July 26, 2002

MEMORANDUM TO: Martin J. Virgilio, Director
Office of Nuclear Material Safety
and Safeguards

THRU: Robert C. Pierson, Director
Division of Fuel Cycle Safety
and Safeguards

FROM: Timothy C. Johnson **/RA/**
Senior Mechanical Systems Engineer
Special Projects Section
Special Projects and Inspection Branch
Division of Fuel Cycle Safety
and Safeguards
Office of Nuclear Material Safety
and Safeguards

SUBJECT: FOREIGN TRIP MEETING SUMMARY: LOUISIANA ENERGY SERVICES TECHNICAL MEETING AND SITE VISITS

On May 21-23, 2002, U.S. Nuclear Regulatory Commission (NRC) staff met with staff from Louisiana Energy Services (LES) to discuss gas centrifuge enrichment technology used by Urenco. NRC staff also visited gas centrifuge plants at Capenhurst, United Kingdom, and Almelo, The Netherlands. I am attaching the meeting summary for your use. This summary contains no proprietary or classified information.

The Division of Fuel Cycle Safety and Safeguards believes the content of this report may be of interest to the Commission, and recommends that the Office of International Programs forward the report to the Commission.

Docket: 70-3103

Attachment: Louisiana Energy Services Foreign Trip
Meeting Summary

cc: William Szymanski/DOE
Rod Krich/Exelon
James Curtiss/W&S
Mario Robles/USEC

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NRC FOREIGN TRIP REPORT

Subject: Louisiana Energy Services Foreign Trip Meeting Summary

Dates of Travel and Countries/Organizations Visited

Dates: May 21-23, 2002

Place: Urenco Gas Centrifuge Plant, Capenhurst, United Kingdom (UK)
Urenco Gas Centrifuge Plant, Almelo, The Netherlands

Author, Title, and Agency Affiliation:

Timothy C. Johnson; Sr. Mechanical Systems Engineer; Office of Nuclear Material Safety and Safeguards

Sensitivity: This report contains no classified or proprietary information.

Background/Purpose:

The purpose of this meeting was to discuss with Urenco staff the gas centrifuge technology it will use in the proposed Louisiana Energy Services (LES) license application for a uranium enrichment facility in the United States (U.S.). Site tours of the Capenhurst and Almelo gas centrifuge plants were also conducted. The meeting agendas are provided in Attachment 1. Meeting attendees are listed in Attachment 2.

Abstract: Summary of Pertinent Points/Issues:

In anticipation of a license application in December 2002 from LES, U.S. Nuclear Regulatory Commission (NRC) staff visited Urenco's gas centrifuge facilities in the UK and The Netherlands. These visits were worthwhile in observing LES operations in facilities that will be similar to that to be proposed in the license application. No new policy issues arose during the visits. NRC staff will continue to interact with LES staff in pre-application meetings to ensure that LES staff understand NRC licensing requirements.

Discussion:

On May 21, 2002, NRC staff met at the Capenhurst site for a short presentation on Urenco and the Capenhurst facilities followed by a tour of the E23 Capenhurst gas centrifuge plant. In the UK, uranium enrichment began in the 1950s with gaseous diffusion. The UK initially operated a 400,000 Separative Work Unit (SWU) per year gaseous diffusion plant at Capenhurst. Enrichment for weapons production stopped in 1962 and production using gaseous diffusion for reactor fuel ended in 1982. The gaseous diffusion plant is owned by British Nuclear Fuels, Ltd. and is currently undergoing decommissioning.

In 1971, the UK, Germany, and The Netherlands signed the Treaty of Almelo, under which Urenco Ltd., was founded and a gas centrifuge enrichment program started. Urenco started its first gas centrifuge plant in 1975. It used 2 percent of the energy as gaseous diffusion for the same SWU production. The E21 plant was the first gas centrifuge facility at Capenhurst. It began operations in 1976. It was operated until 1991 and was subsequently decommissioned.

Consequently, Urenco has directly applicable decommissioning experience and cost data that can be used for the required decommissioning funding plan and environmental report. The next generation gas centrifuge plant, the Capenhurst E22 plant, was completed in 1982. The construction of the most recent Capenhurst gas centrifuge facility, the E23 plant, using the TC-12 centrifuge design, was initially started in the early 1990s, but not completed because of a lack of an adequate rate of return. Subsequently, construction resumed and the E23 plant began operations in 1997. Additional cascades are currently being added. On completion of the E23 plant, Capenhurst will have a 2 million SWU per year capacity.

Urenco has organized its support functions where engineering and design is performed at Capenhurst, gas centrifuge fabrication at Almelo, and research and development in Germany. Urenco's corporate headquarters is in Marlowe, UK.

Urenco currently provides 80 percent of the total SWU demand of the UK. It also provides 15 percent of the U.S. demand. Urenco staff indicated that the recently imposed duties on enrichment services are in effect for this year only and would not have an impact on their marketing.

