public acceptance of construction of commercial-size plants
(5) Radwaste management/disposal

BENEFITS
(1) Utilization of a highly-developed heavy industry
(2) Long term contracts with BNFL/COGEMA meet the demand until domestic supply is provided

FACILITIES
PNC-Purex pilot plant at Tokai-Mura (210 MT/YR - 1974)

SIGNIFICANT PARAMETERS
(1) Tokai-Mura pilot plant was completed and chemical tests were performed in 1974. Testing program interrupted in 1977 due to negotiations with USA on safeguards. Plant has processed 3.3 tonnes fuel from a test BWR, 4.7 tonnes fuel from the Fukushima-1 BWR, and 6.4 tonnes high burnup fuel from a PWR (Notes 8 and 14).
(2) MB-10 issued to Tsuruga-1 (JAPC) because of lack of storage capability (Note 8). See also note 12 on current developments.
(3) Delivery of spent fuel to UK beginning in 1982 with reprocessing to commence in 1987 (Note 11).
(4) Tests have been performed to develop spent fuel shipping cask design and criteria for sea transportation (Note 3).
(5) FBR repro facility (Tokai-two cells) - Construction began 6/78 (Note 10).
(6) Transfer of US-origin spent fuel to Windscale and La Hague must be approved by the USA under the Nuclear Non-Proliferation Act of 1978 (Note 13).

PROGRAM SUMMARY--JA NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. Van Dievoet et al., Plutonium Use - Present Status and Prospects, IAEA-CN-36/477, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-T. Amanuma, K. Uematsu, Plutonium Utilization in Thermal and Fast Reactors in Japan, IAEA-CN-36/162, Proc. of Inter. Conf., Salzburg, May 1977. DOE
3-S. Aoki, Y. Ando, R&D of Spent-Fuel Shipping Casks and the Criteria for Sea-Going Vessels Carrying Them, IAEA-CN-36/155, Proc. of Inter. Conf., Salzburg, May 1977 DOE
4-K. Hashimoto et al., Experience in Constructing a Spent Nuclear Fuel Reprocessing Plant in Japan, IAEA-CN-36/167, Proc. of Inter. Conf., Salzburg, May 1977 DOE
5-Nucleonics Week, 10/6/77 DOE
6-Nuclear Engineering International, Vol. 23, No. 272, p. 7 (6/78) DOE
7-Nuclear Engineering International, Vol. 23, No. 272, p. 3 (6/78) DOE
8-Nuclear Engineering International, Vol. 23, No. 273, p. 5 (7/78) DOE
9-Atoms in Japan, p. 20, July 1978.
10-Atoms in Japan, p. 37, July 1978.
11-Nuclear Engineering International, Vol. 23, No. 273, p. 29 (7/78) DOE
12-The Energy Daily, August 29, 1978 DOE
13-Nucleonics Week, August 24, 1978 DOE
14-Nuclear Engineering International, pp.51-54, September 1978 DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Store high-level waste while developing immobilization technology and identifying geologic isolation site(s).
(2) Solidify high-level waste from processing domestically and place it, and the solidified waste from processing in England and France, underground.
(3) Develop technology for immobilization of low-level waste for dumping at sea or for shallow land burial.

MILESTONES
(1) Basic processes for high-level waste management (e.g., vitrification, transuranic element separation) have been developed and tested on laboratory scale at JAERI and PNC facilities.
(2) Attractive geologic formation (granite and zeolite rock) have been identified (1977). Conceptual isolation systems have been developed.
(3) Processes of low-level waste treatment have been developed.

RESOURCES
R&D, FY 1968-77 ($20 Million), FY 1978-87 (About $1.0 Billion) - Note 1

CURRENT STATUS
(1) Japan-US (DOE) information exchange agreement (under negotiation).
(2) A demonstration facility is under construction - 1986 operation (PNC).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Science & Technology Agency (STA)

KEY CONTACTS
Dr. K. Araki, Chief, Waste Mgmt. Lab, Tokai (JAERI)
Mr. Matsumoto, Deputy Head, Waste Mgmt. Group, Oarai (JAERI)
Mr. T. Segawa, Head, Technology Div., Tokai (PNC)
Dr. H. Yusa, Senior Research (Hitachi)
Mr. T. Kashiwai (Mitsubishi)

R&D ORGANIZATIONS		LOCATION	PROGRAM AREA
(1)	JAERI	Tokai/Oarai	Research, Engineering
(2)	PNC	Tokai	Basic processes (HLW)
(3)	CRIEPI	-	Solidification, disposal
(4)	Mitsubishi API	Kitabukuro-cho/	Non-HLW
(5)	Mitsubishi Metals Corp.	-	Geology
(6)	Hitachi	Kuji-cho	Non-HLW
(7)	Nuclear Materials Control Center		
(8)	Radioactive Waste Disposal Center	Tokyo	Low-level waste

PROGRAM SUMMARY--JA NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop design and safety criteria for waste treatment and disposal.

APPROACH
Establish capability along conventional lines.

PROBLEM AREAS

BENEFITS
Recovery of useful isotopes from liquid waste.
Fission product use as heat sources and gamma sources in food preservation.
Zeolite rock used in HLW vitrification is found in Japan.
Zeolite vitrification suppresses volatilization of radioactive components, uses Al_2O_3 and TiO_2 for product durability.

FACILITIES
(1) High temperature incinerators, 100 kg/hr, Tokai (JAERI)
(2) Thermal-decomposition incinerator, Oarai (JAERI)
(3) Waste Management Technology Center, Tokai (PNC)
(4) Storage capacity of HLLW (PNC) - Four tanks of 90 cubic meters each (Tokai)

SIGNIFICANT PARAMETERS
(1) HLW zeolite vitrification product properties excellent (JAERI).
(2) Solvent extraction and ion exchange TRU partitioning tested on bench-scale (JAERI).
(3) Calcination and conversion to glass in melters (JAERI).
(4) HLW fluidized-bed calcination (15 l/hr) at PNC.
(5) HLW sintering or melting of calcined waste; hot pressing with admixed pyrex glass and copper powder (PNC).
(6) LLW process being developed - Reverse osmosis for Co-60 recovery (JAERI), cryogenic distillation for Kr-85 recovery (PNC), solidification in cement (CRIEPI), solidification with polyethylene (JAERI).
(7) Development of plastic-impregnated concrete containers for waste disposal (JAERI).
(8) Question raised recently about devitrification of vitrified high level waste when stored in deep salt repository. Possibly, there are better alternatives to vitrification (Note 2).
(9) Testing of low-level waste disposal in ocean water scheduled for the Fall of 1979 (Note 3).

PROGRAM SUMMARY--JA NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-Proc. of the IAEA/NEA (OECD Symposium) - Management of Radioactive Wastes from the Nuclear Cycle, Vienna, March 22-26, 1976 DOE
2-Proc. of the First Pacific Basin Conf. on Nuclear Power Development and the Fuel Cycles, ANS, Honolulu, Oct. 11-14, 1976 DOE
3-I. Miyanaga et al., Development of Radioactive Waste Management at the Japan Atomic Energy Research Institute, IAEA-CN-36/156, Proc of Inter Conf, Salzburg, May 1977. DOE
4-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management R&D, Vol. 3, Compiled by K. M. Harmon, January 1978 (DOE) DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Atoms in Japan, p. 20, July 1978
2-Nucleonics Week, August 24, 1978 DOE
3-Nuclear Engineering International, p. 7, September 1978 DOE

PROGRAM SUMMARY--JA NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Improve environmental and safety measures.

MILESTONES

RESOURCES
$51M (1976), $57M (1977) for safety studies (Note 2)
$2M (1976), $4M (1977) for safeguards (Note 2)

CURRENT STATUS
Japan-US (NRC) information exchange agreement (5/30/74-5/30/79)
R&D programs are underway at JAERI on reactor safety research, including LOCA, reactivity-initiated structural accidents, fuels, reactor pressure components and safety analysis methods.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Science & Technlogy Agency (STA)
Ministry of International Trade & Industry (MITI)

KEY CONTACTS
Mr. S. Sakata, Chief, Envir. Safety Div., Tokai Lab (JAERI)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) JAERI	Tokai	-
(2) Nuclear Safety Research Association (Private)	Tokyo	Conduct or sponsor R&D on environmental effects

PROGRAM SUMMARY--JA NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) R&D in engineering safety for nuclear plants
(2) R&D in radiation release from nuclear plants
(3) R&D in radiation dose effects on living organisms
(4) R&D in safe disposal of radwaste
(5) R&D in safety of advanced reactors

APPROACH
(1) LOCA/ATWS, fuel integrity, structure (JAERI)
(2) Behavior of released radioactive materials (JAERI)
(3) HLW solidification/disposal of LLW (PNC/JAERI)

PROBLEM AREAS

BENEFITS

FACILITIES
Nuclear Safety Research Reactor, Tokai (JAERI)
LOCA, ATWS, fuel and structure integrity, radwaste at Tokai (JAERI)
LOCA (FBR), ISI, radwaste at Oarai (PNC)

SIGNIFICANT PARAMETERS
Transient fuel performance investigated by JAERI in the NSR, JMT and HBW reactors (Note 1).

PROGRAM SUMMARY--JA NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-H. Akutsu et al., Safety Aspects of Reprocessing and Plutonium Fuel Facilities in PNC, IAEA-CN-36/550, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-T. Itakura et al., Reduction of Releases of Radioactive Effluents from Light-Water Power Reactors in Japan, IAEA-CN-36/166, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-S. Suguri, Studies on the Pressure Boundary Failure and Loss-of-Coolant Accident, IAEA-CN-36/548, Proc. of Inter. Conf., Salzburg, May 1977 DOE
4-Atomic Power Pocket Book, Japan Atomic Industrial Forum, November 1977 (In Japanese)

PROGRAM SUMMARY--JA NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-A. Morishima et al., Safety of Light-Water Reactor Fuel, IAEA-CN-36/549, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-NAC C-7827, International Data Collection and Analysis, Draft Vol. 3, June 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

PK: PAKISTAN

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	4
Fuel Fabrication	5
Light Water Reactors (LWR)	6
Heavy Water Reactors (HWR)	8
Research and Test Reactors	11
Spent Fuel Processing	12
Safety and Environment	14

PROGRAM SUMMARY--PK NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Small quantities of uranium are believed to be produced in the Deri Ghazi Khan region of Pakistan.
(2) Uranium fuel is purchased from other uranium supplier countries
(3) Pakistan is concentrating efforts in uranium exploration, mining and milling and spent fuel reprocessing to develop a source of fuel supply.

MILESTONES

It is estimated that, in 1975, 182 tons of U3O8 were required and by 1985, 1211 tons of U3O8 will be required to meet the demand of the nuclear power plants in Pakistan.

RESOURCES

CURRENT STATUS

20,000 tons of natural uranium is the minimum assured supply based on very limited exploration. That much is believed to exist in the Deri Ghazi Khan region.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government of Pakistan - Pakistan Atomic Energy Agency

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

Uranium deposits do exist in Pakistan and it is believed indigenous uranium resources are sufficient for the KANUPP CANDU reactor. Notes 1 and 2.

APPROACH

A pilot uranium concentrate plant is located at the Deri Ghazi Khan mining area.

PROBLEM AREAS

BENEFITS

Provide uranium fuel for the KANUPP and other future nuclear power plants.

FACILITIES

SIGNIFICANT PARAMETERS

(1) Pakistan law will not permit any significant expansion of private interest into new deposits or new sectors of mineral development. Private industry is only minimally involved in nonpetroleum mineral development in Pakistan.

(2) Pakistan initiated uranium prospecting program in early 1960s.

PROGRAM SUMMARY--PK NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Shafique, M. et al., Development of a National Nuclear Power Program: Constraints Likely to Influence Timing and Introduction, IAEA-CN-36/546, Nuclear Power and Its Fuel Cycle, Volume 6, May 1977 DOE

2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 4, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Pakistan is concentrating efforts in uranium exploration mining and milling and spent fuel reprocessing to develop a source of uranium fuel.

MILESTONES
A pilot uranium concentration plant is located at the Deri Ghazi mining area.

RESOURCES

CURRENT STATUS
Status of the pilot uranium concentrating plant at Ghazi Khan is not known.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Pakistan Atomic Energy Agency

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 4, Volume 4, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

There is presently no enrichment capability in Pakistan and none is planned.

MILESTONES

The present Pakistan reactor, KANUPP, a CANDU type, is a heavy water reactor and requires natural uranium with no enrichment requirements for the base fuel material. However it is considered that for control purposes, some fraction of the fuel is enriched (up to 10%) to overcome the transient buildup of xenon neutron poisoning during a sudden drop in power.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Pakistan is endeavoring to develop domestic skills and manufacturing industries; however, lack of trained personnel, technology and financing limits this effort.

MILESTONES

Presently, no fuel fabrication capability exists.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827 Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) Pakistan has no domestic reactor vendors.
(2) Because of the lack of a strong technological industry, it is anticipated that Pakistan will depend on reactor imports from foreign vendors.
(3) Pakistan plans to buy light water reactors from foreign vendors.
(4) Obtain self-reliancy for engineering and industrial know-how.

MILESTONES
(1) Pakistan presently has no light water reactors. Pakistan operates a heavy water-natural uranium-CANDU reactor (125 MWe).
(2) Pakistan's planned imports of French FRAMATOME PWRs could create interest in plutonium fuel cycles.
(3) Pakistan estimates for 1990 - 49% of electric power will be nuclear.
(4) Pakistan estimates for year 2000 - 16000 MWe will be nuclear.

RESOURCES
Pakistan has 111,000 scientists and engineers. Pakistan Atomic Energy Commission Budget - $4.77 million in 1976.

CURRENT STATUS
(1) Uranium exploration and attempts to assure continued operation of the KANUPP heavy water reactor are the two clear trends in Pakistan. Financial, political, and trained personnel matters restrict activities toward additional reactors.
(2) A 600-MWe nuclear power plant (type not yet established - either HWR or LWR) is planned at Chasma.
(3) In August 1978, France backed out of the reprocessing plant agreement. Thus, interest in LWRs may be shifted to HWRs (Note 1).
(4) France will sell Pakistan the fuel reprocessing plant provided maximum security safeguards are installed (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS-Pakistan Government, Pakistan Atomic Energy Commission

KEY CONTACTS-Muni Ahmed Khun, Chairman, Pakistan Atomic Energy Comm.

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Pakistan Atomic Energy Commission	Islamabad	Responsible for generation of electric power from nuclear reactors.
(2) Pakistan Science Foundation		Overseas dissemination of information and allocation of funds for university research projects.

PROGRAM SUMMARY--PK NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

(1) Financing - Pakistan desires external financing support.

(2) Lack of engineering and skilled manpower - Pakistan has instituted a training program for engineers and technicians to meet the needs of nuclear plants.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--PK NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-Shafique, M. et al., Development of a National Nuclear Power Program: Constraints Likely to Influence Timing and Introduction from Nuclear Power and its Fuel Cycle, IAEA-CN-36/546, Nuclear Power and its Fuel Cycle, Volume 6, Proceedings of an International Conference in Salzburg, May 1977

2-Nuclear Assurance Corporation; International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Washington Post, August 24, 1978 --

2-Electric Light and Power, Volume 56, Number 9, September 1978 --

PROGRAM SUMMARY--PK NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Plan for nuclear power to supply a significant fraction of its energy needs.
Because Pakistan has little uranium reserves and no enrichment capability, it has selected as its first nuclear power plant a CANDU - heavy water-reactor which only requires natural uranium.

(2) Develop domestic industry.

MILESTONES

(1) Nuclear Power Plant - KANUPP - CANDU HWR - 125 MWe - operational December 1972 - Required 7 years from final commitment to full operation (See Note 1).

(2) KANUPP on-the-job training during construction provided trained personnel to operate and maintain the plant.

RESOURCES

Pakistan has approximately 111,000 scientists and engineers of which 4,160 are engaged in R&D work. Government R&D budget for 1975-1976 was $4.8 million.

CURRENT STATUS

(1) Pakistan is planning to build several more nuclear reactors by 2000. The Chasma Nuclear power plant (CHASNUPP) is a proposed 600-MWe nuclear plant to be built at Chasma Barrage. The type of reactor is not yet decided.

(2) Pakistan arranged with France to purchase a 100-ton/year reprocessing plant in order to produce their own nuclear fuel.

