# FRENCH NUCLEAR REPROCESSING – FAILURE AT HOME, COUP d'ETAT IN THE UNITED STATES

**Shaun Burnie**
Burnieking@btinternet.com
**May 2007**

If the state-funded corporations AREVA/Cogema and Electricite de France (EDF) were to be believed France is basking in a nuclear powered paradise with none of the nuclear waste problems confronting nations such as the United States. Their chosen "solution" to managing nuclear reactor spent fuel is reprocessing. But far from solving their problem - they have created one of the worlds largest and most complex nuclear waste problems, the management of which they continue to struggle with, and for which unknown and unallocated billions of Euros will be required.

French policy on reprocessing is a legacy of decisions taken during the 1950s-1970s. Those decisions were based upon in the first instance a need for a plutonium stockpile for nuclear weapons development, and later the expected demand that large amounts of the nuclear material would be required to fuel a generation of Fast Breeder Reactors.

In 2007, France no longer produces plutonium for military use, and its only commercial Fast Breeder Reactor has been closed ten years (1997) - but reprocessing continues. This analysis summarizes the current state of French policy and its consequences.

## BACKGROUND

The French state from the late 1950's constructed a number of reprocessing and associated fuel cycle centers to provide plutonium for nuclear weapons development and commercial Fast Breeder Reactors. They were located at three principal sites – la Hague in Normandy, and Cadarache and Marcoule in Provence. In contrast to the United States in the 1970's where there was significant separation between DOE weapons plutonium facilities and commercial reprocessing plants, in France there was and remains no such separation. The same sites that built up an infrastructure and workforce (and consequent strong vested interest) to provide a service to the French state were also promoted from the 1970's onwards as commercial sites to receive foreign spent fuel and provide associated fuel services.

The two principal actors in French nuclear policy are AREVA and Electricite de France (EDF) - both are owned by the French state. In terms of reprocessing, AREVA, through one of its member organization Cogema, operates the la Hague complex in Northern France. Two reprocessing plants operate at la Hague, with a maximum capacity of 1600 tons of spent fuel. One of the plants UP2 was built for reprocessing domestic spent fuel, produced by EDF; a second plant UP3 was built and paid for by foreign clients - principally, German, Swiss, Japanese, Belgium and Dutch electric utilities.

Under contracts signed in the 1970s-1980's - spent fuel was transported to la Hague, to be stored and eventually reprocessed. For foreign clients the principal motive was that it removed the

immediate and publicly controversial problem of large spent fuel volumes building up at reactor sites. In addition, their governments at that time were still wedded to the policy of developing Fast Breeder Reactors which would require large volumes of plutonium as fuel. While in large part these programs were terminated before most of the spent fuel was reprocessed, the contracts were drafted in a way that made cancellation expensive – politically and financially.

The UP3 reprocessing plant at la Hague operated through the 1990's solely with foreign spent fuel. In total over 10,000 tons was contracted for reprocessing. By 2004, all the major contracts had been completed. However, during this same period Cogema had been desperately seeking new contracts. Both Japan and Germany (the largest clients) were offered more favorable terms including:

- reduced reprocessing prices of as low as US$150-250 per ton of spent fuel - in contrast to their original contracts of US$1800-2000 per ton;
- long term storage of spent fuel without reprocessing at la Hague with options to extend storage after ten years;

The offers were rejected by German and Japanese clients. The political and economic burden of reprocessing in France proved too great for Cogema's traditional foreign clients.[1] In addition, Cogema was being challenged in the courts in France - it was and remains illegal to import spent fuel without reprocessing.

The consequence of this is that today, AREVA/Cogema's principal reprocessing client is EDF.

**EDF'S REPROCESSING TRAP**

EDF operates France's 58 light water reactors which discharge 1200 tons of spent fuel on average each year. Within this spent fuel there exists as much as 12 tons of plutonium. However, EDF has no plans (and no capacity) to reuse all of this plutonium. In fact, EDF came late to a commitment to reuse any of this plutonium. With the end of plans to commercially develop Fast Breeder Reactors in the early 1980's, the French government dictated that in the national interest, EDF should commit to large-scale reprocessing of spent fuel and the use of plutonium as Mixed Oxide Fuel (MOX) in its reactors. It's worth emphasizing that through the years of behind the scenes conflict between EDF and AREVA, it has been the latter that has generally held sway. AREVA includes the military and research division of the French nuclear state, the CEA (Atomic Energy Commission). In addition, the nuclear complex at la Hague employs upwards of 13,000 employees with strong union and political ties to successive French governments.

