March 9, 2007

Mr. Christopher M. Crane
President and Chief Nuclear Officer
Exelon Generation Company, LLC
4300 Winfield Road
Warrenville, IL 60555

SUBJECT: BYRON STATION, UNIT NOS. 1 AND 2 - EVALUATION OF RELIEF REQUEST I3R-06 FOR CONTROL ROD DRIVE CANOPY SEAL WELDS (TAC NOS. MD3863 AND MD3864)

Dear Mr. Crane:

By letter dated February 14, 2006, Exelon Generating Company, LLC (the licensee) requested relief from the requirements of the 2001 Edition through the 2003 Addenda of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Subarticle IWA-4000, regarding the contingency repair or replacement of control rod drive mechanism canopy seal welds at Byron Station, Unit Nos. 1 and 2. The licensee proposed to use the ASME Code, Section XI, Code Case N-504-2, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping," for weld repair and to perform an enhanced visual examination and a pressure test.

The Nuclear Regulatory Commission (NRC) staff concludes that complying with the ASME Code-specified repair method and the surface examination of the canopy seal welds would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety. The NRC staff concludes further that the proposed alternative is acceptable because the repair or replacement method and associated post-weld examination and pressure testing will provide reasonable assurance of the weld's structural integrity. Therefore, pursuant to Section 50.55a(a)(3)(ii) of Title 10 of the *Code of Federal Regulations* (10 CFR), the licensee's proposed alternative described in relief request I3R-06, Revision 0, is authorized for the third 10-year inservice inspection interval.

The licensee's submittal dated February 14, 2006, also included Relief Requests I3R-02 through I3R-05. Relief Request I3R-02 will be evaluated in a separate letter and I3R-03 through I3R-05 were withdrawn by letter dated January 24, 2007.

Sincerely,

/RA/

Russell A. Gibbs, Chief
Plant Licensing Branch III-2
Division of Operating Reactor Licensing
Office of Nuclear Reactor Regulation

Docket Nos. STN 50-454 and STN 50-455

Enclosure:
Safety Evaluation

cc w/encl: See next page

The licensee's submittal dated February 14, 2006, also included Relief Requests I3R-02 through I3R-05. Relief Request I3R-02 will be evaluated in a separate letter and I3R-03 through I3R-05 were withdrawn by letter dated January 24, 2007.

Sincerely,

/RA/

Russell A. Gibbs, Chief
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Division of Operating Reactor Licensing
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Enclosure:
Safety Evaluation

cc w/encl: See next page

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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO RELIEF REQUEST NO. I3R-06, REV. 0

THIRD 10-YEAR INTERVAL INSERVICE INSPECTION PROGRAM PLAN

EXELON GENERATION COMPANY, LLC

BYRON STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-454 AND STN 50-455

1.0 INTRODUCTION

By letter dated February 14, 2006 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML063530333), Exelon Generation Company, LLC (the licensee) requested relief from the requirements of the 2001 Edition through the 2003 Addenda of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code (ASME Code), Section XI, Subarticle IWA-4000 regarding the contingency repair or replacement of control rod drive mechanism (CRDM) canopy seal welds at Byron Station, Unit Nos. 1 and 2 (Byron). The licensee submitted Relief Request I3R-06 for the third 10-year inservice inspection interval which began on January 16, 2006, and will end on January 15, 2016.

The licensee proposed to repair leaking CRDM canopy seal welds using the guidelines of ASME Code Case N-504-2, "Alternative Rules for Repair of Classes 1, 2, and 3 Austenitic Stainless Steel Piping," which establishes acceptability of a repair by increasing the weld thickness. The licensee also proposed an enhanced visual examination and pressure test in lieu of the ASME Code-required surface examination for final acceptance of the repaired weld. The licensee contended that the ASME Code-required repair and the surface examination of the seal welds would expose personnel to a high radiation dose and, therefore, would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety.

By letter dated September 16, 2003 (ADAMS Accession No. ML032410022), the Nuclear Regulatory Commission (NRC) staff approved an identical relief request for the repair of the CRDM canopy seal welds for the second inspection interval at Byron.