(3) KANUPP - HWR - 75% availability for last 4 years.

(4) Pakistan is actively engaged in training personnel.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Pakistan Atomic Energy Commission

KEY CONTACTS

Muni Ahmed Khun - Chairman of Pakistan Atomic Energy Commission

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
KANUPP - heavy water reactor - operating and support services

APPROACH
(1) Increase domestic nuclear technology to decrease dependence on foreign countries.
(2) Develop uranium resources.
(3) Construct fuel fabrication plant for KANUPP.
(4) Acquire a reprocessing facility.
(5) Train local personnel to operate, maintain, and support nuclear power plants.

PROBLEM AREAS
(1) Because of limited resources, financing for the nuclear power facilities and supporting fuel cycle operations may cause severe problems for Pakistan. Financing would most likely be sought from friendly countries, the World Bank, and other agencies.
(2) Lack of engineers, technicians, and construction industry skills, and associated construction equipment.

BENEFITS
(1) Lessen, and if possible, eliminate the dependence on foreign energy sources.
(2) Meet the rapidly growing demand for energy.
(3) Preserve the limited indigenous natural resource.

FACILITIES
KANUPP - Heavy water power reactor near Karachi

SIGNIFICANT PARAMETERS
(1) KANUPP - 137 MWe Gross, 75% availability over last 4 years.
(2) PAEC's relationship to the utilities is that PAEC has constructed and is operating the KANUPP Power Plant and is selling power to the utility KESC on a contract.
(3) France is trying to back out of the reprocessing plant deal with Pakistan. France will still sell plant to Pakistan provided maximum security safeguards preventing proliferation are installed and enforced (Notes 1 and 2).

PROGRAM SUMMARY--PK NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Engineering International, Volume 22, No. 258, pp. 14-32, April 1977 DOE
2-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Washington Post, August 24, 1978 --
2-Electric Light and Power, Volume 56, Number 9, September 1978 --

PROGRAM SUMMARY--PK NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop domestic nuclear technology to decrease dependence on foreign countries.

MILESTONES
(1) Experimental test reactor at Pakistan Institute of Science and Technology (PINSTECH) near Islamabad
(2) Atomic Energy Center, Lahore, Pakistan

RESOURCES
Government 1976-1977 budget for PINSTECH was $1.8 million

CURRENT STATUS
(1) PINSTECH - involved in programs such as heat transfer, nuclear physics, and radioisotope separation
(2) Atomic Energy Center, Lahore - Application of radioisotopes

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Pakistan Atomic Energy Commission

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Pakistan Institute of Nuclear Science and Technology	Islamabad	Heat transfer, nuclear physics, radioisotope production
(2) Atomic Energy Center	Lahore	Application of Radioisotopes

PROGRAM SUMMARY--PK NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Aquire a spent fuel reprocessing plant to recover uranium and plutonium for further use in nuclear fuel.

MILESTONES

The Government of Pakistan arranged with France in 1976 to purchase a 100-ton/year reprocessing plant. Approximately 95% of the design is completed. However, in August 1978, France backed out of the reprocessing plant deal. Instead, France offered a co-processing plant that does not separate plutonium and uranium. Pakistan is insisting that France honor the contract. In September of 1978, French officials stated they will still make a deal while trying to provide maximum security safeguards preventing nuclear weapons proliferation (Notes 1 and 2).

RESOURCES

CURRENT STATUS

Financing, technical manpower limitations hinder Pakistan's ability to construct the plant.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Technical details on the 100-ton/year reprocessing plant design are not known.

APPROACH

PROBLEM AREAS

BENEFITS
Reprocessing the spent fuel to recover valuable fuel constituents from the KANUPP reactor would provide a source of nuclear material.

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--PK NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

PROGRAM SUMMARY--PK NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Washington Post, August 24, 1978 --
2-Electric Light and Power, Volume 56, Number 9, September 1978 --

PROGRAM SUMMARY--PK NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

No information has been found detailing Pakistan's reactor safety and environmental programs, except it did not have a Nuclear Safety and Radiation Protection Ordinance (1973).

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Pakistan Atomic Energy Commission

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PK NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Assurance Corporation, International Data Collection and Analysis, Task 1, Volume 4, NAC C-7827, Prepared for the U.S. Department of Energy, June 1978 (Draft) DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

PE: PERU

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Fuel Fabrication	4
Light Water Reactors (LWR)	5
Research and Test Reactors	7
Safety and Environment	8

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To prospect for uranium deposits.

MILESTONES
(1) Peru received assistance from U.S. (1956-1960, 1965), France (1959, 1968), and Federal Republic of Germany (1961) in uranium exploration (Note 3).
(2) IAEA provides assistance to Peru under the UN Development Programme for intensified uranium prospecting - since 1977.
(3) Development plans in the use of nuclear energy for the period 1976-81 include development of uranium resources (Note 2).

RESOURCES
IAEA technical assistance to Peru through 1977 totals $764,700 (Note 2).

CURRENT STATUS
IPEN conducts prospecting and exploration of uranium deposits, including geological evaluation of the formations in the Sierra Central and the Plateau (Note 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
A systematic prospecting is planned.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
(1) Peruvian granulite facies rocks show 1500 to 2500 ppm uranium concentration in the subandean zone, and 230 to 270 ppm along the southern part of the coast (Note 1).
(2) The proposed Atomic Research Center at Huarangal will have a division of minerology and geology for uranium prospecting (Note 2). Systematic prospecting of the sedimentary areas, exploration for signs of veins of the mineral, evaluation and development of mineral deposits, and processing and concentrations of minerals are planned.

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-International Atomic Energy Agency Bulletin, No. 3/4, September 1976 DOE

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Radiochronological Preliminary Results of Peruvian Granulite Facies Rocks, INIS-mf-3149, page 62, 1976 DOE
2-Information from ERDA/IP, August 1977
3-Uranium - Resources, Production and Demand, OECD Nuclear Energy Agency and IAEA, December 1977 DOE

PROGRAM SUMMARY--PE NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To process uranium minerals in small scale.

MILESTONES

RESOURCES

CURRENT STATUS
IPEN conducts exploitation of the Colquijurca mine and processing of the mineral on a laboratory scale.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PE NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Processing uranium minerals on small scale.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
The proposed Atomic Research Center at Huarangal will have a uranium concentrate production plant (Note 1). Processing and concentrating minerals will be conducted.

PROGRAM SUMMARY--PE NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Conduct research on fabrication of nuclear fuels.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Raw Materials Division, IPEN		Nuclear fuels (Note 1)

PROGRAM SUMMARY--PE NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--PE NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Assess the feasibility of installing nuclear power reactors.

MILESTONES

RESOURCES

CURRENT STATUS
IAEA provides assistance in nuclear power planning and organization under the UN Development Programme for the period 1977-82.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PE NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Establish technical/economic criteria for building reactors.

APPROACH

PROBLEM AREAS
(1) Seismic features of terrain.
(2) Population dispersion and lack of power distribution networks.
(3) Financing.
(4) Short of scientific and technical manpower (Note 1).

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
The proposed Atomic Research Center at Huarangal will conduct preliminary and feasibility studies on construction of nuclear electric generating installations (Note 2).

PROGRAM SUMMARY--PE NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-International Atomic Energy Bulletin, No. 3/4, September 1976

PROGRAM SUMMARY--PE NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-ERDA-tr-298, Contribution to the Analysis of the Development of Unconventional Energy Sources in Latin America, Inter-American Development Bank and U.S. ERDA, April 1977
2-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--PE NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Promote studies in nuclear energy and train personnel.

MILESTONES
Development plans in the use of nuclear energy for the period of 1976-81 include establishment of a scientific-technological infrastructure (Note 1).

RESOURCES

CURRENT STATUS
A zero-power research reactor supplied by Argentina started operation August 1978 (Note 3). The 20% enriched uranium fuel was originally from U.S. (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--PE NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
The proposed Atomic Research Center at Huarangal will supervise all nuclear research activities.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Construction of the Atomic Research Center at Huarangal is planned, which will contain (1) a nuclear research reactor with a maximum of 10 MW output, (2) a radioisotope production plant, (3) a uranium concentrate production plant, (4) minerology and geology center for uranium prospecting, (5) a center for protection against radioactivity, etc. (Note 1).

PROGRAM SUMMARY--PE NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977
2-Nucleonics Week, May 11, 1978 DOE
3-Nuclear Engineering International, p. 10, September 1978 DOE

PROGRAM SUMMARY--PE NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To protect the public from radioactivity.

MILESTONES
Development plans in the use of nuclear energy for the period 1976-1981 include plans for protection against radioactivity and nuclear safety (Note 1).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Institute of Nuclear Energy (IPEN)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Nuclear Safety and Radiological Protection Division, IPEN	-	Dosimetry

PROGRAM SUMMARY--PE NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Plan and implement safety programs and regulations.

APPROACH

PROBLEMS AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
The proposed Atomic Research Center at Huarangal will have a division for protection against radioactivity (Note 1). A safety program, a program of operational and environmental protection and standards, regulations and nuclear legislation will be developed.

PROGRAM SUMMARY--PE NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

SA: SAUDI ARABIA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Research and Test Reactors	3

PROGRAM SUMMARY--SA NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Exploration to establish whether there are uranium deposits.

MILESTONES
Note 4
(1) Airborne radiometry and mapping by U.S. Geological Survey (late 1960s).
(2) No indication that there are any uranium deposits.
(3) British involvement under contract (sandstone at Eastern areas - no uranium found).
(4) Possible recovery of very low-grade uranium from phosphate deposits in Northern areas (border to Jordan) (Davidson believes that Nuc WK Story - Note 1 - is incorrect regarding uranium deposits.).

RESOURCES
At most a few tens of thousand dollars (Note 4) spent on exploration.

CURRENT STATUS
No activity indicated

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Saudi Directorate - General of Mineral Resources/Ministry of Petroleum and Minerals (Note 2)

KEY CONTACTS
His Excellency Fadil Kabbani, Dep. Minister, Ministry of Petroleum and Minerals, Riyadh (Note 3)

R&D ORGANIZATIONS LOCATION PROGRAM AREA

PROGRAM SUMMARY--SA NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Prospect for uranium deposits.
(2) Establish whether uranium exists.

APPROACH
U.S. Geological Survey work (late 1960s) included airborne radiometry and mapping.

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SA NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, Volume 19, No. 13, March 30, 1978, p. 5 DOE
2-Personal Communication, Saudi Arabian Embassy, Washington, D.C., (202) 483-2111
3-Personal Communication, Mr. Merrick, Dept. of State, Washington, D.C. (202) 632-0865
4-Personal Communication, Mr. Davidson, U.S. Geological Survey, (703) 860-6551 (Northern Virginia)

PROGRAM SUMMARY--SA NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish basic technology in small reactors with assistance from abroad.

MILESTONES
Notes 1 and 2
(1) Completed feasibility study re establishment of a Nuclear Research Center at the Eastern Province.
(2) Technicatome (France) submitted proposal re research reactor for the Center.
(3) Research reactor at Riyadh not to be built - plans cancelled.

RESOURCES

CURRENT STATUS
Negotiations with Technicatome are believed to be going on.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government

KEY CONTACTS
His Excellency Fadil Kabbani, Deputy Minister, Ministry of Petroleum and Minerals, Riyadh (Note 2)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SA NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, Vol. 19, No. 13, March 30, 1978, p. 5 DOE
2-Personal Communication, Mr. Merrick, Department of State, Washington, D.C. (202) 632-0865

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

SF: SOUTH AFRICA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	6
Fuel Fabrication	9
Light Water Reactors (LWR)	10
Research and Test Reactors	12
Spent Fuel Processing	14

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Develop and export its large uranium resources in the Witwatersrand Basin (South Africa) where uranium is produced as a byproduct of extensive gold mining and in the uranium deposits mainly in Rossing (South West Africa - Namibia) while aggressively continuing further exploration.

MILESTONES

(1) Extraction of uranium from Witwatersrand Basin reefs as a by-product of gold mining (1952-current).
(2) Development of the world's largest uranium operation at Rossing (Namibia) in 1976.
(3) Continuing exploration in South Africa and Namibia.
(4) Recoverable reserves of about 295,000 ST U3O8 at below $40/lb.
(5) Feasibility study ($2.65 million) regarding exploration at Africander Lease in the Klerksdorp area. If uranium is found it would be South Africa's sole uranium-only mine.

RESOURCES

$7 million of non-government prospecting (including 300,000 feet drilling) in 1975. Geological Survey Branch budget (1976-1979) was $1.2M.

CURRENT STATUS

(1) South Africa Government Industrial Development Corp. owns 25% of Rossing; Rio Tinto Zinc of London owns 31%.
(2) Current significant exploration
   a. General Mining - 10000 ST U3O8 50 km SE of Rossing, carnotite and soddeyite minerals, require alkaline leach
   b. Gold Fields of SA, Trekkopje uranium prospect near Rossing
   c. Anglo-American/Union Carbide/Compagnie Francaise de Petroles/ Aquitain, large exploration operation in Rossing area - Swakopmund

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Ministry of Labor and Mines/Dept. of Mines
Private domestic and foreign uranium organizations

KEY CONTACTS

Mr. W. P. Viljoen, Dept. of Mines, Ministry of Labor and Mines
Dr. J. F. Enslin, Geological Survey Branch

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Geological Survey Branch/Dept. of Mines		Surveying

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Extract uranium as byproduct of gold mining.
(2) Prospect for uranium deposits.

APPROACH

PROBLEM AREAS
(1) South Africa is under international political pressure to grant independence to Namibia where the significant non-gold by-product uranium deposits are (Rossing, Namib desert).
(2) Nuclear resource activities in Namibia controlled by the South Africa Ministry of Mines (Atomic Energy Act, No. 90, 1967).
(3) Uranium Activities Secrecy--1978 Amendment to Atomic Energy Act of 1967.

BENEFITS
(1) 1968 amendment to the Atomic Energy Act allows private ownership of uranium.
(2) International involvement in uranium exploration in Namibia.

FACILITIES

SIGNIFICANT PARAMETERS
(1) Aeromagnetic and radiometric survey by Geological Survey of SA on behalf of Atomic Energy Board
(2) Paladora area reserves in place amount to 14000 ST U3O8 (carbonatite)
(3) The Witwatersrand Basin consists of 16 reefs. Only seven of these contain sufficient uranium content to make them attractive for uranium extraction even as a by-product of gold mining. Although the uranium/gold ratio varies from reef to reef, it is rather constant in each mine. Unlike gold which is concentrated near the base of the reef, uranium occurs throughout the thickness of the reef.
(4) Recoverable MT U3O8 at below $40/lb

Witwatersrand (S. Africa)		
Klerksdorp	81500,	grade .015-.025, reef, gold by-product
Orange	34800,	grade .010-.013, reef, gold by-product
Other	47100,	grade .013-.024, reef, gold by-product
Rossing (Namibia)	91000,	grade .045-.055, open pit and barren material
Palabora (S. Africa)	3600,	grade .005, minor copper by-product
Namib desert (Namibia)	9000	

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-P. Marshall, Buoyant Uranium Market Brings South African Mining Bonanza, Nuclear Engineering International, September 1977 DOE
2-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978 WENDS

PROGRAM SUMMARY--SF NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Produce U3O8 concentrates and eventually UF6, mainly for export.

MILESTONES
(1) Uranium production initiated in Witwatersrand (1952) at USAEC and UKAEA motivation
(2) Production to 1977 amounted to a total of 88000 MT U3O8
(3) Peak production of 5850 MT U3O8 was achieved in Witwatersrand in 1959
(4) Lab-scale UF6 production for many years, commissioning of the Pelindaba UF6 industrial-scale plant in 1975 (Note 2)
(5) The largest uranium operation began in Rossing (Namibia) in 1976 - nominal capacity of 40000 tons ore/day, 5000 ST U3O8/YR, 0.4-0.5 pct grade
(6) 1977 - 6500 ST U3O8 produced
(7) 1980 - 10400 St U3O8/YR, much of the increase to come from Rossing
(8) 1985 - 13000 ST U3O8/YR
(9) Production increase (1985-) will depend on new discoveries and extent of mining for primary metals (Note 1)

RESOURCES
Rossing operation capital investment - 120 million British pounds. The Atomic Energy Board budget (1975-76) was $12.6 M for all its activities.

