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ORNL

FOREIGN TRIP REPORT

ORNL/FTR-2901

DATE: August 8, 1988

SUBJECT: Report of Foreign Travel of U.S. Department of Energy Delegation to Paris, France

TO: Alexander Zucker

FROM: Delegation Members: S. D. Van Hoesen (Engineering Division) J. M. Kennerly (Chemical Technology Division), L. C. Williams (Environmental and Health Protection Division), W. N. Lingle (USDOE, Oak Ridge Operations), M. S. Peters (Savannah River Plant), and G. R. Darnell (Idaho National Engineering Laboratory)

PURPOSE: To participate in a training program on French low-level radioactive waste management techniques focused on waste characterization, acceptance, and certification, and waste disposal facility design, construction, and operation.

SITES VISITED:

6/6-9/1988	ANDRA	Paris, France	J. Y. Ravachol
6/10/1988	Saclay NRC	Saclay, France	M. Ricard
6/13/1988	L'Aube Site	Soulaines, France	J. Dodemant
6/14/1988	La Manche Site	Cherbourg, France	J. Y. Ravachol
6/15/1988	La Hague Site	Cherbourg, France	H. Giroux
6/16-17/1988	La Manche Site	Cherbourg, France	J. Y. Ravachol
6/20-22/1988	La Manche Site	Cherbourg, France	J. Y. Ravachol
6/23-24/1988	ANDRA	Paris, France	J. Y. Ravachol
6/27/1988	Caderache NRC	Manosque, France	P. Vaunois
7/8/1988	ANDRA	Paris, France	J. Y. Ravachol

ABSTRACT:

The U.S. team consisting of representatives of Oak Ridge National Laboratory (ORNL), Savannah River Plant (SRP), Idaho National Engineering Laboratory (INEL), and the Department of Energy, Oak Ridge Operations participated in a training program on French low-level radioactive waste (LLW) management techniques. Training in the rigorous waste characterization, acceptance and certification procedures required in France was provided at Agence Nationale pour les Gestion des Dechets Radioactif (ANDRA) offices in Paris.

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A visit was made to the Saclay Nuclear Research Center, a French LLW generator which produces waste very similar to that encountered at ORNL. The L'Aube Site, location of the new LLW disposal facility currently under construction, was visited and discussions were held with local officials concerning the planned developments. Detailed training in design, construction, and operation of the French engineered near surface disposal concept was provided at the operating disposal facility at the La Manche site. A visit was made to the La Hague Reprocessing Center to view and discuss reprocessing and waste management operations. Meetings were held at the ANDRA offices in Paris to review reports being prepared by SGN and NUMATEC under subcontract to Martin Marietta Energy System, Inc. A visit was made to the Caderache Nuclear Research Center to discuss solid waste processing operations. Delegation members participation in the various portions of the training program is indicated in their itineraries.

REPORT OF TRAVEL TO FRANCE

June 3 - July 8, 1988

S. D. Van Hoesen, Martin Marietta Energy Systems, Inc.
W. N. Lingle, U. S. Department of Energy, Oak Ridge Operations
J. M. Kennerly, Martin Marietta Energy Systems, Inc.
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G. R. Darnell, EG&G Idaho

The purpose of this trip was for the U.S. team to obtain training in the low-level radioactive waste (LLW) management techniques utilized in France. This training experience was extremely valuable for the Department of Energy (DOE), the Oak Ridge National Laboratory (ORNL), the Savannah River Plant (SRP), the Idaho National Engineering Laboratory (INEL), and other DOE facilities as they begin to implement the rigorous requirements of revised DOE Order 5820.2a and develop new LLW disposal facilities. In particular, the training received in French waste characterization, acceptance, and certification procedures provided valuable information to all involved parties for use in implementing similar requirements in DOE Order 5820.2a. Also, the training received on French LLW disposal facility design, construction and operation will be directly applicable to the construction of similar facilities at ORNL (tumulus), SRP (vaults), and other DOE sites.

This training provided a unique opportunity to gain experience with techniques utilized in the French LLW management system, which is generally regarded as being the world leader in engineered LLW management systems. The engineered LLW management systems utilized in France are of particular interest to DOE, and the Nuclear Regulatory Commission (NRC), because of their potential for providing the increased LLW management system performance being demanded by the U.S. public.

Detailed documentation for the waste characterization, acceptance, and certification training sessions will be provided in a document to be prepared by Societe Generale pour les Techniques Nouvelles (SGN) and their U.S. subsidiary NUMATEC as a part of the contract with Martin Marietta Energy Systems, Inc. which supported conduct of the training program. Detailed descriptions of the waste disposal facility design, construction, and operation training sessions and associated photographs will be documented in a technical report which is under preparation.

Summary of Work Activities

The following section provides an overview of the topics covered in the training program. Itineraries of the U.S. team members are provided in Appendix A. A list of persons contacted during the training program is provided in Appendix B. A list of literature acquired during the training program is provided in Appendix C.

June 6-9, 1988 - Waste Characterization, Acceptance, and Certification Training, Paris, France

The waste characterization, acceptance and certification procedures training began with an overview of the French LLW Management System by Yves Marques, Deputy Director of Agence Nationale pour la Gestion des Dechets Radioactifs (ANDRA). France is committed to obtaining up to 80% of their electricity in the year 1990 by nuclear generation. ANDRA was created as a French governmental agency in 1979 to assure that capabilities are in place to manage the approximately 30,000 m^3 of LLW produced by the nuclear electricity generating, fuel reprocessing, and other nuclear industries. ANDRA is responsible for continued operation of the current LLW disposal site, the Centre de Stockage de la Manche (CSM), as well as development of a new LLW disposal facility to be operational in 1991, and a deep repository for long half-life waste for operation in 2000.