Urenco handles its depleted uranium tails by shipping them to Tenex in Russia. Tenex enriches the tails to natural assay levels and returns the product to Urenco. By enriching tails, Tenex is able to keep its gas centrifuges operating so it does not need to shut any machines down. Shutting down gas centrifuges can adversely affect later operation. The Russians keep possession of the further depleted tails.

Product and tails shipments from Capenhurst are made by ship from Ellesmere Port, about 5 miles from the plant.

Following these initial discussions, Urenco staff conducted a tour of the E23 enrichment plant. During the site tour, Urenco pointed out that the plant is divided into three areas: the feed and withdrawal area, the process services corridor, and the cascade hall. The feed and withdrawal area includes both autoclaves for feed and withdrawal and newer equipment that allows feed and withdrawal directly from uranium hexafluoride (UF_6) solid rather than from a liquid. The new approach is to be proposed in the U.S. license application. By minimizing the use of liquids, Urenco reduces the likelihood of serious accidental releases of UF_6 and accidental criticality. The new feed stations use 120F air to heat the UF_6 below its melting point. A negative pressure (500 mbar) is maintained to sublime the UF_6 to a gaseous state for introduction into the centrifuges. The pressure is further reduced prior to transfer to the cascade. The withdrawal stations are chilled to -25C and also operate at negative pressures (60 mbar). In the U.S. application, only the sampling system will require heating to a liquid and, in this case, the heating will be done using hot air rather than steam. Sampling requires the use of a liquid to ensure that samples are taken from a homogeneous medium and the samples are representative of the entire cylinder. Cylinders containing UF_6 are never handled when the UF_6 is in a liquid state.

Prior to feeding UF_6 into the cascade, about 200 kg of the feed is purified in the Feed Purification System to remove hydrogen fluoride (HF) and air. The first purification stage operates at -25C. A second stage cold trap operates at -60C. Activated carbon and alumina beds adsorb UF_6 and HF, respectively. The residual air and traces of HF and UF_6 are further processed in the Gaseous Effluent Ventilation System.

The process services corridor includes the Feed Purification System and all active components (e.g., pumps and valves) for operating the plant. This layout allows Urenco staff easy access to all active components without having to enter the cascade hall. A decontamination and maintenance area is used for component repair and removal of contamination.

On May 22, 2002, Urenco staff presented a non-classified technical discussion of the Urenco gas centrifuge systems. Presentation handouts are enclosed in Attachment 2.

Urenco staff indicated that its first priority is protection of the public, its workers, and the environment. Its second priority is protection of its investment. The facility quality assurance program is based on International Standards Organization (ISO) 9001. Facility design follows a sequence of design reviews, hazardous operation (HAZOP) reviews, and final design. Independent safety assessments are conducted by Risk Management Consultants, Ltd., at the design review and HAZOP review stages. The safety evaluations are deterministic, with probabilistic analyses conducted only if outstanding items remain after the safety reviews are performed.

For nuclear criticality safety, evacuation procedures are based on projected dose with consideration given to the shielding provided by facility structures and components. If a postulated accident could result in greater than 100 mSv (10 Rem) to a worker, evacuation is conducted to a safe building located a sufficient distance away from areas that could contain critical quantities of nuclear material. Urenco applies the double contingency principal in its criticality assessments and design. In most cases, safe geometry is used to limit criticality accidents. Moderator control, concentration limits, enrichment levels, and administrative controls can also be used. Urenco uses the MONK8A criticality code for its criticality assessments. Urenco also uses a criticality accident alarm system throughout the plant.

Export controls for equipment and technology that could be used for nuclear weapons are in place. Currently, Urenco has no export license for transferring gas centrifuge technology or information to the NRC.

The Urenco operational strategy is to operate its machines until failure. No ongoing maintenance is needed. Upon failure, the machines remain in the cascade, but are inoperable. The cascades are not designed to valve out failed centrifuges for repair. For the TC12 machines, which are proposed for the U.S. application, actual experience is about 0.5 percent machine failures per year. Since failed centrifuge machines are not removed from the cascade, the accumulation of uranium deposits in the failed machine is considered in the plant's nuclear criticality safety program.

Cascade safety is achieved by minimizing the potential for worker injury by placing a casing around the centrifuge rotor to prevent fragments of a failed rotor from acting as high speed missiles and resulting in leakage from the machine. Criticality controls are also in place. UF_6 deposits on pumps also require controls to minimize worker exposures to radiation and UF_6.

Safety controls used in the feed system include automatic trips on high temperature to prevent liquefaction and automatic trips on low pressure. Safety controls in the Feed Purification System include low power output on cold trap heaters to provide long times necessary for UF_6 liquefaction in the event of heater failure. High flow in the activated carbon beds is alarmed to prevent excessive exothermic heat generation.

The Product Ventilation System removes enriched product from the cascade at 2 kg/hr. After transfer to product cylinders, cylinders are vented at 50 mbar to a -60C cold trap and through activated carbon and alumina beds to remove on any remaining UF_6 and HF. The processed stream is then pumped to the Gaseous Effluent Ventilation System for further treatment prior to release. Safety controls for the Product Ventilation System include alarms to prevent an unterminated cold trap defrost cycle and excessive UF_6 flow in the activated carbon bed. The tails withdrawal safety systems are similar to the product withdrawal systems.

