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PNL-3594 Rev. 4

UC-70

International Nuclear Fuel Cycle Fact Book

K. M. Harmon
L. T. Lakey
I. W. Leigh

Issued November 1980
Latest Revision March 1984

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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INTERNATIONAL NUCLEAR FUEL CYCLE FACT BOOK

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Pacific Northwest Laboratory
Richland, Washington 99352

PREFACE

As the US Department of Energy (DOE) and DOE contractors have become more and more involved in cooperative activities with other nations in nuclear fuel cycle and waste management activities, a need has developed for a ready source of information concerning foreign fuel cycle programs, facilities, and personnel. This Fact Book was compiled to meet that need.

The information contained herein has been obtained from many unclassified sources: nuclear trade journals and newsletters; reports of foreign visits and visitors; CEC, IAEA, and OECD/NEA activities reports; proceedings of conferences and workshops; etc.

The information in the Fact Book is subject to frequent change. If you have suggestions which would improve the usefulness of the book or uncover more current information, let us know so that these changes can be included in periodic updates.

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ACRONYMS

ORGANIZATIONS AND FACILITIES

AAEC	Australian Atomic Energy Commission
AEB	Atomic Energy Bureau (Korea)
AEC	Atomic Energy Commission (Korea)
AEC	Atomic Energy Council (Taiwan)
AECB	Atomic Energy Control Board (Canada)
AECL	Atomic Energy of Canada, Limited
AERB	Atomic Energy Regulation Board (India)
ANDRA	Agence Nationale pour la Gestion des Déchets Radioactifs (France)
AWRE	Atomic Weapons Research Establishment (UK)
BARC	Bhabha Atomic Energy Centre (India)
BGR	Bundesanstalt für Geowissenschaften und Rohstoffe (FRG)
BMFT	Bundesministerium für Forschung und Technologie (FRG)
BMI	Bundesministerium des Innern (FRG)
BNFL	British Nuclear Fuels Limited
BRE	Building Research Establishment (UK)
BRGM	Bureau de Recherches Géologiques et Minières(France)
CANMET	Canada Centre for Metals and Energy Technology
CDTN	Centro de Desenvolvimento de Technologia Nuclear de Nuclebràs (Brazil)
CEA	Commissariat à l'Énergie Atomique (France)
CEC	Commission of the European Communities
CEGB	Central Electricity Generating Board (UK)
CEN/SCK	Centre d'Études de l'Énergie Nucleaire/ Studiecentrum voor Kernenergíe (Belgium)
CEN-CA	Centre d'Études Nucléaires de Cadarache
CEN-FaR	Centre d'Études Nucléaires de Fontenay-aux-Roses (France)
CEN-G	Centre d'Études Nucléaires de Grenoble (France)
CEN-S	Centre d'Études Nucléaires de Saclay
CFC	COGEMA Framatone Combustible (France)
CMEA	Council for Mutual Economic Assistance
CNEA	Comisión Nacional de Energía Atomica (Argentina)

CNEN	Commissao Nacional de Energía Nuclear (Brazil)
CNSNS	Comisión Nacional de Seguridad Nuclear y Salvaguardias (Mexico)
COGEMA	Compagnie Générale des Matières Nucléaires (France)
CPE	Countries with Centrally Planned Economies
CRIEPI	Central Research Institute of Electric Power Industry (Japan)
CRPPH	Committee on Radiation Protection and Public Health (NEA)
CSN	Consejo de Seguridad Nuclear (Spain)
DAM	Direction Des Applications Militaires
DBE	Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (FRG)
DHI	Deutsches Hydrographisches Institut (FRG)
DOE	Department of the Environment (UK)
DWK	Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH (FRG)
EC	European Communities
ECN	Energy Centrum Nederland
EIR	Eidgenössisches Institut für Reaktor Forschung (Switzerland)
EMR	Energy, Mines and Resources (Canada)
ENEA	Energia Nucleare e Delle Energie Alternative (Italy)
ENEL	Ente Nazionale per l'Energia Elettrica (Italy)
ENI	Ente Nazionale Idrocarburi (Italy)
ENUSA	Empresa Nacional del Uranio S.A. (Spain)
EPB	Electric Power Bureau (Korea)
ESCOM	Electricity Supply Commission (South Africa)
FBFC	Société Franco-Belge de Fabrication de Combustibles (France)
GIRIO	Government Industrial Research Institute-Osaka (Japan)
GSF/IfT	Gesellschaft für Strahlen-und-Umweltforschung mbH/Institut für Tieflagerung (FRG)
HMI	Hahn-Meitner Institut (FRG)
IAEA	International Atomic Energy Agency
ICRP	International Commission on Radiological Protection
IGS	Institute of Geological Sciences (UK)

INER	Institute of Nuclear Energy Research (Taiwan)
ININ	Instituto Nacional de Investigaciones Nucleares (Mexico)
IPEN	Instituto de Pesquisas Energéticas e Nucleares (Brazil)
IPSN	Institut de Protection et de Sûreté Nucléaire(France)
IRDI	Institut de Recherche Technologie et de Developpement Industriel
JAERI	Japan Atomic Energy Research Institute
JEN	Junta de Energía Nuclear (Spain)
JRC	Joint Research Center (CEC)
KAERI	Korea Advanced Energy Research Institute
KBS	Kärnkräftavfallets Behandling och Slutförvaring(Sweden)
KEMA	N.V. Tot Keuring van Electrotechnische Materialen Arnhem (Netherlands)
KEPKO	Korea Electric Power Corporation
KEWA	Kernbrennstoff-Wiederaufarbeitungs-GmbH (FRG)
KFA	Kernforschungsanlage Jülich GmbH (FRG)
KfK	Kernforschungszentrum Karlsruhe GmbH (FRG)
KOPEL	Korea Power Engineering Company
KTM	Royal Institute of Technology
KWU	Kraftwerk Union AG (FRG)
LDC	Less Developed Country
MAFF	Ministry of Agriculture, Fisheries and Food (UK)
MITI	Ministry of International Trade and Industry
NAGRA/CEDRA	Nationalen Genossenschaft für de Lagerung Radioaktiver Abfälle (Switzerland)
NAK	Naenmden foer Hantering av Atvaenr Kernsbrensle (Sweden)
NEA	Nuclear Energy Agency (OECD)
NII	Nuclear Installations Inspectorate (UK)
NIREX	Nuclear Industry Radioactive Waste Executive (UK)
NRPB	National Radiological Protection Board (UK)
NSC	Nuclear Safety Commission (Japan)
NTL	Nuclear Transport Limited (UK, France and FRG)

OECD	Organization for Economic Cooperation and Development
ÖFZS	Österreichisches Forschungszentrum Seibersdorf GmbH (Austria)
ONDRAF	Organisme National de Déchets Radioactifs et des Matières Fissiles (Belgium)
PNC	Power Reactor and Nuclear Fuel Development Corporation (Japan)
PTB	Physikalisch-Technische Bundesanstalt (FRG)
RWC	Radioactive Waste Management Center (Japan)
RWMAC	Radioactive Waste Management Advisory Committee (UK)
RWMC	Radioactive Waste Management Committee (NEA)
SGN	Société Générale pour des Techniques Nouvelles (France)
SKI	Statens Kärnkraftinspektion (Sweden)
SRD	Safety and Reliability Directorate (UK)
STA	Science and Technology Agency (Japan)
TN	Transnucleaire (France)
UKAEA	United Kingdom Atomic Energy Authority
UKOR/UCOR	Uranium Enrichment Corporation (South Africa)
UNIREP or URG	United Reprocessors GmbH (FRG, France, UK consortium)
URAMEX	Uranio Mexicano
URENCO	British-German-Dutch uranium enrichment consortium
WAK	Wiederaufarbeitungsanlage Karlsruhe Betriebsgesselschaft mbH (FRG)
WOCA	World Outside Centrally Planned Economies Areas

TECHNICAL

AFR	Away-from-reactor spent fuel storage facility
AGR	Advanced gas-cooled reactor, UO_2 fuel (UK)
ALONA	FRG acid digestion plant to be built at Mol, Belgium
ATR	Advanced thermal reactor

AVB	AVM-type HLW vitrification plant to be built at Eurochemic (Belgium)
AVH	AVM-type waste vitrification plant to be built at La Hague (France)
AVM	Atelier de vitrification de Marcoule (France)
BLWR	Boiling light water reactor
BWR	Boiling water reactor
CANDU	Canada deuterium uranium reactor
D&D	Decontamination and decommissioning
ESTER	Multistage pot calcination-vitrification process for HLW (Italy)
FBR	Fast breeder reactor
FBTR	Fast breeder test reactor
FIPS	Fission product solidification process (FRG/KFA)
FRP	Fuel reprocessing plant
GCHWR	Gas-cooled, heavy water moderated reactor
GCR	Gas-cooled, graphite moderated reactor
GWd	Gigawatt days
GWe	10^9 watts of electricity (1000 MWe)
HAO	Oxide head-end
HARVEST	British waste vitrification process
HLLW	High-level liquid waste
HLW	High-level waste
HTGR	High-temperature, gas-cooled reactor
HTR	High-temperature reactor
HWLWR	Heavy water moderated, light water cooled (same as LWCHW)
HWR	Heavy water reactor
IFTF	Immobilized Fuel Test Facility (Canada)
ILW	Intermediate-level waste
KgHM	Kilograms heavy metal
KgU	Kilograms uranium
LGR	Light water cooled, graphite moderated reactor
LHGW	Low heat generating waste
LLW	Low-level waste
LLLW	Low-level liquid waste
LMFBR	Liquid metal fast breeder reactor
LWCHW	Light water cooled, heavy water moderated (same as HWLWR)
LWR	Light water reactor
MLW	Medium-level waste (same as intermediate-level)
MOX	Mixed (plutonium/uranium) oxide

Mtce	Million metric tons of coal equivalent
Mtoe	Million metric tons of oil equivalent
MTR	Materials test reactor
MW	Megawatts
MWd/t	Megawatt days per tonne
MWe	Megawatts electric
MWt	Megawatts thermal
NPT	Non-Proliferation Treaty
PAMELA	West German vitrification pilot plant (Mol, Belgium)
PFR	Prototype Fast Reactor (UK)
PHWR	Pressurized heavy water reactor
PLWR	Pressurized light water reactor
PURR	Prototype d'usine de retraitement des rapids (France)
PWR	Pressurized water reactor
QUAD	10^{15} Btu
t/a	Tons per annum
tHM	Tons heavy metal
tSWU/a	Tons of separative work (uranium enrichment) per annum
tU	Tons uranium per annum
TEKO	Nonradioactive semi-works facility (FRG)
THORP	Thermal Oxide Reprocessing Plant (UK)
THTR	Thorium high-temperature reactor
Th/U	Thorium/Uranium
TRU	Transuranic
TWh	Terawatt hour (million megawatt hours)
URL	Underground Research Laboratory (Canada)
WIP	Waste Immobilization Plant (India)

INTRODUCTION
AND
OVERVIEW

INTRODUCTION

The International Fuel Cycle Fact Book has been compiled in an effort to provide 1) an overview of worldwide nuclear power and fuel cycle programs and 2) current data concerning fuel cycle and waste management facilities, R&D programs, and key personnel in countries other than the United States. Additional information on each country's program is available in the International Source Book: Nuclear Fuel Cycle Research and Development, PNL-2478, Rev. 2.

The Fact Book is organized as follows:

1. Overview section--summary tables which indicate national involvement in nuclear reactor, fuel cycle, and waste management development activities.

2. National summaries--a section for each country which summarizes nuclear policy, describes organizational relationships and provides addresses, names of key personnel, and facilities information.

3. International agencies--a section for each of the international agencies which has significant fuel cycle involvement.

4. Energy supply and demand--summary tables, including nuclear power projections.

5. Fuel cycle--summary tables.

6. Travel aids--international dialing instructions, international standard time chart, passport and visa requirements, and currency exchange rate.

TABLE 1. Reactor Mix

Country	No. of Reactors Online, Ordered, or Under Construction (12-31-83) LWR	HWR	GCR	Other	Advanced Reactor Development
Argentina		3			
Belgium	7				
Brazil	3				
Bulgaria	4				
Canada		24			
China (People's Republic)	1				
Czechoslovakia	10				
Egypt	2				
Finland	4				
France	52	1	7	2 FBR	FBR
Germany (FRG)	26	1		1 FBR, 1 HTR	FBR, HTR
Germany (GDR)	7				
Hungary	4				
India	2	8			FBR
Italy	4	1	1		HWR
Japan	39	1	1	1 FBR	HWR, FBR
Korea (South)	8	1			
Mexico	2				
Netherlands	2				
Pakistan		1			
Philippines	1				
Poland	2				
Rumania	4	2			
South Africa	2				
Spain	17		1		
Sweden	12				
Switzerland	7				
Taiwan	6				
USSR	21			2 FBR, 22 LGR	
UK		1	40	1 FBR	FBR
USA	136			1 HTR, 1 LGR, 1 FBR	HTR, FBR
Yugoslavia	1				

TABLE 2. Fuel Production Program[a]

Country	Mining[b] & Milling	Conversion	Enrichment	Fuel Fabrication UO$_2$	Fuel Fabrication MOX
Argentina	X	X	R&D	X	R&D
Australia	X		R&D		
Belgium		X	(c)	X	X
Brazil	X	X	X	X	
Canada	X	X		X	
France	X	X	X	X	X
Germany (FRG)	X	X	X	X	X
India	X	X		X	X
Italy	X	X	(c)	X	X
Japan	X	X	X	X	X
Korea (South)	R&D	R&D		R&D	
Mexico	X	X		X	
Netherlands			X		
South Africa	X	X	X		
Spain	X			X	
Sweden			(c)	X	
USSR	X	X	X	X	X
UK		X	X	X	X
USA	X	X	X	X	X
Yugoslavia	X				

(a) Legend: X - industrial plant in operation or on order
R&D - R&D stages only

(b) Commercial mining and milling operations are also conducted in the following countries: Central African Republic, Gabon, German Democratic Republic, Namibia, Niger, Philippines and Portugal.

(c) Partnership in Eurodif enrichment plant in France.

TABLE 3. Spent Fuel Management and Waste Treatment Programs

Country	Spent Fuel Transport	Fuel Reprocessing	Waste Conditioning HLW	Waste Conditioning Non-HLW
Argentina		R&D	R&D	X
Australia			R&D	
Austria			R&D	R&D
Belgium		X	X	X
Brazil		R&D	R&D	R&D
Canada		R&D	R&D	X
Denmark				R&D
Finland				X
France	X	X	X	X
Germany (FRG)	X	X	X	X
India		X	X	X
Italy		X	R&D	X
Japan	X	X	X	X
Mexico				X
Netherlands				X
Spain				X
Sweden	X		R&D	X
Switzerland				X
USSR	X	X	R&D	X
UK	X	X	X	X
USA	X	X	X	X

TABLE 4. Spent Fuel and Waste Disposal R&D Programs

Country	Spent Fuel Disposal	HLW Disposal	LLW/ILW Disposal	Spent Fuel Storage
Argentina		X	X	X
Austria		X		
Belgium		X	X	
Brazil			X	
Canada	X	X	X	X
Denmark	X	X		
Finland	X	X	X	X
France		X	X	X
Germany (FRG)	X	X	X	
Germany (DGR)			X	
India		X	X	
Italy		X	X	X
Japan		X	X	X
Mexico			X	X
Netherlands		X	X	X
South Africa	X	X	X	X
Spain	X	X	X	X
Sweden	X	X	X	X
Switzerland	X	X	X	X
USSR		X	X	X
UK		X	X	X
USA		X	X	X

NATIONAL SUMMARIES

ARGENTINA

ARGENTINE HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 6	Epiphany
*February	Carnival
*March/April	Holy Thursday
*March/April	Good Friday
May 1	Labor Day
May 25	Anniv. of 1810 Revolution
*June	Corpus Christi Day
June 20	Flag Day
July 9	Independence Day
August 15	Assumption Day
August 17	Death of Gen. San Martin
October 12	Columbus Day
November 1	All Saints' Day
November 6	Bank Holiday
December 8	Immaculate Conception
December 25	Christmas

ARGENTINA

ENERGY

Population	1980	27 million
Energy Demand	1979	40 Mtoe
Electric Power Plant Capacity	1980	12 GWe
Electric Power Production	1982	27 TWh-- 8% nuclear >50% fossil Balance hydro

NUCLEAR POWER

National Policy. High priority on self-sufficient CANDU-based nuclear power industry; government ownership and operation of all nuclear power plants; develop nuclear plant and services export capability.

Nuclear Power Plant Capacity	1980	0.3 GWe
	1985	0.9 GWe
	1990	1.6 GWe
	2000	3.0 GWe
Reactor Mix	1982	HWR: 1 (1974); 2 (1983-88)

INDUSTRIAL FUEL CYCLE

Policy. Develop domestic capability for D_2O production and all phases of the CANDU-type PHWR fuel cycle; may export Pu to breeder nations.

Waste Management Strategy. Build repository in granite formation, use it for interim (dry) storage of spent fuels until ready to dispose of HLW.

Cumulative Spent Fuel Arisings (HWR)	1980	416 tU
	1985	940 tU
	1990	1,900 tU
	2000	5,800 tU

Industrial-Scale Activities

1. D_2O production: 1984--200 t/a D_2O enrichment plant, supplied by a Swiss firm; develop domestic technology.

2. Uranium mining and milling (t/a): 1981--260; 1985--680.

3. Conversion of yellowcake to UO_2 (tU/a): 1983--150.

4. Uranium enrichment: 500 kg/a of 20% enriched U--1985.

5. Fuel fabrication: UO_2 fuels - see Ezeiza Atomic Centre; MOX fuel R&D.

6. Fuel reprocessing: R&D (see Ezeiza Atomic Centre).

INTERNATIONAL RELATIONSHIPS

1. Member of IAEA but opposed to NPT; has signed but not ratified Tlatalclo Treaty.

2. Nuclear plants and technology purchased from Canada, FRG, and Switzerland.

3. Technical cooperation with Latin America countries, primarily Brazil and Peru.

ORGANIZATION

The Comision Nacional de Energía Atomica (CNEA, National Atomic Energy Commission), owns and operates all facilities.

CNEA

Comision Nacional de Energía Atomica (CNEA)
Avenida del Libertador 8250
1429 Buenos Aires
Argentina

Tel: (54) 1 70 7711
Telex: 121 388

President (Interim) — Renato Radi Chela

EZEIZA ATOMIC CENTRE

Location. 10 miles northwest of Buenos Aires, near airport.

Facilities

1. Conversion of yellowcake to UO_2 (150 tU/a).

2. Fuel production: the first of three planned fabrication lines started up in 1982; capacity, 1-1/2 PHWR assembly per day.

3. Fuel reprocessing: Ezeiza pilot plant, planned capacity of 20 kgU/day feed, 10-15 kgPu/a product; cold runs--1985; hot runs--1986. Potential--expansion of pilot plant to commercial facility by early 1990s.

AUSTRALIA

AUSTRALIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 29	Australia Day
*March/April	Good Friday
*March/April	Easter Monday
April 25	ANZAC Day
December 25	Christmas
December 26	Boxing Day

AUSTRALIA

ENERGY

Population	1982	15 million

Energy Resources: production exceeds consumption by about 20%, but Australia imports 20% of its oil

Electric Power Production	1979	90.9 TWh-- 74% solid fuels 15% hydro 6% oil 5% gas

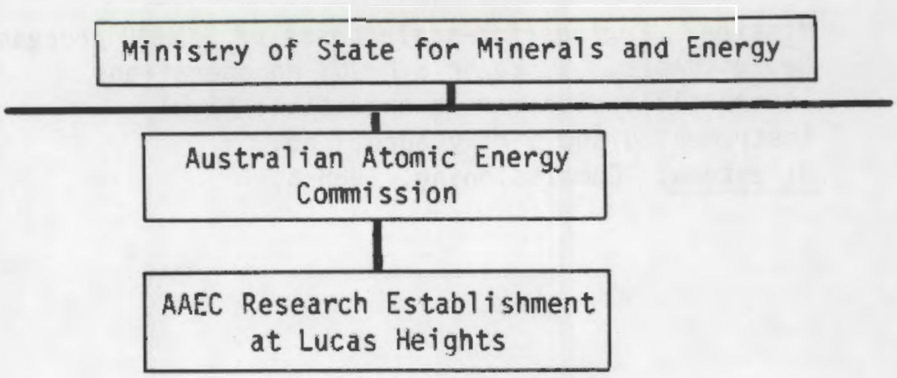
NUCLEAR POWER POLICY

1. No nuclear power installed; none planned.

2. Large uranium reserves; uranium currently produced for export, but labor government opposes opening new mines and recently terminated discussions with URENCO of a proposed joint enrichment project.

3. Government sponsors nuclear R&D, including development of:
   - uranium enrichment technology
   - HTGR and LMFBR systems
   - SYNROC process for immobilizing HLW.

ORGANIZATION



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Tel: (61) 2 543 0111
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Director	Prof. S. T. Butler
Deputy Director, Research	Dr. J. N. Gregory
Chemical Technology Division	Dr. P. G. Alfredsen
Materials Division	Dr. P. M. Kelly
Environmental Science Division	Dr. D. R. Davy
Nuclear Fuel Cycle	Dr. C. J. Hardy
Chemical Engineering Section	Dr. D. M. Levins

Mission. Conduct nuclear R&D; support university research and training projects in all branches of nuclear science and engineering.

Sponsors. AAEC and 17 universities.

Fuel Cycle R&D. Uranium enrichment, HLW immobilization (SYNROC process development and waste form properties), mill tailings treatment (actinide transport, surface hydrology, and radionuclide release).

Facilities

1. Nonradioactive SYNROC Fabrication Plant

   Mission. Engineering-scale tests of SYNROC process.
   Design Basis. 10 kg/hr SYNROC; no operations incompatible with remote operation; highly instrumented and partly automated.
   Milestone. Commissioning, 1985/6.

AAEC LUCAS HEIGHTS RESEARCH LABORATORIES (contd)

2. SYNROC Glove Box Line

Mission. Produce SYNROC containing actinides and ^{99}Tc.
Process Scale. Hundreds of grams.
Milestone. Startup, 1984.

Hot-Cell Processing Line for SYNROC

Milestone. Startup, 1984.

AUSTRALIAN ATOMIC ENERGY COMMISSION (AAEC)

Australian Atomic Energy Commission (AAEC)
P.O Box 41
Coogee 2034
New South Wales
Australia

Tel: (61) 2 665 1211
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General Manager — Maxwell Brennan

AUSTRALIAN NATIONAL UNIVERSITY

Australian National University
P.O. Box 4
Canberra 2600
Australia

Director, Research School of Earth Sciences — Prof. A. E. Ringwood

Fuel Cycle R&D. HLW immobilization (SYNROC process).

AUSTRIA

AUSTRIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 6	Epiphany
*March/April	Easter Monday
May 1	Labor Day
*May/June	Ascension Day
*May/June	Whit Monday
*June	Corpus Christi Day
August 15	Assumption Day
October 26	National Holiday
November 1	All Saints' Day
December 8	Immaculate Conception
December 25	Christmas
December 26	St. Stephen's Day

AUSTRIA

ENERGY

Population	1982	7.6 million
Energy Demand	1979	27 Mtoe (50-60% imported)
Oil Demand	1980	12.7 Mtoe (88% imported)
Electric Power Plant Capacity	1980	13 GWe
Electric Power Production	1980	40.6 TWh-- 73% hydro/geo. 12% oil 9% gas 6% solid fuels

NUCLEAR POWER POLICY

1. 0.7 GWe nuclear plant at Tulnerfeld completed but not approved for operation; exercise of nuclear option requires change in Austrian law.

2. Government sponsors R&D on reactor safety, waste treatment and waste isolation.

INDUSTRIAL FUEL CYCLE

Policy. Initial--depend on foreign suppliers. Reprocessing contract with COGEMA canceled in 1979.

Waste Management Strategy. Prepare to take back HLW canisters from foreign reprocessor, in case the nuclear option becomes acceptable. The government has joined with Egypt in studies of potential cooperative waste storage in Egypt.

ORGANIZATION

Waste treatment and disposal R&D are the responsibility of the Austrian Research Centre Seibersdorf LTD (ÖFZS), which is headquartered in Vienna and has a laboratory at Seibersdorf.

GEOLOGICAL SURVEY

Geological Survey of Austria
Rasumofskygasse 23
A-1031 Wien
Austria

ÖFZS (AUSTRIAN RESEARCH CENTER SEIBERSDORF)

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Incineration Material Test, Cementation	Dr. Peter Patek (43) 2254 80 2568
Bituminization	Dr. Karl Knotik (43) 2254 80 2405

Mission. R&D in peaceful applications of nuclear energy and radiation.

Sponsors. National government, industry, and electric utilities.

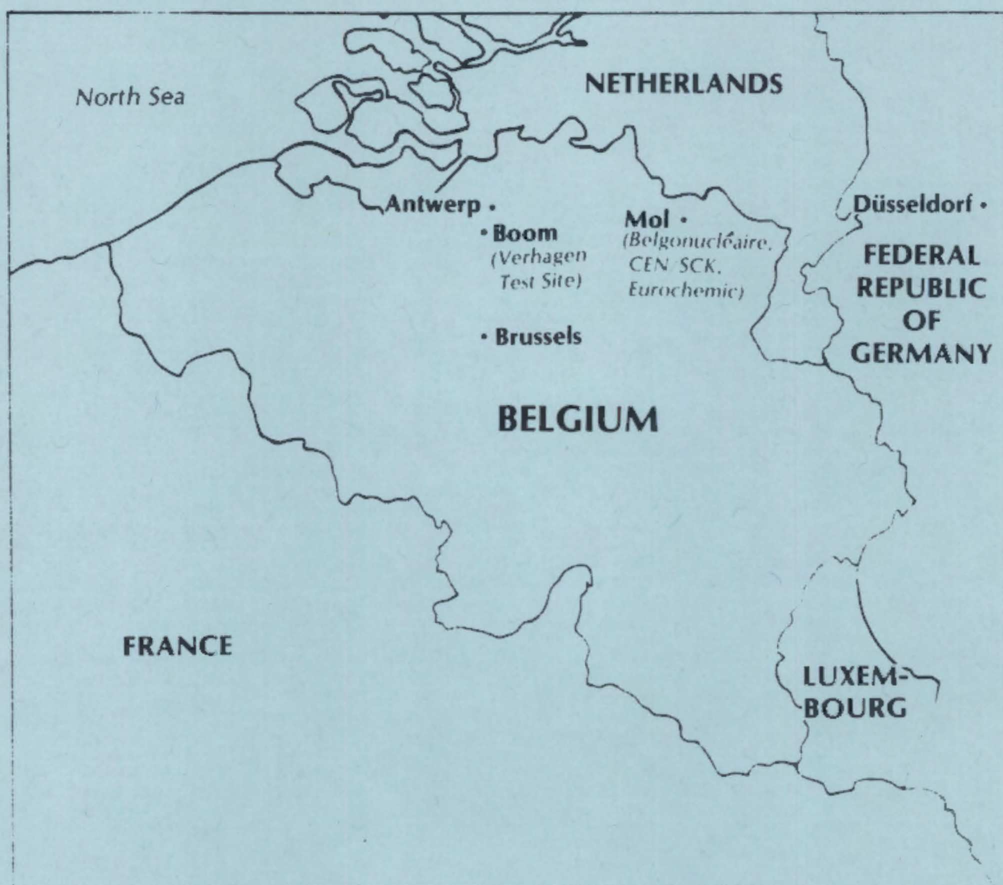
Waste Management R&D. HLW immobilization, LLW and ILW treatment, waste isolation in granite formations (geology, hydrology, heat transfer, corrosion, barrier materials, and risk analysis).

BELGIUM

BELGIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Easter Monday
May 1	Labor Day
*May/June	Ascension Day
*May/June	Whit Monday
July 21	National Day
August 15	Assumption Day
November 1	All Saints' Day
November 11	Armistice Day
December 25	Christmas



BELGIUM

ENERGY

Population	1982	9.9 million
Energy Demand	1980	49.5 Mtoe (84% imported)
Oil Demand	1980	25.8 Mtoe (100% imported)
Electric Power Plant Capacity	1982	15 GWe-- 23% nuclear
Electric Power Production	1982	48 TWh-- 30.2% nuclear 1.5% hydro/geo.
	1985	>50% nuclear

NUCLEAR POWER

National Policy. Complete the LWRs currently under construction; evaluate addition of an eighth (1300 MWe) unit.

Nuclear Power Plant Capacity	1983	3.5 GWe
	1985	5.4 GWe
	1995	6.7 GWe
	2000	8.0 GWe
Reactor Mix	1982	PWR: 4 (1975-82) 3 (1983-85)
Reactor Development	Participation in FRG Kalkar SNR-300 FBR project	

INDUSTRIAL FUEL CYCLE

Policy. Well-rounded capability--uranium enrichment (share in Eurodif); MOX and UO_2 fuel fabrication; purchase of foreign reprocessing services; and operation of former Eurochemic plant and waste treatment facilities.

Waste Management Strategy. Vitrify HLW in AVM-type plant and store for 50 years in surface facility; treat and immobilize other wastes; sea-dump LLW drums and dispose of HLW in clay-formation repository.

Cumulative Spent Fuel Arisings (LWR)	1980	196 tU
	1985	560 tU
	1990	1,290 tU
	2000	3,000 tU

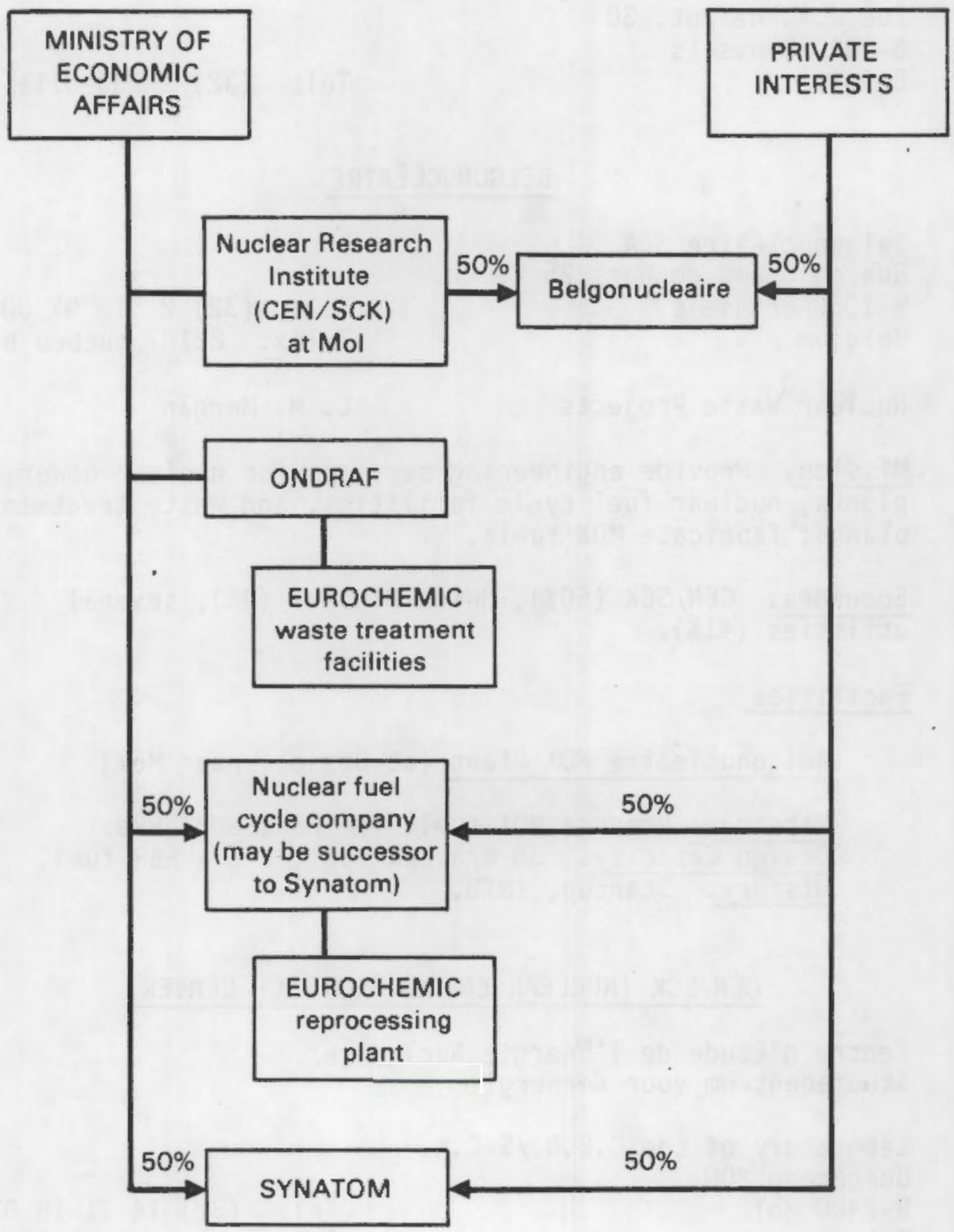
Major Milestones

• Underground research laboratory	1983
• Industrial repository (ILW, TRU)	Mid-1990s
• Startup of German HLW vitrification pilot plant (PAMELA) at Mol	1986
• Vitrification plant (AVM Process)	1987
• Decision on startup of renovated Eurochemic Reprocessing Plant	Mid-1984
• Startup of Eurochemic Plant	1988/9

INTERNATIONAL RELATIONSHIPS

- Member of European Communities, IAEA, and OECD-NEA.
- Partnership in Belgian-Dutch-German FBR project.
- Partnership in Eurodif and Coredif enrichment projects.
- Cooperative waste management agreement with U.S. DOE.
- Home of the Eurochemic Company and facilities (transferred to Belgian ownership in 1980).

ORGANIZATION



BELGIAN ATOMIC ENERGY COMMISSION

Commissariat à l'Énergie Atomique
Rue J.A. de Mot, 30
B-1040 Brussels
Belgium

Tel: (32) 2 233-6111

BELGONUCLÉAIRE

Belgonucléaire S.A.
Rue du Champ de Mars 25
B-1050 Brussels
Belgium

Tel: (32) 2 513 97 00
Telex: 22187 nucbru b.

Nuclear Waste Projects — L. M. Mergan

Mission. Provide engineering services for nuclear power plants, nuclear fuel cycle facilities, and waste treatment plants; fabricate MOX fuels.

Sponsors. CEN/SCK (50%), Union Minière (9%), several utilities (41%).

Facilities

Belgonucléaire MOX Plant (at Dessel, near Mol)

Mission. Produce MOX fuels for FBRs and LWRs.
Design Capacity. 38 t/a LWR fuel, 7 t/a FBR fuel.
History. Startup, 1973.

CEN/SCK (NUCLEAR ENERGY RESEARCH CENTER)

Centre d'Etude de l'Energie Nucleaire/
Studiecentrum voor Kernergie

Laboratory of the C.E.N./S.C.K.
Boeretang 200
B-2400 Mol
Belgium

Tel: (32) 14 31 18 01
Telex: Atomol 31922

General Manager	Prof. A. S. Amelinckx
Deputy General Manager	Prof. P. Dejonghe
Chemistry Department	Dr. L. H. Baetslé
Waste Programs	N. L. C. Van de Voorde
Geological Disposal Projects	R. Heremans

CEN/SCK (NUCLEAR ENERGY RESEARCH CENTER) (contd)

Sponsor. Federal government--Ministry of Economic Affairs and Industry.

Fuel Cycle R&D. FBR fuel reprocessing (head-end and off-gas treatment), incineration of TRU wastes, immobilization of cladding hulls, LLW treatment, geologic waste isolation in clay formations.

Facilities

1. HERMES Pilot Plant (Head-End Research facility on Mockup Engineering Scale)

   Mission. Develop head-end and offgas treatment technology for LWR fuels.
   Design Basis. Chop-leach or chop-grind-leach; silver zeolite and cryogenic treatment of offgas.
   Process Components. Single-pin chopper, critically safe dissolver, mechanical pulverizer, centrifugal filter for solution clarification, fuel residue dissolver, "super dissolver" for cleanup of hulls, offgas scrubbers, silver zeolite bed, cryogenic unit.
   Throughput. 10 kg irradiated fuel (20-30% PuO_2 in UO_2) per batch.
   History. Hot operation, early 1982.

2. FLK Slagging Incinerator (radioactive)

   Mission. Volume reduction of combustible low-activity TRU wastes.
   Design Basis. High-temperature combustion (1200-1500°C); capacity, 50-100 kg/hr; product, granular slag.
   History. First tests with Pu-bearing wastes (tens of grams Pu in several tons of waste), 1983.

3. CEN/SCK Bituminization Plant

   Mission. Immobilize Belgian LLW.
   Design Basis. Stirred evaporator, batch process; capacity, 60-80 ℓ/hr liquid LLW or 15-20 ℓ/hr dried sludge.
   History. Startup, 1964.

CEN/SCK (NUCLEAR ENERGY RESEARCH CENTER) (contd)

4. Underground Research Laboratory

Mission. Develop technology for disposal of ILW, TRU waste, and HLW in clay repositories.
Description. Access shaft to -215 m level, 4.5 m dia; laboratory gallery, 3.5 m useful dia by 30 m length; cast iron liner.
Test Program. Water-flow measurements, in situ heater tests, clay stability studies, liner stresses, borehole atmospheres, corrosion; test emplacement of HLW and TRU incinerator residues.
Milestone. Laboratory operational, early 1984.

EUROCHEMIC

Eurochemic
B-2400 Mol
Belgium

Tel: (32) 14 312 861-70
Telex: EUROCHEM ML 31 924

[Brussels National Airport (Zaventem); then by rental car, Eurochemic driver (1-1/2 hours), or train to Mol.]

Managing Director	Dr. E. J. Detilleux
Deputy Director	H. Eschrich
Industrial Development Laboratories	J. Van Geel
Plant Operation Department	Werner Hild

Mission. Treatment of reprocessing plant wastes. Facilities and site transferred to Belgian ownership in 1980.

Technical Activities. Ceramic melter development (technical support to FRG PAMELA pilot plant being built at Mol), glass marble encapsulation in lead matrices, and non-HL waste conditioning.

Facilities

1. Eurowetcomb (hot pilot plant-acid digestion)

Mission. Wet combustion of combustible TRU wastes.
Design Basis. Acid digestion with H_2SO_4-HNO_3.
History. Startup, 1980.

EUROCHEMIC (contd)

2. Eurobitum (bituminization plant)

Mission. Immobilize ILW.
Design Basis. Batch chemical pretreatment; screw extruder-evaporator (continuous); capacity, 650 m^3/a ILW.
History. Startup, 1978; on-stream time, 80% through July 1980.

3. Eurowatt (hot pilot plant-solvent treatment)

Mission. Treat Purex (TBP-kerosene) solvent.
Design Basis. Extract TBP with concentrated H_3PO_4, pyrolyze H_3PO_4 fraction; capacity, 1 m^3/day.
History. Startup, early 1980.

4. Eurochemic Fuel Reprocessing Plant

Original Mission. Reprocess low- and high-enriched metal and oxide fuels from test reactors for Eurochemic partners.
Original Design Basis. Chemical decladding; PUREX flowsheet; contact maintenance. Capacity, 350 kgU/day for magnesium- or aluminum-clad fuels, 20 kgU/day for SS- or Zr-clad fuels, 5-10 kgU-Al/day for HEU fuels.
Operating History. Operated from 1966-1974 and treated: 180 tU in low-enriched fuels, including 100 tU in LWR/oxides, to yield 67 m^3 HLW; 30 t high-enriched fuels, to yield 806 m^3 HLW. The plant has been decontaminated and is now under Belgium ownership. Renovation and recommissioning, with a target startup date of 1988/9 is currently under study by a Belgian (SYNATOM)-French (Cogema)-German (DWK) consortium.
Renovation Design Basis. 600 kgU/day; chop-leach head-end for LWR fuels.

5. ALONA Acid Digestion Plant (see FRG/KfK).

6. PAMELA HLW Vitrification Pilot Plant (see FRG/DWK-KEWA).

GEOLOGIC SERVICE

Service Géologique de Belgique
Jennerstraat 13
1040 Brussels
Belgium — Tel: (32) 2 649 2094

Director-Geologist	J. Bouckaert
Nuclear Waste	N. Vandenberghe
	H. Goethals
	M. Van den Broeck

MINISTRY OF PUBLIC AND FAMILY HEALTH

Ministère de la Santé Publique
Service de Protection des Radiations Ionisantes
Quatier Vésale
B-1010 Brussels — Tel: (32) 2 564-1755
Belgium — Telex: 21034 IHEBRU

ONDRAF (NATIONAL INSTITUTE FOR RADIOACTIVE WASTES AND FISSILE MATERIALS)

Organisme National des Déchets Radioactifs
et des Matières Fissiles (ONDRAF)
Boulevard du Regent 54
B-1000 Brussels — Tel: (32) 2 513 7460
Belgium — Telex: 65784 Nirond

Chairman, Board of Directors	M. Frerotte
Chairman, Permanent Technical Committee	F. Deconinck
Director	E. Detilleux
Technical Manager & Deputy to General Manager in charge of Exploitation	F. Decamps
	G. Claes

Sponsor. Federal government.

Mission. Provide for transportation of radioactive materials; waste conditioning and interim storage; spent fuel AFR storage; waste disposal; Pu storage; definition of waste management R&D requirements. Operate Eurochemic waste treatment facilities.

