



**UNITED STATES
NUCLEAR REGULATORY COMMISSION**
REGION III
2443 WARRENVILLE RD. SUITE 210
LISLE, ILLINOIS 60532-4352

December 15, 2017

Mr. Bryan C. Hanson
Senior VP, Exelon Generation Company, LLC
President and CNO, Exelon Nuclear
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2—NRC INSPECTION REPORT
05000456/2017008 AND 05000457/2017008

Dear Mr. Hanson:

On November 16, 2017, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Braidwood Station, Units 1 and 2. On November 16, 2017, the NRC inspectors discussed the results of this inspection with the Site Vice President, Ms. M. Marchionda and other members of your staff. The inspectors documented the results of this inspection in the enclosed inspection report.

Based on the results of this inspection, the NRC has identified five findings that were evaluated under the risk significance determination process as having very low safety significance (Green). The NRC has also determined that violations of regulatory requirements are associated with each of these findings. Because the issues were entered into the site's corrective action program (CAP) and actions were initiated to address them, the violations are being treated as Non-Cited Violations (NCVs) consistent with Section 2.3.2 of the NRC Enforcement Policy. The NCVs are described in the subject inspection report.

If you contest the violations or significance of these NCVs, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with copies to: (1) the Regional Administrator, Region III; (2) the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and (3) the NRC Resident Inspectors' Office at the Braidwood Station.

This letter, its enclosure, and your response (if any) will be made available for public inspection and copying at <http://www.nrc.gov/reading-rm/adams.html> and at the NRC Public Document Room in accordance with 10 CFR 2.390, "Public Inspections, Exemptions, Requests for Withholding."

Sincerely,

/RA/

Eric R. Duncan, Chief
Branch 3
Division of Reactor Projects

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

Enclosure:
IR 05000456/2017008; 05000457/2017008

cc: Distribution via ListServ®

Letter to Bryan Hanson from Eric Duncan dated December 15, 2017

SUBJECT: BRAIDWOOD STATION, UNITS 1 AND 2—NRC INSPECTION REPORT
05000456/2017008 AND 05000457/2017008

DISTRIBUTION:

Jeremy Bowen
RidsNrrDorLpl3
RidsNrrPMBraidwood Resource
RidsNrrDirslrib Resource
Cynthia Pederson
Steven West
Kenneth O'Brien
Richard Skokowski
Allan Barker
Carole Ariano
Linda Linn
DRPIII
DRSIII
ROPreports.Resource@nrc.gov

ADAMS Accession Number: ML17349A894

OFFICE	RIII	RIII	RIII	
NAME	DSargis:lg	BBartlett	RSkokowski:Via email	EDuncan
DATE	12/4/17	12/4/17	12/12/17	12/15/17

OFFICIAL RECORD COPY

U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket Nos: 50-456; 50-457
License Nos: NPF-72; NPF-77

Report No: 05000456/2017008; 05000457/2017008;

Licensee: Exelon Generation Company, LLC

Facility: Braidwood Station, Units 1 and 2

Location: Braceville, IL

Dates: October 30 through November 16, 2017

Inspectors: B. Bartlett, Project Engineer (Lead)
D. Sargis, Reactor Engineer

Approved by: E. Duncan, Chief
Branch 3
Division of Reactor Projects

Enclosure

SUMMARY

Inspection Report 05000456/2017008; 05000457/2017008; 10/30/2017 – 11/16/2017; Braidwood Station, Units 1 and 2; Operability Evaluations, Problem Identification and Resolution.

This report covers a three week period of announced baseline inspections by regional inspectors. Five Green findings were identified by the inspectors. The findings were considered Non-Cited Violations (NCVs) of U.S. Nuclear Regulatory Commission (NRC) regulations. The significance of inspection findings is indicated by their color (i.e., greater than Green, or Green, White, Yellow, Red) and determined using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process (SDP)," dated April 29, 2015. Cross-cutting aspects are determined using IMC 0310, "Aspects Within the Cross-Cutting Areas," dated December 4, 2014. All violations of NRC requirements are dispositioned in accordance with the NRC's Enforcement Policy, dated November 1, 2016. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," dated July 2016.

NRC-Identified and Self-Revealed Findings

Cornerstone: Mitigating Systems

Green. The inspectors identified a finding of very low safety significance and an associated NCV of Title 10 of the *Code of Federal Regulations* (CFR) Part 50, Appendix B, Criterion III, "Design Control," for the licensee's failure to ensure that the design basis for the main steam safety valve (MSSV) room maintenance hatches was maintained. Specifically, the high energy line break (HELB) analysis performed for the MSSV rooms and steam tunnels prior to initial construction concluded that no secondary missiles were generated as a result of a HELB although maintenance hatches in the ceiling of the MSSV rooms were identified to become secondary missiles following a HELB in the MSSV rooms and steam tunnels. As part of their immediate corrective actions, the licensee entered this issue into their corrective action program (CAP) as AR 4075641 and performed an operability evaluation.

