Application of Hazard Assessment Techniques in the CISF Design Process

October 29, 1997

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Introduction

The Department of Energy has submitted to the NRC staff for review a topical safety analysis report (TSAR) for a Centralized Interim Storage Facility (CISF). The TSAR will be used in licensing the CISF when and if a site is designated. CISF design events are identified based on thorough review of design-basis events (DBEs) previously identified by dry storage system suppliers and licensees and through the application of hazard assessment techniques. A Preliminary Hazards Assessment (PHA) is performed to identify design events applicable to a Phase I non-site-specific CISF. A PHA is deemed necessary since the Phase I CISF is distinguishable from previous dry store applications in several significant operational scope and design basis aspects. In addition to assuring all design events applicable to the Phase I CISF are identified, the PHA served as an integral part of the CISF design process by identifying potential important-to-safety and defense-in-depth facility design and administrative control features. This paper describes the Phase I CISF design event identification process and summarizes significant PHA contributions to the CISF design.

Reference Dry Storage System Design Events

Events considered for further analysis include DBEs associated with light water reactor SNL dry storage facilities previously identified in industry and regulatory documents, as well as commercial storage system and facility safety analysis reports (SARs). Based on a thorough review of the reference documents, a comprehensive list of events potentially applicable to the Phase I CISF is developed. This list includes over 60 potential events, including natural phenomena, industrial accidents, fires and dry storage system specific related events. Guidance provided in the Probabilistic Risk Assessments Guide is used to develop screening criteria which are applied to determine the significant events which require further detailed analysis and which may be required as a CISF design input. A total of 22 events are identified by the reference system review. DBEs
determined to be potentially applicable to the Phase I CISF include natural phenomena events and other system specific events identified in reference system SARs and regulatory documents such as cask tipover, failure of instrumentation, and canister misalignment.

**Preliminary Hazards Assessment**

It is recognized that the Phase I CISF design effort requires special attention in areas which may not have been reviewed previously in SNF dry store applications. Relatively bounding generic site characteristics, transportation cask receipt operations, large number of operations and storage units and the lack of onsite bare fuel transfer capability are issues identified as somewhat unique to the Phase I CISF design effort and may not have been addressed previously in reference system safety evaluations. Therefore, in addition to the reference dry storage system design event review, a PHA is performed to ensure that all credible accident and off-normal events applicable to the Phase I CISF have been identified. Systematic hazard analysis techniques are employed to provide reasonable assurance that all possible off-normal and accident-level events are identified and appropriately evaluated and considered as part of the facility design process.

The PHA is performed in a two-step process of hazard identification and hazard evaluation. Hazard identification is the process of highlighting material, system, process and facility characteristics having the potential for initiating accidents with undesirable consequences. The hazard identification process requires a thorough understanding of facility design features, design criteria and operational process flow. Two approaches are utilized in identification of Phase I CISF potential hazards. The first approach for hazard identification involves examining detailed step by step descriptions of every operation to evaluate the impact of static performance of structures, systems and components (SSCs) on safety. The second approach for hazard identification is to evaluate SSCs when detailed process flow descriptions are not available (i.e., support SSCs). This review process involves an examination of support subsystems or areas in order
to identify potential hazards in the form of energy sources (e.g., chemical), which could directly or indirectly initiate off-normal or accident-level events with nuclear safety implications. Energy sources are identified within each subsystem for review as potential event initiators. Natural phenomena events which may affect the operability of the subsystems themselves, or which may initiate events involving interaction with important-to-safety SSCs, are also evaluated.

Hazard evaluation constitutes the primary focal point of the PHA. The purpose of the hazard evaluation is to identify significant events that require further evaluation for determination of risk acceptance, and to help identify facility design features or operational administrative controls which can significantly enhance facility safety. A preliminary qualitative evaluation is performed for each identified event by identifying potential causes and consequences for each hazard event. Events are identified for further evaluation if important-to-safety design functions are potentially affected (i.e., criticality control, SNF confinement, radiation protection, SNF retrievability, thermal).

Hazard evaluation measures overall safety significance based on a combined qualitative measure of event frequency and consequence. This qualitative measure is used to screen low probability and/or inconsequential events from further detailed evaluation. Design events identified by the Phase I CISF PHA for further evaluation which may not have been previously reviewed by independent SNI storage facility regulatory authorities, or may be beyond the scope of previous reviews, include radiological release during transportation package lid removal in Phase I CISI receiving areas, and a limited number of dry storage system specific transportation cask lid drop and vertical transfer system load drop events.

Design and Administrative Control Features

Hazard evaluation is performed without taking credit for Phase I CISI design features or administrative controls prior to the screening process. However, another primary function of the
hazard evaluation process is identifying potential important-to-safety and defense-in-depth facility design and administrative control features with nuclear safety relevance for subsequent consideration in the design process.

Conclusion

Hazard assessment techniques have been successfully applied in the Phase I CISF design process. In conjunction with a thorough review of previous SNF dry store applications and associated reference documents, the PHA assures all credible accidents and off-normal events applicable to the CISF have been identified. The PHA was also useful in identifying Phase I CISF important-to-safety and defense-in-depth design and operational control features as an integral part of the design process.

References

