UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

September 6, 2013

MEMORANDUM TO: Sher Bahadur, Deputy Director
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

FROM: John B. Giessner, Acting Deputy Director ***/RA/***
Division of Reactor Safety
Region III

SUBJECT: TASK INTERFACE AGREEMENT – DESIGN SAFETY FUNCTION OF BRAIDWOOD STATION BLOCK WALLS FOR HELB AND SEISMIC LOADS (TIA 2013-01)

This Task Interface Agreement (TIA) documents the regulatory position as determined through consultation between staff from Region III and staff from the Office of Nuclear Reactor Regulation (NRR) regarding the design safety function of safety-related block walls at Braidwood Station with respect to seismic and High Energy Line Break (HELB) loads.

This TIA is submitted using the Concurrence Method as described in NRR Office Instruction COM-106, "Control of Task Interface Agreements," Revision 3.

Background

Safety-related block walls at Braidwood Station were previously evaluated for seismic loads in accordance with the Interim Criteria for Safety-Related Masonry Wall Evaluation provided in Attachment A to the Standard Review Plan (SRP) NUREG-0800, Section 3.8.4, "Other Category I Structures." The subject walls, consisting of 12" thick unreinforced hollow masonry units, are divisional separation walls in the auxiliary building required to maintain the fire and ventilation barrier function while not failing in a manner that would adversely affect safety-related equipment. An overload of the wall could result in structural elements, concrete blocks, steel columns, etc., impacting the safety-related equipment. These walls were assumed to span horizontally in the evaluations and steel columns were provided for additional support along the length of the walls as needed to limit the spans. The HELB analyses at the time did not identify any pressure loading on the walls resulting from postulated pipe breaks.

During turbine building HELB design basis reconstitution, the licensee identified the existence of pressure loading on certain auxiliary building safety-related block walls following postulated pipe break events. The pipe break scenario in the operability/functionality evaluation involved a pipe break in the turbine building which initially communicates with the auxiliary building rooms through open fire dampers. After a given time (200 seconds) as the temperature rises, one fire damper closes while the other fails to close (single active failure considered) resulting in a buildup of differential pressure across the wall separating the two rooms served by the dampers. The licensee performed a functionality evaluation for the subject walls to demonstrate that the

CONTACT: Vijay Meghani, DRS/Region III
(630) 829-9751

walls, while exceeding the design basis allowable stresses, would remain functional. The licensee's evaluation used higher allowable stresses based on the masonry test results documented in the Updated Final Safety Analysis Report (UFSAR).

Based on the evaluation, the licensee considered the walls to be functional but non-conforming and planned actions to return the walls to conformance through more refined analyses and/or field modifications. At this time, such planned actions have not been completed. The inspectors noted that in the functionality evaluation, the licensee did not consider the seismic loads acting concurrently with the pressure loading due to the pipe break. Although a functionality assessment is not necessarily expected to follow the SRP provisions, it should be noted that the design basis load combinations in the Braidwood Station UFSAR are consistent with SRP 3.8.4, Attachment A, "Interim Criteria for Safety-Related Masonry Wall Evaluation," dated July 1981. The Braidwood Station UFSAR requires consideration of the following load combinations:

1. $D + L + 1.5\ P_a$
2. $D + L + 1.25\ P_a + 1.25\ E$
3. $D + L + P_a + E'$

(D = dead load, L = Live loads, E = OBE, E' = SSE, P_a = Pipe break pressure load; Terms not applicable are omitted in the above load combinations)

In their evaluation, the licensee assumed that the seismic and HELB events start at the same time. However, based on the scenario considered, the HELB pressure build up does not start until 200 seconds after the event. Since the seismic event was evaluated as not lasting that long, the licensee concluded that it was not necessary to add the effects of seismic and the HELB loads. In addition, the licensee also concluded that it was not necessary to consider any load factors for the functionality evaluation. Consequently, the three load combinations noted above were reduced to the following load combinations:

- initial 30 seconds, as the seismic activity is assumed to end within 30 seconds and the HELB pressure is negligible during this period
  - $D + L + E'$ - this condition was previously evaluated in the original calculations

- After 200 seconds, the seismic activity has ended and the HELB pressure starts to build
  - $D + L + P_a$ - the functionality evaluation addressed this condition.

