February 28, 2002

MEMORANDUM TO: Eric J. Leeds, Chief
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Office of Nuclear Material Safety
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SUBJECT: FEBRUARY 22, 2002, PHONE CALL SUMMARY: REVIEW OF DUKE COGEMA STONE & WEBSTER CONSTRUCTION AUTHORIZATION REQUEST SUPPORTING DOCUMENTS FOR THE MIXED OXIDE (MOX) FUEL FABRICATION FACILITY

On February 22, 2002, the U.S. Nuclear Regulatory Commission (NRC) reviewed outstanding chemical safety questions with Duke Cogema Stone & Webster (DCS) via phone that are associated with the construction authorization request (CAR) for the mixed oxide fuel fabrication facility (MFFF) submitted by DCS on February 28, 2001. The purpose of this memorandum is to document questions asked by NRC and to reconcile differences between outstanding items being tracked by DCS (described in Enclosure B in DCS's letters dated January 7 and February 11, 2002) versus those being tracked by the staff. With respect to the questions in the attachment, most were asked previously whereas some were provided to DCS for the first time (e.g., those resulting from continuing staff review of the CAR and DCS responses to requests for additional information (RAIs)). DCS will document their responses in a letter to NRC.

1. Dissolution Electrolyzer

A. The applicant has identified the detection of high temperature with electrical shutdown of the electrolyzer as a design basis. No other design bases or principal structures, systems and components (PSSCs) are identified. The text implies that there may be additional design bases and PSSCs. For example, a voltage limit is mentioned but not explained in RAI 50. (The electrolyzer area has been discussed in RAIs 50 and 141.)

Based on the hazards analysis, 1) are there PSSCs to detect high temperature and 2) are additional design bases (e.g., plutonium oxide morphology information and requirements, flow and recirculation rates, and electrical parameters) necessary for the electrolyzer? Spatial and geometric effects and bulk versus localized measurements might be considered (e.g., multiple sensors, in stream, on walls, etc.)

B. Titanium is used for several components in the electrolyzer area because of its corrosion resistance. Destructive titanium fires have occurred from small sparks generated by maintenance activities, including nearby welding, that resulted in localized high temperatures. Localized sparking and high temperatures are possible with electrolysis operations that use several hundred amperes. The applicant has not identified design bases or PSSCs for such events.

Based on the hazards analysis, are design bases for avoiding localized over temperature of the titanium materials necessary?

C. Some tanks and piping in the electrolyzer area are fabricated from stainless steels. The applicant indicates the silver(II) ion will be destroyed prior to the solutions contacting the stainless steel areas of the system. A generic corrosion program is identified as a PSSC for the facility, but it appears that the program may not be able to catch the phenomena due to its rapidity (i.e., no or inadequate peroxide addition to destroy silver(II) resulting in severe pitting/attack and, ultimately, leaks).

Was corrosion from silver contacting stainless steel analyzed in the hazards analysis? Based on the hazards analysis, are specific design bases (e.g., to limit the concentration of silver(II) ions for solutions that contact lower alloys such as stainless steels) necessary to assure that corrosion from silver contacting stainless steel will not occur?

2. Purification Area

It appears that the applicant has not identified any explicit design bases and PSSCs for this area. Based on the hazards analysis, are design bases (e.g., limits on Tributyl Phosphate/solvent/nitric acid mixtures (the red oil phenomena - see Section 8.5.1.5), the solvent (Section 8.5.1.2), hydrazine/hydroxylamine nitrate (HAN) (see Section 8.5.1.3), and flammable gases/vapors in ullage/vent spaces) necessary for the purification area?

3. Solvent Recovery Cycle

It appears that the applicant has not identified any explicit design bases and PSSCs for this area. Based on the hazards analysis, are design bases (e.g., limits on TBP/solvent purity (the red oil phenomena - see Section 8.5.1.5), the solvent temperature (Section 8.5.1.2), and flammable gases/vapors in ullage/vent spaces) necessary for the solvent recovery area?

