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Meeting Title: Brief on Fuel Cycle & Waste Mgmt
Activities in France

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2. Statement of Claude Mandil

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3. Statement of Jean-Louis

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4. Statement of G. Kaluzny

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Title: BRIEFING ON FUEL CYCLE AND WASTE MANAGEMENT
ACTIVITIES IN FRANCE

Location: ROCKVILLE, MARYLAND

Date: JULY 19, 1994

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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BRIEFING ON FUEL CYCLE AND WASTE
MANAGEMENT ACTIVITIES IN FRANCE

- - - -

PUBLIC MEETING

Nuclear Regulatory Commission
One White Flint North
Rockville, Maryland

Tuesday, July 19, 1994

The Commission met in open session,
pursuant to notice, at 10:00 a.m., Ivan Selin,
Chairman, presiding.

COMMISSIONERS PRESENT:

IVAN SELIN, Chairman of the Commission
KENNETH C. ROGERS, Commissioner
E. GAIL de PLANQUE, Commissioner

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STAFF AND PRESENTERS SEATED AT THE COMMISSION TABLE:

JOHN HOYLE, Acting Secretary

KAREN CYR, Office of the General Counsel

CLAUDE MANDIL, Director General for Energy and Natural Resources, Ministry of Industry

JEAN-LOUIS RICAUD, Director, Industrial Branch (COGEMA)

PHILIPPE SAINT-RAYMOND, Deputy Director, DSIN

YVES KALUZNY, Director, ANDRA (National Nuclear Waste Authority)

NOEL CAMARCAT, Director, Nuclear Fuel Cycle Division (CEA) (Atomic Energy Administration)

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P-R-O-C-E-E-D-I-N-G-S

10:00 a.m.

1
2
3 CHAIRMAN SELIN: Good morning, ladies and
4 gentlemen.

5 We're doing something somewhat unusual
6 this morning. The Commission is getting what amounts
7 to a briefing on a set of programs of great general
8 interest to us, although not necessarily a direct part
9 of our domestic regulatory responsibilities.

10 We're pleased to welcome Mr. Claude
11 Mandil, the Director General for Energy and Natural
12 Resources in the Ministry of Industry of the French
13 Republic, and his associates. Mr. Mandil and the team
14 will brief the Commission on fuel cycle and waste
15 management activities in France.

16 France has developed a full nuclear fuel
17 cycle in a technically impressive and professionally
18 competent manner and in a way that differs in some
19 significant fashions from the American philosophy. We
20 greatly appreciate your making this special trip to
21 the United States to describe your current activities,
22 accomplishments and future plans. We look forward to
23 receiving your briefing.

24 Commissioner Rogers?

25 COMMISSIONER ROGERS: Thank you very much.

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1 CHAIRMAN SELIN: Mr. Mandil, the floor is
2 yours. Thank you.

3 MR. MANDIL: Thank you very much, Mr.
4 Chairman, ladies and gentlemen. It's really a
5 pleasure and I deeply appreciate the opportunity I
6 have today to present France's nuclear fuel cycle
7 policy to your Commission. I will try to be very
8 brief.

9 I would like to have one opening remark,
10 which is to recall that obviously France and the
11 United States have a quite different energy situation
12 as France has almost no fossil fuel domestic resources
13 and that means to a quite different energy policy
14 which is evident. We decided a long time ago to have
15 a strong energy policy dedicated to self -- to safety
16 of supply, to security of supply and for the long-
17 term. We thought that resulted in first a strong
18 nuclear policy and, second, a nuclear until the end of
19 the cycle. I understand it's very different in the
20 United States, mainly because of your very abundant
21 fossil fuel resources.

22 (Slide) May I have the first chart,
23 please, which is only to tell you what -- how my
24 presentation will be made. First, one or two minutes
25 of nuclear energy in our country. Second, I will

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1 speak on waste management policy, and third, on
2 reprocessing, recycling and plutonium management, but
3 not in detail. The details will be given by my
4 colleagues.

5 First, the status of nuclear energy in
6 France. France's nuclear program currently consists
7 of 54 pressurized water reactors, all based on
8 standard designs. The second chart shows you where
9 they are in France. Sorry it's not very clear to see.
10 These units have an installed generating capacity of
11 close to 60,000 megawatt, electric megawatt, and
12 generate over 75 percent of electricity produced in
13 France. Since 1993, the units have operated with a
14 greater than 80 percent availability factor and four
15 more units are under construction. The units are,
16 you can see them, in Savoie (phonetic) and Chooz.

17 Second main topic, waste management
18 policy. Ninety percent of the nuclear waste generated
19 in France is short-lived and low and medium level
20 waste. This waste is disposed of at the Centre de la
21 Manche and the Centre de l'Aube facilities operated by
22 ANDRA. Yves Kaluzny is the Director of ANDRA. The
23 Centre de la Manche facility is full now. The last
24 waste deliveries were made last week, I think. The
25 Centre de l'Aube facility has enough capacity to cover

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1 disposal requirements for the next 40 years. This
2 type of disposal facility has never raised, I must
3 say, any problems either in terms of technology in
4 safety, neither in terms of public acceptance as well.

5 For the long-term and high level waste,
6 our approach is defined by the Waste Act of December
7 30, 1991 --

8 (Slide) Next chart, please.

9 -- which is an important act. Sorry for
10 some mistakes in English. That act was passed almost
11 unanimously by the French Parliament. This law
12 requires that research on long-lived and high-level
13 waste management be divided into three areas: first,
14 separation and transmutation of long-lived radioactive
15 elements; second, the potential for disposal in deep
16 geological formations through construction of
17 underground research laboratories; and third, surface
18 storage of waste and the containment issues that this
19 raises.

20 These research programs are funded by the
21 government and the waste generators. In 1994,
22 spending on the three research programs will be
23 approximately 260 million, 500 million and 170 million
24 francs respectively.

25 The Waste Act requires that the research

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1 findings be presented to Parliament in 15 years. That
2 means before 2006, accompanied by a draft repository
3 licensing bill if the findings so dictate. Mr.
4 Kaluzny and Mr. Camarcat will discuss the work being
5 conducted in the framework of the Waste Act in more
6 detail. What I can say is the problems are not
7 solved, the problems are difficult, more difficult in
8 high-level waste management than in low and medium
9 grade. But we have a strong political support by that
10 framework which is that act which was passed by the
11 Parliament without any opponents, two opponents I
12 think.

13 Third item, reprocessing, recycling and
14 plutonium management. We do not need to wait for the
15 outcome of these research programs to know that
16 radioactive products requiring isolation for thousands
17 of years must be minimized if future generations are
18 not to inherit mines of plutonium and long-lived
19 radioactive waste. In fact, plutonium will represent
20 95 percent of the radiotoxicity of the spent fuel
21 after 10,000 years.

22 Reprocessing and recycling of fissile
23 materials help to achieve this goal. Plutonium from
24 spent fuel reprocessing may be recycled in pressurized
25 water reactors as MOX fuel or in fast reactors, in

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1 either a breeding or an incinerating mode. Recycling
2 saves energy supplies and natural resources, which all
3 told was important for us. In addition, reprocessing
4 makes it possible to solidify the minor actinides and
5 fission products, the only real waste, devoid of
6 energy value, into forms suitable for final disposal.

7 To prevent separated plutonium from being
8 stockpiled, the French utility EDF reprocesses its
9 spent fuel only when it has a specific use for the
10 separated plutonium. Therefore, how much fuel is
11 reprocessed is not just a function of reprocessing
12 plant capacity, but also of MOX fuel fabrication
13 capacities and reactors licensed to use MOX fuel.

14 The MELOX plant at Marcoule, scheduled to
15 start up in 1995, will have capacity of 120 tons of
16 MOX fuel from the eight tons of plutonium that
17 reprocessing plant La Hague can produce each year.
18 One hundred and twenty tons of MOX fuel corresponds to
19 nearly 20 reloads. Six reactors are loaded with MOX
20 fuel at the present time. This number will gradually
21 rise to around 20 by the end of the decade and
22 possibly more later.

23 (Slide) Some figures which are given by
24 the -- yes, by that chart, a reactor loaded with MOX
25 fuel produces plutonium and consumes it at the same

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1 time. Currently a reactor loaded with MOX fuel
2 produces a total of 60 kilograms of plutonium per
3 year, while a reactor loaded with conventional fuel
4 produces 230 kilograms of plutonium per year.
5 Research is underway to reduce the net plutonium
6 production of reactor loaded with MOX fuel further or
7 even to make it a negative value. The MOX fuels at
8 the present time is -- the reactors with MOX fuels are
9 30 percent MOX fuels only.

10 Recycling in fast reactors, research is in
11 progress to study the potential for incinerating
12 plutonium in fast reactors. This is the subject of
13 the CEA's CAPRA program in which several countries are
14 participating, including Japan. Superphenix will
15 restart in a few weeks for this purpose.

16 Depending on the results of this program,
17 we could ultimately foresee a mixed reactor program
18 that combines pressurized water reactor operating with
19 conventional fuel or MOX fuel and fast reactors. This
20 would allow us to stabilize our plutonium inventory,
21 whether or not the plutonium is separated.

22 In conclusion, I would like to say that
23 our use of plutonium in the nuclear power program is
24 already a commercial reality that meets our needs in
25 terms of natural resource conservation and

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1 environmental protection and that does not raise
2 proliferation concerns because it is properly
3 safeguarded by international organizations such as the
4 IAEA.

5 Plutonium is produced by reactor
6 operations, not by reprocessing. Reprocessing is a
7 relatively simple chemical operation that merely
8 separates plutonium, but it requires impressive
9 facilities to protect operating personnel from
10 radiation and to protect the environment. Some power
11 reactors, such as the Canadian Candu reactor, permit
12 continuous discharge of low irradiated fuel capable of
13 supplying weapons grade plutonium. These reactors are
14 therefore intrinsically more proliferating than
15 pressurized water reactors and the reprocessing plants
16 that serve them.

17 Lastly, countries that have proliferated
18 in recent years via the plutonium path have done so
19 with materials from continuous discharge reactors or
20 from research reactors. In no case have pressurized
21 water reactors, fast breeder reactors or commercial
22 reprocessing plants safeguarded by the IAEA been
23 implicated.

24 In this regard, there is no need to
25 tighten safeguards on nuclear facilities already

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1 safeguarded by the IAEA, nor is it necessary to adopt
2 international plutonium management measures. However,
3 it is certainly essential to show greater openness and
4 complete transparency and to explain how plutonium is
5 used by the civilian nuclear industry and in what
6 amounts. France is prepared to act so.

7 We will now show you a film, a movie, to
8 illustrate my remarks. Then I will turn the floor
9 over to Mr. Ricaud, Mr. Kaluzny, and Mr. Camarcat, who
10 will explain the points I have raised in greater
11 detail.

12 I thank you.

13 CHAIRMAN SELIN: Thank you.

14 (Video presentation.)

15 FEMALE NARRATOR: The beginning of the
16 summer of 1994 coincides with the completion of the
17 58th French nuclear power station located at Civo in
18 Western France. At present, 54 PWR nuclear units are
19 being operated in France and four more units are
20 currently under construction. In 1993, nuclear power
21 accounted for 78 percent of the electricity produced
22 by EDF, making France the number one user of this type
23 of energy.

24 MALE NARRATOR: Three important
25 organizations contribute to making the French nuclear

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1 industry a coherent system: the CEA, with its research
2 centers at Saclay, Fontiney (phonetic), Grenoble and
3 Cadarache; COGEMA and its subsidiaries, with the
4 Eurodif fuel enrichment plant, the fuel production
5 plants at Omon (phonetic), Pierrelatte and Cadarache,
6 and the reprocessing plant at La Hague; and finally
7 ANDRA with its radioactive waste storage centers in La
8 Manche and L'Aube departments.

9 FEMALE NARRATOR: Development and growth
10 have always gone hand in hand with increased energy
11 demands. However, the world's energy resources are
12 very unevenly distributed between the various consumer
13 countries. The life expectancy of the proven reserves
14 varies considerably from one type of energy to the
15 next. As a result, there are many different energy
16 policies reflecting the diversity of the situations
17 confronting individual countries.

18 Viewed in this context, France's situation
19 is characterized by a distinct imbalance. The country
20 owns less than 0.1 percent of the known energy
21 reserves on the planet, whereas it has a level of
22 consumption which represents almost three percent of
23 the world total.

24 The geography of France certainly lends
25 itself to hydropower production, but almost all the

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1 worthwhile sites have already been equipped. France
2 consequently decided, following the first oil crisis
3 in 1973, to pursue an ambitious policy designed to
4 limit energy dependency. This involved, on one hand,
5 a far-reaching energy saving program and, on the
6 other, the development of nuclear fueled electricity
7 production.

8 Thanks to this strategy which has been
9 diligently implemented, the energy independence of
10 France has climbed from 22 percent in 1973 to almost
11 50 percent today.

12 MALE NARRATOR: In order to guarantee its
13 independence in terms of energy requirements, France
14 has over the last 30 years built up its own nuclear
15 fuel cycle industry. In 1976. COGEMA was appointed to
16 manage this industry. Today, the group is involved in
17 all stages of the cycle, extraction, conversion,
18 uranium enrichment, fuel production, reprocessing and
19 recycling.

