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

October 5, 2015

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 - TRIENNIAL FIRE PROTECTION INSPECTION REPORT 05000456/2015007; 05000457/2015007

Dear Mr. Hanson:

On August 28, 2015, the U.S. Nuclear Regulatory Commission (NRC) completed a Triennial Fire Protection Inspection at your Braidwood Station, Units 1 and 2. The enclosed inspection report documents the inspection results, which were discussed on August 28, 2015, with Mr. J. Bashor and other members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed personnel.

NRC inspectors documented one finding of very low safety significance (Green) in this report. This finding was determined to involve a violation of NRC requirements. However, because of its very low safety significance, and because the issue was entered into your Corrective Action Program, the NRC is treating the issue as a Non-Cited Violation (NCV) in accordance with Section 2.3.2 of the NRC Enforcement Policy.

If you contest the subject or severity of the NCV, you should provide a response within30 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 the Regional Administrator, Region III; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001; and the NRC Resident Inspector at the Braidwood Station.

In accordance with Title 10, of the *Code of Federal Regulations* (CFR), Part 2.390, “Public Inspections, Exemptions, Requests for Withholding,” of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any) will be available electronically for public inspection in the NRC’s Public Document Room or from the Publicly Available Records (PARS) component of the NRC's Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

***/RA/***

Robert C. Daley, Chief
Engineering Branch 3
Division of Reactor Safety

Docket Nos. 50–456; 50–457
License Nos. NPF–72; NPF–77

Enclosure:
IR 05000456/2015007; 05000457/2015007

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U. S. NUCLEAR REGULATORY COMMISSION

REGION III

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|---|---|
| Docket Nos: | 50-456; 50-457 |
| License Nos: | NPF-72; NPF-77 |
| Report No: | 05000456/2015007; 05000457/2015007 |
| Licensee: | Exelon Generation Company, LLC |
| Facility: | Braidwood Station, Units 1 and 2 |
| Location: | Braceville, IL |
| Dates: | July 29 through August 28, 2015 |
| Inspectors: | A. Dahbur, Senior Reactor Inspector<br>D. Szwarc, Senior Reactor Inspector, Lead<br>R. Winter, Reactor Inspector |
| Approved by: | Robert C. Daley, Chief<br>Engineering Branch 3<br>Division of Reactor Safety |

Enclosure

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## SUMMARY

Inspection Report 05000456/2015007, 05000457/2015007; 07/29/2015 – 08/28/2015; Braidwood Station, Units 1 and 2; Routine Triennial Fire Protection Baseline Inspection.

This report covers an announced Triennial Fire Protection Baseline Inspection. The inspection was conducted by Region III inspectors. One finding was identified by the inspectors. The finding was considered a Non-Cited Violation (NCV) of U.S. Nuclear Regulatory Commission (NRC) regulations. The significance of most findings is indicated by their color (i.e., Greater than Green, or Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process (SDP)". Cross-cutting aspects were determined using IMC 0310, "Aspects Within the Cross Cutting Areas." Findings for which the SDP does not apply may be Green or be assigned a severity level after NRC management review. All violations of NRC requirements are dispositioned in accordance with the NRC's Enforcement Policy dated July 9, 2013. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 5, dated February 2014.

**Cornerstone: Mitigating Systems**

- Green. The inspectors identified a finding of very low safety significance, and an associated NCV of the Braidwood Station facility operating license condition 2.E associated with the Fire Protection Program for the licensee's failure to ensure that the safe shutdown capability was independent of the fire area and thus free of fire damage. Specifically, in the event of a fire in the control room, cable spreading rooms, or electrical cable penetration areas the circuits associated with the Pressurizer Power Operated Relief Valve (PORV) block valves, which are relied upon to safely shutdown the plant, could be affected and may not be available due to fire-induced failures. The licensee entered this issue into their Corrective Action Program, established fire watches, and intended to perform plant modifications to correct the issue.

  The inspectors determined that the issue was more than minor because fire-induced circuit failures could impair the operation of the PORV block valves and complicate shutdown of the plant in the event of a fire in the control room, cable spreading rooms, or electrical cable penetration areas. The finding affected the Mitigating Systems Cornerstone. The finding was determined to be of very low safety significance based on a detailed risk-evaluation by a Region III Senior Reactor Analyst. This finding was not associated with a cross-cutting aspect because the finding was not representative of the licensee's current performance. (Section 1R05.6.b)

## REPORT DETAILS

### 1. REACTOR SAFETY

**Cornerstones: Initiating Events and Mitigating Systems**

1R05 Fire Protection (71111.05T)

The purpose of the Fire Protection Triennial Baseline Inspection was to conduct a design-based, plant specific, risk-informed, onsite inspection of the licensee's Fire Protection Program's defense-in-depth elements used to mitigate the consequences of a fire. The fire protection program shall extend the concept of defense-in-depth to fire protection in plant areas important to safety by:

- preventing fires from starting;
- rapidly detecting, controlling and extinguishing fires that do occur;
- providing protection for structures, systems, and components (SSCs) important to safety so that a fire that is not promptly extinguished by fire suppression activities will not prevent the safe-shutdown of the reactor plant; and
- taking reasonable actions to mitigate postulated events that could potentially cause loss of large areas of power reactor facilities due to explosions or fires.