The finding was determined to be more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). In accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," the inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC [Structure, System, and Component], does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality. Therefore, this finding was of very low safety significance. No cross-cutting aspect was assigned to this finding as it was not reflective of current performance. (Section 71111.15)

Green. The inspectors identified a finding of very low safety significance and an associated NCV of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," when the licensee originally designed the MSSV blow out panels in a manner that prevented them

from functioning properly. The licensee entered this issue into their CAP as AR 4075641 and corrected the design issue in March of 2009.

The finding was determined to be more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). In accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," the inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality. Therefore, this finding was of very low safety significance. No cross-cutting aspect was assigned to this finding as it was not reflective of current performance. (Section 4OA2.1.a.(1))

Green. The inspectors identified a finding of very low safety significance and an associated NCV of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," when the licensee failed to promptly correct errors in the design analysis for a main steam line break in the main steam tunnel. As part of their immediate corrective actions, the licensee entered this issue into their CAP as AR 4075641 and completed an operability evaluation.

The finding was determined to be more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). In accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," the inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality. Therefore, this finding was of very low safety significance. No cross-cutting aspect was assigned to this finding as it was not reflective of current performance. (Section 4OA2.1.a.(2))

Green. The inspectors identified a finding of very low safety significance and an associated NCV of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," when the licensee failed to promptly address the identification of secondary missiles following a HELB event. As part of their immediate corrective actions, the licensee entered this issue into their CAP as AR 4075641 and performed an operability evaluation.

The finding was determined to be more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). In accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating

Systems Screening Questions,” the inspectors answered “Yes” to Question 1, “If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?” because the finding did not result in a loss of operability or functionality. Therefore, this finding was of very low safety significance. No cross-cutting aspect was assigned to this finding as it was not reflective of current performance. (Section 4OA2.1.a.(3))

Green. The inspectors identified a finding of very low safety significance and an associated NCV of 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” when the licensee failed to maintain an accurate and up-to-date analysis of record for a postulated HELB in the MSSV rooms and steam tunnels. As part of their immediate corrective actions, the licensee entered this issue into their CAP as AR 4075641 and performed an operability evaluation.

The finding was determined to be more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). In accordance with IMC 0609, “Significance Determination Process,” Attachment 0609.04, “Initial Characterization of Findings,” and Appendix A, “The Significance Determination Process for Findings At-Power,” Exhibit 2, “Mitigating Systems Screening Questions,” the inspectors answered “Yes” to Question 1, “If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?” because the finding did not result in a loss of operability or functionality. Therefore, this finding was of very low safety significance. No cross-cutting aspect was assigned to this finding as it was not reflective of current performance. (Section 4OA2.1.a.(4))

Licensee-Identified Violations

None.

REPORT DETAILS

1. REACTOR SAFETY

Cornerstones: Initiating Events, Mitigating Systems, Barrier Integrity, and Emergency Preparedness

1R15 Operability Determinations and Functionality Assessments (71111.15)

.1 Operability Evaluations and Functionality Assessments

a. Inspection Scope

The inspectors reviewed the following issue:

- The effects of secondary missiles generated by a postulated steam line break in the main steam safety valve (MSSV) rooms and steam tunnels, as documented in issue report (IR) 4049759.

The inspectors selected this potential operability issue based on the risk significance of the associated structures, systems, and components (SSCs). The inspectors evaluated the technical adequacy of the evaluations to ensure that technical specification (TS) operability was properly justified and that the applicable SSCs remained available such that no unrecognized increase in risk occurred. The inspectors compared the operability and design criteria in the appropriate sections of the TSs and Updated Final Safety Analysis Report (UFSAR) to the licensee's evaluations to determine whether the applicable SSCs were operable. The inspectors verified, where applicable, that the bounding limitations of the evaluations were valid. Documents reviewed are listed in the Attachment to this report.

This operability inspection constituted one sample as defined in Inspection Procedure (IP) 71111.15–05.

b. Findings

(1) Failure to Correctly Design and Prevent High Energy Line Break Secondary Missiles

Introduction: The inspectors identified a finding of very low safety significance (Green) and an associated Non-Cited Violation (NCV) of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," when the licensee failed to ensure that the design basis for the MSSV room maintenance hatches was maintained. Specifically, the high energy line break (HELB) analysis performed for the MSSV rooms and steam tunnels prior to initial construction concluded that no secondary missiles were generated as a result of a HELB although maintenance hatches in the ceiling of the MSSV rooms were identified to become secondary missiles following a HELB in the MSSV rooms and tunnels.