The licensee has not provided sufficient information to justify the use of a load factor of 1.0 for the HELB pressure considering the inherent uncertainty of the calculated value based on methodologies and inputs involved in such calculations.

The inspectors further noted that the masonry allowable tensile stress used in the licensee's evaluation was equal to the modulus of rupture value based on test data documented in the UFSAR, which was about 65 percent higher than the allowable stress for the design basis SSE load combination. By omitting the load factor and not considering combined effects of seismic and the HELB, the licensee also significantly reduced the design basis loads. The licensee's current evaluation showed very small margins, suggesting that applying a load factor of 1.25 or 1.5 to the pipe break pressure load, or combining a seismic event of much smaller intensity than an SSE or an OBE with HELB, could result in masonry tensile stresses exceeding the modulus of rupture of masonry.

While the licensee's analysis may be reasonable based on its assumptions regarding the timing of HELB and seismic events, there may be other scenarios with slightly different sequence of events that may not be bounded by the current evaluation. Specifically, the possibility of a seismic event, an initial event, or an aftershock, occurring after the HELB while the differential pressure still exists would subject the wall to combined effects. The inspectors further noted that while the probability of such occurrence could be very low, the current staff guidance precludes the use of probabilities in operability considerations. Specifically, Section C.6 of the Inspection Manual Part 9900 Technical Guidance states, in part, "*the definition of operability is that the SSC must be capable of performing its specified safety function or functions, which inherently assumes that the event occurs and that the safety function or functions can be performed. Therefore, the use of PRA or probabilities of occurrence of accidents or external events is not consistent with the assumption that the event occurs, and is not acceptable for making operability decisions.*" The inspectors also reviewed the licensee's procedure for operability determinations and found that it was consistent with Section C.6 in the NRC's Part 9900 guidance.

Based on the above, the inspector believed that the licensee should provide further technical justification for not adding together the effects of seismic and HELB pressure loading on the masonry walls and for using a load factor of 1.0 for HELB pressure.

Licensee's Position

During discussions, the licensee agreed with the inspectors that the design basis required combining the effects of seismic and HELB loads concurrently. However, regarding the functionality determination evaluation, the licensee's position is that the analysis was based on realistic assumptions and therefore justified. Similarly, the licensee claimed that the load combination considered in the evaluation without the load factors was sufficient to demonstrate a reasonable expectation that the block walls would be able to perform their safety function. In response to the inspector's question, the licensee provided the following:

> *"The scenario involves a very slow pressurization of the turbine building just under the 0.7 blowout panel pressure. The steam leak rate is in the range of 164 to 400 Lbm/sec. At this low steam flow rate, the steam temperature in the turbine building rises slowly until the fusible link setpoint is reached. Fire dampers in each elevation are heated at different rates. Dampers on the same elevation as the HELB heat up and close sooner and those farthest away take longer. As each of the dampers close, it shuts off a flow path and increases the turbine building pressure.* ***This time to reach the fusible link setpoint is what causes the delay in closure of the damper such that the seismic event at time zero causing the HELB is passed by the time the damper is closed.*** *At that time the fire damper closes which takes the isolated room to atmospheric pressure."*
>
> *"****This is consistent with the Standard Review Plan associated with masonry wall evaluations.*** *Standard Review Plan (SRP) 3.8.4, 'Other Seismic Category I Structures', clearly states Normal, Abnormal, and Environmental loads must be applied to structures. However, it also states 'All the loads listed, however, are not necessarily applicable to all the structures and their elements. Loads and the applicable load combinations for which each structure has to be designed will depend on the conditions to which that particular structure may be subjected.' The Operability Evaluations have established reasonable justification for application of the environmental and abnormal loads separate in time based on the delayed abnormal load development."*

"Reference: SRP 3.8.4, Appendix A, Load Combination No. 6 D + L + Ta + Ra + 1.5 Pa, The pressure load is more severe because there is a multiplier."