During the 1990's Cogema reprocessed around 850 tons of EDF spent fuel each year, yielding around 8 tons of plutonium each year. But it was not until 1996 that domestic capacity to produce large volumes of MOX fuel was reached with the opening of the Melox facility at Marcoule. Further, EDF made a decision that it would not use MOX fuel in all of its nuclear reactors. Out of the 58 operating, 20 of the 900MW series are licensed to use MOX, though only 16 are regularly fuelled. Its newer 1200MW reactors will not be loaded with MOX.

[1] In the case of Germany, spent fuel is now stored at reactor sites. In the case of Japan, spent fuel is to be reprocessed at the Rokkasho-mura facility, designed by Cogema.

Even with a less than projected MOX program, more than 10 tons of separated plutonium in highly vulnerable powder oxide form is transported across France on an annual basis. Major security issues remain dangerously unresolved.[2]

## THE ECONOMIC PENALTY OF REPROCESSING

The French state is unique within the European Union as being centrally planned. This has had many benefits in terms of health care, public transport and pension rights. But it has also meant that the real cost of government dictated decisions has rarely been made public. No more so than in the nuclear sector. As noted above, Cogema's principal foreign clients became more convinced during the 1990's that reprocessing made no economic sense. They also did not have the problem of hosting an actual reprocessing plant within their borders. In their more critical and open environments, dry storage without reprocessing, was clearly the cheaper option. Cogema's largest client country Germany has now ended the transport of spent fuel to France and completed its reprocessing contracts.

The economic penalty of reprocessing in France remained largely secret until a government commissioned study in 2000 provided some insight. The so-called Charpin Report[3] to Prime Minister Jospin, concluded:

*"The extra cost associated with reprocessing and MOX (mixed-oxide) fuel fabrication, compared to direct fabrication of UOx (uranium oxide) fuel fabrication (from enriched uranium) is not offset by savings of natural uranium through plutonium use (or savings) resulting from reduction in the direct cost of disposing of final wastes," the experts wrote. "In other words, this strategy, from the viewpoint of the utility, represents an increase in the cost of a kilowatt-hour, which appears as an obstacle to its competitiveness, an element that is increasingly intolerable in (an electricity) market opening to competition."*

The significance of a French government appointed commission concluding that a/reprocessing and MOX fuel use are uneconomical and will remain so for the foreseeable future and that b/reprocessing and MOX fuel use will contribute little to the reduction of the inventory of the transuranic radionuclides in waste, including plutonium, was considerable.

At the time of the study, EDF was receiving the most favorable contract terms for reprocessing, compared with foreign clients[4] and still the study concluded the above.[5] It is clear that France

---

[2] In 2003, Greenpeace tracked and blocked one such transport in the small French town of Chalon. The transports in lightly armed trucks remain predictable, regular and easily identified. It is fare to say that it is possible to set your watch by observing the movement of weapons-usable plutonium across France. For background documentation, photos, video of these transports see www.stop-plutonium.org.

[3] "Economic forecast for nuclear power" by Jean-Michel Charpin, Benjamin Dessus, René Pellat, Report for France's Prime Minister. September 2000, Paris. The report is available in French at: http://www.ladocfrancaise.gouv.fr/fic_pdf/charpinnucleaire.pdf, see NuclearFuel, Vol. 25 No. 17, August 21, 2000 NEW FRENCH REPORT SAYS Pu RECYCLE UNECONOMIC.

[4] Cogema made up for its reduced rate of reprocessing for domestic client EDF by higher prices for foreign clients – generally contract details remained commercially confidential but on occasion through whistleblower and legal action in the French courts, contract details have been made public.

would have been far better off economically without reprocessing. The cumulative cost difference between full reprocessing and no reprocessing amounts to about $25 billion.[6]

Further exposing the French nuclear state to scrutiny was the report from the French Commission for Sustainable Development (CFDD), which reported to the Prime Ministers office in a notice published on 28 February 2001 that nuclear reprocessing has no economic justification and that "the MOX option is not an equitable one for future generations."

So what effect have these critical studies had?

Despite the economic cost reprocessing has continued. French law requires the reprocessing option to allow consideration of actinide partitioning and transmutation using FBR technology. The principal beneficiary of this is the CEA which has sustained a substantial research program. Thus a law created when commercial Fast Breeder Reactor development was still imagined in the short term, is still determining policy, long after such plans had been scrapped.

Another problem for EDF was that the design of their reactor sites, and in particular their storage pools was premised on shipping all spent fuel to la Hague for reprocessing. However, a political decision to store rather reprocess could within a short period of time, allow EDF to develop additional on-site storage capacity.

