

May 3, 2016

J. Bradley Fewell  
Sr. Vice President of Regulatory Affairs  
Exelon Generation Co., LLC  
4300 Winfield Road  
Warrenville, IL 60555

SUBJECT: U.S. NUCLEAR REGULATORY COMMISSION RESPONSE TO BACKFIT  
APPEAL – BRAIDWOOD STATION, UNITS 1 AND 2, AND BYRON STATION,  
UNITS 1 AND 2

Dear Mr. Fewell:

This letter responds to your December 8, 2015, correspondence, "Appeal of Imposition of Backfit Regarding Compliance with Title 10 of the *Code of Federal Regulations* (10 CFR) Section 50.34(b), General Design Criteria (GDC) 15, GDC 21, GDC 29, and Licensing Basis" (Agencywide Documents Access and Management System (ADAMS) Accession No. ML15342A112). In consideration of your appeal, and consistent with the process outlined in Office of Nuclear Reactor Regulation Instruction LIC-202, Revision 2, "Procedures for Managing Plant-Specific Backfits and 50.54(f) Information Requests," I forwarded the issue to an independent Backfit Review Panel (the Panel) that reviewed the facts and related correspondence. The Panel had discussions with members of your staff, along with U.S. Nuclear Regulatory Commission (NRC) staff, to ensure they understood all perspectives. I recently discussed the review of this issue with the Panel and have come to a conclusion on your appeal.

As further explained in the enclosed NRC evaluation, which summarizes the Panel's findings, the imposition of the subject backfit, and the application of the compliance exception as described in 10 CFR 50.109, "Backfitting," Paragraph (a)(4)(i), is appropriate. The analyses in the Braidwood and Byron Updated Final Safety Analysis Report (UFSAR) Sections 15.5.1, 15.5.2, and 15.6.1 are required to show that Condition II events will not cause a more serious event. This is not the case and thus, the UFSAR does not demonstrate compliance with GDCs 15, 21, and 29 and the plant-specific design basis with respect to progression of Condition II events. The UFSAR analyses of reactor coolant system mass addition (Condition II) events predict water relief through pressurizer relief valves that are not water qualified, which could result in a relief valve sticking open and causing a small break loss of coolant accident (Condition III event). Thus, Braidwood and Byron are not in compliance with 10 CFR 50.34(b). The NRC erred in approving a sequence of events that allowed the inadvertent operation of the emergency core cooling system, chemical and volume control system malfunction, and inadvertent opening of a pressurizer safety or relief valve analyses in the 2001 and 2004 Safety Evaluations (ADAMS Accession Nos. ML011420274 and ML042250516, respectively) to credit water relief through pressurizer safety valves (PSVs) that were not water qualified. The NRC has consistently applied the prohibition of progression of Condition II events, and the 2001 and 2004 approvals occurred because the NRC staff understood the PSVs to be qualified for water

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relief when, in fact, they were not. The licensee must take action to resolve the non-compliance, and there are a number of regulatory options available.

You have 30 days from the date of this letter to appeal to the NRC Executive Director of Operations the determination of the backfit or the applicability of the provisions of 10 CFR 50.109(a)(4)(i). Your response should be addressed to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, DC 20555-0001, with a copy to the Resident Inspector Office at the Braidwood and Byron facilities.

In accordance with 10 CFR 2.390, a copy of this letter, its enclosure, and your response will be available electronically for public inspection in the NRC Public Document Room, or from the Publicly Available Records component of NRC's document system (ADAMS). ADAMS is accessible from the NRC web site at <http://www.nrc.gov/reading-rm/adams.html> (the Public Electronic Reading Room).

Should you have any questions concerning this letter, please contact Alex Garmoe at (301) 415-3814, or via e-mail at [alex.garmoe@nrc.gov](mailto:alex.garmoe@nrc.gov).

