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9.0 INTRODUCTION

The CEC includes engineered features which prevent potential accidents. LES uses a combination of engineered features and operational control to prevent the conditions which would allow UF_6 to breach containment or allow a criticality event to occur.

The Commission's regulations, as stated in Section 70.22 (f) of 10 CFR 70, require that each applicant requesting a construction permit or operating license provide an analysis of the performance of the structures, systems, and components of the facility. The objectives of these analyses are to:

a. Assess the adequacy of provisions for protecting the CEC against natural phenomena.

b. Verify the adequacy of the design basis of the principal structures, systems, and components of the plant.

c. Determine if an emergency plan is necessary and on what actions the emergency plan should concentrate.

9.0.1 GUIDELINES FOR PUBLIC EXPOSURE TO HAZARDOUS CHEMICALS

NUREG 1391 (Reference 1) directs that plants handling uranium hexafluoride should be designed to prevent public exposure to concentrations of $(25\ mg/m^3)(30\ min/t)^{0.5}$ of hydrogen fluoride and an intake of 10 mg uranium in the event of certain postulated accidents. (In this calculation intake is proportional to breathing rate, atmospheric concentration and exposure time). Events with potential for exceeding these values are defined by NRC as accidents. Events which could cause releases of UF_6, but not in quantities which exceed the guidelines, are defined by LES as abnormal events. The CEC facility is designed to prevent and/or mitigate abnormal events. The determination of which events are accidents and which are abnormal events is described in Section 9.0.4.

9.0.2 EVENTS CATEGORIZED BY PREDICTED CONSEQUENCES

There are several approaches available for analyzing events. In some cases, events can be analyzed with relative certainty (e.g., how much pressure can a vessel withstand before it fails?). In other cases, there is less certainty associated with an analysis (e.g., how can the 10,000-year hurricane be predicted at a site which has no history of hurricanes?). These analyses predict a range of consequences for various postulated events. At one end of the range are relatively minor events which, if they were to occur, would not impact public safety. At the other end of the range are events which, if they were to occur, would have the potential for exceeding the NUREG 1391 limits for public exposure to radiation or hazardous chemicals. In NUREG 1391, the NRC has evaluated the effects of uranium hexafluoride chemical toxicity and radiation doses in establishing exposure guidelines for workers and the public.

NUREG 1140 (Reference 7) methodology has been used to estimate the amount of UF_6 in the plant which, if it were released, could exceed NUREG 1391 offsite limits. The calculations indicate that if a sudden release develops into a buoyant plume, then a release of at least 1100 kg of UF_6 would be required to exceed NUREG 1391 limits. However, if the release of UF_6 is non-buoyant, occurring in a slower fashion, then a release of only 119 kg would be required to potentially exceed NUREG 1391 limits.

Possible events have been evaluated for the CEC which have potential for releasing more than 119 kg of UF_6. Any event involving an area of the plant with potential for releasing more than 119 kg of UF_6 has been classified as a potential "accident." Other events with potential for releasing only smaller quantities of UF_6 have been classified as abnormal events. (If the release begins indoors, the release point is defined as the exit of the Separations Building.)

9.0.3 APPROACHES USED TO PERFORM EVENT ANALYSES

Accident analysis must consider the effects of equipment failures caused by a variety of initiating events. If the analyst can't predict exactly the conditions of the accident, there are still analytical approaches that can be used. The analyst can envelope bounding conditions, or assume complete release and analyze the consequences. The analysis must also include consideration of common mode failures, human error, mechanical fatigue, natural phenomena, and interaction effects between systems which are coupled together by either operating or spatial considerations. Postulated events at the CEC were analyzed using the combination of methods listed below:

a. Failure modes and effects analysis of UF_6 process and utility support systems.

b. Urenco tests of centrifuge machines.

c. Design of the buildings and selected equipment to withstand design basis loads imposed by natural phenomena.

d. Mechanical and physical/chemical analyses of postulated events which could result in worker or public exposure to the chemical or radiological hazards of UF_6.

These types of analyses evaluate the margin of safety that the plant structures, systems, and components provide for assuring public safety. Analyses include the response of the facility to postulated natural phenomena, equipment failures, and operator errors which are anticipated during the life of the facility. During the analyses, consideration of the historical operating record of Urenco's three European operating sites was also included. A review of the CEC facility design identified equipment and likely initiating events having sufficient inventory of UF_6 at risk, based on physical and chemical characteristics of UF_6, to cause an accident.