Description: Updated Final Safety Analysis Report Section 3.6.1.2, "Potential Sources and Locations of Piping/Environmental Effects," stated, in part, "...there are no credible secondary missiles formed from the postulated break of piping..." In early 2007, the NRC identified an issue with the Auxiliary Feedwater (AFW) tunnel hatches at a similar facility that was documented in NRC Inspection Reports 05000454/455–2007002 and 05000454/455–2007003. To address this issue, the licensee utilized a contractor to

perform a re-analysis of Design Analysis 3C8-0282-001, which was the analysis of record, and which concluded that the MSSV room maintenance hatches would lift at a MSSV room pressure of about 3 pounds per square inch gauge (psig) and that the pressure in the MSSV rooms was anticipated to be on the order of about 20 psig. As a result, the contractor also estimated that the MSSV room maintenance hatches could rise as much as 6 feet from their normal position. The MSSV room maintenance hatches are approximately 12 feet long by 7 feet wide and 20 inches thick. The hatches weigh an estimated 21,720 pounds.

Although the contractor provided their revised analysis results to the licensee in November 2013, the licensee failed to recognize that the presence of secondary missiles was not consistent with the assumptions in the design and licensing basis described in UFSAR Section 3.6.1.2. The inspectors also noted that previous revisions of the analysis concluded that peak room pressure would be greater than the 3 psig required for the maintenance hatches to become secondary missiles.

Subsequently, the licensee issued Operability Evaluation 17-002, Revision 0, in September of 2017 and issued Revision 1 on October 27, 2017. The operability evaluation addressed the secondary missile issue and the potential impact on equipment that could be required to function following a design basis event. The operability evaluation concluded that the secondary missile issue had no impact on the operability of plant equipment.

The inspectors performed walkdowns of the MSSV rooms, steam tunnels, and roof areas above and near the MSSV room maintenance hatches. The inspectors also interviewed licensee engineers and operators as part of their assessment of the operability evaluation. No concerns with the operability evaluation were identified.

Analysis: The failure to ensure that the design basis for the MSSV room maintenance hatches was maintained, which resulted in the introduction of secondary missiles following a postulated HELB in the MSSV rooms and steam tunnels, was a performance deficiency.

The performance deficiency was more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). Specifically, the licensee failed to prevent the introduction of secondary missiles following a postulated HELB in the MSSV rooms and steam tunnel areas.

The inspectors evaluated the finding in accordance with Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," dated October 7, 2016, and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," dated June 19, 2012. The inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality per IMC 0326, "Operability Determination & Functionality Assessments for Conditions Adverse to Quality or Safety." Therefore, this finding was of very low safety significance (Green).

No cross-cutting aspect was assigned to this finding as it was not reflective of current performance.

Enforcement: Title 10 of the *Code of Federal Regulations* (CFR) Part 50, Appendix B, Criterion III, "Design Control," requires, in part, that the licensee provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable test program.

Braidwood UFSAR Section 3.6.1.2 states, in part, that there are no credible secondary missiles formed from the postulated break of piping.

Contrary to the above, starting from original plant construction until November 2013, the licensee failed to verify the adequacy of design of the safety-related MSSV rooms and steam tunnels with respect to credible secondary missiles from a postulated break of piping as evidenced by the November 2013 design analysis that identified potential credible secondary missiles formed from a postulated break of piping. Specifically, the licensee failed to verify that a postulated main steam line break in the safety-related MSSV rooms and steam tunnels would not cause the MSSV room maintenance hatches to lift and become secondary missiles as demonstrated by calculated peak pressures in Design Analysis 3C8-0282-001, which was the analysis of record. As part of their immediate corrective actions, the licensee performed an operability evaluation. Because this violation was of very low safety significance and the issue was entered into the licensee's CAP as AR 4075641, "Potential Green NCVs From the NRC 2.206 Petition Inspection," this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy. **(NCV 05000456/2017008-01; 05000457/2017008-01, Failure to Prevent Secondary Missiles Following a Postulated HELB)**

4. OTHER ACTIVITIES

Cornerstones: Mitigating Systems

4OA2 Identification and Resolution of Problems (71152)

.1 Follow-Up Sample for In-Depth Review: Issues with the Analysis of Record for a Main Steam Line Break in the Main Steam Tunnel

a. Inspection Scope

The inspectors performed an in-depth review of corrective actions that were related to the analysis of record for a main steam line break in the main steam tunnel. Specifically, the inspector's review included corrective actions related to the MSSV room blow out panels; corrective actions related to the use of thermodynamic internal energy in lieu of enthalpy in design calculations; and corrective actions related to the generation of secondary missiles following a main steam line break in the main steam tunnel.

