RAI Volume 2, Chapter 2.1.1.7, Ninth Set, Number 1:

> Provide the technical basis for using a water-based fire-suppression system (SAR Section 1.4.3.2.1.2) in areas where there are potential nuclear criticality concerns in waste handling facilities. In addition, confirm that compliance with NFPA 13 and NFPA 72 design requirements will achieve the desired probability threshold against spurious actuation specified in SAR Table 1.4.3-2.
>
> In SAR Section 1.4.3.2.1.2, the applicant has stated that water-based fire-suppression system will be used in the surface facilities, including the WHF, where spent nuclear fuel will be handled. In addition, portions of the system will be ITS and will have double-interlock pre-action features to minimize inadvertent actuation. It is not clear how the applicant has addressed a criticality concern posed by this system (Section 4.9.1.13.7 of BSC 2007, Project Design Criteria Document), such as fresh water dilution of the WHF borated pool. This information is needed to assess compliance with 10 CFR 63.112(e)(9).

1. RESPONSE

The criticality safety analysis described in SAR Section 1.14 concludes that moderator control is required for dry operations throughout the geologic repository operations area (GROA) such that no event sequence with a mean probability greater than 1×10^{-4} for the preclosure period shall result in moderator intrusion inside spent nuclear fuel (SNF) canisters. The presence of water outside of sealed canisters or in between canisters does not result in criticality potential (SAR Sections 1.14.2.3.2.1.4 and 1.14.2.3.2.3.4). Therefore, actuation of the water-based fire suppression system, inadvertent or caused by a fire, does not result in criticality potential without concurrent or sequential SNF canister breach.

A water-based double-interlocked preaction fire suppression system is included in the design of the waste handling areas of the Canister Receipt and Closure Facilities (CRCFs), the Receipt Facility (RF), the Initial Handling Facility (IHF), and the Wet Handling Facility (WHF). The fire suppression system is designated as important to safety (ITS) only in the CRCF and the WHF with design criteria to achieve an inadvertent actuation reliability requirement of 1×10^{-6} and 6×10^{-7}, respectively, over a 720-hour period following a breach of an SNF canister. This reliability requirement is conservatively based on industry experience associated with frequency of sprinkler head failure. The details of the fire suppression reliability analysis are provided in Section 6.2.2.9.1 of *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis* (BSC 2008a). Consistent with standard industry practice, the double-interlocked preaction fire suppression system will be designed and installed according to NFPA standards, including NFPA 13 and NFPA 72. Therefore, the reliability of these systems and associated components will be consistent with industry experience.

There are no event sequences with a mean probability greater than 1×10^{-4} for the preclosure period that result in a canister breach in the RF and the IHF (SAR Tables 1.7-7 through 1.7-10). In these facilities, sufficient moderator control is provided by the SNF canisters, associated casks, waste packages and overpacks, as well as handling equipment, without reliance on

controlling the availability of moderator from the fire suppression system. Therefore, the fire suppression system is not designated as ITS in the IHF and the RF.

For operations in the CRCF, the mean probability of the limiting event sequence that results in an SNF canister breach is 1×10^{-4}, which is the Category 2 screening threshold (SAR Tables 1.7-11 and 1.7-12). Taking into account the availability of moderator and for that moderator to enter a breached canister, the mean probability of the limiting event sequence that results in failure to control moderator is 1.18×10^{-8} for the CRCFs (BSC 2008a, Table G-4). This probability is approximately four orders of magnitude lower than the Category 2 screening criterion.

For dry operations in the WHF, the mean probability of the limiting event sequence that results in an SNF canister breach is 9×10^{-3} (SAR Tables 1.7-13 and 1.7-14). Taking into account the availability of moderator and for that moderator to enter a breached canister, the mean probability of the limiting event sequence resulting in failure to control moderator is 2.09×10^{-7} for the WHF (BSC 2008b, Table G-4). This probability is approximately three orders of magnitude lower than the Category 2 screening criterion.

