

March 31, 2014

MEMORANDUM TO: Gary L. Shear, Director  
Division of Reactor Safety  
Region III

FROM: Sher Bahadur, Deputy Director */RA/*  
Division of Policy and Rulemaking  
Office of Nuclear Reactor Regulation

SUBJECT: FINAL RESPONSE TO TASK INTERFACE AGREEMENT 2013-02,  
SINGLE SPURIOUS ASSUMPTION FOR BRAIDWOOD AND BYRON  
STATIONS SAFE-SHUTDOWN METHODOLOGY

By memorandum dated October 1, 2010 (Agencywide Documents Access and Management System Accession No. ML102770293), the U.S. Nuclear Regulatory Commission (NRC), Region III Office, requested assistance from the Office of Nuclear Reactor Regulation (NRR) in evaluating the acceptability of the Braidwood Station (Braidwood) and Byron Station (Byron) nuclear plants licensing bases to use only a single spurious actuation assumption to evaluate post-fire safe shutdown capabilities at the units. Region III requested NRR's technical assistance to address the above issue by providing answers to the Task Interface Agreement questions noted in the enclosed staff evaluation.

The NRR staff has reviewed the issue and concluded based on the available information that Braidwood and Byron are in compliance with their current licensing basis because the specific language in the Braidwood and Byron licensing bases with respect to the single spurious actuation assumption, having been expressly approved by the NRC staff, takes legal precedence over the general language of those licensees' commitments to Appendix R. Therefore, it was difficult for the NRC staff to determine in a timely manner a regulatory requirement to support compliance backfitting these four reactors (see enclosure). The NRR staff will continue to review this issue to determine if a safety or risk concern is present that merits regulatory action.

Enclosure:  
Compliance Backfit Discussion

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(301) 415-1053

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**ADAMS Accession No.: ML12194A500 \*No significant change from Draft Response NRR-106**

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**TASK INTERFACE AGREEMENT 2013-02**  
**COMPLIANCE BACKFITTING DISCUSSION**  
**SINGLE SPURIOUS ACTUATION ASSUMPTION FOR**  
**BRAIDWOOD AND BYRON STATIONS SAFE-SHUTDOWN METHODOLOGY**

1.0 INTRODUCTION

By memorandum dated October 1, 2010 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML102770293), the U.S. Nuclear Regulatory Commission (NRC), Region III Office, requested assistance from the Office of Nuclear Reactor Regulation (NRR) in evaluating the acceptability of the Braidwood Station (Braidwood) and Byron Station (Byron) nuclear plants licensing bases to use only a single spurious actuation assumption to evaluate post-fire safe shutdown capabilities. Region III requested NRR's technical assistance to address the above issue by providing answers to three questions concerning the single spurious actuation assumption at Braidwood and Byron.

2.0 BACKGROUND

2.1 Licensing Background

Braidwood Units 1 and 2 received licenses to operate in 1987 and 1988, respectively, and Byron Units 1 and 2 received licenses to operate in 1985 and 1987, respectively.

Since both Braidwood and Byron were licensed after January 1, 1979, they were not required by Title 10 of the *Code of Federal Regulations* (10 CFR) 50.48(b) to comply with the safe shutdown requirements in Section III.G of Appendix R to 10 CFR Part 50. However, as documented in Appendix 5.7 to the Byron/Braidwood Nuclear Stations Fire Protection Report Amendment 25 (ADAMS Accession No. ML14042A095, publicly available) both Byron and Braidwood committed to meet 10 CFR Part 50, Appendix R, including Section III.G. Braidwood and Byron were both reviewed by the NRC staff using the applicable technical guidance contained in the Standard Review Plan (SRP), NUREG-0800, Section 9.5.1, issued in July 1981.