CURRENT STATUS
Offical projected maximum production capability, MT U3O8/YR

Witwatersrand (S. Africa)			
Klerksdorp	2270 (1977),	3070 (1980),	3980 (1982)
Orange	750 (1977),	1370 (1980),	1680 (1982)
Other	760 (1977),	1050 (1980),	1950 (1982)
Rossing (Namibia)	2000 (1977),	5500 (1980),	6500 (1982)
Palabora (S. Africa)	120 (1977),	120 (1980),	120 (1982)
Namib desert (Namibia)		500 (1980),	500 (1982)

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS
R. E. Worrell, Chairman, NUFCOR

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) The Chamber of Mines		
(2) NUFCOR (private-owned by gold mines, closely associated with the Chamber of Mines)		Ammonium Di-uranate (ADU) slurry transportation and conversion to U3O8.
(3) National Institute for Metallurgy		Applied R&D for NUFCOR and Atomic Energy Board

PROGRAM SUMMARY--SF NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Extract uranium as a by-product of gold mining.
(2) Produce U3O8 concentrates and UF6.

APPROACH

PROBLEM AREAS
(1) Uranium production in Witwatersrand Basin depends on price/demand for gold.
(2) Projected realistic production capability 70-80 pct of official projections.
(3) Rossing operation experienced production problems associated with transition from small to large scale production.
(4) Operations in the Witwatersrand Basin deep (3600 ft oper., 4600 feet exploration) gold mines has required mechanization to reduce labor requirements and hazards from high rock stress and 130 F temperatures.
(5) Ore grade in future production from Witwatersrand Basin to decrease about 30 pct.
(6) Rapid labor cost increases have occurred and are expected to continue (20-25% per year) - Cheap foreign labor unavailable, standard of living improvement for blacks.
(7) Rossing mine production expected to be below capacity for one year following heavy damage from fire in May 1978 (Note 3).
(8) Uranium Activities Secrecy -- 1978 Amendment to Atomic Energy Act of 1967.

BENEFITS
(1) Rossing uranium is in the form of fine-grain uraninite and alaskite from open-pit and barren material allowing high uranium recovery with low acid consumption and a coarse grind.

FACILITIES
NUFCOR - capacity of 6000 ST U3O8/YR production plant, 25 miles west of Johannesburg (calcining of ADU slurry which contains 20% uranium by weight)

SIGNIFICANT PARAMETERS
(1) Original operation in Witwatersrand utilized conventional processes - acid leach, liquids/solids separation by filters, solvent extraction. Improvements include acid leach prior to gold extraction (which results in higher gold recovery) and counter-current decantation for liquids/solids separation.
(2) High temperature leaching (to improve uranium recovery 10-15 pct) could be incorporated in new operations if proven economical. Continuous-ion exchange is under investigation for concentrating low-grade leach liquors.
(3) Major R&D is underway by the Chamber of Mines to develop continuous rock cutters and conveyor systems.
(4) NUFCOR U3O8 plant has been operating at about 50% capacity. No expansion needed before mid-1980s.

PROGRAM SUMMARY--SF NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978 WENDS
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-W. Haussermann et al., Demand and Supply Estimates for the Nuclear Fuel Cycle, IAEA-CN-36/493, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-P. Marshall, Buoyant Uranium Market Brings South African Mining Bonanza, Nuclear Engineering International, September 1977 DOE
3-Nuclear Fuel, p. 4, September 4, 1978 --

PROGRAM SUMMARY--SF NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Export enrichment services but first assure self-sufficiency in nuclear fuel supply for its LWR Program.

MILESTONES
(1) An enrichment process was developed in the late 1960s (1970 announcement).
(2) Uranium Enrichment Corp. of South Africa, Ltd. (UCOR) established in 1971 to take over enrichment responsibilities.
(3) Built a prototype module (mfg largely domestically) and tested it in 1977.
(4) A small pilot plant is operating.
(5) A large, commercial plant is planned for mid-1980s (5 million SWU/YR) Note 1.

RESOURCES
UCOR commercial enrichment plant (5 million SWU/YR); projected cost is $1.046 billion (1974 $) - Note 2

CURRENT STATUS
Tentative decision to convert the UCOR pilot plant into a small production facility (200-300,000 SWU/YR needed for the Koeberg LWR station) instead of initially building the 5-million SWU plant--Reason: High cost, low demand, adverse international political climate (Note 3).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Ministry of Labor and Mines/Atomic Energy Board (statutory body)

KEY CONTACTS
Dr. A. J. A. Roux, President, Atomic Energy Board

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
UCOR		Enrichment process development, plant construction and operation
Atomic Energy Board/ National Nuclear Research Center	Valindaba	Enrichment process

PROGRAM SUMMARY--SF NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop the Advanced Vortex Tube Process, a uniquely S. African process (variation of the jet nozzle process).
(2) Test it under small-scale prototype conditions to determine design for industrial-scale plants.
(3) Demonstrate process under industrial-scale conditions.

APPROACH
UF6 - H2 flow/Helikon separator
(See ref. 1 for extensive tech. description of the process)

PROBLEM AREAS
Non-ratification of NPT
Enrichment process secrecy (Note 4)
By law, only the Atomic Energy Board can apply for enrichment patents

BENEFITS
(1) IAEA active membership since 1957. It promised to accept IAEA safeguards arrangements for the commercial enrichment facility as it has done for its experimental facilities.
(2) S. Africa is expected to sign the NPT and put the Valindaba facility under international inspection (Note 5).

FACILITIES
UCOR has a pilot enrichment plant utilizing the unique process that was developed by S. Africa in the late 1960s - 6000 SWU/YR. Valindaba, a site adjacent to Atomic Energy Board's National Nuclear Research Center.

SIGNIFICANT PARAMETERS
(1) Reduced scale prototype module (6 tonne/yr) tests--helikon process principles, separation factor, design of components.
(2) Achievements--development of dependable special instrumentation for UF6-H2 mixtures, large-scale sample analysis, surface treatment and decontamination processes, etc.
(5) A 5 million SWU/YR plant was considered economically viable in 1977 (ref. 1).

PROGRAM SUMMARY--SF NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-A. J. A. Roux et al., Development and Progress of the South African Enrichment Project, IAEA-CN-36/300, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-W. Haussermann et al., Demand and Supply Estimates for the Nuclear Fuel Cycle, IAEA-CN-36/493, Proc. of Inter Conf., Salzburg, May 1977. DOE
2-Nucleonics Week, January 5, 1978 DOE
3-Nuclear Engineering International, p. 7, March 1978 DOE
4-Nucleonics Week, March 16, 1978 DOE
5-The Washington Post, August 24, 1978 --

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Research reactor fuel manufacturing capability (current).

MILESTONES
Nuclear Fuel Production Plant - National Nuclear Research Center (Atomic Energy Board-Pelindaba, near Pretoria) - Capability believed to exist since early 1960s.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Board

KEY CONTACTS
Dr. A. J. A. Roux, President, Atomic Energy Board

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Establish domestic capability of manufacture research reactor fuel
(2) Plan to establish capability to manufacture power reactor fuel (?)

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SF NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Rely on importing LWRs to satisfy their electrical power demand in the most economical way while preserving coal resources for petrochemical and gasification/liquefaction uses.

MILESTONES

(1) Bought the two-reactor (920 MWe each, PWR) Koeberg station from FRAMATOME (France) - schedule for commercial operation in 1982/83.
(2) Installed nuclear generating capacity (LWR) planned to 2000 - 10% of needs.

RESOURCES

The Koeberg station estimated cost is $1.15 billion over eight years (Note 1).

CURRENT STATUS

(1) Construction under way by FRAMATOME
(2) Prepared domestic industry to undertake completion of the Koeberg station should FRAMATOME pull out for political reasons

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Atomic Energy Board

KEY CONTACTS

Dr. A. J. A. Roux, President, Atomic Energy Board

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Electricity Supply Commission (ESCOM)	-	Utility activities
Atomic Energy Board/ National Nuclear Research Center	Pelindaba	Fuels, safety

PROGRAM SUMMARY--SF NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Build power station.
(2) Establish capability in strategic sectors domestically.

APPROACH
(1) Import enriched uranium for the two Koeberg PWRs (1981-84) from the USA under the bilateral agreement (1957, amended in 1967, 1974).
(2) Not known where reactor fuel will be fabricated.

PROBLEM AREAS
(1) No oil resources. Coal resources - 85 billion tonnes (1977)
(2) 1977 - 80% of energy needs met by coal, the remainder by imported oil.
(3) NPT treaty not ratified. Pressure from the USA.

BENEFITS
(1) Alleviate dependence on imported oil.
(2) Conserve and re-allocate coal to industrial uses.
(3) Utilize only a small fraction of domestic uranium resources.
(4) Utilize self-sufficiently the domestic enrichment capability starting in late 1980s at the latest.

FACILITIES
Nuclear Fuels Production Plant - National Nuclear Research Center (Atomic Energy Board - Pelindaba, near Pretoria)

SIGNIFICANT PARAMETERS
South Africa/IAEA/France trilateral agreement (1977) - Provides for IAEA safeguards for Koeberg and follow-on LWRs.

PROGRAM SUMMARY--SF NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 9, October 1977 DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish basic capability in nuclear and materials-related areas.

MILESTONES
(1) High-enriched uranium fuel test reactor, SAFARI-I (1965)
(2) Heavy water facility (1967)

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Board

KEY CONTACTS
Dr. A. J. A. Roux, President, Atomic Energy Board

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SF NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Utilize a research reactor for materials testing.

APPROACH
(1) Import 90% enriched uranium from USA for Safari-I under bilateral agreement.
(2) Import heavy water and 2% enriched uranium from USA for Pelinduna-zero under bilateral agreement.

PROBLEM AREAS
USA currently holding up a shipment of enriched uranium fuel (research reactor) as pressure to induce S. Africa to sign the Non-Proliferation Treaty (NPT) (Note 1).

BENEFITS

FACILITIES
SAFARI-I, a 20 MWt, ORR-type nuclear materials testing and research reactor (1965); Pelinduna-zero, a critical assembly facility (1967)--National Nuclear Research Centre (Atomic Energy Board, Pelindaba, near Pretoria).

SIGNIFICANT PARAMETERS
The Atomic Energy Board completed a pilot plant to produce nuclear-grade uranium metal and compounds suitable for fuels (1961).

PROGRAM SUMMARY--SF NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--SF NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-The Washington Post, August 24, 1978 --

PROGRAM SUMMARY--SF NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
None by policy

MILESTONES
Spent fuel, originally supplied by the USA for the research reactors and the LWRs, must be reprocessed at mutually acceptable facilities outside South Africa according to the South Africa-USA bilateral agreement (1957/1967/1974) and the South Africa-France (Framatome) bilateral agreement (1976/1977).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Atomic Energy Board

KEY CONTACTS
Dr. A. J. A. Roux, President, Atomic Energy Board

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SF NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

UR: SOVIET UNION

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	4
Fuel Fabrication	5
Light Water Reactors (LWR)	7
Gas Cooled Reactors (GCR)	10
Liquid Metal Fast Breeder Reactors (LMFBR)	11
Other Breeder Reactors	14
Research and Test Reactors	16
Spent Fuel Processing	17
Waste Management	19
Safety and Environment	22

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish resources of uranium-bearing ores to support its nuclear power program.

MILESTONES
Based on their nuclear power program and their nuclear weaponry, the USSR has uranium resources. The amount of uranium resources has not been disclosed by the USSR. Public domain publications do not yet have uranium resource data for the USSR.

RESOURCES

CURRENT STATUS
(1) Estimated 80000 - 270000 metric tons of uranium in USSR.
(2) Other communist countries - Democratic Republic of Germany has an estimated 100000 metric tons of uranium.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

It is estimated, based on named plant capacity for the USSR and the European communist countries, that by 1980 the annual requirements for natural uranium will be approximately 2000 metric tonnes (based on plutonium recycle; 0.3 pct tails).

APPROACH

PROBLEM AREAS

It is estimated that by 1990 a total amount of 85000 metric tons of natural uranium will be required. If the total maximum estimated reserves of approximately 370000 metric tons of natural uranium are correct, the USSR resources will be significantly depleted.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-Report to the U.S. Joint Committee on Atomic Energy, Volume 4, pp. 1613-1618, Dated October 1960 LIBC
2-Survey of Energy Resources, Published by U.S. National Committee of the World Energy Conference, 1974
3-D.I. Skorovarov, Processing of Low-Grade Uranium Ores, Anstratian Atomic Energy Commission Research Establishment, AAEC-LIB/Trans 621, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and establish processes and industry for extracting uranium from natural resources.

MILESTONES
(1) USSR has developed a leaching process for extracting uranium from low-grade uranium bearing ores (Reference 1).
(2) Work is currently being performed on a uranium extraction process by granular anion exchange resins from natural water.

RESOURCES

CURRENT STATUS
Information on the resource recovery technique, location, and operations has not been found in public domain literature.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-Laskorin, R. D., Non-Filtration Method of Processing Uranium Ores: IAEA-CN-36/355, Nuclear Power and its Fuel Cycle, Volume 2, Proceedings of the International Conference in Salzburg, May 1977 DOE
2-Recovery of Uranium Found in Natural Water, IAEA-CN-36/327, Nuclear Power and its Fuel Cycle, Volume 2, Proceedings of the International Conference in Salzburg, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Develop and establish industry to provide the necessary uranium enrichment services to meet the demands for present and future nuclear power reactors.

MILESTONES

(1) Enrichment capacity: presently 4-10 million SWU per year.
(2) Exportation of enrichment: 1.5 million SWU in 1978; 4 million SWU in 1985.

RESOURCES

CURRENT STATUS

Details on the enrichment processes are not available in the public domain literature. However, it is expected to be the gaseous diffusion process.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-SWUCO Report, No. 13, June 1, 1978

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Develop and establish fuel fabrication processes and industries to support the nuclear power program.
(2) Recover fissionable Pu and U from spent fuel and recycle to conserve on natural uranium and enrichment.
(3) Build chemical reprocessing and plutonium fuel fabrication plants to meet the needs for thermal and fast reactors in 10 to 15 years.

MILESTONES

(1) Three types of reactor fuel elements; PWR type for WWER cores of 420 to 1000 MWe; light water cooled, graphite moderated type for higher power reactors, RBMK - 1000 MWe; fuel element for sodium cooled, fast breeder reactors of BN type.
(2) Fuel element fabrication will support 21000 MWe by 1980.
(3) Nuclear capacity doubling time is estimated to be 5 to 6 years. Consequently fuel fabrication capacity will double in about the same time frame.

RESOURCES

CURRENT STATUS

(1) The details as to production capability, location, and construction programs for fuel fabrication are not presently found in public domain literature.
(2) The extent of recycling of recovered uranium and plutonium from reprocessed spent fuel is not yet found in public domain literature. However, based on the advanced stage of USSR breeder reactor programs, it is believed that the present mix of fuel fabricated for nuclear power plants utilizes to some degree recycled uranium and bred plutonium.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

(1) PWR type WWER requires 4.4% enriched fuel; refueling requirements are 21 metric tonnes per 1000 MWe per refueling cycle.

(2) Light water, graphite moderated type RBMK fuel requires 1.8% enriched fuel; refueling requirements are 50 metric tonnes per 1000 MWe per refueling cycle.

APPROACH

(1) To conserve natural uranium and uranium enrichment services, the Government is actively engaged in reprocessing spent LWR and fast breeder fuel to recover the plutonium and uranium. The recovered uranium and plutonium is then converted into useful fuel for the light water and breeder reactors.

(2) Chemical reprocessing and plutonium fuel fabrication plants are expected to meet the needs of thermal and fast reactors in 10 to 15 years.

PROBLEM AREAS

BENEFITS

Substantial savings in natural uranium and enrichment requirements are realized by reprocessing spent thermal and fast reactor fuel to recover the useful uranium and plutonium for fuel fabrication.

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-Australian Atomic Energy Commission Research Establishment: Soviet Union Reactor Programme, Translated from German (Atom Wudschaft dated April 1975), August 1975

2-N. P. Dergachen et al., Economic Aspects of Development of Nuclear Power and Fuel Cycle Plants in the USSR, IAEA-CN-36/333, Nuclear Power and its Fuel Cycle, Volume 3, Proceedings of an International Conference in Salzburg, May 1977 DOE

3-A. N. Gregoryanitz et al., Development of the Nuclear Power Industry in the USSR, IAEA-CN-36/357, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Nuclear power is to be used as substitute for fossil fuels in energy short regions.