20 FEMALE NARRATOR: As far as the end of the
21 cycle is concerned, both for energy-related reasons
22 and in order to optimize ultimate waste management,
23 France chose a closed cycle involving the reprocessing
24 of spent fuel and recycling of valuable matter.

25 MALE NARRATOR: Up to now, over 15,000

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1 tons of gas graphite fuel and 6,000 tons of light
2 water fuel have been reprocessed by the Marcoule and
3 La Hague facilities.

4 At present, COGEMA can handle 1600 tons of
5 light water fuel per year at its La Hague facility.
6 The UP2-800 and UP3 plants, each of which can process
7 800 tons per year, equivalent to the tonnage produced
8 by 80 to 100 reactors, process spent fuel from France,
9 elsewhere in Europe, Germany, Switzerland, Belgium and
10 the Netherlands and Japan. These fully automated,
11 remote controlled plants, UP3 was commissioned in
12 1990, followed in 1994 by UP2-800, belong to the new
13 generation of reprocessing plants and represent the
14 advent of industrial maturity for the end of the
15 cycle.

16 FEMALE NARRATOR: The plants were designed
17 to comply with extremely strict standards set by the
18 French authorities with respect to safety, the dose
19 exposure of personnel, environmental impact, and the
20 volume and toxicity of the ultimate waste. In 1994,
21 La Hague will reprocess 1300 tons of fuel and should
22 reach its design capacity of 1600 tons per year by
23 1996. This gradual build-up to full capacity has been
24 taking place since 1990 under excellent operating and
25 safety conditions and the order book for the plant is

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1 almost full for next ten years.

2 MALE NARRATOR: Spent nuclear fuel is
3 transported to La Hague in special containers or
4 casks. The casks are shipped from Japan and
5 transported by rail from other areas of France and
6 Europe. They pass through the Valonia (phonetic) rail
7 terminal and are then taken to the plant on trucks.
8 COGEMA has special lifting facilities at the Port of
9 Chevoir (phonetic) and at Valonia, which have so far
10 handled a total of 15,000 tons of light water fuel.

11 The casks are either unloaded dry in the
12 T0 workshop or underwater in the NPH workshop. The
13 fuel is stored for several years underwater in one of
14 the four pools on the site which have a total capacity
15 of 14,000 tons. After this, the fuel is reprocessed.

16 FEMALE NARRATOR: Reprocessing involves
17 taking the spent fuel and separating any recyclable
18 matter containing energy, uranium, 96 percent, and
19 plutonium, one percent, from unrecoverable fission
20 products, three percent. The latter must be
21 conditioned in the form of final residue prior to
22 long-term storage.

23 MALE NARRATOR: All the reprocessing
24 operations are part of a continuous process. The
25 first stage involves shearing and dissolution. After

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1 removal from the pool, the spent fuel is cut into
2 sections three centimeters long and then immersed in
3 a dissolver filled with nitric acid. Here the nuclear
4 matter, uranium, plutonium and fission products, is
5 transformed into a solution. The uranium and the
6 plutonium are then separated from the fission products
7 by a chemical process, purified and conditioned prior
8 to recycling.

9 FEMALE NARRATOR: Nowadays the recovery
10 rates for plutonium and uranium have reached fairly
11 satisfactory levels, 99.88 percent, which helps to
12 keep the plutonium toxicity of ultimate waste as low
13 as possible. Only 0.1 percent of the plutonium ends
14 up in the vitrified waste.

15 Concerning personnel dose exposures and
16 the impact on the environment, the facilities are
17 designed and operated in such a way as to keep both as
18 low as reasonably achievable, or ALARA. Personnel
19 dose exposure results for 1993 show an annual average
20 per person per year of 0.43 millisevert, which is ten
21 times lower than the standard currently applied to the
22 general public and 100 times lower than the standard
23 for people working in the industry.

24 MALE NARRATOR: The principles underlying
25 the design of the plant, such as the choice of a

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1 completely centralized control system or robot
2 maintenance techniques which are remote-controlled
3 from the workshops, go a long way to explaining these
4 results.

5 FEMALE NARRATOR: An impact study of waste
6 released into the sea shows that its effect has
7 steadily declined, despite the fact that over the same
8 period the plant has gradually been building up to
9 full capacity.

10 MALE NARRATOR: The volume of reprocessed
11 fuel rose from 250 tons in 1984 to almost 1,000 tons
12 in 1993. At the same time, the alpha and beta gamma
13 emitters, not including tritium, contained in the
14 releases have been reduced by a factor of between five
15 and ten. In order to monitor the impact of the
16 releases on terrestrial and marine ecosystems as
17 precisely as possible, COGEMA l'Aube collects and
18 analyzes about 20,000 samples, grass, milk, sand, fish
19 and so on, every year.

20 FEMALE NARRATOR: The results show that
21 when detectable the impact on each species or element
22 under analysis corresponds to a few percent of natural
23 radioactivity. Under these conditions, the releases
24 from La Hague have a negligible effect on the health
25 of the local population, equivalent to about 1,000 of

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1 the permissible annual limit for the general public.

2 Any industrial activity produces waste.
3 The reprocessing and recycling of spent fuel produces
4 two main types of waste: process waste, or in other
5 words fuel components, fission products and the
6 metallic substances in the fuel which cannot be
7 reused; technological waste, or in other words waste
8 produced during reprocessing itself, most of which is
9 fairly inactive.

10 MALE NARRATOR: At La Hague, in the UP3,
11 UP2-800 generation plant, all waste is conditioned on-
12 line. Fission products are enclosed in a glass
13 matrix. Hulls and end fittings are concreted. Solid
14 technological waste, pumps, valves, gloves and used
15 equipment, are also concreted. Effluent processing
16 sludge is packed in bitumen.

17 FEMALE NARRATOR: In all cases, the
18 residues are elaborated in the same way as any other
19 industrial product, with technical specifications
20 which must meet very precise requirements approved by
21 the French safety authorities and their equivalent in
22 Japan, Germany, Switzerland, Belgium and the
23 Netherlands. Following processing at La Hague, the
24 residues are stored for several years on-site before
25 being returned to the owners, the power companies.

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1 MALE NARRATOR: To begin with, the fission
2 product solutions are calcinated in the vitrification
3 facilities at La Hague. The resulting calcine is then
4 mixed with glass frit and the mixture is heated to
5 over 1,000 degrees in order to obtain homogeneous and
6 chemically stable glass, capable of guaranteeing
7 effective, long-term confinement of the radioactive
8 matter. The glass is then poured into refractory
9 steel containers which are subsequently stored in
10 ventilated pits prior to reshipment.

11 Up to now, the vitrification facilities at
12 La Hague have produced over 2700 glass containers and
13 have conditioned all the fission products separated by
14 UP3 and UP2-800.

15 At the end of 1994, the first cask
16 containing 28 glass containers will be handed over to
17 the owners of the residues, a group of Japanese power
18 companies. The cask will return to Japan on one of
19 the ships which regularly transport spent fuel between
20 Europe and Japan.

21 The volume of waste produced by UP3 is
22 already extremely low. Between now and the year 2000
23 further progress is expected. In 1995, the use of
24 bitumen is to be discontinued and the introduction of
25 new compaction and incineration technologies a few

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1 years later should cut the volume of metallic and
2 technological waste by a factor of five.

3 At present, the total volume of high and
4 medium activity waste produced during reprocessing is
5 lower than the estimates made by the Swedes on the
6 basis of direct storage of conditioned spent fuel.
7 Looking ahead to the end of the century, this amount
8 should have fallen to less than 0.5 cubic meters per
9 ton or, in other words, one-third of the volume of
10 conditioned, unprocessed fuel.

11 FEMALE NARRATOR: EDF activity as a
12 nuclear power producer is part of a long-term
13 strategic perspective, especially with regard to the
14 management of plutonium. Part of the plutonium
15 produced in nuclear fuel during its presence in the
16 reactor undergoes a fission reaction and thus accounts
17 for between 30 and 40 percent of the electricity
18 produced by nuclear power stations. The remaining
19 plutonium, which is recovered during reprocessing, can
20 in turn be used. It has considerable potential as an
21 energy source. During the first MOX recycling
22 process, a gram of plutonium can produce as much
23 electricity as a ton of oil. This explains why the
24 French power company plans to recycle its plutonium in
25 the form of MOX fuel for use in its 900 megawatt PWRs.

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1 MALE NARRATOR: Seven PWRs have already
2 been loaded with this fuel and EDF plants do MOX 22 to
3 28 of its 900 megawatt reactors between now and the
4 end of this century. MOX fuel performance is
5 gradually approaching the levels achieved by enriched
6 uranium fuel. High burn-up, 45,000 megawatt days per
7 ton of uranium. Load and grid following, quarter core
8 reload management.

9 FEMALE NARRATOR: A MOX reactor has a
10 distinct advantage over an enriched uranium reactor.
11 It produces very little or no plutonium at all, thus
12 contributing to stabilizing or even reducing the
13 plutonium inventory when burn-up increases. Then, as
14 more and more nuclear power plants are MOXed, so less
15 and less plutonium will be produced.

16 MALE NARRATOR: The techniques used to
17 recycle plutonium are currently the subject of
18 significant research and development programs in
19 France. Their aim is to improve the efficiency of
20 existing reactors and prepare the way for a new
21 generation of reactors. Within this framework, the
22 CEA is pursuing two lines of development, increase the
23 proportion of plutonium in light water reactor fuel
24 and burn-up in MOX cores, develop new types of
25 reactors, in particular fast breeder reactors which

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1 are especially adapted to consume plutonium fuel. It
2 is also studying the use of these new types of
3 reactors for transmuting actinides and fission
4 products separated during reprocessing.

5 FEMALE NARRATOR: This research work
6 benefits in particular from the capacities of the
7 Superphenix fast breeder reactor which, just recently
8 on July 12th, 1994, was newly authorized to start-up
9 operations.

10 MALE NARRATOR: Two manufacturing plants
11 currently supply French and European reactors with MOX
12 fuel, the Dessel plant in Belgium, which belongs to
13 Dessel plant in Belgium, which belongs to Belgo
14 Nucleaire, and the Cadarache plant in France, which is
15 run by COGEMA.

16 FEMALE NARRATOR: From 1995 onwards,
17 capacity will increase with the industrial start-up of
18 the MELOX factory currently nearing completion at
19 Marcoule in Southeast France. MELOX, with a
20 production capacity of 120 tons per year, is the first
21 fully automated plutonium fuel manufacturing unit.

22 MALE NARRATOR: Plutonium arrives at MELOX
23 in specially designed transport casks. Inside each
24 cask, three successive barriers of packing guarantee
25 plutonium confinement. Without leaving its cask, the

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1 plutonium is stored in a safe under the constant
2 surveillance of the factory operator. As is the case
3 with all the other reprocessing and recycling
4 activities in France, MELOX operations are placed
5 under the control of the appropriate national and
6 international authorities and, in particular, the IAEA
7 and EURATOM.

8 FEMALE NARRATOR: The MELOX production
9 process uses proven and qualified techniques. As with
10 the case at La Hague, the search for high performance
11 of MELOX and the determination to provide the best
12 possible working conditions for personnel, lead to the
13 choice of a fully automated control system. A real
14 time computer system tracks products, monitors their
15 compliance with specifications, and manages the
16 nuclear materials passing through the facility.

17 MALE NARRATOR: To begin with, the
18 plutonium and uranium oxide powders are measured and
19 mixed in a ball crusher to obtain a homogeneous
20 mixture. The powder is then made into pellets. The
21 pellets are then centered in high temperature
22 continuous process furnaces prior to being ground and
23 sorted by an expert system using image recognition
24 technology. Product quality is monitored on a
25 permanent basis by laboratory analysis of samples

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1 taken at various stages of the production process.

2 Once they have been accepted, the pellets
3 are packed into fuel rods which are assembled in a
4 special square sided structure to complete the fuel
5 assembly. At MELOX, the assembly technologies are
6 exactly the same as those used in uranium fuel
7 manufacturing plants. MELOX will output approximately
8 100,000 pellets per day or, in other words, 350 rods,
9 corresponding to approximately one fuel assembly.

10 FEMALE NARRATOR: The design of the MELOX
11 plant and its subsequent operation are subject to
12 extremely strict safety requirements, especially with
13 respect to product confinement, fire protection,
14 earthquake resistance, protection of personnel, as
15 well as management of rejects and waste.

16 MALE NARRATOR: The average radiological
17 exposure for operating personnel at MELOX will be less
18 than one-tenth of the maximum permissible annual dose
19 and liquid and gas releases will be negligible. In
20 addition, all the waste produced by the MELOX plant
21 will be sorted, recycled and conditioned on-line.
22 Production rejects will be completely recycled either
23 by the MELOX process itself or by dissolution at La
24 Hague. Wherever possible, waste will be incinerated,
25 ash will be lixiviated in order to extract any

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1 plutonium and the final residues will be vitrified.
2 Waste which cannot be incinerated will be
3 decontaminated and conditioned in concrete prior to
4 final storage.

5 FEMALE NARRATOR: In France, radioactive
6 waste is managed by ANDRA, Agency for Radioactive
7 Waste Management. Management concepts vary, depending
8 on whether they concern long or short-lived waste.

9 MALE NARRATOR: Most short-lived waste is
10 produced by nuclear power plants, but hospitals,
11 industry and certainly research centers are also
12 responsible for small amounts. Waste is compacted and
13 packaged on-site. The waste inside the packages is
14 coated. The packages are checked.