Organization. ONDRAF (NIRAS in Dutch) is governed by a Board of Directors composed of a president, vice-president, and board members representing various national ministries and local government executives. The Board will be advised by a permanent Technical Committee.

ONDRAF (NATIONAL INSTITUTE FOR RADIOACTIVE WASTES AND FISSILE MATERIALS) (contd)

Facilities

AVB (vitrification plant)

Mission. Solidify stored Eurochemic HEWC and future Belgian HLW.
Design Basis. French AVM process: rotary calciner and metallic melter; capacity, 30 ℓ/hr feed; product, borosilicate glass blocks, 0.4 m dia x 1.5 m high.
Milestone. Startup, 1987 (will not be built if Eurochemic reprocessing plant is not recommissioned).

SYNATOM

SYNATOM S.A.
Avenue Marnix, 13
B-1050, Brussels
Belgium

General Manager	Dr. Pierre A. Erkes
Fuel Reprocessing Service	Jean Danguy

Mission. Provide commercial fuel cycle and waste management services for the Belgian nuclear utilities.

Sponsors. Government (50%), INTERCOM (20%), EBES (20%), UNERG (10%).

US EMBASSY - BRUSSELS

USEC Brussels
American Embassy
40, Boulevard du Regent, B3
B-1000 Brussels
Belgium

Tel: (32) 2 513-3830
Telex: 846-21336

US DOE Representative, Energy and Resources Office	Dana M. Marshall

BRAZIL

BRAZILIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*February	Carnival
*March/April	Good Friday
April 21	Tiradentes Day
May 1	Labor Day
*June	Corpus Christi Day
September 7	Independence Day
November 2	All Souls' Day
November 15	Proclamation of the Republic
December 25	Christmas

BRAZIL

ENERGY

Population	1982	122 million
Energy Demand	1980	~95 Mtoe

Indigenous Energy Sources: limited crude oil, shale oil, natural gas, and coal. Oil imports - 80%.

Electric Power Plant Capacity	1982	~30 GWe
	1987	60 GWe
Electric Power Production	1980	125 TWh
	1985	88% hydro
		8% nuclear
		4% thermal

NUCLEAR POWER

National Policy. Ambitious program to develop complete government-owned nuclear industry, based upon technology transfer from FRG and other countries.

Nuclear Power Plant Capacity	1982	0.6 GWe
	1988	1.9 GWe
	2000	4.4 GWe
Reactor Mix	1982	PWR: 1 (1982); 8 (1987-2000)
Reactor Development		Introduction of FBRs is an objective

INDUSTRIAL FUEL CYCLE

Policy. Full commercial capability through a government-owned corporation--conversion of U_3O_8 to UF_6; enrichment; UO_2 fuel fabrication; fuel reprocessing.

Waste Management Strategy. Not yet defined.

Cumulative Spent Fuel Arisings (LWR)	1985	32 tU
	1990	180 tU
	1995	510 tU
	2000	1,000 tU

Demonstration/Production Activities

1. Uranium mining and milling: 500 tU/a--in operation.

2. UF_6 production: 2000 tUF_6/a (1984).

3. Uranium enrichment (Becker nozzle process):
   First Cascade, 24 stages (1984)
   200-300 tSWU/a demo plant (1988).

4. Fuel fabrication: 80 t/a (1982); design capacity--400 tU/a.

5. Spent fuel reprocessing: 10 kg/d pilot plant (1986).

INTERNATIONAL RELATIONSHIPS

1. A member state of IAEA--but has not signed NPT.

2. Depends heavily upon nuclear technology transfer (mainly from FRG).

3. Joint US-Brazil R&D program to study radionuclide transport from a thorium deposit.

4. Current interest in receiving US waste management technology.

ORGANIZATION

Federal Ministry of Mines and Energy: planning, execution and control of nuclear power program.

- Nuclear Energy Commission (CNEN): regulatory and R&D

- Nuclebrás: plant engineering, construction and operation; Nuclebrás operates through partly-owned subsidiaries--Nucon (construction), Nuclen (design), Nuclep (heavy components), Nuclam (mining), Nuclei and Nustep (enrichment), and Nuclemon (thorium production).

CENTER FOR THE DEVELOPMENT OF NUCLEAR TECHNOLOGY

Centro de Desenvolvimento de
Tecnologia Nuclear de Nuclebrás (CDTN)
Rua Goncalves Dias No. 1054
Belo Horizonte, MG
Brazil Tel: (55) 31 226-6988

Mission. Applied research and industrial development of uses of atomic energy.

CNEN (NUCLEAR ENERGY COMMISSION)

CNEN (Comissao Nacional de Energía Nuclear)
Rua General Severiano 90
Botafogo ZC-82
20000 Rio de Janeiro, RJ Tel: (55) 21 246-1747
Brazil Telex: 2121280

President Hervásio Guimaraes de Carvalho

Fuel Cycle and Waste Management R&D. Uranium enrichment; migration of radionuclides from a thorium deposit, a joint Brazil-US study; spent fuel reprocessing. The government is building a 10 kg HM/day pilot reprocessing facility in the Rio de Janeiro area.

IPEN

Instituto de Pesquisas Energéticas e Nucleares
(Energy and Nuclear Research Institute)
Cidade Universitária
Caixa Postal 11.049
Pinheiros - CEP 01000 Tel: (55) 11 211 6011
São Paulo, Brazil Telex: (011) 23592-IPEN

Superintendent Durvaldo Goncalves

Mission. Nuclear R&D.

IPEN (contd)

Areas of Activity. Physics; nuclear physics; high energy physics. Life Sciences; nuclear medicine; radiobiology; radiation health and safety. Engineering and reactor technology; instrumentation. Chemistry; materials in the nuclear industry. Isotope and radiation applications and production. Nuclear waste disposal. Nuclear metallurgy. Radiochemistry.

NUCLEBRÁS

Nuclebrás
Avenida Presidente Wilson 231
CEP 20030, Rio de Janeiro
Brazil

Tel: (55) 21 292-1144
Telex: 23128, 23830

President	Dario Gomes
Director	John Forman

Mission. Establish a nuclear fuel cycle industry, promote nuclear technology, transfer to private industry, design and build nuclear power plants, pursue R&D programs.

Sponsor. Federal government.

CANADA

CANADIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Good Friday
*March/April	Easter Monday
*May	Victoria Day (Monday preceding May 25)
July 1	Canada Day
*September	Labor Day (1st Monday in September)
*October	Thanksgiving Day (2nd Monday in October)
December 25	Christmas
December 26	Boxing Day (observed in all provinces except Quebec)

NOTE

November 11	Remembrance Day observed in all provinces but most businesses remain open

CANADA

ENERGY

Population	1982	24.3 million
Energy Demand	1979	281.3 Mtoe
Oil Demand	1979	90.4 Mtoe (9% imported)
Electric Power Plant Capacity	1980	79 GWe
Electric Power Production	1982	375 TWh-- 10% nuclear 68% hydro 22% thermal

NUCLEAR POWER

National Policy. Strong support of the domestic use and the export of the CANDU reactor system, with possible conversion to a thorium/uranium-233 fuel cycle.

Nuclear Power Plant Capacity	1983	7.0 GWe
	1985	10.1 GWe
	1990	13.4 GWe
	2000	14.9 GWe
Reactor Mix	1983	HWR: 13 (1968-83)
		11 (1984-92)

INDUSTRIAL FUEL CYCLE

Policy. Retrievable storage of spent fuels, pending decision as to reprocessing for recovery and recycle of Pu or reprocessing to implement the Th/U fuel cycle; continue small reprocessing R&D activity.

Waste Management Strategy. Geologic disposal of "nuclear fuel waste," either spent CANDU fuel or immobilized HLW, in a crystalline rock repository; disposal of reactor wastes in engineered surface facilities.

Cumulative Spent Fuel Arisings (HWR)	1980	3,650 tU
	1985	8,800 tU
	1990	17,700 tU
	2000	38,000 tU

Major Milestones

- Start of shaft excavation, Underground Research Laboratory (URL) — Mid-1984
- URL operational — 1986
- Spent fuel immobilization pilot plant — Mid-1980s
- Complete concept verification for a geologic repository — 1990

ORGANIZATION

Commercial Nuclear Enterprise

1. Atomic Energy of Canada Limited (AECL), a Crown Corporation owned by the federal government. Nuclear R&D; design, engineering and sale of CANDU reactors; operation of heavy-water plants.

2. Ontario Hydro, provincial public utility which owns and operates most of Canada's nuclear power plants--those located in Ontario Province.

Regulatory

Atomic Energy Control Board (AECB)

WASTE MANAGEMENT R&D

- AECL-Whiteshell and Chalk River
- Ontario Hydro
- Supporting studies by various other governmental agencies, consulting firms and universities.

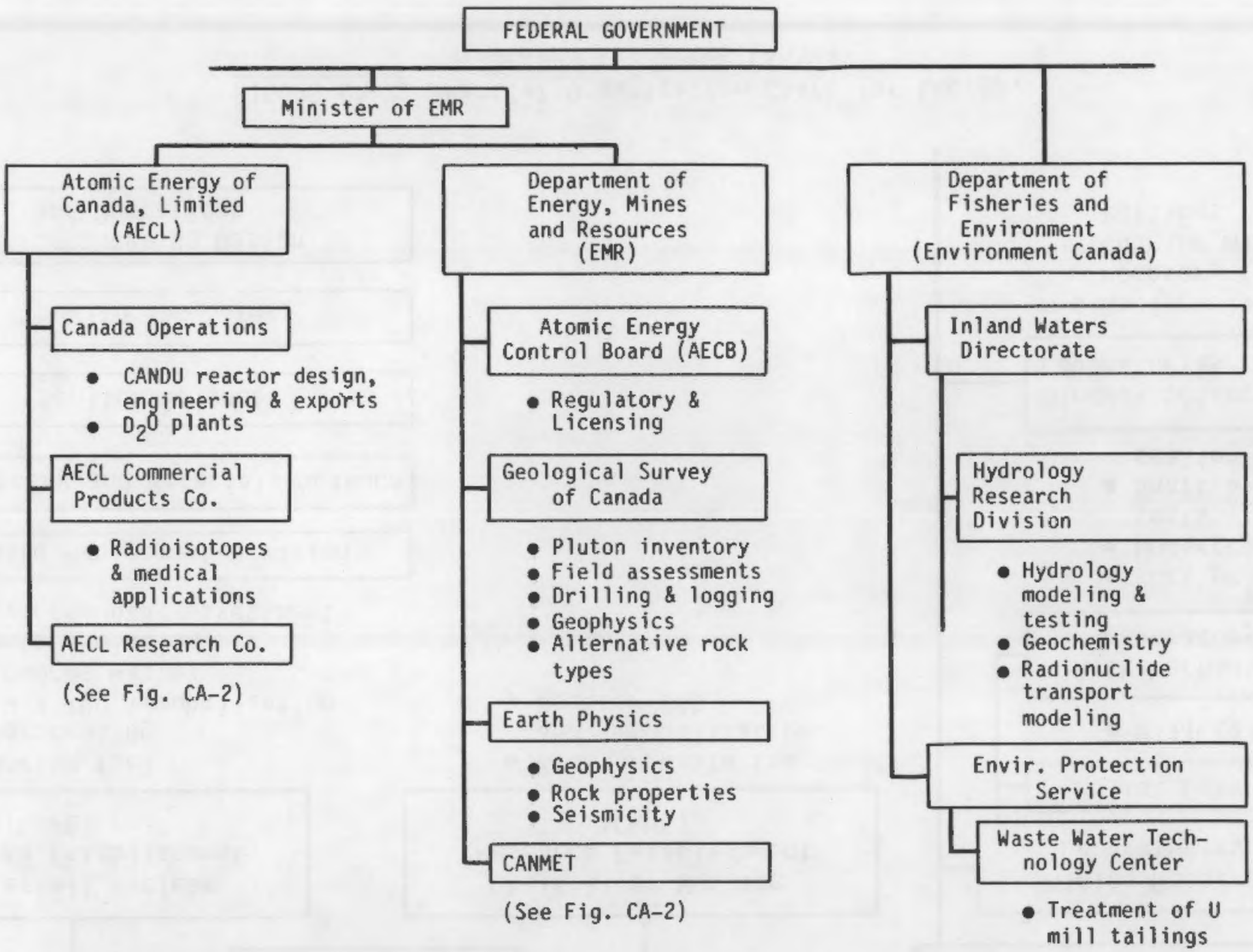


FIGURE CA-1. Government Responsibilities--Fuel Cycle and Waste Management

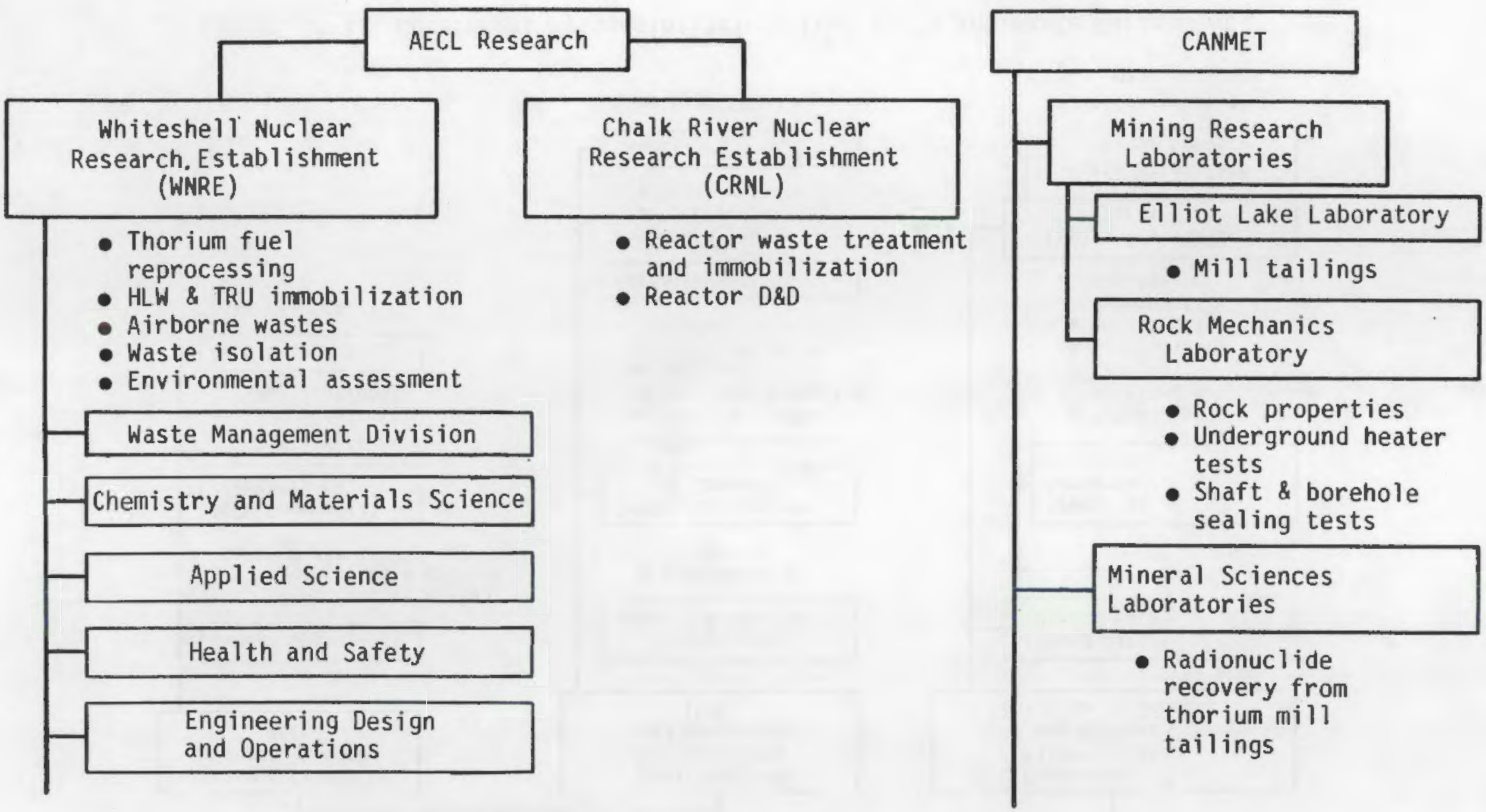


FIGURE CA-2. Partial Organization Chart for Energy, Mines and Resources Canada

AECB

Atomic Energy Control Board
P.O. Box 1046
270 Albert Street
Ottawa, Ontario K1P 5S9 Tel: (613) 995-5894
Canada Telex: 533771

President	J. H. Jennekens
Director, Fuel Cycle/Materials Regulation	W. D. Smythe
Waste Management Division	L. C. Henry (613) 995-3181
Fuel and Heavy Water Plant Division	J. P. Didyk
Director, Regulatory Research Branch	J. W. Bears
Safety and Safeguards Section	J. R. Coady (613) 995-7651

AECL

Atomic Energy of Canada Limited
275 Slater Street
Ottawa, Ontario K1A 0S4 Tel: (613) 237-3270
Canada Telex: 053 31 26

Chairman	Robert Despres
President	James Donnelly
President, AECL Research	Robert Hart
Vice President, R&D	Dr. A. J. Mooradian

CANMET (CANADA CENTRE FOR MINERAL AND ENERGY TECHNOLOGY)

CANMET
555 Booth Street
Ottawa, Ontario K1A 0G1
Canada Tel: (613) 995-4029

CANMET (contd)

Director General	W. G. Jeffery (613) 995-4179
Deputy Director General	V. A. Haw
Rock Mechanics	G. E. Larocque
Waste Management (Elliot Lake Laboratory)	Gordon Ritze

Components

- Mineral Sciences Laboratories (Ottawa)
- Rock Mechanics Laboratory (Ottawa)
- Elliot Lake Laboratory
  Mining Research Laboratories
  Elliot Lake, Ontario P5A 2K2
  Canada

CHALK RIVER

AECL Chalk River Nuclear Laboratories
Chalk River, Ontario KOJ 1J0 — Tel: (613) 687-5581
Canada — Telex: 053-34555

Chalk River Environmental Authority	Dr. D. H. Charlesworth (613) 687-2441
Director, Applied R&D	Dr. H. K. Rae (613) 687-2624
Systems Materials	Dr. G. F. Taylor (613) 687-2771

Facilities

Waste Treatment Centre (WTC)

Mission. Develop reactor waste treatment processes.

EMR (ENERGY, MINES AND RESOURCES CANADA)

Energy, Mines and Resources Canada Energy Sector 580 Booth Street Ottawa, Ontario K1A 0E4 Canada	Tel: (613) 995-3065 Telex: 053 3117
Adviser, Nuclear Waste Management	Joseph Howieson
Energy, Mines and Resources Canada Earth Sciences Geological Survey of Canada 601 Booth Street Ottawa, Ontario K1A 0E8 Canada	Tel: (613) 995-4938 Telex: 053-3117
Director	Dr. D. G. McLaren
Director, Terrain Sciences	Dr. J. S. Scott

ONTARIO HYDRO

Ontario Hydro 700 University Avenue Toronto, Ontario M5G 1X6 Canada	Tel: (416) 592-5111 Telex: 06 217662
Nuclear Design and Development Division	D. A. Meneley (416) 592-5210
Nuclear Materials Management Department	H. N. Isaac (416) 592-5539
Reactor Waste Management	T. J. Carter (416) 592-6024
Irradiated Fuel Management	R. C. Oberth (416) 592-2856

Mission. Design, construction, and operation of CANDU power stations.

ONTARIO HYDRO (contd)

Facilities

1. RWVRF (Radioactive Waste Volume Reduction Facility)

   Location. Bruce Nuclear Complex, Tiverton, Ontario.
   Components. Pyrolysis incinerator (2-chamber), solid waste compactor.
   History. Startup, 1977.

2. Intermediate-Level Waste Storage

   Location. Bruce Nuclear Power Development Waste Management Site, Tiverton, Ontario.
   Components. In-ground concrete tile holes or trenches, above-ground concrete "Quadricell."

WASTEWATER TECHNOLOGY CENTRE

Wastewater Technology Centre
Environmental Protection Service
Department of Fisheries and the Environment
P.O. Box 5050
Burlington, Ontario L7R 4A6
Canada

WHITESHELL

Atomic Energy of Canada Limited (AECL)
Whiteshell Nuclear Research
Establishment
Pinawa, Manitoba ROE 1LO
Canada

Tel: (204) 753-2311
Telex: 0757553

WHITESHELL (contd)

Vice President and General Manager	R. E. Green
Director, Chemistry and Materials Science	M. Tomlinson
Director, Applied Science	W. T. Hancox
Fuel Recycle	D. R. McLean
Engineering Design and Operations	S. A. Mayman
Director, Waste Management	T. E. Rummery (2D4) 753-8432
Scientific Assistant to the Director	E. L. J. Rosinger
Director, Fuel Waste Technology	K. Nuttall
Director, Geochemistry and Applied Chemistry	F. P. Sargent
Director, Applied Geoscience	K. W. Dormuth
Director, Environmental and Safety Assessment	R. B. Lyon

Facilities

1. WIPE (cold pilot plant-vitrification)

   Mission. Develop HLW conditioning process for the CANDU-Thorium fuel cycle.
   Design Basis. 10 kg/hr glass--rotospray calciner/ceramic melter.
   History. Startup, 1983.

2. Hot Pilot Plant-Reprocessing

   Mission. Develop CANDU-Thorium fuel cycle technology; provide HLW for waste studies.
   Design Basis. Thorex process, mixer-settlers; capacity, 0.3 kg/day.
   History. Hot operation, 1980.

WHITESHELL (contd)

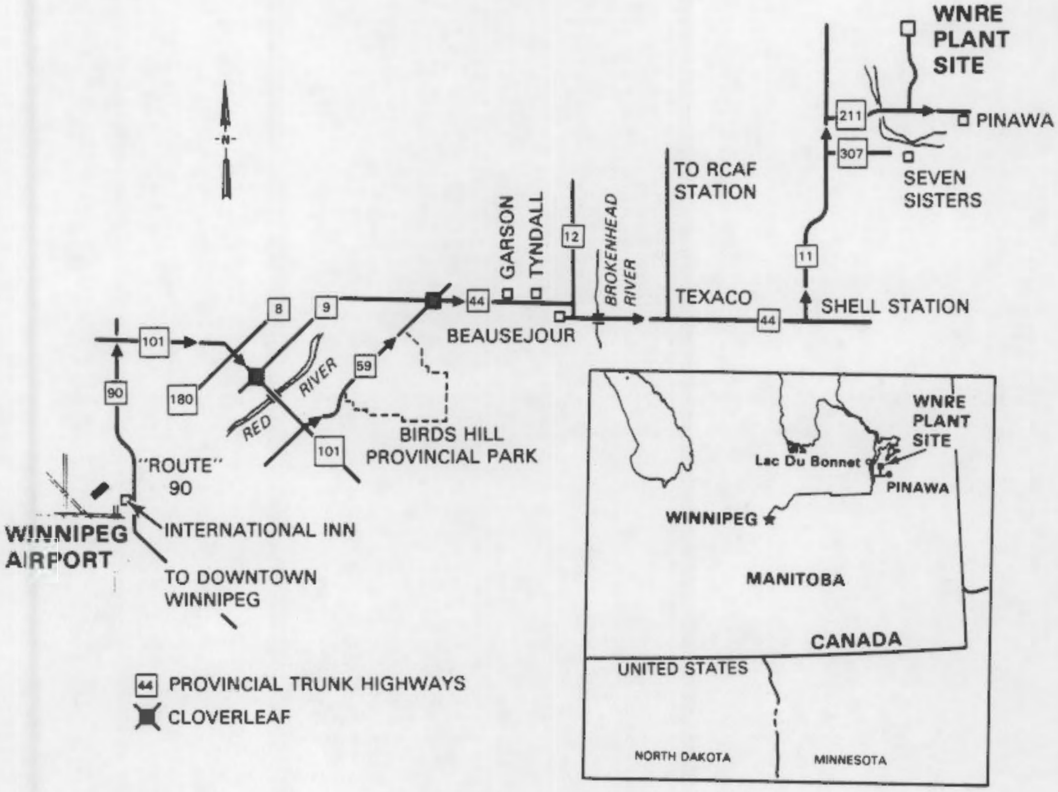
3. URL (Underground Research Laboratory)

Mission. Provide a research facility in a virgin granite pluton characteristic of the Canadian granite formations which may be selected for waste repository construction.
Design Basis. Location about 20 km from the Whiteshell reservation, on the Lac du Bonnet Batholith; horizontal tunnel with adjoining rooms located 300 ± 200 m below the surface, with vertical shaft or ramp access. Licensed radioactive sources and selected tracers may be used in the facility, but no radioactive wastes are to be emplaced there.
Milestones. Start site evaluation, Fall 1980; start URL construction, 1984; start underground operation, 1986.
Construction Cost. $19.2 million.

4. Immobilized Fuel Test Facility (IFTF)

Mission. Experimental studies of the behavior of spent fuels and HLW forms in a radiation field.
Test Beds. Concrete canisters, 2 m dia x 2 m high, which hold heated pressure vessels containing individual experiments.
History. Licensing and commissioning were under way in May 1983.

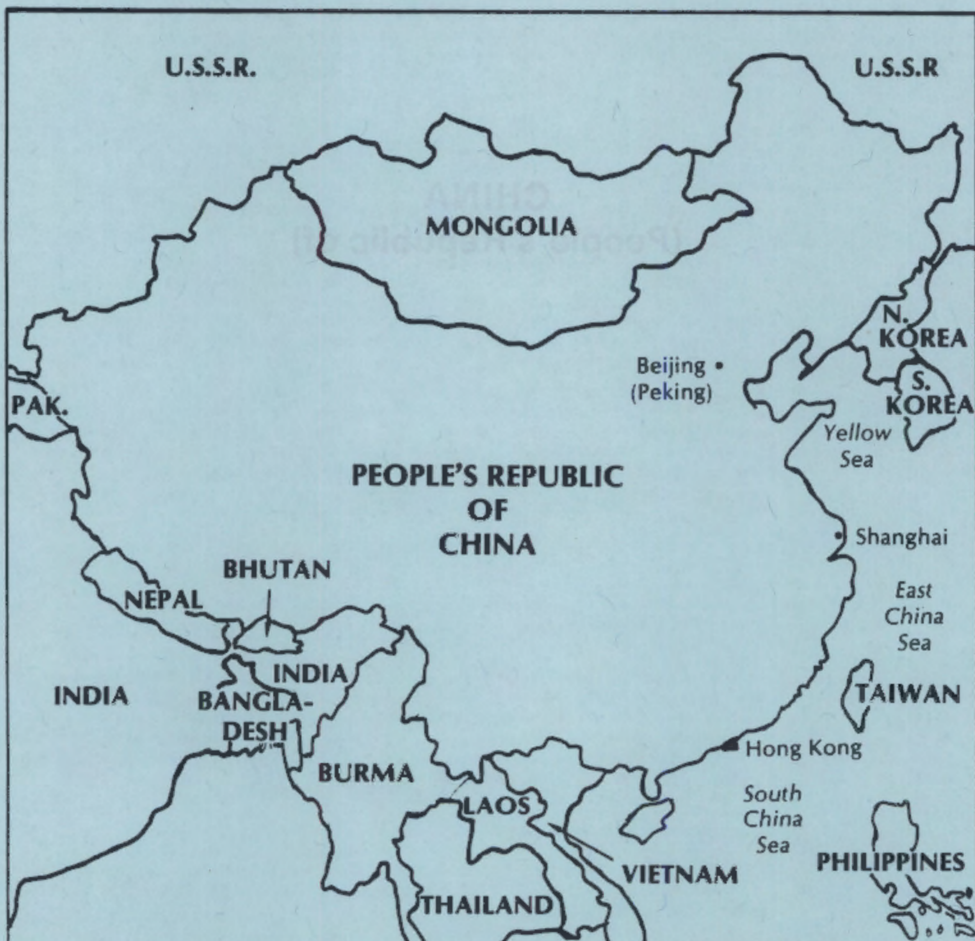
WINNIPEG AIRPORT TO PINAWA (120 km)



CHINA
(People's Republic of)

CHINESE HOLIDAYS

Late January/ early February	Lunar New Year
May 1	Labor Day
Aug 1	Army Day
Oct 1-2	National Liberation Days



CHINA (PEOPLE'S REPUBLIC)

ENERGY

Population	1982	1 billion
Energy Demand	1980	637.2 Mtce-- 69.4% coal 23.8% oil 3.0% gas 3.8% hydro
Electric Power Plant Capacity	1980	55-60 GWe
Electric Power Production	1980	300.6 TWh

NUCLEAR POWER

National Policy. Develop nuclear power as one of three major sources of energy, in response to imperative need to solve problems caused by uneven distribution of resources; be self-sufficient, but introduce foreign advanced technology.

Nuclear Power Plant Capacity	1990 2000	2 GWe 10 GWe
Reactor Mix	1983	PWR: 7 in construction or planning stage
Reactor Development	HWR, BWR, HTGR	

INDUSTRIAL-SCALE FUEL CYCLE ACTIVITIES

Uranium mining, milling and enrichment; fuel fabrication, reprocessing of defense fuels.

ORGANIZATION

- Ministry of the Nuclear Industry--all fields of nuclear power development
- Atomic Energy Research Institute of the Academy of Sciences (Peking Area)--nuclear R&D.

INSTITUTE OF ATOMIC ENERGY

Institute of Atomic Energy
Academia Sinica, Beijing
People's Republic of China

Director	Wang Ganchang

INSTITUTE OF NUCLEAR ENERGY TECHNOLOGY

Institute of Nuclear Energy Technology
Qinghua University
P.O. Box 1021
Beijing, People's Republic of China

Director	Prof. Lu Yingzhong
Deputy Director, Division, Radiochemistry Technology	Prof. Zhu Yong-jun

MINISTRY OF THE NUCLEAR INDUSTRY
(formerly the Second Ministry of Machine Building)

Ministry of the Nuclear Industry
Beijing, People's Republic of China

Minister	Schen Gie
Vice-Minister	Wang Ganchang
Chairman, Science and Techn. Committee	Jiang Sheng-Jie

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

DENMARK

DANISH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Maundy Thursday
*March/April	Good Friday
*March/April	Easter Monday
*May	Prayer Day (4th Friday after Easter)
*May/June	Ascension Day
*May/June	Whit Monday
June 5	Constitution Day
December 25-26	Christmas
December 31	New Year's Eve

NOTE

April 13	Banks close
May 1	Many industries close at noon
December 24	Banks close

DENMARK

ENERGY

Population	1981	5.12 million
Energy Demand	1980	19.7 Mtoe (97% imported)
Oil Demand	1980	13.5 Mtoe (98% imported)
Electric Power Plant Capacity	1980	7 GWe
Electric Power Production	1980	27.1 TWh-- 80% solid fuels 19.6% petroleum products 0.1% hydro

NUCLEAR POWER

National Policy. National energy plan calls for nuclear power, but public opposition has prevented implementation; power companies continue to plan for reactor plant construction and for management of wastes.

INDUSTRIAL FUEL CYCLE

Policy. Not defined; power companies are conducting design, feasibility, and site characterization studies for a Danish salt-dome repository.

ORGANIZATION

- Danish Atomic Energy Commission--overall responsibility for nuclear energy matters
- Risø Research Establishment--nuclear R&D
- Elkraft and Elsam (power companies)--waste disposal studies.

ATOMIC ENERGY COMMISSION

Atomenergikommisionen
Strandgade 29
DK-1401 Copenhagen
Denmark

ELKRAFT

ELKRAFT .
Power Company Ltd., Copenhagen
Lautruphøj 5
P.O. Box 230
DK-2750 Ballerup
Denmark Tel: (45) 2 66 00 22

Waste Repository Project Finn Hasted

ELSAM

Elsam
DK-7000 Fredericia Tel: (45) 5 56 25 00
Denmark Telex: 51151

Waste Repository Project Soren Mehlsen

GEOLOGICAL SURVEY

Geological Survey of Denmark
Thoravej 31
DK-2400 Copenhagen NV
Denmark

RISØ NATIONAL LABORATORY

Risø National Laboratory
P.O. Box 49
DK-4000 Roskilde
Denmark

Tel: (45) 3 37 1212
Telex: 43116

Chemistry Department:

Chairman	Bror Skytte Jensen Ext. 5300
Section Leader	Knud Brodersen Ext. 5340
Project Leader	Lars Carlsen Ext. 5352

Mission. Scientific and technological research on atomic energy.

Sponsor. Federal government.

FINLAND

FINNISH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 6	Epiphany
*March/April	Good Friday
*March/April	Easter Monday
May 1	May Day
*May/June	Ascension Day
*May/June	Whitsunday
June 26	Midsummer's Day
November 1	All Saints' Day
December 6	Independence Day
December 25-26	Christmas

FINLAND

ENERGY

Population	1982	4.8 million
Energy Demand	1981	25.3 Mtoe (73% imported)
Oil Demand	1981	10.6 Mtoe (100% imported)
Indigenous Energy Sources		Hydropower, wood, peat
Electric Power Plant Capacity	1982	11.9 GWe
Electric Power Production	1982	39.5 TWh-- 40% nuclear 33% hydro 9% coal 10% oil & gas

NUCLEAR POWER

Nuclear Power Plant Capacity	1983	2.2 GWe
	1995	3.2 GWe
	2000	3.2 GWe
Reactor Mix	1982	PWR: 2 (1977,1981) BWR: 2 (1979,1982)

INDUSTRIAL FUEL CYCLE

Policy. Purchase fuel and fuel cycle services from other countries (spent fuel from Russian-built reactors is returned to USSR).

Waste Management Strategy. Not fully defined; spent fuel or HLW from non-Russian fuels will be stored for 40 years, then placed in a granite repository; reactor wastes are bituminized and will be stored underground.

Cumulative Spent Fuel Arisings (LWR)	1980	48 tU
	1985	350 tU
	1990	650 tU
	2000	1,400 tU

Major Milestones

- Geologic repository, complete site characterization — 1992
- Complete site selection — 2000
- Repository completion — 2020

ORGANIZATION

1. IVO and TVO: state-owned power companies; IVO operates two Russian-built reactors, while TVO operates two Swedish-built plants.

2. Nuclear Waste Commission of Finnish Power Companies--established by IVO and TVO to do joint analysis and planning for managing their nuclear wastes.

3. Technical Research Center (VTT)--nuclear research, including waste management R&D.

ATOMIC ENERGY COMMISSION

Atomic Energy Commission
Ministry of Trade and Industry
Pohjois Makasiinikatu 6
SF-00130 Helsinki 13
Finland

Telex: 125452 EDEPT SF

Chairman

Prof. Pekka Jauho
Tel: (358) 0 4564100
Telex: 122972

Secretary-General

Prof. Jorma Routti
Tel: (358) 0 4512450
Telex: 125161

GEOLOGICAL SURVEY OF FINLAND

Geological Survey of Finland	
Kivimiehentie 1	
SF-02150 Espoo 15	Tel: (358) 0 46931
Finland	Telex: 123185 geolo SF
Director	Prof. L. K. Kauranne
Research Director	Prof. K. Korpela
Nuclear Waste Disposal Study	Mr. M. Salmi
	(358) 0 8037988

INSTITUTE OF RADIATION PROTECTION

Institute of Radiation Protection	
P.O. Box 268	
SF-00101 Helsinki 10	Tel: (358) 0 61671
Finland	Telex: 122691 STL-SF
Department of Reactor Safety:	
Chief Inspector	S. Väisänen
Inspectors	E. Ruokola
	I. Aro

TECHNICAL RESEARCH CENTRE OF FINLAND

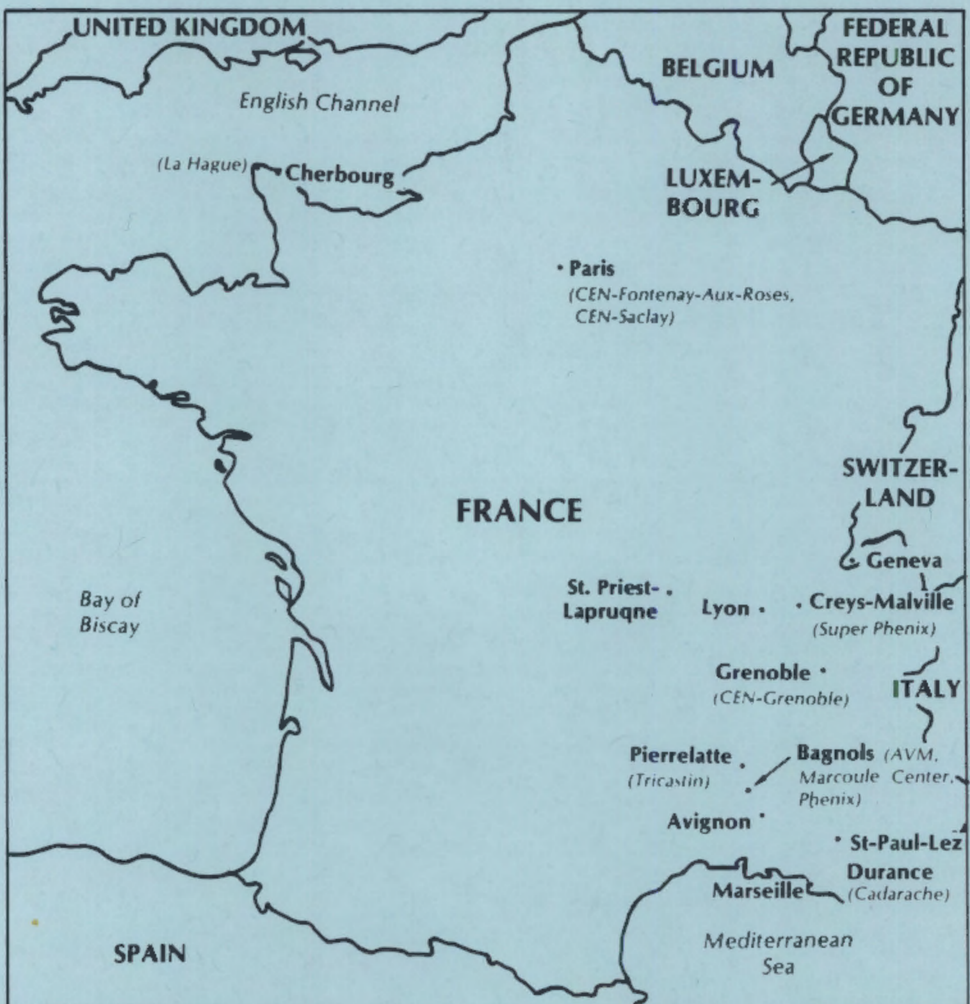
Technical Research Centre of Finland	
Nuclear Engineering Laboratory	
P.O. Box 169	
SF-00181 Helsinki 18	Tel: (358) 0 4561
Finland	Telex: 125175
Director, Nuclear Waste Section	Dr. Esko Peltonen
Nuclear Waste Management	Dr. Seppo Vuori
Reactor Laboratory	
Otakaari 3A	
SF-02150 Espoo 15	Tel: (358) 0 4561
Finland	Telex: 125175
Nuclear Waste Management	Dr. Pekka Hiismaki

FRANCE

FRENCH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Easter Monday
May 1	Labor Day
*May/June	Ascension Day
*May/June	Whit Monday
July 14	Bastille Day
August 15	Assumption Day
November 1	All Saints' Day
November 11	Remembrance Day
December 25	Christmas



FRANCE

ENERGY

Population	1981	53.8 million
Energy Demand	1980	198 Mtoe (74% imported)
Oil Demand	1980	115 Mtoe (98% imported)
Electric Power Plant Capacity	1980	66 GWe
Electric Power Production	1980	258 TWh-- 23.7% nuclear 27.4% hydro/geo. 25.9% solid fuels 23.0% oil & gas
	1982	266 TWh-- 38.7% nuclear

NUCLEAR POWER

National Policy. Aggressive nuclear power program, scaled down recently to construction of one or two new reactors per year; commercialization of the breeder reactor; export of nuclear plants and services.

Nuclear Power Plant Capacity	1983	24.6 GWe
	1985	35.6 GWe
	1990	51.0 GWe
	2000	61.2 GWe
Reactor Mix	1982	GCR: 8 (1959-72)
		PWR: 20 (1967-82)
		32 (1983-90)
		LMFBR: 2 (1973,1985)

Reactor Development: LMFBR commercialization; Super Phenix--1985; follow-on work still under debate.

INDUSTRIAL FUEL CYCLE

Policy. Maintain full domestic fuel cycle capability; aggressive export of fuel cycle plants, equipment and services (including uranium enrichment and spent fuel reprocessing).

Waste Management Strategy. HLW--vitrify and store in engineered storage facility for indefinite period, then emplace in geologic repository (granite, salt, clay or seabed). LLW--immobilize in bitumen, concrete or resin and store in surface facility.

	1980	1985	1990	2000
Cumulative Spent Fuel Arisings, tU	248	2,700	7,700	22,000

	1983	1990	2000
Cumulative Waste Arisings, m^3			
• vitrified HLW	400	750	3,000
• packaged TRU waste	10,000	15,000	45,000
• packaged LLW/ILW	210,000	410,000	800,000

Industrial-Scale Activities

1. Uranium mining and milling (tU): 1981--2,000; 1985--3,900.

2. Uranium enrichment (tSWU/a)
   - Pierrelatte, gaseous diffusion: 400-600
   - Eurodif, gaseous diffusion: 1982--10,800.

3. Fuel fabrication (tHM/a)
   - UO_2: current capacity--400; 1983--600; 1986--1,100
   - MOX: for FBR fuels--5; for LWR fuels--15.