(2) Two LWR reactor types (PWR and LGR) are being utilized at the commercial scale to gain knowledge of the merits of the two types. The great difference in the structural design of the two reactors leads to expansion of existing machine shops that can be used for manufacturing nuclear equipment.

MILESTONES

Two commercial light water reactor types: pressurized water reactor (PWR) type WWER and water-cooled graphite moderated (LGR) type RBMK are currently operating and being built. As of December 31, 1977 there were 5015 MWe of PWR to be in operation by the end of 1978 and 14900 MWe of the LGR type to be in operation by the end of 1980.

RESOURCES

Information regarding financial, institutional, and manpower support for the USSR nuclear power programs have not been found in the public domain literature.

CURRENT STATUS

(1) Presently 19 units operating with 4500 MWe capacity

(2) Nuclear capacity doubling time 5 to 6 years

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

State Committee on the Utilization of Atomic Energy

KEY CONTACTS

Dr. Andranik Petrosyants, Chairman, State Committee on Utilization of Atomic Energy, Moscow

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Kurchatov Institute of Atomic Energy	Moscow	Reactor development, ion exchange, purification of low-level waste.
(2) Physical-Technical Institute at Obninsk	Obninsk	Reactor development

PROGRAM SUMMARY--UR NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

(1) LWR reactor type: pressurized water reactor (PWR) type WWER, 440 & 1000 MWe; light water cooled graphite moderated channel type boiling water reactor (LGR) type RBMK, 1000 to 1500 MWe.

(2) Based on test data of the LGR performance, the LGR reactor types are being considered for higher power levels up to 2400 MWe.

APPROACH

(1) First LGR (100 MWe) went into operation in 1958.
(2) First PWR (210 MWe) went into operation in 1964.
(3) First BWR (50 MWe) went into operation in 1966.
(4) PWR enrichment requirements: approximately 4.4%.
(5) LGR fuel enrichment requirements: approximately 1.8%.
(6) LGR is a high power, boiling water, channel reactor with a graphite moderator.

PROBLEM AREAS

Graphite-moderated reactors may experience a positive reactivity addition on a loss of coolant accident--this characteristic requires a need for reliable and efficient core cooling systems.

BENEFITS

(1) LGR lower enrichment requirement, compared to PWRs, saves on enrichment.

(2) Nuclear powered generating stations provide energy to geographic areas with limited fossil fuels and/or geographic problems with their location and extraction.

FACILITIES

Troitsk (Siberia - 6 units - 100 MWe each - LGR); Beloyarsk 1 and 2 (Sverdlovsk regions - 100 and 200 MWe - LGR); Novo-Voronezh 1,2,3, 4, and 5 (Voronezh - 210, 365, 440, 440, 1000 MWe - PWR); Kolu 1 and 2 (near Murmansk, 440 MWe - PWRs); Armenia 1 and 2 (Arorat Valley - 400 MWe PWR); Leningrad 1,2,3, and 4 (near Leningrad - 1000 MWe - LGR); Kursk 1,2,3, and 4 (1000 MWe - LGR); West Ukranian 1 and 2 (440 MWe - PWR); Smolensk 1 and 2 (1000 MWe - LGR); Chernobyl 1 and 2 (1000 MWe - LGR); Kalanin 1 and 2 (1000 MWe - LGR); VK-50 (Dimitrovgrad - 50 MWe - BWR).

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-A. N. Gregoryanitz et al., Development of Nuclear Power Industry in the USSR, IAEA-CN-36/357, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

2-N. P. Dergachev et al., Economic Aspects of Development of Nuclear Power and Fuel Cycle Plants in the USSR, IAEA-CN-36/333, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

3-V. A. Sidorenko et al., Main Ways for Solution of the Atomic Power Plant Safety Problems in the USSR, IAEA-CN-36/343, Nuclear Power and its Fuel Cycle, Volume 5, Proceedings of an International Conference in Salzburg, May 1977 DOE

4-A. P. Aleksandrov et al., The Development of Uranium Graphite Channel Reactors in the USSR, IAEA-CN-36/586, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Work on a gas cooled fast breeder reactor utilizing N2O4 as the coolant which will drive a direct-cycle gas turbine (see other Breeders).

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-A. N. Gregoryanitz et al., Development of the Nuclear Power Industry in the USSR, IAEA-CN-36/357, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and build breeder reactors to generate power and produce fuel for thermal reactors.

MILESTONES
(1) Obinski BR-5: 12 MWe Breeder - Pu fuel - Na cooled (operation June 1959).
(2) BOR-60: 12 MWe Breeder - UO_2 fueled - Na cooled (operation in 1969). Used for fuel element development and testing.
(3) Shenchenco BN-350: 1000 MWth Breeder - PuO_2 and UO_2 fuel - Na cooled (operation in 1973).
(4) BN-600: 1500 MWth Breeder - PuO_2 and UO_2 fuel - Na cooled (expected to be operating in 1979).
(5) 13000 MWe Breeders installed by 1990; 47000 to 64000 MWe by 2000.

RESOURCES

CURRENT STATUS
(1) BN-350 went critical in 1972 - generates 150 MWe of electric power and provides thermal power for water desalination.
(2) BN-600 is presently under construction.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

(1) The BOR-60 fast test reactor (started up in 1969) is used to test fuel elements, structural materials and steam generator components.
(2) Fast reactors of the BN type use mixed oxide fuel (UO_2 and PuO_2).
(3) Research is currently being performed on uranium and plutonium carbide and nitride fuel for application to fast breeder reactors.
(4) The BN-600 is considered the basic prototype for future Soviet liquid metal fast breeder reactors.

PROBLEM AREAS

The BN-600 (600 MWe) fast breeder reactor has a negative sodium void reactivity coefficient; but for the larger planned units (1000-1500 MWe), the sodium void reactivity coefficient is positive which presents reactor safety concern.

BENEFITS

The fast breeder reactor generates electricity and also plutonium (from natural uranium) which will be used as fuel for thermal and fast reactors. It is estimated that the USSR fast breeder reactor program will reduce their uranium requirements by 25%.

FACILITIES

(1) Melekess BOR-60: located in the Ug (fast breeder test reactor)
(2) Shevchenko BN-350: located in Mangyshalk Peninsula (commercial fast breeder reactor)
(3) BN-600: located in the Urals (commercial fast breeder reactor)

SIGNIFICANT PARAMETERS

(1) The BN-350 operated at 650 MWth (65% of rated) - fuel burnup is approaching target value of 5% of heavy atoms.
(2) The BOR-60 has achieved a fuel burnup of 13.2% of heavy atoms.

PROGRAM SUMMARY--UR NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-N. P. Dergochev et al., Economic Aspects of Development of Nuclear Power and Fuel Cycle Plants in the USSR, IAEA-CN-36/333, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

2-V. A. Sedorenko et al., Main Ways for Solution of Atomic Power Plant Safety Problems in the USSR, IAEA-CN-36/343, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

3-A. N. Gregoryanitz et al., Development of the Nuclear Power Industry in the USSR, IAEA-CN-36/357, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

4-O. P. Kazachkovskii et al., USSR Fast Reactor Development Program and its Current State, IAEA-CN-36/356, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION OTHER BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop the gas-cooled breeder reactor.

MILESTONES
(1) USSR is presently doing research on gas cooled breeder reactors utilizing N2O4 as the coolant. The size of the reactors considered is 1200 to 1500 MWe.
(2) Theoretical and experimental investigations have been performed substantiating design developments.
(3) Construction of a 50-MWe gas cooled test reactor has been underway since 1977.
(4) The design for a 300-MWe gas breeder is presently being performed.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS
Dr. Andranik Petrosyants, Chairman, State Committee on Utilization of Atomic Energy, Moscow

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION OTHER BREEDERS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop design criteria.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
Theoretical, experimental and engineering work conducted in the USSR show that a dissociating system is a promising coolant for gas cooled fast reactors. Such a system could be achieved using N2O4 as the gas. Calculations indicate a potential power density of 800 to 1000 kW/l. Breeder doubling times are estimated to be 5 to 6 years. Fuel clad temperatures are expected to be 650 to 680oC, outlet gas temperature is expected to be 450 to 480oC at a pressure of 150-170 bars and reactor gas inlet temperature is expected to be approximately 220oC.

PROGRAM SUMMARY--UR NUCLEAR FISSION OTHER BREEDERS
KEY REFERENCES DTG 15 SEP 78

1-A. K. Krasin et al., Basic Performance Problems and Prospects for 1200-1500 MW Gas Cooled Fast Reactors With Dissociating Coolant, IAEA-CN-36/332, Nuclear Power and its Fuel Cycle, Volume 1, Proceedings of an International Conference in Salzburg, May 1977 DOE

2-Battelle Pacific Northwest Laboratories, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 4, PNL-2478, January 1978 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION RESEARCH AND TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Conduct research; develop and build test reactors to demonstrate performance of reactor and reactor systems and to provide fundamental characteristics for scaling to larger units.

MILESTONES

(1) Obninsk APS: graphite water reactor - 5 MWe - 1954
(2) Obninsk BR-5: FBR - 12 MWe - startup 1957
(3) Melekess ARBUS: OMR (unknown designation) - 0.5 MWe - startup in 1963
(4) Melekess VK-50: BWR - 70 MWe - startup in 1966
(5) Melekess BOR-60: FBR - 12 MWe - startup in 1969

RESOURCES

CURRENT STATUS

BOR-60 is presently used for testing fast breeder reactor fuels, materials and steam generator components.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Government

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UR NUCLEAR FISSION RESEARCH AND TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-Nuclear Engineering International, Volume 22, Number 258, April 1977 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION SPENT FUEL REPROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

(1) Develop and build reprocessing plants to recover uranium and plutonium fuel for recycle into thermal and fast reactors.
(2) Chemical reprocessing and plutonium fuel fabrication plants are to meet the needs of the thermal and fast reactors by 1987 to 1992.

MILESTONES

(1) Because the USSR committed to a mix of thermal and fast breeder reactors twenty-five years ago, it has considerable experience in the reprocessing of spent fuel for uranium and plutonium recovery.
(2) Two reprocessing processes have been developed.
(3) Spent fuel from the BOR-60 and BR-5 fast breeder reactors has been reprocessed.
(4) Since 1973, V. G. Khlopin Radium Institute, at Leningrad, has operated a 3 kgU/day fuel pilot reprocessing plant.

RESOURCES

CURRENT STATUS

(1) Aqueous (PUREX) and Fluorination reprocessing being developed.
(2) Spent fuel from thermal and fast breeder reactors is reprocessed.
(3) Plans are being made for a reprocessing plant that will handle both thermal and fast reactor fuel with design exposure up to 100,000 MWd/ton.
(4) A commercial reprocessing plant with 5 MT/day capacity is reportedly under construction to be completed by about 1980.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

Dr. Andranik Petrosyants, Chair., State Comm. on Utilization of Atomic Energy, Moscow

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) V. I. Khlopin Radium Institute (USSR Academy of Sciences)	Leningrad	Fuel reprocessing, radiochemistry
(2) Institute of Physical Chemistry (USSR Academy of Sciences)	Moscow	Waste vitrification, chromatographic separation, waste diffusion
(3) Physical-Technical Institute	Obninsk	Reactor development, fuel reprocessing

PROGRAM SUMMARY--UR NUCLEAR FISSION SPENT FUEL REPROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

(1) Two reprocessing processes developed: First, aqueous method based on dissolution of fuel with the isolation and purification of valuable components; Second, fluorination of valuable fuel components and purification by sublimation of higher fluorides.

(2) Based on USSR fuel cycle management, fast fuel is anticipated to be reprocessed with only 3 to 6 months of cooling; the fast reactor spent fuel therefore is more radioactive than the thermal reactor spent fuel during reprocessing.

APPROACH

(1) Aqueous reprocessing requires cutting fuel elements, dissolution, chemical isolation of fuel constituents, and purification by solvent extraction methods.

(2) The fluorination process requires the gaseous fluorination of valuable fuel components and their purification by sublimation of the fluorides. Purification to remove fission products is employed to regenerate uranium fuel of very high activity. The bulk (85%) of the radioactive products concentrate in the fluorination cakes.

PROBLEM AREAS

(1) Environmental protection problems from regeneration of spent fuel

(2) Methods for localizing gaseous, liquid, and solid wastes

(3) Methods development for burial of solidified wastes

BENEFITS

Reprocessed thermal and fast breeder reactor fuel will reduce the need for natural uranium and enrichment.

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION SPENT FUEL REPROCESSING
KEY REFERENCES DTG 15 SEP 78

1-Yanovich, M. A. et al., Basic Problems of Fast Reactor Fuel Reprocessing, Proceedings of an International Conference in Salzburg, Nuclear Power and its Fuel Cycle, IAEA-CN-36/318, May 1977 DOE

2-Battelle Pacific Northwest Laboratories, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 4, PNL-2478, January 1978 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE-Process all radioactive waste materials to a stable form and dispose of in an environmentally safe location.

MILESTONES

(1) Three high-level waste solidification processes have been developed, two-stage glass vitrification, single-stage vitrification, and chemothermal process.
(2) The single-stage high level waste vitrification process has been operating for about three years and has processed about 1400 m3 of waste feed and produced 340 MT of solid phosphate glass.
(3) The chemothermal process obtains a 13-fold volume reduction in waste and delivers a product more stable chemically, thermally, and to radiation than the vitreous material. This process has been developed for application at the disposal site.
(4) Non-high level wastes from nuclear power plants (evaporator concentrates and ion exchange resins) are stored in reservoirs. Effluents from the waste treatment operations (low level) are discharged into filter fields or large bodies of water.
(5) Low to intermediate level wastes are processed by bituminization. In 1976, a high capacity (200 l/hr) two-stage continuous bituminization plant was started.
(6) Extensive efforts are being made to extract the transuranic elements and selected fission products from reprocessed fuel waste.

RESOURCES

CURRENT STATUS

(1) By 1976, at sites near Dimitrovgrad, 75000 m3 of intermediate level waste had been pumped into strata at a depth of 1500 m. The formations selected have stagnant or nearly stagnant underground water pools which are isolated from other water horizons and from the surface.
(2) High level liquid wastes have been disposed of in closed, water-bearing, porous strata 350 to 400 m below the surface at a pressure of 10 to 12 atm. Test results to date have confirmed the technical feasibility and safety of this method. So far, there has not been a radiological emergency of any kind associated with deep-well injection disposal.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS-Government

KEY CONTACTS-Dr. Andranik Petrosyants, Chairman, State Commission on Utilization of Atomic Energy, Moscow

R&D ORGANIZATIONS-See Notes and Evaluations below.

PROGRAM SUMMARY--UR NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

The USSR has concluded that the disposal of solidified wastes in geologic formations provides the best solution to the waste disposal problem and that deep-well injection and hydraulic fracturing are also acceptable methods for disposal. Salt formations are particularly being studied and unused salt mines and solution cavities are candidates for disposal reservoirs.

APPROACH

(1) Storage of high level waste glass: storage areas at ground grade above underground water level; storage building is adjacent to waste vitrification building connected with a tunnel utilizing remote-control, container transfer tools; as wastes age, they will be transferred to a permanent storage facility with retrievability features.

(2) High level storage facilities will be air or water-cooled. Waste with heat densities of 100000 watts/m3 must be water cooled.

(3) Solid radioactive (non-high level radioactive waste) from a nuclear power station is buried at the site in special vaults designed to be water proof.

PROBLEM AREAS

Environmental safety

Potential for devitrification of glass high-level waste in salt formations (Note 2)

BENEFITS

FACILITIES

KS-KT-100 plant--experimental pilot plant for 2-stage glass vitrification process

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-Battelle Pacific Northwest Laboratories, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 4, PNL-2478, January 1978 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Additional information

	R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1)	Moscow Waste Treatment Station	Moscow	Treatment of low level waste from Moscow area nuclear power plants
(2)	V.I. Khlopen Radium Institute	Leningrad	Radiochemistry, chemical separation and allied fields
(3)	Institute of Radiation Hygiene (Ministry of Health)	Leningrad	Radionuclide migration in various environments
(4)	Radioactive Disposal Station	Kharkov	Treatment and storage plant of low-level waste
(5)	Kurchatov Institute of Atomic Energy	Moscow	Ion exchange purification

2-Nucleonics Week, August 24, 1978 DOE

PROGRAM SUMMARY--UR NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Ensure nuclear power plants are safe.