While reprocessing continues in France, commitments to reprocessing all EDF's spent fuel remain unclear. While EDF pursues an aggressive overseas campaign of acquisition, taking advantage of the EU's policy of liberalizing electricity markets, it steadfastly refuses to permit competition within France. Its true financial status remains opaque. So long as these circumstances persist, it will be other factors that will determine whether EDF adopts the economically prudent step of ending reprocessing.

## AREVA'S INTERNATIONAL PROSPECTS

For AREVA, international prospects are not as bright as they would first appear. There is no possibility of securing new reprocessing business with its past client base. Utilities have either abandoned reprocessing, are small scale or in the case of Japan operating their own. After completing the Rokkasho-mura plant in Northern Japan, AREVA declined the offer by Japan Nuclear Fuel Limited to manage its operation. Significant doubts about the construction of the plant and how it will perform was probably a major factor in the AREVA Board decision.

---

[5] Despite the more favorable terms provided to EDF, it confirmed that MOX fuel produced by Cogema came at a price 3-4 times that of conventional uranium fuel. See, Daniel Leroy, deputy fuel Director of Electricite de France (EDF), Nuclear Fuel Jan 22nd 2001.

[6] This amounts to a difference of about $560 million, averaged out over the entire assumed life (45 years) of all the reactors. However, MOX is used in only some reactors and for only a portion of the life of these reactors. Hence, the cost difference between the full reprocessing and no reprocessing scenarios per reactor using MOX per year of MOX use is roughly $50 million (including the related reprocessing costs), see joint analysis by IEER, For more detailed overview of the Charpin study see, Annie Makhijani, IEER at www.ieer.org/sdafiles/vol_9/9-2/charpin.html, and WISE-Paris at www.plutonium-investigation.org

AREVA's reactor construction arm, Framatome is also in difficulty. Its sole European reactor project at Olkiluoto in Finland as of December 2006 was already 18 months behind schedule. It now seems likely that the project will fall at least €700m over-budget.[7]

For AREVA securing business with the United States is central to their future. It was not an accident that they have devoted considerable efforts to establish a role for itself in the US nuclear sector. Such a role was mistakenly provided by the Clinton Administration decision to opt for the MOX path for disposition of weapons plutonium. The fact that the AREVA designed Savannah MOX plant still remains a blueprint, with budget estimates far in excess of those originally cited is another highlights the reality of doing business with AREVA. The Bush administration extended this further when its controversial Energy review recommended overturning 30 year policy against reprocessing. With the launch of GNEP in 2006, a decade long effort by the French (and Japanese) plutonium industry to remove U.S. opposition was achieved.

## THE FRENCH NUCLEAR WASTE CRISIS

As French government and others studies have shown reprocessing does not solve the nuclear waste problem – it amplifies it. Since the origins of the French nuclear industry some 50 years ago, the management of nuclear waste has been largely neglected. Even today, large quantities of waste remain in unconditioned and unstable form, inventories of historical dump sites are lacking or were lost and one of the largest dump sites in the world near the la Hague reprocessing plant is leaking into the underground water.

In 2006 evidence emerged that a new nuclear dumpsite in the Champagne region of France is leaking radioactivity into the ground water threatening contamination of tritium and at a later stage other radionuclides. The French nuclear waste authority ANDRA has only a partial inventory of the multitude of existing waste categories, as large quantities have not yet been declared by the main waste producers EDF and Cogema, including spent nuclear fuel and waste from the uranium enrichment industry. Even French government regulators are expressing their concerns over the conditions at both dump sites. All of this has contributed to a growing unease in France including the safety of planned new underground high level waste disposal site a Bure, bordering the Champagne region of eastern France.

### Centre de Stockage de La Manche (CSM): the leaking giant

CSM containing 520,000 m3 of waste is one of the largest dump sites in the world. Disposal started in 1969 and continued for 25 years until its closure in 1994. The main origin of the waste is from the reprocessing of spent fuel at la Hague (30%), and from nuclear reactors of the French electricity company EDF (30%). There are some 59,000 $m^3$ of foreign waste dumped in CSM, all of which originated from reprocessing of spent fuel from German, Japanese, Swiss, Belgian, Swedish and Dutch utilities in defiance of French law, which prohibits foreign waste disposal.