The inspectors' evaluation focused on the design, operational status, and material condition of the reactor plant's Fire Protection Program, post-fire safe shutdown systems, and B.5.b mitigating strategies. The objectives of the inspection were to assess whether the licensee had implemented a Fire Protection Program that: (1) provided adequate controls for combustibles and ignition sources inside the plant; (2) provided adequate fire detection and suppression capability; (3) maintained passive fire protection features in good material condition; (4) established adequate compensatory measures for out-of-service, degraded or inoperable fire protection equipment, systems or features; (5) ensured that procedures, equipment, fire barriers and systems exist so that the post-fire capability to safely shut down the plant was ensured; (6) included feasible and reliable operator manual actions when appropriate to achieve safe shutdown; and (7) identified fire protection issues at an appropriate threshold and ensured these issues were entered into the licensee's Problem Identification and Resolution Program.

In addition, the inspectors' review and assessment focused on the licensee's post-fire safe shutdown systems for selected risk-significant fire areas. Inspector emphasis was placed on determining that the post-fire safe shutdown capability and the fire protection features were maintained free of fire damage to ensure that at least one post-fire safe shutdown success path was available. The inspectors' review and assessment also focused on the licensee's B.5.b related license conditions and the requirements of Title 10, *Code of Federal Regulations* (CFR), Part 50.54 (hh)(2). Inspector emphasis was to ensure that the licensee could maintain or restore core cooling, containment, and spent fuel pool cooling capabilities utilizing the B.5.b mitigating strategies following a loss of large areas of power reactor facilities due to explosions or fires. Documents reviewed are listed in the Attachment to this report.

The fire zones and B.5.b mitigating strategies selected for review during this inspection are listed below and in Section 1R05.13. The fire zones selected constituted three inspection samples and the B.5.b mitigating strategies selected constituted two inspection samples, respectively, as defined in Inspection Procedure 71111.05T.

| Fire Zone | Description |
|---|---|
| 3.2 B-1 | Unit 1 Lower Cable Spreading Room |
| 5.5-1 | Unit 1 Auxiliary Electrical Equipment Room |
| 11.4-0 | Auxiliary Building General Area, Elevation 383 |

.1 Protection of Safe Shutdown Capabilities

a. Inspection Scope

For each of the selected fire areas, the inspectors reviewed the fire hazards analysis, safe shutdown analysis, and supporting drawings and documentation to verify that safe shutdown capabilities were properly protected.

The inspectors also reviewed the licensee's design control procedures to ensure that the process included appropriate reviews and controls to assess plant changes for any potential adverse impact on the Fire Protection Program and/or post-fire safe shutdown analysis and procedures.

b. Findings

No findings were identified.

.2 Passive Fire Protection

a. Inspection Scope

For the selected fire areas, the inspectors evaluated the adequacy of fire area barriers, penetration seals, fire doors, electrical raceway fire barriers, and fire rated electrical cables. The inspectors observed the material condition and configuration of the installed barriers, seals, doors, and cables. The inspectors reviewed approved construction details and supporting fire tests. In addition, the inspectors reviewed license documentation, such as U.S. Nuclear Regulatory Commission (NRC) Safety Evaluation Reports, and deviations from NRC regulations and the National Fire Protection Association (NFPA) standards to verify that fire protection features met license commitments.

The inspectors walked down accessible portions of the selected fire areas to observe material condition and the adequacy of design of fire area boundaries (including walls, fire doors, and fire dampers) to ensure they were appropriate for the fire hazards in the area.

The inspectors reviewed the installation, repair, and qualification records for a sample of penetration seals to ensure the fill material was of the appropriate fire rating and that the installation met the engineering design.

b. Findings

No findings were identified.

.3 Active Fire Protection

a. Inspection Scope

For the selected fire areas, the inspectors evaluated the adequacy of fire suppression and detection systems. The inspectors observed the material condition and configuration of the installed fire detection and suppression systems. The inspectors reviewed design documents and supporting calculations. In addition, the inspectors reviewed license basis documentation, such as, NRC Safety Evaluation Reports, deviations from NRC regulations, and NFPA standards to verify that fire suppression and detection systems met license commitments.

The team observed an unannounced fire drill simulating a fire near the aboveground vehicle fuel dispensing area. The team observed fire brigade members fight a simulated fire. The team verified that the licensee identified problems, openly discussed them in a self-critical manner at the drill debrief, and identified appropriate corrective actions.

b. Findings

No findings were identified.

.4 Protection from Damage from Fire Suppression Activities

a. Inspection Scope

For the selected fire areas, the inspectors verified that redundant trains of systems required for hot shutdown would not be subject to damage from fire suppression activities or from the rupture or inadvertent operation of fire suppression systems including the effects of flooding. The inspectors conducted walkdowns of each of the selected fire areas to assess conditions such as the adequacy and condition of floor drains, equipment elevations, and spray protection.

b. Findings

No findings were identified.

.5 Alternative Shutdown Capability

a. Inspection Scope

The inspectors reviewed the licensee's systems required to achieve alternative safe shutdown to determine if the licensee had properly identified the components and systems necessary to achieve and maintain safe shutdown conditions. The inspectors also focused on the adequacy of the systems to perform reactor pressure control, reactivity control, reactor coolant makeup, decay heat removal, process monitoring, and support system functions.

The inspectors conducted selected area walkdowns to determine if operators could reasonably be expected to perform the alternate safe shutdown procedure actions and that equipment labeling was consistent with the alternate safe shutdown procedure. The review also looked at operator training as well as consistency between the operations shutdown procedures and any associated administrative controls.

b. Findings

No findings of significance were identified

.6 Circuit Analyses

a. Inspection Scope

The inspectors verified that the licensee performed a post-fire safe shutdown analysis for the selected fire areas and the analysis appropriately identified the SSCs important to achieving and maintaining safe shutdown. Additionally, the inspectors verified that the licensee's analysis ensured that necessary electrical circuits were properly protected and that circuits that could adversely impact safe shutdown due to hot shorts, shorts to ground, or other failures were identified, evaluated, and dispositioned to ensure spurious actuations would not prevent safe shutdown.