Jean Yves Ravachol, ANDRA Project Manager for International Affairs, reviewed the French LLW safety regulations. ANDRA is required to implement regulations established by the French Central Service for Nuclear Facility Safety (SCSIN), which is a section within the Ministry for Industry. The regulations follow European Community Council Directives and recommendations of the International Commission on Radiological Protection (ICRP). Two fundamental safety rules are established and applied to LLW management. The first rule is designed to ensure the protection of human health and the environment and limits the disposal facility institutional control period to 300 years or less. The second rule establishes waste acceptance requirements including radionuclide content limitations and waste performance requirements.

Daniel Boulitrop, Manager, ANDRA Department of Evaluations and Technical Review, Division of Specifications, Quality Assurance, and Quality Control (DSQC), provided an overview of the French LLW acceptance criteria. General criteria (e.g. no free liquids, etc.) are established including the requirement that all waste must be in a form which is structurally stable and free of voids. Two activity-to-weight limits for radionuclides are also set. The first limit establishes radionuclide levels above which the waste must be "immobilized" by conditioning with a material which is designed to retain the radionuclide (e.g., cement, bitumen, polymer). The second limit establishes maximum radionuclide "acceptance" levels.

Annick Pitiot, Project Engineer with ANDRA Department of Evaluation and Technical Review, DSQC, described the French LLW acceptance process. The process involves development by ANDRA of a Waste Acceptance File (WAF) and a Measurement Acceptance File (MAF) for each type of waste package produced by a generator. A standard format and content is used for the development of these files. The goal of these files is to describe the process generating the waste and the processes used to condition the waste. Three levels of waste characterization, and associated testing requirements, are established based on the nature of the waste. It is the responsibility of the waste generator to conduct the tests and analyses required to demonstrate that the waste meets ANDRA requirements.

Jean-Claude Rivier, Project Engineer with ANDRA Department of Quality Control, DSQC, reviewed the French Quality Assurance Program (QAP) for the management of LLW. The QAP is based on requirements for the quality of the design, construction, and operation of nuclear facilities established by the French government in 1984. The QAP is consistent with International Atomic Energy Association (IAEA) QA code 50, and French standards (AFNOR) NFX 5-111 and NFX 50-112. A review of each generator's QAP is conducted at least once each year. In addition, ANDRA selects waste packages at random (approximately 10 per year) for detailed destructive testing to confirm the characteristics of the waste form and package.

Nathalie Rocca Serra provided a description of the technical specifications which have been established by ANDRA to implement the waste acceptance criteria. These specifications provide the detailed guidance, including individual radionuclide activity-to-weight limits, which are to be used by the generators in qualifying their waste for acceptance for disposal. In addition to establishing the required chemical, physical, and radiological characteristics of the waste, the specifications also detail the types of test procedures to be used by the generators in the waste acceptance testing program.

Two case studies of wastes which were reviewed by ANDRA were presented. Daniel Boulitrop described the straightforward waste acceptance process, including results of the waste characterization program, conducted for an evaporator concentrate immobilized in cement. The waste contains primarily long-lived alpha emitters at concentrations above the immobilization limit. The waste/cement mixture is placed in 100 liter (26.4 gal) metallic drums.

Pierre Regimbeau described the acceptance process, which is still underway, for a waste form which was not accepted as originally proposed by the generator. The waste consists of ion exchange resins produced in nuclear power plants. The resins contain as much as 90% of the activity contained in solid LLW produced at the power plants. The cement based waste form originally proposed by the generator was not found to be acceptable by ANDRA based on the results of leach tests which were conducted as a part of the acceptance process. A new waste form consisting of immobilization of the resin in polymer followed by placement in a concrete encased steel tank is currently being developed. Of particular interest was a waste assay technique utilized for this waste which involves comparison of dose rates with and without shielding. This technique provides an indication of changes in relative radionuclide contents not apparent from a single dose rate measurement.

Annick Pitiot, Pascale Rebiffe, and Philippe Vaunois and the U.S. team members conducted a mock waste acceptance exercise on 6 waste streams from the Oak Ridge plants (compactible waste, decontamination and demolition waste, drummed waste, Emergency Avoidance Solidification Campaign waste, Process Waste Treatment Plant waste, and Y-12 sludge). Information on these waste streams (description, radionuclide content, etc.) was provided to ANDRA for review in May. The majority of the discussion focused on clarifying information on the waste and answering ANDRA questions. A major topic of discussion centered on the question of how radionuclide contents of the waste were determined. ANDRA indicated that the radionuclide content of as much as 70% of the waste they accept is based on a dose rate/radionuclide content correlation. This is the same approach used for several of the Oak Ridge waste streams included in the mock exercise. It was apparent from the discussion, however, that ANDRA would expect additional information, such as the results of analyses, spectrographic measurements, etc. to support the validity of the dose rate/radionuclide correlation. This information is not generally available for the Oak Ridge waste streams.

June 10, 1988, Saclay Nuclear Research Center, Saclay, France

A visit was made to the Saclay Nuclear Research Center to discuss the waste acceptance process from the generator view point with M. Doucet, M. LeConnetable, M. Perotin, M. Ricard, and J. Cerles. In addition, information was obtained on the liquid and solid radioactive process facility and the waste package and testing facility. Processes involving in-cell compaction and packaging of higher activity solid waste were observed. The liquid waste evaporation/treatment processes used at Saclay were reviewed and visited. Saclay serves as a central processing point for liquid wastes generated at several French research facilities. The waste is transported in large shielded tanker trucks. The concentrate from the evaporator is treated to "fix" the radionuclides present, followed by embedding in asphalt. A visit was also made to review operation of the OSIRIS research reactor.

June 11 & 12, 1988 - Weekend and travel to Soulaines, France

June 13, 1988, Centre de Stockage de l'Aube, Soulaines, France

A visit was made to the new LLW disposal facility, the Centre de Stockage de l'Aube (CSA) which is being developed near Soulaines, France, approximately 165 km (100 miles) east of Paris. Mr. J. Dodemant of ANDRA provided an overview of the CSA development. The CSA site covers approximately 90 ha (222 acres) and is located in a large forest surrounded by sparsely populated farm land. Operation is expected to begin in 1991 and the site is expected to receive up to 1 million m^3 (35 million ft^3) over its 30 year design life.