In 1996, the government-appointed Turpin Commission concluded that the site, which was designed to contain only low level waste, also contains long-living and higher radioactive waste

[7] See the Economics of Nuclear Power, Thomas/Bradford/Milborrow and Froggatt, May 2nd 2007, Greenpeace International.

and that the inventory was not exactly known. As of 2007, the waste crisis at the CSM continues to get worse. The levels of contamination around the site are high. Water contamination from the CSM waste disposal facility migrates from the dumpsite into the underground aquifer. Farmers then access this water in two ways: directly from contaminated rivers and streams, and from deep wells. In the wells used by farmers to provide water to dairy cattle, levels of radioactivity are at 750 Bequerels per liter (+/-100Bq/l), seven times the European safety limit of 100Bq/l. In agricultural land close to the dumpsite, levels in the underground aquifer averaged 9000 Bq/l or 90 times above the safety limit during 2005.

A former senior engineer at the CSM site has confirmed that the leaking radioactive tritium is a tracer for what contamination will follow in the future – maybe tomorrow, or next month, or later.[8] This includes plutonium and strontium. These are extremely hazardous materials, increasing the risk of cancer and genetic damage. A decision on the future options of the CSM, including whether to open it up to remove and repackage the waste will be made in 2009.

**Centre de Stockage de l'Aube (CSA): State of the art leakage in the Champagne region**

After closure of CSM in 1994, low and intermediate level waste was transported to CSA in the Champagne-Ardenne region. It is claimed to be the state-of-the-art technology, thereby implicitly recognizing the shortcomings of its predecessor CSM. In the late 1980's when French waste agency ANDRA was seeking approval for the site, the people of Champagne were assured that there would be no radioactive discharges.

However, only after 10 years of operation, tritium leakage from CSA has been identified in the underground aquifer while the site had no license to discharge any radioactivity. Furthermore, in 2005, it was discovered that a concrete cell containing the waste cracked under excessive pressure. This was assessed as a generic design failure by the French nuclear authority ASN.[9] By the end of 2002 it is estimated there was as much as 109,000 $m^3$ dumped at the Champagne site as at the end of 2002. These are in concrete cells which are now under suspicion of suffering fissures due to water migration. Nuclear waste dumped at CSA is practically irreversible, as the cells are filled with concrete after the waste barrels are loaded. This makes it impossible to take corrective measures when highly radiotoxic nuclides would start leaking in the aquifer, a likely scenario given the already identified design flaws and tritium releases. It should furthermore be noted that CSA contains important quantities of long-living alpha-emitters, which will remain radioactive for thousands up to millions of years, whereas CSA was designed to contain radioactivity for only 300 years.

As with the contamination of agricultural water used for dairy cattle in Normandy, the CSA site is a direct threat to the production of Champagne through the contamination of ground water used by vineyard owners. Finally, as with the older CSM, some waste is coming from the reprocessing plant of AREVA/Cogema. During the 1990's, 50% of the reprocessing waste at la Hague was generated from foreign clients. Of the waste disposed of at the CSA Champagne site, 20% is from AREVA/Cogema.

---

[8] See interview with Christian Kernaunet – former nuclear engineer at ANDRA, May 2006, available at www.stop-plutonium.org

[9] See, in a letter of May 24th 2006, available at www.stop-plutonium.org

**Waste swapping official policy**

In early 2007, the French parliament reversed long-standing policy which prohibited the disposal of foreign nuclear waste in country.[10] While of major significance, it was confirmation of what had already been industry practice during the past decades. It was a victory for AREVA and their foreign customers in that it permits the substitution of higher volume waste for an equivalent curie content lower volume waste. This will lead to a reduced number of nuclear transports from la Hague to client states, and therefore is of financial benefit. It guarantees that the French environment and population will be permanently exposed to foreign generated nuclear waste.

**Reprocessed uranium - the myth of recycling**

Within the original spent fuel at la Hague, uranium accounts for 96% of weight. The resultant reprocessed uranium (Repu) is claimed to be an asset and recycled. The reality is that the vast bulk of this contaminated material remains unused. The cumulated quantities of Repu produced through light water reactor spent fuel reprocessing at la Hague are over 18,000 tons, of which half is of French origin and half arising from foreign fuel, mainly from Germany and Japan. If one adds the production of Repu at the older UP1 reprocessing plant at Marcoule, French reprocessing has generated a total estimated quantity of Repu at the end of 2003 of 30,000 tons. The bulk of this remains in vast storage areas at the Pierrelatte facility in France.

However investigations during the last five years have confirmed that at least 10,000 tons of this waste uranium was shipped to Russia.[11] A representative of the French Atomic Energy Commission (CEA) was cited in 2001 as confirming that:

*"the solution was until now to export the uranium of reprocessing, in exchange, of enriched natural uranium".*[12]

---

[10] See, Nuclear Fuel February 26th 2007.