15 FEMALE NARRATOR: ANDRA has drawn up
16 specifications relating to the nature and
17 radioactivity of waste as well as how it should be
18 packed. For instance, all waste should be solidified
19 inside the packages. The size and shape of packages
20 have also been standardized. Radioactive waste has
21 become a stable, reliable industrial product.

22 ANDRA carries out regular audits of waste
23 producers, checking the quality of waste packaging.

24 MALE NARRATOR: Once it has been prepared,
25 each package is numbered. It can thus be monitored by

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1 a computer until final storage. Waste packages travel
2 from the production site to the storage center by road
3 and rail. As is the case for all nuclear materials,
4 their transport is subject to national regulations
5 based on international recommendations. Their safety
6 depends to a large extent on the quality of the
7 packaging and the precision of transport procedures.

8 FEMALE NARRATOR: Today, all short-lived
9 waste produced in France is stored at the Aube Center.
10 It is taken over from the Manche Center where the
11 operating phase has just ended. Five hundred twenty
12 five thousand cubic meters of waste are now stored at
13 the Manche Center. The Aube Center has a capacity of
14 one million cubic meters.

15 MALE NARRATOR: On arrival at the center,
16 the load is checked for conformity with a consignment
17 note. Thanks to the experience gained at the Manche
18 storage center, ANDRA has improved the storage
19 conditions for short-lived waste. Waste is placed in
20 concrete enclosures protected from the rain by
21 removable roofs until they are enclosed. A laser beam
22 reads the bar code label on each package. All the
23 data are centralized, providing accurate information
24 as to the location of each package within the
25 structure. A layer of concrete is poured over each

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1 layer of packages. Once the enclosure is full it is
2 enclosed by a reinforced concrete slab.

3 The storage cells at the Aube Center will
4 subsequently be covered in the same way as at the
5 Manche Center, by a final protective layer comprising
6 a bituminous membrane and several layers of clay and
7 topsoil which will then be grassed over. This
8 covering protects the waste packages from the weather.

9 The tightness of the storage systems at
10 the Manche and Aube Centers can be checked from a
11 series of inspection galleries running underneath the
12 structures.

13 FEMALE NARRATOR: The Aube site will enter
14 its monitoring phase in about the year 2040. This
15 phase will last 300 years, until the radioactivity in
16 the waste has declined to the same level as natural
17 radioactivity.

18 MALE NARRATOR: The site has created about
19 200 jobs, 80 percent of which are for local people.
20 It contributes to the local economy and has been
21 accepted by the population, who enjoy access to all
22 the information concerning environmental monitoring
23 and the running of the center.

24 The technology used at the Aube Center has
25 earned international recognition and has been exported

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1 in particular to El Cabril Center in Spain and to the
2 USA.

3 FEMALE NARRATOR: Long-lived radioactive
4 waste, and in particular the glass canisters produced
5 in the reprocessing plants, or CEA centers, is stored
6 temporarily on the production site. During the '70s
7 and '80s, it was thought that this type of waste could
8 be buried deep underground. This type of solution was
9 considered by a number of countries at that time.
10 However, when steady work turned to specific sites,
11 the local population reacted unfavorably to the idea
12 of long-term storage.

13 After a two year moratorium, the French
14 Parliament voted the law dated December 30th, 1991.
15 It sets out lines of research for the long-term
16 management of radioactive waste. The findings of this
17 research work will be examined by Parliament in the
18 year 2006, at which point the appropriate solution
19 will be chosen.

20 MALE NARRATOR: Amongst the solutions
21 currently under study, ANDRA is looking at storage in
22 deep geological formations. In order to check the
23 validity of this solution, it has been decided that
24 ANDRA should build underground laboratories.

25 FEMALE NARRATOR: The government appointed

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1 a member of parliament to act as Mediator and look for
2 local authorities interested in accommodating an
3 underground laboratory.

4 MALE NARRATOR: Following this stage,
5 ANDRA has been authorized to proceed with preliminary
6 work on four sites, one in a granite rock formation,
7 the three others in clay. The siting of the
8 laboratories depends on technical safety
9 considerations, but also requires the approval of
10 local authorities.

11 FEMALE NARRATOR: ANDRA has carried out
12 information campaigns and its own engineers present
13 the projected laboratories to the general public and
14 explain the preliminary work involved. These
15 campaigns are currently underway in four French
16 departments, which volunteered to accommodate a
17 laboratory.

18 MALE NARRATOR: The projects are
19 illustrated by scale models. On the surface, the
20 laboratories look very much like small industrial
21 estates. The underground parts of each laboratory
22 will comprise several experimental halls linked by a
23 system of galleries. Research will be carried out on
24 the digging and the supporting of these galleries.
25 Hydraulic, thermal and mechanical studies will also be

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1 carried out in order to confirm that underground
2 storage is effective and safe for the very long-term
3 confinement of radioactive waste.

4 Experiments are being carried out in
5 association with foreign laboratories. They will
6 subsequently be carried out in underground
7 laboratories in France. They concern excavation
8 techniques as well as rock strength, permeability and
9 confinement capacity.

10 FEMALE NARRATOR: The results of this
11 research work will be taken into account by the French
12 Parliament when it takes its decision in the year
13 2006. Thanks to a flexible schedule and the
14 government's political commitments, the debate on the
15 management of long-lived radioactive waste now enjoys
16 some much needed serenity.

17 (Video presentation concluded.)

18 CHAIRMAN SELIN: That was an excellent
19 film. We are particularly impressed that it includes
20 a fact that happened only last week.

21 MR. MANDIL: That's right. May I give the
22 floor to --

23 CHAIRMAN SELIN: Please.

24 MR. MANDIL: Jean-Louis Ricaud from COGEMA
25 now.

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1 MR. RICAUD: I am Jean-Louis Ricaud,
2 COGEMA Senior Vice President for Reprocessing and
3 Engineering Divisions, and it's a pleasure for us
4 today to have opportunity to share information with
5 you.

6 As you know, COGEMA is a complete fuel
7 cycle company which include front-end activities, like
8 mining, uranium enrichment, fuel fabrication in
9 Framatome and which is also involved in back-end
10 activities like reprocessing and plutonium recycling.

11 As was shown in the movie, COGEMA operates
12 two reprocessing plants in La Hague and these plants
13 have reprocessed from the beginning to now more than
14 6,000 metric tons of light-water fuels. In '94, we'll
15 process more than 1,000 square tons of light-water
16 spent fuel for our European and Japanese and French
17 customers. There are more than 9,000 tons of spent
18 fuel which are now safely stored in our ponds waiting
19 for reprocessing. So, we have the feeling that these
20 results demonstrate safe, reliable and environmentally
21 sound operations.

22 Nowadays, recycling of reprocessed uranium
23 in standard fuels is well demonstrated. Recycling of
24 plutonium as MOX has been demonstrated in light-water
25 reactors since the early '60s. In '93, there are more

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1 than 50 tons of MOX fabrication capacity which is in
2 the operation and it will rise progressively to 300
3 tons by the end of century. So, new plants, like
4 MELOX and BNFL plant in Great Britain. MELOX, the new
5 MOX fabrication plant in Marcoule, the South of
6 France, will start up by the end of this year and will
7 begin with the industrial operation in '95, next year.

8 Today, seven light water reactors, the
9 last one is Blayais, which was just loaded with MOX
10 fuel at the end of last month and which will start up
11 soon. Seven such units now are loaded with MOX fuels.
12 I think it's possible to say that the operating
13 experience is totally satisfactory. By 2000, when all
14 the investment and all the licensing will be done,
15 will be completed, sorry, MOX will be loaded in at
16 least 16 and I'm quite sure 20 to 28 units in France.
17 So, it means that now plutonium recycling is an
18 industrial reality.

19 I would like to focus on two specific
20 topics which are economics and non-proliferation
21 topics, which are, of course, very important ones in
22 these fields because we know, of course, that some,
23 especially here, criticize reprocessing and recycling
24 on economic grounds. Certainly if you look to this
25 cost of reprocessing and recycling and compare it only

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1 to this price for uranium enrichment, you may reach
2 that conclusion. However, in countries which don't
3 have the vast energy resources you enjoy here in the
4 U.S., reprocessing and recycling make eminent sense.

5 Just have a look at the most recent OECD
6 report which tried to compare the cost of recycling
7 route and once-through cycle and it demonstrate that
8 the costs don't differ very much. This chart in front
9 of you show you that with a discount rate of -- the
10 cost difference between the two routes is about .06
11 Francs spent a kilowatt hour. Of course, if you tried
12 to compare these two routes, you are to take into
13 account the fact that cost of reprocessing and
14 recycling are quite well known, while cost of other
15 routes are estimated. But through reprocessing and
16 recycling, waste streams are segregated and
17 conditioned in a manner which would permit
18 optimization of disposal methods. Finally, that the
19 evolution of cost in the future in the front end is
20 forecast to be clear. I mean the cost might increase
21 and the comparison will change.

22 We don't think that those who view the
23 question differently must adopt our conclusions.
24 However, we have the feeling that our choice has been
25 made on the basis of a careful analysis as a part of

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1 a long-term, coherent energy strategy.

2 CHAIRMAN SELIN: I would like to stop you
3 for a minute. First, I'd like to apologize for
4 changing your name. I rather like Jean-Claude as a
5 name, but if you want to still be Jean-Louis, that's
6 all right. But let me ask you a question about the
7 reprocessing.

8 There are actually two stages in the
9 reprocessing, one of which separates out the uranium
10 and some of the plutonium from the rest of the
11 plutonium and the wastes, and the second one which
12 further refines the waste to try to separate almost
13 all the plutonium from the waste. The economic value
14 of the plutonium is not large. You're only talking
15 about one percent of the entire recycled fuel to be
16 plutonium. If you did not have the second stage, if
17 you did not try to purify the wastes of plutonium, it
18 is true there would be some plutonium in the waste,
19 but it would be in a very highly toxic form where the
20 risk of somebody converting this into weapon material
21 is rather low.

22 I should also tell you we are not trying
23 to figure out what the French should do, but we are
24 asked by the Chinese, by the Slovaks, by the Czechs
25 what they should do about waste. I'm trying to

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1 understand what the benefit is of that second stage of
2 plutonium separation because it does contribute
3 considerably to the cost. I wonder if you could
4 address that question.

5 MR. RICAUD: You're absolutely right. In
6 fact, that's true that the new reprocessing plants,
7 like UP3 and UP2-800, have been designed as to reduce
8 as low as possible plutonium quantities in the waste.
9 You saw in the movie a figure which showed that we
10 extract close by 99.9 percent of plutonium and that in
11 the waste it will remain 0.1 percent of plutonium. We
12 made calculation as to try to answer the question you
13 raise. It's our feeling that if we assume that we try
14 to reach only 99 percent and not 99.9, we shall
15 decrease reprocessing and recycling route cost for
16 about 30 persons. So, it means that coming from 99 to
17 99.9 percent of plutonium in spent fuel increased the
18 cost of the route of 30 persons.

19 CHAIRMAN SELIN: What is the benefit of
20 doing this last stage? What is the reason behind
21 doing it?

22 MR. RICAUD: The reason for COGEMA is that
23 its customer asked for and why they ask for, because
24 in France, for example, if the authorities ask for,
25 you have to know. For example, for a MELOX plant

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1 which will manage, roughly speaking, ten tons of
2 plutonium per year, we are asked not to have more than
3 300 grams of plutonium in the waste per year. So, we
4 are asked by our clients to do that. So, that's, in
5 fact, I think linked to the general approach in these
6 fields, which is our approach in France and in some
7 countries where we say we have to decrease as low as
8 reasonably achievable.

9 CHAIRMAN SELIN: But the toxicity of the
10 waste -- is the toxicity of the waste changed
11 considerably by taking out that last one-tenth, one
12 percent of plutonium? It's not an economic question
13 obviously. Is it a question of toxicity or is it a
14 question of safety or is it a question -- I don't
15 quite understand what the benefit is. Is it toxicity?

16 MR. RICAUD: My feeling is that it might
17 be a critical benefit. I mean it will demonstrate
18 that the waste we'll have to bury will be as low
19 contaminated as reasonably achievable. And to say,
20 "Okay, we may prove that the waste, the glass
21 canisters, we include as low quantity of long-lived
22 emitters as we were able to do." I think we say that
23 it was quite important agreement to use --

24 CHAIRMAN SELIN: That's in France. But if
25 we're talking about a third country and they ask,

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1 "Well, what if we don't take out that last one percent
2 plutonium?" would that have a significant effect on
3 the toxicity of the remaining waste?

4 MR. KALUZYNY: Perhaps a complimentary
5 answer. I think as Ricaud said, in France, of course,
6 they are very concerned with this type of waste.
7 Long-lived radioisotope is a concern for the public.
8 We have often the question which is quite simple, have
9 you done the maximum to reduce the toxicity of the
10 waste? So, after you have the industrial process, of
11 course we would like to have even less plutonium in
12 the waste. Of course we would like to have even less
13 neptunium, americium or curium which are also very
14 radiotoxic radionuclide.

15 So, there is a general demand in France.
16 I think that in other countries we could have such a
17 problem when you try to implement the final disposal.
18 This question will raise up. But at a certain stage
19 we must have an assessment between what is possible to
20 do from an industrial point of view and, of course,
21 the environmental point of view.