4. Oxalic Precipitation

It appears that the applicant has not identified any explicit design bases and PSSCs for this area. (RAI 122, RAI 111, and RAI 207)

A. Based on the hazards analysis, are design bases or additional PSSCs (e.g., the nitrogen cooling system and bearing are identified as having a containment function) necessary for maintaining integrity of the calciner, particularly for the seals and bearings?

B. Based on the hazards analysis, are design bases values (e.g., pH, nitric acid) necessary for the residual oxalic acid solution to prevent unintended plutonium precipitation?

5. Oxalic Mother Liquor

B. This area reroutes materials for recovery. In the CAR, plutonium specification and oxalate requirements are stated. In RAI response 111, numerical values are given. The staff review notes that these are to avoid unintended plutonium and plutonium accumulation in locations not designed for such deposits and, thus, may have safety functions.

(1) Based on the hazards analysis, is a plutonium specification (concentration limit) on the distillate product stream a design basis?

(2) Based on the hazards analysis, is the oxalate concentration on the stream that is returned to purification a design basis?

B. The applicant has identified a temperature limit for this evaporator as a design basis (RAI 123). No other design bases were identified. Prior U.S. Department of Energy (DOE) experience with evaporators indicates the potential for the unintended accumulation of solvents and plutonium, and potential explosion and criticality concerns. The applicant has not identified any such limits for this evaporator.

Based on the hazards analysis, are design bases (e.g., plutonium and solvent accumulation limits) necessary for the evaporator and associated vessels?

C. Solvent degradation products can lead to red oil explosions. The staff's review indicates the single design basis and PSSC proposed may not be capable of preventing or mitigating this event.

Based on the hazards analysis, demonstrate that the evaporator and related tanks are limited to a maximum temperature and conditions with direct measurements and controls (e.g., steam shutoff) that ensure that the red oil event is highly unlikely . (Oxalic Acid Mother Liquor)

6. Acid Recovery

A. There are two evaporators and associated tanks in this area. The bottom products from both evaporators contain concentrated americium and uranium. The staff review notes limits and specifications may be needed for the bottoms and tops products from each evaporator. Such limits are in the response to RAI 111. Upon further review, the staff concludes some limits may be need to be identified for safety purposes (contamination control and confinement of radioactive materials).

(1) Based on the hazards analysis, is a distillate specification and/or decontamination factor for each evaporator necessary as a design basis?

(2) Based on the hazards analysis, is a product specification or limit for Pu, Am, and U in the concentrate necessary as a design basis?

(3) Are the evaporators and related vessels PSSCs for confinement of the radioactive materials?

B. Solvent degradation products can lead to red oil explosions (RAI 123). The staff's review indicates the single design basis and PSSC proposed may not be capable of preventing or mitigating this event.

(1) Provide information to demonstrate the efficacy of evaporator controls?

(2) Provide information to demonstrate that the evaporator and related tanks are limited to a maximum temperature and conditions, with direct measurements and controls (e.g., SIS-like, steam shutoff) that ensure that the red oil event is highly unlikely.

7. Silver Recovery

A. This was discussed in the context of the dissolution electrolyzer (RAI 50, 141). The applicant has not identified any design bases or PSSCs with this unit. It recovers silver from the high alpha waste stream; all components in the waste unit (i.e., where this stream goes) have been designated as PSSCs by the applicant (RAIs 135, 140).

Based on the hazards analysis, are design bases (e.g., potential design bases may include plutonium oxide morphology information and requirements, flow and recirculation rates, and electrical parameters). Spatial and geometric effects and bulk versus localized measurements might be considered (e.g., multiple sensors, in stream, on walls, etc.) necessary for the electrolyzer?