As part of the licensing process, Commonwealth Edison (the licensee for Byron and Braidwood at that time) responded in a letter dated October 11, 1984 (ADAMS Accession No. ML102861753), to Final Safety Analysis Report Question 010.65 in which the staff asked the licensee to "identify the plant transients that could be initiated by fire-induced spurious operation of equipment" for each fire area. The licensee response was then revised in an October 15, 1984, letter (ADAMS Accession No. ML102861750), that provided specific information, as discussed in Response 1 below, describing the plant as having a single spurious licensing basis.

The NRC staff documented its review of this information in NUREG-1002, the Safety Evaluation Report (SER) for Braidwood Units 1 and 2, Supplement 2 (SSER 2) dated October 1986 (ADAMS Legacy Library Accession No. 8610310144), which also stated that the shutdown and

ENCLOSURE 1

alternative shutdown capability for Braidwood is the same as that for Byron and was found acceptable. The safe-shutdown methodology was approved for Byron in NUREG-0876, the SER for Byron Station, Supplement 5 (SSER 5), dated October 1984 (ADAMS Accession No. ML091340252). The SERs and subsequent supplements were incorporated into the license conditions for both Braidwood and Byron. The license conditions for Braidwood Units 1 and 2 and Byron Units 1 and 2 are available at ADAMS Accession Nos. ML053040362, ML053040366, ML052910365, and ML052910368, respectively.

During the first triennial fire protection inspection under the Reactor Oversight Process conducted at Braidwood in June 2000 (inspection report dated January 8, 2001, ADAMS Accession No. ML010100073), Region III inspectors identified the licensee's Fire Protection Program (FPP) contained an assumption of a single spurious operation for the duration of a fire event. The same assumption is used in the licensing basis for Byron, which is identical to Braidwood based on the licensing discussion above.

Currently, there are two Unresolved Items (URIs) tracking these issues. URI 05000456/2000006-03; 05000457/2000006-03 (updated in Inspection Report 000456/2009006; 05000457/2009006) is tracking safe shutdown issues for Braidwood. URI 05000454/2004005-02; 05000455/2004005-02 is tracking safe-shutdown issues for Byron.

## 2.2 Compliance Background Timeline

The following timeline lays out the licensing history for multiple spurious actuation assumptions in general, with information available about Byron and Braidwood in particular.

February 19, 1981 – Effective date of the 1980 revision to the NRC's fire protection requirements. 45 FR 76602 (November 19, 1980). Under the 1980 rulemaking, plants licensed prior to January 1, 1979, were backfit to the requirements of 10 CFR Part 50, Appendix R, Section III.G which uses plural language for describing spurious operations. The NRC staff position is that for plants licensed prior to January 1, 1979, consideration of multiple circuit failures that could prevent operation or cause maloperation of redundant trains is a regulatory requirement.

July 1981 – The NRC issued NUREG-0800, Standard Review Plan (SRP) Section 9.5.1 for fire protection. This SRP, which was used to review Byron and Braidwood, included the same discussion of spurious operations, but the discussion is related specifically to alternate or dedicated shutdown. There were no review criteria in the SRP for spurious operations due to multiple fire-induced circuit faults.

June 28, 1984 – Byron Fire Protection Report Amendment 3 (ADAMS Accession No. ML102861901, non-publicly available). Section 2.4.3.2.2.2, of the Fire Protection Report discusses four failure modes of power operated relief valves (PORVs). Failure Mode 4 postulated two PORVs spuriously opening. In Section 2.4.3.2.2.3, the licensee deemed this failure to be incredible.

October 15, 1984 – In response to NRC questions, by letter dated October 15, 1984, the licensee committed "to either prevent or mitigate the spurious operation [of pressurizer PORVs] by one of the following means: 1) the equipment will be isolated from the fire areas of concern

prior to the occurrence of a fire; 2) an electrical isolation device will be added to prevent spurious operation; or 3) a means to detect any spurious operation and procedures to defeat the spurious operation would be provided.”