The site was selected because of its attractive geohydrological characteristics. The site contains a well drained sand member overlaying an impermeable clay layer. The clay layer drains to a stream which borders the site. The French feel that this is an "ideal" site since the clay layer provides a natural barrier to any communication with deeper groundwater and the stream that the clay layer discharges to can be used to monitor for any discharges from the disposal facility. The site was also selected because of the generally positive reception of the nearby towns.

A visit was made to the site to view construction activities. An access road has been constructed and the site has been cleared. A clay layer overlaying the sand layer is being stripped off and used to build up lower portions of the site to provide areas for the construction of support facilities (adminstration building, public information building, waste processing area, etc.). All disposal units will be constructed above-grade on the sand layer. As with other ANDRA operations observed during this trip, the construction activities are being carried out on a large scale with well maintained, new equipment.

The disposal units at CSA will incorporate several "improvements" derived from experience gained at the current operating facility, CSM. First, all waste will be disposed of in above-grade structures in an effort to keep the ground water out. Second, the waste currently placed in the tumulus and monolith units at CSA will be separated instead of having the tumulus located on top of the monolith as at CSM. Third, the vast majority of the waste will be placed in above-grade concrete vaults. To keep the waste packages and the vaults dry during the filling operation, portable metal roofs with overhead bridge cranes will be placed on rails on the vault walls and will be advanced as the waste stack advances. As the metal roof advances, an impervious membrane will be placed on the completed waste stack to keep rainwater out of the waste. When a vault is filled, a concrete roof will be poured in place on top of the impervious-membrane-covered grouted waste. Finally, an engineered earthen cover will be placed over each vault. Fourth, the drainage gallery will be built under the pads as an integral part of the pad, and will include dual collection systems - one "clean" and one "contaminated". This, coupled with the covers mentioned previously, will allow ANDRA to minimize the volumes of water potentially requiring treatment. This is a very important consideration for the isolated CSA site which will not benefit from the nearby location of extensive water treatment facilities as is the case at CSM (La Hague reprocessing facility is located adjacent to CSM).

Following the tour, discussions were held with the mayors of the three towns located nearby the CSA. Messrs. M. Andujar (Soulaines), J. Mosnier (Epothemont), and N. Denizet (Vill-aux-Bois) were universal in expressing their town's positive view of the planned CSA development. They see the economic benefits of the CSA - 70 jobs and tax payments - as critical to the survival of their towns. The mayors were quick to point out however, that they, and the approximately 2000 local citizens were expecting that the disposal operations would be conducted in a safe manner. It was mentioned that visits to the CSM facility by local citizens had left a positive impression of ANDRA's commitment to sound operation of the CSA.

<u>June 14, 1988 - Centre de Stockage de la Manche, Cherbourg, France</u>

Jean Yves Ravachol provided an overview of operations at the CSM, the operating LLW disposal facility for France. The CSM site covers 12 ha (30 acres) and is located adjacent to the La Hague fuel reprocessing facility. Approximately 400,000 m^3 (1.4 million ft^3) of LLW have been disposed at the site since operation began in 1969. Extensive efforts are being implemented to utilize all available space at the CSM to extend operations through 1991 when the CSM capacity of 500,000 m^3 (1.76 million ft^3) is expected to be exhausted and the CSA will be in operation.

Three basic types of disposal units are utilized at CSM. Monoliths, consisting of small cells constructed on a base concrete pad, form the bottom layer of the disposal facility. Containerized waste is placed in the monoliths and immobilized with a cement which provides radionuclide retention capabilities. When monolith loading is completed, a second concrete pad is constructed on top of the monolith. Structurally stable waste packages, concrete cylinders or metal boxes and drums with grouted waste inside, are stacked on the pad to create the tumulus portion of the disposal facility. Small canyons are created between monoliths and tumulus packages which provide shielding capabilities for high activity (>200 mr/hr) waste packages. All of the disposal units are linked to a common drainage gallery which runs around the perimeter of the site. Total thickness of the waste units is approximately 15 m (49 ft). Up to a meter of native soil has been placed over some of the completed units. Development of a design for a final, low permeability cap for the CSM is currently underway.

Interesting operating experience noted during the overview and subsequent tour includes the following:

- monitoring to date indicates that no release of activity has been seen from waste packaged in concrete containers;

- subsidence of limited portions of the waste, primarily involving drums which were disposed early in the CSM operations, has been noted. ANDRA is evaluating ways to stabilize these areas. Increased efforts are now directed through the waste acceptance process at ensuring that only void free, stable waste packages are disposed at CSM; and

- low levels of radioactivity, near detection limits, have been seen in the drainage system. The contamination is attributed to older operations which have since been modified. ANDRA feels that the fact that no covers are in place over the waste has contributed to this problem and they are making plans, as discussed earlier, to minimize waste/water contact at CSA. The drainage gallery effluent is routinely sent to the La Hague reprocessing plant water treatment system.

A meeting was held with three local officials, Messrs. M. Laurent, mayor of Beaumont Hague, the small town where the CSM is located, and J. Mouchel and A. Demetz, deputy mayors of Cherbourg. The local representatives again emphasized the positive economic aspects of the CSM (jobs, tax revenue) and the lack of any negative environmental impact from facility operations.

June 15, 1988 - La Hague Fuel Reprocessing Center

Henri Giroux, Deputy Manager for SGN Site Construction provided an overview of the La Hague operations and the massive construction activities currently underway. The La Hague plant has been reprocessing fuel since 1966. A major construction effort ($10 billion) is currently underway to increase the size of the existing reprocessing plant to 800 t/yr, to build a new plant which will also have a capacity of 800 t/yr, and to construct common support facilities, such as waste processing facilities. Construction is 80% complete overall, but several units of the plant are finished and in operation.

An indication of the size of this construction effort is provided by the following:

- 117,000 m^2 (1.26 million ft^2) of new building space is being developed;
- almost 1 million m^3 (1.3 million yd^3) of concrete will be used;
- the lead contractor, SGN, will subcontract to 1280 other firms, 620 of which are local to the Cherbourg area;
- a total of 61,541,300 manhours of activity, 10,000,000 of which are engineering manhours (16.2%), will be expended on the project; and
- approximately 7162 people are located at the site.