As applicable, the inspectors verified the following attributes during their review:

- Complete and accurate identification of the problem in a timely manner commensurate with its safety significance and ease of discovery;
- Consideration of the extent of condition, generic implications, common cause, and previous occurrences;

- Evaluation and disposition of operability/functionality;
- Classification and prioritization of the resolution of the problem commensurate with safety significance;
- Identification of corrective actions, which were appropriately focused to correct the problem; and
- Completion of corrective actions in a timely manner commensurate with the safety significance of the issue.

This activity constituted one in-depth problem identification and resolution inspection sample as defined in IP 71152–05.

b. Observations

From the interviews performed and the documents reviewed the inspectors determined that the licensee has had extensive inadequacies in the original design and construction of their facility regarding HELBs. Based on a records review, the NRC has identified three HELB issues at Braidwood.

- An AFW tunnel hatch issue at Byron which has led to the issues discussed in this inspection report regarding MSSV room steam line breaks;
- Issues with postulated turbine building HELBs following extensive modifications in 2011 after questions were raised by the Office of Nuclear Reactor Regulation during their review of the licensee's request for a power uprate (IR 05000456/2011004; 05000457/2011004); and
- An issue identified during an NRC engineering inspection in 2016 at Braidwood regarding the effects of a postulated turbine building HELB on the proper functioning of the diesel-driven AFW pump (IR 05000456/2016008; 05000457/2016008).

The second and third examples listed above have been addressed by the licensee. The first example is the subject of this inspection report and at the end of this inspection had not yet been corrected by the licensee. In particular, at the end of this inspection the analysis of record remained inaccurate, necessary field modifications had not been fully identified or implemented, and additional extent of condition reviews had not been completed.

The inspectors questioned the licensee regarding the need to perform extent of condition reviews and opportunities to have identified some of these HELB issues earlier. Licensee staff stated that following the discovery of AFW tunnel hatch and turbine building HELB issues that they performed a plant HELB protection assessment and extent of condition review and had concluded that any additional concerns had been identified and entered into the CAP. Nonetheless, the secondary missile issue identified in this inspection report and the impact of a turbine building HELB on the diesel-driven AFW pumps had not been identified during the licensee's review. The inspectors concluded that the plant HELB protection assessment and extent of condition reviews that were performed by the licensee were ineffective.

a. Findings

(1) Failure to Correctly Design and Install High Energy Line Break Blow Out Panels

Introduction: The inspectors identified a finding of very low safety significance (Green) and an associated NCV of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," when the licensee originally designed the MSSV room blow out panels in a manner that prevented them from functioning properly.

Description: While following up on NRC inspector identified errors with the AFW tunnel hatches that were documented in NRC Inspection Reports 05000454/455–2007002 and 05000454/455–2007003 at Byron the licensee determined that blow out panels located in the upper chambers of the MSSV rooms on both units were inoperable. Specifically, UFSAR Attachment C3.6, Section II.B.1.h, stated that the blow out panels in the upper chambers of the MSSV rooms were initially assumed intact and that a differential pressure equal to 1.5 pounds per square inch (psi) will blow open the panels to atmosphere. However, the blow out panels were designed to be bolted and welded into place, and further analysis showed that they would not have blown out at 1.5 psi. Additionally, the panels were located behind a security barrier that would have prevented the panels from blowing out and relieving pressure from the room. Therefore, during a HELB, the steam would have less area to escape from the room resulting in a higher peak pressure than was calculated.

The issues were entered into the licensee's CAP as AR 789791, "Potential Loss of Margin in MS [Main Steam] Tunnel Pressurization Calc[ulation]," dated June 24, 2008. The erroneous design and construction of the blow out panels existed since original plant startup and were taken credit for in various calculations, including Design Analysis 3C8–0282–001, Revision 3. The blow out panels were subsequently modified and compliance with their design basis was restored on December 20, 2008. A calculation was also performed to ensure that the design error associated with the blow out panels did not invalidate the analysis of record.

Analysis: The failure to maintain the design basis for the MSSV room blow out panels was a performance deficiency.

The performance deficiency was more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). Specifically, the licensee failed to account for the increase in the post-HELB MSSV room pressure due to the unknown decrease in the surface area of the steam release paths resulting from the inadequate design of the blow out panels.