2.0 REGULATORY EVALUATION

The inservice inspection of ASME Code Class 1, Class 2, and Class 3 components is to be performed in accordance with Section XI of the ASME Code and applicable edition and addenda as required by Section 50.55a(g) of Title 10 of the *Code of Federal Regulations* (10 CFR), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). Section 50.55a(a)(3) states in part that alternatives to the requirements of paragraph (g) may be used, when authorized by the NRC, if the licensee demonstrates that: (i) the proposed alternatives would provide an acceptable level of quality and safety, or (ii)

compliance with the specified requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

Pursuant to 10 CFR 50.55a(g)(4), ASME Code Class 1, 2, and 3 components (including supports) shall meet the requirements, except the design and access provisions and the pre-service examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection (ISI) of Nuclear Power Plant Components," to the extent practical within the limitations of design, geometry, and materials of construction of the components. The regulations require that inservice examination of components and system pressure tests conducted during the first 10-year interval and subsequent intervals comply with the requirements in the latest edition and addenda of Section XI of the ASME Code incorporated by reference in 10 CFR 50.55a(b), 12 months prior to the start of the 10-year interval, subject to the limitations and modifications listed therein. The Code of record for the third 10-year ISI interval at Byron is the 2001 Edition through the 2003 Addenda of Section XI of the ASME Code.

The licensee submitted Relief Request I3R-06 pursuant to 10 CFR 50.55a(a)(3)(i), which requires that the proposed alternative provide an acceptable level of quality and safety. In addition to the requirements of 10 CFR 50.55a(a)(3)(i), the NRC staff evaluated this submittal pursuant to 10 CFR 50.55a(a)(3)(ii), which requires the licensee to demonstrate that compliance with the ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

3.0 TECHNICAL EVALUATION

3.1 Relief Request I3R-06, Revision 0

3.1.1 ASME Code Component Affected

Reactor CRDM canopy seal welds - Class 1 appurtenance to the reactor vessel.

3.1.2 Applicable Code Edition and Addenda

The third 10-year ISI program is based on the ASME Code, Section XI, 2001 Edition through the 2003 Addenda. The CRDM assemblies were designed and fabricated to the ASME Code, Section III, 1974 Edition through the Summer 1974 Addenda.

3.1.3 Applicable Code Requirements

Subarticle IWA-4000 of the ASME Code, Section XI, requires that repairs be performed in accordance with the owner's original construction Code of the component or system, or later editions and addenda of the Code. The canopy seal weld is described in the ASME Code, Section III, and a repair to this weld would require the following activities:

a. Excavation of the rejectable indications,
b. A surface examination of the excavated areas,
c. Re-welding and restoration to the original configuration and materials, and
d. Final surface examination

3.1.4 Reason for the Request

The licensee identified the principal issues of this relief request as the excavation of the existing CRDM canopy seal weld, the accompanying radiation dose received during the excavation and examination activities, and the weld material used for the repair or replacement.

The licensee stated that due to the nature of the flaw in the subject canopy seal weld, the excavation of the leaking portion of the weld would result in a cavity that would extend completely through wall. A liquid penetrant examination (PT) of this cavity is required to verify the removal of the rejectable flaw or to verify that the flaw is removed or reduced to an acceptable size. This PT examination would deposit the penetrant materials onto the inner surfaces of the subject weld. The penetrant material would not be readily removable prior to re-welding due to the inaccessibility of the inside surface of the weld. The remnant penetrant material in the weld would introduce contaminants to the new weld metal and reduce the quality of the repair weld. In addition, the configuration of the canopy assembly would prevent the establishment and maintenance of an adequate back-purge during the welding process and would further reduce the quality of the repaired weld.

The licensee stated that the CRDM canopy seal weld is located above the reactor vessel closure head, which is highly congested and subject to high ASME Code requirements would be contrary to the intent of the as low as reasonably achievable (ALARA) radiological controls program. Most of the repair activities would be performed remotely using robotic equipment. This will reduce the radiation exposure to personnel involved in the welding process. However, the required excavation and PT examinations would necessitate hands-on access to the canopy weld and are estimated to result in a total occupational ASME Code-required excavation and examinations are activities that would not be needed if the relief is granted from these requirements and thus, represent the estimated occupational radiation dose savings.

