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NUREG-1567

Standard Review Plan
for Spent Fuel Dry Storage Facilities

Final Report

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NUCLEAR REGULATORY COMMISSION

Docket No. 72-22 Official Exh. No. Staff 53

In the matter of Private Fuel Storage

Staff ✓

Applicant

Intervenor

Cont'g Off'r

Contractor

Other

IDENTIFIED ✓

RECEIVED ✓

REJECTED

DATE 6-24-02

Witness Waters

Reporter R. DAVIS / J. YBESN

9.5.2.1 Identification of Release Events

The reviewer should discuss the proposed design and operations with other reviewers (e.g., structural, operations, site characteristics, etc.) to determine spectrum of events that need to be considered for the specific design and specific site. The discussions should focus on the physical condition of the confinement systems for normal operations and anticipated occurrences, and for design basis accidents. The confinement analyst should use these discussions to understand (a) the physical condition of the equipment that might serve to contain radionuclides, and (b) the forces (physical displacement, pressure differences, temperatures, etc.) that could move radionuclides into the accessible environment if the confinement system fails. The reviewer should categorize the selected events as either (a) normal operations and anticipated occurrences, or (b) design basis accidents. The reviewer-identified scenarios may be more extensive than those presented by the applicant. A specific scenario can be dismissed if the staff reviewer determines that it is less severe that another scenario being considered within the category (i.e., normal operations and anticipated occurrences or design basis accidents).

9.5.2.2 Evaluation of Release Estimates

For each of the scenarios identified and retained in the previous step, the reviewer should either (a) review the applicant's release estimate and determine that applicant's estimate is reasonable, or (b) develop independent estimates and compare them with that provided by the applicant. The method of checking or developing independent release estimates depends (as described below) on the whether the system is designed to be a sealed system and whether the design has been previously reviewed and approved by the NRC staff as part of a certification process. In preparing or reviewing the estimate, the reviewer should identify all radioactive isotopes present in the fuel or waste.

If the design is a sealed system that has not been previously certified, the confinement evaluation reviewer should discuss with the structural reviewer the response of the sealed system (primary containment system). This discussion should determine the response to the structural loads that would occur under the scenario. This discussion should result in an understanding of whether there will be any loss of containment integrity. The discussion should also result in an understanding of any forces or effects that would either promote or impede movement of radionuclides out of primary containment system. For each scenario identified and retained in step 1, the confinement evaluation reviewer should then either determine that the applicant's estimate of radionuclides released to the environment is reasonable, or develop the reviewer's own estimate of release amounts. The confinement evaluation reviewer may find the information in NUREG-1536 and applicable ISGs of value when evaluating release quantity from a low-pressure, gas-filled spent fuel canister.

If the design involves a sealed cask that has been previously certified, the confinement evaluation reviewer should review the information in the certification SER. For each scenario identified and retained in step 1, the confinement evaluation reviewer should use the information from the certification SER to either determine that the applicant's estimate of radionuclides released to the environment is reasonable, or develop the reviewer's own estimate of release amounts.

For a given organ, the total organ dose equivalent, $TODE = \sum CDE_i + \sum DDE_i$

The total skin dose equivalent $SDE = \sum SDE_i$

Compliance with the lens dose equivalent (LDE) limit is achieved if the sum of the SDE and the TEDE do not exceed 0.15 Sv (15 rem). This approach is consistent with guidance in ICRP-26.

In general, the staff should evaluate the applicants analyses for normal, off-normal, and accident conditions.

Normal Conditions

For normal conditions, a bounding exposure duration assumes that an individual is present at the controlled area boundary for one full year (8760 hours). An alternative exposure duration may be considered by the staff if the applicant provides justification.

Because any potential release, resulting from seal leakage, would typically occur over a substantial period of time, the staff accepts (for applications for certificates) calculation of the atmospheric dispersion factors (χ/Q) according to Regulatory Guide 1.145 assuming D-stability diffusion and a wind speed of 5 m/s.

For the likely case of an ISFSI with multiple casks, the doses need to be assessed for a hypothetical array of casks during normal conditions. Therefore, the staff anticipates that the resulting doses from a single cask will be a small fraction of the limits prescribed in 10 CFR 72.104(a) to accommodate the array and the external direct dose.

Note: If the region between redundant, confinement boundary, mechanical seals is maintained at a pressure greater than the cask cavity, the monitoring system boundaries are tested to a leakage rate equal to the confinement boundary, and the seal pressure is routinely checked and instrumentation is verified to be operable in accordance with a Technical Specification Surveillance Requirement, then the staff has accepted that no discernible leakage is credible. Therefore, calculations of dose to the whole body, thyroid, and critical organs at the controlled area boundary from atmospheric releases during normal conditions would not be required for normal conditions.

Off-normal Conditions

For off-normal conditions, the bounding exposure duration and atmospheric dispersion factors (χ/Q) are the same as those discussed above for normal conditions.

To demonstrate compliance with 10 CFR 72.104(a), the staff accepts whole body, thyroid, and critical organ dose calculations for releases from a single cask. However, the dose contribution from cask leakage should also be a fraction of the limits specified in 10 CFR 72.104(a) since the doses from other radiation sources are added to this contribution.

Accident Conditions

For hypothetical accident conditions, the duration of the release is assumed to be 30 days (720 hours). A bounding exposure duration assumes that an individual is also present at the controlled area boundary for 30 days. This time period is the same as that used to demonstrate compliance with 10 CFR 100 for reactor facilities licensed per 10 CFR 50 and provides good defense in depth since recovery actions to limit releases are not expected to exceed 30 days.