Table 9.0-1, Postulated UF_6 Release Scenarios, summarizes the scenarios which were considered during the analyses. These events were selected by engineering staff who are experienced in plant design, operation and safety analysis. Each scenario was analyzed to estimate the bounding quantity of UF_6 released (i.e., worst case release), estimate worker exposures, and identify any public health consequences.

One of the outputs of a typical event analysis is a prediction of the consequences of an event if it were to occur. Analyses of postulated failures of equipment or errors by plant personnel yielded predictions of event consequences. Potential sources of radiation and chemical hazards were thereby identified. Each system was analyzed to identify single failure events which could lead to an uncontrolled release. Incidents are judged to be not credible if, in order to happen, there would need to be two independent, unlikely, simultaneous failures.

The postulated failure of an overheated cylinder was analyzed in detail, because it was found to represent the largest magnitude event. The effect of postulated releases from other UF_6 processes were also evaluated. The evaluation included review of Urenco safety reports, review of published reports on safe handling practices for UF_6, review of accident analyses of prior accidents in the United States, consideration of operating experience at the Urenco plants in Europe and a safety review and accident analysis of the LES design (References 2, 3, and 4). Each process design was reviewed to assure that the instrumentation and control system would detect upset operating conditions.

9.0.4 SIGNIFICANCE OF PLANT DESIGN AND OPERATING FEATURES TO THE EVENT ANALYSIS

The CEC design includes numerous features which either preclude these postulated events or would limit the quantity of UF_6 released if the events were to occur. For example, moving cylinders containing liquid UF_6 is potentially dangerous. Therefore, the CEC operating procedures prohibit removing UF_6 cylinders from an autoclave until the UF_6 is in solid form. This approach lowers the risk of an accident occurring and also limits the quantity of UF_6 that would be released if an accident were to occur. The facility is designed to withstand a 500-year earthquake, per the guidelines given in the Advanced Noticed for

Proposed Rule Making on the Regulation of Uranium Enrichment Facilities (Reference 5). It is also designed to withstand design basis flood and tornado.

Supporting analyses were prepared to identify conditions where major equipment components or structures might fail. Failure modes and effects analyses were performed to verify that design features were provided to prevent those conditions from occurring.

The event analysis was conducted with the recognition that the CEC includes a large variety of systems for monitoring the plant, detecting off normal conditions, and controlling releases. For example, various monitors (pressure, temperature, flow, and HF) have been included in the CEC design which will detect process or equipment failures and signal the need for corrective action. The process control systems are designed to signal out-of-range conditions and to shut down individual systems once preset operating limits are exceeded.

Plant maintenance must be considered in analyses. Each process module and the equipment within it is designed so that it can be decontaminated for the repair or replacement of equipment. The Gaseous Effluent Vent System provides a source of negative pressure to recapture hazardous material that may escape when opening the process system for maintenance. It also serves as a dry scrubber system for fume hoods in the Technical Services Area and for the air within an autoclave prior to opening the autoclave door. The Gaseous Effluent Vent System includes high efficiency filters and activated carbon filters that remove airborne materials before the air is discharged to the atmosphere.

The enrichment process is enclosed within the Separations Building. Under normal operation the building HVAC Systems are designed to maintain a negative pressure in the UF_6 Handling Area, the Blending Area and the Technical Services Area. Air from the Technical Services Area is filtered. This HVAC system is shutdown if a major release occurs, thus minimizing releases to the outside environment.

9.0.5 URENCO OPERATING HISTORY

Urenco has operated 8 plants on 3 sites for a combined total of 33 years. No exposures which have caused any health impairing effects have occurred. Urenco has never had an accident or significant release of UF_6 from any of its facilities since it started operation. Several small releases from the primary process containment have however occurred. Examples of these are listed below:

a. A hot desublimer was vented in error, leading to a vent pump failure which released a few hundred grams of UF_6. The release was completely contained within the process building.

b. An autoclave was contaminated with approximately five pounds of UF_6. This tripped the high pressure alarms. This resulted from a leaking flange packing, not from failure of the autoclave heater control circuits. It did not result in a release from the autoclave. In fact, most of the UF_6 was pumped back into a process vessel. There was no risk to staff or the public, nor were there any releases from the plant to the environment. Plant operation and production were not impaired. Although the magnitude of the event was not large enough to require notification to licensing authorities, agency personnel were nevertheless invited to observe the decontamination campaign, which was video recorded.

