

August 8, 2001

Mr. Oliver D. Kingsley, President
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SUBJECT: ISSUANCE OF EXEMPTION FROM THE REQUIREMENTS OF 10 CFR 50
PART 60 AND APPENDIX G, FOR BYRON STATION, UNITS 1 AND 2, AND
BRAIDWOOD STATION, UNITS 1 AND 2 - (TAC NOS. MB0751, MB0752,
MB0753 AND MB0754)

Dear Mr. Kingsley:

The U.S. Nuclear Regulatory Commission (NRC) has approved the enclosed exemption from specific requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 50, Section [50.60] and Appendix G, for the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2. This action is in response to the Commonwealth Edison Company (ComEd) request dated July 5, 2000, as supplemented by the letter of December 8, 2000, that requested the exemption to allow the use of American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Cases N-588, "Alternative to Reference Flaw Orientation of Appendix G for Circumferential Welds in Reactor Vessels, Section XI, Division 1," and N-640, "Alternative Reference Fracture Toughness for Development of P-T Limit Curves for ASME Section XI, Division 1," instead of the methodologies in 10 CFR Part 50, Appendix G.

Subsequent to the date of the original request, ComEd merged into Exelon Generation Company, LLC (Exelon). By letter dated February 7, 2001, Exelon informed the NRC that it assumed responsibility for all pending actions that were requested by ComEd.

A copy of the exemption is enclosed. The exemption has been forwarded to the Office of the Federal Register for publication.

Sincerely,

/RA/

Mahesh Chawla, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-454 and 50-455
50-456 and 50-457

Enclosure: Exemption

cc w/encls: See next page

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Sincerely,

/RA/

Mahesh Chawla, Project Manager, Section 2
Project Directorate III
Division of Licensing Project Management
Office of Nuclear Reactor Regulation

Docket Nos. 50-454 and 50-455
50-456 and 50-457

Enclosure: Exemption
cc w/encls: See next page

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION
EXELON GENERATION COMPANY, LLC
BYRON STATION, UNITS 1 AND 2
BRAIDWOOD STATION, UNITS 1 AND 2
DOCKET NOS. STN 50-454, STN 50-455, STN 50-456 AND STN 50-457
EXEMPTION

1.0 BACKGROUND

The Exelon Generation Company, LLC, (the licensee) is the holder of Facility Operating License Nos. NPF-37, NPF-66, NPF-72 and NPF-77, which authorize operation of the Byron Station, Units 1 and 2, and Braidwood Station, Units 1 and 2. The licenses provide, among other things, that the facilities are subject to all rules, regulations, and orders of the U.S. Nuclear Regulatory Commission (NRC, the Commission) now or hereafter in effect.

Each of the above facilities consists of two pressurized water reactors. The Byron units are located in Ogle County in Illinois and the Braidwood units are located in Will County in Illinois. This exemption refers to all four units.

2.0 REQUEST/ACTION

Title 10 of the *Code of Federal Regulations* (10 CFR), Part 50, Appendix G, requires that pressure-temperature (P-T) limits be established for reactor pressure vessels (RPVs) during normal operating and hydrostatic or leak rate testing conditions. Specifically, 10 CFR Part 50, Appendix G states that "The appropriate requirements on both the pressure-temperature limits and minimum permissible temperature must be met for all conditions."

Appendix G of 10 CFR Part 50 specifies that the requirements for these limits are the American Society of Mechanical Engineers (ASME) Code, Section XI, Appendix G Limits.