"A nonconforming condition exists in the design of masonry walls and the walls do not meet the current licensing basis. The existing wall design basis calculations consider only seismic loading on the walls; no pressure loads were considered either alone or in combination with seismic loads. Therefore, ***in lieu of the load combinations specified in SRP 3.8.4,*** *the following load combination was considered for the operability evaluation to demonstrate there is a reasonable expectation that an SSC can perform its specified safety function:*

*1.0*D + 1.0*L + 1.0*Pa*

Where D = dead load
L = live load
Pa = abnormal pressure load

However, the design basis calculations currently in progress will include all applicable load cases and install modifications if required to meet the design basis requirements."

In Braidwood Operability Evaluation 12-004, under Revision 1: Limited Break Scenario Discussion, it is stated that the *GOTHIC model was used to simulate limited breaks on elevations 401,426 and 451 in the turbine building. It is further stated that****, "in all cases, the fire dampers did not drop before approximately 200 seconds. Before the fire damper drop occurs, there is essentially zero differential pressure across the structure since the rooms of interest pressurize with the turbine building. While the assumption of a seismic event concurrent with the HELB is part of the design basis, the design basis seismic event does not last 200 seconds so the seismic structural loading is assumed to be zero before the HELB differential pressure is applied as a result of the fire damper closure.*** *Applying the HELB load in a static loading fashion without overlaying the seismic loads, the affected block walls have sufficient design margins to remain intact under the estimated peak differential pressures."*

Staff Evaluation

In accordance with NRC's Part 9900 guidance, the licensee should document its functionality assessment that a reasonable expectation exists that the masonry block walls are functional and capable of performing their necessary and related design safety supporting function to ensure safety-related systems/components are protected in accordance with the licensing basis analyses of record before, during and after external events.

- The licensee's functionality assessment omits the load factors for the HELB pressure loading. As there are uncertainties in the results of GOTHIC analysis due to modeling and input parameters variability, the licensee has not provided a supportable basis regarding the reduction of the load factors for pressure load from 1.5 to 1.0. In addition, the licensee used the modulus of rupture of masonry material derived from test results without assigning any capacity reduction factor to account for uncertainty and variability of strength.

- The licensee's functionality assessment considered a seismic event as an initiating event for HELB and did not combine HELB with seismic loads based on the time required for pressurizing the subject rooms in the Auxiliary Building. The licensee should justify not considering the effects of continued seismic activity upon the HELB pressure built-up on the subject block walls.

- The licensee should provide further information relative to the likelihood of a combination of HELB and seismic loads when HELB is initiated, independent of a seismic event, as described in UFSAR Section 3.6.2.1.2.1.

Conclusions

In accordance with NRC's Part 9900 guidance, the NRC staff has determined that the licensee should document its functionality assessment that a reasonable expectation exists that the masonry block walls are functional and capable of performing their necessary and related design safety supporting function to ensure safety-related systems/components are protected in accordance with the licensing basis analyses of record before, during and after external events.

In addition, based on this review the NRC staff has determined that the licensee (1) did not assign and justify a wall capacity reduction factor in its functionality assessment to account for uncertainty and variability of wall strength; (2) did not provide adequate justification to demonstrate the likelihood and reasonableness of load combinations used in its assessment; and (3) did not provide adequate information to demonstrate that using a load factor of 1.0 on HELB pressure load is adequate considering the expected uncertainties in the results of GOTHIC analysis due to modeling and variability of the input parameters.