In the same letter the licensee responded to Question 010.65, regarding operator response to plant transients caused by fire-induced spurious operation of equipment. The NRC requested details by area and corrective actions. The response included discussion of only single spurious actuations of valves, see additional discussion in response to Question 1 below.

October 31, 1984 – NUREG-0876, SSER 5, Section 1.9, License Condition 7 lists “Compliance with Appendix R of 10 CFR 50, Fire Protection” which is discussed in Section 9.5.1. This section references the October 15, 1984 letter.

February 14, 1985 – Facility Operating License NPF-37 (ADAMS Accession No. ML020850415), which authorized full-power operation of Byron Station, Unit 1, references the October 15, 1984 letter as part of the license condition in Section 2.C(6)(a).

In summary, the licensee initially considered multiple spurious actuations but later stated that only single spurious operations were considered. There was no regulatory requirement for review of fire-induced multiple spurious operations. The review guidance in NUREG-0800, Section 9.5.1, only included discussion of multiple spurious operations in the alternative and dedicated safe shutdown section. However, the licensees’ submittals were evaluated to both 10 CFR Part 50, Appendix R in its entirety and the SRP Section 9.5.1. In cases where licensees’ submittals did not take exception to 10 CFR 50.48, Appendix R, Section III.G.2, the NRC approved the FPPs as meeting Appendix R, Section III.G.2, including the commitment to consider multiple circuit failures. Braidwood and Byron both committed to meet 10 CFR Part 50, Appendix R, which would have included a requirement to address multiple spurious operations, and described using an assumption that “only one spurious operation occurs per single fire” and that “valves are the only plant equipment considered subject to spurious operation, as a result of fire, which could impact the safe shutdown capability of the plant.” Even though the licensee committed to Appendix R, and thereby Section III.G, the licensee did not consider or evaluate multiple spurious operations as part of their licensing basis and claimed that their plants only used a single spurious actuation assumption. The NRC approved the single spurious actuation assumption.

### 3.0 EVALUATION

**Question 1: Is the FPP assumption of only one spurious operation for the duration of a fire event for all fire zones or areas within the Braidwood and Byron licensing bases?**

**Response 1:** Yes, the assumption of only one spurious operation for the duration of a fire event for all fire zones or areas is part of both the Braidwood and Byron licensing bases. The NRC staff could not identify any source that demonstrated that this assumption was verified.

By letter dated October 15, 1984 (ADAMS Accession No. ML102861750), in response to licensing Question 010.65, the licensee informed the NRC staff that:

Valves are the only plant equipment considered subject to spurious operation, as a result of a fire, which could impact the safe shutdown capability of the plant. Spurious starting of pumps due to a fire is not considered because there is no adverse safety impact of a pump starting. An analysis has been performed to identify those valves which are subject to spurious actuation due to a fire and could impact safe shutdown capability.

The assumptions made in performing the analysis were as follows:

1. Appendix R definitions of safe shutdown capability were used;
2. Fire occurs in only one fire zone of the plant;
3. All safe shutdown equipment which could be disabled by a fire in this fire zone is disabled and is thus not available for mitigation of the spurious operation. Additionally, all circuits with cables in the fire zone are assumed to be disabled, and no credit is taken for automatic functions initiated by these circuits.
4. Spurious actuation of a valve results from hot short or open to power or control cables;
5. Only one spurious actuation occurs per single fire;
6. Spurious actuation plus failure of identical redundant components were not considered because separation of redundant equipment is addressed in Section 2.4 of the Fire Protection Report; and
7. Valves with power locked out were not considered because a hot short of the control cables would not cause actuation. [Emphasis added]

In SSER 5 for Byron, the NRC staff stated:

The applicant also performed a detailed analysis of circuits whose fire-induced spurious operation could adversely impact safe shutdown. This analysis included a review of high-low pressure interfaces. For each fire zone, the applicant's analysis assumed all equipment and circuits located in the fire zone were unavailable and one spurious actuation resulted from the fire.