The inspectors' review considered fire and cable attributes, potential undesirable consequences, and common power supply/bus concerns. Specific items included the credibility of the fire threat, cable insulation attributes, cable failure modes, and actuations resulting in flow diversion or loss of coolant events.

The inspectors also reviewed cable raceway drawings for a sample of components required for post-fire safe shutdown to verify that cables were routed as described in the cable routing matrices.

The inspectors reviewed circuit breaker coordination studies to ensure equipment needed to conduct post-fire safe shutdown activities would not be impacted due to a lack of coordination. Additionally, the inspectors reviewed a sample of circuit breaker maintenance records to verify that circuit breakers for components required for post-fire safe shutdown were properly maintained in accordance with procedural requirements.

The inspectors verified for cables that are important to safe shutdown, but not part of the success path, and that do not meet the separation/protection requirements of Section III.G.2 of 10 CFR Part 50, Appendix R, that the circuit analysis considered the cable failure modes. In addition, the inspectors have verified that the licensee has either: (1) determined that there is not a credible fire scenario (through fire modeling), (2) implemented feasible and reliable manual actions to assure safe shutdown capability, or (3) performed a circuit fault analysis demonstrating no potential impact on safe shutdown capability exists.

b. Findings

Failure to Ensure Circuits Associated with Pressurizer Power Operated Relief Valve Block Valves were Free of Fire Damage

Introduction: The inspectors identified a finding of very low safety significance (Green), and an associated Non-Cited Violation (NCV) of the Braidwood Station Operating License for the licensee's failure to ensure that the safe shutdown capability was independent of the fire area and free of fire damage. Specifically, in the event of a fire in the control room, cable spreading rooms, or electrical cable penetration areas the circuits associated with the Pressurizer Power Operated Relief Valve (PORV) block valves, which were relied upon to safely shutdown the plant, may be affected and not available.

Description: The pressurizer is equipped with two types of devices for pressure relief, pressurizer safety relief valves and PORVs. The PORVs are direct current (DC) solenoid controlled air operated valves that are controlled to open at a specific set pressure when the pressurizer pressure increases and close when the pressurizer pressure decreases. The PORVs may also be manually operated from the control room. These valves provide the primary overpressure protection of the Reactor Coolant System (RCS) during most modes of operation. Each PORV discharge line has a normally open motor operated block valve immediately upstream of the PORV itself. The block valves are used to isolate the PORVs in case of excessive leakage or a stuck open PORV. Both PORV discharge lines are routed to the pressurizer relief tank (PRT). The PRT is sized to accept and quench the PORV discharge only for a limited time. Certain post-fire scenarios may require or result in a discharge for a longer time. If a PORV were to discharge to the PRT for a sufficiently long time the PRT pressure would rise to the rupture disc relief pressure, and the PRT contents would be released to the containment atmosphere.

The licensee identified in the Braidwood Station safe shutdown analysis (SSA) that the PORVs and their associated block valves formed a high-low pressure interface between the RCS and low-pressure systems. A detailed evaluation of the high-low pressure interface of these valves was provided in subsection 2.4.3.2 of the SSA. Section 2.4.3.2 indicated that the Division 12(22) PORV and block valves both had control cables in the main control room and in two of the lower cable spreading rooms. The SSA stated that should a fire in any of these zones cause the spurious opening of the PORVs, coincident with control circuit damage to the block valves, the block valves could still be closed. A "remote/local" isolation switch and control switch were provided for the block valves at their motor control center (MCC), located in the Division 12(22) electrical penetration area. The block valves could be closed by placing the "remote/local" isolation switch in "local" and then closing the valves with the control switch provided. The evaluation also indicated that in fire zones where one of the PORVs had a control cable present in the zone that can spuriously open the PORV and its associated block valve and alternating current (AC) power wasn't available, the PORV could be failed closed by pulling its control power fuse at its DC distribution panel. These actions were depicted in the safe shutdown procedures. Operating Procedure 1(2)Bw0A-PRI-5, "Control Room Inaccessibility," Revision 106 included steps indicating that if any PORV block valve can NOT be closed, THEN locally remove the PORV control power fuses to fail its associated PORV closed.

While reviewing the schematic diagrams associated with the pressurizer relief isolation block valves (1/2RY8000A and 1/2RY8000B) the inspectors identified a circuit deficiency for which a design basis fire in either the main control room, cable spreading rooms (lower and upper), or electrical cable penetration areas could prevent the Pressurizer PORV block valves from being closed from the local control switches at their associated MCCs. The inspectors identified that a potential fire induced ground in any of these fire areas could clear/open the associated control power fuses (the normal and alternate), which would prevent the valves from operating at the local or remote control switches.

The licensee, in response to the inspectors' identification of the circuit deficiency, initially determined that the existing SSA and procedures included mitigating actions if such a condition occurred. The actions included steps to locally remove the PORV control power fuse to fail its associated PORV closed. The inspectors were concerned that because the PORVs and their associated block valves formed a high-low pressure interface that required postulating a proper polarity cable to cable fault, these actions may not be effective in preventing the PORVs from spuriously opening or ensuring closing them during a design basis fire in any of these areas.