4. Spent fuel reprocessing
   - Marcoule: 3 tU/day, U metal fuels
   - La Hague: 3 tU/day, U metal fuels; 0.7 tU/day, UO_2 fuels (to be expanded to 5 tHM/day).

Major Milestones

• TOR demonstration reprocessing plant for FBR fuels (Marcoule)	1985
• UP3 reprocessing plant (La Hague)	1988-9
• UP2-800 reprocessing plant (La Hague)	1990
• Completion of foreign reprocessing contracts	1995
• AVH waste vitrification plants (La Hague)	1987-9
• New LLW disposal site	1986-7
• Underground Research Laboratory	1989

INTERNATIONAL RELATIONSHIPS

1. Membership in European Communities, IAEA and OECD/NEA.

2. Major role in international uranium enrichment companies, Eurodif and Coredif.

3. Partnership with DWK (FRG) and BNFL (UK) in United Reprocessors GmbH and in Nuclear Transport, Limited.

4. Leadership of international consortium involved in Super Phenix project.

5. Participation of EdF in SERENA, international FBR technology marketing organization.

ORGANIZATION

1. Electricité de France, EdF (100% government)--public power generation; owns and operates all nuclear plants except Phenix and Super Phenix

2. Atomic Energy Commission, CEA--controls all nuclear R&D and industrial fuel cycle activities

   R&D: Nuclear research centers at Cadarache, Fontenay-aux-Roses, Grenoble, Marcoule, Saclay; Institute for Nuclear Protection and Safety
   Commercial fuel cycle: COGEMA (mining, uranium conversion, enrichment, reprocessing); SGN, a COGEMA subsidiary (design, construction and marketing of fuel cycle facilities)
   Commercial waste disposal: ANDRA.

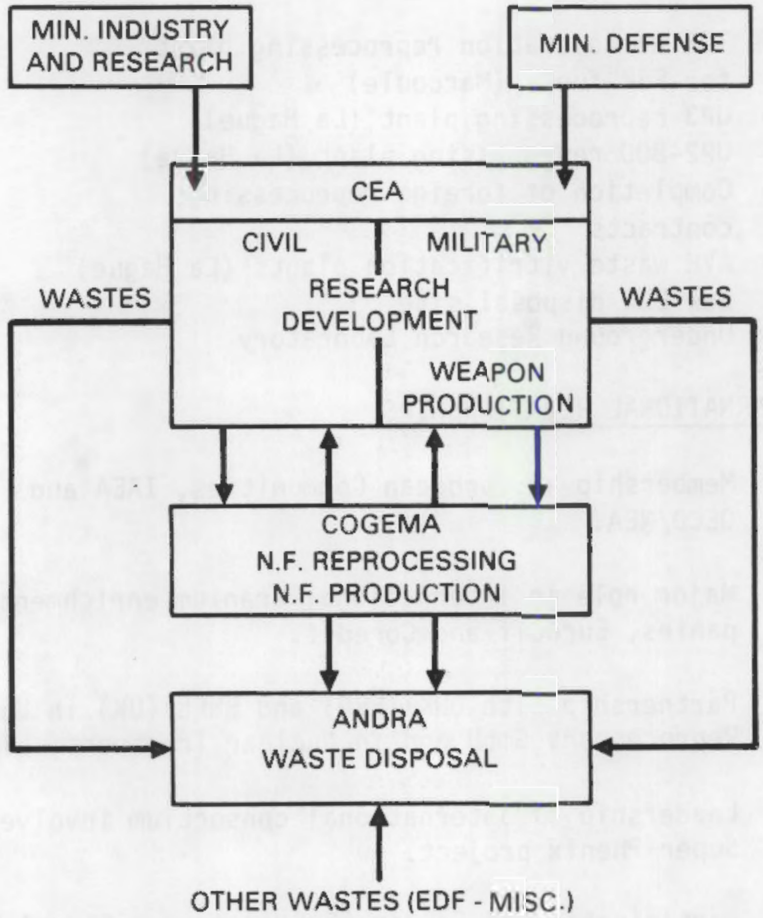


FIGURE FR-1. CEA-COGEMA-ANDRA Activities

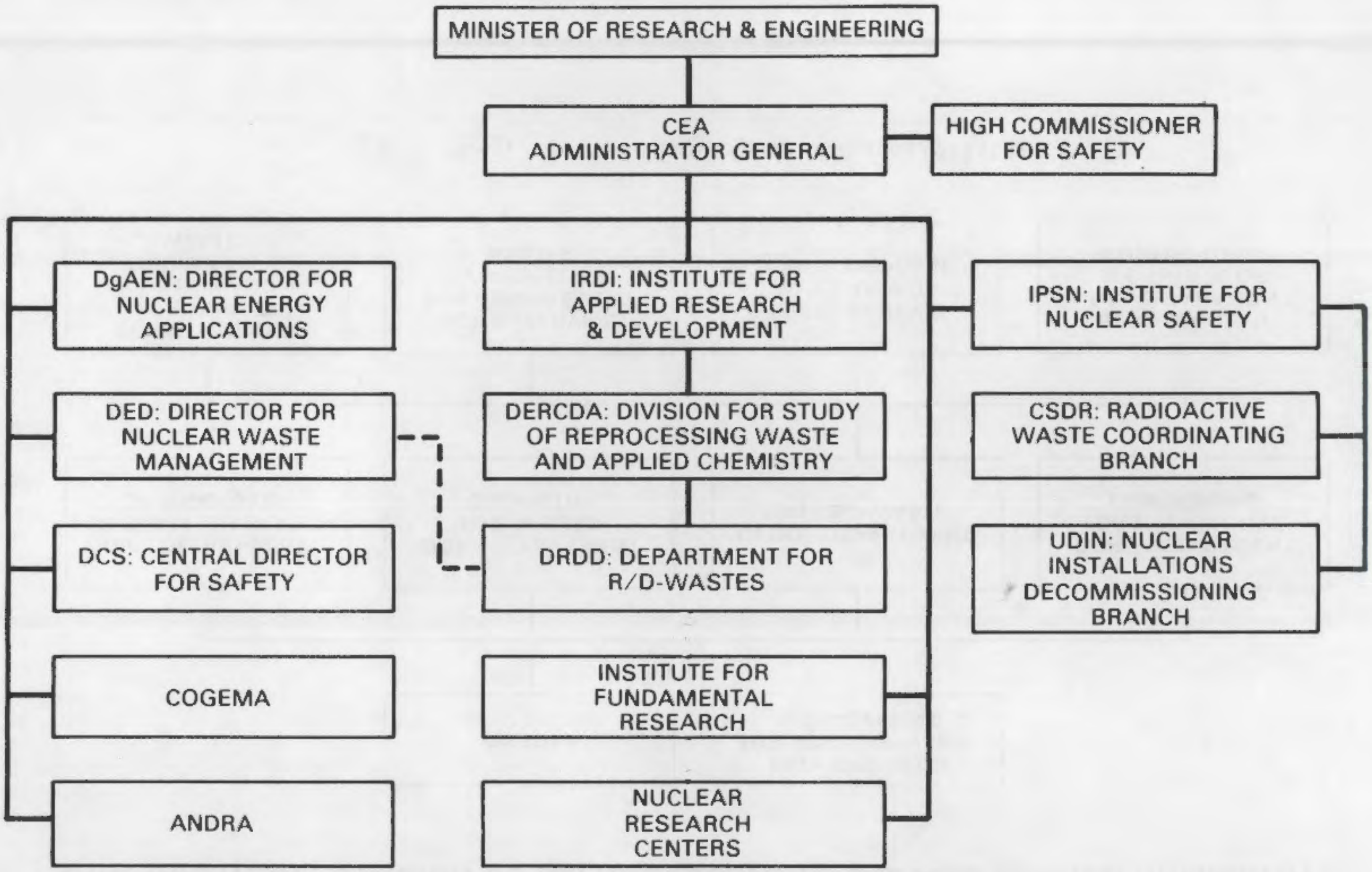


FIGURE FR-2. COGEMA and CEA Research Centers

ORGANIZATION - DIVISION OF REPROCESSING WASTE AND APPLIED CHEMISTRY

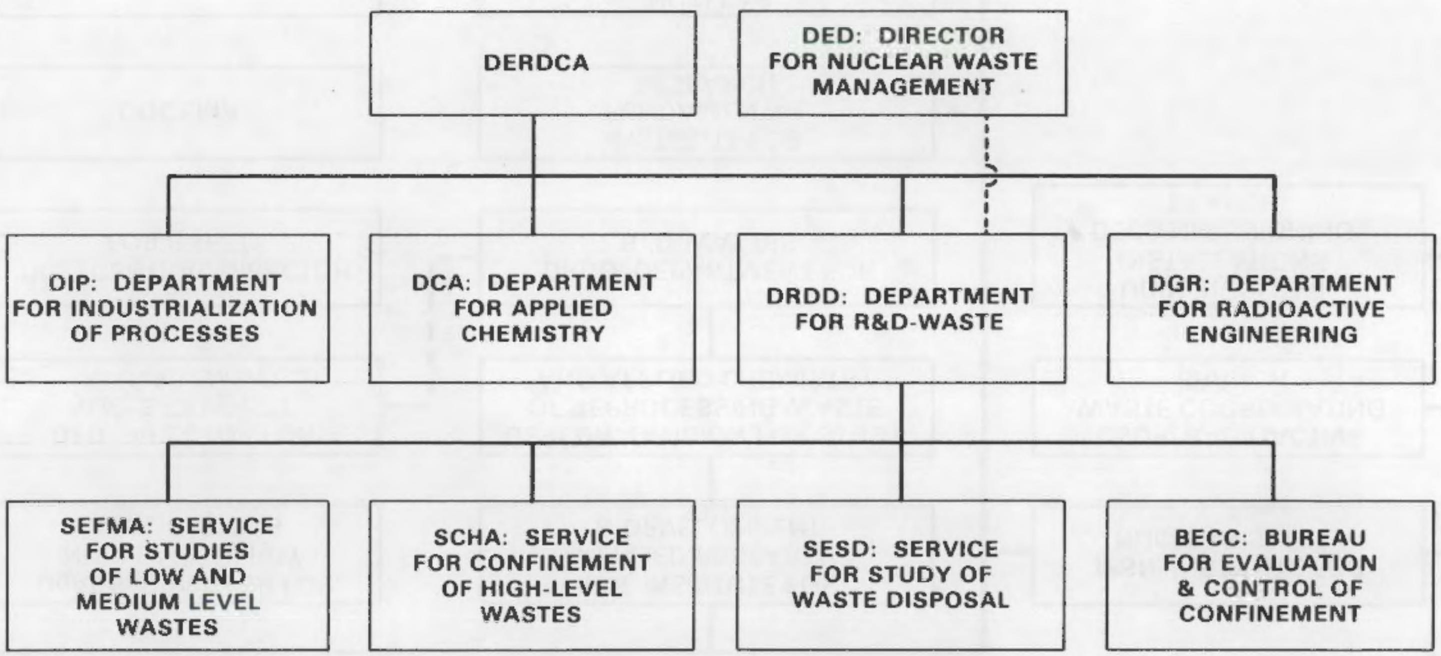


FIGURE FR-3. Nuclear Fuel Cycle Responsibilities

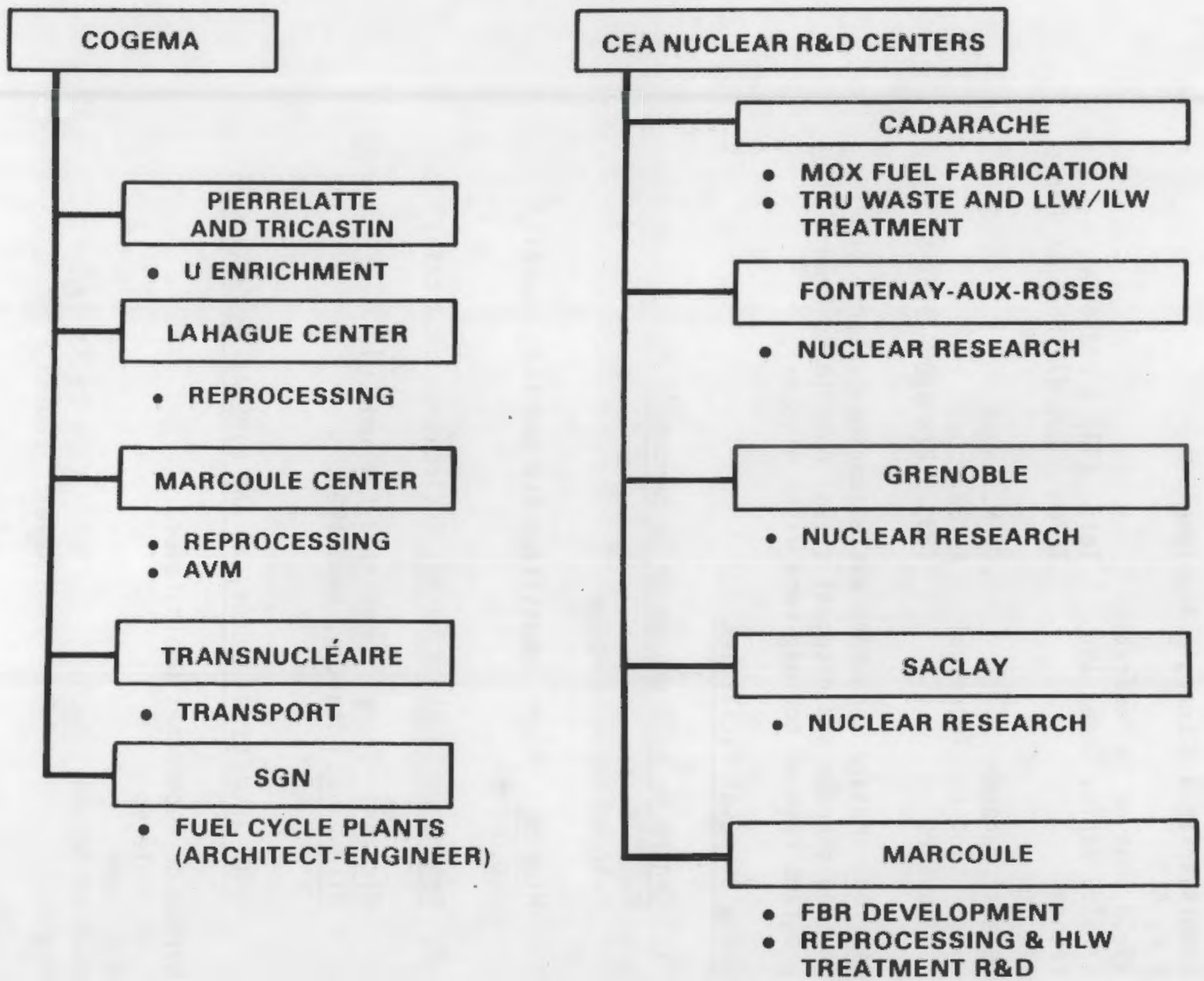


FIGURE FR-4. COGEMA and CEA Research Centers

ANDRA (NATIONAL AGENCY FOR RADIOACTIVE WASTE MANAGEMENT)

Agence Nationale pour la Gestion des Déchets
Radioactifs
Commissariat à l'Énergie Atomique
B.P. 510
29-33, Rue de la Fédération
F-75752 Paris, Cedex 15
France

Tel: (33) 1 273 6000,
Telex: 200 671 Energat Paris

General Manager	J. M. Lavie
Assistant for Technical Matters	A. Barthoux (33) 1 273 6000-49.60

Mission. Manage long-term waste storage centers; provide for new storage and disposal sites; coordinate French R&D programs related to long-term waste disposal.

Waste Disposal Facilities

1. Centre de la Stockage de la Manche (CSM)
   B.P. 71
   F-50440 Beaumont-Hague

   Mission. Store immobilized ILW and LLW; capacity: 300,000 m^3.

2. Centre de la Stockage No. 2 (location uncertain)

   Mission. Store immobilized ILW and LLW.
   Milestone. Startup, 1986/1987.

BRGM (BUREAU OF GEOLOGICAL AND MINERAL RESEARCH)

Bureau de Recherches Géologiques
et Minières
B.P. 6009
F-45060 Orleans, Cedex
France

Tel: (33) 38 63 8001
Telex: 780258 F

Managing Director	H. Astie
Waste Storage	P. Peaudecerf
Hydrogeology Department	J. J. Collin
Geotechnology Department	Ph. Masure

CEA (ATOMIC ENERGY COMMISSION)

Commissariat à l'Énergie Atomique (CEA)
Centre d'Etudes Nucléaires (CEN)
29-33, Rue de la Fédération
F-75752 Paris, Cedex 15 — Tel: (33) 1 273 6000
France — Telex: 200671 Energat

Administrator General	Gerard Renon
High Commissioner for Safety	Jean Teillac
Director, Nuclear Safety	Pierre Tanguy
Director for Nuclear Waste Management (Fontenay-aux-Roses)	Jean Lefevre (33) 1 654 7471
Assistant Director, International	Pierre Jourde
Assistant Director, R&D	Annie Sugier
Director, Safety	Jacques Bellot
Director, Nuclear Energy Applications	Michael Rapin

CEA-IRDI (INSTITUTE FOR APPLIED RESEARCH AND DEVELOPMENT)

Institut de Recherche Technologique
et de Developpement Industriel (IRDI)

Director, Division, Reprocessing Waste and Applied Chemistry	J. Megy
Director, Department, Industrialization of Processes	Courouble
Director, Department, Radioactive Engineering	J. Sauteron
Director, Department, Applied Chemistry	Leveque
Director, Department, R&D--Waste (Fontenay-aux-Roses)	Guy Baudin Tel: (33) 1 654 8222 Telex: FAR 204841
Studies of LLW/ILW (Cadarache)	D. Alexandre
Confinement of High Level Waste (Marcoule)	M. Bonniaud
Waste Disposal Study (Fontenay-aux-Roses)	Jorda
Waste R&D; Evaluation and Control of Waste Confinement (Cadarache)	Paul Pottier Tel: (33) 42 25 7364 Telex: CEACA 440678F

CEA-IPSN (INSTITUTE OF PROTECTION AND NUCLEAR SAFETY)

Institut de Protection et de Sûreté
Nucléaires (ISPN)
B.P. 6 Tel: (33) 1 654 7080
F-92260 Fontenay-aux-Roses Telex: 204841 Energat
France Fnayr

Director, IPSN	P. Tanguy
Safety Analysis	O. Queniart
Technical Protection	J. Pradel
Waste Protection Research	A. M. Chapuis
Studies and Research in Safety (Cadarache)	Bailly

CEA-MARCOULE CENTER

CEA Etablissement de la Vallée du Rhône
B.P. 171
F-30200 Bagnols-sur-Cèze Tel: (33) 66 89 5390
Marcoule, France Telex: 480232F

Manager, Service for Confinement of High-Level Wastes	M. Bonniaud
Deputy Manager	C. Sombret
Manager, Laboratory Studies	N. Jacquet-Francillon
Manager, Cold Technology	A. Jouan
Manager, Hot Technology	F. Laude

Facilities

1. SAP (hot pilot plant-reprocessing)

   Mission. Develop technology for LWR and LMFBR fuels.
   Design Basis. PUREX flowsheet, mixer-settlers and pulsed columns; capacity, 10-30 kg/day (to be increased to 5 tHM/a with addition of TOR head-end).
   History. SAP has processed 50 kg HM from Rapsodie, 2600 kg HM-uranium from Phenix, and 1210 kg HM (MOX) from Phenix. A new head-end (TOR) is being added to allow reprocessing of FBR fuels.

CEA-MARCOULE CENTER (contd)

2. PIVER (hot pilot plant-vitrification)

   Mission. Test batch vitrification processes (1969-1973); produce samples for characterization (1978-).
   Design Basis. Pot calciner/melter; capacity, 90 kg glass/batch or 25-30 m^3 HLLW/a; product, borosilicate glass blocks, 25 cm dia by 2.5 m high.
   History. Produced 12 tons glass, 1969-1973. Now used for special process studies.

3. ATLAS (hot pilot plant-vitrification)

   Mission. Conduct off-gas treatment studies for AVM process.
   Design Basis. AVM: rotary calciner, metallic melter; capacity, 1/2 AVM scale; product, borosilicate glass blocks.
   History. Startup, 1978.

4. TOR (reprocessing head-end pilot plant)

   Mission. Equip Marcoule SAP pilot plant to reprocess Phenix fuels.
   Design Basis. 5 tHM/a.
   Milestones. Startup, 1984-1985.

CEN-CA (CADARACHE NUCLEAR RESEARCH CENTER)

Centre d'Études Nucléaires de Cadarache
B.P. 1
F-13115 Saint-Paul-lez Durance — Tel: (33) 42 25 7000
France — Telex: CEACA 440678 F

(Marseille-Marignane Airport; 65 km to Cadarache by car provided by Center, or rental car.)

CEN-CA (CADARACHE NUCLEAR RESEARCH CENTER) (contd)

Department of Waste R&D (D.R.D.D.); Bureau for Evaluation and Control of Waste Confinement (B.E.C.C.)	Paul Pottier (33) 42 25 7364
Information Center for Nuclear Waste	Y. Francois (33) 42 25 78 82
Service for Studies of LLW/ILW	D. Alexandre (33) 42 25 71 23

Fuel Cycle R&D. Treatment of TRU waste, LLW, and ILW; properties of non-HLW waste forms; MOX fuel fabrication; and waste isolation (radionuclide migration).

Facilities

1. Solid Waste Treatment Pilot Plant

   Mission. Develop methods to handle solid wastes (cryogenic crushing and ultrasonic washing).
   Design Capacity. Eight 200-lb drums/hr.
   History. Startup, 1984.

2. Bituminization Plant

   Design Basis. Immobilize reactor wastes; twin-screw extruder; capacity, 260 m^3/a.
   History. Startup, 1977.

3. MOX Fuel Fabrication

   Mission. Fabricate PuO_2-UO_2 fuels for FBRs and for recycle to LWRs.
   Design Capacity. 15 t/a, LWR fuels; 5 t/a, FBR fuels.

4. LLW Incinerator

5. Solvent Incinerator

CEN-FaR (FONTENAY-AUX-ROSES NUCLEAR RESEARCH CENTER)

Centre d'Études Nucléaires
de Fontenay-aux-Roses
B.P. 6
F-92260 Fontenay-aux-Roses
France

(See CEA-IRDI Institute for Applied R&D)

Waste Management R&D. Safety-related research; airborne waste treatment; solvent extraction processes for waste partitioning; OKLO studies.

CEN-G (GRENOBLE NUCLEAR RESEARCH CENTER)

Centre d'Études Nucléaires de Grenoble	
Avenue des Martyrs 85X	Tel: (33) 76 97 4111
F-38041 Grenoble, Cedex	Telex: 320323 Energat Greno
France	
Director	Pierre Corbet

Waste Management R&D Treatment of reactor wastes and removal of tritium from heavy water used as a reactor moderator.

CEN-S (SACLAY NUCLEAR RESEARCH CENTER)

Centre d'Études Nucléaires de Saclay	
F-91191 Gif-sur-Yvette, Cedex	Tel: (33) 6 908 6000
France	Telex: 690641 F Energat Saclay
Director	Paul Mirat
Nuclear Wastes	Henri Vialettes

CEN-S (SACLAY NUCLEAR RESEARCH CENTER) (contd)

Facilities

Bituminization Plant (radioactive)

Mission. Immobilize non-HLW.
Design Basis. Turbulent film evaporator with heating jacket and internal rotor.

CFC (COGEMA FRAMATOME COMBUSTIBLE)

Location. Under construction at Pierrelatte.

Sponsors. Framatome and Cogema.

Facilities

CFC Fuel Plant

Mission. UO_2 fuel fabrication for EdF.
Design Capacity. 500 t/a.
Milestone. Startup, 1983.

COGEMA (COMPAGNIE GÉNÉRALE DES MATIERES NUCLÉAIRES)

COGEMA, Inc.
Direction Générale
B.P. 4
F-78141 Velizy Villacoublay Cedex — Tel: (33) 3 946 9641
France — Telex: COGEM 697833

President	Francois de Wissocq
Manager, Reprocessing Plants	Claude Aycoberry
Industrial Director, Reprocessing Plants	Maurice Delange
UP_3 Reprocessing Plant	Francois Chenevier

COGEMA-LA HAGUE CENTER

COGEMA, Centre de La Hague
B.P. 270
F-50107 Cherbourg
France

Tel: (33) 33 03 6000
Telex: 170030 Energat Hag

Director	Jean Parmentier
Reprocessing Department	Jean-Louis Ricaud
Waste Management	Mr. Laurent

Fuel Cycle Program. Spent fuel reprocessing and HLW vitrification. The La Hague plant was originally designed to handle magnesium-clad U metal fuels from gas/graphite power reactors. Current plans are to transfer all gas/graphite fuels reprocessing to Marcoule UP-1 and devote La Hague to treating LWR fuels with occasional FBR fuel campaigns through UP-2.

Facilities

1. UP2 (fuel reprocessing plant)

   Mission. Reprocess magnesium-clad, natural uranium metal fuels from gas/graphite reactors and oxide fuels from LWRs and Phenix FBR. (Phenix fuel is diluted with natural uranium fuel for criticality control.)

   Design Basis. *Metal fuels*: mechanical decladding; PUREX flowsheet; capacity, 800 t/a and 1.6 tPu/a; contact maintenance. *FBR and LWR oxide fuels*: shear-leach HAO head-end; remote maintenance; capacity, 1.3 t/day of LWR fuels. The nominal capacity was reduced to 250 t/a in 1980, when one dissolver was taken out of service. HAO expansion to 800 t/a of LWR fuels started in late 1980, to be completed in early 1990s.

   History. Startup: UP-2, 1967; HAO, 1976. During 1967-1977, annual throughputs of gas/graphite reactor fuels reportedly averaged 220-270 tHM. 1980, subsequent throughputs: 253 tHM from gas/graphite fuels, 105 t from LWRs and 1.5 t from Phenix; 1981, 101.3 t from LWRs and Phenix; January 1-June 24, 1982, 153 t LWR fuel. Total HAO throughput from startup through 6/80 = 280 t LWR fuel.

COGEMA-LA HAGUE CENTER (contd)

2. UP3 (fuel reprocessing plant)

   Mission. Reprocess French and foreign LWR fuels.
   Design Basis. Chop-leach head-end; PUREX flowsheet; capacity, 4 t/day each for UP-3A and UP-3B.
   Milestones. Startup, UP3--1988/9.

3. AT-1 (hot pilot plant-reprocessing)

   Mission. Test technology, reprocess FBR fuels.
   Design Basis. Chop-leach head-end and mixer-settlers; capacity, 1 kg HM/day.
   History. Hot startup, 1972. Total throughput by 1979 = 1.1 tHM from FBR fuel.

4. AVH (vitrification plant)

   Mission. Vitrify La Hague HLW.
   Design Basis. AVM process: rotary calciner, metallic or ceramic melter; capacity, 600 m^3/a HLLW (three lines @ 50 ℓ/hr HLLW, 25 kg/hr glass). Canister dimensions: 42 cm dia x 1.3 m high (400 kg glass).
   Milestone. Startup, mid-1986.

COGEMA-MARCOULE CENTER

COGEMA
Centre de Marcoule
B.P. 170
F-30200 Bagnols-sur-Cèze
Marcoule, France

Tel: (33) 66 89 5390
Telex: 480232F MARCOGEMA

(Marseille-Marignane Airport; by train to Avignon; car provided by Center.)

Director	Maurice Allès
Reprocessing Plant	Maurice Chotin

COGEMA-MARCOULE CENTER (contd)

Facilities

1. UP1 (reprocessing plant)

   Mission. Reprocess magnesium-clad natural uranium metal fuels from military or gas/graphite power reactors.
   Design Basis. Mechanical declad; PUREX flowsheet; contact maintenance; capacity, 4.5-6 tHM/day. Expansion is under way to allow treatment of 400-450 tHM/a of gas/graphite reactor fuel, in addition to military fuel load.
   History. Startup, 1958; 280 tHM of gas/graphite fuel processed in 1959, in addition to military fuels. Reportedly, total 1958-1981 throughput was about 12,000 tHM.

2. PURR (prototype d'usine de retraitement des rapids)

   Mission. Reprocess FBR (MOX) fuels.
   Design Capacity. 50-100 tHM/a.
   Milestone. Construction deferred, pending government decision on future of FBR program.

3. AVM (ateliers de vitrification de Marcoule)

   Mission. Demonstrate AVM process: vitrify Marcoule UP-1 wastes.
   Design Basis. Rotary calciner feeding an induction-heated metallic melter; capacity, 30 ℓ/hr HLLW feed and 360 kg/day (1 canister) borosilicate glass product; waste form, glass blocks 0.5 m dia x 1.0 m high.
   History. Hot startup, 6/78; as of 7/1/82, 546 m^3 of HLLW from reprocessing 9657 tonnes of fuel had been vitrified to yield 251 tonnes of glass (734 canisters). Activity in the waste totaled 88 x 10^6 Ci. As of 3/31/83, 623 m^3 of HLLW had been treated.

COGEMA-MARCOULE CENTER (contd)

4. Incinerator

Mission. Volume reduction of combustible wastes.
Design Basis. Triple chamber, propane-heated; capacity, 60-70 kg/hr solids.

5. Bituminization Facility

Mission. Immobilize LLW and ILW.
Design Basis. Continuous screw extruder; capacity, 100 kg/hr.
History. Startup, 1976.

DAM (DIRECTORATE OF MILITARY APPLICATIONS)

Direction des Applications Militaires
Commissariat a l'Energie Atomique
31-33 Rue de la Fédération
F-75752 Paris, Cedex 15
France

FBFC (FRANCO-BELGE COMPANY FOR FUEL FABRICATION)

Société Franco-Belge de Fabrication de Combustibles
Avenue Bertie Albrecht
F-75008 Paris
France

Tel: (33) 1 766 5200
Telex: 290503

Facilities

1. Fuel Fabrication Plant (Romans, France)

Mission. Fabricate UO_2 fuels for power reactors.
Design Capacity. 400 t/a (to be increased to 600 t/a).

2. Fuel Fabrication Plant (Dessel, Belgium)

Mission. Fabricate UO_2 fuels.
Design Capacity. 400 t/a.

PARIS SCHOOL OF MINES

Ecole Nationale Supérieure des Mines de Paris
Centre d'Informatique Géologique
35 Rue Saint-Honoré
F-77305 Fontainebleau — Tel: (33) 6 422 4821
France — Telex: 600736 MINEFON

Director, Mathematical Geology Center	Dr. Ghislain de Marsily
Deputy Director	Dr. Emmanuel Ledoux
Research Engineers	Dr. Patrick Goblet
	Dr. Michel Poulin
	Dr. Anne Ribstein

Waste Management R&D. Geologic waste isolation (fluid flow, heat transport and mass transport studies--theoretical, laboratory and field tests).

SGN (SOCIÉTÉ GÉNÉRALE POUR LES TECHNIQUES NOUVELLES)

Société Générale pour les Techniques Nouvelles
1 Rue des Hérons,
Montigny le Bretonneux
F-78184 Saint Quentin Yvelines, — Tel: (33) 1 058 6000
Cedex, France — Telex: 698316 F

President	Louis Pradere
Managing Director	Pierre Boutaud de la Combe
Technical Director	Claude Bernard
Operations Vice President	Jean-Pierre Giraud
International Projects	Jacques Merlet
International Relations	Michel Lung

TN (TRANSNUCLÉAIRE)

Transnucléaire
11 Rue Christophe-Colomb
F-75008 Paris — Tel: (33) 1 723 7850
France — Telex: 280992

General Manager	Armand Aupetit
Technical Manager	Paul Blum

US EMBASSY - PARIS

US Embassy	
2 Avenue Gabriel	Tel: (33) 1 296-1202
75382 Paris CEDEX 08	(261-8075)
France	Telex: 650221
Science Counselor	J. Boright

GERMANY (FRG)

WEST GERMAN HOLIDAYS

.*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Good Friday
*March/April	Easter Monday
May 1	Labor Day
*May/June	Ascension Day
*May/June	Whit Monday
June 17	Day of Unity
*November	Repentence Day
December 25-26	Christmas

GERMANY (FRG)

ENERGY

Population	1980	61.6 million
Energy Demand	1980	272 Mtoe (55% imported)
	1982	257 Mtoe
Oil Demand	1980	133 Mtoe (96% imported)
Electric Power Plant Capacity	1980	86 GWe
Electric Power Production	1980	348 TWh-- 11.9% nuclear 55.3% solid fuels 26.4% oil/gas 6.4% hydro/other
	1982	17% nuclear
	1985	25% nuclear
	1990	25-30% nuclear

NUCLEAR POWER

National Policy: strong support for private-enterprise nuclear industry; federal funding of nuclear research; joint financing (federal/industry) of demonstration projects.

Nuclear Power Plant Capacity	1983	9.8 GWe
	1985	16.4 GWe
	1990	22.9 GWe
	2000	28.8 GWe
Reactor Mix	1982	PWR: 8 (1972-82); 10 (1983-91)
		BWR: 5 (1972-80); 3 (1983-85)
Reactor Development	1985	THTR (0.3 GWe HTGR)
	1987	Kalkar SNR (0.3 GWe FBR)

INDUSTRIAL FUEL CYCLE

Policy. Full commercial capability (private companies)--enrichment; fuel fabrication; domestic reprocessing of standard LWR fuels; plutonium recycle to FBRs and LWRs. Immediate reprocessing load is to be handled by foreign plants. The federal government provides and operates waste disposal facilities; the power producers pay for the service.

Waste Management Strategy. Vitrification of HLW and interim storage of HLW glass for 20-30 years; disposal of HLW glass, TRU and possibly spent fuels in salt-dome repository; geologic disposal of other radioactive wastes in salt repository or abandoned iron mine.

Cumulative Spent Fuel Arisings (LWR)	1980	960 tU
	1985	2,250 tU
	1990	4,550 tU
	2000	11,000 tU
Cumulative Waste Arisings	2000	250-500,000 drums LLW; 70-100,000 drums ILW; 4,600 blocks HLW glass

Industrial-Scale Activities

1. Uranium mining and milling (tU/a): 100.

2. Uranium enrichment (tSWU/a): 1986--400.

3. Conversion of UO_2 to UF_6 (tU/a): 1000.

4. Fuel fabrication
   - UO_2 fuels: 950 tU/a
   - MOX fuel: 40 tHM/a for LWR fuels, 10 tHM/a for FBR fuel elements (ALKEM).

5. AFR spent fuel storage
   - 1,500 t, dry storage (Ahaus; demonstration license obtained)
   - 1,500 t, dry storage (Gorleben; startup, 1983).

6. Construction of 350 t/a fuel reprocessing plant (DWK--Bavaria and/or Lower Saxony).

Major Milestones

• Complete site characterization at Gorleben	1985
• Policy decision between domestic fuel reprocessing and spent fuel disposal	After 1985
• Spent fuel AFR at Gorleben	1983
• First fuel reprocessing plant	1990
• PAMELA HLW vitrification pilot plant	1985
• HOVA HLW vitrification plant for the WAK pilot plant	1992-3
• Konrad iron mine repository	1988
• Gorleben repository	1995

INTERNATIONAL RELATIONSHIPS

1. FRG is a member state of OECD/NEA, IAEA and the European Communities.

2. Bilateral agreement (BMFT/DOE) for waste management cooperation.

3. Commercial ties with other countries:
   - URENCO, the UK-Netherlands-FRG uranium enrichment consortium
   - United Reprocessors (UNIREP), the UK-France-FRG reprocessing consortium
   - Nuclear Transport, Limited (NTL), with France and the UK
   - Partnership with Belgium and The Netherlands in SNR-300 (FRG)
   - Five percent interest in Super Phenix (France)
   - Thirty-five percent interest in SERENA, FRG-France marketing agency
   - Nuclear technology transfer to Brazil
   - Cooperation with General Atomic in HTGR development
   - Licensing arrangements with US reactor vendors.

ORGANIZATION

1. Federal Government
   - Coordinates FRG nuclear program
   - Sponsors R&D
   - Builds and operates radioactive waste disposal facilities.

2. Privately-owned Utilities
   - Provide spent fuel storage, reprocessing and waste treatment
   - Pay for waste disposal.

3. States (Länder)
   - License nuclear plants.

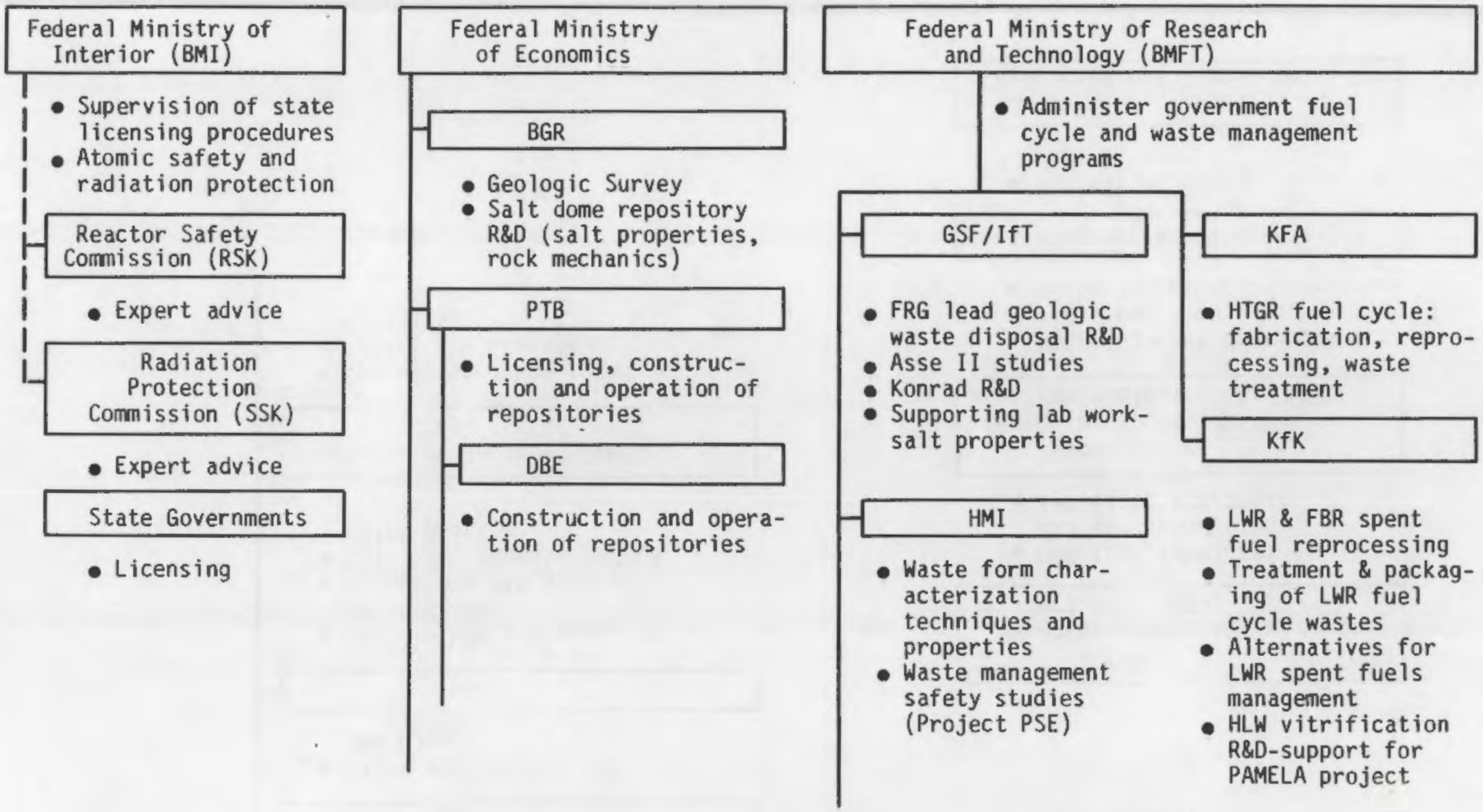


FIGURE GW-1. Government Responsibilities--Nuclear Fuel Cycle and Waste Management

DWK
(Owned by FRG Nuclear Utilities)

- Provide fuel reprocessing and waste conditioning services for FRG utilities
- Finance waste disposal services provided by federal government

KEWA

- Plant engineering for DWK plants

WAK

- Operate WAK reprocessing pilot plant
- Manage DWK R&D programs
- Build and operate PAMELA pilot plant

Brennelement Gorleben GmbH (BLG)

- Operate Gorleben spent fuel & LLW storage facilities

NUKEM
(Owned by DeGussa, 45%; RWE, 25%; RTZ, 18%; MG, 12%)

- LLW & TRU waste treatment R&D & facility design
- Shipping cask development
- R&D--spent fuel packaging for disposal

ALKEM
(Owned by NUKEM, 40% and KWU, 60%)

- MOX fuel fabrication R&D and production
- TRU waste treatment

Transnuklear
(Owned by NUKEM, 80% and Transnucléaire SA, 20%)

- Shipping cask development and production
- Portable LLW solidification

Berlin Technical University

- Repository shaft sealing R&D

University of Munich, Radiochemical Institute

- Actinide chemistry R&D

FIGURE GW-2. Industrial and University Responsibilities--Nuclear Fuel Cycle and Waste Management Activities

ALKEM

ALKEM GmbH
Postfach 110069
D-6450 Hanau 11 (Wolfgang)
Federal Republic of Germany

Tel: (49) 6181 58-0
Telex: 04 184 124 rbu d

Company Directors — Horst Roepenack (49) 6181 58-4600; Dr. Wolfgang Stoll (49) 6181 58-4666

Plutonium Waste Treatment — Dr. Volker Schneider (49) 6181 58-4590; Dr. F.-W. Ledebrink (49) 6181 58-4155

Facilities

MOX Fuel Fabrication Plant

Capacity. 40 t/a, LWR fuel; 10 t/a, FBR fuel.