The NRC staff found this approach acceptable and stated in the conclusion to the evaluation, ". . . [T]hat the post-fire safe shutdown capability for Byron complies with the guidelines of SRP Section 9.5.1, Position [C.5.b]."

This approval was carried forward into the approval for Braidwood by NUREG-1002, Section 1.11 (ADAMS Accession No. ML12114A272), which stated that the program for Braidwood Unit 1 was the same as for Byron, and which concluded in Section 9.5.1.4 that the Braidwood design was acceptable for post-fire safe shutdown.

Therefore, the NRC staff concludes that the NRC approved the Byron and Braidwood applicants' assumption of only one spurious operation for the duration of a fire event for all fire zones or areas, and that this assumption is part of the licensing basis for both plants.

During the course of this review, the following information was discussed and has been added for completeness. The assumption that only one spurious operation occurs per single fire conflicts with the assumption which states that the Appendix R definitions of safe shutdown

capability were used. Safe shutdown capability was defined by 10 CFR Part 50, Appendix R, Section III.G, Fire Protection of Safe Shutdown Capability. Byron and Braidwood committed to Appendix R as documented in Appendix 5.7 to the Byron/Braidwood Nuclear Stations Fire Protection Report Amendment 25 (ADAMS Accession No. ML14042A095).

Although Appendix R to 10 CFR 50 applies strictly to plants licensed to operate prior to January 1, 1979, the NRC has made conformance to 10 CFR 50 Appendix R a licensing requirement for Byron/Braidwood. See NRC question 600.01 (June 3, 1981). (Page A5.7-1)

With regard to the Byron/Braidwood conformance to the requirements of Appendix R, Section III.G.2, it states:

Deviations from the requirements of Section III.G.2 are described in Appendix A5.8 and Generic Letter 86-10 evaluations. In each case, a detailed description of the deviations is included, modifications (if any) implemented as a result of the deviation are described, and a justification for the deviation is provided. (Page A5.7-12.)

Appendix 5.8 does not identify a deviation for the assumption of a single spurious operation per fire as compared to the requirement to address hot shorts, open circuits, or shorts to ground, circuit failure modes identified in Appendix R.

The Fire Protection Report, Section 2.4.1.6.4, Spurious Operations (ADAMS Accession No. ML13004A079 for Byron and ADAMS Accession No. ML13004A078 for Braidwood, non-publicly available), states the licensing basis "... is to assume one spurious operation [actuation] per fire, as documented in the Byron and Braidwood SERs."

The Fire Protection Report appears to be based on conflicting assumptions, (a) and (e) from the Response to Question 010.65, which are not consistent with either Appendix R or Branch Technical Position CMEB 9.5-1. However, given that there is a specific statement that only one spurious actuation is assumed, the staff recognizes this to be an exception to the general statement that the plant's design complies with GDC-3 (and implicitly, with the staff's interpretation of that requirement with respect to multiple spurious actuation).

**Question 2: Does a FPP which relies upon the assumption of only one spurious operation for the duration of a fire event satisfy the requirements of 10 CFR 50.48(a)?**

**Response 2:** No, however the reasoning differs, depending upon whether one is looking from the standpoint of the requirements of the regulations, versus consideration of the matter from a technical standpoint.

*Requirements of the regulations*

For a plant which is required by § 50.48 to meet Appendix R, the answer is no, at least with respect to safe shutdown capability. Paragraph III.G.b.2 refers in the plural to "circuits," and "hot shorts, open circuits, or shorts to ground:"

[W]here cables or equipment, including associated non-safety circuits that could prevent operation or cause maloperation due to hot shorts, open circuits, or shorts to ground, of redundant trains of systems necessary to achieve and maintain hot shutdown conditions are located within the same fire area outside of primary containment, . . . one of the redundant trains [must be ensured to be] free of fire damage . . . [emphasis added]

Hence, the regulatory requirement is reasonably interpreted as requiring consideration of more than one spurious operation.