[11] "Europe's radioactive secret: how EDF and European nuclear utilities are dumping nuclear waste in the Russian Federation" Greenpeace International November 18th 2005. Around 800 MTHM of REPU per year, which can theoretically be re-enriched but given economic conditions, is now transformed into stable U3O8 for long term storage. REPU is *"potentially usable"* in reactors, he noted, and *"if there's a uranium supply crisis in 15 years, we could run our reactors on it for five years."* But it was confirmed by EDF Fuel Division Director Michel Debes "that higher burnups don't favor the use of REPU, since they lead to a higher content in spent fuel of the unwieldy U-236 isotope."

[12] Rapport IPSN (aujourd'hui IRSN) du 28 nov 2001 pour le groupe permanent cycle du combustible. H. Guillaume, R. Pellat, Ph. Rouvillois, "Rapport sur le bilan et les perspectives du secteur nucléaire en France", CEA, May 1989 - p. 87 *"Uranium arising from reprocessing is significantly different from natural uranium. Slightly more enriched (1% instead of 0.7%), it also contains some highly irradiating isotopes (U234 and U236). The presence of these isotopes makes the operations of enrichment and fabrication of fuel more difficult, and moreover more costly, because of stricter rules for operators protection et because of the risk of contamination of the facilities and equipments used. In particular, reprocessed uranium can hardly be re-enriched in the EURODIF plant, where the gaseous diffusion technology used does not allow for the separation of 234 and 236 isotopes from the useful ones (235 and 238); a period of some months of "cleaning" would be necessary after a campaign of reprocessed uranium re-enrichment before the plant can be operated again for natural uranium. The solution has been up to now the export abroad of the reprocessed uranium and the delivery, in exchange, of natural uranium enriched. Reprocessed uranium quantities held by EDF did not amount to an important volume up to now anyway. With the end of the exchange contract planned in 1990, coinciding with the start of large scale reprocessing of EDF spent fuel in La Hague UP2-800 plant, will highlight the problem. This can however be partly solved by incorporating*

The disposal of contaminated reprocessed uranium by AREVA in Russia exposes the lie that reprocessing permits the efficient reuse of spent fuel.

**High-level waste - interim storage before disposal**

Of the many forms of waste generated from reprocessing, Vitrified High Level Waste (VHLW), is the most hazardous in terms of long term risk to the environment. The bulk of French owned VHLW is currently in storage at the la Hague site. Current policy is for this waste to be disposed of underground, but as of 2007 no such facility exists. Over the last ten years multiple sites have been proposed for exploratory research, but due to political opposition, these have been reduced to one site at Bure bordering the Champagne region in eastern France.[13] One proposed site in the Rhone region were abandoned following strong opposition, including from the regional wine producers.

While developments of the underground laboratory are underway there remain major uncertainties as to its suitability (in geological terms) and the timeframe for any actual disposal. In 2005 a prominent geologist member of the government-appointed committee reviewing the French high-level waste (HLW) research program stated that no decision on deep disposal should be made for at least 10-15 years, and possibly not before 30 years of research and demonstration on both deep disposal and long-term surface storage.

Ghislain de Marsily, a member of the French Academy of Sciences and its Academy of Technologies (equivalent to the U.S. National Academy of Engineering) said

*"…research so far into properties of a clay formation at Bure indicates the site is "potentially interesting" for an eventual repository. But he said experiments conducted in Andra's deep laboratory in the Callovo-Oxfordian argillite--clay--layer at the site are not sufficient to confirm the formation's ability to confine wastes as required. Experiments in heat transfer, radionuclide migration, behavior of gases, and sealing of shafts and galleries must still be conducted over 10 to 15 years, he said, and results "could lead to calling into question the choice of the site or the design of the repository."*[14]

Reflecting the uncertainty with the Bure site, the French parliament agreed in 2006 that a further vote in 2012 will be required before proceeding with construction. Other requirements included demonstrating 'reversibility' up to 100 years.

Despite all the efforts of AREVA, the Parliament also confirmed centralized interim storage of VHLW and spent fuel "for which no immediate reuse is envisaged."[15] The Government had sought to avoid this on the basis that existing storage facilities at la Hague and Marcoule could

---

*reprocessed uranium to the strategic stocks, equivalent to three years of consumption, that EDF is bound by regulation to hold. Reprocessed uranium would therefore only be used in the case of a serious crisis of uranium* supply, that would make the overcost due to the higher radioactivity of this resource negligible".

[13] Opposition has also been building to the Bure site, with over 50,000 signatures demanding a local referendum before any decision to proceed with research at the site.

[14] See, Nuclear Fuel December 5th 2005 "CNE member says French repository decision requires up to 30 more years".

[15] See, Nuclear Fuel April 24th 2006 "French MPs force new vote on repository before licensing."

be expanded and that they would be operated until a final repository was ready or spent fuel was ready for recycling.