22 CHAIRMAN SELIN: Thank you very much. But
23 the question was a technical question, is this three-
24 quarters of the toxicity in the remaining fuel, is it
25 five percent, ten percent? There are many other long-

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1 lived radionuclides in the fuel, in the waste as well,
2 but I think you've answered the question. Thank you
3 for that.

4 MR. RICAUD: Now I would like to address
5 in a few words non-proliferation topics.

6 Of course, nuclear proliferation is a
7 serious and complex matter which is first has to be
8 addressed by government representatives. But I think
9 we have to briefly comment our feeling about these
10 topics.

11 The NP Treaty, which was signed in 1970,
12 established a framework for civilian nuclear trade
13 among signatories, each of whom agrees to IAEA
14 safeguards. The NPT guarantees member nations the
15 right to develop peaceful use of nuclear energy and to
16 engage in trade as long as safeguards are respected.
17 COGEMA, as a member of the commercial nuclear industry
18 in a country who signed the NPT, of course supports
19 extension of the whole of NPT as peaceful of the
20 world.

21 So, COGEMA is dedicated to prevent
22 proliferation, as is our government. We adhere
23 stringently to all IAEA and EURATOM safeguards.
24 Safeguards are doing what they are intended to do,
25 prevent diversion of nuclear material from civilian

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1 safeguarded facilities. Physical security and
2 safeguards are an integral and vital part of COGEMA's
3 facilities and transportation system.

4 There has never been a diversion of
5 plutonium from safeguarded facilities. Rather, every
6 instance of known or suspected proliferation involved
7 clandestine production facilities. I think it's
8 necessary to say that contrary to the implication of
9 some reports, reactor-grade plutonium is not
10 realistically a potential weapons material. The
11 chart, try to remember what is the difference between
12 weapons-grade material and reactor-grade material.
13 Weapon-grade in red and reactor-grade in green. This
14 chart shows that more the burn-up of the fuel is high,
15 less the plutonium is close to weapon-grade plutonium
16 and more it becomes reactor-grade plutonium.

17 We appreciate that in a recent
18 publication, a DOE press release citing 32 year-old
19 study by the U.S. defense establishment, confirmed
20 that the fuel which was used to organize this test
21 came from a graphite-moderated reactor of the U.K.
22 which was subjected to extremely low burn-up. That
23 means that no LWR fuel normally used have so low burn-
24 up. So, are able to deliver plutonium which will
25 support such a test. So, it means that, in fact, that

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1 the plutonium used in 1962 was not, not, be classified
2 as civil reactor plutonium. This fuel, in fact, we
3 have the feeling it was closer in nature to fuel used
4 by the defense establishment than to any commercial
5 LWR fuel reprocess.

6 Finally, I would like to say that we treat
7 reactor-grade plutonium in its separated form as only
8 an intermediate step in an entire process whose
9 objective is precisely to use and consume plutonium.
10 In terms of non-proliferation, recycling therefore
11 offers a distinct advantage. The plutonium which is
12 generated by nuclear power plants is burned in those
13 same plants, thereby restricting the growth of the
14 world's plutonium inventories. The chart shows you
15 that the more you have MOX units in a country, the
16 less you generate plutonium for the same total
17 quantity of electricity generated during the year.

18 So, finally, I would like to point out the
19 fact that reprocessing and recycling industry
20 development, in fact, a lot of techniques have been
21 developed which may be applied here and there. You
22 have in mind that, for example, the vitrification
23 technology which was developed in France has been
24 licensed in Great Britain for BNFL use. Spent fuel
25 handling and unloading system which have been

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1 developed for reprocessing plants are used not only
2 for the Japanese reprocessing facilities but also in
3 Sweden for interim storage, known as CLAB, which is
4 equipped with equipments which have been first used in
5 reprocessing plants. We are currently trying to apply
6 some of our expertise in U.S. study of handling
7 system, as you know.

8 Our transportation programs provide a
9 sound experience base for any spent fuel management
10 program. It was said that 15,000 tons of light water
11 spent fuel have been safely transported from reactors
12 in Europe and Japan to La Hague. More than 4,000 cask
13 shipments by rail and sea have been performed in
14 completely safe and secure conditions. So, I have a
15 feeling that these examples simply illustrate the
16 capabilities of technology developed in reprocessing
17 programs to other situations and highlight the
18 continuing importance of international cooperation in
19 addressing issues that face our nuclear industry in
20 every country.

21 To conclude, I would just like to say that
22 we enjoy today to have the opportunity to show these
23 realization and to discuss these topics in depth. As
24 you can see, our viewpoint, as well as we think the
25 viewpoint of our government, is that nuclear recycling

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1 is responsible and maximizes use of energy material.
2 Well, of course, by explaining our position, we hope
3 in fact that those who do not share our views will
4 appreciate and respect what we are doing and why we
5 are pursuing our strategy so decisively.

6 Thank you.

7 CHAIRMAN SELIN: One thing that we need to
8 do in order to appreciate your views is to understand
9 them a little bit better. So, I could ask many
10 questions, but I will content myself with two.

11 The first, when you talk about the
12 economics, these are complicated calculations because
13 they have to do with capital costs, costs later on,
14 the value of what comes -- the results of the
15 reprocessing process. But as I understand it, the
16 reprocessing price is approximately \$1,000.00 U.S.
17 dollars per kilogram today. Is that about right?

18 MR. RICAUD: That's right.

19 CHAIRMAN SELIN: If you were talking to a
20 third country, a country that might buy technology
21 from France or from another one of the reprocessing
22 people and they were going to set up a reprocessing
23 facility, would that be a reasonable estimate of the
24 cost to set up a new facility?

25 MR. RICAUD: I think that in China it may

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1 be a lower cost and in Japan it might be higher. It
2 depends, of course, on the economic situation of each
3 country. So, it's quite difficult to compare such
4 cost from a country to the other one --

5 CHAIRMAN SELIN: Well, that's true.

6 MR. RICAUD: -- because the economic
7 situation condition are so different.

8 CHAIRMAN SELIN: But there were really
9 three parts. The first, is that pretty much the
10 process that you would suggest the Chinese or the
11 Japanese adopt? If you were doing this for, say,
12 China, would you modify the process significantly in
13 a way that would change the costs significantly?

14 MR. RICAUD: Well, I think that the
15 Japanese project is quite similar with our project and
16 in China there are no existing industrial project as
17 I know. But my feeling is that the key parts of the
18 process will be the same.

19 CHAIRMAN SELIN: The second part of this
20 is we've already discussed this last stage of
21 separating the last small amount of plutonium from the
22 waste. Is there any other part of the process that
23 you could consider to be optional that is not
24 intrinsic in the process, or is that basically the
25 largest decision that could be made as far as the

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1 investment cost?

2 MR. RICAUD: In fact, the key part of our
3 processing plant is, in fact, the shearing facility
4 and chemical extraction facilities. So, and that's
5 only one step of the total amount of invest of
6 reprocessing plant. Around that, you may have larger
7 or small ponds to store fuel before reprocessing and
8 you may package all the waste in different forms. For
9 example, in our process we vitrify all the fission
10 products. It's one way to manage. There might be
11 others less or more expensive.

12 So, I think that we have to distinguish
13 when you examine these topics the key part of the
14 process itself, separating uranium products, and I
15 will call them the finishing units and the process you
16 apply to each flow as to recycled materials or as to
17 package the waste in the suitable form, depending upon
18 the place where you have to dispose them.

19 CHAIRMAN SELIN: And the third question,
20 going back to the key part, the separation part, is
21 there much effect on volume? If it were 400 tons or
22 if it were 1200 tons instead of 800 tons, would that
23 change the unit costs?

24 MR. RICAUD: What is true is the fact that
25 the best size for a reprocessing plant is between 800

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1 to 1,000 tons. The invest cost for such a plant
2 whatever would be the capacity between, I would say,
3 100 and 1,000 tons will be quite the same. In fact,
4 it's true that in La Hague we are quite lucky to have
5 the opportunity to have two such plants on the same
6 site because there are a lot of common facilities
7 which are shared between the two plants. For example,
8 the effluent treatment facility. For example,
9 technological waste packaging and so on. So, the air
10 pressure destabilization system. So, all these common
11 facilities costs are shared between the two plants.

12 So, I think that in La Hague we are about
13 to reach quite a competitive price for reprocessing
14 and recycling \$1,000.00 per kilogram of spent fuel.
15 That's due to this good size of these two plants and
16 common units shared between them.

17 COMMISSIONER de PLANQUE: I have a
18 technical question. Once you're into the MOX fuel
19 design, is there any limit to the number of times you
20 can reprocess either from a technical or an economic
21 point of view?

22 MR. RICAUD: We have proved in La Hague
23 that it's possible to reprocess MOX fuels. In '92, in
24 UP2 reprocessing plant, we have reprocessed five tons
25 of MOX fuels. So, now, I think it's possible to say

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1 that reprocessing of MOX fuel is qualified.

2 COMMISSIONER de PLANQUE: Technically.

3 MR. RICAUD: Technically. And the price
4 for reprocessing of MOX fuel is quite the same as for
5 uranium fuel, \$1,000.00 per kilogram, roughly
6 speaking. But of course it is true that when you
7 recycle plutonium in light water fuels, it becomes, I
8 would say, more and more civilian plutonium. I mean
9 that the quantity of fissile isotope decrease. After
10 two or three such recycling steps, the quantity of
11 non-fissile material inside plutonium become too high
12 to enable recycling of this plutonium in light water
13 fuels. But it remains possible at this time to
14 recycle such plutonium in brittle fuels, for example,
15 and that's one of the use of Superphenix which will be
16 starting in the near future.

17 COMMISSIONER ROGERS: Just a question on
18 your transportation casks. Are the regulatory
19 requirements that those transportation casks have to
20 satisfy similar to the ones that are imposed here in
21 the United States? Do you know that, in terms of
22 design basis accident, for an example, in which they'd
23 have to withstand. Are they comparable or are they
24 significantly different?

25 MR. RICAUD: All our casks and

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1 transportation system will fulfill all the
2 international recommendations from IAEA, namely
3 speaking. So, in these fields, our casks are able to
4 travel everywhere in the world. For example, casks
5 are used from Japan to Great Britain to France. The
6 same type of casks are used in Sweden to transport
7 spent fuel from the nuclear power plants to central
8 storage, named CLAB. I have in mind the fact that
9 such casks have been licensed in the past for special
10 use in the U.S. themselves. So, it means that, in
11 fact, they comply with all the regulations which are
12 enforced all over the world.

13 COMMISSIONER ROGERS: Thank you.

14 MR. KALUZNY: Thank you very much. I'm
15 Yves Kaluzny, Director of ANDRA. As you know, ANDRA
16 is a public agency in France in charge of radioactive
17 waste management.

18 So, the film has showed you the two main
19 aspects of radioactive waste management. The first is
20 the industrial aspect such as disposal and the second
21 one is research aspect. That is the deep geology core
22 disposal research program. I would like to focus my
23 speech about the second aspect and to explain how we
24 deal with the Radioactive Waste Act.

25 (Slide) First slide, please.

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1 So, as you know, this act has one main
2 issue for me. That is open widely the field of
3 research. So, we have three ways. ANDRA is
4 responsible for the second one, that is in-situ
5 studies in underground laboratories. Of course, to
6 implement this way of research, we have to know about
7 the two other ways. That is partitioning and
8 transmutation and long-term packing and storage. Why?
9 Because when we have to think about the disposal
10 design, we need to have the results of the other way.
11 What kind of waste we have to put in the disposal?
12 So, it is necessary to know the characteristic of the
13 waste and the evolution we can have because when we
14 are designing our disposal, it's not for today but for
15 the long-term.

16 The second point is, of course, when you
17 look at partitioning and transmutation, what type of
18 radionuclide to separate and transmutate. That it is
19 very important to have with the progress of our safety
20 analysis of the geological disposal to know what are
21 the main radionuclides to concern. For instance, is
22 it important to separate the actinide like neptunium,
23 curium, americium because of their chemical property
24 in underground, or is it important to separate what we
25 call the long-lived fission products? So, all the way

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1 of research are, in fact, interconnected as to know
2 the overall of this way of research.

3 (Slide) Second slide, please. Second
4 chart, please.

5 So, the second issue of this act is to
6 transform ANDRA as an independent public agency in
7 charge of managing radioactive waste and in charge of
8 preparation of the future. That is designing and
9 building future repositories. The first mission of
10 ANDRA is national inventory. This is inventory of all
11 the radioactive waste disposed in France. We have
12 published for the first time last year this inventory
13 and each year we publish a new inventory. For us it
14 is very important because, as you know, radioactivity
15 is not only used in the fuel cycle industry, so it is
16 very easy to know about the fuel cycle industry, but
17 also in hospital and other part of industry. The way
18 to have this inventory is something to organize the
19 memory about radioactive waste, the nature, the
20 quantities and their locations. So, in this inventory
21 we have also the military radioactive waste.

22 (Slide) Next figure, please. Next chart.

23 Just a few words about ANDRA. ANDRA is a
24 very small agency dealing with the responsibility. We
25 have about 450 employees and a budget, this year

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1 budget about one billion francs. Mainly in the
2 research, such as deep geological program and the
3 other part is the industrial part such as Centre de
4 l'Aube operation and achieving Centre de la Manche
5 covering.