The inspectors concluded that the licensee's credited actions to remove the control power fuses to close the PORVs did not meet their design and licensing basis for the PORVs and their associated block valves for high-low pressure interface components as specified in the SSA Section 2.4.1.5.2, "Cable Damage Assumption," which stated, in part, that for components which do form part of a high-low pressure interface between the RCS and a lower pressure system, credible circuit failures include multiple open circuits, short circuits, shorts to ground, and multiple hot shorts within the control circuit. In addition, the SSA stated 3-phase AC power circuit cable-to-cable proper phase sequence faults and 2-wire ungrounded DC circuit cable-to-cable proper polarity faults are considered to be credible, and must be evaluated.

Upon discovery, the licensee entered this issue into their Corrective Action Program (CAP) as Action Request (AR) 02542045, AR 02544447, and AR 2550306 and established fire watches as immediate compensatory actions. In order to resolve this issue the licensee intended to perform plant modifications. In addition, on August 20, 2015, the licensee notified the NRC via Event Notification EN 51334 per 10 CFR 50.72(ii)(B) for an unanalyzed condition related to this issue. On September 2, the licensee updated the previous notification adding that the local actions to close the block valves at the MCC may not be effective because the MCC may not have electrical power during the design basis fire and therefore, the credited safe shutdown action to remove the PORV control power fuses may not prevent the PORV from spuriously opening and may not ensure the closing of the PORV during a design basis fire in the cable spreading rooms.

Analysis: The inspectors determined that the licensee's failure to ensure that the shutdown capability was independent of the fire area and free of fire damage was contrary to Braidwood Station Operating License conditions for the Fire Protection Program and was a performance deficiency. Specifically, in the event of a design basis fire in the control room, cable spreading rooms, or electrical cable penetration areas the licensee failed to ensure that the shutdown capability for Pressurizer PORV block valves would not be affected by fire damage that could impair the operation and closing of the valves from the local control switches located at their associated MCCs in the event of spurious operation of their associated PORVs.

The performance deficiency was determined to be more than minor because it was associated with the Mitigating Systems Cornerstone attribute of Protection Against External Events (Fire), and 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, in the event of a fire in the control room or the upper and lower cable spreading rooms, fire-induced circuit failures could result in spurious operation of the Pressurizer PORVs and impair the operation and the closing of their associated block valves thus affecting and complicating the plant shutdown in the event of a fire in any of these areas. The actions to close the block valve were required in the event of spurious opening of the associated PORV because the action to remove the control power fuse was not consistent with the circuit analysis for high-low pressure interface component and may not prevent the PORV from spuriously opening and did not ensure the closing of the PORV.

In accordance with Inspection Manual Chapter (IMC) 0609, "Significance Determination Process," Attachment 0609.04, "Initial Characterization of Findings," Table 2 the inspectors determined the finding affected the Mitigating Systems Cornerstone. The finding degraded fire protection defense-in-depth strategies, and the inspectors determined, using Table 3, that it could be evaluated using Appendix F, "Fire Protection Significance Determination Process." Using IMC 0609, Appendix F, Attachment 1, "Fire Protection Significance Determination Process Worksheet," the inspectors were not able to screen out the finding using the data available to them, therefore a detailed risk-evaluation was performed by a Region III Senior Reactor Analyst (SRA).

The inspectors assigned the finding to the category of "Post-Fire Safe Shutdown." In Task 1.4.5, ""Post-fire Safe Shutdown," the inspectors answered "Yes" to Question C, "Could the fire result in a piece of equipment required for safe shutdown not being available." The inspectors contacted the Region III SRA for assistance with the risk evaluation.

The change in core damage frequency (ΔCDF) risk for this deficiency is represented by core damage sequences that include the potential for spurious operation of a pressurizer PORV following certain fires in the main control room, cable spreading rooms, and electrical cable penetration areas that also fail the ability to operate the associated PORV block valve. The ΔCDF values in this analysis apply to both Unit 1 and Unit 2 and the total ΔCDF applies to each unit separately.

Main Control Room

The ΔCDF for the main control room was evaluated in two cases. The first case is when evacuation is not required. The second case is when evacuation is required. Each case is discussed below.

Case1: Evacuation Not Required

The frequency of fire for the main control room cabinet (Cabinet 1PM05J) that contained the pressurizer block valves and PORVs was 2.29E-05/yr as listed in the Braidwood Individual Plant Examination of External Events (IPEEE). To estimate the spurious actuation likelihood of the PORVs, the SRA used NUREG/CR-7150, "Joint Assessment of Cable Damage and Quantification of Effects from Fire," Volume 2, Table 8-1, "Summary of Mean Conditional Probability of Spurious Operation for Single Break

Control Circuits." The spurious actuation likelihood given inter-cable shorts with thermoset cables was listed as 6.3E-03. The likelihood of a proper polarity hot short then is (6.3E-03)2 or 4.0E-05. Since there are two PORVs, the likelihood of a proper polarity hot short for either PORV is 8.0E-05. In addition, spurious action likelihood given an inter-cable (6.3E-03) and a ground fault equivalent (0.17) hot short was calculated to be 1.1E-03 (6.3E-03 x 0.17). Since there are two PORVs, the hot short probability for this particular failure mode for either PORV is 2.2E-03. Thus, the overall probability of fire-induced spurious operation to open of either pressurizer PORV due to all possible failure modes was calculated to be 2.3E-03.

For the conditional core damage probability (CCDP), using the Braidwood Standardized Plant Analysis Risk model, Version 8.24, and "Systems Analysis Programs for Hands-on Integrated Reliability Evaluations" Version 8.1.2. The SRA performed an initiating event assessment assuming a small break loss of coolant accident as a result of the block/PORV valves being open. In addition, the SRA assumed one division of electrical equipment was rendered unavailable due to fire. The result was a CCDP of 2.46E-02.

