SAFETY EVALUATION REPORT

DOCKET: 70-1113

LICENSEE: Global Nuclear Fuels – Americas, L.L.C.
Wilmington, North Carolina

SUBJECT: GLOBAL NUCLEAR FUEL - AMERICAS – EXEMPTION TO CRITICALITY MONITORING SYSTEM REQUIREMENTS LICENSE AMENDMENT REQUEST AND AMENDMENT 12 (COST ACTIVITY CODE L33401)

BACKGROUND

On December 15, 2015, Global Nuclear Fuel – America (GNF-A) submitted a request for an exemption to the requirement in Title 10 of the *Code of Federal Regulations* (10 CFR) Section 70.24 to maintain a criticality monitoring system in all areas exceeding a critical mass of special nuclear material (SNM). A "critical mass" is defined in 10 CFR Part 70 as more than 700 grams (g) ^{235}U or 1500 g ^{235}U enriched to no more than 4wt% ^{235}U, 520 g ^{233}U, 450 g Pu, or 450 g of any combination thereof, or half of such quantities if graphite, heavy water, or beryllium moderators are present. The limit of interest at GNF-A is 700 g ^{235}U, based on the types and quantities of fissionable and moderating materials at the site. License Application Section 1.3.11 currently lists two exemptions, for a specified fraction of a minimum critical number of finished fuel rods, and for an unspecified quantity of uranium when packaged for transport. The current exemption request seeks approval for an exemption from 10 CFR 70.24 in areas where no credible accident sequence can be identified that results in criticality, so that the risk of criticality may be considered negligible.

REGULATORY REQUIREMENT

Paragraph 70.24(a) of 10 CFR states that each licensee authorized to possess SNM exceeding 700 of contained uranium-235, 520 of uranium-233, or 450 of plutonium shall maintain in each area in which such licensed SNM is handled, used, or stored, a monitoring system meeting the requirements of either paragraph (a)(1) or (a)(2).

DISCUSSION

The existing exemptions in License Application Section 1.3.11 are in areas where the quantity of SNM exceeds the threshold for a critical mass in 10 CFR 70.24(a), but where risk of criticality may be considered negligible. While the quantity of SNM in a "safe batch" of fuel rods (45% of a minimum critical number when double batching is credible or 75% of a minimum critical batch when not credible) exceeds the threshold for a critical mass in 10 CFR 70.24, it cannot achieve criticality as long as the configuration of the fuel rods remains intact. Similarly, fuel that is packaged for transport is in a fixed configuration and must be demonstrated to be subcritical based on a conservative analysis and under stringent conditions as specified in 10 CFR Part 71. In both cases, the configuration is fixed and protected by one or more passive barriers (e.g., cladding, shipping container, overpack). The current amendment would generalize this to exempt areas in which there is negligible risk of criticality due to the amount or configuration of SNM. In those areas, the likelihood of criticality must be deemed to be very low based on a documented and reviewed criticality accident alarm system (CAAS) “needs evaluation” showing that there are no credible accident sequences leading to criticality. This needs evaluation would be maintained in accordance with the licensee’s configuration management program and would be available for inspection.

The purpose of a CAAS is to alert personnel to evacuate in the event of a criticality accident. In the absence of any credible events leading to criticality, therefore, there is no safety benefit to installing and maintaining a CAAS. The criteria for considering events “not credible” are given in License Application Section 3.3.3, and are identical to those used in performing the integrated safety analysis (ISA). These criteria are consistent with those in Section 3.4.3.2(9) of NUREG-1520, “Standard Review Plan for Fuel Cycle Facilities License Applications.” The licensee has further committed to document the justification for concluding when events are “not credible.” While individual sequences in many processes may be determined to be “not credible,” *every* sequence identified in accordance with approved ISA methods in an area would have to meet the criteria for being considered “not credible” to apply the proposed exemption, and the basis for each sequence would be documented and available for review. As stated in NUREG-1520, “such a demonstration of ‘not credible’ must be convincing despite the absence of designated IROFS [items relied on for safety]. Typically, this can be achieved only for external events known to be extremely unlikely.” Based on the difficulty in meeting the aforementioned criteria, and the anticipated large number of sequences to which they must be applied, it is the staff’s judgment that very few areas containing greater than a safe mass are likely to qualify for an exemption to 10 CFR 70.24 under the proposed exemption criterion. Conversely, as stated in the technical basis for the exemption request, the presence of a CAAS incurs risks to personnel of its own. False alarms may result in process disruption and injury to personnel. Maintaining a CAAS may result in increased occupational exposure to personnel and increased foot traffic in covered areas. While these risk impacts may be small, the staff concurs that where there is no tangible risk benefit to requiring a CAAS (due to negligible risk of criticality), its installation may result in a net modest increase in overall risk to workers. Not requiring a CAAS in such areas is not allowed for in the rule—hence the need to obtain an exemption—but it is consistent with standard industry practice as stated in Sections 4.1.3 and 4.2.1 of ANSI/ANS-8.3-1997 (R2003), “Criticality Accident Alarm System.” Where installing a CAAS would result in a net increase in risk to personnel, an exemption from the requirements of 10 CFR 70.24 is warranted.

GNF-A provided two examples in its submittal to support the proposed exemption. The staff reviewed the two examples to obtain reasonable assurance that the licensee would properly implement the proposed exemption criterion, due to difficulties in the nuclear fuel industry with regard to the basis for events being “not credible.” This Safety Evaluation Report does *not* approve an exemption for these two areas specifically, but only for the general criterion based in part on the examples.