The inspectors evaluated the finding in accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," dated October 7, 2016, and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," dated June 19, 2012. The inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality per IMC 0326, "Operability Determination & Functionality

Assessments for Conditions Adverse to Quality or Safety.” Therefore, this finding was of very low safety significance (Green).

No cross-cutting aspect was assigned to this finding as it was not reflective of current performance.

Enforcement: Title 10 CFR Part 50, Appendix B, Criterion III, “Design Control,” requires, in part, that the licensee provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program.

Braidwood UFSAR Attachment C3.6, Section II.B.1.h states, in part, that the blow out panels in the upper chambers of the MSSV rooms are initially assumed intact and that a differential pressure equal to 1.5 psi will blow open the panels to atmosphere.

Contrary to the above, from original construction until December 20, 2008, the licensee failed to verify the adequacy of design. Specifically, by the analysis completed on December 20, 2008, it was determined that the licensee failed to verify that the blow out panels in the safety-related MSSV rooms were designed in a manner that allowed them to blow open to atmosphere at a pressure of 1.5 psi following a postulated HELB. As part of their immediate corrective actions, the licensee performed an operability evaluation. Because this violation was of very low safety significance and the issue was entered into the licensee’s CAP as AR 4075641, “Potential Green NCVs From the NRC 2.206 Petition Inspection,” this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy. **(NCV 05000456/2017008–02, 05000457/2017008–02, Inadequate Blow Out Panel Design Control)**

(2) Failure to Promptly Correct Errors in the Analysis of Record for a Main Steam Line Break in the Main Steam Safety Valve Rooms and the Main Steam Tunnels

Introduction: The inspectors identified a finding of very low safety significance (Green) and an associated NCV of 10 CFR Part 50, Appendix B, Criterion XVI, “Corrective Action,” when the licensee failed to promptly correct errors in the analysis for a main steam line break in the MSSV rooms and main steam tunnels.

Description: On June 30, 2008, Braidwood Station initiated AR 792215, “MSLB Calc[ulation] Energy Release Error,” which documented errors in the main steam line break analysis of record and which addressed postulated HELBs in the MSIV rooms and steam tunnels. In particular, Design Analysis 3C8–0282–001, Revision 3, which was the analysis of record for a steam line break in the MSSV rooms and steam tunnels, improperly used thermodynamic internal energy instead of enthalpy, as required. The use of thermodynamic internal energy, which was about 13 percent less than enthalpy, resulted in a non-conservative calculation. On August 13, 2008, the licensee generated Action Tracking Item 792215–03 to track completion of a revised design analysis to address mass and energy release and steam tunnel pressurization. The licensee contracted a vendor to revise the existing design analysis to reflect the correct mass and energy release.

The inspectors reviewed corrective actions for the errors in the design analysis. The incorrect value for enthalpy had been assessed through operability evaluations and the

licensee concluded that the MSSV rooms remained operable. However, at the end of this inspection the licensee had not yet corrected the analysis of record.

Analysis: The failure to promptly correct errors in the design analysis for a main steam line break in the MSSV rooms and steam tunnels was a performance deficiency.

The performance deficiency was more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). Specifically, the design analysis required significant re-assessment to ensure there were no immediate operability issues.

The inspectors evaluated the finding in accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," dated October 7, 2016, and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," dated June 19, 2012. The inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality per IMC 0326, "Operability Determination & Functionality Assessments for Conditions Adverse to Quality or Safety." Therefore, this finding was of very low safety significance (Green).

No cross-cutting aspect was assigned to this finding as it was not reflective of current performance.

Enforcement: Title 10 CFR 50, Appendix B, Criterion XVI, "Corrective Action," requires, in part, that measures shall be established to assure that conditions adverse to quality, such as non-conformances, are promptly identified and corrected.

Contrary to the above, as of November 16, 2017, the licensee failed to promptly correct a condition adverse to quality. Specifically, the licensee failed to promptly correct errors in Design Analysis 3CB-0282-001, Revision 3, for a main steam line break in the safety-related MSSV rooms and steam tunnels that were identified on June 30, 2008. As part of their immediate corrective actions, the licensee performed an operability evaluation. Because this violation was of very low safety significance and the issue was entered into the licensee's CAP as AR 4075641, "Potential Green NCVs From the NRC 2.206 Petition Inspection," this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy. **(NCV 05000456/2017008-03; 05000457/2017008-03, Failure to Promptly Correct Errors in Design Analysis for Main Steam Line Break in Main Steam Tunnel)**

(3) Failure to Promptly Correct Secondary Missile Issues Resulting from a Steam Line Break in the Main Steam Safety Valve Rooms and Steam Tunnels

Introduction: The inspectors identified a finding of very low safety significance (Green) and an associated NCV of 10 CFR Part 50, Appendix B, Criterion XVI, "Corrective Action," for the licensee's failure to promptly address the introduction of secondary missiles resulting from a main steam line break in the MSSV rooms and steam tunnels.