Using the above data and assumptions, the main control room fire risk contribution for Case 1 is 1.30E-09/yr:

$$\Delta CDF_{Case\ 1} = (2.29E\text{-}05/yr) * (2.3E\text{-}03) * (2.46E\text{-}02) = 1.30E\text{-}09/yr$$

Case 2: Evacuation Required

The frequency of fire for the main control room was again assumed to be 2.29E-05/yr. The fire is assumed to result in abandonment of the main control room given suppression attempts fail at 15-minutes. Table 5-2 of NUREG-2169, "Nuclear Power Plant Fire Ignition Frequency and Non-Suppression Probability Estimation Using the Updated Fire Events Database: United States Fire Event Experience Through 2009," lists the 15-minute non-suppression probability as 8.0E-03. As stated in Case 1, the probability of fire-induced spurious operation to open of either pressurizer PORV is 2.3E-03. For the CCDP, the SRA used a single overall human error probability of 0.1 as a screening CCDP surrogate.

Using the above data and assumptions, the main control room fire risk contribution for Case 2 is negligible:

$$\Delta CDF_{Case\ 2} = (2.29E\text{-}05/yr) * (8.0E\text{-}03) * (2.3E\text{-}03) * (1.0E\text{-}01) = 4.21E\text{-}11/yr$$

The total ΔCDF for the main control room is estimated as the sum of the two cases, or a ΔCDF value of 1.34E-09/yr.

Cable Spreading Rooms

The SRA estimated the frequency of fire in the two upper and two lower cable spreading rooms as 1.4E-03/yr using Table A1.3 of IMC 0609 Attachment 1, "Fire Frequency Evaluation Worksheet." This value is conservative as it assumes that the cable spreading rooms contain nonqualified cables with high loading. Fires in the cable spreading rooms are not assumed to result in control room abandonment.

The upper cable spreading room uses an automatic halon suppression system. NUREG/CR-6850, "Fire PRA Methodology for Nuclear Power Facilities," lists the

non-suppression probability for automatic halon systems as 0.05. The lower cable spreading room uses an automatic CO2 suppression system. The NUREG lists the non-suppression probability for automatic CO2 systems as 0.04. The SRA used the higher non-suppression probability of 5E-02 for fires in the upper and lower cable spreading rooms. As stated in Case 1 above, the probability of fire-induced spurious operation to open of either pressurizer PORV is 2.3E-03. For the CCDP, the SRA used the 2.46E-02 value assuming a small break loss of coolant accident.

Using the above data and assumptions, the ΔCDF for the cable spreading room fire for both the upper and lower rooms' contribution to the risk of this issue is estimated at 1.58E-8/yr:

$$\Delta CDF_{\text{cable spreading rooms}} = (4 \text{ rooms}) * (1.4E\text{-}03/yr) * (5.0E\text{-}02) * (2.3E\text{-}03) * (2.46E\text{-}02) = 1.58E\text{-}8/yr$$

Division 11(21) Electrical Penetration Area

The SRA estimated the frequency of fire in the Division 11(21) Electrical Penetration Area as 1.4E-03/yr using Table A1.3 of IMC 0609 Attachment 1, "Fire Frequency Evaluation Worksheet." This value is conservative as it assumes that the electrical penetration areas contain nonqualified cables with high loading. Fires in the Division 11(21) Electrical Penetration Area are not assumed to result in control room abandonment.

The Division 11(21) Electrical Penetration Area has no automatic fire suppression, although there is detection, and the area is accessible to the fire brigade. Table 5-2 of NUREG-2169 lists the 15-minute non-suppression probability for cable fires as 0.126. As stated in Case 1 above, the probability of fire-induced spurious operation to open of either pressurizer PORV is 2.3E-03. For the CCDP, the SRA assumed only random failures of equipment, and calculated a value of 5.49E-03 assuming a small break loss of coolant accident.

Using the above data and assumptions, the ΔCDF for the Division 11(21) Electrical Penetration Area fire contributions to the risk of this issue is estimated at 2.2E-09/yr:

$$\Delta CDF_{\text{Division 11(21) Electrical Penetration Area}} = (1.4E\text{-}03/yr) * (0.126) * (2.3E\text{-}03) * (5.49E\text{-}3) = 2.2E\text{-}09/yr$$

Division 21(22) Electrical Penetration Area

The ΔCDF for the Division 21(22) Electrical Penetration Area was estimated assuming the areas are symmetrical and the same data and assumptions applied as for the Division 11(21) Electrical Penetration Area. The ΔCDF for the Division 21(22) Electrical Penetration Area fire contributions to the risk of this issue is estimated at 2.2E-09/yr.

Total ΔCDF

The total ΔCDF due to this performance deficiency is estimated as the sum of the individual ΔCDF values, or 2.2E-08/yr. The dominant core damage sequences involved small break loss of coolant accident scenarios.

Based on the detailed risk evaluation, the SRA determined that the finding was of very low risk significance (Green).

The inspectors did not identify a cross-cutting aspect associated with this finding, because the finding was not representative of the licensee's current performance. The last opportunity for the licensee to identify and evaluate this issue was during the Multiple Spurious Operations (MSOs) project in 2012. However, it was outside the scope of the MSO project to look at the detailed wiring configuration for the PORVs and their associated block valves because the scenario of spurious operation of the PORVs and its mitigating strategy was thought to be previously very well thought out.

Enforcement: License Conditions 2.E of the Braidwood Station operating licenses, for Units 1 and 2, required, in part, that the licensee implement and maintain in effect all provisions of the fire protection program as described in the Final Safety Analysis Report, as supplemented and amended, and as approved in Safety Evaluation Reports and their supplements.