In addition to the VHLW, EDF is also generating around 100 tons of spent MOX fuel each year. None of this is being reprocessed (underscoring the mythology of recycling).The higher heat generation from spent MOX means disposal underground is even further delayed than VHLW. The Charpin report of 2000 confirmed that cooling times for spent MOX was in the range of 150 years, prior to final disposal. The CFDD commission in 2001 concluded that:

*"A single MOX reprocessing cycle only reduces consumption of natural uranium by around 5 per cent and production of transuranium elements (plutonium and minor actinides) by 12-15 per cent. The amount of dangerous waste is therefore only slightly reduced by this operation."*

Plans to eventually reprocess the spent MOX fuel and use the plutonium in a new generation of FBR's after 2050 remain highly uncertain.

## ENVIRONMENTAL IMPACT OF REPROCESSING

Radioactive discharges from reprocessing plants in general and la Hague in particular, are very much higher than from nuclear power stations. For example, gaseous discharges in 1991 from all four PWR reactors at Tricastin were about 0.03% of the activity discharged from La Hague in that year; liquid discharges were less than 1% of the activity discharged from La Hague.[16] Moreover, Cogema is allowed to discharge radiotoxic alpha emitters but other nuclear plants are not.

As a consequence, the discharges from la Hague have been one of the most controversial issues confronting Cogema and AREVA over the years. There are extensive and authoritative assessments on reprocessing discharges from la Hague.[17] One of the most contentious issues arose after the publication in January 1997 of a study suggesting a direct linkage between reprocessing at la Hague and the higher incidence of childhood leukemia within the communities in the immediate vicinity of la Hague.[18] Despite sustained attacks on the authors of this study by

---

[16] CEPN. Externalities of Energy. Vol 5: Nuclear. European Commission, Directorate-General XII. Luxembourg 1995.

[17] RADIOACTIVE DISCHARGES from LA HAGUE D J Sumner 23 May 2000 Greenpeace International. For a comprehensive assessment of the discharges from la Hague (and Sellafield) see, Final Report for the STOA Study Project on POSSIBLE TOXIC EFFECTS FROM THE NUCLEAR REPROCESSING PLANTS AT SELLAFIELD (UK) AND CAP DE LA HAGUE (FRANCE) Project Directed by: Mycle SCHNEIDER#,1 Contributions by: Xavier COEYTAUX#,3, Yacine B. FAID#,3, Ian FAIRLIE, David LOWRY, Yves MARIGNAC#,2, Emmanuel ROUY#,3, David SUMNER, Mycle SCHNEIDER#,1, Gordon THOMPSON*,1. # WISE-Paris – 1 Director, 2 Assistant Director, 3 Research Associate * IRSS (Institute for Resource and Security Studies) – 1 Director à Independent Consultant August 2001 Commissioned by the European Parliament Directory General for Research Scientific and Technological Option Assessment (STOA) Programme Contract No EP/IV/A/STOA/2000/17/0

[18] Pobel D, Viel JF. Case-control study of leukemia among young people near La Hague nuclear reprocessing plant: the environmental hypothesis revisited. *British Medical Journal* 1997. More recently, The incidence of childhood leukemia around the La Hague nuclear waste reprocessing plant (France): a survey for the years 1978–1998, A-V Guizard, O Boutou, D Pottier, X Troussard, D Pheby, G Launoy, R Slama, A Spira, and ARKM, in *Journal of Epidemiology Community Health* 2001;55:469–474

the French nuclear establishment, ten years after the original publication there has been no resolution to this controversy.

To summarize some of the major issues:

- Authorized discharges from the Cogema plants at la Hague are much higher (by a factor of one hundred or more) than from any other nuclear installations in France. Cogema provide only limited information on the actual levels of gaseous and liquid discharges. Historically, several important radionuclides, such as carbon-14 and iodine-129, have not been shown separately.

- During maximum reprocessing throughput in the 1990's the discharges of several radionuclides rose steadily. These include: tritium (both to sea and atmosphere), iodine-129 to sea, krypton-85 to atmosphere, carbon-14 to atmosphere, and ruthenium-106 to atmosphere. Carbon-14 and iodine-129 have very long half-lives.The reprocessing of high burn-up spent fuels from EDF has resulted in significant increases in the discharges of tritium, carbon-14, krypton-85 and iodine-129. Cogema compare doses to individuals in the la Hague area with a dose limit. This is contrary to the recommendations of the International Commission for Radiological Protection (ICRP), specifically, doses from a single source should be compared with a dose constraint, which is less than the dose limit.