BAM (FEDERAL INSTITUTE FOR MATERIAL TESTING)

Bundesanstalt für Material Prüfung (BAM)
Unter den Eichen 87
D-1000 Berlin 45
Federal Republic of Germany

Tel: (49) 30 8104-1
Telex: 183261 BAMB D

BGR (FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES)

Bundesanstalt für Geowissenschaften und Rohstoffe
Postfach 510153
D-3000 Hannover 51
Federal Republic of Germany

Tel: (49) 511 6468-1
Telex: 923730 bfb

BGR (FEDERAL INSTITUTE FOR GEOSCIENCES AND NATURAL RESOURCES) (contd)

Director, Division 2, General and Technical Geology	Prof. Helmut Venzlaff
Director, Subdivision, Engineering Geology	Prof. M. Langer
Rock Mechanics	Prof. A. Pahl
Soil Mechanics	Dr. R. Lüdeling
Salt Mechanics	Dr. H. Albrecht
Rock Mechanics in Mining and Technical Research	Dr. D. Meister
Disposal of Radioactive Waste	Dr. W. Jaritz
Underground Storage	Dr. H. Reum
Hydrogeology	Dr. H. Vierhuff
Groundwater Geophysics	Dr. W. Giesel

BMFT (FEDERAL MINISTRY FOR SCIENCE AND TECHNOLOGY)

Bundesministerium für Forschung und Technologie
Heinemannstrasse 2
Postfach 200706
D-5300 Bonn-Bad Godesberg — Tel: (49) 228 591
Federal Republic of Germany — Telex: 885674 BMFT

Minister for Science and Technology	Dr. Heinz Riesenhuber
Deputy Minister for Energy, Environment/Raw Materials	Dr. Günter Lehr
Director, Energy Science/ Technology	Dr. Manfred Popp
Chief, Nuclear Backend Fuel Cycle Section	Dr. Alois Ziegler

BMFT (FEDERAL MINISTRY FOR SCIENCE AND TECHNOLOGY) (contd)

FRG Reprocessing Programs, Pu-Fabrication, International Programs (Backend of the Fuel Cycle)	Dr. Rolf-Peter Randl (49) 228 591-3275
FRG Alternative, Spent Fuel Management Program, Spent Fuel Transport and Interim Storage	Helmut H. Geipel
Waste Treatment	Dr. Karlheinz Hübenthal
Safety Assessment	Dr. Bernd Reuse
FRG Repository Programs	Reinhard Ollig

BMI (FEDERAL MINISTRY OF THE INTERIOR)

Bundesministerium des Innern
Graurheindorfer Strasse 198
D-5300 Bonn 1
Federal Republic of Germany

Chairman, Advisory Committee on Reactor Safeguards (RSK)	D. Smidt
Chairman, Advisory Committee on Radiological Protection (SSK)	A. Kaul

DBE (GERMAN COMPANY FOR CONSTRUCTION AND OPERATION OF WASTE DISPOSAL FACILITIES)

Deutsche Gesellschaft zum Bau und Betrieb von Endlagern für Abfallstoffe mbH (DBE)
Woltorfer Strasse 74
D-3150 Peine, 1 — Tel: (49) 5171 431
Federal Republic of Germany — Telex: 092646 dbe d

DBE (GERMAN COMPANY FOR CONSTRUCTION AND OPERATION OF WASTE DISPOSAL FACILITIES) (contd)

Managing Director, Surface Facilities, Purchase and Stores, Nuclear Handling and Protection	Arno Jacobi (49) 5171 43-200
Managing Director, Underground Facilities, Licensing, Project Related R&D	Wolfgang Pitz
Director, Mining	G. Grübler
Director, Licensing	G. Holtz
Director, Project Related R&D	Dr. H. Jezierski

DHI (GERMAN HYDROGRAPHIC INSTITUTE)

Deutsches Hydrographisches Institut
Isotopenlaboratorium
P.O. Box 220
D-2000 Hamburg 7 — Tel: (49) 40 3190-1
Federal Republic of Germany — Telex: 0211 138 bmvhh d

President	Prof.-Dr. Gerhard Zickwolff

DWK (GERMAN FUEL REPROCESSING COMPANY)

Deutsche Gesellschaft für Wiederaufarbeitung von Kernbrennstoffen mbH
Hamburger Allee 4, Postfach 1407
D-3000 Hannover 1 — Tel: (49) 511 3390-0
Federal Republic of Germany — Telex: 9220202 dwk

Board Member for Engineering/ Technical Director	Joachim Mischke
Manager, Waste Management	Dr. Klaus Einfeld
Manager, Fuel Element Handling	Dr. Klaus Janberg
Manager, Reprocessing	Dr. W. Weinländer
Project Direction	Dr. Hess
Board Member for Research	Dr. Carsten Salander

DWK (KEWA DIVISION)

KEWA Kernbrennstoff-Wiederaufarbeitungs-GmbH
Hamburger Allee 4, Postfach 1407
D-3000 Hannover 1
Federal Republic of Germany
Tel: (49) 511 33901
Telex: 9 222 202 dwk (für kewa)

Company Directors	Dipl.-Ing. Joachim Mischke
	Dr. H.-J. Mylord
Director, Process Engineering	Mr. W. A. Issel
Engineering and Technology	Dr. Knoch

Facilities

1. AFR Spent Fuel Storage Facilities (Gorleben and Ahaus sites)

   Design Basis. Dry storage in CASTOR casks - 400 casks in a building which has dimensions of 600 ft x 125 ft x 62 ft high; capacity, 1500 t.
   Milestone. Startup of Gorleben AFR, 1983.

2. Fuel Reprocessing Plant (Bavaria or Lower Saxony)

   Mission. Demonstrate operability and safety of small commercial plant; reprocess spent LWR fuels commercially.
   Design Basis. Shear-leach head-end; PUREX process; capacity, 350 t/a.
   Milestone. Startup, 1990.

3. PAMELA Pilot Plant (Mol, Belgium)

   Mission. Demonstrate ceramic melter and VITROMET production with stored Eurochemic LEWC.
   Design Basis. Denitration; liquid-fed ceramic melter, 0.72 m^2 surface area; capacity, 36-ℓ/hr feed, 25 kg/hr glass (3 canisters/day @ 150 kg glass/canister); product, either borosilicate glass blocks or VITROMET, 0.3 m dia by 1.2 m high.
   Milestone. Hot operation, 1985.

GSF/IfT (INSTITUTE FOR UNDERGROUND STORAGE, COMPANY FOR RADIATION AND ENVIRONMENTAL RESEARCH)

Gesellschaft für Strahlen-und
Umweltforschung mbH München
Institut für Tieflagerung (GSF/IfT)

Theodor-Heuss-Strasse 4
D-3300 Braunschweig
Federal Republic of Germany

Tel: (49) 531 8012-1
Telex: 0952865 iftta d

*Schachtanlage Asse
D-3345 Remlingen
Kreis Wolfenbüttel
Federal Republic of Germany

Tel: (49) 5336 191

Director, Technical and Scientific Departments (Asse Operations and Waste Disposal R&D)	Dr. Klaus Kühn
Mine Superintendent	*Kurt Thielemann
Manager, Konrad Mine	M. Alpert
Staff Geologist	*Dr. K. Klarr
Hydrology/Geology (Konrad Mine Qualification)	Dr. Wernt Brewitz
Geotechnology	M. W. Schmidt
Asse Brine Migration Testing	*Tilman Rothfuchs
Geomechanics	Klaus Dürr
Salt Characterization Studies	Dr. Norbert Jockwer
Cement Waste Form and Backfill Studies	*W. Fischle

Facilities

1. Asse II Salt Mine (10 km S.E. of Wolfenbüttel)

   Mission. In situ testing and disposal technology development for a salt dome repository; through 1978, disposal of LLW and ILW.
   History. Startup, 1967.

2. Konrad Iron Mine (10 km S.W. of Braunschweig)

   Mission. Disposal of non-TRU LLW; R&D on hard-rock disposal.
   Milestone. Startup as disposal site, 1988.

GSF/IfT (INSTITUTE FOR UNDERGROUND STORAGE, COMPANY FOR RADIATION AND ENVIRONMENTAL RESEARCH) (contd)

3. Chemical and Hydrology Laboratories (Braunschweig)

   Mission. Provide supporting services for Asse Mine in-situ testing.

4. Rock Mechanics Laboratory (Braunschweig)

   Mission. Rock mechanics R&D for GSF/IfT waste disposal studies.

HMI (HAHN-MEITNER INSTITUTE)

Hahn-Meitner Institut für Kernforschung, GmbH	
Postfach 390128	
Glienicker Strasse 100	
D-1000 Berlin 39	Tel: (49) 30 8009-1
Federal Republic of Germany	Telex: 185763
Scientific Technical Director	Prof.-Dr. H. Lindenberger
Managing Director	Dr. M. Nettesheim
Manager, Reactor Chemistry Section (HMI Waste Program)	Dr. Werner Lutze

KFA (JÜLICH NUCLEAR RESEARCH CENTER)

Kernforschungsanlage Jülich GmbH	
Postfach 1913	
D-5170 Jülich	Tel: (49) 2461 610
Federal Republic of Germany	Telex: 833556
Director, Institute of Chemical Technology	Prof. Erich Merz
Reprocessing and Final Waste Storage	Prof. Erich Zimmer
HTGR Fuel Cycle Project/ JUPITER Project	G. Kaiser
Director, Decontamination Institute	Dr. Manfred Laser
Director, Institute for Reactor Materials	Prof. H. Nickel

KFA (JÜLICH NUCLEAR RESEARCH CENTER) (contd)

Facilities

1. Jupiter Pilot Plant (radioactive)

   Mission. Develop HTGR fuel reprocessing technology.
   Design Basis. Grind-burn-leach head-end; Thorex solvent extraction. Capacity, 2 kg/day.
   Milestone. Startup, 1985.

2. FIPS II (radioactive)

   Mission. Develop vitrification technology for HTGR fuel cycle HLW.
   Design Basis. Denitration to form sludge, drum dryer, in-can melter. Capacity, 1 kg/hr glass; product, phosphate or borosilicate glass.
   Milestone. Hot operation, TBD.

KfK (KARLSRUHE NUCLEAR RESEARCH CENTER)

Kernforschungszentrum Karlsruhe GmbH
Postfach 3640
D-7500 Karlsruhe 1 — Tel: (49) 7247 821
Federal Republic of Germany — Telex: 7826484

(Most convenient way from US is to fly to Frankfurt and go by train or car to Karlsruhe.)

Manager, Fuel Reprocessing and Waste Management Project (PWA)	Dr. Reinhard Kroebel (49) 7247 82-2032
Director, Waste Treatment Department (HDB)	Dr. Gunter Höhlein
Director, Institute for Hot Chemistry	Prof. Klaus Ebert
Deputy Director	Dr. Gunter Koch

KfK (KARLSRUHE NUCLEAR RESEARCH CENTER) (contd)

Director, Institute for Nuclear Waste Technology (INE)	Dr. Helmut Krause (49) 7247 82-2230
Manager, Final Disposal	Dr. R. Köster (49) 7247 82-2302
Manager, Chemistry (WMRD)	Dr. Theodor Dippel
Manager, Process Engineering	Dr. Siegfried Weisenburger
Director, Institute for Radiochemistry (INE)	Prof. Ache

Facilities

1. Ceramic Melter (nonradioactive)

   Mission. HLW vitrification process development, to support PAMELA pilot plant design and operation.
   Design Basis. Liquid-fed joule heated melter; capacity, 30 ℓ/hr HLLW or 20 kg/hr glass.
   History. Startup, May 1980.

2. MILLI Hot Cell Facility (fuel reprocessing)

   Mission. LWR and FBR fuel reprocessing R&D.

3. Ceramic Melter (nonradioactive)

   Mission. Test remote operation of a ceramic melter facility which is a prototype of the PAMELA hot cell.
   Design Capacity. 30 ℓ/hr HLLW.
   History. Startup, Fall 1981. As of 5/83, had produced 5 + glass beads and 30 + blocks, and had demonstrated 90% availability.

4. ALONA (radioactive acid digestion pilot plant built and operated by KfK at Mol, Belgium)

   Mission. Demonstrate acid digestion of combustible TRU wastes.
   Design Basis. Treatment with H_2SO_4-HNO_3 in thermal loop system. Capacity, 1000 m^3/a.
   History. Startup, 1982.

KfK (KARLSRUHE NUCLEAR RESEARCH CENTER) (contd)

5. KRETA

Mission. Develop ^{85}Kr recovery technology.
Design Basis. Cryogenic distillation; capacity, 50 m^3/hr.

6. Bituminization Plant (radioactive)

Mission. Immobilize KfK LLW.
Design Basis. Self-cleaning screw-extruder-evaporator.
History. Startup, 1972.

7. Waste Concreting Plant (radioactive)

Mission. Immobilize KfK ILW.
Design Capacity. 2.5 t/day waste.
History. Startup, 1977.

MUNICH TECHNICAL UNIVERSITY

Technische Universität München
Walther-Meissner-Strasse
8046 Garching bei München — Tel: (49) 89 3209 2201
Federal Republic of Germany — Telex: 522 854 tumue d

Director, Institute for Radiochemistry	Prof. Dr. Franz Baumgärtner

NUKEM

NUKEM GmbH
Postfach 110080
D-6450 Hanau 11 — Tel: (49) 6181 58-0
Federal Republic of Germany — Telex: 4184113 nuk d

Managing Directors	P. Jelinek-Fink
	Dr. K. G. Hackstein
Division Managers, Process Engineering	H. Pirk
	H. Dyroff
Department Manager, R&D	Dr. H. Huschka

NUKEM (contd)

Facilities

Pyrohydrolysis Incinerator

Mission. Volume reduction of TRU wastes.
Design Capacity. 25 kg/hr.
History. Startup, 1980.

PTB (FEDERAL SCIENCE AND ENGINEERING LABORATORY)

Physikalisch-Technische Bundesantalt
Bundesallee 100
Postfach 3345
D-3300 Braunschweig
Federal Republic of Germany

Tel: (49) 531 592-1
Telex: 952822 ptb d

Director, Division Storage/ Disposal of Radioactive Wastes	Prof. H. Röthemeyer (49) 531 592-7620
Subdivision Science/Technology (Waste Disposal)	
Waste Product	Dr. E. Warnecke
Repository Technical Mine Safety	Dr. P. Oesterle (49) 531 592-7635
Radiation Safety	Dr. Ehrlich
R&D, Accident Analysis	Dr. Illi
Explorations, Construction of Mines	G. Wosnick
Director, Subdivision Fuel Materials	Dr. W. Collin
Transport Licensing	M. Blechschmidt (acting)
Interim Storage Facilities Licensing	M. Blechschmidt

PTB (FEDERAL SCIENCE AND ENGINEERING LABORATORY) (contd)

Facilities

Gorleben Disposal Site

Mission. Dispose of high-level and TRU wastes.
Repository Concept. 65-m deep boreholes in tunnel floors at depths of 800-1000 m in the Gorleben salt dome.
Milestone. Startup, 1995.

TRANSNUKLEAR

Transnuklear GmbH Postfach 110030 D-6450 Hanau 11 Federal Republic of Germany	Tel: (49) 6181 500-1 Telex: 4184123 tnf d
Company Executives	Dr. Peter Vygen Dr. Horst Keese

UHDE

Uhde GmbH Friedrich-Uhde-Strasse 15 Postfach 262 D-4600 Dortmund 1 Federal Republic of Germany	Tel: (49) 231 547-0 Telex: 822841-25 ud d
Nuclear and Electrochemical Division	Dr. Bernd Strasser
Nuclear Division	Mr. Karl-Heinz Knickel
Processing Engineering Department	Dr. Wolfgang Strewe

US EMBASSY - BONN

American Embassy Delchmannsaue 5300 Bonn 2 Federal Republic of Germany	Tel: (49) 228 339-3390 Telex: 885452

WAK GmbH (FUEL REPROCESSING COMPANY)

Wiederaufarbeitungsanlage Karlsruhe
Betriebsgesellschaft mbH
Postfach 220
D-7514 Eggenstein-Leopoldshafen 2
Federal Republic of Germany

Tel: (49) 7247 881
Telex: 7826893 gwk d

(WAK and the WAK plant are located next to Karlsruhe Nuclear Research Center. WAK is a subsidiary of DWK.)

Chief Executive	Dr. Walter Schüller
Operations	Dr. Wilhelm Heinz
HLW Solidification Technology Project	Dr. Karl-Dieter Kuhn

Facilities

1. WAK Reprocessing Plant (owned by KfK)

   Mission. Reprocess UO_2 fuels; recover plutonium for recycle; test advanced technology.
   Design Basis. Chop-leach head-end; PUREX process; capacity, 175 kg HM/day.
   History. On-line from 9/71 to early 1980, when it was shutdown for dissolver replacement. Total throughput to 1980, 115 tHM (43 tHM from LWR fuel). Operation resumed, October 1982.

2. TEKO Hall (cold semi-works, owned by KfK)

   Mission. Test fuel cycle components and unit operations; currently being equipped for fuel reprocessing studies.
   Design Basis. Shear, dissolver, centrifuge, solvent extraction battery; head-end capacity, 4 tHM/day.
   Milestones. Beneficial occupancy for uranium testing of solvent extraction system--late 1981; installation of head-end components--1982, 1983.

3. AZUR

   Mission. Demonstrate dissolver off-gas treatment.
   Design Basis. Varied; includes cryogenic recovery of ^{85}Kr.
   History. Startup, late 1970s.

WAK GmbH (FUEL REPROCESSING COMPANY) (contd)

4. HOVA

Mission. Vitrify WAK plant HLW.
Design Basis. French AVM process; product, borosilicate glass blocks, 0.3 m x 1.3 m high; capacity, 30 ℓ/hr HLW feed or 15 kg/hr glass.
Milestone. Startup, 1990.

INDIA

INDIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day	*August	Janmashtami
*January	Id-ul-Fitr	*September	Anant Choudas
January 26	Republic Day	*October	Dusehra
*February	Vasanta	October 2	Mahatma Gandhi's Birthday
*February	Maha Sivarati	*October	Diwali
*March	Holi	*October	Bhaiya Dooj
*March	Dulhendi	*November	Guru Nanak's Birthday
*April	Durga Ashtmi	December 25	Christmas
*April	Muharram	*December	Guru Gobind Singh's Birthday
*April	Mahavir Jayanti	December 31	Bank Holiday
*March/April	Good Friday		
April 13	Baisakhi		
*August	Raksha Bandhan		
August 15	Independence Day		

INDIA

ENERGY

Population	1981	684 million
Energy Demand	1979	94 Mtoe
Oil Demand	1980	28 Mtoe (65% imported)
Electric Power Plant Capacity	1981-82	35 GWe-- 2.2% nuclear
	1985	50 GWe
Electric Power Production	1982	107 TWh-- 2.7% nuclear 50% coal 42% hydro 6% oil

NUCLEAR POWER

National Policy. Heavy dependence on nuclear power to augment the nation's electric power generating capacity. A three-phase program--first phase, reactors fueled with natural uranium; second phase, FBRs fueled with Pu produced by first-phase reactors; third phase, self-sustaining thorium-uranium cycle reactors.

Nuclear Power Plant Capacity	1983	1.0 GWe
	1985	1.2 GWe
	1990	1.9 GWe
	2000	4.4 GWe
Reactor Mix	1982	BWR: 2 (1969) HWR: 2 (1973-81); 4 (1984-89); 2 (1992)
Reactor Development	1983	40 MWt FBR test unit
	1990	500 MWe commercial FBR

INDUSTRIAL FUEL CYCLE

Policy. Achieve self-sufficiency in CANDU-type fuel cycle--uranium milling, conversion to UO_2, fuel fabrication, reprocessing (in small plants adjacent to power stations); if enriched UF_6 supply for India's BWRs is cut off, they may fuel with UO_2-PuO_2.

Waste Management Strategy. Vitrification of HLW, interim storage for at least 20 years and disposal in a granite or gneiss formation.

Cumulative Spent Fuel Arisings (LWR and HWR)	1980	370 tU
	1985	780 tU
	1990	1,580 tU
	2000	5,000 tU

Cumulative Waste Arisings	1982	2000
Primary solid wastes	1,700 m^3	107,000 m^3
LLW concentrates	2,500 m^3	77,000 m^3
ILW	650 m^3	20,000 m^3
HLW	350 m^3	8,000 m^3

Industrial-Scale Activities

1. Heavy-water production (t/a): 1981--300; additional capacity is planned, sufficient to yield a 13,000 t inventory by the year 2000.

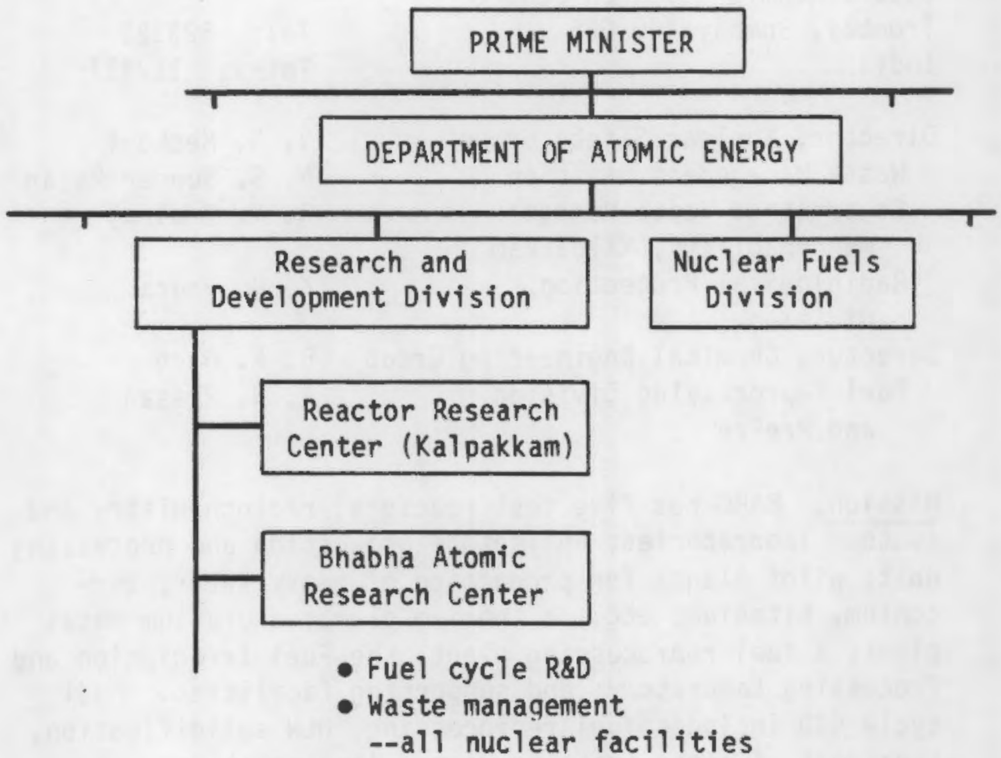
2. Uranium mining and milling (t/a): 200.

3. UO_2 fuel fabrication (t/a): 1981--100; 1984--210.

4. Fuel reprocessing: Trombay pilot plant, 30 t/a (1962--); Tarapur plant, 100 t/a (1982--); Kalpakkam plant, 100 t/a.

5. HLW vitrification: Tarapur (1982--).

ORGANIZATION



AEC (ATOMIC ENERGY COMMISSION)

Government of India
Department of Atomic Energy
Atomic Energy Commission
Chhatrapati Shivaji Marharaj Marg
Bombay 400 039
India *Tel: 242823

Chairman Dr. Raja Ramanna

AERB (ATOMIC ENERGY REGULATION BOARD)

Mission. Regulation and Licensing of Nuclear Facilities.

Chairman A. K. De
(Indian Institute of Technology)

* No direct dialing to India.

BARC

Bhabha Atomic Research Centre
Trombay, Bombay 400 085
India

Tel: 523321
Telex: 112817

Director, Nuclear Safety Group	V. N. Meckoni
Waste Management Division	N. S. Sunder Rajan
Centralized Waste Management Facility, Kalpakkam	R. V. Amalraj
Radiological Protection Division	K. G. Vohra
Director, Chemical Engineering Group	B. K. Garg
Fuel Reprocessing Division and PreFre	A. N. Prasad

Mission. BARC has five test reactors; radiochemistry and isotope laboratories; an isotope production and processing unit; pilot plants for production of heavy water, zirconium, titanium, etc.; a thorium plant; a uranium metal plant; a fuel reprocessing plant; the Fuel Irradiation and Processing Laboratory; and supporting facilities. Fuel cycle R&D includes fuel reprocessing, HLW solidification, treatment of alpha-emitting wastes (incineration, wet oxidation, decontamination, and immobilization of cladding hulls), D&D, and waste isolation in geologic formations.

Facilities

1. Trombay Fuel Reprocessing Plant

   Mission. Reprocess natural uranium metal fuels. Design Basis. Chemical declad, PUREX flowsheet; contact maintenance; capacity, 0.1-0.15 tHM/day. History. On-line, 1965-1974; modified and being readied to operate again.

2. HLW Vitrification Plant

   History. Construction start, 1981.

KOLAR WASTE DISPOSAL RESEARCH STATION

Location. In the Kolar gold mine area at the Karnataka State.

Mission. Assess the suitability of peninsular gneisses for location of a repository (in situ studies).

Description. Tunnel extended from abandoned section of one of the Kolar gold mines into a neighboring gneissic formation.

History. Startup, "soon" (after October 1979).

MADRAS ATOMIC POWER PROJECT

Madras Atomic Power Project
Kalpakkam
India

Mission. Nuclear power production, FBR development, fuel reprocessing and waste treatment, plutonium fuel fabrication for FBRs.

R&D. FBR technology, reprocessing of FBR fuels.

Facilities

1. Kalpakkam Fuel Reprocessing Plant

   Mission. Reprocess spent fuel from the Kalpakkam reactors and from the 15-MW FBTR due for commissioning in mid-1981.
   Design Basis. Purex process, with a separate line for FBTR mixed-carbide fuels; capacity, 0.5 tHM/day for PHWR fuels.

2. Kalpakkam Fuel Reprocessing Laboratory

   Mission. Develop and test equipment and unit operations for FBR fuel reprocessing.

3. Kalpakkam HLW Vitrification Plant

   Milestone. Construction start, 1983.

NUCLEAR FUEL COMPLEX

Nuclear Fuel Complex
Department of Atomic Energy
Cherlapalli, near Moula Ali
Hyderabad, 500 040
India

Tel: 78371, 71801-4
Telex: 015304

Chief Executive Dr. Rao

Mission. Integrated fuel and nuclear component manufacturing complex to supply Indian nuclear power plants.

TARAPUR ATOMIC POWER STATION

Tarapur Atomic Power Station
Tarapur, Maharashtra
India

Mission. Provide electric power for India, reprocess spent fuel from Tarapur reactors and immobilize the associated wastes.

Facilities

1. Tarapur Fuel Reprocessing Plant (PreFre)

   Mission. Reprocess natural and low-enriched UO_2 fuels (zircaloy clad).
   Design Basis. Chop-leach head-end; PUREX flowsheet; contact maintenance; capacity, 0.5 tHM/day.
   History. Construction completed, 1975; hot operation, 12/82.

2. WIP (Waste Immobilization Plant)

   Mission. Vitrify Tarapur HLW.
   Design Basis. Two-step calcination and melting in drainable pot; capacity, 25 ℓ/hr HLLW, 125 kg glass/canister, 1 canister/day; product, borosilicate glass blocks.
   Milestone. Construction completed 1981; Startup, 1982.

TARAPUR ATOMIC POWER STATION (contd)

3. Solid Storage Surveillance Facility

Mission. Provide air-cooled storage for WIP products.
Design Basis. Stack-induced natural-draft air cooling; capacity for 20 years' storage of Tarapur and Trombay WIPs.

4. ILW Bituminization Plant

Mission. Immobilize LLW.
Design Basis. Capacity--120 ℓ/hr LLW; wiped film evaporation.

5. Polymerization Facility

Mission. Immobilize low heat generating waste (LHGW).
Design Basis. LHGW is mixed with polyesterstyrene and vermiculite in conditioning tanks emplaced in a concrete trench.

ITALY

ITALIAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Easter Monday
April 25	Liberation Day
May 1	Labor Day
August 15	Assumption Day
November 1	All Saints' Day
December 8	Immaculate Conception
December 25-26	Christmas

ITALY

ENERGY

Population	1981	57 million
Energy Demand	1980	142.1 Mtoe (80% imported)
Oil Demand	1980	95 Mtoe (97% imported)
Electric Power Plant Capacity	1981	47.4 GWe-- 2.7% nuclear 33.5% hydro 38.4% oil & gas 25.4% solid fuels
Electric Power Production	1980	185.7 TWh-- 1.2% nuclear 61.3% oil & gas 27.0% hydro/geo. 10.5% solid fuels
	1982	174 TWh-- 3.8% nuclear

NUCLEAR POWER

National Policy. National government supports nuclear power growth, but is hampered by financial and siting problems.

Nuclear Power Plant Capacity	1983	1.3 GWe
	1990	1.3 GWe
	1995	4.8 GWe
	2000	6.7 GWe
Reactor Mix	1982	GCR: 1 (1964)
		PWR: 1 (1965)
		BWR: 1 (1981)
		2 (1987-88)
		HWR: 1 (1986)
Reactor Development		HWR, FBR; membership in Super Phenix consortium

INDUSTRIAL FUEL CYCLE

Policy. Reprocess spent fuel and recycle Pu to breeders; develop indigenous fuel cycle and waste treatment capability.

Waste Management Strategy. HLW--vitrify and store in engineered surface facility for 50-60 years; emplace canisters in geologic repository (clay).

Cumulative Spent Fuel Arisings (LWR)	1980	160 tU
	1985	330 tU
	1990	520 tU
	2000	2,000 tU

INTERNATIONAL RELATIONSHIPS

1. Membership in European Communities, IAEA, OECD/NEA.

2. Participation in Eurodif, Coredif, Super Phenix projects.

3. A CEC Joint Research Centre laboratory is located in northern Italy at Ispra.

ORGANIZATION

1. Ministry of Industry--overall nuclear responsibility.

2. ENEA--safety and regulatory; nuclear R&D (principally at the Casaccia, Saluggia and Trisaia Centres).

3. ENI--federal oil and energy holding company, which provides fuel cycle services. The former AGIP Nucleare, an ENI subsidiary, has now been blended into the parent company.

4. Nucleco--manages institutional and reactor LLW/ILW.

5. Interministerial Council for Economic Planning (CIPE)--designates regions where nuclear plants are to be located.

6. ENEL--state-owned power utility.

ENEA (NATIONAL COMMISSION FOR RESEARCH AND DEVELOPMENT OF NUCLEAR ENERGY AND ALTERNATIVE FORMS OF ENERGY)

ENEA Regina Margherita 125
I-00198 Rome
Italy

Tel: (39) 6 85281
Telex: 61183

Vice President	Prof. Carlo Salvetti
Director General	Fabio Pistella
Research Laboratory	Guiseppe Grossi
Fuel Cycle Department	Ing. Venditti

Mission. Supervise pure and applied nuclear research, maintain technical control over nuclear power plants, cooperate in international program.

Sponsor. Federal government.

ENEA: CASACCIA CENTER

ENEA-Casaccia Center
S. Maria di Galeria
S.P. Anguillarese km 1+300
I-00060 Rome
Italy

Tel: (39) 6 6948-1
Telex: 613296

For Correspondence:
Casella Postale 2400
I-00100 Rome
Italy

Director, Fuel Cycle	Dr. A. Donato
Waste Management	Mr. Dello Vicolrio
HLW Vitrification Project	Dr. Piero Risoluti
Reprocessing and Waste	Dr. G. Rolandi

Mission. Applied research--nuclear energy and alternative sources of energy.

Sponsor. ENEA.

Waste Management R&D. MOX fuel reprocessing, HLW solidification, actinide transmutation, treatment of LLW and characterization of waste forms, waste isolation in clay formations (site characterization and thermal properties).

ENEA: SALUGGIA CENTER

ENEA-Impianto Eurex
I-13040 Saluggia (Vercelli)
Italy

Tel: (39) 161 48415
Telex: 380058 EURI

(Located about 35 km from Torino and 120 km from Milano.)

Director, Eurex Pilot Plant — Dr. Franco Pozzi
Deputy Director, Eurex — Arnoldo Hall

Sponsor. ENEA.

Mission. Applied nuclear research (EUREX fuel reprocessing pilot plant is located here).

Facilities

1. EUREX (fuel reprocessing pilot plant-radioactive)

   Mission. Reprocess MTR and low-enriched uranium (including UO_2) fuels.
   Design Basis. PUREX process; chop-leach head-end has been added; capacity, 30 kg U-Al/day of MTR fuels, 50-100 kg/day of LWR oxides.
   History. Built and operated under a CNEN-Euratom convention 1964-1983. Startup, 1970. CANDU fuels from Canada processed in 1983. A unit is to be added for MOX fuel reprocessing.

2. IVEX (HLW vitrification plant-radioactive)

   Mission. Immobilize EUREX HLW.

3. IFEC (fuel element fabrication)

   Mission. Fabricate ceramic uranium fuel for Cirene research reactor.

ENEA: TRISAIA CENTER

ENEA-CRE Trisaia
S.S. 106 Jonica, Km. 419+500
I-75025 Policoro (Matera) Tel: (39) 835 972241
Italy Telex: 760085 ENEATR I

(Located near Rotondella, about 5 km from the coast of the Ionian Seas in the Gulf of Taranto.)

Director, Energy Research	G. Lapolla
Director, ITREC Plant	T. Candelieri
Oirector, Technology Development for the Backend of the Fuel Cycle	A. Canonico
Vitrification Plant Operations	E. Scoditti

Mission. Applied nuclear research (ITREC fuel reprocessing pilot plant is located here).

Sponsor. ENEA.

Waste Management R&D. Fuel reprocessing, centrifugal contactor development, cladding hulls compaction, HLW vitrification, D&D, and waste isolation (clay repositories).

Facilities

1. ITREC (fuel reprocessing pilot plant-radioactive)

   Mission. FBR fuel reprocessing R&D; reprocess thorium and MOX (FBR) fuels.
   Design Basis. Chop-leach head-end; maintenance by remote removal of modules; capacity, 15 kg HM/day (ThO_2 and UO_2).
   History. Startup, 1975; 10 m^3 HLLW produced.

ENEA: TRISAIA CENTER (contd)

2. IVET-1 (vitrification pilot plant-nonradioactive)

   Sponsors. CNEN and AGIP Nucleare.
   Mission. Develop HLW vitrification process.
   Design Basis. IVET-1 pot vitrification (two-stage, rising level process); capacity, 20 ℓ/hr feed; product, borosilicate glass cylinders, 0.25 m dia x 1 m.
   History. Operation, from July 1980.

3. IVET-2 (HLW vitrification pilot plant-radioactive)

   Owners. CNEN and AGIP Nucleare.
   Mission. Process development; solidify HLW from EUREX fuel reprocessing pilot plant.
   Design Basis. Pot vitrification (two-stage, rising level process); capacity, 15 ℓ/hr feed (2 canisters/wk) or 10 m^3 HLLW/a; product, borosilicate glass cylinders, 0.25 m dia x 1 m.
   History. Startup, late 1980s.

ENEL (NATIONAL ELECTRIC ENERGY AGENCY)

Ente Nazionale per L'Energia Elettrica
Casella Postale 386
Via Giovan Battista Martini 3
I-00198 Rome
Italy

Tel: (39) 6 85091
Telex: 610518

Vice President	L. Magno
Director General	M. Moretti

Mission. Responsible for electric power produced by all sources.

Sponsor. Federal government.

ENI

Ente Nazionale Indrocarburi SPA
San Donato Milanese
I-20093 Milan
Italy

Tel: (39) 2 5353-1
Telex: 34192

President — Mr. Franco Reviglio

Mission. Oil and energy holding company, owned by the federal government.

NUCLECO

Nucleco
Via Europa-Cologno Monzese 46
I-20093 Milan
Italy

Mission. Treat and dispose of low- and intermediate-level wastes from hospitals, laboratories, industrial establishments, and nuclear powerplants. Eventual plans include decommissioning work on nuclear installations.

Sponsor. Italian government (CNEN--40%; AGIP--60%).

SNIA TECHINT

Snia Techint
Tecnologie Energetiche Avanzate SPA
Via A. Bargoni 34
I-00153 Rome
Italy

Tel: (39) 6 5894041
Telex: 614354 SNITEC

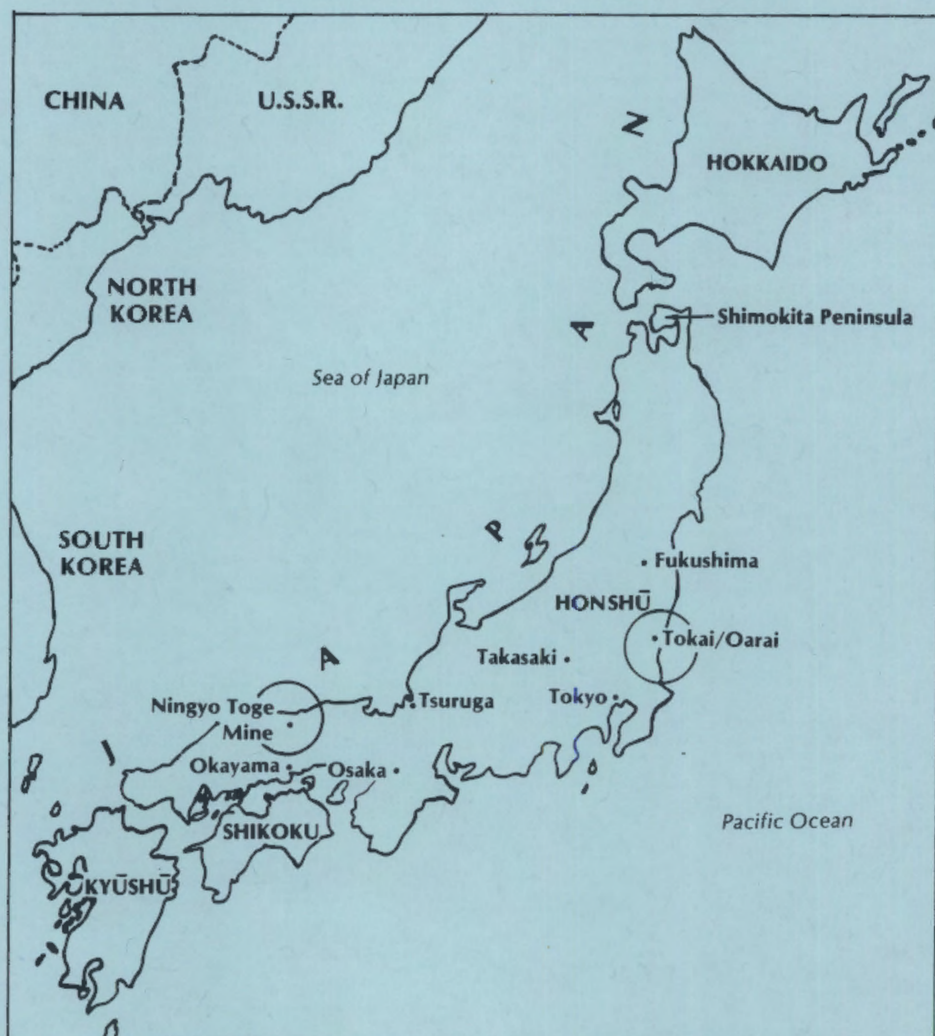
General Manager — Marino Fiorelli

Mission. Provide architect-engineering services for reprocessing, fuel handling and HLW conditioning facilities.

JAPAN

JAPANESE HOLIDAYS
*Asterisks denote movable holidays

January 1	New Year's Day
January 15	Adult's Day
February 11	National Foundation Day
*March	Vernal Equinox
April 29	Emperor's Brithday
May 3	Constitution Day
May 5	Children's Day
September 15	Respect for the Aged Day
*September	Autumnal Equinox
October 10	Physical Culture Day
November 3	Culture Day
November 23	Labor Thanksgiving Day



JAPAN

ENERGY

Population	1982	118.4 million
Energy Demand	1980	370 Mtoe (85% imported)
	1990	622 Mtoe (78% imported)
Oil Demand	1980	255.4 Mtoe (99% imported)
Electric Power Plant Capacity	1982	137 GWe-- 13% nuclear
	1985	170 GWe
Electric Power Production	1980	577.5 TWh-- 14.3% nuclear 61.6% oil & gas 16.2% hydro/geo. 7.9% solid fuels
	1982	511 TWh-- 20.3% nuclear

NUCLEAR POWER

National Policy. Strong nuclear power program, to lessen dependence on foreign energy sources--install LWRs for near-term needs; develop an advanced HWR; aim for commercial FBR operation by the year 2010. Supply domestic needs and build export business.

