

ISA Treatment of NPH

Purpose

This paper provides the basis for industry's fuel cycle licensees' treatment of natural phenomena hazards (NPH). The relevant regulation (10CFR70 Subpart H) was established, in part, to assure that workers and the general public are adequately protected from the hazards inherent with fuel cycle facilities, including NPH. To comply with this regulation, fuel cycle licensees have informed the NRC, by means of the ISAs, of the risks associated with licensed facilities relative to NPH, and those same documents have shown that the risks to workers and the general public are acceptable.

Despite the recent moves toward probabilistic approaches by 10CFR50 commercial reactor licensees (i.e., quantitative risk assessment), the regulations in 10CFR70, coupled with the regulatory guidance in NUREG-1520, acknowledge that many NPH are hard to define quantitatively and allow these risks to be assessed deterministically. In fact the majority of 10CFR70 licensees have used risk indexing (a qualitative or semi-quantitative approach) to deal with internal facility hazards, while deterministic methods are used to address NPH.

Justification

Section 70.62(c)(1)(iv) requires that each application for a license to possess and use special nuclear material identify "potential accident sequences caused by process deviations...and credible external events, including natural phenomena." However, there is no requirement in the regulations or statements in the applicable NRC guidance documents that the natural phenomena to be protected against must be a "Highly Unlikely" NPH event (ranging from 10^{-4} to 10^{-5} depending on the licensed facility's definition of highly unlikely and the methodology used in the analysis).

Section 70.64(a)(2) Natural phenomena hazards, states that "the (facility) design must provide for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site." This requirement is applicable to new facilities and new processes at existing facilities. It provides for the characterization of natural phenomena severity based on documented historic data and not a probabilistic approach. This is important in two respects: 1) the regulation focuses on a historical basis; and 2) the clause "for the site" gives rise to a reasonable inference that the scope of historical events is to be limited to the more specific location.

The NRC provides additional guidance relative to natural phenomena in several guidance documents, including NUREG-1520 Revision 1, and NUREG-1513. Excerpts from NUREG-1520 discussing the selection of NPH events clearly indicate that design-basis NPH be identified and evaluated, and "Appendix D discusses acceptable ways for the ISA to address natural phenomena." [NUREG-1520, Revision 1, page 3-24] Appendix D acknowledges that "for natural phenomena, deterministically defined events... can also be applied to 10 CFR Part 70 facilities as "highly unlikely" events. The actual probability (or likelihood) of such events may be difficult to define quantitatively and varies from site to site." [NUREG-1520, Revision 1, Appendix D to Chapter 3, page 3-D-1, footnote 1]

NUREG-1520 provides Regulatory Acceptance Criteria for the review of a license application and ISA Summary. The guidance states that the NRC reviewer should find the applicants site description acceptable if it includes natural phenomena and the “applicant presents appropriate design-basis values for lightning, high winds, tornado, hurricane, and other severe weather conditions that are applicable to the site.” [NUREG-1520, Revision 1, Section 1.3.4.3, page 1-11]

NUREG-1520 outlines the Regulatory Acceptance Criteria for the ISA Summary, which includes criteria for the characterization of natural phenomena. NUREG-1520 states “the description in the ISA Summary of the site for processing nuclear material is considered acceptable if the applicant includes, or references, the following safety-related information, with emphasis on those factors that could affect safety”: “Characterization of natural phenomena (e.g., tornadoes, hurricanes, floods, and earthquakes) and other external events sufficient to allow assessment of their impact on facility safety and their likelihood of occurrence. At a minimum, the 100-year flood should be postulated, consistent with U.S. Army Corps of Engineers flood plain maps. The applicant should also provide earthquake accelerations for the site associated with a 250-year and 500-year earthquake. The discussion should identify all design-basis natural events for the facility, indicate which events are considered incredible, and describe the basis for that determination. The assessment should also indicate which events could occur without adversely impacting safety.” [NUREG-1520, Revision 1, Section 3.4.3.2 (1) c]

The NRC’s acceptance criteria for the ISA Summary do not require that the natural phenomena events characterized in the ISA Summary (and used in the ISA) be equal to a highly unlikely event. In fact, the above examples of the minimum data to be provided equates to frequencies of 10⁻² for floods, and 4 x 10⁻³ and 2 x 10⁻³, respectively, for the 250- and 500-year earthquakes.