Sincerely,

*/RA/*

William M. Dean, Director  
Office of Nuclear Reactor Regulation

Docket No.: 50-456; 50-457; 50-454; 50-455  
License No.: NPF-72; NPF-77; NPF-37; NPF-66

Enclosure:  
NRC Evaluation of Backfit Appeal

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**ADAMS Accession No.: ML16095A204**

\* concurrence via e-mail

NRR-106

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| <b>DATE</b>   | 04/08/2016      | 04/11/2016      | 04/12/2016    | 04/14/2016                |
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| <b>DATE</b>   | 05/03/2016      |                 |               |                           |

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## **NRC EVALUATION OF LICENSEE BACKFIT APPEAL**

### **Introduction**

In a memorandum dated January 12, 2016, the Director of the Office of Nuclear Reactor Regulation appointed a Backfit Review Panel (the Panel) to review Exelon Generation Company, LLC's (EGC's) appeal of a compliance backfit imposed by the U.S. Nuclear Regulatory Commission (NRC) on the Braidwood and Byron Stations. The Panel reviewed the December 8, 2015, letter (Agencywide Documents Access Management System (ADAMS) Accession No. ML15342A112) in which EGC appealed the NRC October 9, 2015, backfit (ADAMS Accession No. ML14225A871) related to water qualification of relief valves predicted by the licensee's Updated Final Safety Analysis Report (UFSAR) Chapter 15 analyses to relieve water. The backfit was issued under the compliance exception provision of Title 10 of the *Code of Federal Regulations* (10 CFR) 50.109, "Backfitting," Paragraph (a)(4)(i). EGC disagreed with the NRC and in its appeal stated that the NRC failed to justify imposition of a backfit under the compliance exception. EGC further stated that the NRC should have pursued a cost justified substantial safety benefit analysis per 10 CFR 50.109(a)(3). At issue was the Braidwood and Byron UFSAR prediction of water relief through a valve that is not qualified for water relief in the UFSAR analyses of inadvertent operation of emergency core cooling system (IOECCS) during power operation (UFSAR Section 15.5.1), chemical and volume control system malfunction that increases reactor coolant inventory (UFSAR Section 15.5.2), and inadvertent opening of a pressurizer safety or relief valve (UFSAR Section 15.6.1). Specifically, water relief through a relief valve that is not water-qualified could result in the valve sticking open and causing a small break loss of coolant accident. For the reasons discussed below, the NRC determined that the appeal should be denied.

By letter dated January 20, 2016, the Nuclear Energy Institute discussed instances where it thought NRC's documentation of its basis for the compliance exception was unclear, and that it would be helpful if future NRC documentation were to specifically address five specified items that cover aspects of the supplementary information published with the 1985 final backfitting rule. The NRC believes the five specified items can be helpful when considering compliance backfits. Thus, this NRC evaluation of EGC's compliance backfit appeal includes consideration of the five specified items.

### **Background**

Pressurized water reactors, including the Braidwood and Byron plants, are designed with a closed-loop reactor coolant system (RCS). Water circulates through the RCS to remove heat from the reactor core and transfer it to heat-removal systems. Pressure in the RCS is controlled in the pressurizer, which contains heaters for increasing pressure and vent valves as a method of decreasing pressure. The pressurizer is typically partially filled with water, such that the heaters are covered with water that can be heated to raise RCS pressure and the steam space above the water can be vented to reduce RCS pressure. The vent valves consist of power operated relief valves (PORVs), which can be manually opened and closed to lower or maintain pressure, and pressurizer safety valves (PSVs), which cannot be manually controlled and serve as structural overpressure protection for the RCS. Proper level in the pressurizer is maintained by balancing any RCS mass (water) addition with RCS mass (water or steam) removal. Certain

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events can occur that could cause the pressurizer to fill by adding water to the RCS. Events of this type are classified as mass addition events. If the mass addition is not terminated soon enough, continued mass addition would force water out of the PORVs or PSVs, which normally relieve steam.

The Standard Review Plan (SRP), NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants: LWR Edition," provides the NRC staff with guidance that describes methods or approaches that the NRC staff has found acceptable for meeting NRC requirements. The NRC staff uses the categorization of accidents and transients as described in Chapter 15.0, "Introduction - Transient and Accident Analyses," of the SRP to review UFSAR Chapter 15 safety analyses. Chapter 15.0, Section I.1.A of the SRP states, "Incidents of moderate frequency and infrequent events are also known as Condition II and Condition III events, respectively, in the commonly used, [often cited] but unofficial American Nuclear Society (ANS) standards." In other words, Condition II events are more frequent than Condition III events. Additionally, Condition II events should produce less severe consequences than Condition III events, as noted in Chapter 15.0 to the SRP:

If the risk of an event is defined as the product of the event's frequency of occurrence and its consequences, then the design of the plant should be such that all the AOOs [anticipated operational occurrences] and postulated accidents produce about the same level of risk (i.e., the risk is approximately constant across the spectrum of AOOs and postulated accidents). This is reflected in the general design criteria (GDC), which generally prohibit relatively frequent events (AOOs) from resulting in serious consequences, but allow the relatively rare events (postulated accidents) to produce more severe consequences.