MILESTONES
In the earlier stages of the USSR nuclear power program, nuclear plants were built without a secondary containment or emergency core cooling system. The USSR did not consider a double-ended break, loss of coolant accident or a massive core meltdown as a possible accident. The USSR philosophy is that this type of accident is prevented from ever occurring by the engineered safeguards, design conservatism, and quality control/inspection activities. Presently, this attitude has changed. All new nuclear power plants will be built with secondary containment over the reactor and primary coolant circuits. Also all new plants will have emergency core cooling systems and more formal reviews of nuclear plant safety are in the making.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

CONTACTS
Dr. Andranik Petrosyants, Chairman, State Committee on the Utilization of Atomic Energy, Moscow

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Physical-Technical Institute	Obninsk	Reactor Development
Kurchatov Institute of Atomic Energy	Moscow	Reactor Development

PROGRAM SUMMARY--UR NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Reactor Safety

APPROACH
Presently, nuclear safety is assured by the following areas: high quality of manufacturing; inspection of equipment and manufacturing processes; remote inspection of operating equipment; design and application of protective systems to prevent failures and components for initial disturbances; radioactive gas and liquid processing systems; new plants have emergency core cooling and secondary containment.

PROBLEMS
(1) Graphite Moderated Reactor (LGR) has a positive reactivity coefficient on loss of coolant. Therefore there is a greater need for a reliable and effective core cooling system.
(2) LMFBR BN-600 type greater than 1000 MWe, has a positive reactivity coefficient on loss of coolant. This condition requires effective safety systems and design criteria.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UR NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-V. A. Sidorenko et al., Main Ways for Solution of the Atomic Power Plant Safety Problems in the USSR, IAEA-CN-36/343, Nuclear Power and its Fuel Cycle, Volume 5, Proceedings of an International Conference in Salzburg, May 1977 DOE
2-J. Lewin, Russian Approach to Nuclear Reactor Safety, Nuclear Safety, Volume 18(4), pp. 438-445, May 1977 DOE
3-Battelle Pacific Northwest, International Source Book: A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Volume 4, PNL-2478, January 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

SP: SPAIN

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	5
Fuel Fabrication	6
Light Water Reactors (LWR)	7
Gas Cooled Reactors (GCR)	9
Liquid Metal Fast Breeder Reactors (LMFBR)	10
Research and Test Reactors	11
Spent Fuel Processing	13
Waste Management	15
Safety and Environment	17

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Spain is making a major effort in maximizing its uranium production and supply.

MILESTONES
National Plan for Uranium Prospecting approved by government covers a period from 1974 to 1985 (Note 1).

RESOURCES
$11 million in 1977 (Note 2)

CURRENT STATUS
(1) Spain's total indigenous uranium resources estimated at 248,500 tonnes, 126,200 tonnes economically recoverable.
(2) Empresa Nacional del Uranio S.A. (ENUSA) signed a contract in June 1978 with Colombian Institute of Nuclear Affairs (IAN) for joint uranium exploration in Colombia for a time limit of eight years. ENUSA 49% interest and IAN 51% (Note 3).
(3) ENUSA involved in uranium exploration in Canada, Chile, South Africa and Niger.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Limited domestic exploration plus active engagement in joint undertakings in foreign countries.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Ciudad Rodrigo mine/mill complex in Salamanca Province, 100 MTU/year, operational since 1975. Capacity expansion to 460 MTU/year in 1981. Average grade 1000 ppmU.

SIGNIFICANT PARAMETERS
(1) Domestic uranium production in 1975-187 short tons of U3O8; imported uranium-144 short tons-all from USA.
(2) Annual consumption 1510 tonnes U3O8 in 1975; 5680 tonnes projected for 1985.

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE
2-Uranium-Resources, Production and Demand, OECD Nuclear Energy Agency and IAEA, December 1977 DOE
3-Nuclear Fuel, June 26, 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Spain is making a major effort in maximizing its domestic uranium production.

MILESTONES

RESOURCES

CURRENT STATUS
(1) ENUSA has 10% ownership of COMINAK, a 2360 tonnes U3O8/year mine/mill complex in Niger, operational 1979.
(2) Two domestic mills are currently in operation.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nucleare (JEN) and Empresa Nacional del Uranio S.A. (ENUSA).

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Bague, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Juan Vigon Nuclear Research Center	Moncloa, Madrid	U3O8 milling research

PROGRAM SUMMARY--SP NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Two domestic uranium mills currently in operation.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
(1) A small mill at Andujar near Cordoba, 54 MTU/year, operational since 1959. Expected to operate another 2 to 3 years.
(2) ENUSA owns Ciudad Rodrigo mine/mill complex in Salamanca Province, 100 MTU/year, operational since 1975. Capacity expansion to 460 MTU/year in 1981.

SIGNIFICANT PARAMETERS
JEN is investigating possible extraction of uranium from Spanish lignite and phosphorites (Note 1).

PROGRAM SUMMARY--SP NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Partnership with other European countries appears to be Spain's present objective in acquiring enrichment services.

MILESTONES

RESOURCES

CURRENT STATUS

(1) ENUSA holds 11.11% interest in Eurodif and through Eurodif 5.67% interest in Coredif.

(2) Projected 1980 requirement-1.5 million SWU/year, all from the USA. After 1980, 60% from USA, 25% from Eurodif and 15% from the USSR. Projected enrichment service required in 1985-3 million SWU/year (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

Empresa Nacional del Uranio S.A. (ENUSA)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Spain has an ambitious fabrication program (see LWRs).

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Juan Vigon Nuclear Research Center	Moncloa, Madrid	Reactor fuel production

PROGRAM SUMMARY--SP NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978. DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Spain has an ambitious nuclear program aimed at achieving self-sufficiency in the complete supply of LWR power plants. There is clearly a national commitment to LWR technology.

MILESTONES

(1) Pre-1977 capacity: 593 MWe. Projecting 39500 MWe for 2000.
(2) A ten-year energy plan involving an investment of $7.8 billion approved by the government May, 1978.

RESOURCES

Export-Import Bank and other U.S. banking institutions provided loans for U.S. supplied equipment.

CURRENT STATUS

Empresa Equipos Nucleare S.A. has license agreement with Westinghouse and technology transfer agreement with GE and KWU. (Plant located near Santander). Initial target capacity; 3-sets of nuclear steam supply systems per year by 1980. Projected 1987 installed capacity set at 10,500 MWe (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Three reactors in operation totaling 1,073 MWe, seven units under construction totaling 6,555 MWe, and three more units (900-1000 MWe class) in planning.

APPROACH

PROBLEM AREAS
(1) Opposition to nuclear energy, terrorist attacks and labor disputes (Note 1).
(2) Because of tight US export rules, Spain turned to West Germany for supply of nuclear equipment (Note 3).

BENEFITS
Less dependence on imported oil.

FACILITIES
Power plant description/status published annually (April) by NUCLEAR ENGINEERING INTERNATIONAL and semiannually (July, January) by NUCLEAR NEWS.

SIGNIFICANT PARAMETERS
Empresa Nacional del Uranio S.A. (ENUSA) plans to build an LWR fuel fabrication plant at Juzbada of Salamanca Province, 400 MT/year, operational 1981. It has license agreements with Westinghouse, GE and KWU.

The 1000-MWe PWR, which a consortium of three Spanish utilities is to build at Trillo, is a standard KWU plant; it follows German safety philosophy, but project management is handled by the consortium (Note 3).

PROGRAM SUMMARY--SP NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, March 16, 1978 DOE
2-Nuclear News, June 1978 DOE
3-Nuclear Engineering International, pp. 31-43, September 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
No plan is known for developing GCR technology though one medium-size GCR is in operation.

MILESTONES
Vandellos-1 reactor (Magnox type) commissioned - May, 1972.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
The Vandellos-1 reactor was built by CEA (France) and is operated by HIFRENSA.

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SP NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Spain generally in favor of breeder reactors, but no deployment commitment at present.

MILESTONES

RESOURCES

CURRENT STATUS
Two sodium loops are being installed, one at Soria and the other at Juan Vigon, for studying sodium technology (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Juan Vigon Nuclear Research Center	Moncloa, Madrid	Fast breeder technology

PROGRAM SUMMARY--SP NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH
Spain looks at other countries for a joint LMFBR research and development program (Note 1).

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SP NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To establish basic nuclear technology.

MILESTONES
(1) JEN established in October 1951. One of JEN's responsibilities is to promote basic and applied nuclear research and to train scientists (Note 1).
(2) Decree of 7/22/74: joint nuclear research and development by power companies and the Nuclear Energy Board.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Five research reactors are in operation.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
List of research and test reactors:

NAME	OWNER	TYPE	MW(th)	DATE
JEN-1	JEN	GE pool 20% U235 MTR assemblies	6	1958
JEN-2	JEN	Pool	10kw	1968
CORAL-1	JEN	Split bed, fast, zero power	-	1968
ARBI	Bilbao Superior Technical School	Argonaut	10kw	1962
ARGOS	Barcelona Superior Technical School	Argonaut	10kw	1962

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SP NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Spain favors reprocessing, but will wait and see how reprocessing plans work out in other countries.

MILESTONES

RESOURCES

CURRENT STATUS
(1) No need for fuel reprocessing until 1995 (Note 2).
(2) Spain participates in the Mol plant operated by OECD Eurochemic Corporation (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Juan Vigon Nuclear Research Center	Moncloa, Madrid	Fuel processing

PROGRAM SUMMARY--SP NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
No immediate plan to develop large scale reprocessing facilities.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
A small pilot plant processes MTR type fuel, operational since 1967 (Note 1).

SIGNIFICANT PARAMETERS
JEN has a feasibility study for a national fuel reprocessing plant. No immediate implementation is seen.

PROGRAM SUMMARY--SP NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, January 1977 DOE
2-Nucleonics Week, July 27, 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To develop safe methods for waste disposal.

MILESTONES

RESOURCES

CURRENT STATUS
JEN is responsible for interim storage of radioactive waste until technology is available for processing and permanent disposal (Notes 1 and 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)

KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Juan Vigon Nuclear Research Center	Moncloa, Madrid	Waste management

PROGRAM SUMMARY--SP NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Test repository for solid wastes.

APPROACH
Waste solidification (Note 2) and rock disposal (Note 3) are the major experimental work areas in the waste research programs.

PROBLEM AREAS

BENEFITS

FACILITIES
A pilot repository for solid radioactive wastes of IAEA categories 1 and 2 is located at Sierra Albarrana (Note 2).

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--SP NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE
2-Nuclear Power and Its Fuel Cycle, Proceedings of Salzburg Conference, May 1977, Vol. 4, p. 437 DOE
3-Nucleonics Week, July 27, 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To protect the environment and the public from the effects of ionizing radiation.

MILESTONES
JEN was established (October 1951). One of JEN's responsibilities is to evaluate nuclear safety of power plants and other radioactive installations (Note 1).

RESOURCES

STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Junta de Energia Nuclear (JEN)
KEY CONTACTS
Lt. Gen. D. Jesus Olivares Baque, President, JEN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--SP NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-NAC C-7827, International Data Collection and Analysis, prepared by Nuclear Assurance Corporation for DOE, June 1978 DOE

PROGRAM SUMMARY--SP NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, February 1977 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

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TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Enrichment Plants	3
Fuel Fabrication	5
Light Water Reactors (LWR)	7
Heavy Water Reactors (HWR)	9
Research and Test Reactors	10
Spent Fuel Processing	12
Waste Management	14
Safety and Environment	15

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop firm overseas sources of uranium ore to support an energy policy utilizing thermal and nuclear power as a base with hydropower providing support at peak load times.

MILESTONES
(1) Contract for initial requirements.
(2) Develop new sources through joint exploration efforts in the USA and other parts of the world (currently) (Note 2).

RESOURCES
Not available

CURRENT STATUS
No uranium deposits of commercial value have been found in Taiwan.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Co. (TPC)

KEY CONTACTS
D. S. Chu, President (TPC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Purchase materials and services from foreign sources.

APPROACH
Contract for long-term assured sources of uranium ore and/or UF6.

PROBLEM AREAS
Taiwan was expelled from IAEA in 1972 and must depend on bilateral agreements.

BENEFITS
Even though no longer a member of IAEA, Taiwan nuclear activities are subject to IAEA safeguards and not treaty provisions.

FACILITIES

SIGNIFICANT PARAMETERS
Anschutz Corp, USA, and Korea Electric announced in 1977 the formation of a joint venture to explore for uranium in Paraguay. Anschutz has an exclusive-rights contract with Paraguay for mineral resource exploitation. Taiwan press announced a two-year contract with the government of Paraguay (thus with Anschutz) to prospect for uranium.

Taiwan needs to purchase from foreign suppliers 20 million lbs of uranium through 1990. Purchases to date meet its needs to 1984 (Note 1).

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, Vol. 5, June 1978 (Draft) DOE
2-Latin America Economic Report 30, Vol. VI, Number 25, June 1978

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, May 5, 1977 DOE

PROGRAM SUMMARY--TW NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Taiwan requires an assured source of low enrichment services to support the planned LWR power program. This source is the USA through bilateral agreement.

MILESTONES
(1) Taipower will convert LTFC contracts with the US DOE to AFC contracts in FY78 (Notes).
(2) Additional contracts will be negotiated as needed.

RESOURCES

CURRENT STATUS
(1) Taipower has one requirements-type enriching services contract to support LWR units 1 and 2 for a 30-year period.
(2) Taipower has four long term fixed commitment type contracts to support LWR units 3, 4, 5, and 6.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Co. (TPC)

KEY CONTACTS
D. S. Chu, President (TPC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--TW NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Procure enriching services from USA.

APPROACH
Renegotiate LTFC contracts to the more flexible AFC type.

PROBLEM AREAS
Limited to bilateral agreements due to expulsion from IAEA.

BENEFITS

FACILITIES
None

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

Enrichment Contracts with US DOE

CI/1	Chin Shan Units 1 and 2	Requirements type
CI/100	Kuosheng-1	LTFC
CI/101	Kuosheng-2	LTFC
CI/103	Nuclear-Unit 5 (Maanshau-Unit 1)	LTFC
CI/104	Nuclear-Unit 6 (Maanshan Unit 2)	LTFC

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Procure assured supply of fuel fabrication services from US LWR fuel fabricators.

MILESTONES

RESOURCES

CURRENT STATUS
All development work on plutonium handling and mixed oxide fuel fabrication has been discontinued and the equipment placed in standby (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Co. (TPC)

KEY CONTACTS
D. S. Chu, President (PNC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Institute of Nuclear Energy Research (INER)-operated by the Atomic Energy Council	Adjacent to but separate from the Chung Shen Institute of Science	Fabrication plant (25-30 MT/YR) for TRR metal fuel Heavy water clean-up facility for ZPRL

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop alternate USA sources of fabrication services.
Train personnel for possible future domestic fabrication.

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-INER catalogue, December 1974
2-ERDA, Division of International Security, Taiwan Energy Fact Book, February 1975 (Draft)

PROGRAM SUMMARY--TW NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Private discussion with G. Helfrich, DOE-International Division. The hot laboratory for research on second generation power reactor fuels and plutonium handling facilities were completed and placed in standby (all work on plutonium has been discontinued).

PROGRAM SUMMARY--TW NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Expand nuclear power program in Taiwan through deployment of large LWRs from USA.

MILESTONES
(1) One 636 MWe BWR was operational in June 1978 (First Nuclear Unit 1).
(2) Under construction: one 636 MWe BWR is scheduled for operation August 1979 (First Nuclear Unit 2); one 985 MWe BWR is scheduled for operation October 1981 (Second Nuclear Unit 1); one 985 MWe BWR is scheduled for operation October 1982 (Second Nuclear Unit 2); one 951 MWe PWR is scheduled for operation April 1984 (Third Nuclear Unit 1); one 951 MWe PWR is scheduled for operation April 1985 (Third Nuclear Unit 2).
(3) Planned: one 1200 MWe (?) scheduled for operation March 1988 (Second Nuclear Unit 3); one 1200 MWe (Type ?) scheduled for operation March 1989 (Second Nuclear Unit 4); one 1200 MWe (Type ?) scheduled for operation March 1990 (Third Nuclear Unit 3).