Section 2.4.3.2, "Pressurizer PORVs and Block Valves" of the SSA, stated, in part, that the Division 12(22) PORV and block valves both have control cables in the main control room and in two of the lower cable spreading rooms. Should a fire in any of these zones cause the spurious opening of the PORV, coincident with control circuit damage to the block valve, the block valve could still be closed. A "remote/local" isolation switch and control switch are provided for the block valve at its motor control center, located in the Division 12(22) electrical penetration area. The block valve can be closed by placing the "remote/local" isolation switch in "local" and then closing the valve with the control switch provided. Additionally, Section 2.4.3.2 also stated that in fire zones where one of the PORVs had a control cable present in the zone that can spuriously open the PORV and its associated block valve does not have AC power available, the PORV will be failed closed by pulling its control power fuse at its DC distribution panel.

Contrary to the above, as of August 28, 2015, the licensee failed to implement and maintain all provisions of their approved fire protection program. Specifically, the licensee failed to ensure that control circuits associated with the PORVs and local control switches for the PORV block valves were not affected by a fire in the main control room, cable spreading rooms, and electrical penetration areas. As a result, the licensee failed to ensure that the pressurizer block valves could be closed should a fire cause the spurious opening of the PORVs.

This violation is being treated as an NCV, consistent with Section 2.3.2 of the Enforcement Policy because it was of very low safety significance, and was entered into the licensee's CAP as AR 02542045, AR 02544447, and AR 2550306. The licensee established fire watches as compensatory measures and planned to implement modifications to correct the issue. (NCV05000456/2014007-01; 05000457/2014007-01, Failure to Ensure Circuits Associated with Pressurizer PORVs Block Valves were Free of Fire Damage).

.7 Communications

a. Inspection Scope

The inspectors reviewed, on a sample basis, the adequacy of the communication system to support plant personnel in the performance of alternative safe shutdown functions and

fire brigade duties. The inspectors verified that plant telephones, page systems, sound powered phones, and radios were available for use and maintained in working order. The inspectors reviewed the electrical power supplies and cable routing for these systems to verify that either the telephones or the radios would remain functional following a fire.

b. Findings

No findings were identified.

.8 Emergency Lighting

a. Inspection Scope

The inspectors performed a plant walkdown of selected areas in which a sample of operator actions would be performed in the performance of alternative safe shutdown functions. As part of the walkdowns, the inspectors focused on the existence of sufficient emergency lighting for access and egress to areas and for performing necessary equipment operations. The locations and positioning of the emergency lights were observed during the walkdown and during review of manual actions implemented for the selected fire areas.

b. Findings

No findings were identified.

.9 Cold Shutdown Repairs

a. Inspection Scope

The inspectors reviewed the licensee's procedures to determine whether repairs were required to achieve cold shutdown and to verify that dedicated repair procedures, equipment, and material to accomplish those repairs were available onsite. The inspectors also evaluated whether cold shutdown could be achieved within the required time using the licensee's procedures and repair methods. The inspectors also verified that equipment necessary to perform cold shutdown repairs was available onsite and properly staged.

b. Findings

No findings were identified.

.10 Compensatory Measures

a. Inspection Scope

The inspectors conducted a review to verify that compensatory measures were in place for out-of-service, degraded or inoperable fire protection and post-fire safe shutdown equipment, systems, or features (e.g., detection and suppression systems, and equipment, passive fire barriers, pumps, valves or electrical devices providing safe shutdown functions or capabilities). The inspectors also conducted a review of the adequacy of short term compensatory measures to compensate for a degraded function or feature until appropriate corrective actions were taken.

b. Findings

No findings were identified.

.11 Review and Documentation of Fire Protection Program Changes

a. Inspection Scope

The inspectors reviewed changes to the approved Fire Protection Program to verify that the changes did not constitute an adverse effect on the ability to safely shutdown. The inspectors also reviewed the licensee's design control procedures to ensure that the process included appropriate reviews and controls to assess plant changes for any potential adverse impact on the Fire Protection Program and/or post-fire safe shutdown analysis and procedures.

b. Findings

No findings were identified.

.12 Control of Transient Combustibles and Ignition Sources

a. Inspection Scope

The inspectors reviewed the licensee's procedures and programs for the control of ignition sources and transient combustibles to assess their effectiveness in preventing fires and in controlling combustible loading within limits established in the fire hazards analysis. A sample of hot work and transient combustible control permits were also reviewed. The inspectors performed plant walkdowns to verify that transient combustibles and ignition sources were being implemented in accordance with the administrative controls.

b. Findings

No findings were identified.

.13 B.5.b Inspection Activities

a. Inspection Scope

The inspectors reviewed the licensee's preparedness to handle large fires or explosions by reviewing selected mitigating strategies. This review ensured that the licensee continued to meet the requirements of their B.5.b related license conditions and 10 CFR 50.54(hh)(2) by determining that:

- Procedures were being maintained and adequate;
- Equipment was properly staged, maintained, and tested;
- Station personnel were knowledgeable and could implement the procedures; and
- Additionally, inspectors reviewed the storage, maintenance, and testing of B.5.b-related equipment.

The inspectors reviewed the licensee's B.5.b-related license conditions and evaluated selected mitigating strategies to ensure they remain feasible in light of operator training, maintenance/testing of necessary equipment and any plant modifications.

In addition, the inspectors reviewed previous inspection reports for commitments made by the licensee to correct deficiencies identified during performance of Temporary Instruction 2515/171 or subsequent performances of these inspections.