Subarticle IWA-4200 of the ASME Code, Section XI, requires that the repair material conform to the original design specification or the ASME Code, Section III. In the proposed alternative, the replacement weld material would have the same resistance to stress corrosion cracking as the original weld material. Use of the original material does not guarantee that the repaired component will continue to maintain leakage integrity throughout the intended life of the item. The licensee will use applicable portions of ASME Code Case N-504-2 as guidance for repair by weld overlay to provide a new leakage barrier. In lieu of performing PT examinations of CRDM seal weld repairs or replacement, the licensee will perform a 5X or better magnification visual examination after repair welding is completed.

In addition, the licensee will use Alloy 52 nickel-based weld material rather than austenitic stainless steel as required by ASME Code Case N-504-2. The licensee selected Alloy 52 nickel-based weld repair material based on its resistance to stress corrosion cracking. Consequently, the ferrite requirements of Code Case N-504-2 do not apply. The suitability of the replacement material has been evaluated and is determined to be compatible with the existing component and will provide a leakage barrier for the remainder of the intended life of the CRDM.

The licensee stated that industry experience with failure analyses performed on leaking canopy seal welds removed from service at other plants has attributed the majority of the cases to transgranular stress corrosion cracking (SCC). The size of the opening where the leakage

occurs has been extremely small, normally a few thousandths of an inch. The crack orientations vary, but often radiate outward such that a pinhole appears on the surface, as opposed to a long crack. The SCC results from exposure of a susceptible material to residual stress, which is often concentrated by weld discontinuities, and to a corrosive environment. A corrosive environment can form with water being trapped in the cavity behind the seal weld that is mixed with air initially in the cavity, resulting in a higher oxygen content than is in the bulk primary coolant.

3.1.5 Proposed Alternative and Basis for Use

Following the guidance of ASME Code Case N-504-2, the licensee will not remove the flaw(s) in the CRDM canopy seal weld, but will deposit Alloy 52 weld material on the surface of the existing seal weld. The licensee will also perform an analysis of the repaired weldment using Paragraph (g) of the code case as guidance to assure that the remnant flaw will not propagate unacceptably. The proposed canopy seal weld is not a structural weld, nor a pressure-retaining weld, but provides a seal to prevent reactor coolant leakage if the mechanical joint leaks. The weld buildup is considered a repair in accordance with Subarticle IWA-4110 of the ASME Code, Section XI. Applicability of the original code of construction or design specification is mandated because the weld is performed on an appurtenance to a pressure-retaining component. The alternative CRDM canopy seal weld repair uses a gas tungsten arc welding (GTAW) process controlled remotely.

The licensee will examine the repaired weld visually using methods and personnel qualified to the standards of ASME VT-1 requirements. The visual examination will be performed using the welding equipment video camera with 5X or better magnification within several inches of the weld. The visual examination is qualified to ensure the identification of flaws so that an adequate margin of safety is maintained. The examination technique will be demonstrated to resolve a 0.001-inch thick wire against the surface of the weld. The repaired weld will be examined for quality of workmanship and discontinuities will be evaluated and dispositioned to ensure the adequacy of the new leakage barrier.

The automated GTAW weld repair and alternate VT-1 examination methods result in significantly lower radiation exposure because the equipment is remotely operated after setup. The licensee will perform a post-maintenance pressure test at nominal temperature and pressure to determine potential leakage with a VT-2 visual examination.

The licensee will document the repair or replacement activities, using the process described in this relief request, on the required NIS-2 forms. This relief request will be identified on the NIS-2 forms in lieu of an adopted or invoked ASME Code case. The repair documents will be reviewed by the Authorized Nuclear Inspector, and maintained in accordance with the requirements for archiving permanent plant records.

3.1.6 Duration of Proposed Alternative

Relief is requested for the third inspection interval which began on January 16, 2006 and will end on January 15, 2016.