The Gaseous Effluent Ventilation System scrubs gaseous effluents for removal of any UF_6 and HF that remains in the effluents. The system has redundant components and includes HF monitors upstream and downstream of prefilters and High Efficiency Particulate Air filters. Fans have a diesel backup power supply system. The ventilation system for the decontamination operations area is a separate system of similar design. Ventilation systems have continuous HF and alpha monitoring systems.

Worker safety is verified by periodic urine sampling and external exposure controls. Film badges and criticality dosimeters are issued to all workers. An exposure that could produce a 2mSv/yr (200 mrem/yr) level will trigger an investigation. Urenco has had no measurable internal exposures.

Accidents are minimized by maintaining negative pressures in plant systems. Autoclaves, in the older design, and cooling and heating boxes, in the newer designs, provide secondary containment in the feed and withdrawal stations. In the new designs, which would be proposed for use in the U.S. application, feed and withdrawal stations would operate with UF_6 only in the solid and gaseous states. In addition, heater power limits minimize the potential of liquefaction of UF_6 in cold trap defrost modes.

Urenco considers that chemical safety is the predominant safety concern at a gas centrifuge plant because of potential releases of UF_6 and HF, and is given substantial consideration in HAZOP reviews. By minimizing the potential for releases, Urenco considers that it minimizes the potential for accidents. Industrial safety is also considered in the HAZOP reviews. Urenco has a policy of internal reporting and investigating both accidents and near-miss situations involving radiological, chemical, and industrial safety areas.

Urenco has analyzed external accidents that include earthquakes and aircraft and vehicular impacts. Urenco has not determined impacts from intentional impacts of large aircraft.

The Capenhurst site currently releases to the atmosphere less than 10 g of uranium and less than 1 kg of fluorine on an annual basis. Solid wastes are generated in several operations, with most being generated in equipment decontamination operations. Urenco has not determined if wastes meeting U.S. mixed waste criteria are generated. However, its philosophy will be to avoid generating mixed wastes.

Tc-99 is present in the gas centrifuge system and plates out on the aluminum surfaces. Urenco has not had problems meeting Tc product specification requirements. Furthermore, recycled material has not been introduced into the E23 plant at Capenhurst.

On May 23, 2002, Urenco conducted a tour of its Almelo plant in The Netherlands. Prior to the plant tour, Urenco staff indicated that its business strategy is that market demand should lead investment. At the Almelo site, non-nuclear activities involve providing products to the aerospace industry in the area of high-speed turbo machinery and production of non-uranium

isotopes (both radioactive and non-radioactive). Currently, Urenco has 150 staff at the Gronau plant, 200 at Almelo, and 270 at Capenhurst for its nuclear and non-nuclear operations. For uranium enrichment operations at Almelo, about 65 operations staff are used in 5 shifts with 9 needed to operate the plant on each shift. Additional staff is needed to support equipment maintenance activities.

The most difficult operational problem is loss of offsite power, which occurs several times per year for short durations. Backup power supplies are used to ensure that safety systems can operate, but backup power is not provided to gas centrifuge motor drives. The principle concern during loss of power situations is the wind-down and restart of the centrifuges through the critical speed ranges.

At Almelo, Urenco conducted a tour of the SP4 and SP5 plants. The SP4 plant uses several different centrifuge designs. As new designs are incorporated, new cascades have been built using the advanced technology. Operators, however, would prefer to have only a single design as operating procedures differ for the differing cascades. At SP4 feed stations use both steam autoclaves and the newer low pressure heating boxes that do not liquify UF_6.

The SP5 plant is under construction. This plant will be of similar design to that proposed for the U.S. and will use the TC-12 centrifuges. Feed and withdrawal stations will not require liquefaction of UF_6. Sampling stations will require UF_6 liquefaction to obtain representative samples.

At Almelo, once an enrichment plant is shutdown, it is completely decommissioned to a greenfield status. The Urenco staff pointed out part of the site where the first SP1 plant had existed and had since been decommissioned. These decommissioning efforts provide real data to support development of a reasonable cost estimate needed for the decommissioning funding plan.

Pending Actions/Planned Next Steps for NRC: None

Points for Commission Consideration/Items of Interest: NA

Attachments: 1. Meeting agendas
2. Meeting attendees

"On the Margins": NA

Urenco Foreign Trip Attendees:

D. Brown/U.S. Nuclear Regulatory Commission (NRC)
J. Giitter/NRC
T.C. Johnson/NRC
R. Krich/Exelon
C. Andrews/Urenco
P. Upson/Urenco (at Capenhurst)
I. Crombie/Urenco (at Capenhurst)
S. R. Hooley/Urenco (at Capenhurst)
A. Pilkington/Risk Management Consultants (at Capenhurst)
P. te Riele (at Almelo)
P. de Jong/Urenco (at Almelo)
M. Lynch/Urenco (at Almelo)

Attachment 2