To address provisions of amendments to the technical specifications (TS) P-T limits in the uprating submittal, the licensee requested in its supplement dated December 8, 2000, to its original submittal for power uprates for Byron and Braidwood, dated July 5, 2000, that the staff exempt Byron and Braidwood units from application of specific requirements of 10 CFR Part 50, Section 50.60(a) and Appendix G, and substitute use of ASME Code Cases N-588 and N-640. This request, to apply these code cases to the proposed P-T limits, was later withdrawn by the licensee for application with the power uprate in a letter dated February 20, 2001. However, the licensee requested the NRC to complete its review of the exemption request for future P-T limit applications. Code Case N-588 permits the postulation of a circumferentially-oriented flaw (in lieu of an axially-oriented flaw) for the evaluation of the circumferential welds in RPV P-T limit curves, whereas, Code Case N-640 permits the use of alternate reference fracture toughness (K_{IC} fracture toughness curve instead of K_{Ia} fracture toughness curve) for reactor vessel materials in determining the P-T limits. Since the pressure stresses on a circumferentially-oriented flaw are lower than the pressure stresses on an axially-oriented flaw by a factor of 2, postulating a circumferentially-oriented flaw for the evaluation of the circumferential welds, as permitted by Code Case N-588, in establishing the P-T limits would be less conservative than the methodology currently endorsed by 10 CFR Part 50, Appendix G. Further, since the K_{IC} fracture toughness curve shown in ASME Section XI, Appendix A, Figure A-2200-1 provides greater allowable fracture toughness than the corresponding K_{Ia} fracture toughness curve of ASME Section XI, Appendix G, Figure G-2210-1, using the K_{IC} fracture toughness, as permitted by Code Case N-640, in establishing the P-T limits would be less conservative than the

methodology currently endorsed by 10 CFR Part 50, Appendix G. Considering both, an exemption to apply the Code Cases would be required by 10 CFR 50.60.

3.0 DISCUSSION

Pursuant to 10 CFR 50.12, the Commission may, upon application by any interested person or upon its own initiative, grant exemptions from the requirements of 10 CFR Part 50, when (1) the exemptions are authorized by law, will not present an undue risk to public health or safety, and are consistent with the common defense and security; and when (2) special circumstances are present.

Postulations of Circumferential Flaws in Circumferential Welds (Code Case N-588)

The licensee proposed to revise future P-T limits in the pressure temperature limits report (PTLR) for Byron and Braidwood units using the postulation of a circumferentially-oriented reference flaw as the limiting flaw in an RPV circumferential weld in lieu of an axially-oriented flaw required by the 1995 Edition (1996 Addenda) of ASME Section XI, Appendix G.

Postulating the Appendix G reference flaw (an axially-oriented flaw) in a circumferential weld is physically unrealistic and overly conservative because the length of the flaw is 1.5 times the vessel thickness, which is much longer than the width of the reactor vessel girth weld. Industry experience with the repair of weld indications found during preservice inspection and data taken from destructive examination of actual vessel welds, confirms that all detected flaws are small, laminar in nature, and do not transverse the weld bead orientation. Therefore, any potential defects introduced during the fabrication process and not detected during subsequent nondestructive examinations, would only be expected to be oriented in the direction of weld fabrication. For circumferential welds, this indicates a postulated defect with a circumferential orientation.

An analysis provided to the ASME Code's Working Group on Operating Plant Criteria (WGOPC) (in which Code Case N-588 was developed) indicated that if an axial flaw is postulated on a circumferential weld, then based on the stress magnification factors (M_m) given in the Code Case for the inside diameter circumferential (0.443) and axial (0.926) flaw orientations, it is equivalent to applying a safety factor of 4.18 on the pressure loading under normal operating conditions. Appendix G requires a safety factor of 2 on the contribution of the pressure load in the case of an axially-oriented flaw in an axial weld, shell plate, or forging. By postulating a circumferentially-oriented flaw on a circumferential weld and using the appropriate stress magnification factor, the margin of 2 is maintained for the contribution of the pressure load to the integrity calculation of the circumferential weld. Consequently, the staff determined that the postulation of an axially-oriented flaw on a circumferential RPV weld is a level of conservatism that is not required to establish P-T limits to protect the RCS pressure boundary from failure during hydrostatic testing, heatup, and cooldown.