For wet operations in the WHF, soluble boron is relied upon to ensure that criticality safety is maintained. The minimum required boron concentration in the WHF pool is 2,500 mg/l of boron enriched to 90 atom % in ^{10}B. As described in the response to RAI 2.2.1.1.3-3-020, criticality safety is maintained while crediting no more than 15% of the minimum required boron concentration for normal operations and 40% of the minimum required boron concentration for end-states of event sequences.

As shown in SAR Figure 1.4.3-8, there is no fire suppression coverage over the pool, and drains will divert fire suppression water away from the pool. Nonetheless, if fire suppression water were to drain into the pool, the maximum non-borated water volume that could dilute the pool water would be limited to the freeboard volume of approximately 137,000 gallons. This volume is based on four feet of freeboard in the pool at the normal operation height, and pool areal dimensions of 75 ft x 61 ft (BSC 2008c, Section 6.4.9). The borated water volume in the WHF pool is 1.44 million gallons (BSC 2008c, Section 6.1.1). Even under conditions that result in the entire volume of freeboard in the pool being filled with non-borated water (i.e., 137,000 gallons), the resulting boron concentration fraction would be greater than 90%. This dilution level is the ratio of the normal borated water volume (1.44 million gallons) to the sum of the borated and non-borated water volumes (1.58 million gallons). In addition, even if the entire volume of water available to the fire suppression system of 1.2 million gallons, as described in SAR Section 1.4.3.2.1.1, were to hypothetically drain into the pool, the resulting boron concentration fraction would remain greater than 50%. This dilution level is the ratio of the normal borated water volume (1.44 million gallons) to the sum of the borated and non-borated water volumes (2.64 million gallons).

In summary, based on a conservative reliability evaluation of the double-interlocked preaction fire suppression system, event sequences that impact criticality control parameters (i.e., moderator control and soluble boron concentration) are screened out with significant margin.

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2008a. *Canister Receipt and Closure Facility Reliability and Event Sequence Categorization Analysis*. 060-PSA-CR00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080311.0031.

BSC 2008b. *Wet Handling Facility Reliability and Event Sequence Categorization Analysis.* 050-PSA-WH00-00200-000-00A. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080312.0033.

BSC (Bechtel SAIC Company) 2008c. *Pool Water Treatment and Cooling System.* 050-M0C-PW00-00100-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080212.0002; ENG.20080528.0001; ENG.20080630.0015.

RAI Volume 2, Chapter 2.1.1.7, Ninth Set, Number 2:

> Describe the Important to Safety (ITS) functions of the two detectors labeled as AE (non-flow through type detectors) shown as ITS in SAR Figure 1.4.3-21. This information is needed to assess compliance with 10 CFR 63.112(e)(9).

1. RESPONSE

The two detectors labeled as AE on SAR Figure 1.4.3-21 (Typical Double-Interlocked Preaction Sprinkler Arrangement) are flame detectors that provide the redundant, positive action logic to actuate the double-interlocked preaction sprinklers. The important to safety (ITS) function of these detectors is to detect an actual fire, thus reducing the probability of inadvertent actuation of the sprinkler system.

As discussed in the May 12, 2009, clarification call, the quantity of detectors shown is representative; the actual number will vary depending on the size of the protection area. Additional information about double-interlock preaction sprinkler systems with ITS features and where they are used can be found in the fire hazards analyses for the Canister Receipt and Closure Facility (BSC 2007) and the Wet Handling Facility (BSC 2008).

2. COMMITMENTS TO NRC

None.

3. DESCRIPTION OF PROPOSED LA CHANGE

None.

4. REFERENCES

BSC (Bechtel SAIC Company) 2007. *Canister Receipt and Closure Facility 1 Fire Hazard Analysis*. 060-M0A-FP00-00100-000-00B. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20071129.0032.

BSC 2008. *Wet Handling Facility Fire Hazard Analysis*. 050-M0A-FP00-00100-000-00C. Las Vegas, Nevada: Bechtel SAIC Company. ACC: ENG.20080213.0001.