By contrast, for a plant which is not required by § 50.48 to meet Appendix R, the more general requirements of § 50.48 and GDC 3 apply. There is no explicit reference in either § 50.48 or GDC 3 to spurious actuation (single or multiple).

### *Technical Considerations*

The staff believes, from a technical standpoint, that assumption of a single spurious actuation is not in compliance with the requirements of 50.48(a), regardless of whether a plant is subject to Appendix R, or to the more general requirements in § 50.48 and GDC 3 unless the NRC has expressly approved the use of the single spurious actuation with a valid technical justification.<sup>1</sup>

The occurrence of multiple spurious operations has been documented based on both industry tests (“Spurious Actuation of Electrical Circuits Due to Cable Fires: Results of an Expert Elicitation” (Report No. 1006961, May 2002) and NRC sponsored tests (Electrical Cable Test Results and Analysis During Fire Exposure (ELECTRA-FIRE), A Consolidation of Three Major Fire-Induced Circuit and Cable Failure Experiments Performed Between 2001 and 2011: Final Report (NUREG-2128)), and the circuit failures that occurred during the Browns Ferry fire (Recommendations Related to Browns Ferry Fire (NUREG-0050)). This information supports the NRC staff continuing their efforts to determine if there are safety or risk concerns related to multiple spurious operations. The NRC staff will continue to review multiple spurious operations to determine if there are safety issues that merit regulatory action. A fire protection program for a plant licensed before January 1, 1979, that relies on a single spurious actuation assumption would not be consistent with the regulatory requirements. Plants licensed after January 1, 1979, were reviewed against Appendix R and the SRP, NUREG-0800, Section 9.5.1. There is no basis for distinguishing between pre-1979 plants versus post-1979 plants with respect to their vulnerability to multiple hot shorts and multiple spurious actuations. Therefore, the staff believes that post-1979 plants – no different than pre-1979 plants - must consider multiple cable shorts and multiple spurious actions in order to satisfy the requirements of 10 CFR 50.48(a). The only exception is if the NRC had reviewed and approved the consideration of a single spurious actuation, and there exists a cognizable and technically-defensible NRC safety basis for the NRC’s approval.

### **Question 3: Is a compliance backfit to ensure that Braidwood and Byron have a FPP which satisfies 10 CFR 50.48(a) supportable?**

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<sup>1</sup> The staff notes, however, that plants with NRC approval of a single spurious actuation assumption can be reevaluated to determine if they provide reasonable assurance of adequate protection.



Response 3: A compliance backfit for Braidwood and Byron with respect to the single actuations would be difficult to support, based upon current information.

Braidwood and Byron were licensed after January 1, 1979. Therefore, Appendix R is not, by its terms, a regulatory requirement for these two plants. However, Braidwood and Byron both contain statements indicating that their licensing basis includes Appendix R. As discussed above, plants licensed after January 1, 1979 were reviewed by the staff against Appendix R and the SRP, even though the regulation itself did not apply to such plants. The NRC staff did review Braidwood's and Byron's FPPs against Appendix R and the SRP, but the NRC approved the single spurious actuation assumption per fire for Braidwood and Byron and that only spurious operation of valves could impact safe shutdown capability. Thus, the specific language in the Braidwood and Byron licensing bases with respect to the single spurious actuation assumption, having been expressly approved by the NRC staff, takes legal precedence over the general language of those licensees' commitments to Appendix R.