B. Titanium is used for several components in the electrolyzer area because of its corrosion resistance. Destructive titanium fires have occurred in the CPI from small sparks generated by maintenance activities, including nearby welding, that resulted in localized high temperatures. Localized sparking and high temperatures are possible with electrolysis operations that use several hundred amperes. The applicant has not identified design bases or PSSCs for such events.

Based on the hazards analysis, are design bases for avoiding localized over temperature of the titanium materials necessary?

C. Some tanks and piping in the electrolyzer area are fabricated from stainless steels. The applicant indicates the silver(II) ion will be destroyed prior to the solutions contacting the stainless steel areas of the system. A generic corrosion program is identified as a PSSC for the facility, but it appears that the program may not be able to catch the phenomena due to its rapidity (i.e., no or inadequate peroxide addition to destroy silver(II) resulting in severe pitting/attack and, ultimately, leaks).

Was corrosion from silver contacting stainless steel analyzed in the hazards analysis? Based on the hazards analysis, are specific design bases (e.g., to limit the concentration of silver(II) ions for solutions that contact lower alloys such as stainless steels) necessary to assure that corrosion from silver contacting stainless steel will not occur?

8. Offgas

A. The staff review of the CAR found two design bases for this system–venting and exhaust–to avoid explosive vapors. However, these were phrased broadly as goals without the identification of PSSCs, values, codes and standards, etc. As part of the response to RAI 127, the applicant stated there were no additional design bases and no additional information was provided for venting and exhaust. The applicant listed other functions of the unit in the response. Upon review, the staff concludes that additional information is needed to complete review of the design bases identified by the applicant and that additional design bases may need to be included (literature sources have identified design bases for reactive systems).

Based on the hazards analysis, are design bases that take into account the potential effects of chemical reactions necessary for venting systems? (Note: at a minimum, consider red oil and HAN phenomena should be considered.)

B. Based on the hazards analysis, is the offgas treatment unit a PSSC? Like for the sintering furnace, it appears that the design basis for the offgas unit should maintain potentially flammable gases and vapors within limits. Information is provided in response 124 on the sintering furnace room, that may also be applicable here. What are the design bases for the offgas system?

C. The offgas and filtering line also collect solvent vapors and entrained solvent droplets. In RAI 126, a solvent temperature limit is identified. The staff believes this may also apply to the offgas area.

(1) Based on the hazards analysis, is a design basis necessary to maintain the temperature below the design basis temperature used to avoid the flashpoint of the solvent/vapors at all times?

(2) Based on the hazards analysis, are design basis (e.g., adequate removal of potentially reactive and toxic gases and maintenance of the first confinement barrier; a requirement on minimum flow rate for air and scrubbing media) and PSSCs necessary for the offgas treatment unit?

9. Liquid Waste Reception Unit

The staff review of the CAR found no PSSCs and design bases identified for this system. In response to RAI 135, the applicant identified the entire unit as items relied on for safety (IROFS)/PSSC. PSSCs and design bases are not fully identified. Clarification is needed.

A. Based on the hazards analysis, what are the design basis (e.g., desired values and any inventory restrictions, and the proposed controls needed to attain a highly unlikely probability of criticality in this unit) and PSSCs for U-235 dilution in the waste unit?

B. Based on the hazards analysis, what are the design basis and PSSC(s) for acidification, sampling, and analysis to avoid azide formation?

C. To assure that waste volume does not exceed that in the CAR, the staff requests: (1) a written commitment by DCS that the MFFF will meet the waste acceptance criteria (WAC) and (2) confirmation of Savannah River Site (SRS) acceptance of MFFF wastes meeting the WAC, preferably by an agreement or formal documentation between DCS and SRS. Is a maximum limit on silver included in the WAC?

D. What are the design bases for a maximum inventory of radioactivity and liquids for the waste unit and associated PSSCs and on what are they based? If this limit is reached, what actions will occur (e.g., will additional dissolution operations and active waste generation cease until DOE/SRS has accepted the waste backlog and the waste has been transferred to the SRS)?