c. There have been four reportable incidents involving UF_6 releases within Urenco facilities. One involved a broken UF_6 cylinder superior valve nut. The nut broke during a routine transfer of UF_6 from a tails desublimer to a transport container, and this released several grams of UF_6 into the building. Two night shift operators inhaled a notifiable quantity of UF_6. After the event, the transfer procedure was modified to prevent a recurrence. The three remaining reportable incidents involved maintenance of pumps.

d. A hot desublimer was vented in error to a mobile pump set which had previously been used to evacuate UF_6 lines leading to a product container station. About 18 Kg of UF_6 were absorbed into the active carbon trap in the pump. This was within the capacity of the trap. The speed of the reaction at the inlet end of the trap led to overheating. The uranium had been chemically reduced from UF_6 to UF_4 and the stainless steel of the trap housing was locally discolored. The carbon nearer to the outlet of the trap was found later to contain almost no uranium. No uranium reached the vacuum pump of the pump set.

(Note that desublimers for product and tails take-off are not used in the LES design.) Operational procedures for product and tails take-off systems are described in SAR 6.4-10.

None of these incidents resulted in worker injury. Apart from the one event releasing a few hundred grams of UF_6, all the other releases were in the order of tens of grams of UF_6. These quantities are not significant in terms of chemical toxicity or radiation doses. CEC maintenance practice will involve standard procedures of valve isolation, dry nitrogen purging and activity in air sampling. These procedures will confirm in-plant airborne activity levels to be of a satisfactory standard prior to break in. Where it is not possible to achieve this, for any reason, portable breathing apparatus will be worn.

The more significant accidents at the Urenco facilities are reported below.

a. Trichloroethylene Leak

During Plant commissioning when the trichloroethylene plant was set to a non-standard state, the cold trichloroethylene system was inadvertently connected through to the hot trichloroethylene system. The cold trichloroethylene caused shrinkage and hardening of valve seals on three valves in the hot trichloroethylene system resulting in trichloroethylene leakage. No personnel were exposed to significant fume inhalation. No specific recommendations were made other than noting commissioning always requires vigilance. There is no trichloroethylene system in the LES facility.

b. Transformer Leak

A Transfer Set was being commissioned, the set was energized but off-load. An internal explosion and fire occurred. Recommendations were made regarding the specification of new sets.

c. Occurrence Involving a "Nifty" Lift Working Platform

An electrician was working on a lift platform in the process of changing a crane warning lamp. The stabilizing legs of the platform had not been fully extended, and when the electrician began to ascend the platform it tilted coming to rest at an angle of 30°, resting on a cable tray. No one was injured. Recommendations were made that specialized training be given for users of the platform, and that explanatory notices be attached.

The experience gained at the Urenco plants has been incorporated into the CEC design and operating procedures. Consequently, the probability of similar occurrences is extremely low. The safety analysis concluded that such occurrences would not result in the release of hazardous materials in amounts sufficient to contaminate the offsite environs. The impact of a release at CEC, should one occur, is likely to be limited to disruption of plant operations and shutdown of the plant for cleanup and repair.

No criticality events have occurred at Urenco's operating facilities. The CEC plant is designed and operated to preclude them.

9.0.6 SUMMARY

Accident analysis calculations and discussions are discussed in several parts of the SAR. Events have been analyzed using several methods which differ in their degree of sophistication. The analysis identified the components of greatest significance to preventing releases. As discussed in sections 6.4 and 9.2, plant components are designed in the first place to prevent circumstances which might develop into an accident. LES has implemented a strict quality assurance program to assure proper design and operation of the processing equipment of greatest significance to preventing an accident, as discussed in Section 4.6. Section 4.6 discusses the identification of structures, systems, and components which are important to public safety. Section 9.2 discusses the consequences of design basis accidents. Criticality is discussed in Sections 4.5 and 9.2. Systems and components which prevent or mitigate smaller releases of hazardous materials are discussed in Section 9.1, Abnormal Operations. Events caused by failures of utility and support systems are described in Section 6.4. The events described in Chapter 6.4 were considered as initiating events for the analyses described in Chapter 9. The component failures which caused failures of the utility and support system are also included in Section 6.4.

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4. C. R. Barlow, K. T. Ziehlke, W. A. Pryor, "Effects of Fire Exposure on Integrity of UF_6 Shipping Cylinders", Martin Marietta Energy Systems, Inc.

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7. NUREG 1140, "A Regulatory Analysis on Emergency Preparedness for Fuel Cycle and Other Radioactive Material Licensees," January 1988.