The NRR approval of the single spurious actuation for Braidwood and Byron was not based on the guiding principle of the NRC position on associated circuits concerns as evident in the regulatory history.<sup>2</sup> It is our understanding that there may be other plants besides Braidwood and Byron for which the single spurious actuation was either: (i) expressly approved, or (ii) known to the NRC during the licensing review – although not discussed expressly in either the application, RAI responses, or the SER - and thereafter followed by issuance of the operating license. In addition, the staff has not been able to identify specific documentation, contemporaneous to the issuance of the revised fire protection rule extending to the period

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<sup>2</sup> Specifically, requirements for addressing associated circuits, i.e., spurious actuations, were incorporated into the rule following the Browns Ferry Nuclear Power Plant (Browns Ferry) fire in order to ensure adequate safe shutdown capability would be preserved during and following a fire event. The NRC staff's position on this issue was consistently stated and reiterated in numerous correspondence and communications prior to, during, and following the licensing of Braidwood and Byron. That position is that consideration of associated circuits, including multiple spurious operations, has always been considered to be required analyses in order to demonstrate compliance with the rule.

This definition was followed by guidelines on how to protect "the shutdown capability from fire-induced failures of circuits (cables)," e.g., spurious actuations. Specifically, the GL 81-12 clarification letter provided two methods for how to prevent damage to associated circuits of concern in order to protect safe shutdown capability from the adverse effects of fires. The first method was to provide protection between associated circuits of concern and shutdown circuits as per Section III.G.2 of Appendix R. The second method outlined protective measures for associated circuits with a common power source; circuits of equipment and/or components whose spurious operation would affect safe shutdown capability; and for associated circuits with a common enclosure. In addition, the staff acknowledged two different approaches available to licensees for evaluating the interaction of associated circuits of concern that included "The Fire Area Approach" and "The Systems Approach."

Although GL 81-12 was addressed to all power reactor licensees with licenses issued prior to January 1, 1979, the underlying technical issue and concern regarding multiple spurious operations is the same for plants licensed after January 1, 1979. Given that the issuance of GL 81-12 occurred just five months prior to the issuance of the SRP, which was used to perform the staff's licensing review for Braidwood and Byron, it can be inferred that the staff had established its position on the associated circuits matter prior to its review of Braidwood and Byron and never intended a lesser standard or practice to be applied based on whether a licensee had received a license before or after January 1, 1979.

where the Braidwood and Byron licenses were issued, which clearly documents a staff position that post-1979 plants are to be reviewed to the same requirements on multiple hot shorts and multiple spurious actuations as the pre-1979 Appendix R plants. In such circumstances, it would be difficult to justify a compliance backfit.

However, a number of factors can be relied upon to support compliance backfitting, such as, evidence of clear guidance for plants with licenses issued after January 1, 1979, to address multiple spurious actuation assumption; general guidance relating to multiple spurious actuations for plants with licenses issued after January 1, 1979; or if the guidance is not clear, information to support that a specific plant was an outlier based on the general NRC staff review and acceptance of fire protection programs at that time. Currently, it is difficult to support compliance backfitting with the available information.

In summary, although Braidwood and Byron both have specific single spurious actuation assumption language in its licensing basis, the NRC could argue that this approval was an error and rectify the situation using a compliance backfit. However, it would be difficult to establish a clear and consistent staff position and practice with respect to the acceptability of post-1979 plants to use the single spurious actuation assumption (absent an exemption from § 50.48(a)). Thus, the staff concludes that the regulatory action for Braidwood and Byron to withdraw the NRC's approval of the single spurious actuation assumption should not be pursued as a compliance backfit at this time.

#### 4.0 CONCLUSION

Based on its review of Task Interface Agreement 2013-02, the NRR staff concludes:

1. As post-1979 plants (where the applicable regulations do not expressly address multiple spurious operations/actuations), Braidwood and Byron are in compliance with their licensing bases which specifically provide for the assumption of only one spurious operation of a valve to occur per single fire.
2. Given the information that the NRR staff has reviewed thus far, a compliance backfit could not be pursued in a timely manner with the available information. Thus, the specific language in the Braidwood and Byron licensing bases with respect to the single spurious actuation assumption, having been expressly approved by the NRC staff, takes legal precedence over the general language of those licensees' commitments to Appendix R. NRR staff will continue to review this issue to determine if a safety or risk concern is present that merits regulatory action.

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Date: March 31, 2014