The first example involves the Hydrofluoric Acid (HF) Neutralization and Waste Treatment Facility area. Dilute HF acid in the storage tank is sampled and confirmed to be less than 3 ppm uranium before being transferred to the HF transfer truck and transported to the HF Neutralization Facility. There it is treated with calcium hydroxide and precipitated as calcium fluoride (CaF_2). The licensee stated that the resulting CaF_2 precipitate and decanted water will contain no more than 1 ppm uranium. The minimum critical concentration for a uranyl fluoride (UO_2F_2) solution, as stated in Table 1 of ANSI/ANS-8.1-2014, “Nuclear Criticality Safety in Operations with Fissionable Materials outside Reactors,” is 11.6 $g^{235}U/l$, or roughly 11,500 ppm ^{235}U. Therefore, reaching a minimum critical concentration would necessitate concentrating the uranium in solution by more than a factor of 3800.

To support the first example, GNF-A submitted its Criticality Safety Analysis CSA-703.00.100 CWS DAM20 Elimination, “CAAS Needs Evaluation: Criticality Warning System DAM 20,” Rev. 0, dated January 2016. This analysis describes the areas currently covered by criticality alarm cluster DAM 20, the HF Neutralization and Waste Treatment Facility processes, the identified criticality accident sequences for these processes, and the technical basis for exemption under the proposed exemption criterion. The areas covered by DAM 20 include the HF Neutralization Facility and associated lagoons, a non-uranium bearing equipment storage area (boneyard), an empty sea van and drum storage area, a remediated building, and outside storage pads. The HF Neutralization Facility and lagoons are expected to contain only very dilute concentrations of uranium as described above, while the remaining areas with the exception of the storage pads will contain only residual quantities of uranium; the outside storage pads will not be used for uranium storage. The staff reviewed the process description for the HF Neutralization Facility and determined that major process upsets would be needed to achieve high concentrations of uranium. Dilute HF is condensed from the off-gas from the licensee’s dry conversion process. Based on the nature of the process and historical measurements of the uranium entrained in the HF stream, the concentration is expected to be significantly less than the 3 ppm limit. The dilute HF solution is sampled for concentration in the HF Recovery Building prior to being transferred by truck to a series of unfavorable geometry tanks at the HF Neutralization Facility. There are no hard-piped connections between the HF Recovery Building and HF Neutralization Facility. The solution is treated with calcium hydroxide and precipitated as calcium fluoride for disposal. The decanted water is transferred to the lagoons.

The licensee performed a hazard analysis and identified three criticality scenarios in HF Receipt Tank that is filled from the transfer truck: high uranium concentration in the HF solution, long-term accumulation of greater than a safe mass in the tank, and settled uranium exceeds a safe areal density. High concentration is prevented by upstream process controls and sampling prior to truck transfer. At the concentration limit, the Receipt Tank contains tens of grams of uranium. The licensee calculated that over the course of a year, the amount of uranium entering the tank at full production capacity is a fraction of the minimum critical mass for an optimally moderated and fully reflected heterogeneous hemisphere. Even if all the uranium in the tank precipitates, it is insufficient to exceed a minimum critical areal density. Therefore, the licensee concluded that criticality in the HF Receipt Tank is not credible. The hazard analysis contains similar scenarios for the downstream tanks.

In the HF Neutralization Tank, calcium hydroxide is hard-piped in to initiate the precipitation of CaF_2. The use of calcium hydroxide in this manner to complex the fluoride ion does not produce a concentrated uranium precipitate and the uranium concentration in the precipitate will be less than 1 ppm. No other precipitating agents are used in the facility and calcium hydroxide is not added by hand. However, even if too much, or the wrong precipitating agent were added, there would be insufficient uranium in the tank for criticality to be possible. Processes downstream of the Neutralization Tank up to and including the lagoons also consist of unfavorable geometry, but based on the nature of the upstream process and upstream sampling controls on concentration, the staff agrees with the licensee’s determination that the risk of criticality in the HF Neutralization Facility is negligible. The uranium concentration throughout the facility is thousands of times smaller than the minimum critical concentration, which is subcritical for an infinite system. There are no credible chemical mechanisms for concentrating the uranium to the extent needed for criticality to be possible. In addition, with the implementation of upstream controls, the amount of uranium in the tank is insufficient for criticality even if concentrated in the most reactive heterogeneous configuration. Multiple process upsets would have to occur upstream to accumulate significant quantities of uranium in the HF Neutralization Facility and associated lagoons. Based on the foregoing, the staff has reasonable assurance that the risk of criticality in these areas is negligible.

The second example involves the Aeration Basin, pH Adjustment Tank, and Process Lagoon Area. Waste streams entering the rad waste system are limited to a few grams per liter and are subsequently reduced by chemical treatment, filtration, and dilution with non-rad liquid waste to less than 5 ppm, as confirmed by daily sampling for environmental control. Historical sampling of the pH Adjustment Tank and Process Lagoons indicate a low uranium concentration and an uncredited high concentration of neutron absorbing materials. No chemical processing is done that would lead to concentrating uranium in the rad waste sludge. As with the HF Neutralization Facility, the uranium concentration in the rad waste system is thousands of time smaller than the minimum critical concentration. While the staff did not review a detailed analysis for these areas, they appear to meet the criteria for concluding that the risk of criticality in these areas is negligible.

CONCLUSION

The staff has determined that an exemption from the requirements for a criticality monitoring and alarm system under 10 CFR 70.24 is warranted in areas in which the risk of criticality is negligible such that no credible criticality accident sequences have been identified. In such areas there is no benefit to having an alarm system and its installation may actually result in a net increase in risk to workers. Based on the two examples provided, the staff has reasonable assurance that the licensee will properly apply the exemption criterion. In accordance with 10 CFR 70.17, the staff concludes that the requested exemption is authorized by law, that it will not endanger life or property or the common defense and security, and that for the reasons stated above it is otherwise in the public interest.

PRINCIPAL CONTRIBUTORS

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