In addition to the NRC’s approval of the AREVA Horn Rapids Road (HRR) facility’s use of the most severe documented historic data to characterize NPH events in its ISA, the agency has also approved this same approach at other facilities. For example, several of the NPH events the NRC accepted for General Electric-Hitachi (GE-H) Global Laser Enrichment (GLE) were based on the most severe documented historic data for that area and were more frequent than an event with a Highly Unlikely frequency (10⁻⁵ for GLE). These NPH events included severe weather associated with rainfall, snow, and temperature extremes. [NUREG-2120, Safety Evaluation Report for the General Electric-Hitachi Global Laser Enrichment LLC Laser-Based Uranium Enrichment Plant in Wilmington, North Carolina]

The Technical Evaluation Report issued for Westinghouse’s ISA summary approval (NRC letter August 20, 2007) provides yet another example where the NRC has accepted most severe documented historic data for the site approach.

“Richland County is located in central South Carolina. The climate is temperate with moderate rainfall and winds. Severe weather occurs in the form of thunderstorms and tornadoes. In the Columbia area, thunderstorms occur on average of 53 days per year, with the majority occurring in summer months. Tornadoes average 11 per year in the state of

South Carolina. WEC estimates the mean recurrence interval for a tornado in any location within Richland County to be one in a 700-year recurrence frequency. In response to an RAI, WEC estimated that the probability of a tornado strike to the CFFF building is approximately 5×10^{-4} , therefore, a tornado strike to the CFFF building is an unlikely event. WEC made this estimation using the information provided in NUREG/CR-4461. NUREG/CR-4461 suggests that the maximum wind speed of a tornado, with an annual probability of 10^{-4} for the eastern United States, is approximately 129km/h [80 mph] with a 90% confidence interval. This wind speed is smaller than the 145 km/h [90 mph] design basis wind speed. Consequently, the NRC staff determines that the potential for a tornado to damage the CFFF is highly unlikely. Most hurricanes affect only the coastal areas of South Carolina, and the CFFF is located approximately 160 km [100 miles] from the South Carolina coast.”

Another example of the NRC accepting design-basis natural events that do not require meeting “highly unlikely” (i.e., a 10^{-4} to 10^{-5} NPH event frequency of occurrence) is the licensing-basis NPH analyses for the Nuclear Fuel Services facility in Erwin, Tennessee. The NRC recently issued an inspection report describing a review the inspectors performed of licensing basis documents and the safety analysis to determine the facility design and licensing bases as they related to natural phenomena hazards (NPHs). Specifically, the inspectors evaluated the following hazards: earthquakes, high winds, flooding, and extended loss of power and water. The licensing-basis natural events described in the inspection report (70-143/2012-006 dated April 30, 2012) were less severe, and more frequent than an event with the aforementioned definition of a “highly unlikely” frequency. For example, a 100-year flood and an earthquake with a 1000-year return period were reviewed. This approach was approved by the NRC during the licensing of the BLEU Complex facilities in 2003 and 2004, and provided the basis for the example in the Annex to Appendix D of NUREG-1520 (originally contained in ISG-08). [NUREG-1520, Revision 1, Chapter 3, Annex to Appendix D]

Design-basis and Licensing-basis Events

In the NRC guidance documents, the term “design-basis” is routinely used when discussing natural events. Design-basis natural events are those events that a facility is designed to withstand, and therefore, will not be adversely impacted by the natural event. The design-basis event (e.g., maximum wind speed or maximum snow loading) provides design criteria to which the building is constructed. When NUREG-1520 states that the design-basis natural events for a facility be identified, it means those events that the building is designed to withstand with no significant structural damage.

When NUREG-1520 discusses natural phenomena for existing facilities, it states that they are not required to meet 10 CFR 70.64 baseline design criteria which include the requirement that the facility design provide for adequate protection against natural phenomena with consideration of the most severe documented historical events for the site. In general, existing facilities were constructed to the relevant local building code in effect at the time of construction which, in the absence of more stringent design bases, becomes the default design-basis natural events identified for the site. The actual demonstration of meeting the design-basis for older facilities is sometimes

difficult to obtain. Therefore, the term design-basis natural event is not accurate terminology for existing facilities. Perhaps a better, more accurate term to describe the natural events for existing facilities is "licensing-basis" natural events.