Nuclear Power Plant Capacity	1983	16.6 GWe
	1985	21.2 GWe
	1990	32.0 GWe
	2000	49.8 GWe
Reactor Mix	1982	GCR: 1 (1966)
		BWR: 12 (1970-1982)
		6 (1984-1987)
		PWR: 11 (1970-1982)
		7 (1984-1990)
		HWR: 1 (1979)
		LMFBR: 1 (1991)

Reactor Development	HWR, LMFBR

INDUSTRIAL FUEL CYCLE

Policy. Obtain ownership of foreign uranium resources; develop complete fuel cycle capability (enrichment, reprocessing and waste treatment, buying foreign reprocessing services as long as necessary); recycle Pu to FBRs, HWRs, and LWRs.

Waste Management Strategy. HLW--vitrify and store in engineered surface facility until repository is ready. LLW--sea dump is preferred, but land disposal is being developed in case sea dump option is not available. Preferred geology for HLW repository has not been selected.

Cumulative Spent Fuel Arisings (LWR)	1980	1,450 tU
	1985	4,100 tU
	1990	8,200 tU
	2000	20,000 tU

Industrial-Scale Activities

1. Power production (GWe): 1981--16.4; 1990--51.

2. Uranium mining and milling (tU/a): 30 (domestic).

3. Conversion (tUF_6/a): 200.

4. Uranium enrichment (tSWU/a): 1981--75; 1985--1000; 2000--3000.

5. Fuel fabrication
   - UO_2
   - MOX--15 kg/day for FBR fuels, 10 t/a for the LWCHW.

6. Reprocessing (t/day): 1981--0.7; 1990--6.

Major Milestones

• HLW solidification pilot plant (PNC)	1990
• Commercial reprocessing plant for LWR fuels	~1990
• FBR fuel reprocessing pilot plant	~1991
• HLW solidification commercial plant	~1995
• Return of HLW from COGEMA and BNFL	~1990
• Experimental sea-dumping of LLW	TBD
• Selection of candidate geological or seabed repository formations	~1985
• Selection of repository test site for in situ test with a simulated waste package	~1995
• Selection of demonstration site for in situ test with actual waste package	~2005
• Startup of disposal site	After 2015
• MONJU LMFBR	1991

INTERNATIONAL RELATIONSHIPS

1. Member of IAEA and OECD/NEA.

2. LMFBR exchange agreement with DOE.

3. Licensing agreements with GE and Westinghouse.

ORGANIZATION

Government funds nuclear R&D and is responsible for HLW disposal. Industry handles the commercial fuel cycle and LLW disposal, and pays for HLW disposal. See Figures JA-1, JA-2, JA-3 for organizational relationships and responsibilities.

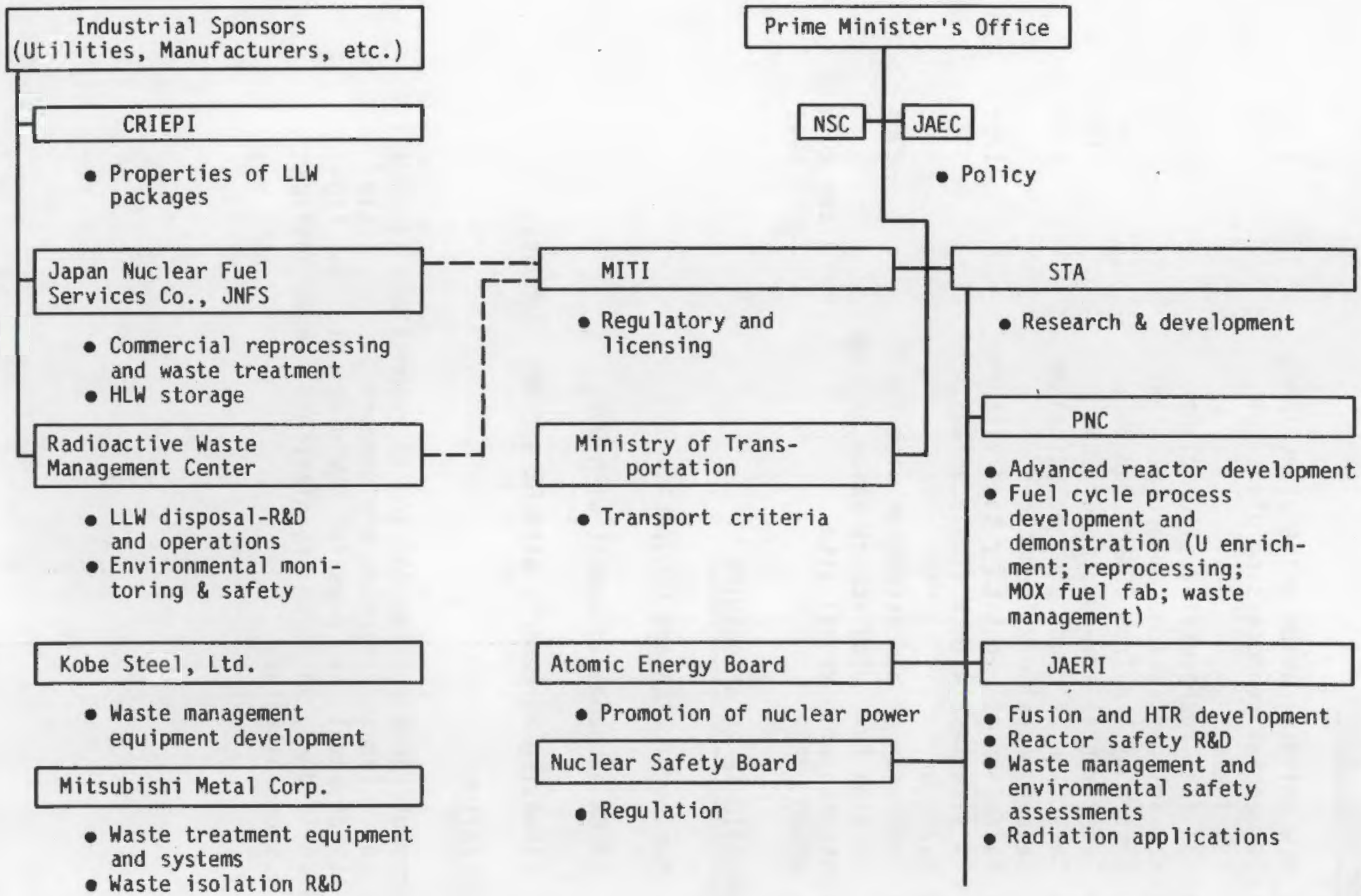


FIGURE JA-1. Nuclear Fuel Cycle Responsibilities

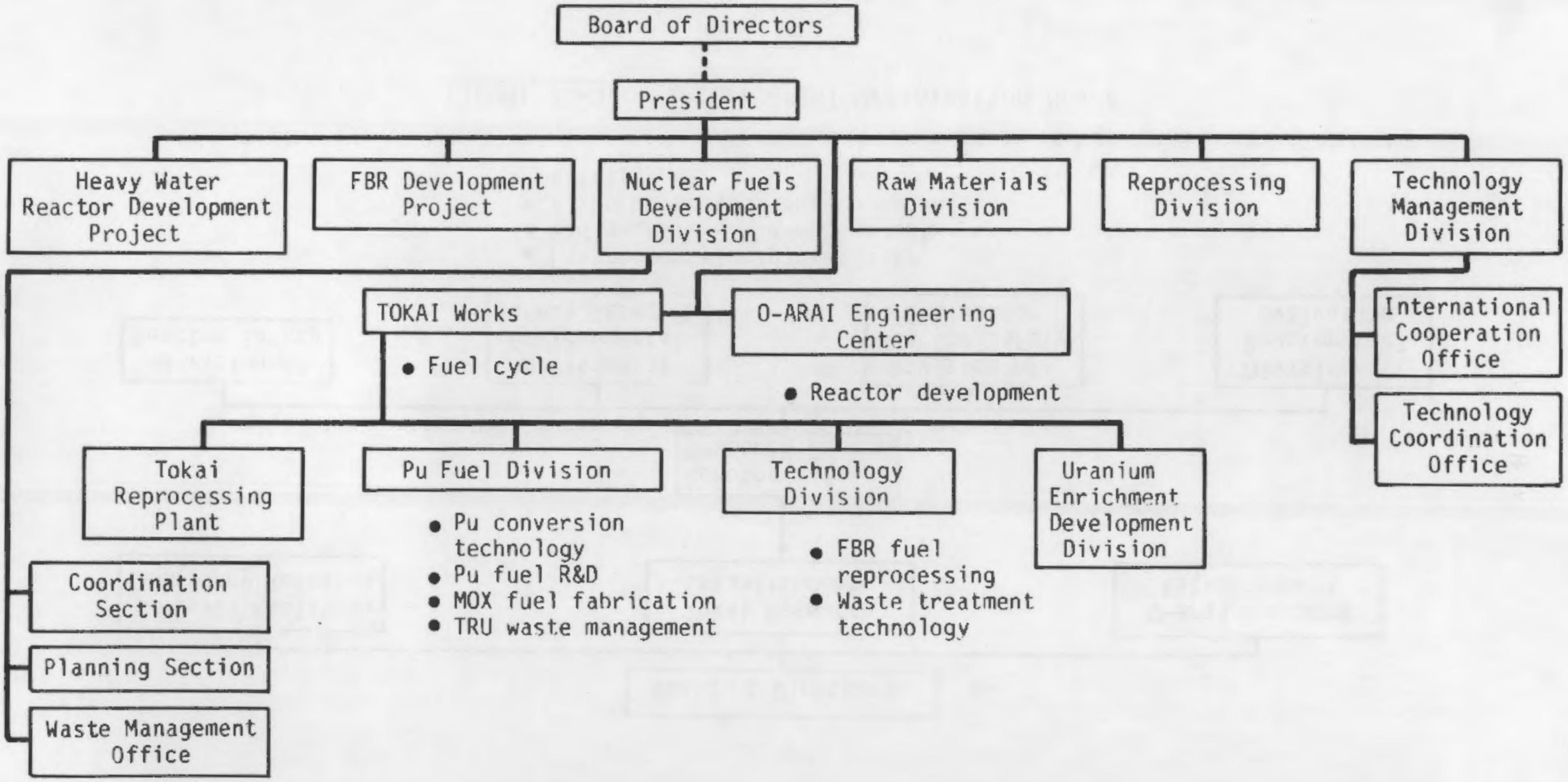


FIGURE JA-2. Partial PNC Organization

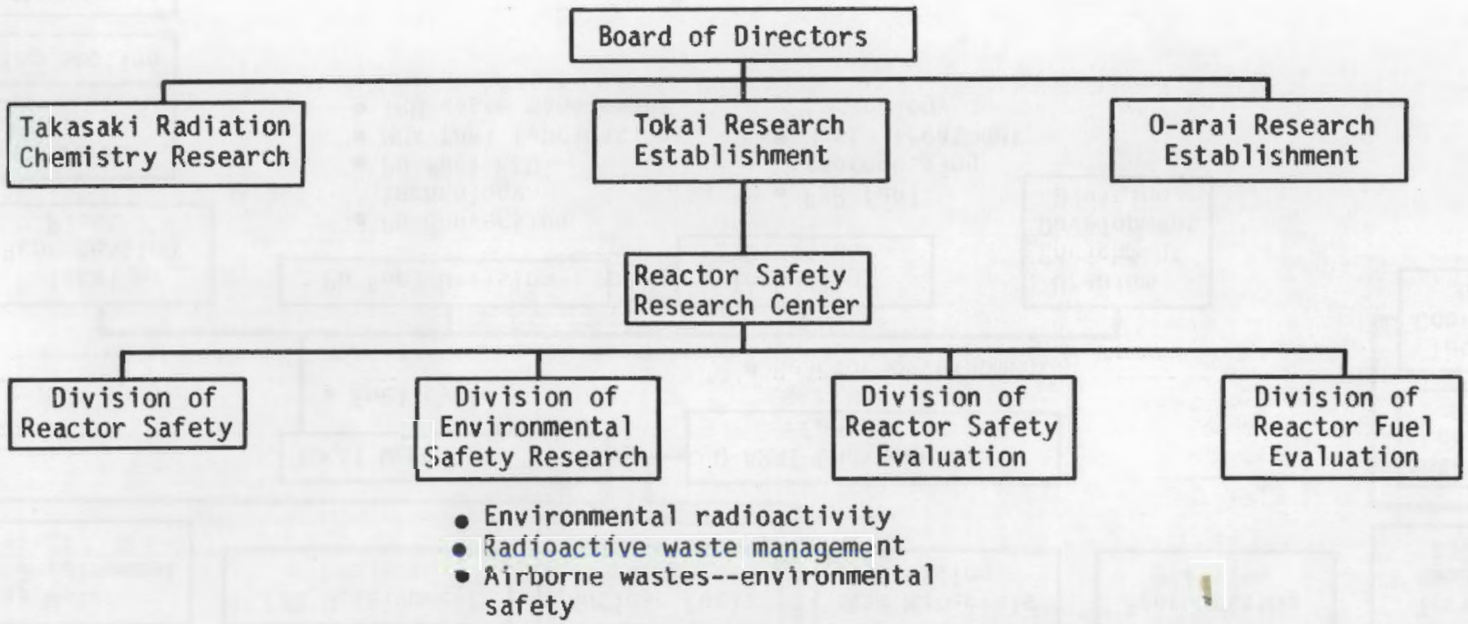


FIGURE JA-3. Partial JAERI Organization Chart

AEC (ATOMIC ENERGY COMMISSION)

Atomic Energy Commission
2-2-1 Kasumigaseki
Chiyoda-ku, Tokyo
Japan Tel: (81) 3 581-2585

Chairman T. Yasuta

Mission. Formulate national policy on nuclear energy research, development and utilization.

CRIEPI (CENTRAL RESEARCH INSTITUTE OF ELECTRIC POWER INDUSTRY)

Civil Engineering Laboratory
1646, Abiko, Abiko-Shi,
Chiba Pref. 270-11
Japan Tel: (81) 471 82-1181

Energy and Environmental Laboratory
11-1, Iwato-kita, 2-chome,
Komae-shi, Tokyo 201 Tel: (81) 3 480-2111
Japan Telex: 2423098 CRIEPI J

GIRIO

Government Industrial Research Institute, Osaka
1-8-31 Midorigaoka, Ikeda-shi
Osaka 563, Japan Tel: (81) 727 51-8351

Director, 4th Department Dr. Ryozo Hayami
Nuclear Waste Program Dr. Ryohei Terai

R&D. Alternatives for HLW solidification; waste form characterization.

HITACHI

Hitachi Engineering Co., Ltd.
1-1 Saiwai-cho, 3-chome
Hitachi-shi, Ibaraki-ken, 317 — Tel: (81) 294 21-1111
Japan — Telex: 03645511

Nuclear Power Plant Construction Department	Kiyoshi Shimizu
Nuclear Fuel Project	Yasuo Hirose
Nuclear Fuel Cycle Project	Sadatoshi Inoue

Fuel Cycle R&D. Develop technology to reprocess spent LWR fuel; fixation, storage, and disposal of HLW; spent fuel storage; Pu fuel production; and decommissioning.

JAERI

Japan Atomic Energy Research Institute
2-2-2, Uchisaiwaicho
Chiyoda-ku, Tokyo 100 — Tel: (81) 3 503 6111
Japan — Telex: J24596

Location. JAERI headquarters and Radioisotope Center are in Tokyo. The Tokai and O-arai Research Establishments share government reservations at Tokai-mura and O-arai-machi with PNC. Tokai and O-arai are 120 and 100 km, respectively, northeast of Tokyo, near the ocean. These sites can be reached by train from Tokyo to the city of Mito, then by taxi.

JAERI: O-ARAI

O-Arai Research Establishment
O-Arai-machi, Higashi-Ibaraki-gun
Ibaraki-ken 311-13
Japan — Tel: (81) 2926 7-4111

JAERI: TOKAI

Tokai Research Establishment
Tokai-mura, Naka-gun
Ibaraki-ken 319-11
Japan

Tel: (81) 2928 2-5111
Telex: 3632340 J TOKAI J

Director	Dr. H. Ishikawa
Director, Division of Environmental Safety Research (DERS)	Dr. H. Amano
Deputy Director, DERS	Dr. K. Araki

Facilities

WASTEF (glove box and hot cell facilities)

Mission. Safety evaluations for high level waste.
History. Startup, cold tests, 1981; hot tests, 1982.

JAPAN NUCLEAR FUEL SERVICE COMPANY

Japan Nuclear Fuel Service Company, Ltd.
2-2, 2-chome, Uchisaiwaicho
Chiyoda-ku, Tokyo 100
Japan

Tel: (81) 3 580 6911

President	Kiyoshi Goto
General Manager	Shigeru Sato
Managing Director and Gen'l Mgr., International Affairs Dept.	Shigefumi Tamiya

Facilities

Commercial Fuel Reprocessing Plant

Mission. Reprocess Japanese fuels.
Design Basis. Two lines @ 3 tHM/day; 3000 tU storage pool; HLW vitrification and storage. Cost estimate - 690 billion yen.
Milestone. FRP startup, 1990; HLW vitrification and storage, 1993.

JGC CORPORATION

Nuclear Project Division
New Ohtemachi Bldg., 2-1
Ohtemachi 2-chome
Chiyoda-ku, Tokyo 100 — Tel: (81) 3 279-5441
Japan — Telex: 02223096 JGCTOK J

Research and Development Division
14-1, Bessho 1-chome
Minami-ku,
Yokohama 232 — Tel: (81) 45 712-1111
Japan — Telex: 03822451 JGCYOK J

Mission. Design and construction of fuel reprocessing and radwaste treatment facilities.

Waste Management R&D. Treatment of reactor wastes (acid digestion of resins, immobilization of residues).

Facilities

Acid Digestion Pilot Plant

Mission. Provide engineering-scale test of process for treatment of reactor wastes.
Milestone. Startup, 1984.

KOBE STEEL

*Kobe Steel, Ltd.
Tekko Building
No. 8-2, 1-chome, Marunouchi
Chiyoda-ku, Tokyo 100 Tel: (81) 3 218-7111
Japan Telex: 2223601 KOBESTEEL TOK

Kobe Steel, Ltd.
No. 3-18, 1-chome, Wakinohama-cho
Chuoh-ku, Kobe, 651 Tel: (81) 78 251-1551
Japan Telex: 5622177 KOBESTEEL KOB

General Manager, Mechanical Engineering Research Lab. (MERL)	Dr. Kazuo Ikeda
Senior Researcher, MERL	Tokuya Ishikawa
Assistant Manager, Energy Equipment and Projects Department	*Norio Nakahashi
Technical Advisor	*Dr. Yasuji Nakamura

MEIDENSHA

Meidensha Electric Manufacturing Co., Ltd.
New Ohtemachi Building
2-1, 2-chome, Ohtemachi
Chiyoda-ku, Tokyo 100 Tel: (81) 3 246-7086
Japan Telex: 02223507 Meiden J

Senior Managing Director and Director of Development Division	H. Hamoda

R&D. Remote maintenance systems for PNC fuel cycle activities.

MITI (MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY)

Ministry of International Trade and Industry
3-1, Kasumigaseki
Chiyoda-ku, Tokyo 100
Japan Tel: (81) 3 501-1511

MITI (MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY) (contd)

Director, Nuclear Energy Industry Division	Kazuhiko Ohtsuka
Deputy Director, Nuclear Industry Division	Hirotoshi Inaba

MITSUBISHI

Mitsubishi Metal Corporation
5-2 Ohte-machi 1-chome,
Chiyoda-ku, Tokyo 100 — Tel: (81) 3 213-2111
Japan — Telex: 2226533 MMCTOKJ

General Manager, Nuclear Energy Division	Dr. Yumi Akimoto
Manager, Technical Planning Section	Dr. Tamotsu Ishii
General Manager, Technology Department	Eiji Yagi
General Manager, Nuclear Resources Development and Waste Management	Takaaki Kashiwagi

R&D. Design and research on facilities for spent fuel storage and reprocessing, waste treatment and geologic disposal.

NSC (NUCLEAR SAFETY COMMISSION)

Nuclear Safety Commission
2-2-1, Kasumigaseki
Chiyoda-ku, Tokyo 100
Japan — Tel: (81) 3 581-5271

Chairman	Tokuo Suita

PNC

Power Reactor and Nuclear Fuel Development Corporation
Sankaido Building
1-9-13 Akasaka
Minato-ku, Tokyo 107
Japan

Tel: (81) 3 586 3311
Telex: J26462

President	M. Yoshida
Executive Director, FBR R&D	K. Mochizuki
Executive Director; Director Nuclear Fuels Development	K. Uematsu
Deputy Director	T. Nishiya
Manager, Waste Management	T. Nishiya (Acting)
Director, Reprocessing	T. Koizumi
Director, Technology Management	M. Koizumi
Manager, International Cooperation	C. Kinoshita
DOE Representative	D. H. Jones (HEDL) Ext. 493

US Office:
Power Reactor and Nuclear Fuel Development Corporation
Suite 908
2600 Virginia Avenue N.W.
Washington, DC 20037

Tel: (202) 338-3770
Telex: 892777

Manager, US Office	Kikuo Nagasawa

PNC: O-ARAI

PNC O-Arai Engineering Center
Oarai-machi, Higashi Ibaraki-gun
Ibaraki Pref. 311-13
Japan

Tel: (81) 2926 7-4141
Telex: J26482

Director	K. Tanaka
Waste Management	S. Masuda

PNC: TOKAI

PNC Tokai Works
Muramatsu 3371,
Tokai-mura, Naka-gun
Ibaraki-ken 319-11
Japan

Tel: (81) 2928 2-1111

Director	M. Ichikawa
Deputy Director	T. Watanabe
Director, Reprocessing Plant	G. Fukuda
Director, Processing	T. Yamanouchi
Director, Reprocessing Technology Development	K. Matsumoto
Director, Fuel Cycle Technology Development	M. Yamamoto
Director, Plutonium Fuel	S. Watanabe
Director, Conversion Technology	N. Tsujo

Facilities

1. Fuel Reprocessing Plant

Mission. Reprocess low-enriched UO_2 and natural uranium metal fuels.
Design Basis. Metal fuels: mechanical decladding. Oxide fuels: chop-leach head-end. Purex flowsheet; capacity, 0.7 tHM/day. Remote maintenance of chop-leach equipment; contact maintenance of other components.
History. Startup, September 1977; 170 tU in spent fuel have been processed through December 1983.

2. Co-Conversion Facility

Mission. Demonstrate PNC microwave process for co-conversion production of MOX.
Design Basis. 10 kg/day MOX (50% PuO_2, 50% UO_2).
Milestone. Start-up, 1984.

PNC: TOKAI (contd)

3. Plutonium Fuel Fabrication Facility (PFFF)

Mission. Fabricate FBR and ATR fuels.
Design Basis. FBR fuels--15 kg/d (30% PuO_2 in enriched UO_2); ATR fuels--10 t/a (2% PuO_2 in UO_2).
Throughput to Date. 50 t MOX; 400 kg Pu from Tokai-mura has gone into FUGEN ATR.

4. Fuel Fabrication Plant

Mission. Fabricate MOX fuel for FUGEN MONJU, new ATR, and LWRs.
Design Basis. 40 t MOX/a, expandable to 140 t/a. MONJU fuel contains 30% PuO_2.

5. Vitrification Pilot Plant

Mission. Vitrify and store HLW from the Tokai-mura fuel reprocessing plant; demonstrate technology.
Design Basis. Ceramic melter to produce a borosilicate glass (tentative); capacity, 0.79 m^3 HLLW/day or 1 canister (76 ℓ)/day of glass.
Milestone. Startup, 1987.

6. Mockup Test Facilities

Mission. Nonradioactive, full-scale tests of vitrification and fuel reprocessing processes and equipment.
Milestone. Startup, March 1982 (vitrification); reprocessing, mid-1983.

7. HLW Vitrification Facility

Mission. Develop ceramic melter technology.
Design Basis. Joule-heated melter--45 kg/hr glass; induction-heated melter--7.5 kg/hr glass.

PNC: TOKAI (contd)

8. Engineering Test Facility (reprocessing and HLW treatment)

Mission. Industrial-scale, nonradioactive studies of FBR spent fuel reprocessing and HLW solidification (pulse columns, electrolytic Pu/U partitioning, off-gas treatment, solvent treatment, ceramic melters).
Design Basis. Reprocessing--Purex; HLW--evaporation and denitration, vitrification (ceramic melter); melter capacity, 80 ℓ/day glass.
History. Facility startup, February 1980.

9. Chemical Processing Facility (reprocessing and HLW treatment)

Mission. Radioactive studies of spent fuel reprocessing (FBR and other advanced fuels) and HLW solidification processes.
Design Basis. Five standard hot cells for breeder-fuel reprocessing R&D, five cells for waste conditioning R&D. Reprocessing--1 kg/batch; HLW solidification--30 ℓ/hr HLW, 6 kg/hr glass.
Milestones. Cold tests, 1981; hot tests, March 1982.

10. FBR Fuel Reprocessing Test Facility (reprocessing and HLW treatment)

Mission. Demonstrate FBR fuel reprocessing and HLW solidification.
Design Basis. 120 kg MOX/day (12 t/a).
History. Hot operation, 1981.

11. ^{85}Kr Recovery Pilot Plant

Mission. Demonstrate ^{85}Kr recovery from Tokai-mura reprocessing plant offgas.
Design Basis. Cryogenic distillation and pressurized cylinder storage.
Milestone. Start of Operation, early 1983.

PNC: TOKAI (contd)

12. Bitumization Facility

Mission. Immobilize PNC's LLW.
Design Basis. 200 ℓ/hr.

13. Incinerator (Tokai)

Mission. Burn solid LLW.
Design Basis. 100 kg/hr.

14. Incinerator (O-Arai)

Mission. Burn solid LLW.
Design Basis. Three chambers--pyrolysis, combustion, after-burning.

15. Acid Digestion Facility (nonradioactive)

Mission. Confirm laboratory-scale results on acid digestion process for TRU wastes.
Design Basis. 200-ℓ tantalum digester vessel and ancillary equipment, glass-lined steel where necessary; capacity, 4-8 kg/hr.
History. In operation.

16. Plutonium Waste Treatment Facility

Mission. Prepare PNC TRU wastes for disposal.
Design Basis. Acid digestion of chloride-containing wastes; incineration of other combustibles; mechanical volume reduction.
Milestone. Acid digestion facility to be operational by 1986.

RMC (RADWASTE MANAGEMENT CENTER)

Radioactive Waste Management Center
No. 15, Mori Building
2-8-10, Toranomon
Minato-ku, Tokyo, 105
Japan
Tel: (81) 3 504-1081

President	Ryoichi Takeuchi
Managing Director	Syunichi Murakoshi

Sponsors. Japanese industry, MITI and STA.

Mission. Promote the study of safe and rational operation of low-level radioactive waste disposal.

STA (SCIENCE AND TECHNOLOGY AGENCY)

Science and Technology Agency
2-2-1 Kasumigaseki
Chiyoda-ku, Tokyo 100
Japan
Tel: (81) 3 581 5271
Telex: 2226720 STASGD

Minister of State for Science and Technology	Takaaki Yasuta
Deputy Minister	Hiroko Hayashi
Administrative Vice Minister	Takao Ishiwatari
Director-General, Nuclear Safety Bureau	Eiichi Tsuji
Director, Nuclear Materials Regulation Division	Tetsushi Kuramochi
Director, Nuclear Safety Division	Hiroyoshi Kurihari
Director-General, Atomic Energy Bureau	Yukinobu Takaoka
Director, Nuclear Fuel Division	Fujio Sakauchi
Deputy Director	M. Nomura

US EMBASSY - TOKYO

American Embassy
10-5 Akasaka 1-chome
Minato-ku, Tokyo 107
Japan

Tel: (81) 3 583 4121
Telex: 2422118

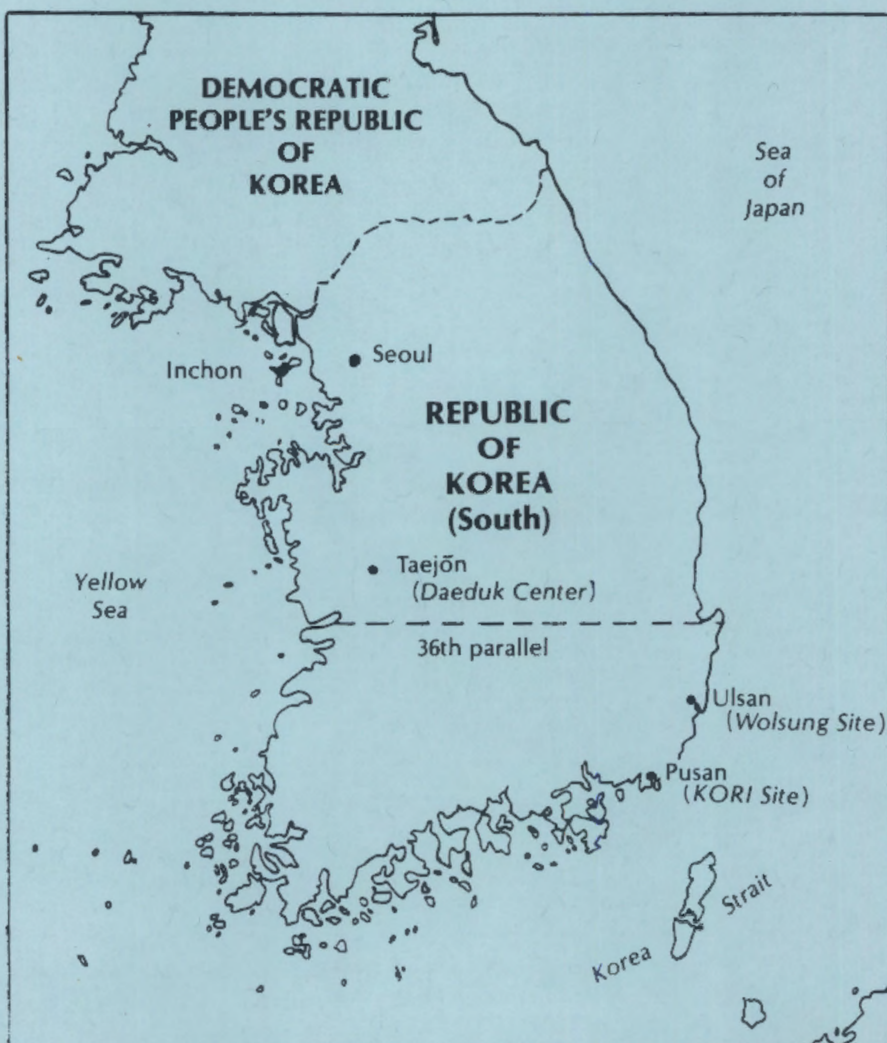
US DOE Representative — Billy D. Hill

KOREA
(Republic of Korea)

SOUTH KOREAN HOLIDAYS

*Asterisks denote movable holidays

January 1-3	New Year's Days
March 1	Sam Il Chul (Independence Movement Day)
April 5	Arbor Day
May 1	Children's Day
*May	Buddha's Birthday
June 6	Memorial Day
July 17	Constitution Day
August 15	Liberation Day
September 12	Chusuk (Thanksgiving Day)
October 1	Armed Forces Day
October 3	National Foundation Day
October 9	Hangul Korean Alphabet Day
December 25	Christmas



KOREA (REPUBLIC OF KOREA)

ENERGY

Population	1983	40 million
Energy Demand	1980	44.1 Mtoe (73.6% imported)
	1985	58.1 Mtoe (78.2% imported)
Oil Demand	1980	26.6 Mtoe (100% imported)
Electric Power Plant Capacity	1983	13.1 GWe-- 14.6% nuclear 54.8% oil 1.1% hydro
	1990	51% nuclear
Electric Power Production	1981	35.4 TWh-- 7.7% nuclear 1.5% hydro
	1986	57.1 TWh-- 46% nuclear

NUCLEAR POWER

National Policy. Continue expansion in electric power capacity; reduce dependence on foreign oil by strong nuclear program; develop indigenous manufacturing capacity; develop FBR capability.

Nuclear Power Plant Capacity	1983	1.8 GWe
	1985	2.7 GWe
	1990	7.4 GWe
	2000	11.2 GWe
Reactor Mix	1982	PWR: 1 (1978); 7 (1983-89) HWR: 1 (1983)
Reactor Development		National plan calls for FBR development

INDUSTRIAL FUEL CYCLE

Policy. Develop long-term contracts for fuel supplies; holdings of foreign uranium resources; fabrication capability for PWP and CANDU fuels; "wait and see"--reprocessing and recycle of Pu to FBR, CANDU and LWRs.

Waste Management Strategy. Not yet defined.

Cumulative Spent Fuel Arisings	1980	17 tU
	1985	360 tU
	1990	1,450 tU
	2000	4,400 tU

Industrial-Scale Activities

1. Uranium milling--3 t ore/day pilot plant, under construction.

2. Uranium conversion, yellowcake to UO_2--150 tU/a.

3. UO_2 fuel fabrication--200 tU/a. Startup, 1988.

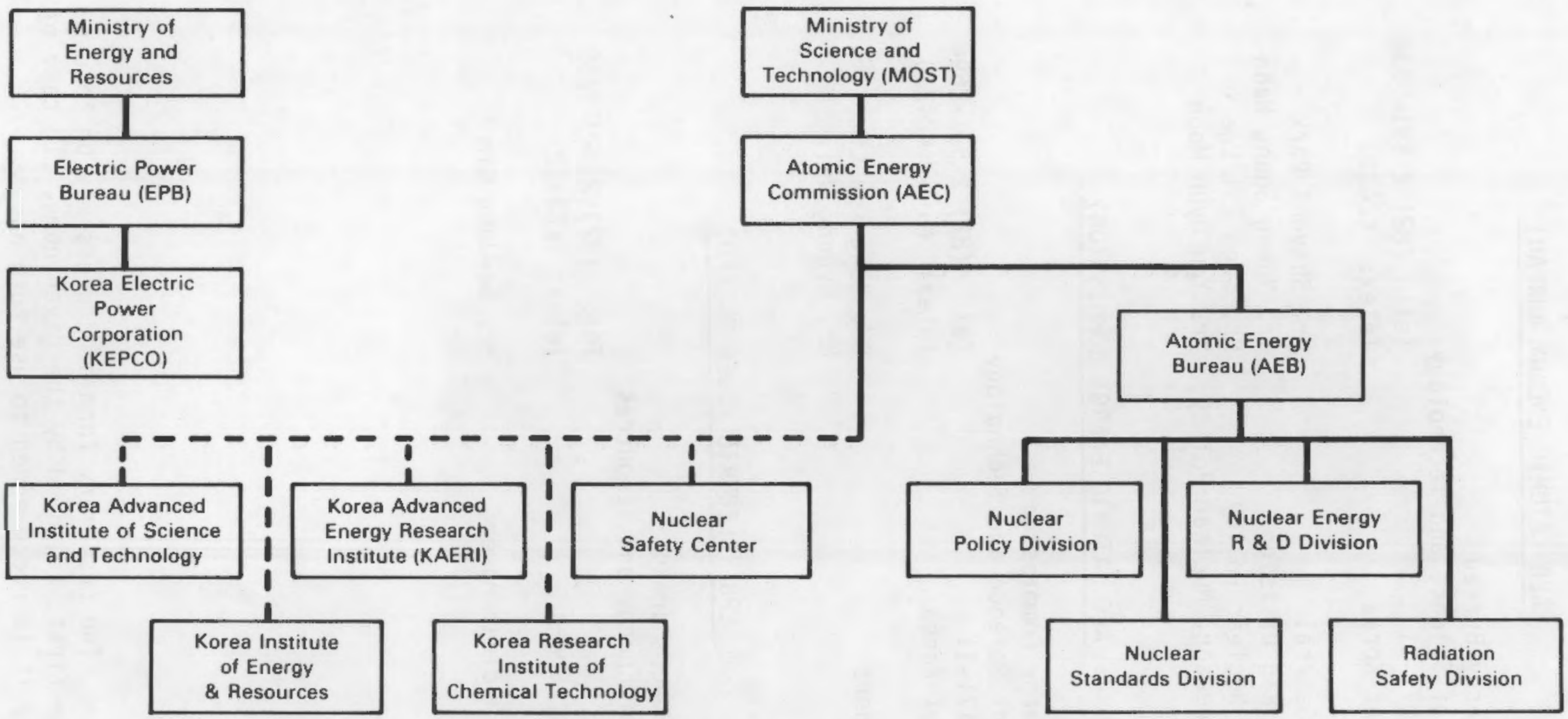


FIGURE KS-1. Partial Organization Chart for the Ministries of Science and Technology, and Energy and Resources

AEB (ATOMIC ENERGY BUREAU)

Atomic Energy Bureau
Ministry of Science and Technology
GWACHEON 171-11 — Tel: (82) 2 591-9038
Republic of Korea — Telex: K24230

Director-General	Mr. Shiyohl Park
Director, R&D Division	Mr. Young Soung Hahn
Director, Nuclear Policy	Mr. Sang Tai Lee
Ass. Director, Nuclear Policy	Mr. You Hyun Moon

AEC (ATOMIC ENERGY COMMISSION)

Atomic Energy Commission
Ministry of Science and Technology
GWACHEON 171-11 — Tel: (82) 2 591-7694
Republic of Korea — Telex: MIOST K24230

Commissioners	Dr. Yong-Kyu Lim
	Mr. Byoung Whie Lee

EPB (ELECTRIC POWER BUREAU)

Electric Power Bureau
Ministry of Energy and Resources
Seoul — Tel: (82) 2 720-2369
Republic of Korea — Telex: K23472

Director, Nuclear Power	Mr. Se-Jong Kim

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

KAERI (KOREA ADVANCED ENERGY RESEARCH INSTITUTE)

Korea Advanced Energy Research Institute
Head Office and Seoul Research Center
P.O. Box 7, Cheong Ryang R1
Seoul 131
Republic of Korea

Tel: (82) 2 972-2081/9
Telex: KAERI K23241

President,	Mr. Jong Hee Cha
Vice President Nuclear Policy	Dr. Pilsoon Han
	Dr. Poong-Eil Juhn

Mission. Reactor engineering R&D; radiation applications; basic nuclear research.

KAERI: DAEDUK

Daeduk Engineering Center, KAERI
P.O. Box 7
Daeduk Danji
Choongnam
Republic of Korea

Tel: (82) 42 822-6811
Telex: KAERI K 5553

Director	Dr. Pilsoon Han (822-6821 Ext. 231)
Nuclear Fuel Cycle	Dr. Hyun-Soo Park
Nuclear Fuel Cycle Process Development	Dr. Hun-Hwee Park

Mission. R&D on nuclear fuel cycle technology

- Fuel fabrication
- Uranium ore processing and conversion
- Radioactive waste management
- Post-irradiation examination.

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

KOPEC (KOREA POWER ENGINEERING COMPANY)

Korea Power Engineering Co., Inc.
P.O. Box 109
YEOEUIDO
Seoul 150 — Tel: (82) 2 783-7606
Republic of Korea — Telex: KOPEN K22562

Vice President, Engineering — Mr. Kui Yong Park

KEPCO (KOREA ELECTRIC POWER CORPORATION)

Korea Electric Power Corporation
87, Samseong-Dong
Gangnam-Ku
Seoul, — Tel: (82) 2 562-9926
Republic of Korea — Telex: Kelecco K24287, K28350

Manager, Nuclear Fuel — Mr. Chang Kook Yang

KOREA NUCLEAR FUEL COMPANY

Korea Nuclear Fuel Company, Ltd.
P.O. Box 7
Daeduk Danji, Daejeon
Choongnam 300 — Tel: (82) 42 822-6820/9
Republic of Korea — Telex: K5553

President — Dr. Pilsoon Han

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

MEXICO

MEXICAN HOLIDAYS

*Asterisk denotes movable holidays

January 1	New Year's Day
January 6	Three Kings Day
February 5	Promulgation of Constitution
March 21	Birthday of Benito Juarez
*March/April	Maundy Thursday
*March/April	Good Friday
May 1	Labor Day
May 5	Victory of Gen. Zaragosa
September 16	Independence Day
October 12	Columbus Day
November 2	All Souls' Day
November 20	Anniv. of the Revolution
December 3	Immaculate Conception
December 12	Our Lady of Guadalupe's Day
December 25	Christmas

MEXICO

ENERGY

Population	1982	76 million
Energy Demand	1979	77 Mtoe
Electric Power Plant Capacity	1983	18 GWe
Electric Power Production	1978	53 TWh-- 69% oil & gas 30% hydro 1% geothermal
	1980	64.2 TWh

NUCLEAR POWER

National Policy. Future is cloudy; ambitious plans to use extensive uranium reserves in domestic nuclear power production have been thwarted by national economic problems, cost overruns with nuclear plant construction, etc.

Nuclear Power Plant Capacity	1986	0.7 GWe
	1990	1.3 GWe
	2000	1.3 GWe
Reactor Mix	1982	BWR: 2 (1984-85)

INDUSTRIAL FUEL CYCLE

Policy. Future is cloudy; plans for pilot reprocessing and waste management facilities have been dropped, but uranium mining/milling and fuel fabrication work continues.

Waste Management Strategy. Not announced.

Cumulative Spent Fuel Arisings (LWR)	1990	100 tU
	2000	500 tU

ORGANIZATION

All nuclear activities controlled by federal government through:

- National Atomic Energy Commission (CNEA)
- URAMEX--fuel cycle activities, including exploitation of uranium resources
- National Nuclear Research Institute (ININ)--R&D
- National Commission of Nuclear Security and Safeguards (CNSNS)--safety R&D and licensing of nuclear facilities.