For hypothetical accidents conditions, the staff has accepted calculation of the atmospheric dispersion factors (χ/Q) of Regulatory Guide 1.145 or Regulatory Guide 1.25 on the basis of F-stability diffusion, and a wind speed of 1 m/s.

To demonstrate compliance with 10 CFR 72.106(b), the staff accepts whole body, thyroid, critical organ, and skin dose calculations for releases of radionuclides from a single cask.

The reviewer should ensure that all supportive information or documentation has been provided or is readily available. This includes, but is not limited to, justification of assumptions or analytical procedures, test results, photographs, computer program descriptions, input and output, and applicable pages from referenced documents. Reviewers should request any additional information needed to complete the review.

9.5.3 Confinement Monitoring

9.5.3.1 Confinement Casks or Systems

If applicable, assess the seals used to provide closure. Because of the performance requirements over the 20-year license period, evaluate the potential for deterioration. The NRC staff has previously accepted only metallic seals for the primary confinement. Coordinate with the thermal reviewers to ensure that the operational temperature range for the seals, specified by the manufacturer, will not be exceeded.

The NRC staff has found that casks closed entirely by welding do not require seal monitoring. However, for casks with bolted closures, the staff has found that a seal monitoring system has been needed to adequately demonstrate that seals can function and maintain a helium atmosphere in the cask for the 20-year license period. A seal monitoring system combined with periodic surveillance enables the licensee to determine when to take corrective action to maintain safe storage conditions. (Note that some fuel designs may not require an inert atmosphere in the cask. In such designs, a periodic surveillance program to check seal leak tightness may be appropriate.)

Although the details of the monitoring system may vary, the general design approach has been to pressurize the region between the redundant seals, with a non-reactive gas, to a pressure greater than that of the cask cavity and the atmosphere. The monitoring system is leakage tested to the same leak rate as the confinement boundary. Installed instrumentation is routinely checked per surveillance requirements. A decrease in pressure between these seals indicates that the

15 ACCIDENT ANALYSIS

15.1 Review Objective

The objective of this chapter is to provide guidance to the staff for a systematic evaluation of the applicant's identification and analysis of hazards for both off-normal and accident or design basis events involving structures, systems, and components (SSCs) important to safety.

Off-normal events are those expected to occur with moderate frequency or once per calendar year. ANSI/ANS 57.9 refers to these events as Design Event II.

Accident events are considered to occur infrequently, if ever, during the lifetime of the facility. ANSI/ANS 57.9 subdivides this class of accidents into Design Event III, a set of infrequent events that could be expected to occur during the lifetime of the ISFSI, and Design Event IV, events that are postulated because they establish a conservative design basis for SSCs important to safety. For purposes of this chapter of the Facilities Standard Review Plan (FSRP), no distinction is made between these two classes of events. The effects of natural phenomena, such as earthquakes, tornadoes, hurricanes, floods, tsunami, and seiches, are considered to be accident events.

A minimum list of events to be considered is in Section 15.2.

The interrelationship between the accident analysis review and other areas of review is illustrated in Figure 15.1. The figure shows that the evaluation draws on information in the application as well as results of other technical reviews. The figure also shows that the results of this review are used in other technical reviews.

15.2 Areas of Review

The following outline provides a minimum list of accident scenarios to be analyzed. The acceptance criteria for those events are in Section 15.4, and the review procedure for those events are in Section 15.5.

15.2.1 Off-Normal Events

- 15.2.1.1 Cask Drop less than Design Allowable Height
- 15.2.1.2 Partial Vent Blockage (if applicable)
- 15.2.1.3 Operational Events
- 15.2.1.4 Off-normal Ambient Temperatures
- 15.2.1.5 Off-normal Events Associated with Pool Facilities

Table 15.1 Relationship of Regulations and Areas of Review

Areas of Review	10 CFR Part 72 Regulations										
	72.24	72.90	72.92	72.94	72.104	72.106	72.122	72.124	72.126	72.128	72.236
Off-Normal Events	•	•	•	•	•	•	•	•	•	•	•
Accidents	•	•	•	•		•	•	•	•	•	•
Other Non-Specified Accidents	•					•	•	•	•	•	•

Criticality

10 CFR 72.124(a) and 72.236(c) require that the spent fuel must be maintained in a subcritical condition (i.e., k_{eff} equal to or less that 0.95) under credible conditions. At least two unlikely, independent and concurrent or sequential changes must be postulated to occur in the conditions essential to nuclear criticality safety before a nuclear criticality accident is possible (double contingency).

Confinement

10 CFR 72.128(a)(3) and 72.236(d) and (l) require that the systems important to safety must be evaluated, using appropriate tests or by other means acceptable to the Commission, to demonstrate that they will reasonably keep radioactive material confined under credible accident conditions. A breach of a confinement barrier is not acceptable for any accident event. A confinement system is defined in 10 CFR 72.3 as a system, including ventilation, that acts as a barrier between areas containing radioactive substances and the environment.

Retrievability

10 CFR 72.122(l) requires that ISFSI storage systems allow ready retrieval of the stored spent fuel or high-level waste for normal and off-normal design conditions. Retrievability is the capability of returning the stored radioactive material to a safe condition without endangering public health and safety or causing additional exposure to workers. Any potential release of radioactive materials during retrieval operations must not exceed the radioactive exposure limits in 10 CFR Part 20 or 10 CFR 72.122(h).

Instrumentation

10 CFR 72.122(h) through (j) and 72.128(a)(1) require that the SAR identify all instruments and control systems that must remain operational under accident conditions.