6 I would like just to say that with so few
7 people ANDRA is not performing its rituals by itself,
8 but have some subcontractors like Commissariat a
9 l'Energie Atomique for the radioactive part, like
10 universities in France and, of course, other
11 institutions dealing with geological matters.

12 (Slide) Next chart.

13 What is the time table? The law said to
14 us that in 2006 we need a specific evaluation of the
15 three research directions and so to propose the final
16 decisions. So, to be able to do such a thing at this
17 date, we need several steps. First, Bataille's
18 mission. Bataille's mission was very successful
19 because he raised four volunteer departments. One of
20 the major things about the process in France is that
21 we have asked for volunteer departments. There was
22 not only a technical choice based on geological
23 characteristic, but also we try to have a political
24 consensus, not only on the national level but also at
25 local level.

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1 I think that Bataille's mission was
2 successful for two reasons. First, the Radioactive
3 Waste Act set the institutional control to control
4 ANDRA activities, and also there was some financial
5 incentive to accept a laboratory. For the first
6 stage, which is preliminary site study, each community
7 will have 5 million francs per year. Then when we
8 will be at the laboratory stage, that will be about 60
9 million francs per year. So, it's very important for
10 the local community to have this opportunity to
11 perform some economical development. Of course, a
12 laboratory is also a very huge investment. This is
13 about 1.5 billion francs, each laboratory.

14 So, after Bataille's mission, today we are
15 on the site to perform some preliminary work and to
16 prepare the public inquiry and hearings. Of course in
17 this process we need to have the formal approval of
18 each local communities to be authorized to implement,
19 to set up the laboratories.

20 CHAIRMAN SELIN: Could I stop you for a
21 minute, Mr. Kaluzny?

22 MR. KALUZNY: Please.

23 CHAIRMAN SELIN: The three laboratories
24 are to be built.

25 MR. KALUZNY: The basic figure is two

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1 laboratories, but the law didn't say anything about
2 the number of laboratories. That is more than one and
3 I think that will be less than four.

4 CHAIRMAN SELIN: Is part of the evaluation
5 to have waste forms in the laboratories to actually
6 put some waste in these underground laboratories and
7 measure the effects?

8 MR. KALUZNY: No. We don't plan to have
9 radioactive waste in the laboratories. We perform
10 only research. So, of course we could use some
11 radioactive sources, but we have the obligation to put
12 it out of the laboratory after the test. So, in this
13 part, the laboratory is not a nuclear facility, it is
14 only a research facility.

15 CHAIRMAN SELIN: I see.

16 COMMISSIONER ROGERS: Excuse me, on that
17 point, is there a commitment at the very beginning
18 that the laboratory will never ever be a site for
19 high-level waste disposal?

20 MR. KALUZNY: No. Of course this research
21 program is not only generic program but it is site-
22 specific. So, we are very clear on this point. The
23 laboratory can be transformed in a repository. But do
24 to that, we need the evaluation. We need to have
25 another act. So, another parliamentary discussion

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1 about this program.

2 COMMISSIONER ROGERS: But that is not
3 excluded?

4 MR. KALUZNY: No.

5 COMMISSIONER ROGERS: In fact, it's
6 contemplated that eventually one would be a site. Is
7 that it?

8 CHAIRMAN SELIN: I think we should have
9 Mr. Bataille come brief us in the future. That's
10 really quite an extraordinary process that you have
11 gone through, including the public in the political
12 life, both in your low-level and in your high-level
13 waste experimental programs.

14 Please.

15 MR. KALUZNY: (Slide) Okay. Next chart,
16 please. Next chart. Okay.

17 Just to show the location of the area, we
18 have the Vienne Department in the west part of France.
19 This is a granite formation. This is the only granite
20 formation we have for this program. We have on the
21 east part of France Department of Gard, Haute-Marn and
22 Meuse, which are clay formations. So, this year we
23 are performing some geophysic works on each site and
24 some core bore hole. Our target is to confirm the
25 potentiality of this area and then to be able to say

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1 to the government at the end of this year, "We would
2 like to implement the laboratory in such and such
3 area." So, the government has to decide to authorize
4 ANDRA to prepare the applications and then the
5 construction of the laboratory.

6 Of course, the overall assessment is not
7 for the end of this year, but at the end of the
8 process, in 2006.

9 (Slide) Next chart, please.

10 To come back to what we call the openness,
11 that is all the institutional controls related with
12 the research program implementations. We have to
13 perform some annual progress reports and review by a
14 national board. This national board is not a
15 governmental board, but its member was designated by
16 both the Parliament and the government. This is
17 independent. ANDRA has, of course, to report to the
18 board and the board has to be report to the
19 Parliament. So, the Parliament is still engaged in
20 all the process. So, for us it is very important to
21 be sure that we will have a good political involvement
22 in all the process during such a long period of time.

23 What could be the role of this national
24 board? The board has not only to look at the ANDRA
25 works, but also the works performed in the two other

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1 area of research. To assume that resources, financial
2 resources are enough for each field of research and
3 also to assess the priority of research. For us, this
4 is a scientific guarantee and also a political
5 guarantee because of the intervention of the
6 Parliament.

7 The other point is a discussion with the
8 communities. The first step was Bataille missions, of
9 course. We have also some informal discussion with
10 all the political responsible in the communities, but
11 we have some formal instrument. That is to set up
12 local information committees. What is a local
13 information committee? This is a committee with some
14 elected people, associations, trade unions and
15 including some environmentalist associations. They
16 have the opportunity to discuss about the project.
17 This committee has a budget of one million francs per
18 year to be able to appoint experts by instance to
19 review ANDRA activities and sites. So, this is a very
20 strong guarantee for the local community.

21 Then, concerning the final governmental
22 decisions in 2006, there will be a general review and
23 the government has to decide to propose a new
24 radioactive waste act to decide other solutions. Of
25 course, at this stage ANDRA will propose some designs

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1 for disposal and so this will be an opportunity to
2 have a parliamentary debate and to see at what
3 condition a laboratory could be transformed in
4 repository, so that is another strong guarantee for
5 us.

6 CHAIRMAN SELIN: Assuming that the
7 schedule is met, what date would you expect the
8 repository to be available?

9 MR. KALUZNY: 2020 about.

10 COMMISSIONER de PLANQUE: Could you go
11 back just a moment to the Board? You may have said it
12 and I missed it, but how many people are on the Board
13 and what types of people are on the Board?

14 MR. KALUZNY: (Slide) Please may I have
15 the next chart? I think I have a chart.

16 COMMISSIONER de PLANQUE: We didn't plan
17 that.

18 MR. KALUZNY: (Slide) Next one. The
19 Board has about 12 people, six named by the
20 Parliament, and including two international experts,
21 one coming from OECD, that is Mr. Olivier in charge of
22 the fuel cycle, and another coming from Switzerland
23 that is Mr. Romanche (phonetic), former Chairman of
24 Negal (phonetic), six experts named by the government,
25 four proposed by the academicians, and two proposed by

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1 the High Council of Information and Nuclear Safety.
2 This Council has to give advice to the minister in
3 charge of industry and also the minister in charge of
4 the environment and all affiliated with nuclear
5 energy.

6 COMMISSIONER de PLANQUE: Thank you.

7 MR. KALUZNY: Okay. So, to be very brief
8 on the conclusions, I'd like to say that the process
9 I've tried to describe to you is certainly a possible
10 process, but not a unique solution. Each country has
11 to think what could be a solution to try to deal with
12 this huge problem which is radioactive waste
13 management, and in this process we try to avoid only
14 scientific and technical approach but we try to
15 include a way, a political approach to which a minimum
16 consensus on the main options we propose.

17 Thank you very much.

18 CHAIRMAN SELIN: Did you want to ask a
19 question?

20 COMMISSIONER ROGERS: Yes, just one
21 question. Several years ago you identified something
22 like four possible sites and then found it necessary
23 to postpone that process. Were those different sites
24 from the four that you have now or were there some
25 combination of those and these?

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1 MR. KALUZNY: They are different.

2 COMMISSIONER ROGERS: They are.

3 MR. KALUZNY: Of course, during his
4 mission Mr. Bataille tried to ask to the previous
5 site, is their will voluntary? The answer was no.
6 And that is very interesting because when you are
7 political men who have taken some very strong
8 positions it is very difficult to come back, and so
9 these are new sites. And I would just like to say
10 that Vienne, the site in the Vienne Department, is
11 very close to the previous site which was in the Deux-
12 Sevres Department and Menenwel (phonetic) Department.

13 And one interesting thing I have on the
14 field today, that we have very low -- very few people
15 against the laboratory which coming from the previous
16 department, so I could say today that the process we
17 engage is not so bad because we have a local consensus
18 and a national consensus until now.

19 COMMISSIONER ROGERS: Thank you.

20 CHAIRMAN SELIN: That's very impressive.

21 COMMISSIONER ROGERS: Yes. It sounds very
22 good.

23 CHAIRMAN SELIN: It's very good.

24 Before we go on to Mr. Camarcat, what is
25 interesting is that those few countries, France,

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1 Sweden, for instance, that have been successful so far
2 in finding sites for their waste have had a very open
3 process and have spent a lot of time and effort
4 involving people. I've also noticed that all your
5 sites are in places that have very good restaurants.
6 I'm sure that's just a coincidence.

7 Mr. Camarcatt?

8 MR. CAMARCAT: Thank you. My name is Noel
9 Camarcatt and I'm a Director for the Nuclear Fuel Cycle
10 Division at France CEA.

11 (Slide) Can I have viewgraph number 1,
12 please?

13 (Slide) Next one, please.

14 Now, as we've heard previously this
15 morning, research for the back end of the nuclear fuel
16 cycle is organized to answer the three items of the
17 1991 law, and so I will not go any further in the
18 three research lines.

19 (Slide) And I will go to the next
20 viewgraph, please, which is the petitioning and
21 transmutation, what we call in French the SPIN, S-P-I-
22 N Program. Now, it is organized in two research
23 lines. The first one, we call it PURETEX, which has
24 for objective the reduction of reprocessing waste, and
25 we've seen it in the film. This is done closely, in

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1 close effort with COGEMA, with the target for 1995 of
2 .9 cubic meter processed of uranium and it has to
3 decrease by nearly a factor of two by year 2000.

4 In research we make increased use of
5 glasses and glasses have to be designed for a new kind
6 of waste, the ones which were before in bitumen, and
7 the research also has to improve the processes which
8 will be used in plants UP2-800.

9 The second line of research of the SPIN
10 Program is the ACTINEX, which we call partitioning of
11 actinides and long-lived fission products. Two
12 sublines of research, one, and this is going further
13 than our previous discussion this morning, is to
14 extract actinides with new solvents. One line is to
15 make coextraction of americium, curium, and some
16 fission product lanthanides with the new solvents.
17 Experiments are being performed at lab scale in 1995.

18 The next step is the separation of
19 americium and curium from the lanthanides, and then
20 you go to actinide oxides which are mixed
21 homogeneously and burned in a reactor. Obviously this
22 line, it is not written on the viewgraph, goes also
23 with the transformation of neptunium and the
24 transformation of neptunium into oxide for burning,
25 since neptunium has a very long half-life.

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1 The second main research line is the
2 extraction of long-lived fission products, but with
3 special molecules which we call long cyclic
4 macromolecules, and have listed a few scientific items
5 of these specific atoms to be used.

6 (Slide) May I have next slide, please?

7 Now once you have a separation program or
8 petitioning program you go to the transmutation part
9 of the program and this work is performed in the
10 Nuclear Reactor Division in which cores have been
11 optimized for transmutation, that is PWR cores and
12 breeder reactor cores. Studies have been performed
13 for hybrid systems, accelerators and reactors, and
14 fuel design studies include homogeneous fuels and
15 nonhomogeneous fuels. And of course also there has
16 been some previous transmutation experiments are
17 analyzed in terms of transmutation efficiencies.

18 (Slide) May I have next slide, please?

19 Now these transmutation studies have, in
20 terms of core calculation, similarities with the
21 important program which is the Enhanced Plutonium
22 Consumption Program in Fast Reactors, and this program
23 in French we call the CAPRA program. This is also
24 performed in the Nuclear Reactor Division and it uses
25 two kind of cores and fuel design.

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1 The first core and fuel design is based on
2 classical mixed oxide fuel with a Plutonium content
3 increased to 45 percent of plutonium, and this allows
4 net plutonium consumption up to 70-80 kilograms per
5 TWh. These are the figures which were quoted in Mr.
6 Mandil's speech, talk.

7 Now you can have more advanced solutions
8 based on plutonium fuel without the Uranium
9 components, since the uranium component is what
10 creates plutonium in a reactor, in which case the
11 consumption can be increased to 110 kilograms per TWh
12 electrical. You have to replace the uranium content
13 with what we call "transparent additives," in which
14 case you can use ceramics. I have used a few in
15 French language and scientific language. We call them
16 the "cercers." Or, you can have also absorbing
17 additive, a metallic matrix based on chromium with
18 tungsten additives, and we call these in French
19 language the "cermets."

20 Now the CAPRA Program has a feasibility
21 study phase which ends in 1994 where neutronics,
22 safety, and fuel will be studied, and this is to be
23 followed by a second phase.

24 (Slide) Next slide, please.

25 Yes. The second phase of the CAPRA

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1 Program, which starts from 1995 onwards, there will be
2 experiments in Superphenix with two CAPRA type
3 assemblies and there will be one assembly which will
4 be including pins for homogeneous burning of
5 neptunium. So, separate neptunium, transform it into
6 oxide, mix it homogeneously. Now obviously this is a
7 research program, so only one or a few pins, not a
8 complete assembly, of course, will be tested.