F. Monnet, Project Engineer of Technicatome, discussed the La Hague solid waste management operations and facilities. The major solid wastes produced at the plant are: waste water sludges solidified in bitumen; fuel hulls and end pieces; resins; contaminated equipment; and technological waste. The majority of the technological waste is sent to ANDRA for compaction and grouting. The bitumen, fuel pieces, resins, and equipment are stored for future repository disposal.

Two new solid LLW facilities are being constructed as common facilities for the La Hague plant. The AD2 facility will treat solid waste. Several buildings are being constructed to condition waste from various zones of the plant, ranging from slightly contaminated waste to highly contaminated equipment. Various cleaning, compacting, and grouting/packaging operations are included in the AD2, some of which are conducted remotely in cells. The EDS facility will store solid waste. Three separate areas are being prepared for:

- the storage of high alpha content waste, such as resins and contaminated processing equipment, destined for geological repository disposal;

- high activity beta/gamma/alpha waste, such as fuel pieces, destined for the geological repository; and

- low activity beta/gamma/alpha waste expected to be suitable for near surface disposal after a period of decay.

A tour was provided of portions of the EDS facility. Construction is almost complete, with most major equipment installed. Extensive remote handling equipment and maintenance capabilities are provided to ensure continued operation. The equipment (cranes, etc.) appear to be of high quality, state-of-the-art construction. Concrete work is massive, and reminiscent of reactor type construction. A container constructed from asbestos reinforced concrete, with handling grooves which are machined, is planned for use in these facilities.

June 16-17 & 21, 1988 - Training on CSM Design, Construction, and Operation

Francois Damoy, Health Physics Manager, CSM reviewed the environmental and health monitoring activities at CSM. Health physics monitoring is conducted to establish a zone system for the CSM and to monitor employee exposures. Plant zones are established based on fixed and local monitoring for direct radiation and airborne contaminant levels. Access controls are established for entry into the zoned areas. It was stated that the average exposure for the employees at CSM was 700 mr/yr. Perimeter health physics monitoring is also conducted to determine exposure levels at the plant fence. Environmental monitoring of water, air, vegetation, and sediments is conducted on a regular basis, usually monthly. Water flows around the plant (surface runoff, drainage gallery discharge, groundwater at 25 m (82 ft) both on- and off-site, and nearby streams) are sampled once per month for alpha, beta, gamma, tritium and some individual radionuclides. The discharge from the surface drainage system at CSM is monitored by real-time instruments for gross alpha, beta/gamma, and tritium. A valve system is connected to the monitors which can divert the flow from release to nearby streams to release to the La Hague water treatment plant if needed.

Monitoring results indicate that releases to the public are very low, if existent at all. Levels are reported to be near detection limits. Evidence of some contamination, particularly tritium, has been found in the drainage gallery. The levels of this contamination vary depending on rainfall and ongoing operations. General trends indicate constant levels in the drainage gallery, and slightly decreasing levels in the surface drains. Groundwater monitoring levels for both on and off site wells are generally below detection limits. The exception is tritium where levels in on-site wells are slightly above the level of detection. Tritium levels in off-site wells are occasionally above the level of detection but are still significantly below (by a factor of 2 or 3) regulatory thresholds.

ANDRA submits a report to the SCSIN every six months which provides the results of the health physics and environmental monitoring programs. ANDRA has agreed to provide a copy of the latest report (untranslated) in September.

M. Nicolas and M. Casenave of ANDRA provided a detailed discussion of CSM design, construction and operation activities. Information on design and construction details for all types of disposal units used at CSM was obtained. Construction of a typical tumulus pad, and various stages of construction of monoliths were observed. Waste processing operations involving grout injection of 5 m^3 metal boxes were observed. Waste compactor operations were reviewed but the unit was not operational due to a hydraulic system malfunction which was being repaired. Loading of waste into high activity canyons, monoliths, and tumulus was observed. In addition, loading of a high activity package into an interim storage well was also witnessed. Important aspects of this training include the following:

- the disposal units are designed on the basis of structural loading requirements. Durability for 300 year life is provided by the characteristics of the concrete used, not by over-design. ANDRA indicated that considerable effort, involving extensive testing was required in the development of the concrete mix. The concrete used meets structural as well as radionuclide retention requirements;

- the concrete pad design and construction is very similar to that used for the ORNL tumulus demonstration. The CSM tumulus is composed of a number of small pads [10 m x 14 m (33 ft x 46 ft.)] linked together with a PVC rubber water stop. The French indicated that the small units linked together in this manner provided enhanced resistance to earthquake damage. It is interesting to note that the size of the pads proposed for the CSA facility [400 m^2 (4306 ft^2)] are close to the size of the ORNL tumulus pad [627 m^2 (6825 ft^2)];

- reinforcing steel utilized in the CSM units is standard steel rebar, as opposed to the epoxy coated steel used in the ORNL tumulus;

- monoliths are constructed in such a manner that a layer of plastic foam is incorporated between each monolith. The French again point to improved earthquake response as a reason for this approach;

- liquid generation during the compactor operation is a problem frequently experienced. On the average 1 liter of liquid is generated from each 200 liter drum. The liquids are collected and shipped to the La Hague plant for processing. The French were interested in the reduction in water content of drums ORNL was able to achieve when real-time radiography of drums was implemented;

- approximately 40,000 m^3 (1.3 million ft^3) of LLW are disposed at CSM each year after conditioning and packaging operations are conducted on the 30,000 m^3 (1.06 million ft^3) of waste received each year. A major space inefficiency is associated with use of cylindrical concrete waste containers; and

- the overall cost of disposal at CSM (not including waste acceptance program, shipment costs, and ANDRA personnel salaries) was stated to be FF 3,500/m^3 (\$17/ft^3). ANDRA stated that the cost of all nuclear fuel cycle waste management (LLW disposal, deep repository, etc.) was estimated to be 1% of the cost of electricity.