Chapter 15.0 to the SRP identifies acceptance criteria for the various categories of events, including the following criterion applicable to Condition II events:

By itself, a Condition II incident cannot generate a more serious incident of the Condition III or IV category without other incidents occurring independently or result in a consequential loss of function of the RCS or reactor containment barriers.

Section 15.5.1-15.5.2, "Inadvertent Operation of ECCS and Chemical and Volume Control System Malfunction that Increases Reactor Coolant Inventory," Revision 2, of the SRP provides that water relief through a valve not qualified for water relief is assumed to result in the valve sticking fully open. This would effectively produce a Condition III small-break loss of coolant accident that originates as a Condition II event, and therefore would violate the ANS design requirement.

In its October 9, 2015, letter, the NRC stated that, "based upon the NRC staff's review of the analyses contained in the Braidwood and Byron UFSAR, [Sections] 15.5.1, 'Inadvertent Operation of Emergency Core Cooling System During Power Operation (IOECCS),' 15.5.2, 'Chemical and Volume Control System that Increases Reactor Coolant Inventory Malfunction (CVCS),' and 15.6.1, 'Inadvertent Opening of a Pressurizer Safety or Relief Valve (IOPORV),' the NRC determined that the UFSAR predicts water relief through a valve that is not qualified for water relief. Therefore, the staff concludes that the UFSAR does not contain analyses that demonstrate the structures, systems, and components will meet the design criteria for

Condition II faults as stated in the Braidwood and Byron UFSAR, [Section] 15.0.1.2.” The NRC found that the UFSAR was, therefore, not in compliance with 10 CFR 50.34(b) since it did not demonstrate compliance with the following General Design Criteria, which are contained in 10 CFR 50, Appendix A:

- GDC 15, “Reactor Coolant System Design,” requires that the reactor coolant system and its associated auxiliary control and protection systems be designed with sufficient margin to assure that the design conditions of the reactor coolant pressure boundary are not exceeded during any condition of normal operations, including anticipated operational occurrences (AOOs).
- GDC 21, “Protection System Reliability and Testability,” requires, in part, that the protection system be designed for high functional reliability and in-service testability commensurate with the safety functions to be performed. Redundancy and independence designed into the protection system shall be sufficient to assure that (1) no single failure results in loss of the protection function, and (2) removal from service of any component or channel does not result in loss of the required minimum redundancy unless the acceptable reliability of operation of the protection system can be otherwise demonstrated.
- GDC 29, “Protection Against Anticipated Operational Occurrences,” requires that the protection and reactivity control systems be designed to assure an extremely high probability of accomplishing their safety functions in the event of AOOs.

The NRC conclusions with respect to noncompliance with GDCs 15, 21, and 29, 10 CFR 50.34(b), and UFSAR provisions with respect to prohibition of progression of Condition II events differ from a previous NRC position on the acceptability of the Braidwood and Byron design bases. The earlier position was documented in the Safety Evaluation (SE) for an increase in reactor power enclosed with a letter dated May 4, 2001 (ADAMS Accession No. ML011420274). Therefore, the NRC staff determined that the new conclusion and position constituted backfitting under 10 CFR 50.109(a)(1), and, the compliance exception in 10 CFR 50.109(a)(4)(i) applied.

Backfitting is defined in 10 CFR 50.109(a)(1) as the modification of, or addition to systems, structures, components, or design of a facility; or the design approval or manufacturing license for a facility; or the procedures or organization required to design, construct or operate a facility; any of which may result from a new or amended provision in the Commission’s regulations or the imposition of a regulatory staff position interpreting the Commission’s regulations that is either new or different from a previously applicable staff position. Backfitting requires an analysis to determine that there is a substantial increase in the overall protection of the public health and safety or the common defense and security, and that the direct and indirect costs of implementation are justified. There are three exceptions to the need to perform this analysis, one of which is if the modification is necessary to bring a facility into compliance with a license or the rules or orders of the Commission, or into conformance with written commitments by the licensee (the compliance exception). To invoke the compliance exception, the NRC staff must provide a documented evaluation containing the basis for the use of the exception.