The B.5.b mitigating strategies selected for review during this inspection are listed below. The offsite and onsite communications, notifications/emergency response organization activation, initial operational response actions and damage assessment activities identified in Table A.3 1 of Nuclear Energy Institute (NEI) 06-12, "B.5.b Phase II and III Submittal Guidance," Revision 2 are evaluated each time due to the mitigation strategies' scenario selected.

| NEI 06-12, Revision 2, Section | Licensee Strategy (Table) |
|---|---|
| 3.3.3 | Manual Operation of Diesel Driven Auxiliary Feedwater Pump (Table A.4-3) |
| 3.3.6 | Containment Flooding with Portable Pump (Table A.4-6) |

b. Findings

No findings were identified.

## 4. OTHER ACTIVITIES

4OA2 Identification and Resolution of Problems (71152)

a. Inspection Scope

The inspectors reviewed the licensee's CAP procedures and samples of corrective action documents to verify that the licensee was identifying issues related to the Fire Protection Program at an appropriate threshold and entering them in the CAP. The inspectors reviewed selected samples of condition reports, design packages, and fire protection system non-conformance documents.

b. Findings

No findings were identified.

4OA6 Management Meetings

.1 Exit Meeting Summary

On August 28, 2015, the inspectors presented the inspection results to Mr. J. Bashor, 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.

ATTACHMENT: SUPPLEMENTAL INFORMATION

## SUPPLEMENTAL INFORMATION

## KEY POINTS OF CONTACT

Licensee

J. Bashor, Engineering Director
M. Kanavos, Site Vice President
M. Marchionda, Plant Manager
F. Piriano, Electrical Design Branch Manager
D. Riedinger, Senior Design Manager

U.S. Nuclear Regulatory Commission

J. Benjamin, Senior Resident Inspector
D. Betancourt, Resident Inspector
K. O'Brien, Director, Division of Reactor Safety

## LIST OF ITEMS OPENED, CLOSED AND DISCUSSED

Opened and Closed

| | | |
|---|---|---|
| 05000456/2015007-01; 05000457/2015007-01 | NCV | Failure to Ensure that Circuits Associated with Pressurizer PORVs and Block Valves Were Free of Fire Damage (Section 1R05.6.b) |

## LIST OF ACRONYMS USED

| | |
|---|---|
| ΔCDF | Change in Core Damage Frequency |
| AC | Alternating Current |
| ADAMS | Agencywide Document Access and Management System |
| AR | Action Request |
| CAP | Corrective Action Program |
| CCDP | Conditional Core Damage Frequency |
| CFR | *Code of Federal Regulations* |
| DC | Direct Current |
| IMC | Inspection Manual Chapter |
| MCC | Main Control Center |
| MSO | Multiple Spurious Operations |
| NCV | Non-Cited Violation |
| NEI | Nuclear Energy Institute |
| NFPA | National Fire Protection Association |
| NRC | U.S. Nuclear Regulatory Commission |
| PARS | Publicly Available Records System |
| PORV | Power Operator |
| PRT | Pressure Relief Tank |
| RCS | Reactor Coolant System |
| SDP | Significance Determination Process |
| SSA | Safe Shutdown Analysis |
| SSC | Structure, System, and Component |
| SRA | Senior Reactor Analyst |

## LIST OF DOCUMENTS REVIEWED

The following is a list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspectors reviewed the documents in their entirety, but rather, that selected sections of 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.

### CALCULATIONS

| Number | Description or Title | Revision |
|---|---|---|
| BRW-11-0119-E | Multiple Spurious Operations (MSO) Scenario Analysis | 0 |

### CORRECTIVE ACTION PROGRAM DOCUMENTS ISSUED DURING INSPECTION

| Number | Description or Title | Date |
|---|---|---|
| 2534707 | Transient Combustible\Housekeeping | 07/2915 |
| 2541560 | FP Seal Inspection Procedure MA-BR-EM-5-00008 Enhancement | 08/13/15 |
| 2541896 | NRC Questioned Storage of Pipe Insulation in 2B AF Pump Room | 08/14/15 |
| 2542045 | NRC Question on MCR Fire/PORV Block Valves | 08/14/15 |
| 2544447 | NRC Identified Potential In-Adequate Safe Shutdown Strategy | 08/20/15 |
| 2545656 | Wrong EPN in EDMG-1 | 08/24/15 |
| 2546794 | NRC Identified: Inadequate Seismic Housekeeping | 08/26/15 |
| 2546799 | NRC Identified – 2B AF Pump Room Housekeeping Issue | 08/26/15 |
| 2547616 | Equipment Operator B.5.b Training Enhancements | 08/28/15 |
| 2550306 | EOC Review of IR 2544447 PORV Fire SSD Strategy | 09/02/15 |

### CORRECTIVE ACTION PROGRAM DOCUMENTS REVIEWED

| Number | Description or Title | Date |
|---|---|---|
| 0756949 | Enhancements Captured during NRC's B.5.b Inspection | 03/31/08 |
| 1386351 | B.5.B Pump #2 Failed Weekly Surveillance | 07/26/12 |
| 1393564 | NRC Triennial FP Inspection – Security Training Of B.5.b | 07/26/12 |
| 1394082 | NRC Observations During Fire Protection Triennial (B.5.b) | 07/27/12 |
| 1449886 | OCA Gasoline And Diesel Fuel Tanks Required | 12/09/12 |
| 1566305 | PM For Fire Barrier inspection Could Not Be performed | 10/01/13 |
| 2444324 | Scaffold Was Moved 4" to 6" From Original Position | 01/29/15 |
| 2449084 | Pipe insulation Worn Away – 2SX2191 | 02/07/15 |
| 2470758 | Degraded Fire Door Requires Assistance To Close (D-441) | 03/19/15 |
| 2503072 | PMID Credited To WO That Has Not Been Completed | 05/19/15 |
| 2545580 | Evaluation Of Alternate Fire Protection Compensatory Actions | 08/24/15 |