I. Pacquetet and S. Bruhn described the CSM portion of the ANDRA waste tracking and information system. This system is used to ensure that only accepted waste is disposed at CSM, and that the location of the disposed waste is recorded. Daily computer data transmissions are made to CSM to update the CSM data base on waste which is acceptable for disposal. When waste arrives at CSM it is checked against the approved data base before being accepted. Data recording devices at the entrance to the compactor keep track of which generator waste packages are compacted into CSM disposal casks. Hand held bar code readers are used by the operating personnel to identify packages as they are disposed, and to record the disposal unit location. The disposal unit location information is transmitted back to ANDRA once per month.

P. Barnoiun described the security and health monitoring measures in place at CSM. Security is based on typical industrial security measures (fences, access control, etc.). CSM security is designed to detect any intrusions, then to call local authorities for assistance. Guns are not carried by the CSM guards. Dogs are used for night and weekend patrols to detect human intrusions. Workers at CSM undergo varying levels of security checks. ANDRA personnel (approximately 10) have full background security checks conducted before employment. No security checks are required for the contractor personnel who work at CSM (approximately 50).

Three levels of medical surveillance are employed at CSM. The first level is for workers who are likely to be exposed to radiation for more than 200 hrs/yr. These workers receive two complete medical exams per year at the La Hague facility. The second level is for workers who may be exposed to radiation for less than 200 hrs/yr. These workers are also examined twice per year at the La Hague facility. The third level is for workers with no potential for exposure. These workers must be examined by their own physician once per year as French law requires that all workers must have a physical exam once every year to check that they are fit for work.

June 21, 1988 - Visit to Cover Experiment at Saint Sauveur, France and Railway Terminal at Volgnes, France

The team members met with G. Rousset and E. Molinas of ANDRA at the LLW disposal facility cover demonstration experiment under way at Saint Sauveur, France. The experiment is being conducted to develop information to support discussions with the safety authorities concerning the cover to be developed for CSM. The site of the experiment is approximately 60 km from CSM, the closest source of the type of clay needed for the CSM cover.

Currently the safety authorities have established a goal for the cap of no more than 0.2% of the incident rainwater infiltrating through the cover to the waste. It was understood that this would translate to a permeation rate of 10^{-9} cm/sec. ANDRA is concerned with the feasibility of constructing a cover with this level of performance, thus the experiment was undertaken to determine if this level of performance is achievable, and to develop experience with cap construction techniques. Two main variables are being tested in the cover experiment. The first variable is the amount of sand and clay to be mixed together to form the cover infiltration barrier. The second variable is use of a fine sand layer as a capillary wick to remove water from the cover.

Two experimental covers were constructed in 1986. A large cover 50 m (164 ft) long by 20 m (66 ft) wide, represents a full cross section of the cover sections being considered for use at CSM. The large cover is divided into two separate sections - one utilizing the capillary wick and one without the wick. Both sections utilize an infiltration barrier which is a mixture of 35% clay and 65% sand. Total thickness of this cap is 4 m (13 ft) at the top of the 10% slope and 6 m (20 ft) at the bottom. (The cover is thicker at the bottom edge because the layers are wedge shaped.) The cap layers include (from the bottom up, with measurements at the top edge):

- an impervious membrane;
- a final drainage layer of sand, 30 cm thick,
- a clay-sand mixture infiltration barrier layer, 2 m thick;
- a fine gravel layer, 30 cm thick;
- a fine sand layer, 50 cm thick (this capillary wick layer is eliminated in one section);
- a poor-soil-and-rocks layer, 60 cm thick;
- a rich soil layer, 30 cm thick; and
- vegetation in the top layer.

The small cover experiment, which is 20 m (66 ft) by 20 m (66 ft), is similar to the large experiment, except that the infiltration barriers utilize 15 and 25% clay mixtures and no capillary wick layer is used. Both covers have water drainage and collection systems to support evaluations of the cover performance.

ANDRA indicated that valuable experience was gained in the construction of the cover. Very tight controls over clay moisture content were required to produce a material which could be effectively mixed with the sand. The clay was spread out in a layer about 20 cm (8 in.) thick and allowed to dry for 2-3 days. The sand was mixed in with the clay by a tractor mounted power rototiller. The sand/clay mixture, with about 20% moisture content, was moved into large covered piles and stored until enough material was prepared to construct the covers. The clay/sand mixture was laid in 20 cm (8 in.) layers and compacted by 10-20 passes with a sheepsfoot roller. Other compaction techniques that were tried were not effective.

Results of the cover performance monitoring to date were discussed. Measurements indicate that about 70% of incident rainfall, which is evenly spread throughout the year, is removed via evapotranspiration. Both zones of the small cover have experienced infiltration rates of 1.5-2% of rainwater falling on the cover. The section of the large cover utilizing the capillary action wick has infiltration rates of 2%. ANDRA believes that the complicated drainage system required to separately monitor the fine sand capillary wick layer and the coarse sand drainage layer is not working correctly. The other section of the large cover is experiencing infiltration of < 0.1% of incident rainwater. This is in the range of performance desired by the regulators and discussions are apparently now underway to finalize the cover design for CSM.

The French believe the sand-clay mixture will settle with time and thereby gradually improve its water shedding properties. An impervious membrane having a life expectancy of at least 30 years will be used to provide the impervious layer needed while the sand-clay mixture is developing its full potential.

A document which describes the cover experiment construction and monitoring results will be provided by ANDRA later this fiscal year.

A visit was also made to the railway-truck terminal at Volognes which is operated by the CEA. This terminal receives LLW shipped by rail, primarily from nuclear power plants, which is reloaded onto trucks for shipment to CSM. The terminal also receives spent fuel which is then shipped on to the La Hague plant. The facility includes large waste transfer cranes and a large building with decontamination, inspection and maintenance bays. Surface water from the loading areas is collected in a large basin and monitored before release.