In summary, the ASME Section XI, Appendix G, procedure was developed for axially-oriented flaws, which is physically unrealistic and overly conservative for postulating flaws of this orientation to exist in circumferential welds. Hence, the NRC staff concurs that relaxation of the ASME Section XI, Appendix G, requirement by postulating a circumferentially-oriented flaw for the evaluation of the circumferential welds, as permitted by Code Case N-588, is acceptable and would maintain, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable margin of safety.

Using the K_{Ic} Fracture Toughness Curve (Code Case N-640)

The licensee proposed to revise future P-T limits in the PTLR for Byron and Braidwood units using the K_{Ic} fracture toughness curve, in lieu of the K_{Ia} fracture toughness curve, as the lower bound for fracture toughness.

Use of the K_{Ic} curve in determining the lower bound fracture toughness in the development of P-T operating limits curve is more technically correct than the K_{Ia} curve since the rate of loading during a heatup or cooldown is slow and is more representative of a static condition than a dynamic condition. The K_{Ic} curve appropriately implements the use of static initiation fracture toughness behavior to evaluate the controlled heatup and cooldown process of a reactor vessel. The staff has required use of the initial conservatism of the K_{Ia} curve since 1974 when the curve was codified. This initial conservatism was necessary due to the limited knowledge of RPV materials. Since 1974, additional knowledge has been gained about RPV materials, which demonstrates that the lower bound on fracture toughness provided by the K_{Ia} curve is well beyond the margin of safety required to protect the public health and safety from potential RPV failure. In addition, P-T curves based on the K_{Ic} curve will enhance overall plant safety by opening the P-T operating window with the greatest safety benefit in the region of low temperature operations.

In summary, the ASME Section XI, Appendix G, procedure was conservatively developed based on the level of knowledge existing in 1974 concerning RPV materials and the estimated effects of operation. Since 1974, the level of knowledge about these topics has been greatly expanded. The NRC staff concurs that this increased knowledge permits relaxation of the ASME Section XI, Appendix G, requirements by applying the K_{Ic} fracture toughness, as permitted by Code Case N-640, while maintaining, pursuant to 10 CFR 50.12(a)(2)(ii), the underlying purpose of the ASME Code and the NRC regulations to ensure an acceptable margin of safety.

The staff concurs with the licensee's determination that an exemption would be required to approve the use of Code Cases N-588 and N-640. The staff examined the licensee's rationale to support the exemption request and concurred that the use of the Code Cases would

meet the underlying intent of these regulations. Based upon a consideration of the conservatism that is explicitly incorporated into the methodologies of 10 CFR Part 50, Appendix G, of the ASME Code; and Regulatory Guide 1.99, Revision 2, the staff concludes that application of Code Cases N-588 and N-640, as described, would provide an adequate margin of safety against brittle failure of the RPV. This is also consistent with the determination that the staff has reached for other licensees under similar conditions based on the same considerations. Therefore, the staff concludes that pursuant to 10 CFR 50.12(a)(2)(ii) special circumstances are present and that an exemption may be granted to allow use of the methodology of Code Cases N-588 and N-640 to revise future P-T limits in the PTLR for Byron and Braidwood units.

4.0 CONCLUSION

Accordingly, the Commission has determined that, pursuant to 10 CFR 50.12(a), the exemption as authorized by law, will not endanger life or property or common defense and security, and is, otherwise, in the public interest. Therefore, the Commission hereby grants Exelon Generation Company, LLC, exemption from the requirements of 10 CFR Part 50, Section 50.60(a) and 10 CFR Part 50, Appendix G, for Byron Units 1 and 2 and Braidwood Units 1 and 2.

Pursuant to 10 CFR 51.32, the Commission has determined that the granting of this exemption will not have a significant effect on the quality of the human environment. The environmental assessment is published in the Federal Register (66 FR 38755).

This exemption is effective upon issuance.

Dated at Rockville, Maryland, this 8th day of August 2001.

FOR THE NUCLEAR REGULATORY COMMISSION

/RA/

John A. Zwolinski, Director
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