- Cogema has never attempted to justify the practices at la Hague, that is, to demonstrate that the benefits exceed the detriment, as required by the first principle of radiation protection. There are serious deficiencies in environmental monitoring data provided by Cogema. The persistent omission of iodine-129 in the data presented by Cogema has been of particular source of concern, given the importance of iodine-129 in the critical group doses. Cogema have consistently ignored the work done on the identification of critical groups by the Nord-Cotentin Radioecology Group, and present critical groups of their own. The models used to estimate doses to these groups appear to be relatively crude, and have not been validated with environmental measurements. Given the considerable uncertainties in the estimation of these doses, it is conceivable that doses to individuals could be significantly higher than the mean.

- Carbon-14 is an important radionuclide which has been largely overlooked by Cogema. Doses to individuals from carbon-14 could be an order of magnitude higher than estimated.

- Annual discharges of krypton-85 at the 'nominal' level from la Hague could result in 600 cases of skin cancer. The iodine-129 discharged from la Hague in 1999 was more than six times the total iodine-129 from weapons test fallout. There are very considerable uncertainties in estimating the doses to individuals from iodine-129. Cogema have made no estimates of collective doses. These are very large for la Hague discharges, comparable with some major nuclear accidents in the past. If France adopted the industry norm of dry storage of spent fuel collective doses could be reduced by three or four orders of magnitude

## PROLIFERATION IMPLICATIONS OF FRENCH PLUTONIUM PROGRAM

As is well known, France was the fourth nation to join the nuclear weapons club. The necessary infrastructure and personnel required for their weapons development, was one of the major determinants in creating its commercial nuclear, in particular reprocessing, program. Its track record on controlling the most sensitive nuclear technology is not good. In fact successive French governments through the past fifty years have rejected some of the more effective policies of the United States, by actively exporting reprocessing technology to nations regardless of the proliferation impact. From the supply of Israel's Dimona facility in the late 1950' and 1960's, to the delivery and construction of Saddam Hussein's bomb reactor at Osirak (O'Chiraq as it is better known in France), France and nuclear non-proliferation have been a contradiction in terms. During the same period, France has accumulated one of the world's largest stockpile of weapons usable plutonium, and provided reprocessing plants and plutonium to Japan. The same organizations referred to in this paper, specifically the CEA and Cogema, are fully implicated in France's determined efforts to export the most dangerous technologies and materials in the nuclear fuel cycle.

For critics of successive French disregard for effective non-proliferation and strong supporters of the 30 year policy of the United States to reject and oppose commercial reprocessing and plutonium use, the last few years have been to say the least a shock. In the corridors of power in France today they are smiling at the reversal of long-standing US policy. There has been a coup d'etat at the US Department of Energy initiated by AREVA.

The future for AREVA's proliferating ways may appear bright but if past experience is any indicator, there will be many obstacles and delays, and they will come of course at a heavy price. Two issues to focus on in this summary overview, plutonium stocks and advanced breeder research.[19] Both are directly linked to the Bush Global Nuclear Energy Partnership (GNEP).

Despite having the most commercial reactors using MOX, France is not significantly reducing its plutonium stockpile. As of December 2005 its declared inventory was 60 tons[20]. With an additional 8 tons arising each year from reprocessing, which is the amount EDF is able to incorporate into fresh MOX each year, France's surplus plutonium stock will remain one of the world's largest into the foreseeable future. Earlier plans to bring plutonium supply and demand into balance have failed. Safety demands from regulators restricting enrichment and fuel burn-ups, and the poor economics of MOX fuel, as well as a reluctance of EDF to increase the number

---

[19] For an overview of Advanced Fuel Cycle developments with a focus on North-east Asia see, "Proliferation report: sensitive nuclear technology and plutonium technologies in the Republic of Korea and Japan, International collaboration and the need for a comprehensive fissile material treaty, Shaun Burnie, Greenpeace International Paper presented to the International Conference on Proliferation Challenges in North-east Asia: The Korean Peninsula and Japan, National Assembly Republic of Korea, April 28th 2005.

[19] See, French report to IAEA, as reported December 2006, available at: www.iaea.org, Seoul, Republic of Korea, April 28, 2005.

[20] See, French report to IAEA, as reported December 2006, available at: www.iaea.org. A further 30 plus tons belonging to foreign clients remained at la Hague and Melox in Marcoule. The approval in April 2007 for an extension of the Melox license to 195 tons heavy metal MOX each year is largely intended for future production of MOX fuel for Japanese clients – not increased MOX production for EDF.

of MOX reactors have been major factors in creating France's unused and usable plutonium stockpile.