Approximately 10 trains of LLW are received per week, each with 5 cars. Seven truckloads of waste per day are shipped to the CSM. Each shipment is checked for surface dose rate (<200 mr/hr) and surface contamination.

June 22, 1988 - Travel from Cherbourg to Paris, France

June 23, 1988 - LLW Tracking System Demonstration, Paris, France and Visit to SGN, Versailles, France

A demonstration of the ANDRA LLW Tracking and Information System, a computer based interactive system, was conducted at ANDRA headquarters. The generator initiates the process by filing a "Declaration of Package," which provides a list of waste packages to be disposed, along with information on each waste package. Each waste package is assigned a unique code number in this process. The computer inspects and processes the information against a data base of approved waste package types for that generator. The system calculates the activity-to-weight for the package and compares it to allowable levels. The computer lets the generator know if any of the waste packages are not acceptable. At the conclusion of this process, ANDRA has approved the package for disposal.

The generator initiates the next step in the process when he is ready to make a waste shipment. A waste shipment number is developed and the unique identity number of all the waste packages to be included in the shipment is listed. The computer checks the data base to ensure that all the waste packages included in the proposed shipment have in fact been accepted, and again alerts the generator to any problems. A general schedule for waste shipments from each generator has been previously developed by ANDRA and the generators. When the shipment is ready to leave, the generator alerts ANDRA. The system notifies ANDRA quality control, shipment, and disposal groups of the impending shipment.

When the shipment arrives at CSM the bar code label on each package is checked as discussed in the report on the CSM portion of the Tracking System. After the package disposal location data is fed back to ANDRA, the computer checks to ensure that overall acceptance criteria involving local, average, and total radionuclide amounts are met.

Discussions were also held with M. Lung, J. Maillet, R. Pierlas, K. Jaouen, E. Tchemitcheff, and B. de Wavrechin of SGN concerning activities in waste processing and treatment. SGN provides engineering, project management, and construction services and is jointly owned by COGEMA and Technip. SGN employs 3500 people with annual revenues of FF 2 billion ($450 million). SGN efforts are 80% nuclear engineering related, 15% manufacturing related, and 5% other.

The following radioactive waste related activities are being performed by SGN:

- cooperative R&D activities (with CEA and universities) including ion exchange processes, low- and medium-activity waste conditioning with bitumen and cement, vitrification, ceramics, and cement containers, and

- facility operations for COGEMA (ion exchange processing and vitrification), Electricite de France (evaporation and ion exchange processing), and ANDRA (disposal studies and alpha waste management).

The following items of interest were mentioned during the discussion.

- SGN is developing a metallic fiber reinforced cement with high compressive and tensile strength, low water porosity, and high resistance to shrinkage. Prototype products are expected to be produced by the end of 1988.

- SGN has conducted some work with cement solidification of high nitrate wastes. Nitrate concentrations are limited to 200 mg/l to meet disposal requirements.

- SGN (and the French in general) are relooking at incineration of radioactive waste. During previous visits, the French were negative about incineration due to high costs. Apparently, increased disposal costs have made incineration look more attractive from a cost point of view. Concern was expressed with corrosion problems associated with incineration of polyvinyl chloride materials.

June 24, 1988 - Discussion with ANDRA and SGN on Training Program Results and Documentation, Paris, France

Discussions were held with J. Y. Ravachol concerning the results of the training program and status of associated documentation. Both the U.S. team and ANDRA agreed that the training program was very successful. It was requested that all the ANDRA participants be thanked for their participation and cooperation during the training program. The following specific items were raised during the discussion.

- Documentation of the training is being prepared. Schedules for preparation will be provided at the final wrapup meeting after consultation with SGN and NUMATEC.

- It was requested that ANDRA provide copies of technical specifications for various disposal units that were discussed during the CSM portion of the training program. ANDRA agreed to consider the request.

- It was requested that ANDRA provide a copy of presentation transparencies used during the CSA presentation. ANDRA agreed noting that a revision to update the material was in process and that the material would be provided when the update was complete.

- ANDRA was requested to provide a copy of the latest monitoring program results summary document for CSM which is provided to the French regulatory authorities. ANDRA agreed to consider the request.

- ANDRA was requested to provide a copy of the design, construction and results document for the Saint Sauvuer cover experiment. ANDRA agreed to consider the request.

- ANDRA requested that developed film and pictures taken during the visit to the railway facility at Volognes be provided to ANDRA for "review". Apparently there was a misunderstanding regarding approval to take pictures at the railway facility. ANDRA also requested that copies of photos taken at the CSM and CSA facilities be provided to ANDRA for information. It was agreed that both ANDRA requests would be met.

- It was suggested that the first presentation by the French called for in the Energy Systems/SGN contract be conducted in early October in conjunction with the DOE Model Conference in Oak Ridge, and that this would be used as an opportunity for final review of training program documents and discussion of the contract option task.

June 27, 1988 - Visit to Caderache Nuclear Research Center, Manosque, France

Discussions of Caderache Nuclear Research Center LLW management activities were held with P. Vaunois, J. Marcaillou, H. Henry, A. Saas, and R. Bossy. Solid and liquid waste management operations were reviewed. Caderache has established its own waste acceptance criteria which are designed to ensure that ANDRA requirements are met. These criteria provide guidance on activity limits and packaging requirements. Radionuclide concentrations in waste are established by a variety of techniques. A gamma spectrograph is developed for each drum of waste. This information is used with gamma/beta correlations to estimate beta/gamma contents. The correlations are developed on the basis of incineration and analysis of the resulting ash. Installation of active neutron assay equipment is planned.

Two types of solid LLW processing are utilized at Caderache. Up to 80% of the solid LLW produced is compacted. As many as twenty 100 liter drums are compacted and grouted into a 1 m^3 (35 ft^3) steel container. The final waste form weighs approximately 1.5 t. Any liquids generated during the compaction process are incorporated in the backfill grout. Up to 50 m^3 (1776 ft^3) of solid waste are incinerated in a 20 kg/hr pilot plant. The incinerator incorporates primary and secondary combustion chambers.