9 The international cooperation in the CAPRA
10 Program is also listed, the European partners of the
11 fast reactors, that is the English teams and the
12 German teams, but also Italian teams at ENEA, some
13 people from Switzerland, PNC from Japan, and also a
14 Russian team from Obninsk.

15 (Slide) Can I have next slide, please?

16 Now for waste conditioning and storage, as
17 Mr. Kaluzny has told you in his speech, underground
18 laboratories are under ANDRA responsibility and CEA
19 participates in the definition of experiments to be
20 performed, small scale mock-ups, source term
21 calculations, geochemical models. And also, these
22 geochemical models have to take into account
23 thermodynamic properties of actinides, so we measure
24 these in special labs.

25 The second research line in the waste

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1 conditioning and storage program includes improvements
2 for conditioning and have an intermediate storage of
3 waste. The first thing to do, and this was also
4 stressed in Mr. Kaluzny's speech, is the
5 characterization of waste objects. As an example, I
6 have listed up there the characterization of compacted
7 hulls. And there are also research lines to improve
8 conditioning techniques, again minimization of the
9 source term, demonstration of durability for several
10 hundreds of years -- the point that degradation
11 products will be innocuous, that is quite important --
12 and also retrievability has to be taken into account.

13 Now for the back end of the fuel cycle,
14 research programs at CEA are funded at the
15 approximately one billion French franc level, that is
16 \$190-200 million American dollars, and finance, the
17 budget, comes from government subsidies and also money
18 paid from industrial operators, COGEMA, EDF, and a
19 small amount from ANDRA.

20 (Slide) May I have next slide, please?

21 We have reached the end of the back end of
22 the fuel cycle and when --

23 CHAIRMAN SELIN: May I stop you?

24 MR. CAMARCAT: Yes.

25 CHAIRMAN SELIN: I have a question.

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1 There's been some interest in amorphous matrices
2 instead of using glass. The Australians have the
3 cimrock (phonetic) process. The Russians are doing
4 some research. Do you see any benefits in that? Not
5 so much from a research point of view, but, if this
6 process is successful, would it change either the
7 characteristics or the cost of the back end in any
8 significant fashion?

9 MR. CAMARCAT: I would say it's too early
10 to answer. As you've seen, the law says research is
11 being pursued until 2006, so the question you're
12 asking is basically the results of the research
13 program so far.

14 CHAIRMAN SELIN: Well, you're supposed to
15 know the answer.

16 MR. CAMARCAT: No, no. Otherwise, the
17 research would not be done.

18 CHAIRMAN SELIN: Another difference
19 between our countries.

20 MR. CAMARCAT: If you knew the answer on
21 an industrial scale, why do the research?

22 CHAIRMAN SELIN: Because it reduces
23 uncertainties.

24 MR. CAMARCAT: Okay.

25 CHAIRMAN SELIN: Fine. Thank you.

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1 MR. CAMARCAT: Shall we come back to the
2 front end of the fuel cycle?

3 CHAIRMAN SELIN: Yes, please.

4 MR. CAMARCAT: So this is uranium
5 enrichment using the SILVA process, similar to what in
6 your country you call AVLIS, same acronyms but the
7 wording is different. For us it has to be for the
8 long-term industrial replacement of the Eurodif plant,
9 which I recall was commissioned in 1981. And these
10 plants have a lifetime of at least 30 years, so for us
11 replacement has to be envisioned beyond 2005, so it's
12 not a short-term program.

13 And if you want to think about long-term,
14 you have to be able to reduce enrichment costs by at
15 least a factor of two and this has to be done using
16 the SILVA assets, which are the selectivity of laser
17 light instead of having 1,400 stages like in gaseous
18 diffusion. You enrich only in one step, so that gives
19 you modular plants. You can start at a million sous
20 (phonetic) instead of 10 million sous like in Eurodif,
21 and also you have low energy consumption which is a
22 major factor in the price of sous.

23 As an intermediate objective of the
24 program, we have to demonstrate by 1997 the technical
25 and economic feasibility of the process. We have two

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1 major lines of research in terms of programs and
2 facilities: one which is the development of
3 technological components in Pierrelatte, and I have
4 listed a few facilities; and the other one is the
5 integration of the 1993 design capabilities in an
6 integration system which we call ASTER, A-S-T-E-R, and
7 which is located in Saclay.

8 (Slide) Next viewgraph, please.

9 This is basically the same information,
10 but this is done on a schedule. The basic studies for
11 model physics and basic process studies was started in
12 1985 and between 1990 and '95 we had the process
13 demonstration phase which resulted in integration of
14 the functions and enrichment products of the order of,
15 let's say, ten grams, so it's a small scale. In 1992
16 onwards to 1997, a technological development phase,
17 much greater scale components, as I've said, in
18 Pierrelatte, and also building of the integration
19 system, ASTER, and this goes to the general assessment
20 of the program by 1997.

21 Now, all the research which is before 1997
22 is firmly contracted with COGEMA. On this viewgraph,
23 what goes on beyond 1997, production demonstration and
24 industrial deployment around year 2005, this is in
25 discussion. This is not yet firmly contracted and of

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1 course it does depend on the results of the 1997
2 general assessment.

3 This concludes my -- oh, one figure for
4 the front end of the fuel cycle. Research money in
5 1994 is about 430 million French francs, which is
6 around \$80 million American dollars.

7 This concludes my talk. Thank you very
8 much, ladies and gentlemen.

9 CHAIRMAN SELIN: Thank you.

10 Did you have some closing remarks,
11 because, we have some general questions we would --

12 MR. MANDIL: I have no closing remarks.

13 COMMISSIONER ROGERS: I just had one, just
14 the technological components in the Pierrelatte
15 facilities. What are they? Can you describe what
16 they are?

17 MR. CAMARCAT: Oh, yes. Yes, definitely.

18 Major components for the separator, the
19 program, are the gun to produce the electron beam, the
20 reflux parts of the separator which allows your liquid
21 uranium to reflux the crucible, and also the
22 extractor. This is on the separator side.

23 Now on the laser side we have development
24 of a couple lasers up to 400 watts, and this is done
25 by an industrial contractor which is CILAS, and the

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1 program, this particular program is managed by the
2 Pierrelatte team.

3 COMMISSIONER ROGERS: I see. I was amused
4 by the names of Egyptian gods, but not all of them, I
5 take it.

6 MR. CAMARCAT: Yes. This is a French
7 custom.

8 CHAIRMAN SELIN: Dates only to the time of
9 Napoleon.

10 Did you have something else?

11 COMMISSIONER ROGERS: No. That's all.
12 Thank you.

13 COMMISSIONER de PLANQUE: I have no
14 further questions. I would just like to thank you
15 very much. It's been an excellent presentation.

16 CHAIRMAN SELIN: I have no questions, but
17 I do have some remarks.

18 First of all, we are very pleased that the
19 team was able to come and that you were able to
20 assemble a group that could speak so authoritatively
21 about such a large range of subjects.

22 The second is I would like to stress that
23 this isn't so much an attempt to understand why the
24 French program is the way it is in France, it's to
25 understand the elements so that when we speak to third

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1 countries we can separate that which is specific to
2 the French situation and that which is more general.
3 We are not trying to export our own philosophy when
4 people ask us for advice. We really do try to learn
5 from everybody's experience, not only from our own,
6 and the French program is an elegant program. It's a
7 complete program, starts from a different philosophy,
8 but it has all aspects covered and so it's a wonderful
9 opportunity to learn about an alternate universe, to
10 use a heuristic approach in the language.

11 And the third thing I would like to do is
12 I would like to -- we've had excellent cooperation
13 with all aspects of the French nuclear program,
14 whether it's the fuel cycle discussed here, the
15 regulatory areas that we've discussed before, the
16 reactor side or the production of electricity. But
17 one place we have not done very much, and I would like
18 to continue this discussion quite a bit, has to do
19 with the economics of reprocessing so that we can in
20 fact understand in some depth what is special and what
21 is general, where there are formulas, how much weight
22 you are putting on the salvage value of the Uranium as
23 opposed to the processing questions, what would be
24 different if the geology of the third country is
25 different, and even some of these research questions.

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1 A more serious answer to Mr. Camarcat's
2 question is when one does industrial research you do
3 have an idea of what the potential benefits are.
4 You're trying to test them. It's not advanced
5 research. We do know that if the scaling up is
6 according to the formulas we have some idea of what
7 the benefits of the cost are.

8 And in looking at the research programs we
9 would very much like to benefit from the analyses that
10 you've done on some of these new technologies. The
11 SILVA or AVLIS is one because that's of great interest
12 to the United States, but some of the more exotic
13 technologies where we don't have any real experience
14 in the United States as well.

15 So, we do thank you very much. I hope
16 that this will be the first of many steps of enhanced
17 cooperation in the fuel cycle comparable to what we
18 have on the reactor and on the general regulatory
19 side, and we've very pleased to welcome you here for
20 the first time, Mr. Mandil, so thank you very much.

21 MR. MANDIL: And thank you for a very
22 interesting discussion. Of course, I will tell you
23 further, but we welcome all of your Commission very
24 well and as often as you want to see and to have
25 discussions with us in France.

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1 CHAIRMAN SELIN: Thank you. We have a
2 great deal of respect for your technical skill, but we
3 are in complete awe of your political skills and how
4 you work with the general public.

5 Thank you.

6 (Whereupon, at 11:48 a.m., the above-
7 entitled matter was adjourned.)
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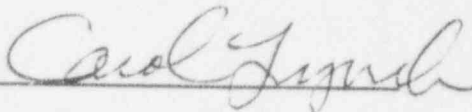
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TITLE OF MEETING: BRIEFING ON FUEL CYCLE AND WASTE MANAGEMENT
ACTIVITIES IN FRANCE

PLACE OF MEETING: ROCKVILLE, MARYLAND

DATE OF MEETING: JULY 19, 1994

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R&D for the back and front end of the Nuclear Fuel Cycle

N. Camarcat, CEA, France



R&D for the back end of the nuclear fuel cycle

- **Organized to answer the 3 items in the law voted 12/30/91**
 - 1-Separation and Transmutation of **actinides** and long lived fission products
 - 2-Waste storage in deep geological repositories
 - building of 2 underground laboratories
 - parliamentary decision to be made in 2006
 - 3-Improvement of processes and conditioning to store waste for long periods at ground level, including present volume reductions
- **R&D paid by government and industrial operators (Edf, Cogema, Andra)**



Reprocessing, Recycling, Waste Management

- Long Term Objectives
 - 1-Environmental Considerations
 - Dose Reduction, Reduce Waste in volume and activities
 - the 3 items of the law voted december 1991
 - 2-Optimal use of energy intensive raw materials
 - management of Plutonium and reprocessed Uranium
 - 3-Cost reduction for the back end of the fuel cycle
 - Improvements of the actual processes
 - replacement by new processes and equipments
 - 4-Integration of new developments and ideas to outline reprocessing in 2015
- Short and Intermediate term objectives
 - Technical and scientific support to plants in operation, in the start-up phase or in the building phase : UP3, UP2-800, MELOX, Rokasho-Mura (Japan), Surface Storage Center (Soulaines)

Separation and Transmutation : the SPIN program

- **PURETEX-Reduction of reprocessing Waste with COGEMA**
 - target 1995 0,9 m³/tU (suppression of bitumen, various kinds of glasses for different categories of waste...)
 - target 2000 0,5 m³/tU
- **ACTINEX-Separation of actinides and long lived fission products (longer term goal of the 1991 law)**
 - Actinides with new solvents : Coextraction of Am, Cm, Ln with diamex solvent at lab scale in 1995. It is to be followed by the separation of Am+Cm from lanthanides. If necessary, oxydation of Am to separate from Cm. Actinide oxydes mixed homogeneously in the fuel and recycled.
 - long lived fission products extracted with macromolecules (cyclic molecules with N,O,S atoms, calixarens.....)



Enhanced Plutonium Consumption in Fast Reactors-the CAPRA program

- performed in the nuclear reactor division
- Core and fuel design based on mixed oxide fuel with a Plutonium content of 45%- Net Pu Consumption : 70-80 kg/TWh-electrical
- More advanced solution based on Pu fuel without U- Net Pu consumption increased to 110 kg/TWh-electrical
 - Transparent additives : Ceramics MgO, MgAl₂O₃... "Cercers"
 - Intermediate absorbing additives : metallic matrix Cr, Cr-W..... "Cermets"
- Feasibility study phase : till the end of 1994 (neutronics, safety, fuel.....)
- Second phase from 1995-onwards : Experiments in Superphenix with CAPRA type assemblies and one assembly containing pins for homogeneous burning of Np.
- International cooperations : European partners of EFR, Paul Scherrer Institute (Switzerland), PNC (Japan), Obninsk russian team.