### **Summary of Licensee Appeal**

In its letter dated December 8, 2015 (ADAMS Accession No. ML15342A112), EGC appealed the NRC's October 9, 2015, backfit. The appeal claimed that the compliance exception does not apply because the NRC did not explain how its prior positions were erroneous due to an omission or mistake of fact. The appeal noted that in documented SEs associated with a 2001 stretch power uprate license amendment and a 2004 license amendment approving pressurizer safety valve setpoint changes (ADAMS Accession Nos. ML011420274 and ML042250516, respectively), the NRC approved the same inadvertent operation of the IOECCS analysis that it now claims to be inadequate.

In the appeal, EGC stated that the NRC's 2001 review and approval included requests for additional information (RAIs) that discussed the IOECCS analysis and Electric Power Research Institute (EPRI) testing of the PSVs in particular, and that the NRC staff concluded it was acceptable to credit PSV liquid water discharge during an IOECCS event. The appeal further noted that the NRC's 2004 review and approval also included an RAI that discussed PSV water discharge as a result of an IOECCS event. EGC's appeal stated that the NRC staff did not further explain its statement in the backfit that these prior approvals were "based on the use of water qualified PSVs, which upon further review was found to be unsubstantiated."

The appeal noted that the NRC's position that Condition II events cannot transition to Condition III events has remained consistent, but that NRC's application of GDCs 15, 21, and 29 to support the backfit appeared to differ from previous documented positions in the 2001 and 2004 SEs for Braidwood and Byron. EGC concluded in reiterating its position that the NRC did not identify an omission or mistake of fact, which it believes is required to use the compliance exception to the backfit rule's requirement to perform a cost/benefit analysis.

### **Panel Evaluation of Licensee Appeal**

The Panel reviewed EGC's December 8, 2015, appeal and met with EGC in a March 7, 2016, public meeting. The Panel was chartered with determining whether a backfit is necessary at Braidwood and Byron stations, and whether the NRC staff's application of the compliance exception was in accordance with 10 CFR 50.109(a)(4)(i), and was otherwise appropriate.

The Panel determined that the NRC staff correctly entered the backfit process due to a proposed change in staff position, and that a backfit was necessary due to the proposed change in position. The October 9, 2015, backfit stated that the Braidwood and Byron UFSAR does not demonstrate compliance with GDCs 15, 21, and 29, the plant-specific licensing basis, or 10 CFR 50.34(b) because the UFSAR does not demonstrate that the Braidwood and Byron PSVs will reseal to prevent a Condition II event from transitioning to a Condition III event. This represented a change in NRC position from the 2001 and 2004 license amendments. In its appeal, the licensee acknowledged that the Agency's position on the unacceptability of Condition II events transitioning to Condition III events has not changed. This is the "known and established standard" at issue.

As depicted in figure 2 of NUREG-1409, given that the proposed staff position is a backfit, the NRC staff must next perform a cost/benefit analysis to determine if the proposed backfit is a

cost-justified substantial safety enhancement, or identify an applicable exception and provide a statement as to why that exception applies. The NRC staff identified the compliance exception as applicable here.

The licensee argued that approval of the PSVs, first in 2001, was not a deviation from an NRC position, but application of it; pointing to specific RAIs and SE report text that appears to specifically recognize the basis the licensee provided for its analyses as acceptable, even though the licensee's RAI responses did not demonstrate water qualification of the PSVs. However, the Panel determined that the October 9, 2015, backfit showed that the approvals at issue for Braidwood and Byron were inconsistent with the Agency's general position on the known and established standard at issue, in this case the progression of Condition II events. The fact that, at the time, the NRC staff appeared to have some awareness of an approach inconsistent with the requirements discussed here, in this case references to EPRI reports on the ability of these non-water qualified PSVs to reseal in certain circumstances, is not sufficient to support the licensee's position. NRC requirements at the time provided that the valves should have been water qualified, and EGC did not demonstrate that they were. As discussed in the NRC staff's backfit analysis, this is the mistake of fact. The basis for this conclusion is fully set out in the October 9, 2015, SE discussion of water qualification, Section 3.1.2.4, "Water Qualification of PSVs:"