CNSNS (NATIONAL COMMISSION OF NUCLEAR SECURITY AND SAFEGUARDS)

Comisión Nacional de Seguridad
Nuclear y Salvaguardias
Av. Insurgentes Sur No. 1806
Colonia Florida, Delegación Alvaró Obregón
01030 Mexico, D.F. (Mexico City) Tel: (52) 5 534 1401

ININ (NATIONAL NUCLEAR RESEARCH INSTITUTE)

Instituto Nacional de Investigaciones
Nucleares
Benjamin Franklin No. 161
Colonia Condesa Delagacion Cuauh'temóc
06140 Mexico, D.F. (Mexico City) Tel: (52) 5 271 0547

Director General	R. Bello
Manager, Radiological Safety	Jose Roberto Martinez Salinas

(ININ's Salazar Plant is located about 35 km from Mexico City. Mail should be addressed to the Mexico City headquarters.)

URAMEX

Uranio Mexicano
Insurgentes Sur No. 1079
Colonia Noche Buena Delegación Benito Juárez
03720 Mexico, D.F. (Mexico City) Tel: (52) 5 563 7752

Director General	Dr. Alberto Escofet
Director, Fuel Cycle	Dr. Carlos Graef Fernandez

NETHERLANDS

DUTCH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Good Friday
*March/April	Easter Monday
April 30	Queen's Birthday
*May	Ascension Day
*May	Whit Monday
December 25-26	Christmas

NETHERLANDS

ENERGY

Population	1980	14.1 million
Energy Demand	1980	65.5 Mtoe
Oil Demand	1979	40.1 Mtoe (>90% imported)
Electric Power Plant Capacity	1980	17 GWe
Electric Power Production	1980	64.8 TWh-- 6.5% nuclear 15.2% solid fuels 38.3% petroleum products 39.7% gas
	1982	53 TWh-- 6.8% nuclear

NUCLEAR POWER

National Policy. The government favors expansion of nuclear power capacity, but faces public opposition; the utilities want three more plants (1,000 MWe each). Polls in a lengthy series of lightly attended public meetings have shown a large number of those attending as being opposed to nuclear power.

Nuclear Power Plant Capacity	1982	0.5 GWe
	2000	0.5 GWe
Reactor Mix	1982	BWR: 1 (1969) PWR: 1 (1973)
Reactor Development		Participation in FRG Kalkar SNR-300 FBR project

INDUSTRIAL FUEL CYCLE

Policy. Use foreign services (fuel fabrication, reprocessing).

Waste Management Strategy. LLW--resume ocean dumping, if political climate improves; HLW--develop interim storage capability and evaluate geologic disposal on land, in a salt dome under the North Sea, or under the seabed.

Cumulative Spent Fuel Arisings (LWR)	1980	103 tU
	1985	190 tU
	1990	270 tU
	2000	420 tU

INTERNATIONAL RELATIONSHIPS

1. Member state of European Communities, OECD/NEA, IAEA.

2. Partnership with FRG and Belgium in SNR-300 FBR.

3. Partnership with FRG and UK in Urenco (uranium enrichment consortium).

ORGANIZATION

1. Overall control of nuclear matters is exercised by the Ministries of Economic Affairs, Public Health and Environmental Control, and Social Affairs; Parliament approves decisions of the ministries.

2. Waste management R&D is integrated under a program called ILONA, directed by a policy committee which includes representatives from the ministries and the Netherlands energy research center at Petten (ECN), ILONA is partly financed by the CEC Indirect Action Program. Supporting R&D studies are conducted at:

   - ECN (in situ experiments at the Asse Mine in Germany--borehole convergence at elevated temperatures)

- Delft University, Department of Mining (stress cracking in gallery walls, repository design, borehole closure, safety assessment)
- Utrecht University, Department of Earth Sciences (salt rheology under repository conditions).

ECN (NETHERLANDS ENERGY RESEARCH FOUNDATION)

Stichting Energieonderzoek Centrum Nederland
Scheveningse Weg 112
P.O. Box 80404
2508 GK The Hague — Tel: (31) 70 51 4581
The Netherlands — Telex: 31459

Chairman, Governing Board	G. W. zen Stein Callensels
Chairman, ECN Scientific Advisory Center	Prof. J. van Loef
Chairman, Program Committee of the Energy Study Center	Prof. P. de Wolff

Mission. Organize and sponsor energy research and development.

Sponsor. Federal government.

ECN: PETTEN

Research Centre
ECN Netherlands Energy Research Foundation
P.O. Box 1
1755 ZG Petten — Tel: (31) 2246 6262
The Netherlands — Telex: 57211 Reacp NL

ECN: PETTEN (contd)

Managing Director of Research	Prof. J. A. Goedkoop
Nuclear Waste	Dr. B. Verkerk
Technical Services	Mr. J. Hamstra
Geological Disposal in Salt	Mr. L. H. Vons
Radionuclide Migration Studies	Dr. A. van Dalen
Radioactive Waste Treatment	L. Smeets

Mission. Scientific and technical center for ECN, applied energy research, treat and dispose of all Dutch radioactive waste.

Sponsor. ECN.

Waste Management R&D. Geologic waste isolation--salt dome repositories (conceptual design, thermal studies, and radionuclide migration), seabed disposal, sea disposal of ^{85}Kr, decontamination of large components.

GEOLOGICAL SURVEY OF THE NETHERLANDS

Geological Survey of the Netherlands
Nieuwe Gracht 13
Postbus 157
2000 AD Haarlem — Tel: (31) 23 319362
The Netherlands — Telex: 71105 geold

Dr. H. M. van Montfrans

KEMA (RESEARCH AND TESTING ELECTROCHEMICAL MATERIALS COMPANY)

N.V. Tot Keuring van Elektrotechnische Materialen Arnhem
Utrechtseweg 310
P.O. Box 9035
6800 ET Arnhem — Tel: (31) 85 457057
The Netherlands — Telex: 45016 Kema nl

KEMA (RESEARCH AND TESTING ELECTROCHEMICAL MATERIALS COMPANY) (contd)

Deputy Director, Research	Dr. M. E. A. Hermans
Research Technology	Dr. J. Kuypers
Nuclear Waste Research	Dr. H. Boekschoten
Acid Digestion and Incineration	Dr. J. Matteman

Mission. Development and engineering for the Dutch utilities.

R&D. Volume reduction and storage of reactor station wastes.

Facilities

Acid Digestion Pilot Plant

Mission. Explore process parameters and establish equipment operability.

MINISTRY OF HOUSING, PHYSICAL PLANNING AND ENVIRONMENT

Ministry of Housing, Physical Planning
and Environment
P.O. Box 5811
Koopmansstraat 1
2280 HV Rijswijk
The Netherlands

Tel: (31) 70 949505
Telex: 32691

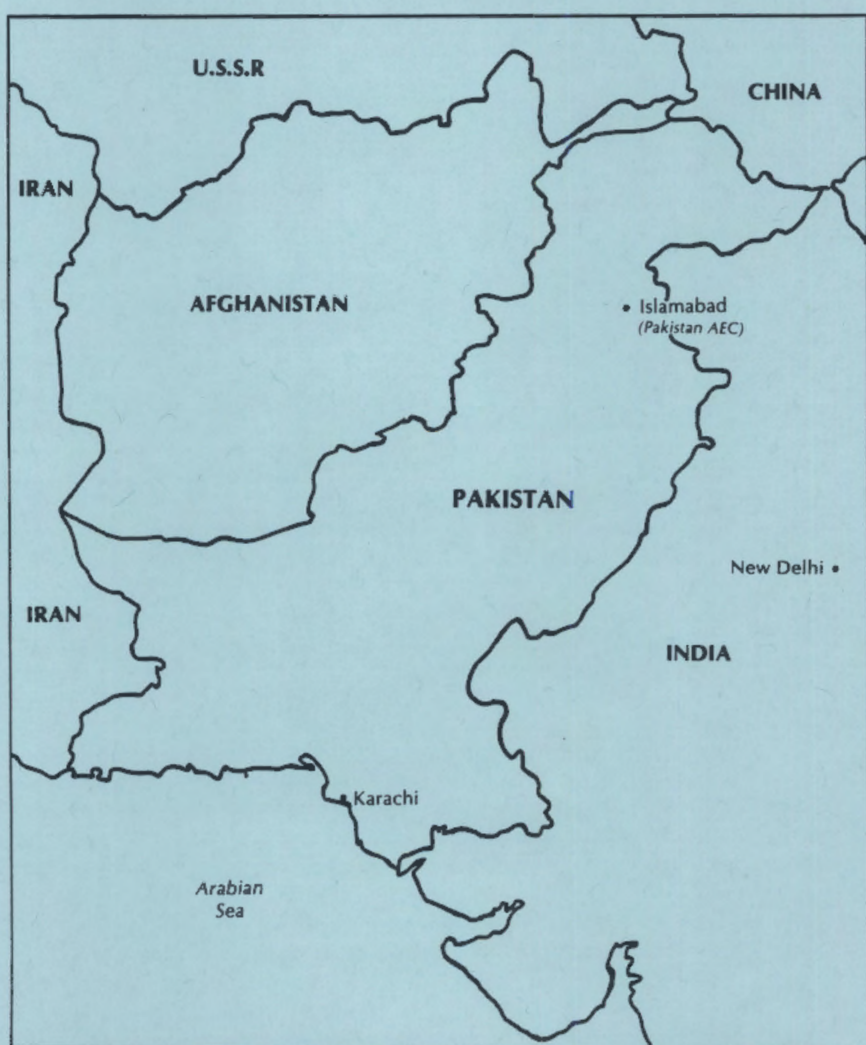
Deputy Chief	Dr. J. Ch. Cornelis
Director, Radiation Protection	Dr. J. L. Baas

PAKISTAN

PAKISTANI HOLIDAYS

*Asterisks denote movable holidays

*January	Mavlid An-Nabi (Birth of the Prophet)
March 23	Pakistan Day
*March/April	Good Friday
*March/April	Easter Monday
May 1	May Day
*August	Id ul Sitr (End of Ramadan)
August 14	Independence Day
September 6	Defense of Pakistan
September 11	Death of Quaid-i-Azam
*October	Id ul Azba (Feast of the Sacrifice
*November	Muhurran (Ashura)
December 25	Birthday of Quaid-i-Azam; Christmas



PAKISTAN

ENERGY

Population	1980	81.5 million
Energy Demand	1980	12.4 Mtoe
	1981-82	0.3% nuclear
		42.6% gas
		35.0% oil
		17.2% hydro
		4.9% coal
Oil Demand	1980	90% imported
Electric Power Plant Capacity	1981-82	4 GWe
Electric Power Production	1981-82	12.6 TWh-- 56% hydro

NUCLEAR POWER

National Policy. Provide up to 50% of electrical power supply with nuclear.

Nuclear Power Plant Capacity (LWR and HWR)	1982	0.1 GWe
	1995	1.1 GWe
Reactor Mix	1982	HWR (CANDU): 1 (1972)
		PWR: 1 (1993)

INDUSTRIAL FUEL CYCLE

Policy. Develop complete domestic fuel cycle: uranium mining and milling; enrichment; fuel fabrication; reprocessing.

Cumulative Spent Fuel Arisings	1980	49 tU
	1985	110 tU
	1990	170 tU
	2000	440 tU

ORGANIZATION

1. Pakistan Atomic Energy Commission--control of nuclear matters.

2. Pakistan Institute of Science and Technology (Rawalpindi)--fuel cycle R&D, including lab-scale reprocessing facility.

PAKISTAN ATOMIC ENERGY COMMISSION

Pakistan Atomic Energy Commission
P.O. Box 1114
Islamabad, Pakistan

Chairman	Dr. Munir Ahmad Khan

SOUTH AFRICA
(Republic of)

SOUTH AFRICAN HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*April	Founder's Day
*March/April	Good Friday
*March/April	Family Day
*May	Ascension Day
May 31	Republic Day
October 10	Kruger Day
*December	Covenant Day
December 25-26	Christmas

SOUTH AFRICA

ENERGY

Population	1980	28 million
Energy Demand	1980	85.7 Mtoe
Oil Demand		100% imported
Electric Power Plant Capacity	1982	20 GWe
	2000	70 GWe-- 5% nuclear
Electric Power Production	1980	95.8 TWh

NUCLEAR POWER

National Policy. Expand electric power production capacity chiefly through coal-burning plants, but develop small nuclear capability.

Nuclear Power Plant Capacity	1984	0.9 GWe
	1990	1.8 GWe
	2000	2.8 GWe
Reactor Mix	1982	PWR: 2 (1984-85)

INDUSTRIAL FUEL CYCLE

Policy. Produce and export uranium (7,000-8,000 tU/a); develop enrichment capability (200-300 tSWU/a). No current plans for fuel fabrication or reprocessing.

Waste Management Strategy. Store reactor wastes at the reactor until a disposal site is operational (1994); build a repository for HLW or spent fuel in an area 800-900 miles west of Pretoria, south of the Kalahari Desert.

Cumulative Spent Fuel Arisings (LWR)	1985	40 tU
	1990	310 tU
	2000	1,200 tU

ORGANIZATION

The Atomic Energy Corporation of South Africa (government-owned) controls nuclear matters through:

- Atomic Energy Board--regulating and licensing
- Nuclear Development Corporation of South Africa (NUCOR)--R&D, including waste disposal and repository work
- Uranium Enrichment Corporation of South Africa (UKOR).

ATOMIC ENERGY CORPORATION

Atomic Energy Corporation of South Africa Ltd.
South African Atomic Energy Board
Private Bag X256
Pretoria 0001
South Africa

Tel: (27) 12 21-3311
Telex: 3-0253 SA

Chairman — J. W. de Villiers

ESCOM (ELECTRICITY SUPPLY COMMISSION)

Electricity Commission of South Africa
P.O. Box 1091
Johannesburg 2000
South Africa

Tel: (27) 11 800-8111
Telex: 4-24 481 SA

Chairman — Jan H. Smith
Senior General Manager — I. D. van der Walt

NUCOR (NUCLEAR DEVELOPMENT CORPORATION)

Nuclear Development Corporation
of South Africa (Pty), Ltd.
Private Bag X256
Pretoria 0001
South Africa

Tel: (27) 12 21-3311
Telex: 3-0253 SA

Managing Director	Dr. J. P. Hugo
Geology	P. D. Toens
Chemical Operations	H. J. Van der Westhuizen

UKOR/UCOR (URANIUM ENRICHMENT CORPORATION)

Uranium Enrichment Corporation
of South Africa (Pty), Ltd.
P.O. Box 4587
Pretoria 0001
South Africa

Tel: (27) 12 296-9111
Telex: 30805 SA

Managing Director	W. L. Grant

SPAIN

SPANISH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 6	Epiphany
*March/April	Maundy Thursday
*March/April	Good Friday
May 1	Labor Day
*June	Corpus Christi Day
July 25	St. James Day
August 15	Assumption Day
October 12	Columbus Day
November 1	All Saints' Day
December 8	Immaculate Conception
December 25	Christmas

SPAIN

ENERGY

Population	1982	38.3 million
Energy Demand	1982	64.3 Mtoe
	1990	106.5 Mtoe
Oil Demand	1982	48.2 Mtoe (96% imported)
	1990	48.1 Mtoe (94.7% imported)
Electric Power Plant Capacity	1982	33.5 GWe
	1990	44.2 GWe
Electric Power Production	1982	114.1 TWh-- 7.68% nuclear 28.66% oil & gas 39.65% solid fuels 24.01% hydro/ geothermal

NUCLEAR POWER

Nuclear Power Plant Capacity	1983	2.0 GWe
	1985	5.5 GWe
	1990	7.5 GWe
	2000	10.2 GWe
Reactor Mix	1982	GCR: 1 (1972)
		PWR: 2 (1969,1981)
		8 (1983-90)
		BWR: 1 (1971)
		3 (1984-88)

Reactor Development: breeder and fusion R&D

INDUSTRIAL FUEL CYCLE

Policy. No domestic reprocessing and no further contracts for foreign reprocessing.

Waste Management Strategy. Store spent fuels at the reactor sites for 10 years, then transfer to AFR engineered (dry) storage facility until geologic repository is ready to receive "high-level wastes" (spent fuels); locate AFR and fuel encapsulation facility at repository site (salt dome or granite formation). Shallow-land burial of LLW in trenches. Institutional radioactive wastes are currently placed in a worked-out uranium mine.

Cumulative Spent Fuel Arisings (LWR)	1980	176 tU
	1985	490 tU
	1990	1,300 tU
	2000	3,400 tU

Industrial-Scale Activities

1. Uranium mining and milling: 200 tU/a.

2. Uranium enrichment: 11.1% interest in Eurodif.

3. Fuel fabrication: 200 tU/a.

4. AFR spent fuel storage: 1500 tU.

CSN (COUNCIL OF NUCLEAR SAFETY)

Consejo de Seguridad Nuclear
Paseo de la Castellana 135
Madrid 16, Spain

Tel: (34) 1 450 5062
Telex: 49051 CSNM E

President	Francisco Pascual
Counselor	Prof. L. Guitiérrez Jodra

Mission. Assess the safety of nuclear technology and environmental protection; perform plant inspections and issue licenses.

ENUSA (NATIONAL FUEL CYCLE COMPANY)

Empresa Nacional del Uranio S.A.
Santiago Rusiñol 12 — Tel: (34) 1 233-6207
Madrid 3, Spain — Telex: 43402 URAN E

Director General	Manuel Isla

Mission. Supply fuel cycle services except waste management and disposal (uranium mining and milling; nuclear fuel) to all Spanish nuclear power plants.

JEN (NUCLEAR ENERGY COMMISSION)

Junta de Energía Nuclear
Avenida Complutense 22
Ciudad Universitaria — Tel: (34) 1 224-1200
Madrid 3, Spain — Telex: 23555 JUVIG E

President	Martín Gallego
General Director	Gonzalo Madrid
Director, Radioactive Waste	Baldomero López-Pérez
Waste Treatment	V. González
Spent Fuel Storage	A. Uriarte
Waste Storage	A. Martínez Martínez

Mission. R&D: nuclear fuel cycle, nuclear reactor technology, waste treatment, and terminal storage.

JUAN VIGON NATIONAL NUCLEAR ENERGY CENTER

Centro Nacional de Energía
Nuclear Juan Vigon
Avenida Complutense 22
Madrid 3, Spain

MINISTRY OF INDUSTRY AND ENERGY

Minister	Carlos Solchaga
Director General of Energy	María del Carmen Mestre

SWEDEN

SWEDISH HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
January 6	Epiphany
*March/April	Good Friday
*March/April	Easter Monday
May 1	Labor Day
*May/June	Ascension Day
*May/June	Whit Monday
*June	Midsummer Eve Day
*November	All Saints' Day
December 25-26	Christmas

SWEDEN

ENERGY

Population	1980	8.3 million
Energy Demand	1980	47.7 Mtoe (54% imported)
Oil Demand	1980	16 Mtoe (100% imported)
Electric Power Plant Capacity	1980	29 GWe
Electric Power Production	1980	96.3 TWh-- 27.7% nuclear 60.5% hydro/geo. 11.0% oil 0.8% solid fuels
	1982	96.5 TWh-- 38.7% nuclear

NUCLEAR POWER

National Policy. Complete a total of 12 power stations by 1985-86, to provide 45% of Sweden's electricity; phase out all nuclear plants at the end of a 25-30 year operating life.

Nuclear Power Plant Capacity	1983	7.3 GWe
	1985	8.4 GWe
	1990	9.4 GWe
Reactor Mix	1982	BWR: 7 (1972-1981) 2 (1985) PWR: 2 (1975,1981) 1 (1983)

INDUSTRIAL FUEL CYCLE

Policy. Honor present commitments (870 tU) to foreign reprocessors, but put the rest of the spent fuel (~6000 t) into a repository. No Pu recycle is planned. Waste management costs are paid from fees collected from the nuclear utilities.

Waste Management Strategy. Store vitrified HLW (returned from reprocessors) and spent fuel for 30-40 years in an underground storage facility; encapsulate HLW glass in lead/titanium overpack, spent fuel in a copper canister; emplace in a deep geologic (crystalline rock) repository. New facilities: 3000 t AFR; interim storage plants for conditioned reprocessing wastes; HLW and spent fuel encapsulation plants; repositories for reactor wastes, HLW glass, spent fuel, and other long-lived wastes.

Cumulative Spent Fuel Arisings (LWR)	1980	465 tU
	1985	1,330 tU
	1990	2,360 tU
	2000	5,000 tU

Cumulative Waste Arisings	2020	Spent fuel	4,500 canisters
		HLW glass	730 canisters
		TRU wastes	4,000 m^3
		Reactor core components	5,000 m^3
		Reactor waste	122,000 m^3
		Decommissioning wastes	151,000 m^3

Industrial-Scale Activities

LWR fuel fabrication: 400 tU/a.

Major Milestones

- CLAB AFR facility for spent fuels 1985
- Repository for reactor wastes, SFR 1988
- HLW repository site selection 2000
- HLW repository operational 2020-2025
- Interim HLW dry storage facility 1990
- Encapsulated spent fuel repository 2026-2050

INTERNATIONAL RELATIONSHIPS

1. Membership in IAEA and OECD/NEA.
2. Waste management cooperative agreement with US.
3. Host country for Stripa project.

ORGANIZATION

1. Waste Management

- National Board for Spent Fuel (NAK)--administers waste management fund collected from the nuclear utilities; oversees back-end-of-the-fuel-cycle activities

- Swedish Nuclear Fuel Supply Company (SKBF)--execute spent fuel and waste management program for the utilities; manage waste disposal R&D programs.

2. Licensing Responsibilities

- Swedish Nuclear Power Inspectorate, SKI (erection and operation of nuclear facilities)

- Swedish National Institute of Radiation Protection

- National Swedish Franchise Board for Environment Protection

- Municipality where the facility is to be located (right of veto).

ASEA-ATOM

ASEA-Atom AB (Headquarters)
P.O. Box 53
S-721 83 Västerås
Sweden

Tel: (46) 21 1000 00
Telex: 40720

ASEA AB
High Pressure Laboratory
S-910 40 Robertsfors
Sweden

President	Lars Halle
High Pressure Laboratory	H. T. Larker
Waste Treatment	Tore Waltersten

ASEA-ATOM (contd)

Mission. Develop, design, and manufacture nuclear power plants and nuclear fuel components.

Sponsor. ASEA.

Waste Management R&D. Application of hot isostatic pressing in spent fuel and waste treatment operations; AFR spent fuel storage facility design.

CHALMERS UNIVERSITY OF TECHNOLOGY

Chalmers Tekniska Högskola
Fack
S-402 20 Göteborg 5
Sweden

Nuclear Chemistry — Prof. Jan Rydberg, Dr. Bert Allard

R&D. Radionuclide transport by groundwater, sorption on natural clays and rock minerals.

KEMAKTA KONSULT AB

Luntmahangatan 94
S-113 51 Stockholm
Sweden

Tel: (46) 8 150380

Bertil Grundfelt

Computer calculations on hydrology and nuclide migration.

KTM (ROYAL INSTITUTE OF TECHNOLOGY)

KTM
S-100 44 Stockholm
Sweden

Department of Chemical Engineering	Prof. Ivars Neretnicks

Near- and far-field migration modeling, rock-matrix diffusion experiments.

NAK (NATIONAL BOARD FOR SPENT NUCLEAR FUEL)

Naenmden foer Hantering av Atvaent Kaernbraensle
Kungsgatan 38
S-111 56 Stockholm
Sweden

Chairman	Sven Romanus
Director	Gerhard Rundquist
Chief Engineer	Nils Rydell

Mission. Serve as the government's control agency to oversee back-end fuel cycle technology, financing and information.

Sponsor. Federal Government.

NATIONAL INSTITUTE OF RADIATION PROTECTION

National Institute of Radiation Protection
Fack
Box 60204
S-104 01 Stockholm 60 — Tel: (46) 8 2440 80
Sweden — Telex: 11771 SAFE RAD

Director	Gunnar Bengtsson
Department Director	Dr. J. O. Snihs
Rad Waste Group	Ragnar Boge

NUCLEAR SAFETY BOARD

Radet for Kärnkräftsäkerhet
Nuclear Safety Board of the Swedish Utilities
Box 5864
S-102 48 Stockholm
Sweden

Tel: (46) 8 6795 40
Telex: 13108

Director	Thomas Eckered

Mission. Promote coordination and cooperation among the Swedish utilities in their nuclear power plant safety work.

Sponsors. The four Swedish nuclear power station owners.

SGU (GEOLOGICAL SURVEY OF SWEDEN)

Sveriges Geologiska Undersökning (SGU)
Vretgränd 18, Box 670
S-751 28 Uppsala
Sweden

Tel: (46) 18 1552 80
Telex: 76154 GEOSWED S

Director-General	Gunnar Ekevärn
Hydrogeology	Leif Carlsson
Geologic Waste Disposal	Otto Brotzen

R&D. Evaluation of rock formations for use as waste disposal sites (permeability; groundwater behavior, age and chemistry).

STUDSVIK

Studsvik Energiteknik AB
S-611 82 Nyköping
Sweden

Tel: (46) 155 800 00
Telex: 64013 studs s

Deputy Managing Director Nuclear Technology	Stig Bergström
Waste Management Department	Lennart Devell
Waste Management Section	Åke Hultgren

STUDSVIK (contd)

Mission. Nuclear energy R&D to support Swedish power programs, contract research.

Sponsor. Federal government.

Fuel Cycle R&D Programs. Waste isolation (field tracer migration tests in granite), HLW waste form characterization, LLW and ILW treatment, D&D techniques, leaching of UO_2 from spent fuel, biosphere migration, dose-calculations.

SWEDISH METEOROLOGICAL AND HYDROLOGICAL INSTITUTE

Swedish Meteorological and Hydrological Institute
Folkborgsvägen 1
S-602 36 Norrköping
Sweden

Tel: (46) 11 1080 00

SKBF (SWEDISH NUCLEAR FUEL SUPPLY COMPANY)

Svensk Kärnbränsleförsörjning AB
Box 5864
S-102 48 Stockholm
Sweden

Tel: (46) 8 6795 40
Telex: 13108 SKBFS

President	Sten Bjurström
Project Manager, CLAB Project	Bo Gustafssten
Manager, KBS Project	Lars Bertil Nilsson
Chemistry	Fred Karlsson
Geology and Hydrology	Hans Carlsson/ Harald Åhagen
Material Sciences	Lars Werme
Waste Forms	Hans Forsström
Engineered Barriers	Anders Bergström
Safety Analysis	Tönis Papp
Stripa Test Station	Hans Carlsson/ Harald Åhagen
Foreign Activities and Documentation	Claes Thegerström
Repository for Reactor Waste	Tommy Hedman

SKBF (SWEDISH NUCLEAR FUEL SUPPLY COMPANY) (contd)

Mission. Coordinate and arrange for nuclear fuel supply and reprocessing services for all Swedish nuclear power reactors; manage and fund R&D for the back end of the fuel cycle. Demonstrate that spent nuclear fuel and fuel reprocessing wastes can be disposed of safely and permanently.

Sponsors. State Power Board (50%) and utilities (Sydkraft, 25% and Oskarshamn, 25%).

Facilities

1. CLAB (Central Storage for Spent Fuel, to be located at Simpevarp)

   Mission. AFR storage facility.
   Design Capacity. Initially, 3000 t.
   Milestones. Start of construction, May 1, 1980; start of operation (1500 t), January 1985; 1500 additional, June 1985.

2. Stripa Mine

   Stripa Mine Service AB
   S-717 00 Storå
   Sweden — Tel: (46) 581 4142 0

   Stripa Project Manager — Hans Carlsson (SKBF/KBS)
   Mine Operations (Stallbergsbolagen) — Per-Axel Halen

   Location. Near Kopparberg, 15 km north of Lindesborg and about 250 km west of Stockholm.
   Mission. Evaluate the use of granite formations as nuclear waste repositories, develop repository technology.
   Description. Granite body, about 350-400 m below surface, adjacent to the Stripa iron mine.
   Sponsor. Project Sponsor: SKBF/KBS; Site Owner: Stallbergsbolagen.

SKI (SWEDISH NUCLEAR POWER INSPECTORATE)

Statens Kärnkraftinspektion	
Box 27106	
S-102 52 Stockholm	Tel: (46) 8 6355 60
Sweden	Telex: 11961 Sweatom S
Director	Lars Nordstrom
Waste Management	Alf Larsson

SWEDISH STATE POWER BOARD

Statens Vattensfallswerk	
S-162 87 Vällingby	Tel: (46) 8 739 5000
Sweden	Telex: 19653 Svtelvxs S
Thermal Engineering Development	Per-Erik Åke Ahlstrom
Low- and Medium-Level Wastes	Stig Pettarsson

Mission. Own and operate the power distribution grid in Sweden, produce power.

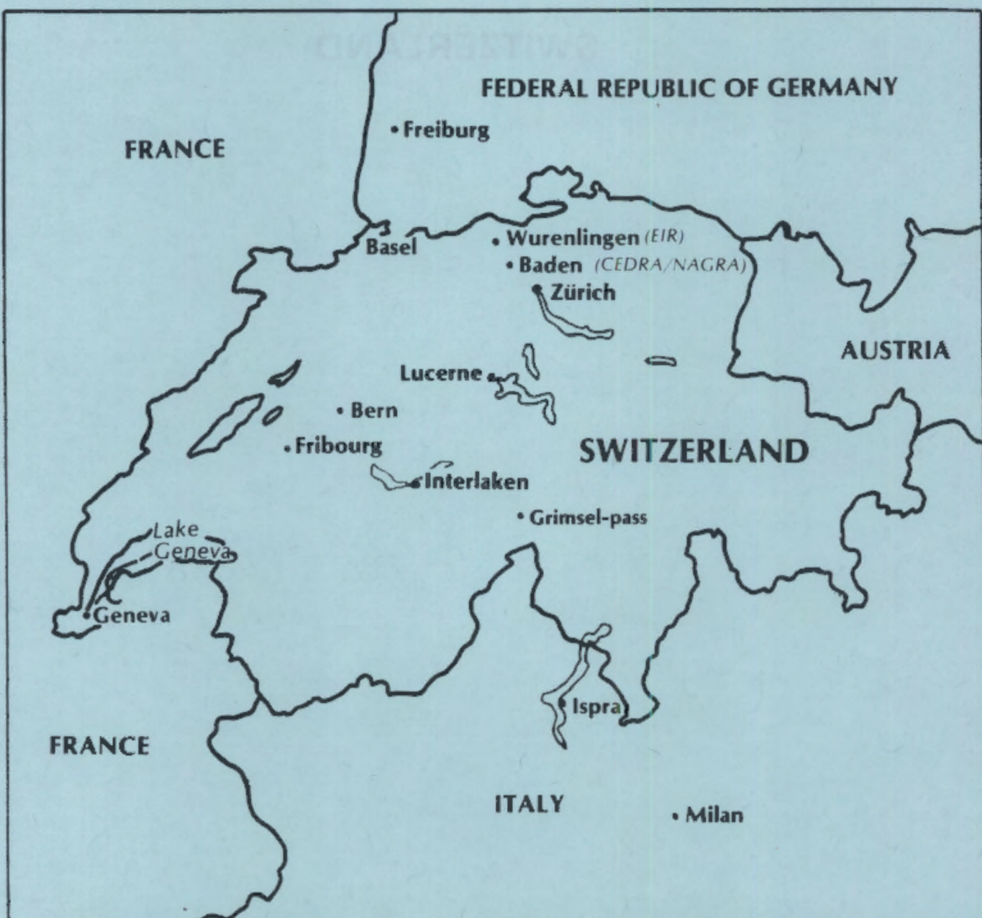
Sponsor. Swedish State (Ministry of Industry).

SWITZERLAND

SWISS HOLIDAYS

*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Good Friday
*March/April	Easter Monday
*May/June	Ascension Day
*May/June	Whit Monday
August 1	Day of Independence
December 25	Christmas
December 26	St. Stephen's Day



SWITZERLAND

ENERGY

Population	1982	6.4 million
Energy Demand	1980	25.4 Mtoe (57% imported)
Oil Demand	1980	13.1 Mtoe (100% imported)
Electric Power Plant Capacity	1980	15 GWe
Electric Power Production	1982	50.7 TWh-- 29% nuclear 69% hydro/geo.

NUCLEAR POWER

National Policy. Government is pro-nuclear, but has encountered much public opposition. Policy now requires that by the end of 1985 the nuclear utilities establish a project guaranteeing safe waste management or lose their operating licenses.

Nuclear Power Plant Capacity	1983	1.9 GWe
	1985	2.9 GWe
	2000	3.4 GWe
Reactor Mix	1982	BWR: 1 (1972)
		2 (1984,1993)
		PWR: 3 (1969-79)
Reactor Development		FBR R&D: reactor core thermohydraulics; physics; fuels

INDUSTRIAL FUEL CYCLE

Policy. Foreign reprocessing of spent fuels and Pu recycle to either LWRs or FBRs.

Waste Management Strategy. Develop two waste repositories, one near the surface for LLW and a deep repository (crystalline rock) for HLW glass. Switzerland practiced sea-dumping of LLW until 1983.

Cumulative Spent Fuel Arisings (LWR)	1980	380 tU
	1985	650 tU
	1990	1,090 tU
	2000	2,000 tU

Cumulative Waste Arisings: After 40 years' operation of their proposed nuclear power system:

LLW	100,000 m^3
LLW/ILW	70,000 m^3
HLW glass	1,000 m^3
	or
Spent fuel	15,000 m^3

Major Milestones

- Field laboratory in a granite formation — 1983
- Feasibility of safe and final disposal demonstrated — 1984
- Initial receipt of HLW glass from COGEMA (France) — 1992
- Intermediate-depth storage facility for ultimate repository for reactor wastes — 1995
- Geologic repository for HLW or spent fuels — After 2020

ORGANIZATION

1. NAGRA--company formed by the utilities and the government to handle their fuel cycle and waste management activities. Budget for 1980-1985 is about US $90 million

2. Federal Institute for Reactor Research--nuclear R&D

3. Federal Energy Office--sets criteria for waste management practices, including geologic disposal.

EIR (SWISS FEDERAL INSTITUTE FOR REACTOR RESEARCH)

Eidgenössisches Institut für
Reaktorforschung (EIR)
CH-5303 Würenlingen
Switzerland

Tel: (41) 56 99 2111
Telex: 53714 eir ch

Director	Prof.-Dr. H. Gränicher
Deputy Director	M. Breu
Staff Assistant, Research	Dr. U. Flückiger
Materials Technology	D. H. P. Alder
Hot Laboratory	Dr. W. Hausmann
Metallurgy	G. Ullrich
Chemistry	Dr. P. Baertschi
Fuel Division (Waste Disposal Concept, 1985)	H. Flury
Radioactive Waste Project	Dr. G. Bart
Fuel Program	R. W. Stratton

Mission. Nuclear research and development, including fuel cycle and waste management R&D to support national programs.

Sponsor. Federal government--Department of Interior.

Waste Management R&D. Incineration of TRU wastes, modeling of radionuclide migration through heterogeneous media, chemical behavior of radionuclides during migration, hydrological studies, sorption constants on different rocks, immobilization of LLW and ILW in cements, leaching rates on LLW and ILW waste forms, and long-term corrosion tests on waste package materials.

Facilities

ADA (Acid Digestion Plant for TRU Wastes)

Mission. Treat Pu-contaminated solids.
Design Basis. Carbonization/digestion in H_2SO_4/HNO_3 at 250°C; capacity, 1 kg/hr solid wastes.
Milestones. Non-Pu runs, late 1981; Pu runs, 1982.

FEDERAL OFFICE OF ENERGY

Federal Office of Energy
Nuclear Safety Department
CH-5303 Würenlingen — Tel: (41) 56 98 2853
Switzerland — Telex: 59058

Waste Management — Dr. U. Niederer

Mission. License nuclear installations.

FEDERAL OFFICE OF PUBLIC HEALTH

Office Fédéral de la Santé Publique
Bollwerk 27
CH-3001 Berne — Tel: (41) 31 61 9620
Switzerland — Telex: 33880

Manager, Radioprotection Section — Dr. H.-R. Stadelmann

NAGRA/CEDRA (NATIONAL COOPERATIVE FOR THE STORAGE OF RADIOACTIVE WASTE)

Nationale Genossenschaft für die Lagerung
radioaktiver Abfälle (NAGRA)
or
Société Coopérative Nationale pour l'Entreposage de
Déchets Radioactifs (CEDRA)
Parkstrasse 23
CH-5401 Baden — Tel: (41) 56 20 5511
Switzerland — Telex: 57333

President	Dr. Rudolph Rometsch
Managing Director	Hans Issler
Geology	Dr. Marc F. Thury
Nuclear Technology	Dr. Charles McCombie

Mission. Provide for the safe disposal of radioactive wastes produced by the Swiss nuclear industry.

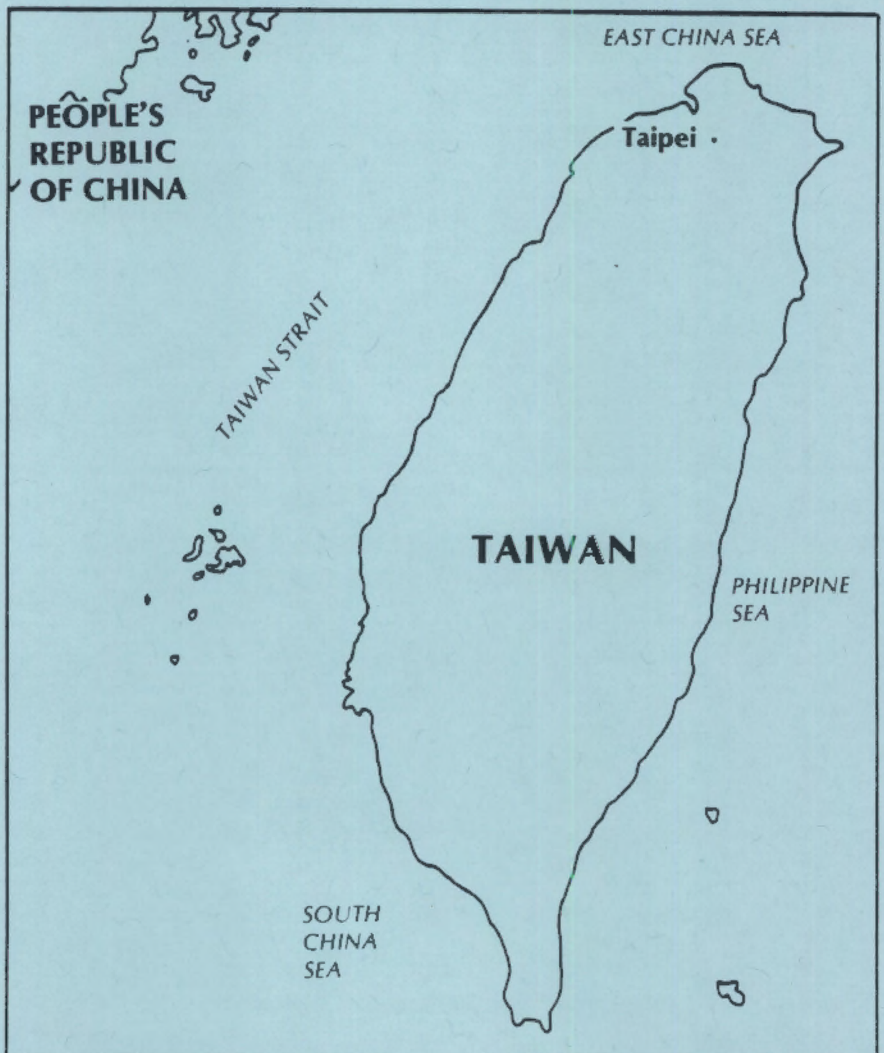
Sponsors. Swiss utilities and government.

TAIWAN REPUBLIC OF CHINA

TAIWANESE HOLIDAYS

*Asterisks denote movable holidays

January 1-2	Founding Day
*January	Lunar New Year
March 29	Youth Day
*April	Tomb Sweeping Day
*June	Dragon Boat Festival
September 28	Teachers' Day
*October	Moon Festival
October 10	National Day
October 25	Taiwan Retrocession Day
October 31	President Chiang Kai-Shek's Birthday
November 12	Dr. Sun Yat-Sen's Birthday
December 25	Constitution Day



TAIWAN

ENERGY

Population	1982	18 million
Energy Demand	1980	79% imported
Oil Demand	1980	100% imported
Electric Power Plant Capacity	1981	10.16 GWe-- 21.4% nuclear
	1991	18.17 GWe-- 29.9% nuclear
Electric Power Production	1982	40.9 TWh-- 30% nuclear 12% hydro 48% oil 10% coal
	1985	44.7 TWh-- 55% nuclear

NUCLEAR POWER

National Policy. Look to nuclear power to meet rapidly growing demand for electric energy.

Nuclear Power Plant Capacity	1983	3.1 GWe
	1985	4.0 GWe
	1990	4.9 GWe
	2000	8.7 GWe
Reactor Mix	1983	BWR: 4 (1978-83) PWR: 2 (1984-85)

INDUSTRIAL FUEL CYCLE

Policy. Develop indigenous fuel production capability; fuel assembly (1986); fuel hardware; UO_2 pellets; UF_6 conversion. May choose to reprocess.

Waste Management Strategy. Policy not yet defined on domestic reprocessing, HLW/spent fuel disposal; reactor wastes are to go to new National Waste Storage Facility on nearby Orchid Island.