Given US recognition that separated plutonium from commercial reprocessing plants remains a proliferation hazard, France has demonstrably failed to comply with international norms. In fact its export of plutonium to client states, in particular Japan, has played an important role in driving nuclear proliferation. When Japanese politicians[21] have claimed that they could use plutonium from the nuclear reactor program to develop nuclear weapons – it has been French supplied reprocessing technology and plutonium that they have been referring to. U.S. diplomats that understood the risks were warning of these years ago.[22]

The consequences in North-east Asia, including its knock on effect on the Korean peninsula and with China are of major concern to anyone with an awareness of the potential conflicts that could arise in the coming years. That AREVA has been in active negotiations with the Chinese government to provide full fuel cycle services, including reprocessing technology, is yet a further example of French disregard for the proliferation consequences of its nuclear export policies. They really will sell to anyone. AREVA's prospects for exporting its plutonium technology to China, has already been enhanced by the embrace and endorsement by the USDOE through GNEP.

On the development of so-called Advanced Fuel Cycle's, in particular Generation IV FBR's, the French CEA has played a major role in the last decade in trying to sustain the dwindling interest and knowledge base within the international nuclear community. Along with Japan, France has proliferated through technical workshops and funding its most sensitive plutonium information. The active support of FBR development has continued despite the commercial disaster of France's sole large-scale FBR, Superphenix. By the year 2000, the reactor had cost 60 billion francs (about US$6 billion), while barely generating any electricity during its 14 year lifetime. France's one sole remaining fast reactor, Phenix will be closed in 2008. The CEA has plans to construct a new reactor as part of its commitment to Generation IV development however to date it has not secured financing of this from within the European Union.

The French breeder advocates located inside AREVA have found themselves a new mission in the last few years to deliver safe, sustainable and proliferation resistant energy. Policy makers in the U.S. at least, bombarded by spurious evidence from the French nuclear state appear to believe that these 'new' reactor concepts under the banner of Generation IV' will deliver cheap energy, solve the nuclear waste problem, and not increase proliferation risks while also saving the climate.

The international track record in FBR development including that of France would counter that this is wholly misguided. The reactor concepts are not new, but reinventions of ideas developed

---

[21] See, "It would be so easy for us to produce nuclear warheads – we have plutonium at nuclear power plants in Japan, enough to make several thousand such warheads." Ichiro Ozawa, Lecture in City of Fukuoka, Kyushu, April 6th 2002.

[22] *U.S. Ambassador to Japan, Armacost to U.S. Secretary of State Christopher, March 1993, "Can Japan expect that if it embarks on a massive plutonium recycling program that Korea and other nations would not press ahead with reprocessing programs? Would not the perception of Japan's being awash in plutonium and possessing leading edge rocket technology create anxiety in the region?"*

at a cost of billions and then abandoned over the last three-four decades. The US breeder community that has survived the lean period of the 1980's-1990's following the cancellation of programs such as the Integral Fast Reactor, and the scrapping of the Clinch River breeder, have dragged the Generation IV debate towards the concepts of which they know best – fast neutron reactors with supposedly closed fuel cycles.[23] For those who thought that the breeder concept was long-buried, defeated by its disastrous economics, safety and technical problems, and of course the inherent proliferation threat posed by breeding and reprocessing plutonium – the new reality under GNEP is that they will be back. It's like the last thirty years did not happen; if it possible to have nuclear ground-hog day, this is it.

## CONCLUSION

In summary, an understanding of the French experience of reprocessing and plutonium use should lead to its rejection by any country operating nuclear power plants. The majority of AREVA's reprocessing clients have reached this conclusion and have ended reprocessing, switching instead to the less costly and more secure dry storage. Its no accident that AREVA's sole remaining large reprocessing client, EDF, is a state owned utility. Left to the free market it would have long ago ended reprocessing.

France continues to reprocess nuclear spent fuel due to combination of institutional inertia, vested interests within the state, and a rejection and active opposition to a deregulated electricity market. The United States with the world's largest stock of spent fuel is an obvious target for a French state corporation whose traditional market has dried up.

AREVA, backed by the French government, actively proliferates its technology and materials worldwide with the sole aim of survival, in disregard for long-standing non-proliferation norms, creating instability and the potential for nuclear conflict. The strange reality where despite this terrible track record, AREVA has performed a coup d'etat on U.S. nuclear policy needs to be recognized, challenged, and overturned. A good starting point would in the U.S. Congress.

[23] The Integral Fast Reactor and Clinch River Breeder were reactors in the U.S. Other fast reactor facilities – the EBR II and Fast Flux Test Facility have been closed with the sodium coolant drained.