3.2 NRC Staff Evaluation

In lieu of ASME Code-required weld repair, the licensee proposed to perform the repair of leaking CRDM canopy seal welds using the applicable provisions of ASME Code Case N-504-2, which establishes acceptability of a repair by increasing the weld thickness. The code case allows deposition of one or more layers of the weld overlay to seal unacceptable indications in the area to be repaired without excavation. The multiple layers of weld metal provide a redundant CRDM nozzle-to-canopy seal. The code case further requires a stress analysis of the repaired weldment to assure that the existing flaw will not propagate unacceptably for the design life of the repair. The analysis will consider potential flaw growth due to fatigue and stress corrosion cracking which is most likely the mechanism that initiated the flaw. This analysis will establish a critical flaw size that can be used as a benchmark to qualify the VT-1 examination method to ensure the capability of detecting sufficiently small flaw size to assure that an adequate margin of safety is maintained. The seal weld itself is neither a structural weld nor a pressure-retaining weld (i.e., the weld does not support any loads). The NRC staff finds the proposed alternative repair method acceptable because the proposed weld repair is applicable for the purpose of preventing leakage and not for the purpose of supporting loads.

The licensee proposed to use Alloy 52 nickel-base weld repair material in place of austenitic stainless steel as required by Code Case N-504-2. The NRC staff finds that this material is acceptable for use due to its resistance to stress corrosion cracking as documented in the Electric Power Research Institute Report, “Materials Reliability Program: Resistance to Primary Water Stress Corrosion Cracking of Alloy 690, 52, and 152 in Pressurized Water Reactors (MRP-111),” 1009801, (ADAMS Accession No. ML0416805460).

In lieu of surface examination, the licensee would conduct a remote visual examination using a video camera with 5X magnification and 0.001 inch resolution within several inches of the weld. The visual resolution of this video camera system has greater capability than that of the ASME Code-required direct VT-1 visual examination of resolving a wire segment as narrow as 1/32-inch black line on a 18 percent neutral gray card. Therefore, the resolution and consistency of the licensee’s enhanced visual examination technique are much greater than that provided by an ASME Code VT-1 examination. Based on the capability of the remote visual examination system to resolve flaws of a size 0.001 inch in width, reasonable assurance of detecting surface flaws is provided. Therefore, the NRC staff has determined that the remote visual examination is acceptable in lieu of the ASME Code-required surface examination.

In addition, the adequacy of the seal is verified with a routine system leakage test that is performed at normal operating temperature and pressure, and held at such conditions for a ASME Code-required soak time prior to returning to the system to service. The licensee will perform a VT-2 examination during the pressure test to observe any potential leakage.

As the licensee stated above, the radiological dose associated with strict compliance with the ASME Code-required repair would be high because the canopy seal weld is located in a high radiation area. Plant personnel will receive the radiological dose during the manual excavation of the flaws, PT of the excavated areas of the weld, and final PT of new weld. According to the licensee, the estimated total occupational radiation dose is 1.688 person-Rem per CRDM

canopy seal weld. The NRC staff agrees with the licensee that this radiological dose is significant and that compliance with the specified ASME Code requirements would result in hardship or unusual difficulty without a compensating increase in the level of quality and safety.

The NRC staff finds that proposed alternative will result in reducing radiation dose exposure and that the proposed alternative repair will provide acceptable leakage integrity for the CRDM canopy seal weld while maintaining reasonable assurance of structural integrity.

4.0 CONCLUSION

Based on the above evaluation, the NRC staff concludes that the ASME Code-required repair or replacement, and surface examination of the CRDM canopy seal welds would result in a hardship or unusual difficulty without a compensating increase in the level of quality and safety. The NRC staff concludes further that the proposed alternative described in Section 3.1.5 above is acceptable for the repair or replacement of the CRDM canopy seal welds because the repair or replacement method and associated post-weld examination and pressure testing will provide reasonable assurance of the weld integrity. Therefore, pursuant to 10 CFR 50.55a(a)(3)(ii), the NRC staff authorizes use of the proposed alternative as stated in Relief Request I3R-06, Rev. 0 for the third inservice inspection intervals at Byron.

All other ASME Code, Section XI requirements for which relief was not specifically requested and approved in this relief request remain applicable, including third party review by the Authorized Nuclear Inservice Inspector.

Principle Contributor: J. Tsao

Date: March 9, 2007