For example although some of the primary process buildings at a facility's site may have more stringent design bases, the licensing-basis natural phenomena events are those events applicable to the site which are based on the most severe, documented historical data, or the adverse environmental conditions to the limits of the building code. Some of the licensing-basis natural phenomena events applicable to the facility sites have already been reviewed and approved by the NRC in earlier licensing submittals. One specific example of this is the AREVA HRR licensing commitment with regard to the environmental conditions that the facilities can withstand (i.e., the licensing-basis events) are defined in Section 1.3.5 of the facility license, SNM-1227. Relative to seismic design, this commitment states:

"The UBC Seismic Risk Map places the AREVA NP site within Seismic Zone 2B. The UBC for this seismic zone requires structures to be able to withstand peak ground acceleration (PGA) of 0.20g. The AREVA NP Richland facility plant structures are designed to withstand this level of earthquake acceleration with no significant structural damage. As such, the buildings will withstand acceleration associated with a Seismic Zone 2B event without experiencing a loss of geometry control provided by the facility design."

Demonstration that NPH Event Sequences Meet 10 CFR 70.61

Once the licensing-basis NPH for the facility have been identified, the ISA must evaluate credible accident sequences that may be initiated by these NPH events and ensure the performance requirements of 10 CFR 70.61 are satisfied. Attachment 2 illustrates how the decision process for this determination is made.

If a facility is constructed to a building code design criteria such that it can withstand a licensing-basis NPH event (with some margin of safety), then the performance requirements of 10 CFR 70.61 have been met. For example, if the building structure remains intact, the only potential consequences of concern as defined in 10CFR 70 which could potentially occur are loss of containment or spacing (criticality) type events. Such loss of containment or spacing events are often prevented by the facility design or are frequently bounded by the initiating events documented in the ISA that occur more frequently than these types of NPH events.

A specific example follows. If the Ice/Snow NPH event equates to a roof snow load of 20 PSF, and the roof is constructed to a building code that specifies a 25 PSF load, then the building roof can withstand the load from the severe weather event. A licensing-basis snow load event leading to roof collapse for this example would then be equivalent to and categorized as "highly unlikely". If on the other hand, the building code specifies a roof loading of 20 PSF, the licensing-basis NPH event is close to or equivalent to what the roof can withstand. Potential collapse of the roof would need to be carefully evaluated to assure that collapse would be equivalent to highly unlikely, and if not, the establishment of IROFS is necessary to meet the performance requirements of 10CFR70.61.

AREVA's current NRC approved ISA Summary contains the following statement and reference which are tantamount to an endorsement of this position by the NRC:

7.1 External Hazards

This section covers both natural phenomena and man-made hazards external to the facility that could impact on-site activities.

7.1.1 Potentially Hazardous Natural Phenomena

This section discusses the natural phenomena that could potentially impact the AREVA Richland Facility. Consistent with the guidelines provided by the NRC on the impact of natural phenomena on Category 1 and 3 uranium processing facilities, AREVA has used standard or uniform building codes, as applicable, to establish the threshold for highly unlikely initiating event frequency¹. In other words, the natural phenomena discussed in this section that are of such a magnitude so as to exceed the building code-based facility design basis are considered highly unlikely.

In accordance with AREVA's established emergency plan under highly unusual circumstances, the AREVA emergency response organization in conjunction with municipal authorities will evacuate the facility and surrounding areas and restrict public access as necessary to minimize risk to workers and the public.

¹ NRC memorandum from Patrick Castleman, "Meeting Summary of the NRC/NEI-Sponsored Workshop on Integrated Safety Analysis, September 23 and 24, 2003," dated October 15, 2003.

In accordance with existing regulations and NRC guidance documents, NPH events more severe than the licensing-basis events defined in the facility license or ISA are not required to be evaluated. NPH events that are more severe than the licensing-basis events are considered "beyond licensing-basis events". These events, if they occur, are handled by the relevant Emergency Preparedness programs. In the highly unlikely event that a facility experiences a beyond licensing basis event, the evacuation of non-essential workers and the general public will provide the needed mitigation.

The NRC is currently evaluating what action, if any, may be necessary for beyond licensing-basis NPH events at Part 70 facilities in response to the Tohoku-Taiheiyu-Oki Earthquake in Japan.

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