Cumulative Spent Fuel Arisings (LWR)	1980	70 tU
	1985	430 tU
	1990	1,140 tU
	2000	2,600 tU

ORGANIZATION

- Nuclear power plants are owned by the government, operated by Taiwan Power
- Atomic Energy Council--regulatory functions; waste disposal
- Institute of Nuclear Energy Research--nuclear R&D.

AEC (ATOMIC ENERGY COUNCIL)

Atomic Energy Council
67, Lane 144
Keelung Road, Section 4
Taipei, Taiwan
Republic of China

Tel: (56) 2 392-4180
Telex: 26554

Secretary General	Dr. Victor Cheng
Director, Radwaste Administration	Dr. Chao-Ming Tsai
Director, Planning Division	Mr. Yi-Ching Yang

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

INER (INSTITUTE OF NUCLEAR ENERGY RESEARCH)

Institute of Nuclear Energy Research
P.O. Box 3
Lung tan Taiwan
Republic of China

Tel: (56) 2 381-4014
Telex: 34154 CAEC

Deputy Director	Dr. Jen-Chang Chou (Ext. 2302)
Health Physics	W. L. Chen
Engineering Development and Implementation	Tise-Sheng Chou (Ext. 2525)
Waste Management and Decontamination	S. L. Hwang

Fuel Cycle R&D. Solvent extraction technology; yellowcake conversion to UO_2; production of Zr, TiO_2 and $TiCl_4$; cement and thermoplastic waste forms for reactor wastes; HLW conditioning processes; irradiation of sewage sludge with spent fuels; burial of LLW.

TAIPOWER (TAIWAN POWER COMPANY)

Taiwan Power Company
242 Roosevelt Rd., Sec. 3
Taipei, Taiwan 107
Republic of China

Tel: (56) 2 396-7777
Telex: 2564 TPCAPD

Deputy Directors, Atomic Power	Mr. Eng Lin (Ext. 2521)
	Mr. R.C.T. Hsu (Ext. 2522)

Please Note: The customary form of address may be to use the surname first, followed by the given name. In case of uncertainty it is recommended to use both names.

INER (INSTITUTE OF NUCLEAR ENERGY RESEARCH)

Institute of Nuclear Energy Research
P.O. Box 3
Lung-tan, Taiwan — Tel: (50) 2 381-40[illegible]
Republic of China — Telex: 26154 CAEC

Deputy Director	Dr. Jen-Chang Chou (Ext. 2502)
Health Physics	W. L. Chen
Engineering Development and Implementation	Tise-Sheng Chou (Ext. 2526)
Waste Management and Decontamination	S. L. Wang

Fuel Cycle R&D: Solvent extraction technology; yellowcake conversion to UO_2; production of Zr, HfO_2 and $TiCl_4$. Cement and thermoplastic waste forms for reactor wastes. RLW conditioning processes; irradiation of sewage sludge with spent fuels; burial of LLW.

TAIPOWER (TAIWAN POWER COMPANY)

Taiwan Power Company
242 Roosevelt Rd., Sec. 3
Taipei, Taiwan 107 — Tel: (50) 2 390-777
Republic of China — Telex: 2564 TPCAPO

Deputy Directors, Atomic Power	Mr. Eng Lin (Ext. 2521)
	Mr. R.C.T. Hsu (Ext. 2522)

Please Note: The customary form of address may be to use the surname first, followed by the given names. In case of uncertainty, it is recommended to use both names.

UNION OF SOVIET SOCIALIST REPUBLICS

SOVIET HOLIDAYS

January 1	New Year's Day
March 8	Women's Day
May 1-2	May Day
May 9	Victory over Fascism
November 7-8	October Revolution
December 5	Constitution Day

USSR

ENERGY

Population	1980	265 million
Electric Power Plant Capacity	1982	281 GWe-- 6% nuclear 27% oil 27% gas 25% coal 15% hydro
	1993	20-22% nuclear 460 GWe
Electric Power Production	1982	1277 TWh-- 6.5% nuclear
	1985	1550 TWh-- 14% nuclear

NUCLEAR POWER

National Policy. Major program to develop nuclear power, to avoid transport of fossil fuels from east of the Ural Mountains to European Russia.

Nuclear Power Plant Capacity	1982	
	1985	25 GWe
	1992	90-100 GWe
Reactor Mix	1982	LGR: 18 (1958-82) 1 (1984) PWR: 12 (1964-82) 3 (1983-85) LMFBR: 2 (1973,1980)
Reactor Development		LMFBRs, 1,500-MWe PWRs

INDUSTRIAL FUEL CYCLE

Policy. Complete domestic fuel cycle capability, including enrichment, fuel fabrication (UO_2 and MOX); develop commercial reprocessing capability.

Waste Management Strategy. Vitrify HLW, provide terminal storage in geologic repository.

ORGANIZATION

Nuclear Program Control

- USSR State Committee on Utilization of Atomic Energy
- Ministry of Energy and Electrification.

R&D

- Institute of Physical Chemistry, Moscow, a branch of the USSR Academy of Sciences (geologic waste disposal; waste form properties; personnel: V. I. Spitsyn,[a] N. E. Brezneva, M. K. Pimenov)
- V. G. Khlopin Radium Institute, Leningrad (chemical separation; fuels reprocessing; geochemistry)
- All-Union Scientific Research Institute for Inorganic Materials, Moscow (properties of solid waste forms; personnel: A. S. Polyakov,[a] V. V. Kulichenko,[a] N. V. Krylova[a])
- Chemical Plant Research Institute, Sverdlovsk (vitrification pilot plants).

STATE COMMITTEE ON THE UTILIZATION OF ATOMIC ENERGY

State Committee for Atomic Energy
Staromonetny Pereulok 26
Moscow 109180
USSR

Chairman	A. M. Petrosyants
Deputy Chairman	Prof. I.D. Morokhov

Waste Management R&D. USSR laboratories are developing processes for treating spent fuel (cladding, thermal decladding, meltdown of hulls), improved partitioning of TRU wastes, handling off-gases, and storing ^{85}Kr.

(a) Also a member of the State Committee on the Utilization of Atomic Energy

Facilities[a]

1. Reprocessing Pilot Plant (radioactive)

   Owner. Khlopin Radium Institute, Leningrad.
   Mission. Develop LWR fuel reprocessing technology.
   Design Basis. Chop-leach head-end; Purex flowsheet; capacity, 3 kg/day uranium.
   History. Startup, 1973.

2. Cold Pilot Plant-Vitrification

   Mission. Develop waste vitrification technology.
   Design Basis. Liquid-fed ceramic melter, two-chamber unit; 150 ℓ/hr HLLW; 30 ℓ/hr glass; product, phosphate glass blocks.
   History. Startup, 1974.

3. KS-KT-100 (cold pilot plant-vitrification)

   Location. Chemical Plant Research Institute, Sverdlovsk.
   Mission. Develop vitrification technology for high-Al, high-Na HLW.
   Design Basis. Fluid bed calciner; in-crucible melter (two-stage process); capacity, 20 kg/hr glass; 160-180 kg glass/batch; product, phosphate glass blocks.
   Personnel. V. I. Davydov; V. V. Dolgov.

KHLOPIN RADIUM INSTITUTE

Khlopin Radium Institute
Ul. Rentgena 1
Leningrad 22
USSR

Chief of Laboratory	Yergeniy Shashukov

(a) Because there is only limited information available, it is not always known at which nuclear agency a facility is located.

UNITED KINGDOM

BRITISH HOLIDAYS
*Asterisks denote movable holidays

January 1	New Year's Day
*March/April	Good Friday
*March/April	Easter Monday
May 3	May Day
*May	Whitsuntide or Spring Bank Holiday
August 30	Summer Bank Holiday
December 25	Christmas
December 26	Boxing Day

UNITED KINGDOM

ENERGY

Population	1982	60 million
Energy Demand	1980	201.5 Mtoe
Oil Demand	1980	81 Mtoe (1% imported)
Electric Power Plant Capacity	1980	82 GWe
Electric Power Production	1980	285 TWh-- 13% nuclear 73% solid fuels 12% oil & gas 2% hydro
	1982	254 TWh-- 16.4% nuclear

NUCLEAR POWER

National Policy. Aggressive development of nuclear power, based to date on gas-cooled reactors but diversifying to PWRs and eventually to FBRs.

Nuclear Power Plant Capacity	1983	6.4 GWe
	1985	10.0 GWe
	2000	13.6 GWe
Reactor Mix	1982	GCR: 26 (1956-72)
		AGR: 5 (1976-82)
		9 (1983-88)
		LMFBR: 1 (1976)
Reactor Development		Major LMFBR development program, including fuel cycle

INDUSTRIAL FUEL CYCLE

Policy. Reprocess and recycle Pu to FBR system; develop and maintain complete fuel cycle capability (enrichment, UO_2 and MOX fuel fabrication, spent fuel reprocessing); sell fuel cycle services to foreigners.

Waste Management Strategy. Reprocess spent fuels as rapidly as plant capacity permits; vitrify HLW (French technology); long-term interim storage of HLW glass, deferring decision on disposal; shallow-land burial or sea-dump of LLW and ILW.

Cumulative Spent Fuel	1980	250 tU
Arisings (LWR and AGR)	1985	830 tU
	1990	2,000 tU
	2000	5,330 tU

Industrial-Scale Activities

1. Power production (GWe): 1981--9.8; 1990--14.8.

2. Uranium conversion (Springfields)
   - UF_6 production--9500 t/a
   - UF_6-UO_2 conversion--700 t/a.

3. Uranium enrichment (Capenhurst)
   - gas diffusion plant--400 tSWU/a
   - centrifuge plant--225 tSWU/a.

4. Fuel fabrication
   - U metal (Magnox)--2500 t/a (Springfields); UO_2 fuels--500 t/a (Springfields)
   - MOX fuels for recycle to FBRs (BNFL/Sellafield): current--10 t/a; future new capacity--20 t/a, 1984 and 50 t/a, 1987.

5. Fuel reprocessing
   - Magnox fuels (Sellafield)--5 to 7 t/a
   - UO_2 fuels (THORP)--6 t/day (1990)
   - FBR fuels (PFR reprocessing pilot plant, Dounreay)--50 kg HM/day
   - FBR fuels (CDFR reprocessing plant, 1993).

6. HLW vitrification. Design and construction of Windscale Vitrification Plant (1988).

7. Waste disposal. Underground repository for conditioned ILW, 1987-88.

INTERNATIONAL RELATIONSHIPS

1. Member of European Communities, IAEA and OECD/NEA.

2. LMFBR exchange agreement with US DOE.

3. BNFL has partnership in URENCO (uranium enrichment), United Reprocessors GmbH (reprocessing), and Nuclear Transport Limited (spent fuel transport) and Pacific Nuclear Transport Limited.

ORGANIZATION

1. UKAEA--nuclear research; laboratories at Harwell, Risley, Springfields, Dounreay

2. Department of Environment--develops waste management strategy and coordinates waste management R&D

3. BNFL--commercial fuel cycle for domestic and foreign customers

4. NIREX--disposal of LLW and ILW

5. Institutes of Geological and Oceanographic Sciences--supporting R&D for the waste management program

6. NRPB--environmental R&D

7. Nuclear Installations Inspectorate--licensing.

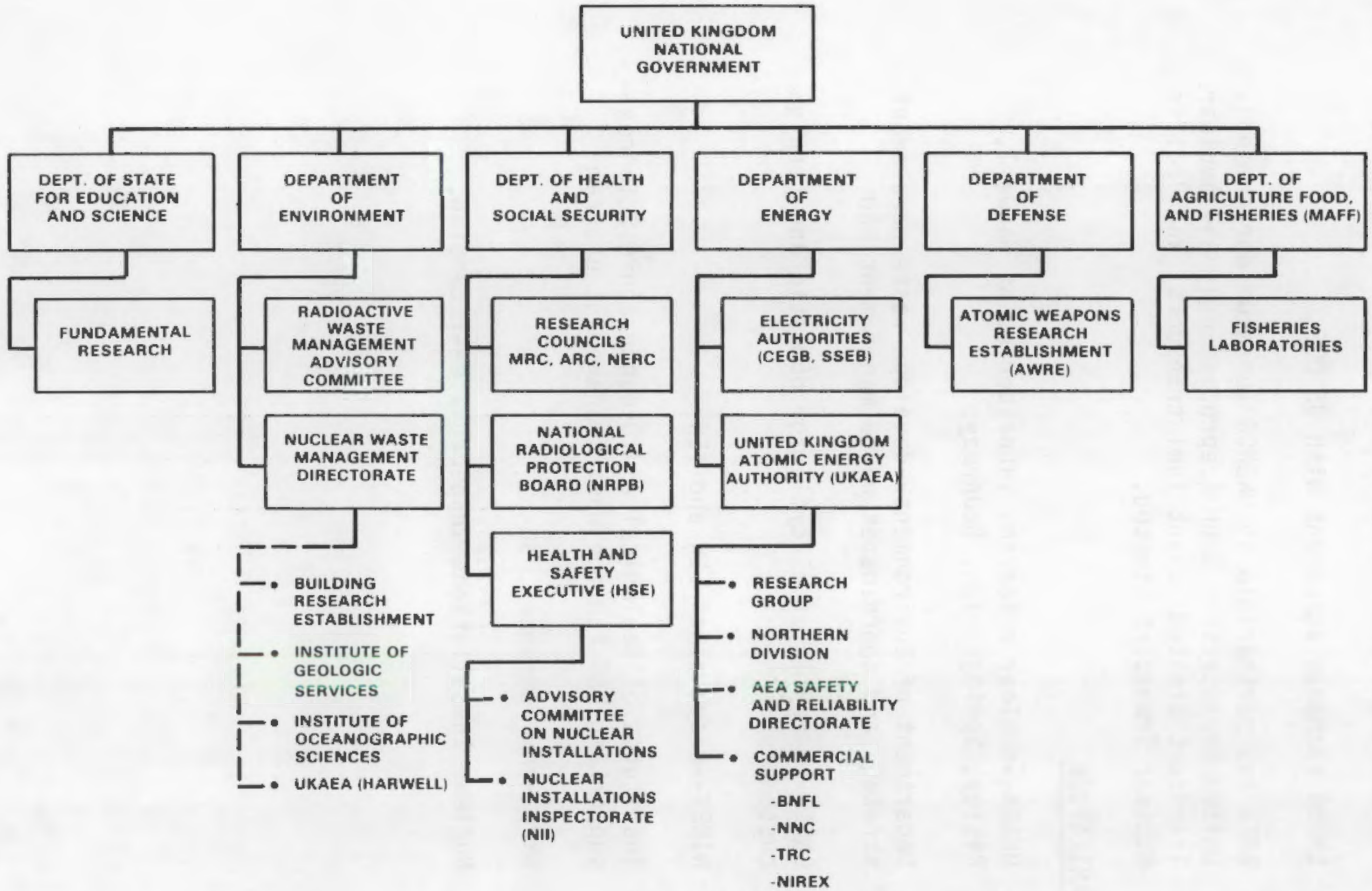


FIGURE UK-1. Nuclear Fuel Cycle Responsibilities

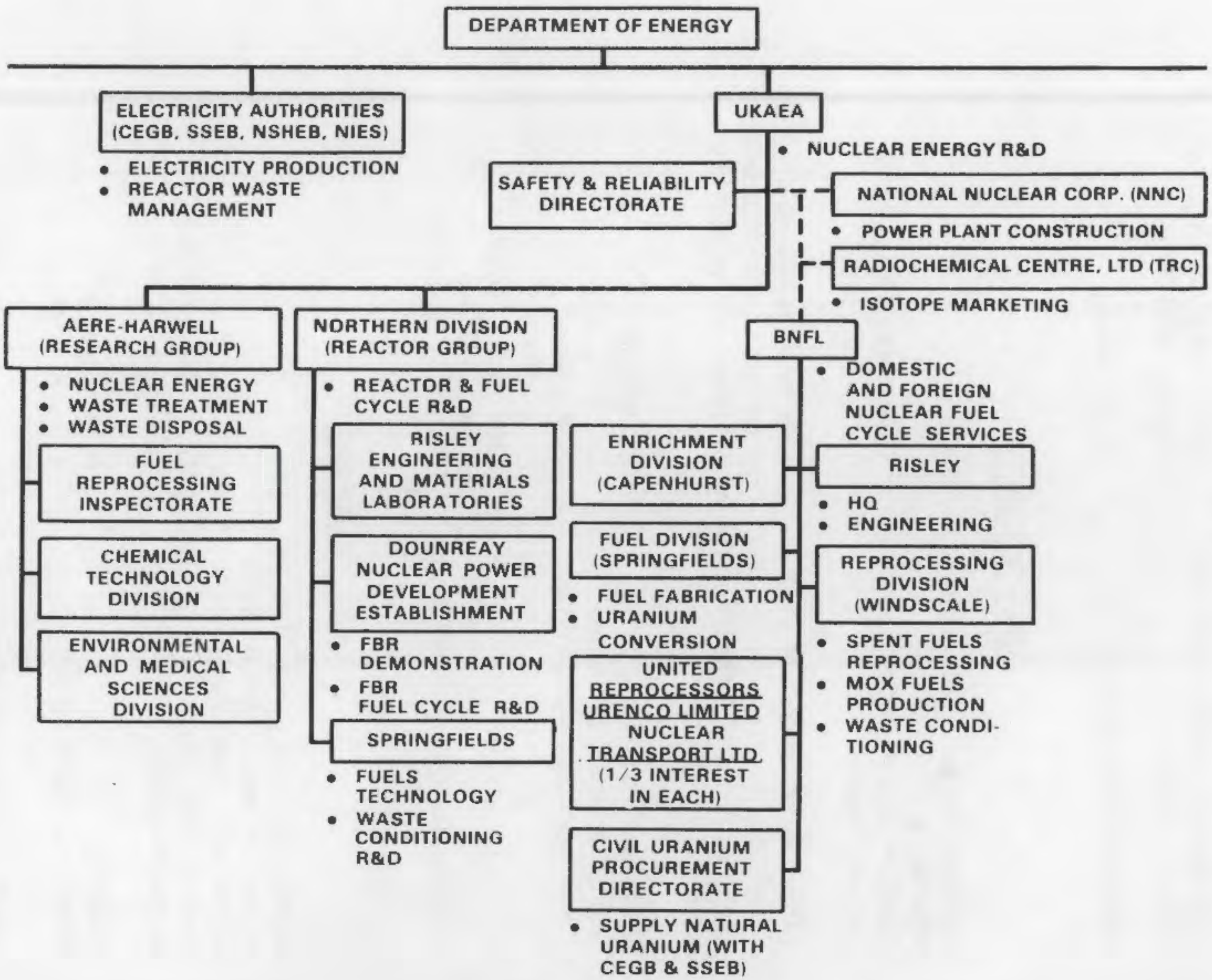


FIGURE UK-2. Nuclear Fuel Cycle Responsibilities - Department of Energy

AWRE (ALDERMASTON)

Atomic Weapons Research Establishment	
Aldermaston, Reading RG7 4PR	Tel: (44) 735 64111
United Kingdom	Telex: 848104/5
Manager, Waste Management	E. Whitehead

BNFL: RISLEY (HQ)

British Nuclear Fuels Limited	
Risley, Warrington	
Cheshire WA3 6AS	Tel: (44) 925 35953
United Kingdom	Telex: 627581

[About 20 miles by official car or taxi from Manchester International Airport; or train from London to Warrington (approx. 3 hours), then 6 miles by official car or taxi to Risley.]

Chairman, BNFL	C. Allday
Deputy Managing Director	Dr. D. G. Avery
R&D Reprocessing Division	N. R. Geary
	L. P. Shortis
	Alan D. W. Corbet
	D. W. Clelland
Waste Management Development	Dr. K. R. Schneider

BNFL: SELLAFIELD

British Nuclear Fuels Limited	
Windscale and Calder Works	
Sellafield, Seascale	
Cumbria CA20 1PG	Tel: (44) 940 28333
United Kingdom	Telex: 64237/8
Director	Gordon Steele
Director, Reprocessing	W. L. Wilkinsen

[By train from London-Euston Station to Carlisle Station (4 hours); transport can be arranged by BNFL from Carlisle to site (approx. 1-1/2 hours). From Manchester International Airport to site by car is approx. 3 hours.]

BNFL: SELLAFIELD (contd)

Reprocessing Facilities

1. B204-Windscale

   Mission. Reprocess military fuels.
   Design Basis. BUTEX process; "no-maintenance" concept.
   History. On-line, 1952-1964. Converted to oxide fuel head-end plant for B205-Windscale, 1969.

2. B205-Windscale

   Mission. Reprocess Magnox (magnesium-clad, U metal) fuels from UK GCRs. Oxide head-end added in 1969 to handle AGR and LWR fuels.
   Design Basis. Magnox fuels: mechanical declad; PUREX flowsheet; "no-maintenance" concept; nominal capacity, 8 tHM/day. New oxide head-end: shear-leach and one BUTEX cycle in B204; solution transferred to B205 for further processing; remote maintenance; nominal capacity, 1.3 tHM/day. Liquid HLW storage: SS tanks, 70 m^3 and 150 m^3, in SS-lined concrete cells.
   History. Magnox fuels: B205 startup, 1967; annual throughput of Magnox fuels, 1000-1200 tHM. Oxide head-end operation, 1969-1973; 90 t oxide fuel processed before the plant was shut down after a contamination release incident.

3. Windscale Reprocessing Test Unit (nonradioactive)

   Mission. Test the THORP first solvent extraction cycle.
   Design Basis. Purex flowsheet; nominal capacity, 4 t/a LWR fuels.
   History. Startup, 1979.

BNFL: SELLAFIELD (contd)

4. THORP (Thermal Oxide Reprocessing Plant)

Mission. Reprocess AGR and domestic or foreign LWR fuels.
Design Basis. Purex flowsheet, pulsed columns and mixer-settlers. AVM process for HLW vitrification. Nominal capacity, 6 tU/day.
Milestone. Startup, 1989 or later.

5. Windscale Reprocessing Pilot Plant (radioactive)

Mission. Support THORP design and operation.
Design Basis. 1/5000 scale.

MOX Fuel Fabrication Facilities

1. MOX Fuel Fabrication Plant

Design Capacity. 10 t/a FBR fuels.

2. MOX Fuel Fabrication Plant

Design Basis. Gel precipitation; capacity, 0.5 kg/day.
Milestone. Startup, 1981-82.

3. MOX Fuel Fabrication Production Plants

Design Basis. Mechanical mixing or coprecipitation. 20 t/a (startup, 1984); 50 t/a (startup, 1987).

Waste Treatment Facilities

1. FSIF (cold demonstration plant-vitrification)

Mission. Test prototype equipment and maintenance techniques.
Design Basis. French AVM process (rotating-tube calciner/metal melter); capacity, 11 kg/hr glass; product, borosilicate glass blocks.
Milestone. Startup, 1982.

BNFL: SELLAFIELD (contd)

2. Windscale Vitrification Plant

   Mission. Solidify Windscale HLW.
   Design Basis. AVM process; product, borosilicate glass blocks.
   Milestone. Startup, 1987.

3. Incinerator Pilot Plant (radioactive)

   Mission. Volume reduction of contaminated waste.
   Design Basis. Pyrolysis-incineration process; capacity, 5 kg/hr.
   History. Startup, 1973.

4. Windscale Waste Treatment Complex

   Mission. Prepare non-HLW for ocean dumping; extract Pu from process residues.
   Construction. Ten-year period, starting in 1981 (estimated cost: $\$225 \times 10^6$).

BNFL: SPRINGFIELDS

British Nuclear Fuels Limited
Springfields Works
Salwick, Preston,
Lancashire PR4 OXJ
United Kingdom

Tel: (44) 772 728262
Telex: 67526/7

Chief Technical Manager — A. Naylor

BRE (BUILDING RESEARCH ESTABLISHMENT--DOE)

Building Research Establishment
(Department of the Environment)
Building Research Station
Garston, Watford WD2 7JR — Tel: (44) 9273 74040
United Kingdom — Telex: 923220

Assistant Director, Geotechnics and Structural Engineering	Dr. J. B. Menzies
Head, Geotechnics Division	J. B. Boden
Seabed Disposal	T. Freeman
Continental Disposal	Ms. C. M. Cooling

Waste Management Mission. Emplacement engineering and related activities; rock mechanics R&D.

CEGB (CENTRAL ELECTRICITY GENERATING BOARD)

Central Electricity Generating Board
Sudbury House
15 Newgate Street
London, EC1A 7AU — Tel: (44) 1 248-1202
United Kingdom — Telex: 883141

Chairman	Sir W. Marshall
Director, Plant Engineering	P. M. Billam
Director, Research	Dr. J. K. Wright
Fuel and Core Division	Dr. B. C. Masters

DOE (DEPARTMENT OF THE ENVIRONMENT)

Department of the Environment
Nuclear Waste Management Division
43 Marsham Street
London SWI 3py — Tel: (44) 1 212-6315
United Kingdom — Telex: 22221

DOE (DEPARTMENT OF THE ENVIRONMENT) (contd)

Director, Radioactive Waste Professional Division	Dr. Frank S. Feates (44) 1 212-8804
RWP I Branch	Brian Hookway (49) 1 212-6937
RWP II Branch	Dr. Allan G. Duncan (49) 1 212-8673
RWP III Branch	Dr. Haydn Richards (49) 1 212-6937

Waste Management Responsibility. Administer UK waste management programs; fund and coordinate waste treatment and waste isolation R&D at Harwell, IGS, NRPB, etc.; regulate discharge of radioactive materials to the environment.

IGS (INSTITUTE OF GEOLOGICAL SCIENCES)

Institute of Geological Sciences (HQ)
Keyworth
Nottingham, NG12 5GG — Tel: (44) 6077 6111
United Kingdom — Telex: 378173 ISGKEY G

Director	Dr. G. M. Brown
Fluid Processes	Dr. John D. Mather

Institute of Geological Sciences
Harwell Laboratory
Building 151
Harwell, Oxon OX11 ORA — Tel: (49) 235 24141
United Kingdom — Telex: 83135 ATOMHA G

Institute of Geological Sciences
Exhibition Road — Tel: (44) 01 589-3444
London, SW7 2DE — Telex: 8812180 GEOSCI G

Assistant Director, Geophysics and Hydrogeology	David A. Gray

IOS (INSTITUTE OF OCEANOGRAPHIC SCIENCES)

Institute of Oceanographic Sciences
Brook Road
Wormley, Godalming
Surrey GU8 5UB — Tel: (49) 42 879 4141
United Kingdom — Telex: 858833

Director	Dr. Anthony S. Laughton
Nuclear Waste	Dr. T. J. G. Francis

MAFF FISHERIES LABORATORIES

Fisheries Radiobiological Laboratories
Ministry of Agriculture, Fisheries, and Food
Pakefield Road
Lowestoft, Suffolk NR32 OHT — Tel: (49) 502 4381
United Kingdom — Telex: 97470

Director, Fisheries Research Directorate	Alan Preston
Head, Aquatic Environment Protection Division	Harry Hill (49) 502 62244

NRPB (NATIONAL RADIOLOGICAL PROTECTION BOARD)

National Radiological Protection Board
Chilton Didcot
Oxfordshire OX11 ORQ — Tel: (49) 235 83 1600
United Kingdom — Telex: 837124

Director	H. J. Dunster
Secretary	Dr. R. H. Clarke
Assistant Director, Nuclear Assessments	G. A. M. Webb
Nuclear Assessments	Ms. M. D. Hill
Waste Management	Dr. M. J. Clark
Environmental Transfer	Dr. G. S. Linsley

NIREX (NUCLEAR INDUSTRY RADIOACTIVE WASTE EXECUTIVE)

Nuclear Industry Radioactive Waste Executive
Harwell
Didcot, Oxon OX11 ORA
United Kingdom — Tel: (49) 235 24141

Managing Director	M. E. Ginniff
Repository Development	H. Beale
Disposal at Sea; International Relations; Packaging and Transport	Dr. J. Grover
Waste Inventory R&D; Packaging and Transport	D. George

Mission. Locate, develop and operate facilities and sites for disposal of LLW and ILW.

Sponsors. UKAEA, BNFL, regional electricity generating boards.

NII (NUCLEAR INSTALLATIONS INSPECTORATE)

Nuclear Installations Inspectorate
Thames House North
Millbank, London SW1P 4QJ — Tel: (44) 1 211-3000
United Kingdom — Telex: 918777 ENERGY G

Nuclear Installations	R. Anthony
Overseas Liaison	J. S. MacLeod

RWMAC (RADIOACTIVE WASTE MANAGEMENT ADVISORY COMMITTEE)

Mission. Advise Secretaries of State for the Environment, Scotland and Wales, on waste management.

Organization. Eleven independent scientists and representatives from four nuclear and electric utilities and three labor unions form the committee that reports progress to Parliament every year.

RWMAC (RADIOACTIVE WASTE MANAGEMENT ADVISORY COMMITTEE) (contd)

Chairman (also Vice-Chancellor, University of Sussex, Brighton, United Kingdom)	Sir Denys Wilkinson

SRD (SAFETY AND RELIABILITY DIRECTORATE)

UKAEA Safety and Reliability Directorate
Wigshaw Lane, Culcheth
Warrington WA3 6AT — Tel: (44) 925 31244
United Kingdom — Telex: 629301 atomry-g

Mission. Advise the UKAEA on safety, coordinate reactor safety research, and provide advice and services on safety to government and industry.

UKAEA (UNITED KINGDOM ATOMIC ENERGY AUTHORITY)

United Kingdom Atomic Energy Authority
11 Charles II Street
London SW1 4QP — Tel: (44) 1 930 5454
United Kingdom — Telex: 22 565

Chairman	Sir Peter Hirsch

UKAEA: HARWELL

UKAEA Atomic Energy Research Establishment
AERE, Harwell
Didcot, Oxon OX11 ORA — Tel: (44) 235 24141
United Kingdom — Telex: 83135

UKAEA: HARWELL (contd)

Director (and Member of UK Radioactive Waste Management Advisory Council, RWMAC)	Dr. L. E. J. Roberts
Authority's Fuel Processing Director	Dr. R. H. Flowers Ext. 2323
Authority's Underlying Research Director and Harwell Research Director, Nuclear Research	Dr. J. Williams
Chemical Technology	Dr. R. L. Nelson
Radioactive Waste Management	M. J. Smyth
Fuel Cycle	Dr. J. R. Findlay
Reactor Chemistry	R. L. Faircloth
Industrial Chemistry	Dr. K. W. Carley-Macauly
Liquid Processes Technology	B. Partridge
Materials Processing	M. J. S. Smith

Waste Management Facilities

1. HARVEST Pilot Plant (nonradioactive)

   Mission. Develop waste vitrification technology.
   Design Basis. Rising-level pot calcination/vitrification process; capacity, 240 kg glass/run; product, borosilicate glass blocks.
   History. Startup, 1975.

2. Harwell Ceramic Melter Test Unit (nonradioactive)

   Mission. Develop ceramic melter capability for UKAEA.
   Design Basis. Liquid-fed ceramic melter; capacity, 700 kg/day glass; product, borosilicate glass.
   Milestone. Startup, Fall 1981-Spring 1982.

UKAEA: RISLEY

Risley Nuclear Power Development Establishment
UKAEA (Northern Division)
Risley, Warrington
Cheshire WA3 6AT — Tel: (44) 925 31244
United Kingdom — Telex: 629301

Director, Process Technology and Safety	R. H. Allardice Ext. 2181
Waste Management (General)	H. Barton Ext. 2451
Decommissioning	D. F. Rawson Ext. 2919

UKAEA: DOUNREAY

Dounreay Nuclear Power Development Establishment
UKAEA (Northern Division)
Thurso, Caithness KW14 7TZ
Scotland — Tel: (44) 847 62121
United Kingdom — Telex: 75297

[From London by air to Wick (via Aberdeen), then approx. 30 miles by car to Dounreay; or by train from London to Thurso (via Inverness), then approx. 10 miles by car to Dounreay.]

Director	Clifford W. Blumfield
Assistant Director, Fuels	O. Pugh

Reprocessing Facilities

PFR Reprocessing Plant

Mission. Reprocess Dounreay Prototype Fast Reactor (MOX) fuels.
Design Basis. Shear single pins and leach; PUREX process; capacity 9-10 tHM/a of 180-day cooled PFR assemblies with 8-10% burnup.
History. Dounreay Fast Reactor fuels processed from 1961 to 1975; plant rebuilt to handle PFR oxide fuels, resumed operation in October 1980.

UKAEA: SPRINGFIELDS

UKAEA Springfields Nuclear Power
Development Laboratories
Salwick, Preston
Lancashire PR4 ORR
United Kingdom

Tel: (44) 772 728262
Telex: 67545

Chemical Engineering Division	John V. Shennan
Chemical Plant Development	P. Laurie Allen
Process Engineering Technology	Cliff Etherington
Head-End and Solid Waste Management	Brian E. Meredith

INTERNATIONAL AGENCIES

CMEA (COUNCIL FOR MUTUAL ECONOMIC ASSISTANCE)

MEMBER STATES

Bulgaria	Mongolia
Cuba	Poland
Czechoslovakia	Rumania
German Democratic Republic	USSR
Hungary	Yugoslavia

MISSION

Promote economic and industrial cooperation among the countries with centrally-controlled economies.

ORGANIZATION

CMEA has a Standing Commission on the Use of Atomic Energy for Peaceful Purposes. The Commission holds meetings to review national waste management R&D programs and defines areas for additional cooperation.

Council for Mutual Economic Assistance
Prospekt Kalinina 56
Moscow
USSR

EC (EUROPEAN COMMUNITIES)

MEMBER STATES

Belgium	Ireland
Denmark	Italy
France	Luxembourg
Germany (FRG)	Netherlands
Greece	United Kingdom

NUCLEAR MISSION

Promote growth in nuclear industries of member countries, operate joint research center sites, sponsor and fund R&D, exchange information and establish safety standards.

FUEL CYCLE PROGRAM ADMINISTRATION

1. Financing--R&D programs supported by a tax on the member states.

2. Two types of R&D programs
   - Direct action--fully funded by EC, conducted by Euratom Joint Research Centre establishments at Ispra (Italy) and Karlsruhe (FRG)
   - Indirect action--partly funded by EC under cost-sharing contracts, conducted by research centers in the member states.

3. Cooperation with US DOE--waste management cooperative agreement runs from October 6, 1982 to October 6, 1987.

ORGANIZATION

The Commission of the European Communities (CEC) is the executive body for the combined communities (Euratom, Coal and Steel, Common Market).

Commission of the European Communities
200 Rue de la Loi
B-1049 Brussels
Belgium

Tel: (32) 2 235 1111
Telex: 21 877 COMEU B

Vice-President for Industrial Affairs, Energy, Euratom Supply Agency, Research and Science, Joint Research Centre	Viscount Etienne Davignon
Director, Nuclear Research and Development	Sergio Finzi
Fuel Cycle Systems	Serge Orlowski
Reactors and Technologies	Mario De Bacci
Nuclear Plant Safety	Willem Vinck
Director, Nuclear Energy Policy	Fabrizio Caccia Dominioni

CEC-JRC (JOINT RESEARCH CENTRE)

Director General, CEC Joint Research Centre (JRC)	Jean-Albert Dinkespiler

JRC: ISPRA

Ispra Establishment
I-21020 Ispra (Varese)
Italy

Tel: (39) 332 780131/780271
Telex: 380042/38058 euratom

(Northern Italy; it may be reached by air travel to Milan and ground transport to Ispra, about 50 km.)

Director	George Robert Bishop
Scientific Coordinator, Waste Management Programs	Francesco Girardi

Mission. R&D in the areas of reactor and nuclear plant safety, treatment and storage of radioactive wastes, standards and reference substances, and training.

Waste Management R&D. TRU wastes--volume reduction and actinide transmutation; waste disposal--risk analysis, nuclide migration, and waste form properties.

JRC: KARLSRUHE

Karlsruhe Establishment
(European Institute for Transuranium
Elements)
Postfach 2266
D-7500 Karlsruhe — Tel: (49) 7247 841
Federal Republic of Germany — Telex: 7825483 Eu D

Director — Roland Lindner

Mission. Basic research in the transuranium elements, especially plutionium, reactor fuels development.

Fuel Cycle R&D. Plutonium conversion and plutonium fuels, characterization of waste forms.

IAEA (INTERNATIONAL ATOMIC ENERGY AGENCY)

MEMBER STATES

Over 100 nations (UN members), including USA.

MISSION

Develop the peaceful use of atomic energy: safeguards, nuclear safety and standards, information exchange, and technical assistance.

Waste Management Activities

- Development of mutually agreed upon safety standards and criteria for the management and disposal of radioactive waste arising from all stages of the nuclear fuel cycle.

- Promotion of information exchanges in the radioactive waste management area through international conferences and symposia, technical committees and advisory groups, and specialized training courses and seminars.

- Coordination of research programs in specific technical areas.

- Issuance of publications in the field of waste management, including the annual "Waste Management Research Abstracts."

ORGANIZATION

International Atomic Energy Agency
P.O. Box 100
A-1400 Vienna
Austria

Tel: (43) 222 23600
Telex: 112645

Director General	Hans Blix
Deputy Director General	Boris Semenov
Director, Division of Nuclear Fuel Cycle	Syed Fareeduddin
Waste Management	J. Hirling
U.S. National on Waste Management Staff	A. Hagan

ICRP (INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION)

MISSION

Provide principles of radiation protection as a basis for each country to use to establish technical codes of practice.

ORGANIZATION

International Commission on Radiological Protection
Clifton Avenue
Sutton, Surrey SM2 5PU
United Kingdom

Tel: (44) 1 642-4680
Telex: 895 1244 ICRPG

Chairman, Main Commission	Dr. B. Lindell
Scientific Secretary	Dr. F. D. Sowby
Chairman, Committee on Radiation Effects	Dr. A. C. Upton
Chairman, Committee on Secondary Limits	Dr. J. Vennart
Chairman, Committee on Protection in Medicine	Dr. C. B. Meinhold
Chairman, Committee on Application of the Commission's Recommendations	Dr. H. P. Jammet

OECD-NEA (NUCLEAR ENERGY AGENCY)

MEMBER STATES

Australia	Finland	Japan	Sweden
Austria	Germany (FRG)	Luxembourg	Switzerland
Belgium	Greece	Netherlands	Turkey
Canada	Iceland	Norway	United Kingdom
Denmark	Ireland	Portugal	United States
France	Italy	Spain	

(New Zealand and Yugoslavia cooperate in certain projects.)

MISSION

Promote orderly development of peaceful uses of nuclear energy through cooperation among Member States. Initiate, encourage, and coordinate cooperative work in the following areas: reactor research, nuclear fuel cycle studies, radiation protection and waste management, nuclear safety, regulatory matters, and nuclear data collection.

Technical Activities

1. Workshops, technical meetings, symposia, and publications.

2. Maintenance of the Multilateral Consultation and Surveillance Mechanism for Sea Disposal, which monitors sea dumping of LLW/ILW in the Northeast Atlantic.

3. Joint projects: International Stripa Mine Project (Sweden); International Sorption Information Retrieval System (ISIRS); Ågesta International Decontamination Project (Sweden).

ORGANIZATION

OECD Nuclear Energy Agency
38 Boulevard Suchet
F-75016 Paris
France

Tel: (33) 1 524 8200
Telex: 630 668

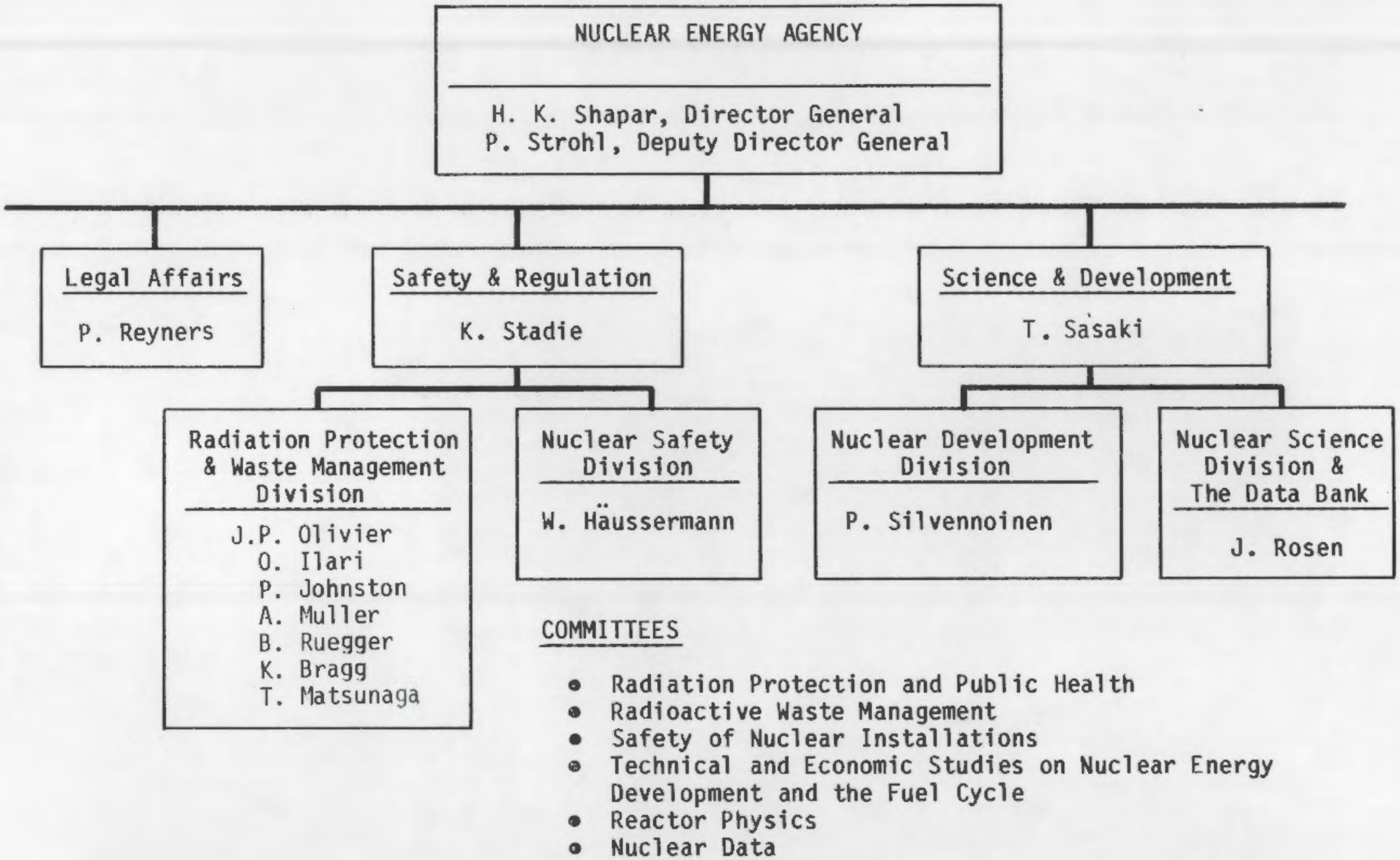


FIGURE Intl-1. NEA Organization

ENERGY SUPPLY AND DEMAND

ENERGY SUPPLY AND DEMAND

ENERGY RESERVES

The world's measured, recoverable, nonrenewable energy reserves (as of 1974) are shown in Figure E-1 and listed by resource in Table E-1. The numbers are relatively old estimates but they do provide an order-of-magnitude picture. (The North American numbers are approximately 1/3 of US-ERDA 1976 estimates for the US alone.)