Liquid wastes are hauled via tanker truck to a central processing facility and are placed in storage tanks. Alpha containing liquid wastes are pre-treated with chemical addition, precipitation, and filtration. The sludge is mixed with cement and the filtrate is evaporated. A two stage evaporation process is used with the second stage solids concentration limited to 250 g/l. The concentrate is solidified in either cement or bitumen, depending primarily on the Cs concentration. Bitumen, with a ferrocyanate fixation process as a pretreatment, is used for high (>0.3 ci/m^3) Cs content wastes. Cement is used for low Cs wastes.

A tour was provided of the processing facility, including the compaction, grouting, incineration, and bitumen equipment, as well as the waste characterization facility.

July 8, 1988 - Review of Status of Martin Marietta-SGN Contract and Training Program Wrap-up

J. Y. Ravachol and B. de Wavrechin discussed the status of the Energy Systems/SGN/NUMATEC contract and ANDRA responses to requests made at the June 24 meeting.

ANDRA indicated that their preparation of documentation of the mock waste acceptance exercise was approximately 30% complete. They expect to provide a draft report on this effort to NUMATEC by the end of August. SGN indicated that they and NUMATEC expect the draft report on the training program to be available for U.S. team review by the end of August. The final training report and associated document compilation was targeted for early September. Resolution of final comments is planned for a meeting in Oak Ridge in early October.

SGN indicated that approximately 825 hours had been expended on the contract to date out of a total contract level of 1145 hours. SGN indicated that more hours would likely be required to complete the effort than were included in the contract, but that the promised product would be delivered at the contract price. Consequently, it was suggested that SGN and ANDRA participation in the planned October meeting would not likely be possible, but that participation by NUMATEC would take place as planned.

ANDRA indicated that the cover experiment document, monitoring results summary document, and CSA presentation information would be provided as requested. ANDRA indicated that the monitoring document may be marked as a proprietary document, although they agreed to consider release of summary level information from the document to support regulatory interactions. ANDRA indicated that they did not feel that the contract scope currently in place covered provision of the disposal facility technical specifications. ANDRA also indicated that they felt that the scope of the contract option did not cover provision of these documents, although they suggested that it would be possible for them to provide bid specifications for the disposal units.

Discussion were also held regarding potential for interactions in the area of concrete mix designs utilized by ANDRA. The U.S. team felt that the French had made significant advances in this area and were interested in obtaining further information. ANDRA indicated that the contract option scope would not cover their providing the specific concrete formulations used in their facilities, nor would this information be directly useful since the concrete formulation had to be based on the specifics of the materials (cement, aggregate, etc.) used in the U.S. mix which would be different from those used in France. ANDRA and SGN suggested that we consider an approach which would involve the French in identifying tests to be performed which would provide the information needed to develop concrete mixes with the same performance characteristics as those used by ANDRA. This could include review of any test results developed by the U.S. by SGN and ANDRA.

SUMMARY AND CONCLUSIONS

France has made the decision that most of its electrical needs, as much as 80%, will be met by nuclear power. Significant efforts are expended to ensure that the nuclear fuel cycle is closed with effective management of the wastes produced. The French estimate that only 1% of the cost of the electricity generated is needed to support waste management, including near surface LLW and high level waste repository disposal. A rigorous, two pronged program has been implemented to ensure that LLW is managed in a fashion which continues to meet public expectations.

First, a rigorous waste acceptance program has been established for LLW. The program emphasizes ensuring that the LLW packages are structurally stable for the period of control required for the waste to decay - 300 years. For higher activity LLW, the waste and its package must also provide radionuclide retention capabilities. An extensive program of tests must be conducted by the waste generator to demonstrate that the waste meets acceptance criteria. This program is similar to that required by NRC and is much more prescriptive than current DOE requirements. In addition, the generator must establish the radionuclide content of the waste through a program of process controls and measurements. The radionuclide content of up to 70% of the LLW in France is established through the use of dose rate correlations, an approach used by many of the DOE waste generators.

Second, the French have focused on ensuring that the LLW disposal facilities will perform as required for the waste control period. The facilities are designed to provide the needed structural stability to support the closure cap which the French feel is the key to ensuring long-term performance. The disposal design approach also provides capabilities through extensive facility drainage networks, to monitor the performance of the disposal units, and to collect leachates for treatment if needed. Finally, the LLW disposal facility site provides the characteristics needed to ensure that performance goals are achieved.

The training program provided an excellent opportunity to gain experience with the French LLW acceptance process (and its application to DOE facility LLW) and disposal facility design and operation. This experience will be very useful to the DOE LLW generating facilities in developing technical capabilities to meet the enhanced requirements of DOE Order 5820.2a. In addition, cost savings will be achieved through the transfer of French knowledge and experience which occurred. It was particularly encouraging to note the many similarities between the French disposal facility design, construction, and operation approach and that being implemented at new DOE facilities such as the Oak Ridge tumulus and the Savannah River vaults.

Appendix A

U. S. Delegation Itineraries

S. D. Van Hoesen

June 4-5, 1988	Travel to Paris, France
June 6-9, 1988	LLW Acceptance Training, Paris, France
June 10, 1988	Visit to Saclay NRC, Saclay, France
June 11-12, 1988	Weekend and Travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France
June 14, 1988	Visit to la Manche site, Cherbourg, France
June 15, 1988	Visit to La Hague site, Cherbourg, France
June 16-17, 1988	LLW Disposal Facility Training, Cherbourg, France
June 18-19, 1988	Weekend
June 20, 1988	LLW Disposal Facility Training, Cherbourg, France
June 21, 1988	Visit to LLW Cover Experiment at Saint Sauveur, France and Railway Terminal at Volognes, France
June 22, 1988	Travel to Paris, France
June 23-24, 1988	Discussions at ANDRA Headquarters, Paris, France and SGN Offices, Versailles, France
June 25-26, 1988	Weekend and travel to Marseille, France
June 27, 1988	Visit to Caderache NRC, Manosque, France
June 28- July 7,1988	Vacation, holiday, weekends, and travel to Paris, France
July 8, 1988	Discussions at ANDRA Headquarters, Paris, France
July 9, 1988	Return to Clinton, TN