Transmutation Studies the SPIN/Actinex Program

- Work performed in the nuclear reactor division
- Optimisation of reactor cores for transmutation (PWR's and Breeders)
- Studies for hybrid systems accelerators, reactors
- homogeneous and inhomogeneous fuel design studies
- analysis of transmutation efficiencies from previous irradiations in Phenix and preparation of new irradiations for Np, Am



Waste conditioning and storage

- **Underground laboratories under ANDRA responsibility**
 - Cea participates in the definition of experiments to be performed (mock-ups, source term calculations using geochemical models, measurements of actinides thermodynamic properties)
- **Improvements for conditioning and interim storage of waste**
 - **Characterisation of waste objects**
 - preliminary specifications of the objects for underground storage (1995). (R&D guide)
 - characterisation of compacted hulls
 - **Conditioning techniques will be improved to**
 - minimise the source term
 - demonstrate durability for several hundred years
 - demonstrate that the degradation products are innocuous
 - take retrievability into account



Waste Conditioning and storage (2)

- **examples of conditioning improvements**
 - new glasses or ceramics for medium activity waste
 - synthetic phosphates for non transmuted long lived elements (Cs, I, Cm)
- **Examples of research of new processes to treat and condition waste**
 - dose and volume reduction
 - solid waste burning with plasma torch
 - liquid waste : macromolecules for better extraction



Uranium Enrichment using the SILVA process

- Long term industrial replacement of Eurodif plant commissioned in 1981
- beyond 2005, reduce enrichment costs by at least a factor 2 using the SILVA assets :
 - selectivity of laser light, modularity of the plants and low energy consumption
- **Intermediate objective : demonstrate by 1997 the technical and economic feasibility of the process**
 - by developing technological components in the Pierrelatte facilities : Maeva, Horus, Apis, Anubis, Amon
 - by integrating the 1993 design capabilities in the ASTER integration system

The Intermediate Term SILVA Research Plan

- By 1997, demonstrate the technical and economical feasibility of the SILVA process
 - *Basic studies* : physics, models and process optimization
 - *technological facilities* : development of components at significant scale
 - *integration facilities* : photons and Uranium vapor and all process functions at a not too expensive scale
 - *plant lay out studies* and economics
- R&D partnership with COGEMA, other industrial participants include : CILAS, GEC-ALSTHOM, SNECMA.....

Washington D.C., July 19, 1994

The Nuclear Fuel Cycle Policy of France

Claude Mandil
Director of Energy and Natural Resources

It is truly a pleasure for me to be here today to present France's nuclear fuel cycle policy to the Commissioners of the Nuclear Regulatory Commission.

I - The Status of Nuclear Energy in France

France's nuclear program currently consists of 54 pressurized water reactors, all based on standard designs. These units have an installed generating capacity of close to 60,000 MWe and generate over 75% of France's electricity. Since 1993, the units have operated with a greater than 80% availability factor. Four more units are under construction (Figure 1).

II - Waste Management Policy

Ninety percent of the nuclear waste generated in France is short-lived and low- and medium-level waste. This waste is disposed of at the Centre de la Manche and the Centre de l'Aube facilities operated by Andra. The Centre de la Manche facility is full; the last waste deliveries were made this month. The Centre de l'Aube has enough capacity to cover disposal requirements for the next forty years. This type of disposal facility has never raised any problems, either in terms of the technology or in terms of public acceptance.

Our approach to long-lived waste is defined by the Waste Act of December 30, 1991, which was passed almost unanimously by the French Parliament. The law requires that research on long-lived and high-level waste management be divided into three areas:

- separation and transmutation of long-lived radioactive elements;
- the potential for disposal in deep geologic formations through construction of underground research laboratories; and
- surface storage of waste and the containment issues that this raises.

These research programs are well funded by the government and the waste generators. In 1994, spending on the three research programs will be approximately 260 million, 500 million and 170 million francs respectively.

The Waste Act requires that the research findings be presented to Parliament in fifteen years, accompanied by a draft repository licensing bill if the findings so dictate. Mr. Kaluzny and Mr. Camarost will discuss the work being conducted in the framework of the Waste Act in more detail.

III - Reprocessing, Recycling and Plutonium Management

However, one does not need to wait for the outcome of these research programs to know that radioactive products requiring isolation for thousands of years must be minimized if future generations are not to inherit veritable mines of plutonium and long-lived radioactive waste. In fact, plutonium will still represent 95% of the radiotoxicity of the spent fuel after 10,000 years.

Reprocessing and recycling of fissile materials help to achieve this goal. Plutonium from spent fuel reprocessing may be recycled in pressurized water reactors as Mox fuel or in fast breeder reactors in either a breeding or an incinerating mode. Recycling saves energy supplies and natural resources. In addition, reprocessing makes it possible to solidify the minor actinides and fission products--the only real waste, devoid of energy value--into forms suitable for final disposal.

To prevent separated plutonium from being stockpiled, EDF reprocesses its spent fuel only when it has a specific use for the separated plutonium. Therefore, how much fuel is reprocessed is not just a function of reprocessing plant capacity, but also of Mox fuel fabrication capacities and reactors licensed to use Mox fuel.

2.1 - Recycling with Mox Fuel

The Melox plant at Marcoule, scheduled to start up in 1995, will be capable of fabricating 120 tons of Mox fuel from the 8 tons of plutonium that the UP2-800 reprocessing plant at La Hague can produce each year. One hundred twenty tons of Mox fuel corresponds to nearly twenty reloads. Six reactors are loaded with Mox fuel at the present time. This number will gradually rise to around twenty by the end of the decade, and possibly more later.

A reactor loaded with Mox fuel produces plutonium and consumes it at the same time. Currently, a reactor loaded with Mox fuel produces a total of 60 kilograms of plutonium per year, while a reactor loaded with conventional fuel produces 730 kilograms of plutonium per year. Research is under way to reduce the net plutonium production of a reactor loaded with Mox fuel further, or even to make it a negative value.

2.2 - Recycling in Fast Breeder Reactors

Similarly, research is in progress to study the potential for incinerating plutonium in fast breeder reactors. This is the subject of the CEA's Capra program, in which several countries are participating, including Japan. Superphenix will restart in a few days for this purpose.

Depending on the results of this program, we could ultimately foresee a mixed reactor program that combines pressurized water reactors operating with conventional fuel or MOX fuel and fast breeder reactors. This would allow us to stabilize our plutonium inventory, whether or not the plutonium is separated.

* *
*

In conclusion, I would like to say that our use of plutonium in the nuclear power program is already a commercial reality that meets our needs in terms of natural resource conservation and environmental protection and that does not raise proliferation concerns because it is properly safeguarded by international organizations such as the International Atomic Energy Agency.

Plutonium is produced by reactor operations, not by reprocessing. Reprocessing is a relatively simple chemical operation that merely separates plutonium, but it requires impressive facilities to protect operating personnel from radiation and to protect the environment. Some power reactors, such as the Canadian Candu reactor, permit continuous discharge of low irradiated fuel capable of supplying weapons grade plutonium. These reactors are therefore intrinsically more proliferating than pressurized water reactors and the reprocessing plants that serve them.

Lastly, countries that have proliferated in recent years via the plutonium "path" have done so with materials from continuous discharge reactors or from research reactors. In no case have pressurized water reactors, fast breeder reactors or commercial reprocessing plants safeguarded by the IAEA been implicated.

In this regard, there is no need to tighten safeguards on nuclear facilities already safeguarded by the IAEA, nor is it necessary to adopt international plutonium management measures. However, it is certainly essential to show greater openness and to explain how plutonium is used by the civilian nuclear industry and in what amounts.

We will now show you a film to illustrate my remarks. I will then turn the floor over to Mr. Ricaud, Mr. Kaluzny and Mr. Camarcai, who will explain the points I have raised in greater detail.



**MAIN ISSUES OF THE BACK-END OF THE
FUEL CYCLE**

Jean-Louis RICAUD

COGEMA



MAIN ISSUES OF THE BACK-END OF THE FUEL CYCLE

J.L. RICAUD
COGEMA
Vélizy Villacoublay - FRANCE

INTRODUCTION

All human activities consume natural resources and produce waste. Man has made increasing use of fossil energy and mineral resources which will ultimately be depleted and, to a certain extent transformed into waste products polluting the environment and having a detrimental impact on the global climate (acid rain, greenhouse effect). For illustration, in a current nuclear reactor, an annual electric energy output of 6.6 billion kwh, produced by 21 tons of PWR fuel at a burn-up of 43 GWd/t, corresponds to the burning of 2 million tons of coal in a conventional power plant releasing 120 000 tons of ashes, 5.4 millions tons of CO₂ and 50 000 tons of SO₂.

In the recent years, there has been a growing interest for recycling in all industrial activities, as making good environmental sense, fully embraced by the public at large. Recycling is seen as a wise strategy in general, whose economics must be assessed with regard to the specificities of each industry.

It should then be surprising that a number of "environmentalists" which see themselves as ardent supporters of all recycling schemes, are opposed to the nuclear industry's recycling plans. Plutonium in particular is the centerpiece of many complex and biased debates, attempting to diabolize this energetic resource.

The fact is that the nuclear industry and scientific community, aware of its social and long-term responsibility, has been a leader since many years in pursuing reprocessing/recycling as a resource management strategy to recover plutonium and uranium safely, recycle them (an indisputable benefit in terms of long-term energy availability), minimize the volume of final wastes to be disposed of, reduce the waste toxicity thus protecting the environment.

The stake of recycling in terms of clean energy production must be put in global perspective : the world nuclear power reactors produce today 50 tons of plutonium per year. Recycling this resource would represent an electricity amount equivalent to up to 100 MTOEs per year, the oil production of Kuwait ; adding uranium recycling, the global potential of recycling fissile materials arise to 150 MTOEs per year, which is comparable to the 180 MTOEs per year production of all the oil fields of the North Sea.

This paper describes the present situation of the reprocessing/recycling industry, mainly through the experience of COGEMA, and discuss the main trends of the recycling route through waste volume reduction, MOX usage, economics and non-proliferation issues.



A DEMONSTRATED INDUSTRY

Reprocessing operations

The COGEMA La Hague reprocessing plants whose capacity is 1,600 tons per year of LWR spent fuel, shows very high levels of performance regarding product quality, radiological impact and occupational exposure. Actual operating experience put personnel average exposure at less than 0.43 mSv in 1993, well below the level of natural radioactivity, and there is every reason to believe that this performance will continue.

The products : uranium and plutonium, meet all quality requirement, and the various waste forms produced at La Hague have undergone a stringent waste acceptance process and are licensed by regulatory authorities of France, Japan, Germany, etc...

Waste volume reductions

For the La Hague UP3 plant, improvements to waste treatment methods will result in greater waste volume reductions, when bituminized waste forms (450 liters per ton in 1991 and 100 liters per ton today) are to eliminated completely by 1995. Regarding metallic and technological waste, the introduction of new technologies : compacting and incineration, will give in a few years, a volume reduction factor up to five.

Current waste volume goals are shown in the following table.

La Hague Waste Volume Reduction : General Goals

	Nominal	Actual 1994	Anticipated 1995	Anticipated 2000
Waste which does not meet current French near-surface disposal requirements	3 m ³ /MTU	1.06 m ³ /MTU	0.9 M ³ /MTU	< 0.5 M ³ /MTU

This non-surface waste volume reduction program has led to a performance level already less than the Swedish announced estimation for the direct disposal technology. In a few years, these reprocessing waste will represent only 0.5 m³/MTU, one-third of the corresponding direct disposal figure.

Recycling, the MOX fuel use

Recycling is the indispensable natural complement to reprocessing : after spent fuel components efficient separation and waste conditioning, the valuable fissile materials : plutonium and uranium are available to produce energy.

Today, of EDF's 55 reactors in service, seven are loaded with MOX fuel. EDF plans to extend such MOX fuel use in most of its twenty eight 900 MWe PWRs by the end of the century.

Regarding reprocessed uranium, EDF is also engaging in a full-scale recycling scenario.

MOX fuel design continues to be improved, particularly in terms of burn-up. In France, the MOX operating licence already allows a maximum burn-up at 39 GWd/t for a third core fuel reload cycle and in the near future, MOX fuel performance will be brought to the highest levels currently achieved with uranium fuels which have an average burn-up of 45 GWd/t.



To respond to the utilities engagement in MOX fuel use, a new MOX fuel fabrication capacity is to be added to the current European facilities : Dessel (BN) and Cadarache (COGEMA), with the completion of the MELOX plant, to start up in 1995, with a capacity of 120 tonnes per year, able to increase in the following years.

To keep pace with the growing global use of MOX, other large-scale MOX fuel fabrication plants are under project or construction in Europe and Japan : shortly after the turn of the century, a worldwide MOX fuel fabrication capacity of 400 to 500 metric tons per year will be in place, which will enable to recycle up to 40 metric tons of plutonium annually.

Then, for the next future decades, the fuel cycle industry has undergone the assessment of further strategies with multiple plutonium recyclings and growing plutonium in-core percentages, to provide for the best optimized plutonium management, incorporating possibly new reactor types.

This global energy strategy of reprocessing and recycling, key to the sustainable development of the nuclear power option, provides considerable advantages in terms of reduced long-term waste inventory, volumes, radioactivity and radiotoxicity compared with the direct disposal alternative.

ECONOMICS

The economics of the back-end of the fuel cycle is always a subject of heated debate for several reasons :

- i) The overall objective of plutonium recycling should be unambiguously exposed :
 - Either one considers that the plutonium is a highly toxic material, which cannot reasonably be disposed of as such. In this case one should admit the reprocessing/recycling strategy which recovers 99.9 % of the Pu included in the spent fuel, in order to burn it and transform it into electricity. Such strategy has a well-known, industrially demonstrated cost, and has benefits which must be expressed both in monetary and extra economics terms.
 - Or the definitive storage of plutonium is environmentally and strategically accepted and in such case direct disposal of spent fuel may be envisioned, even if not currently available.