RESOURCES

CURRENT STATUS
Taiwan has no domestic reactor mfg capability.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Company (TPC)

KEY CONTACTS
David Shi Chu, President (TPC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Hsing Hua University Department of Nuclear Engineering (INS)	Hsinchu	Designed mobile educational reactor for technician training in nuclear science, radiation safety and waste disposal
Chinese Atomic Energy Council Nuclear Energy Institute (INER)		Nuclear power generation planning, supervising, regulating development

PROGRAM SUMMARY--TW NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Operate imported LWRs

APPROACH

PROBLEM AREAS
Expulsion from IAEA

BENEFITS

FACILITIES
LWRs

Chinshan-1	commercial operation June 1978
Chinshan-2	Kuosheng 1 & 2, Maanshan 1 and 2 are under construction
Chinshan	Kuosheng, Maanshan

SIGNIFICANT PARAMETERS
Chinshan 1 & 2, 636 gross MWe, BWR-4, General Electric
Kuosheng 1 & 2, 985 gross MWe, BWR-6, General Electric
Maanshan 1 & 2, 951 gross MWe, PWR-3LOOP, Westinghouse

PROGRAM SUMMARY--TW NUCLEAR FISSION LWR
KEY REFERENCES DTG 15 SEP 78

1-Taiwan Power General Report, 1977 - revised land forecast, April 1978
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, Vol. 5, June 1978 (Draft) DOE

PROGRAM SUMMARY--TW NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Operate the Taiwan Research Reactor (TRR) purchased from AECL.

MILESTONES
Natural uranium metal fuel (112 tonnes) purchased from S. Africa, heavy water supplied by Canada.

RESOURCES

CURRENT STATUS
Reactor started in October 1973, now in operation after a 2-year shutdown (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
INER		

PROGRAM SUMMARY--TW NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
N/A

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
A 40-MWt HWR, natural uranium fueled (modified version of NRX reactor at Chalk River, Ontario, Canada).

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-INER Catalogue, December 1974
2-ERDA Division of International Security, Taiwan Energy Fact Book, February 1975, (Draft)
3-DOE, ROC Energy Program Survey, 1977 (Draft)

PROGRAM SUMMARY--TW NUCLEAR FISSION FWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-TRR is now operating full time producing isotopes for medical uses

PROGRAM SUMMARY--TW NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Conduct studies in fundamentals of nuclear power technology.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Co. (TPC)

KEY CONTACTS
David Shi Chu, President (TPC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Tsing Hua University-Institute of Nuclear Science	Hsin-Chu	Radiation safety and waste disposal, technician training
Institute of Nuclear Energy Research	CSIS	Promote R&D of reactor technology, fuel cycle and other related projects

PROGRAM SUMMARY--TW NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES

NAME	LOCATION	CONSTRUCTOR	TYPE	POWER
THOR	INS-Hsin-Chu	GE	Pool, 20% U-H2O	1 MWt
THAR	INS-Hsin-Chu	ANL	Argonaut-LWR	10 kw
MER	INS-Hsin-Chu	Tsing-Hua	LWR	0.1 W
TRR	INER	AECL	Nat U-HW	40 MW
ZPRL	INER	INER	LWR	10 kw
WBR	INER	INER	18% Uranyl Sulfate-H2O	100 kw

SIGNIFICANT PARAMETERS

THOR - Tsing-hua Open-Pool Reactor
THAR - Tsing-hua Argonaut Reactor
MER - Mobile Educational Reactor
ZPRL - Zero Power Reactor Lungten
WBR - Water Boiler Reactor

PROGRAM SUMMARY--TW NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-ERDA, Division of International Security, Taiwan Energy Fact Book, February 1975 (Draft)

PROGRAM SUMMARY--TW NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Contract for spent fuel reprocessing outside of Taiwan.

MILESTONES
Taiwan has terminated all efforts directed toward or associated with reprocessing (Note 1).

RESOURCES

CURRENT STATUS
No contracts have been concluded to date.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Power Co. (TPC)

KEY CONTACTS
D. S. Chu, President (TPC)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--TW NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS
USA policy on reprocessing and expulsion of Taiwan from IAEA

BENEFITS

FACILITIES
Nuclear Research Institute - LAR scale facility under construction for reprocessing metal fuel has been dismantled (Note 1).

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-J. E. Gray et al., International Cooperation on Breeder Reactors, Rockefeller Foundation, Mar. 1978 DOE

PROGRAM SUMMARY--TW NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Private communication with Jerry Helfrich, DOE-International Division. All work associated with reprocessing has been terminated and the reprocessing pilot plant scheduled to process one TRR fuel element per week was dismantled following cold checkout.

PROGRAM SUMMARY--TW NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Study radioactive waste disposal aspects.

MILESTONES

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Government

KEY CONTACTS
Chen-Hwa Cheng, Director, INS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Tsing Hua University (INS)	Hsing-Chu	Studies in radioactive waste disposal

PROGRAM SUMMARY--TW NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS

FACILITIES
Solid waste disposal facility at INER has compaction, vehicle decontamination, and alpha decontamination cells.

Low level liquid waste facility consists of three 200-ton tanks for collection and two 200-ton tanks for sampling decontaminated waste before discharge.

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-ERDA, Division of International Security, Taiwan Energy Fact Book, February 1975 (Draft)
2-J. J. Stobbs, International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--TW NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

MILESTONES

RESOURCES

STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Taiwan Government

KEY CONTACTS
Chen-Hwa Cheng, Director, INS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
National Tsing Hua University, Institute of Nuclear Science (INS)	Hsing-Chu	Studies of radiation safety and monitoring nuclear engineering lab
Institute of Nuclear Energy Research	Chung Shan Institute of Science	Nuclear Engineering and Health Physics

PROGRAM SUMMARY--TW NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEMS

BENEFITS

FACILITIES
INS - Nuclear Engineering Laboratory
INER - Divisions of Nuclear Engineering Radiation Chemistry, Nuclear Instrumentation, and Health Physics

PARAMETERS

PROGRAM SUMMARY--TW NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-ERDA, Division of Internationl Security, Taiwan Energy Fact Book, February 1975, (Draft)

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

UK: UNITED KINGDOM

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Enrichment Plants	5
Fuel Fabrication	7
Light Water Reactors (LWR)	9
Heavy Water Reactors (HWR)	11
Gas Cooled Reactors (GCR)	13
Other Non-Breeder Reactors	16
Liquid Metal Fast Breeder Reactors (LMFBR)	18
Other Breeder Reactors	21
Research and Test Reactors	22
Spent Fuel Processing	24
Waste Management	27
Safety and Environment	30

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Rely on imports from Commonwealth countries in whose uranium programs UKAEA has been involved actively.

MILESTONES
(1) Systematic exploration by Institute of Geological Sciences (1968-73)
(2) No deposits identified
(3) Estimated resources - 7400 tonnes U ($30-50/lb U3O8)
(4) Overseas activities since 1950s by UKAEA and industry

RESOURCES
$0.59 million explo cost (1968-73)

CURRENT STATUS
(1) CEGB-20% interest in Canada ($1.5 million explo), 1/3 interest in URANIA (West. USA)
(2) Rio Tinto Zinc
  (a) 81% interest in Conzinc Rio Tinto (Australia)
  (b) 52% interest in Rio Algom Ltd. (Canada)
  (c) 45% interest in Rossing (S.W. Africa-Namibia)

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA, Central Electricity Generating Board (CEGB), Rio Tinto Zinc

KEY CONTACTS
Dr. W. Marshall, Deputy Chairman, UKAEA

R&D ORGANIZATIONS		LOCATION	PROGRAM AREA
(1)	BNFL	Niger	Exploration
(2)	CEGB-state utility	(1) Canada	Exploration
		(2) West USA	Exploration
(3)	Rio Tinto Zinc-private	(1) Australia	Explo/Prod
		(2) Canada	Explo/Prod
		(3) Rossing/Namibia	Explo/Prod

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Become actively involved in overseas activities for lack of domestic resources

APPROACH

PROBLEM AREAS

BENEFITS
Signing of a safeguards agreement with Australia expected (Note 1)

FACILITIES

SIGNIFICANT PARAMETERS
Exploration in N. Scotland, Cornwall, 1800 tonnes assured/4000 tonnes additional resources ($15-30/lb U3O8)

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL SUPPLY
KEY REFERENCES DTG 15 SEP 78

1-URANIUM-Resources, Production and Demand, A joint report by OECD/ NEA and IAEA, December 1977 DOE
2-N. B. McLeod, J. J. Steyn, Foreign Uranium Supply, EPRI EA-725, April 1978 WENDS

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, July 13, 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish uranium ore processing capability in support of its military activities, first, and its multi-faceted nuclear power program

MILESTONES
Uranium ore purification/conversion activities since early 1950s.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA, Rio Tinto Zinc

KEY CONTACTS
Dr. W. Marshall, Dep Chair, UKAEA
Dr. H. Rogan, Gen Mgr, BNFL-Springfields

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
Rio Tinto Zinc-private	Overseas	U3O8 production
BNFL-Springfields	Lancashire	UF4, UF6

PROGRAM SUMMARY--UK NUCLEAR FISSION RESOURCE RECOVERY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Establish conventional ore purification and uranium production capability.

APPROACH
Production of UF4 from which either U metal is produced for MAGNOX, or UF6 for enrichment.

PROBLEM AREAS

BENEFITS
BNFL - Worldwide exporter of UF6 services

FACILITIES
BNFL, Springfields plant in Lancashire: (1) UF4, 12000 MT/YR (early 1970s), (2) UF6, 8000 MT/YR (1974), 10000 MT/YR (1980)

SIGNIFICANT PARAMETERS
(1) Uranium imported as U3O8 concentrate. It is converted to UF4, U metal or UF6 utilizing conventional processes.
(2) Cumulative production (pre-1977) - 16000 MT UF4, 14000 MT UF6

PROGRAM SUMMARY--UK NUCLEAR FISSION RESOURCE RECOVERY
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION ENRICHMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish commercial capability domestically under government sponsorship and base further expansion on multi-national programs.

MILESTONES
(1) UKAEA diffusion enrichment activities--originally military--since 1950s.
(2) BNFL took over UKAEA production (1971).
(3) URENCO established in 1970 (Almelo agreement - 1/3 interest each of UK, FRG, Holland). Centrifuge capacity planned - 2 million SWU/YR (1983), an add-on 8 million SWU/YR (1988)--Notes 1 and 2. Cap expansion - 1 million SWU/YR (1982) to 1.5 million SWU/YR (mid-1980s).
(4) BNFL will expand on behalf of URENCO the Capenhurst plant to double its capacity to 400 thous SWU/YR-comm operation in 1981, cost to range between 73 and 130 million British pounds (Note 3).

RESOURCES
URENCO, Capenhurst plant (200 thous SWU/YR), $87 million

CURRENT STATUS
Production meets domestic demand. URENCO firm business exceeds 2 million SWU/YR for delivery in 1980s and beyond.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA, URENCO

KEY CONTACTS
W. Taylor, Gen Mgr, BNFL-Capenhurst

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
BNFL	Capenhurst	Diffusion
URENCO	Capenhurst	Centrifuge

PROGRAM SUMMARY--UK NUCLEAR FISSION ENRICHMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Commercialize the diffusion technology that was developed for its military programs
(2) Evaluate technical and economic feasibility of alternative processes

APPROACH
Decided that expansion should be based on the more energy efficient centrifuge process. UK had not been able to export services based on the Capenhurst diffusion facility.

PROBLEM AREAS
URENCO expansion plans deferred to 1988 because of client nuclear program delays

BENEFITS
(1) Utilization of existing domestic technology
(2) Multi-national cooperation
(3) Self-sufficiency
(4) Safeguards inspection under EURATOM, agreement with IAEA
(5) Low-enrichment limit of URENCO re proliferation

FACILITIES
At Capenhurst, Cheshire (capacity, SWU/YR)
(1) BNFL - Diffusion, 1971 (400 thousand)
(2) URENCO - Pilot centrifuge, 1975 (15 thousand)
(3) URENCO - Prod centrifuge, 1977 (40 thousand), 1978 (200 thousand)

SIGNIFICANT PARAMETERS
(1) URENCO operates two pilot plants at Almelo (Holland)
(2) URENCO second comm plant at Almelo (200 thous SWU/YR-1978), site of the third comm plant (in Germany) not chosen
(3) BNFL-partner in CENTEC which develops and makes enrichment facility components (W. Germany)
(4) Centrifuge - modular plant, high separation factor
(5) URENCO plants designed to produce 4.5% enrichment max

PROGRAM SUMMARY--UK NUCLEAR FISSION ENRICHMENT
KEY REFERENCES DTG 15 SEP 78

1-D. Aston, E. Roetz, Status of the URENCO/CENTEC Centrifuge Project and Advantages of the Process, IAEA-CN-36/99, Proc. of Inter. Conf., Salzburg, May 1977. DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION ENRICHMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-W. Haussermann et al., Demand and Supply Estimates for the Nuclear Fuel Cycle, IAEA-CN-36/493, Proc of Inter. Conf., Salzburg, May 1977. DOE
2-J. J. Steyn, Worldwide Separative Work Supply/ Demand, AIF Inter. Conf., New Orleans, Jan. 30, 1978. DOE
3-Nuclear Engineering International, p.7, September 1978. DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL FABRICATION
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish domestic capability to produce fuel for its reactors.

MILESTONES
(1) UKAEA - began fuel fabrication in 1948 for plutonium production reactors (military)
(2) Commercial capability for MAGNOX (GCR) fuels (1958)
(3) Prototype plant capability for UO2 fab (AGR, SGHWR) - early 1960s
(4) Commercial UO2 fuel capability (1968)
(5) BNFL plut MOX fuel fab - since 1963 for domestic and foreign thermal reactors, since 1974 for breeder program

RESOURCES

CURRENT STATUS
Self-sufficiency in fuel fabrication

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
Mr. P. Mummery, Gen. Mgr, BNFL-Windscale
Dr. H. Rogan, Gen. Mgr, BNFL-Springfields

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
UKAEA	Springfields	Fuels Development
BNFL	Windscale	Plut fuel mfg
BNFL	Springfields	U metal, UO2

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL FABRICATION
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Produce uranium metal for MAGNOX GCRs
(2) Produce enriched UO_2 for AGRs and SGHWRs
(3) Develop and demonstrate breeder fuel fabrication (highly enriched U-initially, plut-U mixed oxide)

APPROACH
(1) Metal fuel used in early programs as an extension of military know-how
(2) Transition to UO_2 in AGRs
(3) Use of conventional pellet-fuel in recent programs

PROBLEM AREAS

BENEFITS
(1) Export of U metal for overseas MAGNOX GCRs
(2) Export plut MOX fuel fab services
(3) IAEA membership

FACILITIES
BNFL
(1) Springfields plant (Lancashire): 2500 MT/YR MAGNOX fuel fab (1958), 300-500 MT/YR UO_2 fab (1968-72)
(2) Windscale plant: 10 MT/YR breeder MOX fuel (early 1970s) Note 1

SIGNIFICANT PARAMETERS
(1) Stockpile of plutonium in the form of mixed uranium and plutonium oxides (BNFL-Windscale)
(2) BNFL - 50% interest in Combustibili Nucleari, a small MAGNOX fuel fab plant in Italy
(3) Cum production (pre-1977) - 16000 MT U metal, 1300 MT UO_2

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL FABRICATION
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION FUEL FABRICATION
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. Van Dievoet et al., Plutonium Use - Present Status and Prospects, IAEA-CN-36/477, Proc. of Inter. Conf., Salzburg, May 1977. DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Import PWR capability if the government finally decides to rely on water reactors or any AGR/LWR mix to meet its needs until the transition to breeders is made.

MILESTONES
(1) General Electric Co. (UK) - Licensee of Westinghouse
(2) The PWR adopted as the reference system (1976-77)

RESOURCES

CURRENT STATUS
Policy under evaluation.
The Central Electricity Generating Board (CEGB) does consider site work for a PWR could start before 1982 (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
Dr. W. Marshall, Dep Chair, UKAEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) NPC	-	Safety
(2) CEGB	-	Safety

PROGRAM SUMMARY--UK NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Evaluate US LWR (BWR, PWR) design, performance and safety for potential commercialization in England.