Description: On June 30, 2008, Braidwood Station generated IR 792215, “MSLB [Main Steam Line Break] Calc[ulation] Energy Release Error,” which documented errors in the main steam line break design analysis that addressed postulated HELBs in the MSSV rooms and steam tunnels.

On November 12, 2013, a vendor informed the licensee that a draft of a new calculation would credit venting steam through the concrete maintenance hatches that cover the roof of the MSSV rooms. Based on the calculated pressures in the design analysis for the MSSV rooms, the roof hatches were expected to lift, making them secondary missiles following a main steam line break. UFSAR Section 3.6.1.2.1 stated, “There are no credible secondary missiles formed from the postulated break of piping.” Therefore, the plant configuration was not consistent with the design basis as described in the UFSAR. Braidwood entered this issue into their CAP as AR 4060293, “Enhancements to MSLB Operability Evaluation 17–002, Revision 0,” and issued Operability Evaluation 17–002, Revision 1.

The inspectors reviewed corrective actions for the secondary missile issue. The secondary missile issue was analyzed through an operability evaluation and the licensee determined that the MSSV rooms were operable. However, at the end of this inspection, the licensee had not yet addressed the failure to prevent secondary missiles.

Analysis: The failure to implement prompt corrective actions to address a failure to prevent secondary missiles was a performance deficiency.

The performance deficiency was more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core damage). Specifically, the secondary missile issue required an operability evaluation to verify that the proper operation of the safety-related components and structures were not significantly impacted.

The inspectors evaluated the finding in accordance with IMC 0609, “Significance Determination Process,” Attachment 0609.04, “Initial Characterization of Findings,” dated October 7, 2016, and Appendix A, “The Significance Determination Process for Findings At-Power,” Exhibit 2, “Mitigating Systems Screening Questions,” dated June 19, 2012. The inspectors answered “Yes” to Question 1, “If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?” because the finding did not result in a loss of operability or functionality per IMC 0326, “Operability Determination & Functionality Assessments for Conditions Adverse to Quality or Safety.” Therefore, this finding was of very low safety significance (Green).

No cross-cutting aspect was assigned to this finding as it was not reflective of current performance.

Enforcement: Title 10 CFR 50, Appendix B, Criterion XVI, “Corrective Action,” requires, in part, that measures shall be established to assure that conditions adverse to quality, such as non-conformances, are promptly identified and corrected.

Contrary to the above, as of November 16, 2017, the licensee failed to promptly correct a condition adverse to quality. Specifically, the licensee failed to promptly correct an

error in the design and construction of the safety-related MSSV rooms that would result in secondary missiles following a postulated HELB, which was identified on November 12, 2013. As part of their immediate corrective actions, the licensee performed an operability evaluation. Because this violation was of very low safety significance and the issue was entered into the licensee's CAP as AR 4075641, "Potential Green NCVs From the NRC 2.206 Petition Inspection," this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy. **(NCV 05000456/2017008-04; 05000457/2017008-04, Untimely Corrective Action for Secondary Missiles)**

(4) Errors Contained in Analysis of Record for Main Steam Line High Energy Line Break

Introduction: The inspectors identified a finding of very low safety significance (Green) and an associated NCV of 10 CFR Part 50, Appendix B, Criterion III, "Design Control," for the licensee's failure to maintain an accurate and up-to-date design analysis of record for a postulated HELB in the MSSV rooms and steam tunnels. Specifically, the HELB Design Analysis 3C8-0282-001 contained errors.

Description: On June 30, 2008, Braidwood Station generated AR 792215, "MSLB Calc[ulation] Energy Release Error," which documented errors in the main steam line break analysis of record and which addressed postulated HELBs in the MSSV rooms and steam tunnels. These errors were identified in response to NRC questions in 2007 regarding the AFW tunnel hatch.

Design Analysis 3C8-0282-001, Revision 3, dated October 22, 1996, was the design analysis of record for a postulated steam line break in the MSSV rooms and steam tunnels. UFSAR Attachment C3.6 discussed a main steam line break in the main steam tunnel and its conclusions were supported by the analysis of record. The UFSAR stated that during a HELB event, the MSSV rooms would retain their structural integrity and that the safety-related main steam isolation valves and feedwater isolation valves would perform their safety function.