References

Standard Review Plan (SRP, NUREG-0800), Section 3.8.4, Revision 1

NRC Inspection Manual, Part 9900: Technical Guidance, Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety

Docket Nos. 50-456 and 50-457
License Nos. NPF-72 and NPF-77

DISTRIBUTION:
cc: K. O'Brien, DRP Division Director (Acting)
J. Lara, DRP Deputy Director (Acting)
G. Shear, DRS Division Director
J. Giessner, DRS Deputy Director (Acting)
E. Duncan, DRP Branch Chief
D. Hills, DRS Branch Chief
J. Wiebe, Project Manager
H. Cruz, TIA Project Manager
A. Sallman, DSS, SCVB
V. Meghani, Lead Inspector

- The licensee's functionality assessment considered a seismic event as an initiating event for HELB and did not combine HELB with seismic loads based on the time required for pressurizing the subject rooms in the Auxiliary Building. The licensee should justify not considering the effects of continued seismic activity upon the HELB pressure built-up on the subject block walls.

- The licensee should provide further information relative to the likelihood of a combination of HELB and seismic loads when HELB is initiated, independent of a seismic event, as described in UFSAR Section 3.6.2.1.2.1.

Conclusions

In accordance with NRC's Part 9900 guidance, the NRC staff has determined that the licensee should document its functionality assessment that a reasonable expectation exists that the masonry block walls are functional and capable of performing their necessary and related design safety supporting function to ensure safety-related systems/components are protected in accordance with the licensing basis analyses of record before, during and after external events.

In addition, based on this review the NRC staff has determined that the licensee (1) did not assign and justify a wall capacity reduction factor in its functionality assessment to account for uncertainty and variability of wall strength; (2) did not provide adequate justification to demonstrate the likelihood and reasonableness of load combinations used in its assessment; and (3) did not provide adequate information to demonstrate that using a load factor of 1.0 on HELB pressure load is adequate considering the expected uncertainties in the results of GOTHIC analysis due to modeling and variability of the input parameters.

References

Standard Review Plan (SRP, NUREG-0800), Section 3.8.4, Revision 1

NRC Inspection Manual, Part 9900: Technical Guidance, Operability Determinations and Functionality Assessments for Resolution of Degraded or Nonconforming Conditions Adverse to Quality or Safety

Docket Nos. 50-456 and 50-457
License Nos. NPF-72 and NPF-77

DISTRIBUTION:
cc: K. O'Brien, DRP Division Director (Acting)
J. Lara, DRP Deputy Director (Acting)
G. Shear, DRS Division Director
J. Giessner, DRS Deputy Director (Acting)
E. Duncan, DRP Branch Chief
D. Hills, DRS Branch Chief
J. Wiebe, Project Manager
H. Cruz, TIA Project Manager
A. Sallman, DSS, SCVB
V. Meghani, Lead Inspector

*Concurrence by e-mail
DOCUMENT NAME: Memo 090613 Braidwood TIA Structural Evaluation of Block Walls.docx
☒ Publicly Available ☐ Non-Publicly Available ☐ Sensitive ☒ Non-Sensitive
To receive a copy of this document, indicate in the concurrence box "C" = Copy without attach/encl "E" = Copy with attach/encl "N" = No copy

OFFICE	RIII DRS EB1	RIII DRS EB1	RIII DRP BR3	RIII DRS/DDD	NRR/DPR/PLPB
NAME	VMeghani:cs	DEHills	EDuncan	PLouden	HCruz
DATE	05/30/13	06/10/13	06/12/13	06/20/13	7/25/13*
OFFICE	NRR/DE/EMCB	NRR/DSS/STSB	NRR/DPR/PLB	NRR/DPR/DD	RIIIDRS/DDD
NAME	AMcMurtray	RElliott	AMendiola	SBahadur	JGiessner
DATE	08/15/13*	07/26/13*	08/19/13*	08/20/13*	09/06/13

OFFICIAL RECORD COPY