### DRAWINGS

| Number | Description or Title | Revision |
|---|---|---|
| 1A-FP-37 | Fire Protection Large Bore Isometric | E |
| 20E 1-3857 | Lighting Turb. Bldg. 426'0" Col H-L; 4-8 | M |

**DRAWINGS**

| Number | Description or Title | Revision |
|---|---|---|
| 20E 1-4409A | Wiring Diagram Lighting Junct. Boxes | D |
| 20E-1-4030RY12 | Schematic Drawing Pressurizer Relief Isolation Valves 1RY8000A & 1RY8000B | U |
| A-262 | Auxiliary Building Cable Room Floor Plan | BO |
| BwHS 4009-005 | Location Of Detectors 451' AUX Building | 5 |
| M-2545A, sht. 15 | Fire Protection Typ. Valve Arrangement Auxiliary Bldg. | A |
| M-52 | Diagram Of Fire Protection At Lake Screen House Units 1 & 2 | AO |
| M-603 | Auxiliary Building Viking Sprinkler Systems EL.383'0" | A |
| M-96 | Diagram of Control Room HVAC System | Z |
| PG-2545A-48 | Fire Protection 2" And Under Isometric | C |

**PROCEDURES**

| Number | Description or Title | Date or Revision |
|---|---|---|
| 0BwOS FP.B.5.b.SA-3 | B.5.b and Flex Equipment Area Check Surveillance | 3 |
| 0BwOS FP-Q5 | Fire Brigade Equipment Area Check Surveillance | 18 |
| 1BwOA PRI-5 | Control Room Inaccessibility Unit 1 | 106 |
| 2BwOA ELEC-3 | Loss of 4KV ESF Bus Unit 2 | 102 |
| BwAP-1100-23 | Seismic Housekeeping Requirements For The Temporary Storage Of Materials In Category I Areas | 4 |
| BwAR 1-12-B2 | Pressurizer or SAF Valve Open | 11 |
| BwMS 3350-002 | Semi-Annual Inspection of Fire Protection Program Required Fire Doors | 11 |
| BwOP FP-100 | Fire Response Guidelines | 15 |
| BwOP FP-100T33 | Fire Zones 5.6-1 & 5.6-2, 5.4-1 & 5.4-2 Unit 1/Unit 2 Miscellaneous Electrical Equipment & Battery Rooms 1D-67, 2D-67 | 3 |
| BwOP FP-100T33 | Fire Zones 5.6-1 & 5.6-2, 5.4-1 & 5.4-2 Unit 1/Unit 2 Miscellaneous Electrical Equipment & Battery Rooms 1D-67, 2D-67 | 2 |
| BwOP FP-100T35 | Fire Zones 5.5-1 & 5.5-2 Unit 1/Unit 2 Auxiliary Electrical Equipment Rooms 1D-69, 2D-69 | 10 |
| BwOP FP-100T38 | Fire Zone 2.1-0 Main Control Room 1D-75 | 9 |
| BwOP FP-100T50 | 3.2-0 Auxiliary Building 439' LCSR Entry Area | 8 |
| BwOP FP-100T6 | 11.4-0, 11.4A-1, 11.4A-2, 11.4B-0 383' Auxiliary Building General Area and 1B / 2B AF Pump Rooms 1-D11, 1S41, 1S-42, 2S-41, 2S-54 | 11 |
| EDMG-1 | Extensive Damage Mitigation Guideline | 5 |
| EDMG-1 | Extensive Damage Mitigation Guideline | 5 |
| MA-AA-723-350 | Emergency Lighting Battery pack Quarterly Inspection | 14 |
| MA-BR-726-633 | Installation of Post-Fire Cold Shutdown Emergency Cable | 3 |
| OCAG | Operational Contingency Action Guideline for Dealing with a | 04/18/13 |

**PROCEDURES**

| Number | Description or Title | Date or Revision |
|---|---|---|
| | Security Threat – OCAG | |
| Pre-Fire Plan #132 | AB 383' Aux. Bldg. General Area - Center | 0 |
| Pre-Fire Plan #21 | CSR 439' Lower Cable Spreading Room, Zone B-1 | 1 |
| Pre-Fire Plan #49 | SWGA 451' Unit 1, Aux. Electrical Equip. Room | 0 |

**WORK ORDERS**

| Number | Description or Title | Date |
|---|---|---|
| 01267080 01 | Fire Barrier Penetration Inspection On GRP 4 Seals | 01/24/14 |
| 01422027 01 | Fire Seals GRP 18 Inspection (U2 REFL/BUS243 OTG BUS DUCTS) | 10/25/12 |
| 01729604 01 | #1 Pump Flow Water Through Pump & Re-Rack All Hoses | 04/25/15 |
| 01757587 01 | Perform PM On ELB Group 8 | 10/20/14 |
| 01790190 01 | #1 Pump Functional Run & Equipment Checks | 05/06/15 |
| 01798887 01 | Perform PM On ELB Group 7 | 02/20/15 |
| 01818158 01 | Fire Brigade Cages Equipment Surveillance | 07/03/15 |
| 01832267 01 | Inventory of Emergency Cold Shutdown Materials | 08/07/15 |

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Sincerely,

***/RA/***

Robert C. Daley, Chief
Engineering Branch 3
Division of Reactor Safety

Docket Nos. 50–456; 50–457
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