J. M. Kennerly

June 3-5, 1988	Travel to Paris, France and weekend
June 6-9, 1988	LLW Acceptance Training, Paris, France
June 10, 1988	Visit to Saclay NRC, Saclay, France
June 11-12, 1988	Weekend and Travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France
June 14, 1988	Visit to la Manche site, Cherbourg, France and travel to Paris, France
June 15-26, 1988	Vacation and weekends
June 27, 1988	Return to Knoxville, TN

L. C. Williams

June 10-12, 1988	Travel to Paris, France, weekend, and travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France

L. C. Williams (cont'd)

June 14, 1988	Visit to la Manche site, Cherbourg, France
June 15, 1988	Visit to La Hague site, Cherbourg, France
June 16-17, 1988	LLW Disposal Facility Training, Cherbourg, France
June 18-19, 1988	Weekend
June 20, 1988	LLW Disposal Facility Training, Cherbourg, France
June 21, 1988	Visit to LLW Cover Experiment at Saint Sauveur, France and Railway Terminal at Volognes, France
June 22, 1988	Travel to Paris, France
June 23, 1988	Discussions at ANDRA Headquarters, Paris, France and SGN Offices, Versailles, France
June 24, 1988	Return to Clinton, TN

W. N. Lingle

June 4-5, 1988	Travel to Paris, France and weekend
June 6-9, 1988	LLW Acceptance Training, Paris, France
June 10, 1988	Visit to Saclay NRC, Saclay, France
June 11-12, 1988	Weekend and Travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France
June 14, 1988	Visit to la Manche site, Cherbourg, France and travel to Paris, France
June 15-17, 1988	Vacation
June 18, 1988	Return to Oak Ridge, TN

M. S. Peters

June 9-10, 1988	Travel to Paris, France
June 11-12, 1988	Weekend and Travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France
June 14, 1988	Visit to la Manche site, Cherbourg, France
June 15, 1988	Visit to La Hague site, Cherbourg, France
June 16-17, 1988	LLW Disposal Facility Training, Cherbourg, France and travel to Paris, France
June 18, 1988	Return to Aiken, SC

G. R. Darnell

June 10-12, 1988	Travel to Paris, France, weekend, and travel to Troyes, France
June 13, 1988	Travel to Soulaines, France for visit of l'Aube site and Travel to Cherbourg, France
June 14, 1988	Visit to la Manche site, Cherbourg, France
June 15, 1988	Visit to La Hague site, Cherbourg, France
June 16-17, 1988	LLW Disposal Facility Training, Cherbourg, France
June 18-19, 1988	Weekend
June 20, 1988	LLW Disposal Facility Training, Cherbourg, France
June 21, 1988	Visit to LLW Cover Experiment at Saint Sauveur, France and Railway Terminal at Volognes, France
June 22, 1988	Travel to Paris, France
June 23, 1988	Return to Idaho Falls, ID

Appendix B

Persons Contacted

C. Hutchison	NUMATEC	US
C. Hoxie	NUMATEC	US
Y. Marques	ANDRA	France
J. Y. Ravachol	ANDRA	France
D. Boulitrop	ANDRA	France
A. Pitiot	ANDRA	France
J. C. Rivier	ANDRA	France
N. R. Serra	ANDRA	France
P. Regimbeau	ANDRA	France
P. Rebiffe	ANDRA	France
P. Vaunois	Caderache, NRC	France
M. Douchet	Saclay, NRC	France
M. LeConnetable	Saclay, NRC	France
M. Perotin	Saclay, NRC	France
M. Ricard	Saclay, NRC	France
J. Cerles	Saclay, NRC	France
J. Dodemant	ANDRA	France
M. Andujar	Soulaines	France
J. Mosnier	Epothemont	France
N. Denizet	Ville-aux-Bois	France
M. Laurent	Beaumont Hague	France
J. Mouchel	Cherbourg	France
A. Demetz	Cherbourg	France
H. Giroux	SGN	France
F. Monnet	Technicatome	France
F. Damoy	ANDRA	France
M. Nicolas	ANDRA	France
M. Casenave	ANDRA	France
I. Pacquetet	ANDRA	France
S. Bruhn	ANDRA	France
P. Barnoiun	ANDRA	France
M. Noraz	ANDRA	France
G. Rousset	ANDRA	France
E. Molinas	ANDRA	France
M. Lung	SGN	France
J. Maillet	SGN	France
R. Pierlas	SGN	France
K. Jaoven	SGN	France
E. Tchemitcheff	SGN	France
B. de Wavrechin	SGN	France
J. Marcaillou	Caderache	France
H. Henry	Caderache	France
A. Saas	Caderache	France
R. Bossy	Caderache	France

Appendix C

Literature Acquired

1. ANDRA, "Materials for Training Course On Low-Level Waste Acceptance Process," Paris, France, June 1988.

2. A. Saas, "Comparative Listing of Acceptance Criteria for Waste Disposal Package Characteristics and Test Procedures Employed or Developed in Different CEC Countries," (Draft Copy).

3. A. Saas, "Caracterisation des Dechets de Faible et Moyenne Activite en France et dans les Pays de la Communaute Europeene (CCE)," IAEA-SM-303/49, Stockholm, May 1988.

4. CEA, "Specifications de Prise en Charge des Dechets Solides Radioactifs," CA-SAR/EDT 00189, Caderache, France, July 1987.

5. T. H. Kodama, et al, "Advanced Cement Solidification Process," Tucson, AZ, March 1985.

6. H. Gaines and G. Magnin, "System Design for the Transportable Grout Equipment Facility at Hanford," Paris, France, August 1987.

7. S. Carpentier, "Excess-Air Incineration with High Temperature Filtering for Efficient Off-Gas Cleaning", Hong Kong, December 1987.

8. B. Vigreux and C. Jaouen, "Recent Advances in Cement Solidification of Radioactive Wastes," Hong Kong, December 1987.

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