APPROACH
(1) Depend on imported technology (GEC-Westinghouse licensee)
(2) Utilize PWRs to augment (possibly) AGR power generation program

PROBLEM AREAS
No domestic PWR reactor industry available. Domestic industry manufactures PWR components such as pumps, valves, and piping for export (Note 1).

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UK NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nucleonics Week, Dec. 8, 1977 DOE
2-Nuclear Engineering International, p.9, September 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION HWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop, demonstrate and commercialize a heavy water reactor system (SGHWR - steam generating heavy water reactor).

MILESTONES
(1) The first and only SGHWR, 100 MWe, went commercial (Winfrith-1967). The system was designed and built by UKAEA at the Atomic Energy Establishment (AEE-Winfrith) - Note 1.
(2) SGHWR adopted by government as reference system (1974).
(3) Subsequently, the SGHWR system was rejected by the Central Electricity Generating Board (CEGB) and Nuclear Power Co (NPC-Mfg). CEGB and NPC favor interim AGR deployment to be followed by PWRs. Policy re-evaluation by government continuing.

RESOURCES
Cumulative SGHWR development cost amounts to $290 million (Note 3).

CURRENT STATUS
No SGHWRs being built

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
Dr. W. Marshall, Dep Chair, UKAEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) UKAEA	Risley	Engineering/Systems
(2) CEGB	--	Engineering/Construction
(3) BNFL	Risley	Fuel
(4) NPC	Risley	Sole reactor vendor

PROGRAM SUMMARY--UK NUCLEAR FISSION HWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop and demonstrate a reliable fuel design in a small plant.
(2) Establish safety criteria for designing large plants.

APPROACH
(1) Base design on pressure tube reactor with boiling light water coolant and an auxiliary heavy water moderator contained in a calandria tank
(2) Standardize fuel element design based on system performance

PROBLEM AREAS
Fuel failures - (1) At low burnup due to cladding overheating caused by copper-rich crud, (2) QA related.

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
(1) SGHWR fuel based on enriched uranium. Plut MOX fuel loaded (36 rods) in 1969 - Note 2
(2) Recently, replacement of sintered UO2 by a high matrix density fuel (TD exceeding 98%)
(3) Satisfactory steady-state performance - 60 kW/m, 21 GWD/MTU
(4) Loss-of-Coolant-Accident experimental program completed.
(5) The 60-pin fuel element preferred now over the 36-pin fuel element

PROGRAM SUMMARY--UK NUCLEAR FISSION HWR
KEY REFERENCES DTG 15 SEP 78

1-D. O. Pickman, G. H Inglis, SGHWR Fuel Performance, Safety and Reliability, IAEA-CN-36/63, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-D. R. Smith et al., SGHWR Safety Design and Evaluation, IAEA-CN-36/73, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION HWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-S. Catchpole, F. P. Jenkin, UK Experience of Planning the Nuclear Contribution to the UK Power Programme, IAEA-CN-36/53, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-A. Chamberlain, C. Melches, Prospects for the Establishment of Plutonium Recycle in Thermal Reactors in the Foratom Countries, IAEA-CN-36/143, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-Nucleonics Week, August 31, 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION GCR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and commercialize gas-cooled, thermal reactors.

MILESTONES
(1) UKAEA built two experimental GCR (MAGNOX) stations - Calder Hall & Chapelcross, 4 reactors each, 50 MWe per reactor - 1956 to 1959
(2) Another eighteen small to medium GCRs (4 GWe total) installed to date
(3) Demonstrated next generation gas-cooled reactor technology at the 33 MWe AGR at Windscale
(4) The first two AGRs went commercial in 1976 but have shown poor performance
(5) Ten 600-MWe AGRs ordered to date
(6) No decision made on AGR/LWR future deployment

RESOURCES

CURRENT STATUS
No more GCR installations. AGR program is experiencing long and costly delays. Ongoing government evaluation on further AGR commercial deployment.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
J. R. Griffin, Dir Eng., UKAEA/Risley

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
UKAEA	(1) Risley	Engineering
	(2) Windscale	Dev Labs
BNFL	Risley	Engineering
CEGB	--	Reactor systems
Nuclear Power Co. (35% UKAEA)	--	Sole reactor vendor

PROGRAM SUMMARY--UK NUCLEAR FISSION GCR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop gas-cooled reactor technology based on the experience with the military, air-cooled, plutonium production piles
(2) Establish a commercial system for domestic deployment and export

APPROACH
(1) Develop the MAGNOX GCR initially
(2) Developed the advanced, gas-cooled reactor (AGR) subsequently. This was a major departure in fuel design - MAGNOX (metal U in magnesium alloy), AGR (UO_2 in SS cladding)

PROBLEM AREAS
(1) MAGNOX GCRs reduced to 70-80% of full power because of corrosion problems
(2) The two oper AGRs (Hinkley Pt B1, Hunterston B1- 1976) have shown poor performance to date (30% CF) - Note 2
(3) AGR delays (Dungeness B)-cost escalated from 89 million pounds (1969) to 344 million pounds (1978) - Note 2
(4) AGR boiler, insulation redesign - Note 2

BENEFITS

FACILITIES
UKAEA/Reactor Group-Risley Engineering and Materials Laboratory (reactor components, labs)

SIGNIFICANT PARAMETERS
(1) AGR uses enriched uranium
(2) Nuclear Installations Inspectorate - Demanded extra safety systems in the Dungeness B (AGR) - startup end of 1979, Note 2
(3) Last AGR order was placed in 1971. No new orders expected in 1970s.
(4) Plut MOX (192 rods) were loaded in the Windscale AGR (1964) - Note 1
(5) A new emergency fuel cooling system to be installed at Hinkley Pt B1 and Hunterston B1 - the modification could allow on-line refueling (Note 3)
(6) Examination of discharged fuel from AGRs indicated if performed as expected (Note 4)

PROGRAM SUMMARY--UK NUCLEAR FISSION GCR
KEY REFERENCES DTG 15 SEP 78

1-S. Catchpole, F. P. Jenkin, UK Experience of Planning the Nuclear Contribution to the UK Power Programme, IAEA-CN-36/53, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION GCR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-A. Chamberlain, C. Melches, Prospects for the Establishment of Plutonium Recycle in Thermal Reactors in the Foratom Countries, IAEA-CN-36/143, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Nuclear Engineering International, p. 31, July 1978. DOE
3-Nucleonics Week, September 7, 1978 DOE
4-Nuclear Engineering International, p.9, September 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION OTHER NON-BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Establish high temperature reactor (HTR) basic technology without any firm long-term commitment.

MILESTONES
The 20 MWt DRAGON HTR (Winfrith) was operated (1966). It was based on 93% U, Thorium, graph-mod, Helium-cooling. The reactor was shutdown in late 1975. The DRAGON experimental reactor achieved an overall availability of 78% (Note 1).

RESOURCES

CURRENT STATUS
HTR program de-emphasized (Note 2)

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
Dr. W. Marshall, Dep. Chair., UKAEA

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UK NUCLEAR FISSION OTHER NON-BREEDERS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Develop and test fuels, materials and components.

APPROACH
Note 1
(1) Build a research reactor
(2) Develop coated particle fuels (TRISO, PyC, SiC, Th, U dicarbides)
(3) Irradiate fuel to high burnup
(4) Test components and materials for HTR application

PROBLEM AREAS

BENEFITS
Activities paralleled similar but more extensive programs abroad (USA, FRG)

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--UK NUCLEAR FISSION OTHER NON-BREEDERS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-K. H. Beckurts et al., The Gas-Cooled High Temperature Reactor, IAEA-CN-36/94, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION LMFBR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop, demonstrate, and commercialize the LMFBR system.

MILESTONES
(1) Dounreay exper fast reactor (DFR), 60 MWt (crit 1959, full power 1963, shutdown 1976)
(2) Dounreay proto fast reactor (PFR), 250 MWe (crit 1974, full power 1977)
(3) Commercial fast reactor (CFR), 1300 MWe, at design stage (oper early 1990s)
(4) Plans for 5 GWe LMFBR by 2000 (Note 1); hope for 33 GWe by 2010

RESOURCES
$500 million (pre-1973), $92 million (1977)

CURRENT STATUS
(1) UKAEA/US DOE agreement (9/76-9/81)
(2) Talks on coordinating policies on breeders, reprocessing and rad-waste between Common Market countries stopped by UK (Note 2).
(3) Breeder deployment policy not firmly established. Wide-ranging inquiry on fast reactors planned. First, two issues must be settled, (a) definition of UKAEA and utility responsibility in CFR project, and (b) submittal of proposal to Dept of Energy to build the CFR. Design changes to date based on PFR experience (Note 4).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA, CEGB, Nuclear Power Co. (NPC)

KEY CONTACTS
(1) M. C. Blumfield, Director, DERE-Dounreay
(2) Mr. J. Moore, Dir, Fast Reactor Systems, UKAEA/Risley
(3) Dr. N. L. Franklin, Chairman, NPC

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
UKAEA	Risley	Fast Reactors
DERE-Dounreay	Thurso	Fast Reactors
NPC	Risley	Reactor
CEGB	--	Components

PROGRAM SUMMARY--UK NUCLEAR FISSION LMFBR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop LMFBR design, safety and operational criteria
(2) Establish economics of the LMFBR and time-scale for commercialization
(3) Deploy LMFBR commercially according to needs

APPROACH
(1) Establish LMFBR feasibility on pilot plant (DFR)
(2) Develop design and fuel performance criteria in a prototype (PFR)
(3) Accumulate manufacturing and operating experience to base design of the commercial breeder (CFR)
(4) Determine key LMFBR features which would require large facilities.

PROBLEM AREAS
(1) PFR: Steam gen leaks in 2 out of 3 secondary circuits kept the plant at low power until 1977
(2) Public acceptance of plutonium; non-proliferation climate
(3) Program slow-down; slow growth in electricity demand. In 1976, the Royal Commission on the Environment (Flowers Report) called for deferral of the breeder
(4) The UK Select Comm. on Science and Technology called for an inquiry regarding broad socio-technological aspects of breeders (Note 3)

BENEFITS
(1) Utilization of the plutonium stockpile from GCRs and AGRs
(2) Long-term energy self-sufficiency
(3) IAEA membership

FACILITIES
Risley
(1) Large water-flow test facility
(2) A general-purpose large sodium facility (capable of handling CFR fuel)
(3) A high-temperature sodium loop

SIGNIFICANT PARAMETERS
(1) DFR utilized highly enriched uranium/Repro at Dounreay
(2) PFR utilizes U, Pu mixed oxide/Repro planned at Dounreay
(3) Reference fuel for fast reactors--laboratory-compacted gel fuel (UKAEA). Work on pellet fuel continuing.
(4) High integrity LMFBR spent fuel shipping cask design continuing (UKAEA)
(5) Steam generator problems being gradually resolved adequately
(6) Emphasis on large component materials development after neutron-induced void swelling was observed in DFR
(7) Design changes for CFR include-alternative core support system, a more easily managed fuel, new steam generators, modified heat exchangers and revised sodium thermal insulation. Dynamic sodium loop tests scheduled at Risley for late 1978 (Note 4)

PROGRAM SUMMARY--UK NUCLEAR FISSION LMFBR
KEY REFERENCES DTG 15 SEP 78

1-J. F. W. Bishop et al., Fast Reactor Fuel Design and Development, IAEA-CN-36/64, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-N. L. Franklin, J. M. Hill, Status and Programme for the Fast Breeder Reactor in the United Kingdom, IAEA-CN-36/54, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-PNL-2478, International Source Book - A Compedium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Compiled by K. M. Harmon, January 1978 DOE
4-J. E. Gray et al., International Cooperation on Breeder Reactors, The Rockefeller Foundation, May 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION LMFBR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 7, July 1978 DOE
2-Nucleonics Week, July 20, 1978 DOE
3-Nature, p. 524, Vol. 274, No. 5671, 10 August 1978 DOE
4-Nucleonics Week, September 14, 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION OTHER BREEDERS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
(1) None indicated
(2) England has thermal, gas reactor technology base for gas-cooled fast reactor R&D, but it is inactive in this area. Instead, its primary objective is the LMFBR
(3) The establishment believes alternative reactor systems/fuel cycles (e.g., GCFR, MSBR, thorium, etc.) do not fundamentally eliminate the proliferation aspects of LMFBRs/plutonium (Note 1)

MILESTONES

RESOURCES

CURRENT STATUS
No activity indicated

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
UKAEA	Risley	Reactor technology

PROGRAM SUMMARY--UK NUCLEAR FISSION OTHER BREEDERS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Atom, No. 263, p. 234, September 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE

Design, construct, and operate research reactor facilities in support of power reactor fuel, design, and component development.

MILESTONES

(1) Thirty-five facilities commissioned to date. Only 24 are still operating.

(2) The Dragon project (High Temp reactor) was de-emphasized in 1976. The 20 MWt DRAGON reactor, Winfrith (93% U, Thorium, graph-mod, Helium-cooled) was shutdown in 1976 after about two years of operation.

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS

UKAEA/Universities/Atomic Weapons Research Establishment

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--UK NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS

BENEFITS
IAEA membership

FACILITIES
Profile of operating facilities (complete list in ref. 1)

Name/Year	Location	Type
GLEEP/47	Harwell	Nat U, graph, air (.05 MWt)
ZETR/52	Harwell	High enr. U/Pu, H_2O
DIDO/56	Harwell	93% U-Al, D_2O (22 MWt)
JASON/59	Greenwich	80% U, graph, H_2O (.01 MWt)
HERALD/59	Aldermaston	Pool, 90% U, H_2O (5 MWt)
ZENITH/59	Winfrith	Enr. U, plut or Th; graph, CO_2
VERA/61	Aldermaston	High enr. U, FAST
ZEBRA/62	Winfrith	U/Pu, air
WAGR/62	Windscale	UO_2, graph, CO_2 (124 MWt)
VIPER/67	Aldermaston	37.5% U, FAST (pulsed)
TRIGA/71	Teesside	20% U, ZrH, H_2O (.25 MWt)
ZENITH-II/72	Winfrith	UO_2/PuO_2, graph

SIGNIFICANT PARAMETERS
Reactivity excursion experiments in the pulsed, fast reactor facility VIPER (Note 1)

PROGRAM SUMMARY--UK NUCLEAR FISSION RESEARCH & TEST REACTORS
KEY REFERENCES DTG 15 SEP 78

1-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-J. Bailly et al., European In-Pile Investigations of Fast Breeder Reactor Safety, IAEA-CN-36/245, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION SPENT FUEL PROCESSING
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Install commercial plants to reprocess its own spent fuel and fuels from other countries.

MILESTONES
(1) Reprocessing by UKAEA at Windscale since 1952
(2) Reprocessing of material test reactor fuel (1958), and breeder fuel (1961) at Dounreay - Note 1
(3) Windscale MAGNOX fuel repro plant (B-205), 15000 MT reprocessed
(4) BNFL takes over UKAEA production (1971)
(5) UO2 head-end plant installed at Windscale (1972); startup accident and shutdown (1973). Refurbishing and startup (1978, 400 MT/YR)
(6) Comm UO2 repro plant, THORP, Windscale, cap-1000 MT/YR (1984), 2000 MT/YR (1987)
(7) Japanese fuel repro (1600 MT, THORP, 1987-)

RESOURCES

CURRENT STATUS
Windscale MAGNOX plant operational, UO2 head-end being refurbished/ Dounreay plant modified to repro (PUREX) plut fuel from prototype breeder/ THORP in planning stage/Spent fuel storage at Windscale.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
B. F. Warner, Deputy Head, R&D Dept, Windscale, BNFL
C. W. Blumfield, Director, DERE - Dounreay

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
BNFL	(1) Risley	Hdqrs.
	(2) Windscale	Operations
	(3) Dounreay/Thurso	FR fuel repro
DERE-Dounreay	Dounreay/Thurso	Lasers/Solv. Extr./ FR fuel repro.
UKAEA	Risley	Ship casks.

PROGRAM SUMMARY--UK NUCLEAR FISSION SPENT FUEL PROCESSING
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Develop and demonstrate repro capability for MAGNOX (GCR-U metal clad in magnesium alloy), UO2 (AGR-SS; LWR), and breeder (U, Pu oxide) fuel.
(2) Build and operate large commercial plants.