The Braidwood and Byron IOECCS analysis depends on water relief through the PSVs. PSVs typically provide protection against over pressurization during Condition III and IV events (e.g., feedline break). The Braidwood and Byron plants' reliance upon the PSVs for mitigation of Condition II events is a departure from the design (or functional) objectives of the PSVs as described in the UFSAR Chapter and Reference 8. Additionally, the licensee has invoked the PSVs as a mitigation system but has not applied the single-failure assumption (required in accident analyses to show compliance with GDC 21) to that system (i.e., failure of a PSV to close) nor have they provided ASME water qualification documentation for the PSVs, causing the staff to be unable to conclude that there is compliance with GDC 21. Specifically, the following information is necessary to support water qualification of the PSVs:

- 1) Under the ASME Code [American Society of Mechanical Engineers Boiler and Pressure Code] requirements [Reference 9], it is necessary to provide the original Overpressure Protection Report showing the IOECCS event as a Condition II event and defining the operating conditions and required relief capacities associated with it. It is also necessary to provide the manufacturer's certification of the valves' relief capacity, under pressurized water conditions, and including test results.
- 2) According to the ASME OM [Operation and Maintenance] Code [Reference 10], it is necessary to provide the in service test history (procedure and results) for the pressurizer PSVs, including both water and steam tests, or alternatively provide a certified correlation test procedure and justification for use of an alternative test fluid.

The licensee argued that the NRC staff failed to satisfy the compliance exception because the staff did not identify an omission or mistake of fact in the subject backfit. This language regarding an omission or mistake of fact comes from the Statements of Consideration, which, in describing the applicability of the backfit rule's compliance exception, states that "[t]he



compliance exception is intended to address situations in which the licensee has failed to meet known and established standards of the Commission because of omission or mistake of fact.” In the October 9, 2015, SE, the NRC staff stated that its “acceptance of the IOECCS analysis in 2001 was based, among other things, on the use of water qualified PSV’s which upon further review, during the 2011 [measurement uncertainty recapture power uprate], was found to be unsubstantiated.” The NRC staff also stated in the October 9, 2015, SE:

Specifically, the analyses contained in the Braidwood and Byron UFSAR, [Sections] 15.5.1, ‘Inadvertent Operation of Emergency Core Cooling System During Power Operation,’ 15.5.2, ‘Chemical and Volume Control System Malfunction that Increases Reactor Coolant Inventory Malfunction,’ and 15.6.1, ‘Inadvertent Opening of a Pressurizer Safety or Relief Valve,’ predict water relief through a valve that is not qualified for water relief. Therefore, the UFSAR does not contain analyses that demonstrate the structures, systems, and components will meet the design criteria for Condition II faults as stated in the Braidwood and Byron UFSAR, [Section] 15.0.1.2.

Thus, as discussed in detail in the NRC staff’s backfit analysis, but for the mistake of fact that the PSVs were thought to be water qualified, the NRC would not have approved UFSAR analyses that do not demonstrate compliance regarding the prohibition of progression of Condition II events.

### **Panel Conclusion**

Based on its review, the Panel determined that (1) imposition of the backfit is necessary, and (2) application of the compliance backfit exception was done in accordance with 10 CFR 50.109, and is appropriate. The NRC staff appropriately identified that its current view, while consistent with long held Agency policy (as noted by EGC), represented a change from the position the Agency took in the 2001 and 2004 licensing reviews specific to Braidwood and Byron. The NRC staff also noted that the reason for the incorrect positions taken in 2001 and 2004 involved the water qualification of the PSVs. Since the PSVs were predicted to relieve water, they were required to be water qualified and they were not. The current analyses in Braidwood and Byron UFSAR Sections 15.5.1, 15.5.2, and 15.6.1 do not demonstrate compliance with GDC 15, GDC 21, and GDC 29; therefore, Braidwood and Byron are not in compliance with 10 CFR 50.34(b) and their UFSAR Section 15.0.1.2 provisions with respect to the prohibition of progression of Condition II events to Condition III events.