ENERGY DEMAND

According to the reference for Figure E-1, in 1974 the world consumed 1 percent of its recoverable, nonrenewable energy resources with the US accounting for one-third of that consumption. In 1978, the world consumed about 250 quads of energy, and the rate of energy use is accelerating, particularly for the developing countries (see Table E-2). The supply form of this 250 quads varied enormously from country to

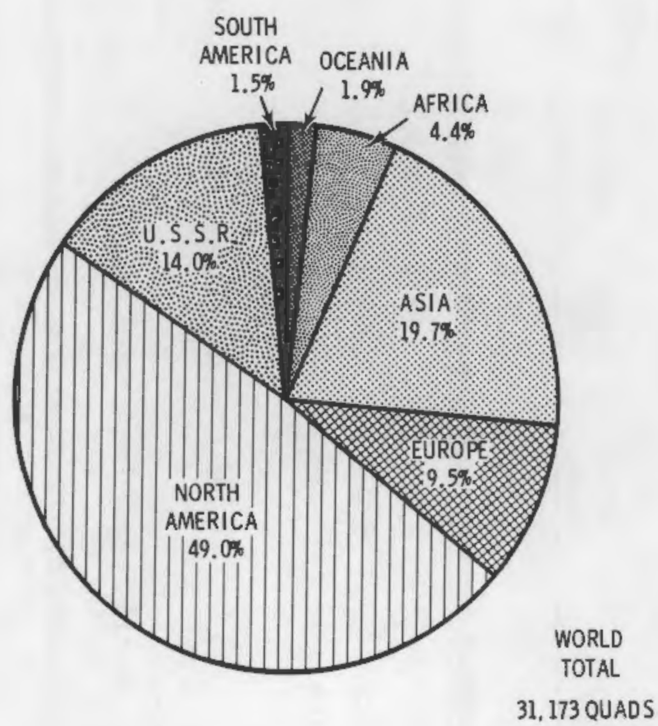


FIGURE E-1. World Recoverable, Nonrenewable Energy Reserves
Source: Energy Perspectives 2, June 1976, U.S. Department of Interior

TABLE E-1. Measured World Recoverable Energy Reserves, 1974 (Quads)[a]

Area	Solid Fuels	Crude Oil	Natural Gas	Oil Shale and Tar Sands[b]	Uranium (nonbreeder)[c]	Total
Africa	361.7	526.6	201.7	81.4	198.1	1,359.5
Asia (less USSR)	2,608.7	2,204.4	432.6	870.2	3.1	6,126.0
Europe (less USSR)	2,581.5	57.1	153.6	117.0	46.4	2,955.6
North America	5,070.9	301.0	380.6	9,111.0	422.7	15,286.2
South America	49.8	311.5	60.6	23.7	11.9	457.5
Oceania	459.8	9.4	24.9	9.2	99.1	602.4
Total	11,132.4	3,407.6	1,254	10,212.5	>781.3	>26,803.2

(a) Source: World Energy Conference, Survey of Energy Resources, New York, 1974.
(b) According to the U.S. Department of the Interior, Bureau of Mines, North American tar sands and shale oil reserves may be severely overstated. Development of most of these reserves is not economic at present.
(c) Energy content using breeders 60-100 times as great. Thorium resources neglected.

TABLE E-2. World Energy Usage (Quads)[a]

	1980	2000
Industrialized Countries (including CPEs)	224.8	340.4/386.1[b]
Developing Countries	69.8	173.1/215.7

(a) Source: IAEA Book: "Energy, Electricity, and Nuclear Power Estimates Up to 2000," April 1981.
(b) Low/high projections are given.

enormously from country to country. In the major WOCA countries, the supply pattern was as shown in Figure E-2. This figure illustratesthe relatively high dependence on imported oil for Japan,West Germany, and France.

NUCLEAR POWER SUPPLY

Electricity generation by commercial nuclear power began in the early 1950s in a few highly industrialized countries. From that beginning it has grown to the point where 24 nations (19 WOCA countries) now operate commercial nuclear power plants, and at least a dozen others have active nuclear power programs. Installed electric grid and nuclear power capacities as of the end of 1981 are shown in Table E-3, while Table E-4 provides high/low growth projections into the twenty-first century. Table E-4 utilizes the numbers generated for the INFCE study (1978 estimates) and also lists the nuclear projections obtained in 1980 from NEA Member States in response to a NEA/IAEA questionnaire. The INFCE projections shown in this table are currently too high. For example, the US now estimates a 125 GWe level for the year 2000, as opposed to the 255-395 GWe projection shown in the table.

The relative nuclear power capacities of the countries with major nuclear programs, as of 1979 and as projected to the year 2000, are depicted in Figures E-3 and E-4, respectively. Table E-5 provides low/high estimates of total electrical and nuclear capacities for regions of the world, for 1980 and for the year 2000.

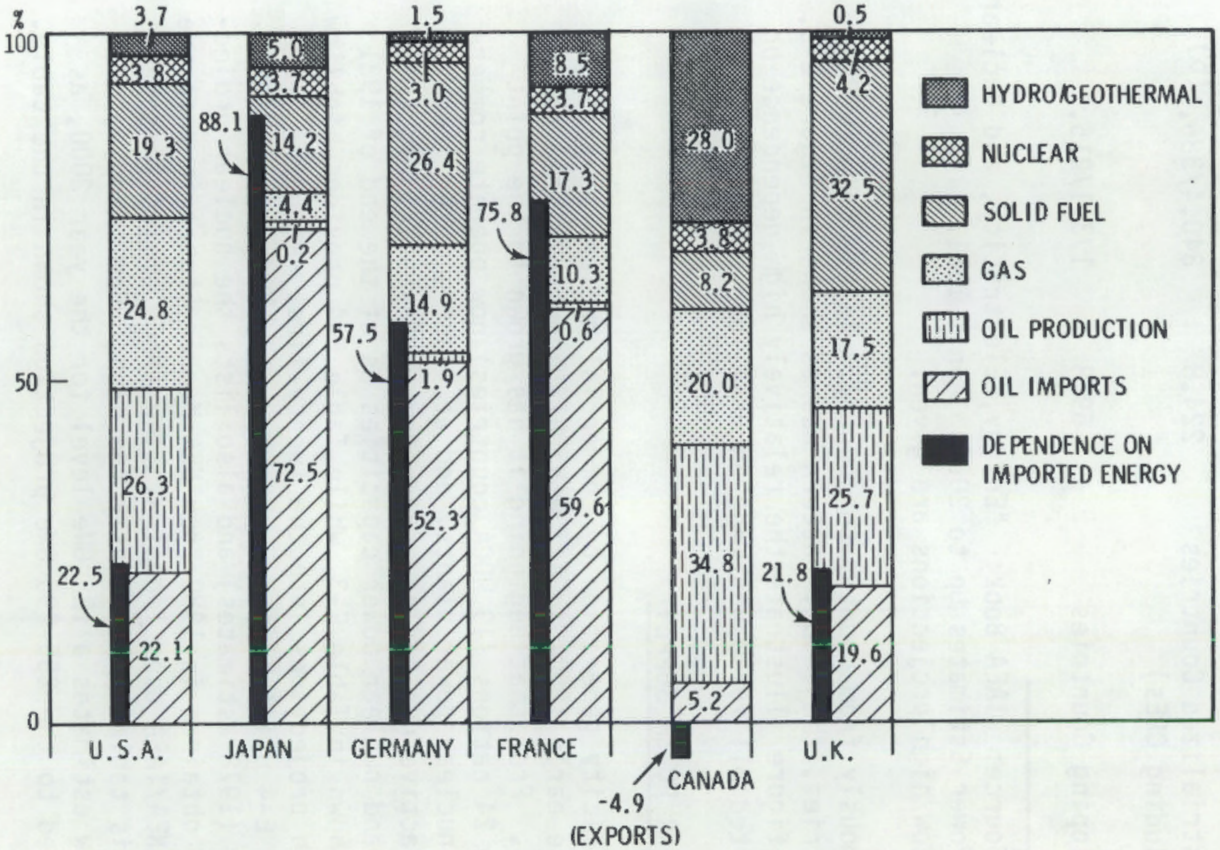


FIGURE E-2. Primary Energy Supply Patterns (1978)
Source: Japan and the Oil Problem, February 1980

TABLE E-3. Installed Electrical Grid Capacities in Countries with Nuclear Power Programs

Country	Populations (millions, 1980)	Total Electric Power Plant Capacity (GWe, 1980)	Primary Energy[a] Demand		
			Mtoe	Mtce	Year
Argentina	27	13	40		1979
Austria	7.1	13	27.0		1979
Belgium	9.8	13	49.5		1980
Brazil	119	31	95		1980
Canada	23.9	79	231.3		1980
China, People's Republic of	972	60		766	1978
Egypt	42	4		18.3	1978
Finland	4.8	12	25.3		1981
France	53.5	73	193		1981
Germany, Federal Republic of	61.5	86	257		1982
India	700	29	93		1979
Italy	56.7	47	142		1980
Japan	117	148	386		1980
Korea (South)	38	6	41.4		1981
Mexico	69	17	80		1979
Netherlands	14.1	17	75.7		1980
Pakistan	81.5	2		13	1978
Philippines	48	4.6			
South Africa	28	19	40.1		1981
Spain	38.3	36	73.4		1979
Sweden	8.4	29	50.6		1979
Switzerland	6.3	15	25.4		1980
Taiwan	17.7	9			
United Kingdom	56	82	201.5		1980
USA		623	1853		1980
USSR	265.5	270			

(a) 1 Mtoe = 1.6-1.9 Mtce and is equivalent to 3.75 to 4.5 terawatt hrs electric (TWh).

TABLE E-4. Nuclear Power Growth Projections, GWe[a]

Country	Nuclear Power Capacity 1983	1985	1990	1995	2000	Reactor Mix
Argentina	0.3	0.9	1.6	2.3	3.0	PHWR
Belgium	3.5	5.4	5.4	6.7	8.0	PWR
Brazil	0.6	0.6	1.9	3.1	4.4	PWR
Bulgaria*	1.6	2.6	3.5			PWR
Canada	7.0	10.1	13.4	15.1	14.9	PHWR
Cuba*	--	--	0.4			PWR
Czechoslovakia*	0.8	3.3	3.3			PWR
Egypt	--	--	--	1.8	2.7	LWR
Finland	2.2	2.2	2.2	3.2	3.2	BWR, PWR
France	24.6	35.6	51.0	57.4	61.2	PWR, GCR, FBR
Germany (DR)*	1.7	1.7	1.7			PWR
Germany (FR)	9.8	16.4	22.9	25.4	28.8	BWR, PWR, HTGR, FBR
Hong Kong				1.8	1.8	
Hungary*	0.4	1.2	1.6			PWR
India	1.0	1.2	1.9	3.0	4.4	BWR, PHWR
Italy	1.3	1.3	1.3	4.8	6.7	BWR, PWR, GCR
Japan	16.6	21.2	32.0	39.6	49.8	BWR, PWR, HWR, GCR
Korea (ROK)	1.8	2.7	7.4	9.3	11.2	PWR, PHWR
Mexico	--	--	1.3	1.3	1.3	BWR
Netherlands	0.5	0.5	0.5	0.5	0.5	BWR, PWR
Pakistan	0.1	0.1	0.1	1.1	1.1	PHWR, LWR
Philippines	--	0.6	0.6	0.6	1.2	PWR
Romania*			1.3			PHWR
South Africa	--	1.8	1.8	1.8	2.8	PWR
Spain	2.0	5.5	7.5	8.3	10.2	BWR, PWR, GCR
Sweden	7.3	8.4	9.4	9.4	9.4	BWR, PWR
Switzerland	1.9	2.9	2.9	3.8	3.4	BWR, PWR
Taiwan	3.1	4.0	4.9	5.8	8.7	BWR, PWR
United Kingdom	6.4	10.0	10.4	10.8	13.6	GCR, PWR, FBR
USA	60.3	77.9	110.2	114.3	114.4	BWR, PWR, HTR
USSR*	--	25	90-100			PWR, FBR, LGR
Yugoslavia	0.6	0.6	0.6	0.6	2.6	PWR

(a) Capacity figures are taken from "NUKEM Market Report on the Nuclear Fuel Cycle," February 1984, unless marked with an asterisk; the latter are taken from Nuclear Engineering International, August 1983, p. 2.

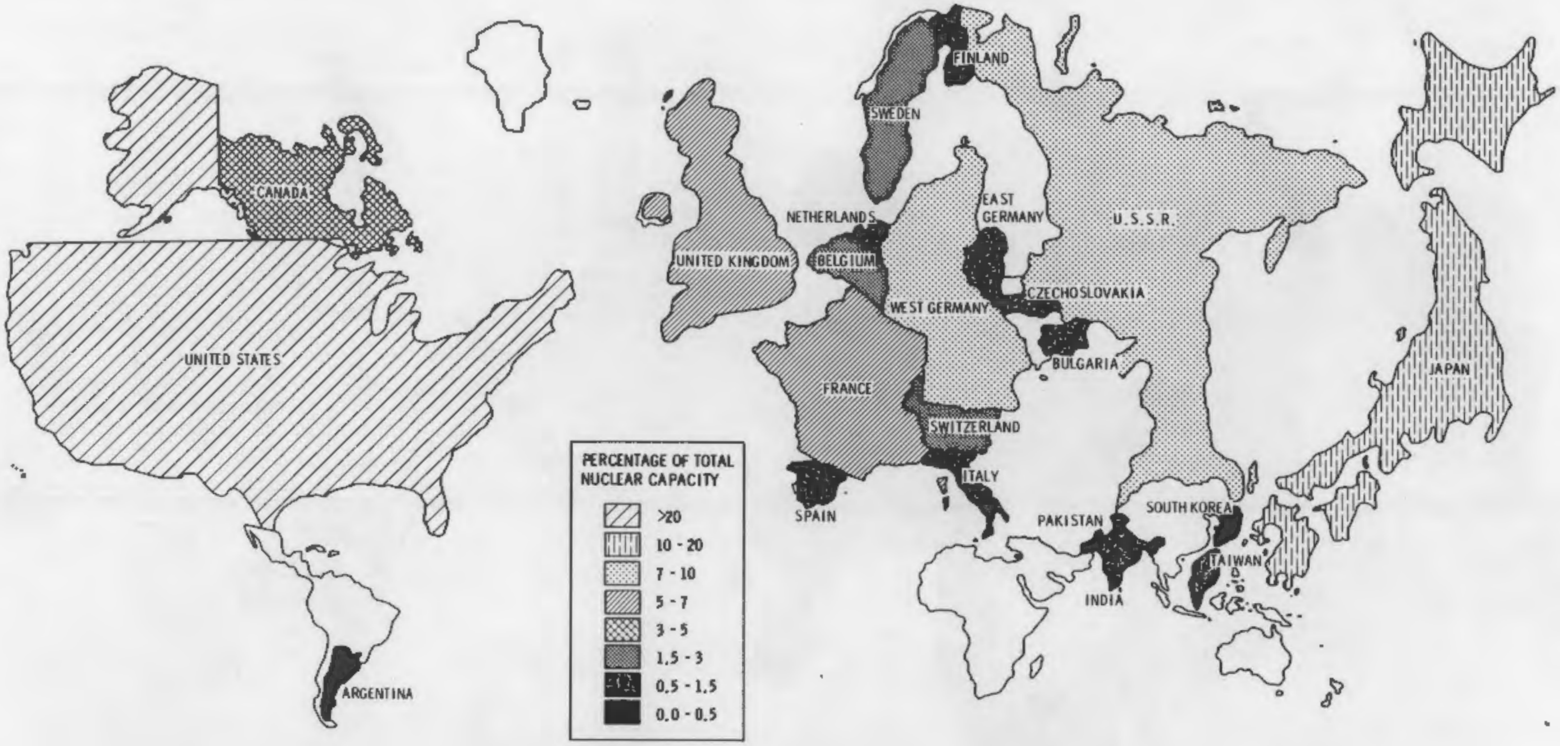


FIGURE E-3. Proportionate World Nuclear Capacity for Named Countries, As of 12/79
Source: Nuclear News, February 1980, Courtesy of HEDL

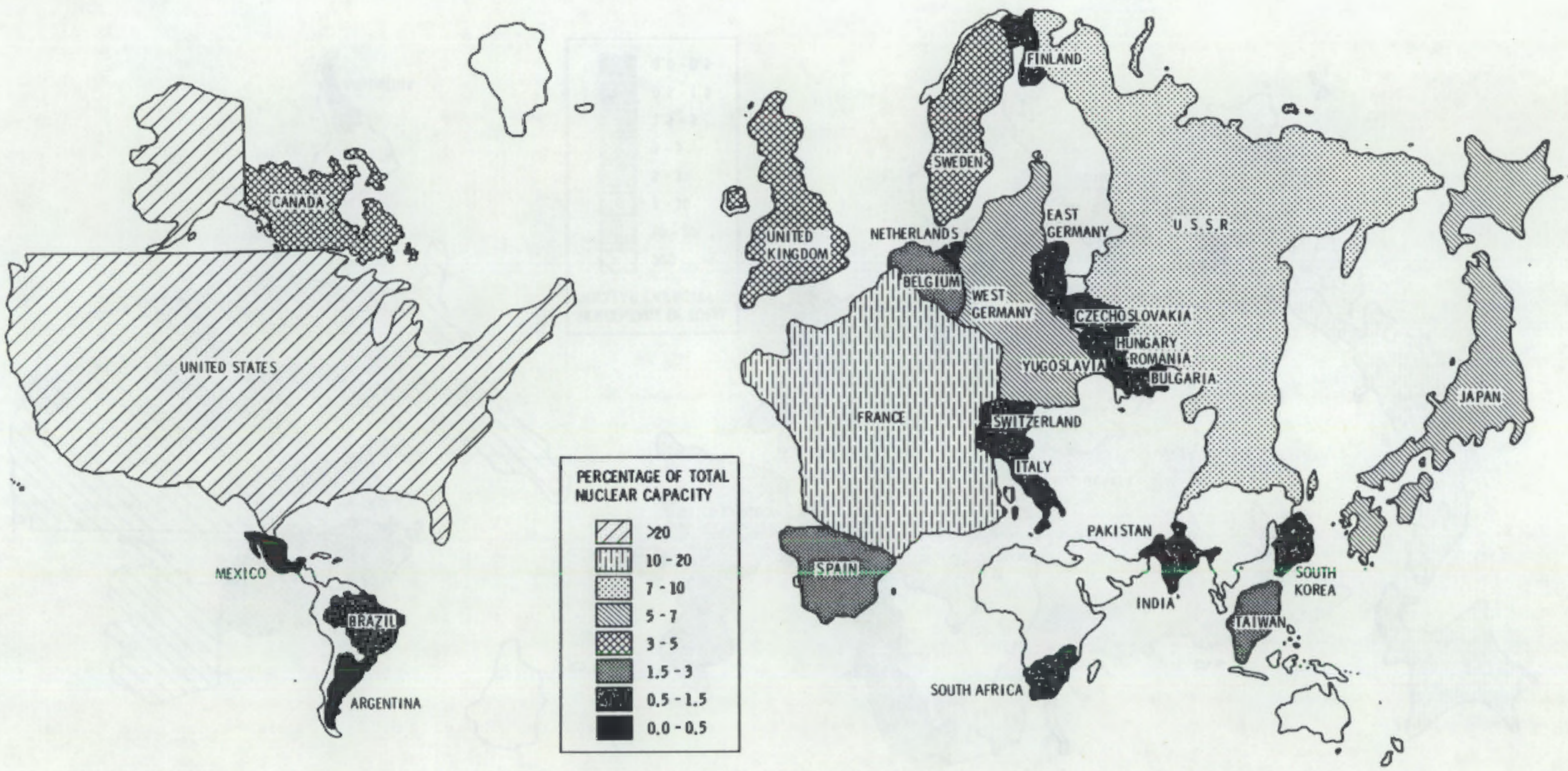


FIGURE E-4. Proportionate World Nuclear Capacity for Named Countries, As of 12/85
Courtesy of HEDL

TABLE E-5. Estimates of Total and Nuclear Electrical Generating Capacity[a]

	1980		2000[b]	
Country Group	Total Electrical GWe	Nuclear, %	Total Electrical GWe	Nuclear, %
(1) OECD North America	713	8.0	1213 1600	13.9 14.9
(2) OECD Europe	441	10.1	985 1213	29.6 29.3
(3) OECD Pacific	178	8.4	437 578	22.9 29.4
(4) Centrally-Planned Europe	368	4.3	1051 1344	9.2 15.7
(5) Asia	131	2.0	945 1132	4.7 7.1
(6) Latin America	101	0.3	304 386	7.6 11.2
(7) Africa and Middle East	63		232 311	8.0 8.8
World Total	1996	6.8	5167 6554	14.4 17.1
Industrialized Countries	1720	7.7	3716 4790	17.8 20.5
Developing Countries	276	1.1	1451 1774	5.7 8.1

(a) Source: IAEA Book "Energy, Electricity and Nuclear Power Estimates for the Period up to 2000," April 1981.
(b) The top and bottom figures are low and high estimates, respectively.

FAST BREEDER REACTOR STATUS

The relative status of FBR development worldwide is provided in Figures E-5 and E-6. The US clearly led the world in the initial stages of development. The Experimental Breeder Reactor, EBR-1, provided the first electricity ever generated by nuclear power. The US has maintained its lead in research and development but three countries, France, the Soviet Union and the United Kingdom are now operating large prototype reactors. The US prototype, CRBR, is not expected to be at full power until the end of the decade, at the earliest. A near commercial plant, the 1200 MWe Super Phenix, is scheduled to be connected to the electrical grid in France in 1985.

CONVERSION FACTORS

Tables E-7 and E-8 provide heat content and energy conversion factors.

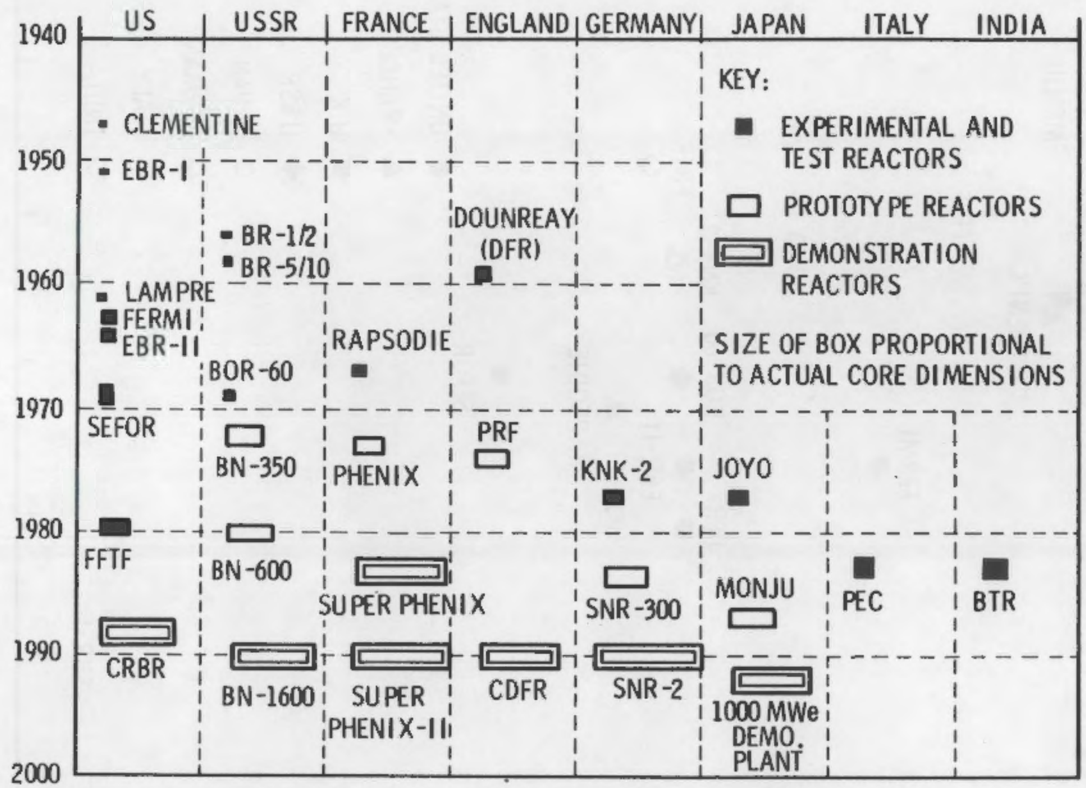


FIGURE E-5. International Fast Reactor Development

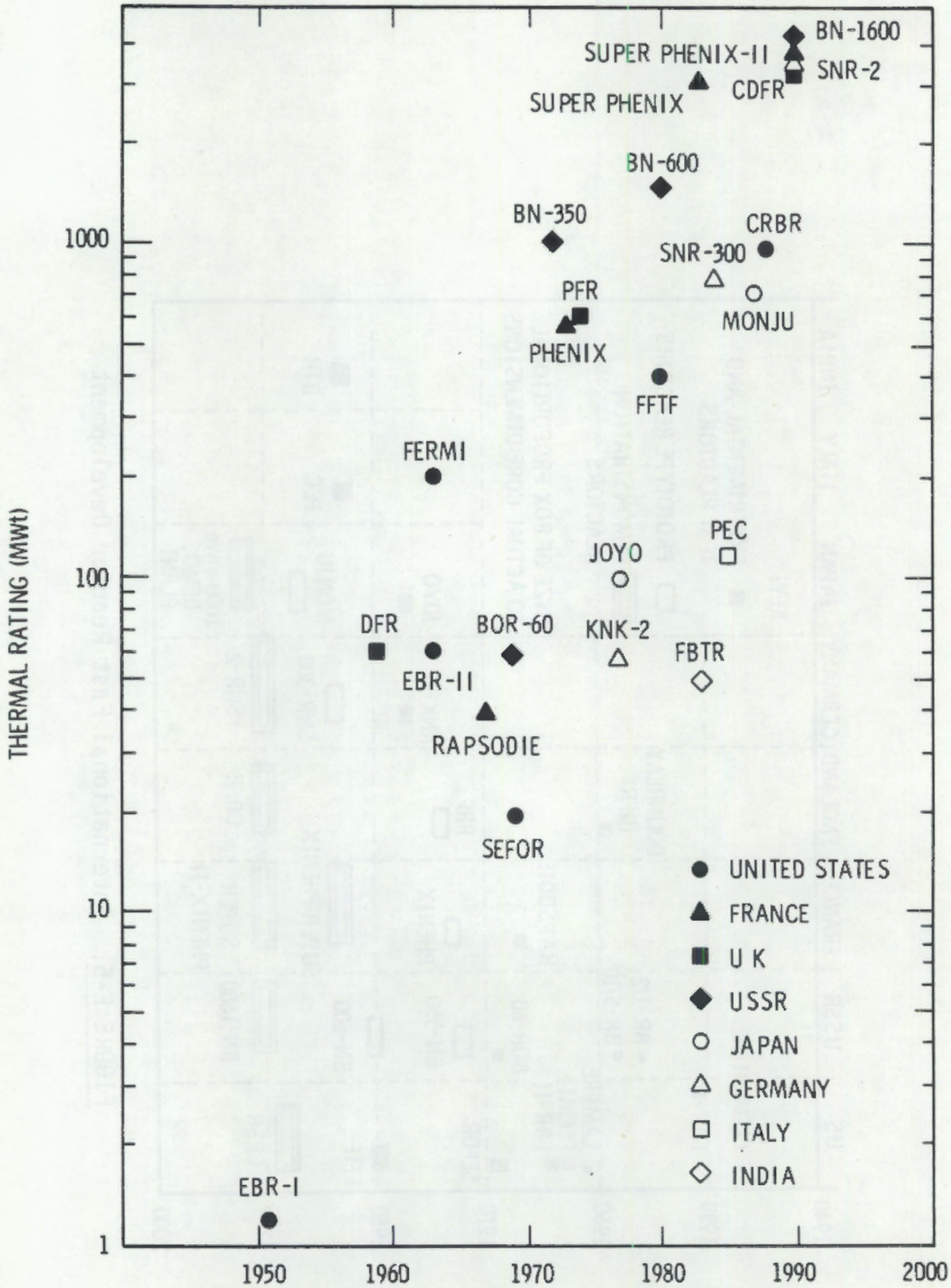


FIGURE E-6. International Fast Reactor Development

TABLE E-6. Heat Content Conversion Factors

To convert from million tonnes oil equivalent (Mtoe), multiply by the following conversion factors.

	Canada	U.S.	OECD Europe	Japan	Overall
Million tonnes coal equivalent[a]					
Hard Coal	0.69		0.70	0.73	
Lignite	0.34		0.20		
Terawatt hours[a] thermal (TWh[t])					12.5
Terawatt hours[a] electrical (TWh[e])	4.22	3.86	3.9-4.4	4.08	
Million therms[b]					425
Terajoules[b]					44,800
Barrels of oil					7.76×10^6

1 Barrel = 42 gallons
1 Terawatt hour = 10^9 kilowatt hours
1 Kilowatt hour = 3415 Btu = 8.60×10^5 calories
1 Therm = 10^5 Btu
1 Quad = 10^{15} Btu

(a) World Energy Outlook, OECD, 1977.
(b) The World Energy Book, Nichols Publishing Co., 1980.

TABLE E-7. Energy Conversion

1 Mile of Supply Train	≈10,000 T coal ≈50,000 bbl oil
Quads/Yr (input)	≈1.7 GWe capacity (32% thermal efficiency @ 0.63 capacity factor)
1 GWe power plant requires	≈51,000 T coal/week (at 32% thermal efficiency, 100% capacity)
U.S. coal-fired plants Actual coal consumption (1980)	≈56,900 miles of supply train or 569 x 10^6 T coal
U.S. oil-fired plants Actual coal consumption (1980)	≈8,420 miles of supply train or 421 x 10^6 bbl oil

FUEL CYCLE

TABLE F-1. Values of Selected Reactor Parameters[a]

Power Station	Core Power MWe(net)/MWt	Fuel Inventory (Mg HM)	Fuel Element Weight (Mg HM)
Tricastin-2 (PWR-France)	925/2785	72.46	0.46
Novo Voronezh (PWR-USSR)	420/1375	42	0.12
Krümmel KKK (BWR-FRG)	1260/3690	155.8	0.185
Bruce 4 (PHWR-Canada)	740/2515	115	0.018
Wylfa 1 (GCR-UK)	420/1650	595	0.012
Hinckley Point B1 (AGR-UK)	621/1494	113.7	0.046
Super Phenix (LMFBR-France)	1200/3000	32	0.089

(a) Information gathered from Nuclear Engineering International, July/August 1980 supplement; "World List of Nuclear Power Plants, Nuclear News, June 30, 1980; and Power Reactors in Member States, International Atomic Energy Agency, 1978.

TABLE F-2. Values of Selected Spent Fuel Parameters[a]

Power Station	Fuel Material	Cladding	Discharge Burnup (MW_t d/Mg HM)	Discharge Rate (Mg HM/ GWe Yr)
Tricastin-2 (PWR-France)	Enriched UO_2	Zr-4	33,000	33
Novo Voronezh (PWR-USSR)	Enriched UO_2	Zr	28,000	43
Krümmel KKK (BWR-FRG)	Enriched UO_2	Zr-2	27,500	39
Bruce 4 (PHWR-Canada)	Natural UO_2	Zr-4	7,085	175
Wylfa 1 (GCR-UK)	Natural U	Magnox	3,500	409
Hinckley Point B1 (AGR-UK)	Enriched UO_2	SS	18,000	49
Super Phenix (LMFBR-France)	19-27% PuO_2 in UO_2	SS	100,000	9

(a) Information gathered from Nuclear Engineering International, July/August 1980 supplement; "World List of Nuclear Power Plants, Nuclear News, June 30, 1980; and Power Reactors in Member States, International Atomic Energy Agency, 1978.

TABLE F-3. Forecast of Spent Fuel Arisings[a]

Country	Fuel Discharged (cumulative tU) 1980	1985	1990	2000
Argentina	416	940	1,900	5,800
Belgium	196	560	1,290	3,000
Brazil	--	32	180	1,000
Canada	3,650	8,800	17,700	38,000
Egypt	--	--	--	360
Finland	48	350	650	1,400
France	248	2,700	7,700	22,000
Germany (FR)	960	2,250	4,550	11,000
Hong Kong				250
India	370	780	1,580	5,000
Italy	160	330	520	2,000
Japan	1,450	4,100	8,200	20,000
Korea (ROK)	17	360	1,450	4,400
Mexico	--	--	100	500
Netherlands	103	190	270	420
Pakistan	49	110	170	440
Philippines	--	--	80	270
South Africa	--	40	310	1,200
Spain	176	490	1,300	3,400
Sweden	465	1,330	2,360	5,000
Switzerland	380	650	1,090	2,000
Taiwan	70	430	1,140	2,600
United Kingdom	250	830	2,000	5,300
USA	8,989	13,811	27,073	57,886
Yugoslavia	--	50	130	420

(a) Only UO_2 fuels from LWRs, British AGRs, HWRs and Russian oxide-fueled graphite-moderated reactors are included.

For all countries except the US, the spent fuel forecasts are estimated from data in NAC Reports C-8023, "Worldwide Spent Fuel Disposition Analysis," September 1980; and T-8106, "Light-Water Reactor Spent Fuel Storage and Reprocessing in Europe in the 1980s," December 1981; corrected to reflect current projections of nuclear power plant capacity.

US data is from "Spent Fuel and Radioactive Waste Inventories, Projections and Characteristics," DOE/NE-0017-2, May 1983.

TABLE F-4. Spent Fuel Reprocessing Activities and HLW Inventories

Country (Site)	Operation Dates	Fuel Reprocessed	HLW Inventory
Eurochemic (Mol, Belgium)	1966-1974	1,360 kg HEU 181 t LEU	800 m^3 HEWC 67 m^3 LEWC
Canada	-1979	Lab studies	16 m^3
FRG (WAK)	1971-1980	100 t (43 t LWR)	65 m^3
France (UP-1) (AVM)	1958-1983 6/78-3/83	12,000 t (GCR)	 286 t HLW glass (836 canisters)
France (UP-2, La Hague)	1966-1977 1976-1983	4,000 t (GCR) 731 t (LWR)	
India (Trombay) (Tarapur)	1965-1974 1982-		
Italy (Saluggia) (Trisaia)			 100 m^3 3 m^3
Japan (Tokai)	1977-1983	170 t	
United Kingdom	1979 1952-1980 1969-1973	 20,000 t (GCR) 90 t (LWR)	1000 m^3
United States (Nuclear Fuel Services)	1966-1971	244 t oxides 375 t metal	2100 m^3

TABLE F-5. Foreign Fuel Reprocessing Contracts (tHM)

Country	COGEMA/La Hague 1st Series (1971-1974)	COGEMA/La Hague 2nd Series (1974-1976)	COGEMA/La Hague 3rd Series (After 1976)	BNFL/ THORP
Japan	151	--	2200	1600
FRG	210	327	2141	
Sweden	57	--	672	1300
Switzerland	39	50	469	
Spain	--	?	--	
Belgium	4	99	398	
Netherlands	40	--	120	
Unknown	13	237		
Total	514[a]	713[a]	6000[a]	2900
Received Through 6-30-81	459	226	51	
Reprocessed Through 6-30-81	~220	75		

(a) Total contracted by COGEMA--each series under different terms. Reference: The Energy Daily, September 10, 1981.

TRAVEL AIDS

INTERNATIONAL DIALING INSTRUCTIONS

Telephone numbers in the International Nuclear Fuel Cycle Fact Book show country code, city code and local number, however, direct dial is not available in all areas and operator assistance may be necessary.

TO DIAL DIRECT	011 +	COUNTRY CODE 2-3 Digits	+	CITY CODE 1-5 Digits	+	LOCAL NUMBER 2-9 Digits

TO DIAL WITH OPERATOR ASSISTANCE	0 +	REQUEST THE OVERSEAS OPERATOR FOR THE COUNTRY YOU ARE CALLING

Dial "0" and ask for an overseas operator to obtain:

- numbers
- country and city codes
- rates
- other assistance.

Points to remember:

- It may take up to 45 seconds for the overseas phone to ring
- Overseas ringing and busy signals may vary
- There are time differences
- Rate discounts may apply. Call the overseas operator for information.

INTERNATIONAL STANDARD TIME CHART

	Hours From Wash., DC	Daylight Saving Time Effective Period (first and last day)
Argentina	+2	--
Australia		
(New South Wales)	+15 1/2	10/30/83-03/03/84
Austria	+6	03/25-09/29/84
Belgium	+6	03/25-09/29/84
Brazil		
(East-including all coast)	+2	--
Canada		
(Atlantic)	+1	
(Eastern)	0	04/29-10/07/84
(Pacific)	-3	
China (People's Republic)	+13	10/03/83-03/10/84
Denmark	+6	03/25-09/29/84
Finland	+7	03/25-09/29/84
France	+6	03/25-09/29/84
Germany (FRG)	+6	03/25-09/29/84
India	+10 1/2	--
Italy	+6	03/25-09/29/84
Japan	+14	--
Korea (Republic of)	+14	--
Mexico		
(Baja Calif. Norte)	-3	04/29-10/27/84
Netherlands	+6	03/25-09/29/84
Pakistan	+10	--
South Africa	+7	--
Spain	+6	03/25-09/29/84
Sweden	+6	03/25-09/29/84
Switzerland	+6	03/25-09/29/84
Taiwan (Republic of China)	+13	--
USA		
(Central)	-1	
(Mountain)	-2	
(Pacific)	-3	04/29-10/27/84
(Alaska)	-4	
(Hawaii)	-5	
USSR (Moscow time)	+8	04/01-09/30/84
United Kingdom	+5	03/25-10/27/84

PASSPORTS AND VISA REQUIREMENTS

PASSPORTS

Passports are needed to depart and re-enter the United States. To obtain current information and passport application/renewal forms contact your county courthouse. Most travel agencies also provide current information and necessary forms.

VISAS

While many foreign countries no longer have visa requirements for U.S. citizens, some still do. Most travel agencies can provide up-to-date information on visa requirements as well as the necessary forms. It is necessary to obtain most visas prior to departure, and they should be obtained well in advance from the nearest consulate of the country to be visited.

Visas are currently required for visits to the following countries:

- Argentina
- Australia
- Brazil
- China (People's Republic)
- India
- Japan
- Korea (Republic of)
- Mexico
- Pakistan
- South Africa
- Taiwan (Republic of China)
- USSR

CURRENCY EXCHANGE RATES

The following table illustrates the US dollar equivalent on 3-7-84.[a] As rates fluctuate daily, it is recommended that current rates be obtained from local banks or newspapers prior to departure.

Country	Currency	US $ Equivalent
Argentina	Peso	0.034
Australia	Dollar	0.95
Austria	Shilling	0.055
Belgium	Franc	0.019
Brazil	Cruzeiro	0.008
Canada	Dollar	0.79
China (People's Republic)	Yuan	0.49
Denmark	Krone	0.10
Finland	Markka	0.18
France	Franc	0.12
Germany (FRG)	Mark	0.39
India	Rupee	0.09
Italy	Lira	0.0006
Japan	Yen	0.004
Korea (South)	Won	0.0012
Netherlands	Guilder	0.34
South Africa	Rand	0.84
Spain	Peseta	0.0067
Sweden	Krona	0.13
Switzerland	Franc	0.47
Taiwan (Republic of China)	Dollar	0.024
United Kingdom	Pound	1.47

(a) Wall Street Journal, 3/8/84.

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