The energy release calculation in the analysis of record improperly used thermodynamic internal energy instead of enthalpy, as required. Thermodynamic internal energy for this analysis was about 13 percent less than enthalpy, which resulted in a non-conservative calculation. Therefore, the analysis of record was no longer adequate to demonstrate that the MSSV rooms were consistent with their design basis.

On August 13, 2008, the licensee created Action Tracking Item 792215-03 to track completion of a revised design analysis to address mass and energy release and steam tunnel pressurization. The licensee contracted a vendor to revise the existing analysis of record to reflect the correct mass and energy release.

Analysis: The identification of errors in Design Analysis 3C8-0282-001, Revision 3, which was the analysis of record for a postulated HELB in the MSIV rooms and steam tunnels was a performance deficiency.

The performance deficiency was more than minor because it was associated with the Mitigating Systems cornerstone attribute of Design Control and adversely affected the cornerstone objective of ensuring the availability, reliability, and capability of systems that respond to initiating events to prevent undesirable consequences (i.e., core

damage). Specifically, the licensee failed to maintain an accurate design analysis of record for the MSSV rooms and steam tunnels.

The inspectors evaluated the finding in accordance with IMC 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," dated October 7, 2016, and Appendix A, "The Significance Determination Process for Findings At-Power," Exhibit 2, "Mitigating Systems Screening Questions," dated June 19, 2012. The inspectors answered "Yes" to Question 1, "If the finding is a deficiency affecting the design or qualification of a mitigating SSC, does the SSC maintain its operability or functionality?" because the finding did not result in a loss of operability or functionality per IMC 0326, "Operability Determination & Functionality Assessments for Conditions Adverse to Quality or Safety." Therefore, this finding was of very low safety significance (Green).

No cross-cutting aspect was assigned to this finding as it was not reflective of current performance.

Enforcement: Title 10 CFR Part 50, Appendix B, Criterion III, "Design Control," requires, in part, that the licensee provide for verifying or checking the adequacy of design, such as by the performance of design reviews, by the use of alternate or simplified calculational methods, or by the performance of a suitable testing program.

Braidwood UFSAR Attachment C3.6, Section I, stated, in part, that qualification tests have been conducted for the components in the MSSV rooms and that these tests applied worst case environmental (temperature, pressure, and humidity) loading, and showed that a loss of function did not occur. In particular, the UFSAR stated that an assumed pipe crack or break in the steam tunnel, main steam isolation valve room, or MSSV rooms cannot cause a structural failure.

Contrary to the above, as of October 22, 1996, and continuing today, the licensee failed to verify the adequacy of design. Specifically, the licensee failed to verify that Design Analysis 3C8-0282-001, Revision 3, which was the analysis of record addressing a postulated HELB in the safety-related MSSV rooms, would not cause a structural failure since it failed to apply worst case environmental loading. As part of their immediate corrective actions, the licensee performed an operability evaluation. Because this violation was of very low safety significance and the issue was entered into the licensee's CAP as AR 4075641, "Potential Green NCVs From the NRC 2.206 Petition Inspection," this violation is being treated as a NCV, consistent with Section 2.3.2 of the NRC Enforcement Policy. **(NCV 05000456/2017008-05; 05000457/2017008-05, Inaccurate Analysis of Record)**

4OA6 Management Meetings

.1 Exit Meeting Summary

On November 16, 2017, the inspectors presented the inspection results to the Site Vice President, Mr. M. Marchionda, and other members of the licensee staff. The licensee acknowledged the issues presented.

The inspectors confirmed that none of the potential report input discussed was considered proprietary. Proprietary material received by the inspectors and reviewed in the course of these inspections was returned to the licensee.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee

M. Marchionda, Site Vice President
A. Ferko, Plant Manager
J. Cady, Radiation Protection Manager
R. Cameron, Training Director
B. Currier, Engineering Director
R. Hall, Chemical Environment & Radwaste Manager
T. Leaf, Operations Director
P. Raush, Work Management Director
D. Riedinger, Senior Manager Design Engineering
S. Reynolds, Regulatory Assurance Manager
R. Schliessmann, NRC Coordinator
M. Avers - Engineering

U.S. Nuclear Regulatory Commission

E. Duncan, Chief, Reactor Projects Branch 3
J. Weibe, NRR Project Manager for Byron and Braidwood
D. Kimble, Senior Resident Inspector, Braidwood