Such questions should be raised clearly in each country engaged in nuclear energy, with possibly a different answer according to the general policy of such country in terms of energy and environment.

But a paradoxical situation arises when some so-called environmentalists insist at the same time on a specific toxicity of plutonium, recommend the direct disposal, and are opposed to recycling on economic grounds, pretending moreover that this incoherent reasoning is valid for all countries !...

- ii) This being clarified, one should then discuss the applicable economic valuation methods for comparing reprocessing/recycling and direct disposal :
 - Cost comparisons between alternative processes and technologies can only be made on the basis of equivalent services. It has been shown above that this is obviously not the case when comparing the reprocessing/recycling scenario with the direct disposal option, both in terms of global energetic strategy and of ultimate waste disposal.
 - It is well known that standard accepted economic calculations are dependent on assumptions about the economic life and technical performance of the physical assets, on the appropriate rate of return on capital, on fuel and operational costs over time, etc. Discounted cash-flow analyses involving periods several decades long systematically favor scenarios in which



capital investment and operating expenses are postponed, even when the amount of these investments and expenses has not yet been established.

This is because the discounted cash-flow method reduces their present value to negligible amounts compared to capital investment made today. It is useful to realize that in terms of present value, 1 FF now is valued as more expensive than 100 FF in 60 years. This obviously introduces a bias in favor of no decision scenarios.

In light of these observations, it is rewarding to comment on the conclusions of the most recent study on the costs of various options in the back-end of the fuel cycle by the Nuclear Energy Agency of the OECD, in which a dozen countries and international organizations participated :

- i) With the same sequence of expenses, the two alternate fuel cycles present very close results in term of costs per kWh.
- ii) The only reason for the reduction of the direct disposal cycle cost is the mathematical effect of the discounting method, which may have a devastating demotivation effect on the rational planning of future investments.
- iii) The reprocessing/recycling costs are completely controlled as established commercial prices, while direct disposal costs are only preliminary estimates, which can only rise when industrially demonstrated.
- iv) Observing the industrial situation in Europe shows that almost all the investments for the reprocessing/recycling cycle have been already done, to compare with the direct disposal option where 90 % of the expenses still need to be done. As a consequence, comparative cash-flow analyses would usefully complement the usual economic approach and favor the already industrially implemented solution.
- v) Finally one must well understand the size and structure of the respective costs of fuel fabrication : in a MOX fuel fabrication plant, two-third of the production costs are associated with investment, to be progressively amortized in the next coming years, while the UO₂ fuel fabrication plants are already almost written-off.
Taking all this into account, the OECD final discounted cost shows only a 10 % difference between the two options, which can only be reduced in the near future, due to the developments in progress in the recycling industry.

NON PROLIFERATION

For the knowledgeable, honestly concerned community, the history of the past twenty years shows that proliferation is not simply a matter of plutonium on one side and everything else on the other. In fact, when some vocal people ask for banning reprocessing as the essential component of a non-proliferation policy, they tend to forget that :

- plutonium from current electronuclear reactors (LWRs) is not a weapon-grade quality material ;
- today, uranium enrichment technology, not reprocessing/recycling, might be the easiest pathway to nuclear weapons ;
- there is no example of a nation attempting to divert safeguarded plutonium or use plutonium recovered from commercial LWRs to acquire nuclear weapons capability. In fact all attempts to



acquire a nuclear weapons capability have centered on clandestine operation of non-safeguarded facilities ;

- commercial reprocessing and MOX recycling is an indispensable step to control now the plutonium generation as each recycling scheme decreases both the residual quantity of plutonium and its isotopic quality.

The fact is that commercial reprocessors are firmly committed to the peaceful use of nuclear energy, as demonstrated over the past 30 years. They operate under transparent safeguards arrangements, appropriate international controls and strict procedures which permit the safe and secure management of plutonium.

CONCLUSION

The future of the nuclear fuel cycle will certainly differ from one country to another. Those can afford expensive natural resources may decide for political reasons to curtail their nuclear programs and adopt the once-through option. Others will master and develop their nuclear programs and implement a closed cycle.

In both cases, the choice for the back-end proceeds from a national policy, combining energy and environmental considerations.

The once-through option or the "wait and see" attitude strengthen people's feeling of unresolved waste management issues and do give a bad impression of wavering in front of the rational use of energy resources and waste minimization issues, whereas the advancing reprocessing and recycling industry gives a more persuading evidence of capability. Moreover, it is not wise to treat plutonium as a waste and throw it away ; human societies usually are incline to forget things that are considered of no value, and in the long term, such an attitude might give rise to more serious risks of misuse or harmful impacts than a conscious, well controlled and steady management of plutonium.

The reprocessing/recycling strategy, by enhancing the safety, reliability and economic viability of the fuel cycle and ensuring the long-term growth of the nuclear power, is the guide to a modern and sustainable industrial development.

PRESENTATION OF ANDRA
to
U.S Nuclear Regulatory Commission

July 19,1994

Y.KALUZYNY

Andra was created to manage radioactive waste. We consider ourselves to be "environmentalists" whose task is to manage waste in a safe and suitable manner to protect the environment now and in the future. We know that waste management not only requires technical and scientific answers but that it must integrate in a pragmatic approach science, society, psychology and politics.

My presentation will be focused on three main lines :

- A the implication of politicians and elected people
- B the technical works and studies
- C the monitoring and control of ANDRA's actions.

A) Politicians and elected people involment.

A.1 In the late eighties, we had a negative experience in trying to investigate four potential repository sites. In February 1990, after heavy public contest, the government declared a moratorium of "at least one year" on Andra's field work.

Immediately thereafter, a new decision-making process was begun, one designed to restore confidence and to be as open as possible, to provide guarantees for each step of the process.

Following substantial work involving public hearings, the French Parliamentary Committee on Science and Technology issued several reports concluding that the societal aspects of waste magagement were to be handled by the Society, represented by the Parliament and the elected people ; finally, the Waste Management Research Act was passed on December 30, 1991.

A.2 Members of Parliament were very concerned by radioactive waste questions. The Act was voted by a very wide majority.

Moreover, the Act and its application decrees set up 3 important dispositions :

a) to open widely the fields of research : to reduce radiotoxicity of waste by partitioning and transmutation; to evaluate and assess "in situ" through the use of underground laboratories the possibility of disposing long lived radioactive waste in deep underground host rocks; to improve waste conditioning for long term interim storage.

b) the foreseen laboratories will only be set up in communities which are volunteer candidates.

c) the establishment of ANDRA as a public Agency and the control of ANDRA's action.

To raise up volunteer candidates, a Member of Parliament, Mr. Bataille, has been appointed as a Mediator charged with identifying sites for two underground laboratories. Mr Bataille was confirmed by the new French government elected in March 1993, giving the evidence that in France the waste problem is an apolitical and national one transcending party politics. Mr. Bataille proposed four Departments, representatives of which had voted in favor of hosting a laboratory after the project has been presented by the Mediator. None of them were from the four sites where work was interrupted by the 1990 moratorium, which goes to show how difficult it is to reverse strong political positions adopted under intense public pressure. Local elected and association people will constitute local information Committees, enhancing the involvement of people living in the surroundings.

A.3 Politicians also consider that their responsibility is engaged in establishing suitable and adequate systems aiming at monitoring and controlling how the organisation in charge of waste management is performing the assigned mission. I will detail this point later.

B) Actual on site situation

Following the conclusions of Mr Bataille's report at the end of his mediation mission, the government decided to allow ANDRA to start a detailed geologic review in four departments (map) namely :

Gard near Bagnols sur Cèze,
Haute Marne near Chevillon, Poissons, Joinville, Doulaincourt, Saucourt,
Saint Blin Semilly
Meuse almost the whole territory
Vienne near Charroux and Civray.

The agenda is now as follows:

Designation of the mediator	December 1992
Phase 0-Mediator mission	1993
Agreement on the proposed departments	January 1994
Phase 1-Local prospection and selection of sites	1994- 1995
Phase 2-Application for the building and operating licence	
Public enquiry for two laboratories	1996
Phase 3-Building and research in the labs	1998 2005
Phase 4-Assessment of research	
Proposal from ANDRA on disposal concepts	2006

Today, we are proceeding the first phase with the objective of choosing the sites. Criteria are given by the Basic Safety Rule III 2 f.

C) Institutional Control

Three different types of control systems have been set up.

C.1 Control by the Parliament

The ultimate decision concerning the eventual political agreement about final repository will be taken, as written in the Act, by the Parliament through a new law. A first dead line is also proposed in the Act. A National Review Board will be in charge of submitting a report as a technical, scientific and social basis for the decision. This Board, now constituted, will follow year after year the results of the various studies launched on the three paths of research defined by the law (and not only on deep underground disposal). To do so, the Board will receive each year a synthesis report from each involved responsible organisation (ANDRA as responsible

for underground disposal, CEA as responsible for the two other ways of research, ANDRA informed of all results concerning the final product).

A Member of Parliament participating in the French Parliamentary Committee on Science and Technology (analogous to your National Waste Technical Review Board) was recently assigned a mission of follow up of the actions resulting from the Act. He will act as an external political auditor although we have not yet a clear idea of his interrelations with the National Committee.

C.2 Control by the Safety Authority

Obviously, design, building and operation of a repository will be in agreement with the existing regulation governing "French Basic Nuclear Installations". The siting of the repository is closely linked to the results provided by the underground laboratory. In that sense, the operation of the laboratories falls under the control of the Safety Authority.

C.3 Control by local involved representatives

As already said, each laboratory, and later if some decision is taken the repository, will provide open information to the local community and to their representatives in the Local Information Committees. People living near by the installations and often working inside are fully aware of every type of operation running on inside the installation. In that sense, their feelings constitute an acceptance signal and a first step of defence in depth against any wrong, unrealistic, dangerous or not announced programme or action inside the installation.

R&D for the back and front end of the nuclear fuel cycle

N. Canartat, CEA, France

7/19/1994

Following the previous speakers, this talk will review Research & Development programs performed in France in the Cea laboratories for the back and front end of the nuclear fuel cycle. The research is funded both by the government and by the industrial operators i.e. EDF, COGEMA and ANDRA.

(Viewgraph 2) Research for the back end of the fuel cycle is organised according to the 3 goals written in the 1991 law :

1-the partitionning and the transmutation of actinides and long lived fission products.

2-The building of 2 underground laboratories to study waste disposal in deep geological repositories, in which research will be pursued until 2006. At this point, in view of the available results, the parliament will decide whether to go ahead with industrial repositories.

3-the improvement of processes and conditioning to store waste for long periods at ground level

The first topic when considered from the reprocessing point of view can be supplemented with the long term objectives outlined in viewgraph 3. In a shorter time frame, the research programs provide technical and scientific support to plants in operation, in the start up phase or in the building phase.

Viewgraph 4 outlines the 2 items of the SPIN program (partitionning and transmutation) including :

-the PUREX line, in close association with COGEMA to reduce waste from reprocessing plants in operation.

-the ACTINEX line which answers the longer term goal of the 1991 law. Processes will be tried at the lab scale to co-extract Americium, Curium and Lanthanides from Fission Products of the present process. Neptunium can be extracted with the U and Pu partition products after an oxydation stage at valence VI using more conventional techniques. Actinides can be further separated from lanthanide like fission products, transformed into oxydes and recycled in reactors. Another route to selective extraction is the use of cyclic macro-molecules to extract long lived fission products.

Viewgraph 5 presents the reactor programs to transmute the separated actinides, using homogeneous and inhomogeneous fuels. Neptunium will be the first actinide to be transmuted experimentally by inserting specially designed pins in fast reactor cores.

The CAPRA program to enhance plutonium consumption in fast reactors is shown in viewgraph 6. "Classical" fast core designs plan to use Plutonium contents of 45% to increase Pu consumption up to 70-80 kg/TW_{electrical}. More advanced designs rely on fuels without Uranium which is the primary source of Plutonium formation. Calculations show that they can increase Plutonium consumption up to 110 kg/TW_{electrical}. The feasibility study phase terminates at the end of 1994. It is to be followed by experiments in Superphenix of CAPRA type assemblies.

Viewgraphs 7 and 8 show the waste conditioning and storage programs pertaining to topics 2 and 3 of the 91 law. Research is sponsored by ANDRA to define scientific experiments to be performed in the underground labs (mock-ups to simulate actinide migration at the best extrapolable scale, improvement of geochemical models coupling aqueous transport and chemistry, measurements of thermodynamic properties of actinides.....). Research programs also include improved characterisation of waste objects so that specifications can be regularly improved both at the underground laboratory level and further. This concerns primarily B and C class waste, since A class waste is stored industrially in Souaines, as shown earlier in the film. Examples of conditioning improvements include new glasses or ceramics for medium activity waste (replacement of bitumen) and synthetic phosphates for non transmuted long lived elements (Cs, Cm, I...).

The last 3 viewgraphs outline the Uranium Enrichment research for the front end of the fuel cycle. The SILVA process is developed for long term replacement of the Eurodif Plant commissioned in 1981. Cost targets are at least a factor 2 below costs of depreciated gaseous diffusion. The 1997 milestones in the program will establish the technical and economical feasibility of the process using the technological components of the Pierrelatte facilities and the ASTER integration system in Saclay.