E. Based on the hazards analysis, are design bases and PSSCs necessary for leak detection and radiation monitoring?

10. MOX Process (MP)

MP is a dry powder operation. The staff has posed questions about heat loads and potential pyrophoric reactions of uranium and plutonium powders in air. (RAI 49 and an in-office review.)

A. Based on the hazards analysis, are design bases and PSSCs necessary to prevent potential oxidation reactions that might release radioactive materials considering the potential pyrophoric nature of some UO2 powders? (The potential pyrophoric nature of some UO2 powders needs to be reviewed by the applicant to see if design bases and PSSCs are needed to prevent potential oxidation reactions that might release radioactive materials. This concern applies to all units handling UO2 (in air; nitrogen cover gas is not currently identified by the applicant as a safety function.)

B. Based on the hazards analysis, are design bases and PSSCs necessary to prevent potential oxidation reactions that might release radioactive materials considering plutonium oxidation reactions and the pyrophoric nature of plutonium? This applies to all open (unclad or non-containerized) plutonium handling areas.

11. Plutonium Feed Design Basis

The applicant has identified a feed specification for the plutonium delivered to the facility. The NRC inquired about a feed material design basis. In response to RAI 50, the applicant stated there was no design basis for the feed material. However, Section 11.2.6 identifies it as a design basis for non-PSSCs. Upon further review, the staff concludes this may also need to be a design basis for PSSCs.

Based on the hazards analysis, are design bases (e.g., specifications on the feed material) necessary?

12. Radiolytic Hydrogen Generation

The CAR discusses a number of items and requirements for hydrogen generation.

Based on the hazards analysis, what are the design bases associated with hydrogen generation by radiolysis?

13. Solvents Fire

A. The applicant identifies a list of preventive measures for preventing solvent fires.

Based on the hazards analysis, what are the design bases associated with preventing solvent fires?

B. The applicant identifies a solvent design basis temperature to keep the solvent below its flashpoint. The staff review indicates this might not be sufficiently conservative to provide an adequate safety margin.

Justify the temperature design basis for the solvent is sufficiently conservative or provide one that provides for greater margin and assurances of safety, and accommodates potential spatial variations in temperature measurements.

14. HAN and Hydrazine

The applicant discusses the use of HAN and hydrazine and implies that there are safety controls. The staff requested clarification on the following (RAI 125):

A. Based on the hazards analysis, what PSSCs (engineered safety features and controls) and associated design bases are necessary for HAN and hydrazine in nitric acid media?

B. Based on the hazards analysis, what PSSCs and design bases are necessary for hydroxylamine and its mixing with nitric acid to make HAN?

C. Based on the hazards analysis, justify that the resultant set of design bases is complete.

15. Habitability

The proposed facility uses relatively large quantities of asphyxiating gases. In RAI 128, the applicant responded that "... high ventilation rates preclude the creation of an asphyxiating atmosphere." Design bases were not identified. The applicant plans to use a case-by-case analysis during detailed design. Based on the hazards analysis, what PSSCs and design bases are necessary in this area? Identify appropriate habitability standards design bases and identify any PSSCs needed to meet these standards.

16. Red Oil

The applicant proposes a temperature design basis of 135°C and an indirect means of temperature control. The staff review has identified several explosions that have occurred at similar facilities in the past. More conservative (lower) temperatures and additional design bases are being used at similar facilities. The staff has posed questions on the subject (RAI 123). The applicant intends to do hazard and operability

studies on the evaporator for the operating license phase. The applicant has committed to provide a comprehensive discussion justifying their approach.

Based on hazards analysis, are the current design bases sufficient or are additional PSSCs and design bases necessary to adequately address the red oil concerns in the evaporators and nearby tanks?

Docket: 70-3098

cc:
P. Hastings, DCS
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D. Moniak, BREDL
G. Carroll, GANE
R. Thomas, Environmentalists, Inc.

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