APPROACH
(1) Repro technology tied to weapons material production initially
(2) Adopted PUREX technology
(3) Integrated MAGNOX and UO2 repro facilities initially
(4) Decided to build separate commercial UO2 repro capability

PROBLEM AREAS
(1) Startup accident at Windscale head-end, UO2 repro plant (1973). Plant refurbished for startup 1978 (400 MT/YR capacity, UO2, PUREX)
(2) COGEMA (France) competition in overseas marketing
(3) Non-proliferation climate

BENEFITS
(1) Near-term plutonium self-sufficiency for breeder program
(2) Long-term dependence on plutonium as an energy source
(3) Potential for export services in 1990s
(4) IAEA membership

FACILITIES
BNFL
(1) Windscale, Reprocessing: Cap 2500 MT/YR MAGNOX (1964), 400 MT/YR UO2 (1978)
(2) Windscale, spent fuel storage: Cap 1500 MT, 3000 MT (1980)
(3) Dounreay, breeder fuel repro (10 MT/YR, 1978)
(4) THORP, Windscale, pilot-active operation in mid-1979 (Note 2)

SIGNIFICANT PARAMETERS
(1) Windscale MAGNOX repro based originally on BUTEX, later modified to PUREX. UO2 head-end provides solution to MAGNOX plant for purification. Capability to convert plut nitrate to oxide. Coprocessing of U and Pu installed.
(2) 120 MT UO2 fuel repro at Windscale (1972-73) prior to shutdown.
(3) Dounreay PUREX repro plant: High enr. U from Dounreay exper fast breeder (DFR) in 1961-72. Plut from prototype fast breeder (PRF) in 1978.
(4) HLLW from Dounreay repro to storage
(5) BNFL, COGEMA (France) and KEWA (FRG) - own United Reprocessors GmbH
(6) BNFL, TRANSNUCLEAR (FRG), TRANSNUCLEAIRE (France) - own international spent fuel transport company (Nuclear Transporters, Ltd.)
(7) BNFL has a wide range of spent fuel shipping casks
(8) Airborne plutonium contamination at Windscale - ventilation system problems (Note 3)

PROGRAM SUMMARY--UK NUCLEAR FISSION SPENT FUEL PROCESSING
KEY REFERENCES DTG 15 SEP 78

1-W. Haussermann et al., Demand and Supply Estimates for the Nuclear Fuel Cycle, IAEA-CN-36/493, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-G. K. Rossney, Status and Prospects for Reprocessing, IAEA-CN-36/56, Proc. of Inter. Conf., Salzburg, May 1977 DOE
3-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management Research and Development, Compiled by K. M. Harmon, January 1978 DOE
4-J. J. Stobbs et al., International Data Collection and Analysis, NAC C-7827, June 1978 (Draft) DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION SPENT FUEL PROCESSING
NOTES AND EVALUATIONS DTG 15 SEP 78

1-R. H. Allardice et al., Fast Reactor Fuel Reprocessing in the United Kingdom, IAEA-CN-36/66, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Nuclear Engineering International, p. 29, July 1978 DOE
3-Nuclear Fuel, September 4, 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION WASTE MANAGEMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Develop and demonstrate the technology for treatment and/or isolation and ultimate disposal of nuclear wastes.

MILESTONES
(1) R&D work at Harwell (AERE) since the 1950s.
(2) The FINGAL/HARVEST pot process (incorp. of HLLW into glass matrix) was demonstrated - Note 2.
(3) The FINGAL pilot plant had completed 72 runs (8 involved processing of active waste) before it was shutdown in 1966.
(4) The HARVEST pilot plant at Windscale to be completed by end of 1978--no plans for an industrial-scale facility before 1982 (Note 4).
(5) The glass characterization pilot plant at Windscale to be completed by end of 1978.
(6) HLLW solidification plant to be built at Dounreay (breeder fuel waste, 30 liter/hr, late 1980s).

RESOURCES
(1) Windscale pilot plant - 3 million pounds
(2) Windscale glass char plant - 2.5 million pounds

CURRENT STATUS
On-going work on HLLW glass characterization, disposal systems.

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
UKAEA

KEY CONTACTS
(1) Dr. L. E. Roberts, Director, AERE-Harwell
(2) Mr. C. W. Blumfield, Director, DERE-Dounreay
(3) Mr. R. F. Jackson, Geol Repository, UKAEA-Risley
(4) Dr. A. W. Woodland, Director, IGS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
AERE-Harwell	Harwell	HLLW solid./ LLLW treat./ TRU/solids
DERE-Dounreay	Thurso	HLLW solid./store
UKAEA/Reactor Group	Risley	HLLW solid.
Inst of Geologic Sciences	London	Geology
BNFL	Windscale/Risley	Engineering/Off-gas/Handling/Glass Charact.
NRPB	Harwell	Ocean bed/hard rock (Note 2)

PROGRAM SUMMARY--UK NUCLEAR FISSION WASTE MANAGEMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Concentrate HLLW and store in engineered facilities/treat other wastes
(2) Develop HLLW vitrification processes
(3) Select and evaluate ultimate disposal modes (crystalline rock, ocean-bed, geologic formations) - Note 2
(4) Build processing plants

APPROACH
(1) Selected the batch HLLW vitrification process to minimize handling waste nitrates
(2) Is evaluating alternative permanent disposal systems
(3) Has not made heavy commitment to any one technology/system yet

PROBLEM AREAS
Effect of waste composition (e.g., Magnox vs. UO2) on glass formation/performance.

BENEFITS
(1) Unrestrained growth with adequate waste management solution
(2) EEC sponsorship - crystalline rock deposit evaluations (Note 3)
(3) OECD sponsorship - geological disposal evaluation (Note 1)

FACILITIES
(1) HARVEST pilot plant at Harwell (non-active waste, 1975, 240 kg glass/run)
(2) Solid waste incinerator plant at Windscale (1973, 5 kg/hr)

SIGNIFICANT PARAMETERS
(1) FINGAL/HARVEST process - borosilicate glass by simultaneous evaporation, denitration and glass formation in a metal container. The container is used both as the vitrification vessel and the storage container.
(2) In-situ heating experiment in an unused granite quarry (Note 1)
(3) Tritium from repro discharged mainly as tritiated water. On-going work at Windscale on Tritium separation based on isotope distillation technology (such as D20).
(4) Encouraging results in Kr-85 incorporation in metal matrix at Harwell.
(5) TRU alpha-particle effects on glass evaluated (Harwell)
(6) In-reactor TRU transmutation evaluated (Harwell)
(7) Potential for devitrification of vitrified high level water in salt formations (Note 5)
(8) UKAEA experiencing public opposition in its program to drill test bores in granite for vitrified waste disposal (Note 6)

PROGRAM SUMMARY--UK NUCLEAR FISSION WASTE MANAGEMENT
KEY REFERENCES DTG 15 SEP 78

1-N. T. Mitchell et al., Options for the Disposal of High-Level Radioactive Waste IAEA-CN-36/67, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-PNL-2478, International Source Book - A Compendium of Worldwide Programs in Nuclear Energy Supply and Radioactive Waste Management R&D, Vol. 4, Compiled by K. M. Harmon, January 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION WASTE MANAGEMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Nuclear Engineering International, p. 36, January 1978 DOE
2-Nuclear Engineering International, p. 53, January 1978 DOE
3-Nuclear Engineering International, p. 61, June 1978 DOE
4-Nuclear Engineering International, p. 63, June 1978 DOE
5-Nucleonics Week, August 24, 1978 DOE
6-Nucleonics Week, September 7, 1978 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION SAFETY & ENVIRONMENT MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Protect the public and the environment.

MILESTONES
(1) Legislation re safety regulation of nuclear facilities effective since 1960
(2) Nuclear Installation Act (1965)
(3) Health and Safety at Work Act (1974)

RESOURCES
FY 76-77, Department of Environment budget - 11 million pounds

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Department of Environment/Government

KEY CONTACTS
P. Bryant, G. Webb (NRPB-Harwell)/H. Hill (FRL)

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA
(1) Natural Environment Research Council	-	-
(2) Universities	-	-
(3) UKAEA	Risley	Safeguards
(4) NRPB-Harwell	Harwell	Envir. Safety
(5) Fisheries Radiobiological Laboratories	Suffolk	Sea-bed disposal/ Plut. dispersal in ocean

PROGRAM SUMMARY--UK NUCLEAR FISSION SAFETY & ENVIRONMENT
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
(1) Formulate criteria for radioactive release to environment
(2) Regulate operations in power facilities and fuel cycle facilities (fab, repro, waste treatment, transport)
(3) Develop safety criteria for permanent disposal of nuclear waste

APPROACH

PROBLEM AREAS
Public opposition - UK Friends of Earth
Worker Contamination with plutonium (Note 2)

BENEFITS
IAEA membership

FACILITIES

SIGNIFICANT PARAMETERS
(1) Developed and demonstrated spent fuel shipping casks
(2) Good experience (re safety) in transport of spent fuels-Note 1
(3) Remote reprocessing and fabrication of plutonium fuels envisaged

PROGRAM SUMMARY--UK NUCLEAR FISSION SAFETY & ENVIRONMENT
KEY REFERENCES DTG 15 SEP 78

1-A. R. Baker et al., Safety Consideration in the Fast Reactor Fuel Cycle, IAEA-CN-36/74, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-J. K. Donoghue et al., Safety Aspects of a Fuel Reprocessing Plant, IAEA-CN-36/75, Proc. of Inter. Conf., Salzburg, May 1977 DOE

PROGRAM SUMMARY--UK NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-C. J. Edney, R. L. Rutter, Some UK Experience and Practice in the Packaging and Transport of Irradiated Fuel, IAEA-CN-36/70, Proc. of Inter. Conf., Salzburg, May 1977 DOE
2-Nuclear Engineering International, p. 7, September 1978 DOE

WENDS PROGRAM SUMMARIES
FOR NUCLEAR FISSION

VE: VENEZUELA

TABLE OF CONTENTS

Program	Page
Fuel Supply	1
Resource Recovery	3
Light Water Reactors (LWR)	4
Research and Test Reactors	5
Safety and Environment	7

PROGRAM SUMMARY--VE NUCLEAR FISSION FUEL SUPPLY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Venezuela is one of the large oil producers. Nuclear energy has been given much less attention.

MILESTONES

RESOURCES

CURRENT STATUS
CoNaN prospects for radioactive minerals with the participation of the Department of Geology of the Ministry of Mines and Energy. Greater prospecting activities are planned for uranium and thorium deposits (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Consejo Nacional para el Desarrollo de la Industria Nuclear (CoNaN)

KEY CONTACTS
Jesus Taborda Romero, Executive Secretary of CoNaN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--VE NUCLEAR FISSION FUEL SUPPLY
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE
Uranium supply totally from U.S. currently.

APPROACH

PROBLEM AREAS
Nationalization of industries is commonly practiced in Venezuela. In 1975, 14 foreign oil companies were expropriated. This practice inhibits the inflow of foreign investment and technology (Note 2).

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS
As of June 30, 1977, Venezuela received from U.S. 7.627 kg of U235 contained in 39.940 Kg uranium, 10 grams of plutonium and one kg of thorium (Note 1).

PROGRAM SUMMARY--VE NUCLEAR FISSION FUEL SUPPLY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977
2-The Energy Daily, August 30, 1978 DOE

PROGRAM SUMMARY--VE NUCLEAR FISSION RESOURCE RECOVERY
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Some laboratory scale work to be conducted in recovering uranium and thorium resources.

MILESTONES

RESOURCES

CURRENT STATUS
CoNaN conducts work to determine uranium and thorium contents in minerals by using the slow-neutron method (Note 1).

SPONSORS
Consejo Nacional para el Desarrollo de la Industria Nuclear (CoNaN)

KEY CONTACTS
Jesus Taborda Romero, Executive Secretary of CoNaN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--VE NUCLEAR FISSION RESOURCE RECOVERY
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--VE NUCLEAR FISSION LWR
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
No power reactors are planned.

MILESTONES
(1) A ten-year research and power Agreement for Cooperation between Venezuela and the United States became effective on February 9, 1960. An amendment extending the Agreement for ten years entered into force August 3, 1970 (Note 2).
(2) A Trilateral Safeguards Agreement entered into force March 27, 1968 and was permitted to expire as scheduled on June 23, 1974 in view of NPT adherence and conclusion of NPT Safeguards Agreement (Note 2).

RESOURCES

CURRENT STATUS

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Consejo Nacional para el Desarrollo de la Industria Nuclear (CoNaN)

KEY CONTACTS
Jesus Taborda Romero, Executive Secretary of CoNaN

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--VE NUCLEAR FISSION LWR
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS
(1) Seismic terrain
(2) Population dispersion and lack of power distribution networks
(3) Lack of scientific and technical manpower (Note 1)

BENEFITS

FACILITIES

SIGNIFICANT PARAMETERS

PROGRAM SUMMARY--VE NUCLEAR FISSION LWR
NOTES AND EVALUATIONS DTG 15 SEP 78

1-ERDA tr-298, Contribution to the Analysis of the Development of Unconventional Energy Sources in Latin America, Inter-American Development Bank and US ERDA, April 1977
2-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--VE NUCLEAR FISSION RESEARCH & TEST REACTORS
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
Promote nuclear research activities.

MILESTONES

RESOURCES
A research grant of 350,000 from the U.S. for the IVIC reactor in 1960 (Note 2).

CURRENT STATUS
Principal activities include application of radioisotopes in metallurgy and petroleum industries, neutron radiography, production of radioisotopes of short half-life, monitoring environmental radioactivity and providing health physics services, irradiation of flies and sorgum seeds and providing graduate courses on radioisotopes, radiation analysis and industrial application of radioisotopes (Note 2).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Instituto Venezolano de Investigaziones Cientificas (IVIC)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--VE NUCLEAR FISSION RESEARCH & TEST REACTORS
TECHNICAL SUMMARY DTG 15 SEP 78

SCOPE

APPROACH

PROBLEM AREAS
Lack of trained personnel and reactor operators.

BENEFITS

FACILITIES
A 3-MWth pool type GE research reactor, located 10 miles from Caracas, completed in 1960, shut down in 1961 and reactivated in 1965 (Notes 1 and 2).

SIGNIFICANT PARAMETERS
(1) Radioisotope studies at IVIC on intestinal absorption of radioactive iron in hookworm-infested patients was contracted with IAEA in 1961-63 and supported by USAEC (Note 2).
(2) IVIC collaborated with the University of Michigan on genetics research on primitive Indians in Venezuela, sponsored by USAEC (Note 2).
(3) Fifty-three Venezuelan students trained at the Puerto Rico Nuclear Center as of January 1976 (Note 2).
(4) A 10,000 Ci Cobalt irradiation source was loaned by USAEC to IVIC in 1968 and abandoned in place in 1973 (Note 2).
(5) Venezuela received from the IAEA expert assistance, equipment and fellowships totalling approximately $549,000 from 1958 to 1975. For the 1977 technical-assistance program year, Venezuela received $24,500 from IAEA (Note 2).

PROGRAM SUMMARY--VE NUCLEAR FISSION RESEARCH & TEST REACTORS
NOTES AND EVALUATIONS DTG 15 SEP 78

1-PB-251-497, Comparative Analysis of Utilization of Research Reactors in a Number of Developing Asian and Latin American Countries, by V. P. Guinn, December 1975 DOE
2-Information from ERDA/IP, August 1977

PROGRAM SUMMARY--VE NUCLEAR FISSION SAFETY & ENVIRONMENT
MANAGEMENT SUMMARY DTG 15 SEP 78

OBJECTIVE
To protect the public against environmental radioactivity.

MILESTONES

RESOURCES

CURRENT STATUS
IVIC monitors levels of the environmental background radioactivity around the country and provides health physics services (Note 1).

SOURCE: NUS CORPORATION DATE: 15 SEPT 1978

SPONSORS
Instituto Venezolano de Investigaciones Cientificas (IVIC)

KEY CONTACTS

R&D ORGANIZATIONS	LOCATION	PROGRAM AREA

PROGRAM SUMMARY--VE NUCLEAR FISSION SAFETY & ENVIRONMENT
NOTES AND EVALUATIONS DTG 15 SEP 78

1-Information from ERDA/IP, August 1977