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

05000456/2017008-01; 05000457/2017008-01;	NCV	Failure to Prevent Secondary Missiles Following a Postulated HELB
05000456/2017008-02; 05000457/2017008-02;	NCV	Inadequate Blow Out Panel Design Control
05000456/2017008-03; 05000457/2017008-03;	NCV	Failure to Properly Correct Errors in Design Analysis for Main Steam Line Break in Main Steam Tunnel
05000456/2017008-04; 05000457/2017008-04;	NCV	Untimely Corrective Action for Secondary Missiles
05000456/2017008-05; 05000457/2017008-05	NCV	Inaccurate Analysis of Record

Closed

05000456/2017008-01; 05000457/2017008-01;	NCV	Failure to Prevent Secondary Missiles Following a Postulated HELB
05000456/2017008-02; 05000457/2017008-02;	NCV	Inadequate Blow Out Panel Design Control
05000456/2017008-03; 05000457/2017008-03;	NCV	Failure to Properly Correct Errors in Design Analysis for Main Steam Line Break in Main Steam Tunnel
05000456/2017008-04; 05000457/2017008-04;	NCV	Untimely Corrective Action for Secondary Missiles
05000456/2017008-05; 05000457/2017008-05	NCV	Inaccurate Analysis of Record

Discussed

None

LIST OF DOCUMENTS REVIEWED

The following is a partial list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspector reviewed the documents in their entirety, but rather that selected sections or portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

Action Requests/Issue Reports:

- IR 653093; The AF [Auxiliary Feedwater] Tunnel Covers Do Not Meet Expected Safety Factors; July 24, 2007
- IR 654270; AF Tunnel Cover Bolt Eval[uation] Uses Non-Standard Safety Factor; July 26, 2007
- IR 789344; Error in MS [Main Steam] Tunnel Pressurization Calculation; June 23, 2008
- IR 789791; Potential Loss of Margin in MS Tunnel Pressurization Calc[ulation]; June 24, 2008
- IR 792213; MSLB [Main Steam Line Break] Calc Energy Release Error; June 30, 2008
- IR 792215; MSLB Calc Energy Release Error; June 30, 2008
- IR 1284054; Legacy Issues with Main Steam Tunnel Pressurization Calculation; October 31, 2011
- IR 1531420; No Actions Tracking Update to Calculation 3C8-0282-001; July 1, 2013
- IR 4046781; Typographical Errors in UFSAR Section C3.6; August 29, 2017
- IR 4046785; Typographical Errors in UFSAR Section C3.6; August 29, 2017
- IR 4049814; Unanalyzed Consequence from the MSLB Outside Containment; September 7, 2017
- IR 4075608; Potential Green NCVs From the NRC 2.206 Petition Inspection; November 16, 2017

Calculations/Technical Evaluations

- Calculation 3C8-0282-001; Main Steam Tunnel Pressure Study For Main Steam Line Break; Revision 3
- Calculation 5.6.1-BYR-96-233; Evaluation of Main Steam and Aux[iliary]-Feedwater Tunnels for Revised Accident Pressures and Temperatures Associated with Replacement Steam Generators; Revision 0
- Operability Evaluation 07-006; Auxiliary Feed Water Tunnel Covers Installation; July 1, 2009
- Operability Evaluation 17-002; Unanalyzed Consequence from a MSLB Outside Containment; Revision 1

Drawings

- M-1265, Sheet 2; Main Steam Pipe Tunnel and Safety Valve Enclosure Ventilation System; Revision U
- M-1265, Sheet 2; Main Steam Pipe Tunnel and Safety Valve Enclosure Ventilation System; Revision T

Other

- Letter from David Gullott to U.S. Nuclear Regulatory Commission; Response to Request for Voluntary Response to Petition Regarding Byron Station, Unit Nos. 1 and 2, and Braidwood Station, Units 1 and 2 High Energy Line Break in Main Steam Isolation Valve Room; September 1, 2017

LIST OF ACRONYMS USED

ADAMS	Agencywide Documents Access and Management System
AFW	Auxiliary Feedwater
AR	Action Request
CAP	Corrective Action Program
CFR	<i>Code of Federal Regulations</i>
HELB	High Energy Line Break
IMC	Inspection Manual Chapter
IP	Inspection Procedure
IR	Inspection Report
MSSV	Main Steam Safety Valve
NCV	Non-Cited Violation
NRC	U.S. Nuclear Regulatory Commission
NRR	Office of Nuclear Reactor Regulation
psi	pounds per square inch
psig	pounds per square inch gauge
SDP	Significance Determination Process
SSC	Structure, System, and Component
TS	Technical Specification
UFSAR	Updated Final Safety Analysis Report

PHOTOGRAPH OF MAIN STEAM SAFETY VALVE HOUSE

