UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

# SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

## RELATED TO THE INSERVICE INSPECTION PROGRAM

## COMMONWEALTH EDISON COMPANY

## 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

### 1.0 INTRODUCTION

The Technical Specifications (TS) for Byron Station, Units 1 and 2 and Braidwood Station, Units 1 and 2, state that the inservice inspection (ISI) of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code (Code) Class 1, 2, and 3 components shall be performed in accordance with Section XI of the ASME Code and applicable Addenda as required by 10 CFR 50.55a(g), except where specific written relief has been granted by the Commission pursuant to 10 CFR 50.55a(g)(6)(i). 10 CFR 50.55a(a)(3) states that alternatives to the requirements of paragraph (g) may be used when authorized by the NRC if (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 difficulties 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 preservice examination requirements, set forth in the ASME Code, Section XI, "Rules for Inservice Inspection 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 ten-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) twelve months prior to the start of the 120-month interval, subject to the limitations and modifications listed therein. The applicable edition of Section XI of the ASME Code for the Byron and Braidwood first 10-year ISI interval is the 1983 Edition through Summer 1983 Addenda. The components (including supports) may meet the requirements set forth in subsequent editions and addenda of the ASME Code incorporated by reference in 10 CFR 50.55a(b) subject to the limitations and modifications listed therein and subject to Commission approval.

Enclosure

Pursuant to 10 CFR 50.55a(g)(5), if the licensee determines that conformance with an examination requirement of Section XI of the ASME Code is not practical for its facility, information shall be submitted to the Commission in support of that determination and a request made for relief from the ASME Code requirement. After evaluation of the determination, pursuant to 10 CFR 50.55a(g)(6)(i), the Commission may grant relief and may impose alternative requirements that are determined to be authorized by law, will not endanger life, property, or the common defense and security, and are otherwise in the public interest, giving due consideration to the burden upon the licensee that could result if the requirements were imposed. In a letter dated March 28, 1996, Commonwealth Edison Company (ComEd, the licensee), submitted its First Ten-Year Interval Inservice Inspection Program Plan Requests for Relief Nos. NR-19 and NR-24 for Byron and Braidwood, respectively. Additional information was provided by ComEd in its letter dated April 23, 1996.

## 2.0 EVALUATION AND CONCLUSIONS

The staff, with technical assistance from its contractor, the Idaho National Engineering Laboratory (INEL), has evaluated the information provided by ComEd in support of its First Ten-Year Interval Inservice Inspection Program Plan Requests for Relief Nos. NR-19 and NR-24 for Byron and Braidwood, respectively. Additional information was provided by ComEd in its letter dated April 23, 1996.

Based on the information submitted, the staff adopts the contractor's conclusions and recommendations presented in the Technical Letter Report attached. The staff has reviewed ComEd's submittal and concludes that based on the burden associated with removing insulation, the potential damage to the ceramic heater connections, and the assurances provided by the examination of other Class 1 nozzles and performance of the Code-required pressure tests, compliance with the Code requirements for the pressurizer surge nozzle and inside radius sections would result in hardship without a compensating increase in quality and safety at the Byron and Braidwood plants. Therefore, ComEd's proposed alternatives contained in Requests for Relief Nos. NR-19 and NR-24 for the Byron/Braidwood plants, respectively, are authorized pursuant to 10 CFR 50.55a(a)(3)(ii) as requested for the first ten-year ISI interval. However, since ComEd can examine approximately 60 percent of the nozzle-to-vessel weld and 100 percent of the nozzle inside radius section with the insulation removed, volumetric examination of these areas shall be performed if the insulation is removed for any reason in the future.

The staff has reviewed ComEd's submittal and concludes that compliance with the Code requirements for the pressurizer surge nozzle and inside radius sections would result in hardship without a compensating increase in quality and safety at Byron and Braidwood. Therefore, ComEd's proposed alternative may be authorized pursuant to 10 CFR 50.55a(a)(3)(ii).

Attachment: Technical Letter Report

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# TECHNICAL LETTER REPORT

# ON THE FIRST TEN-YEAR INTERVAL INSERVICE INSPECTION

# REQUESTS FOR RELIEF NR-19 AND NR-24 FOR

# COMMONWEALTH EDISON COMPANY

# BYRON NUCLEAR POWER STATION, UNITS 1 AND 2

# BRAIDWOOD NUCLEAR POWER STATION, UNITS 1 AND 2

# DOCKET NUMBERS: 50-454, 50-455, 50-456 AND 50-457

## 1.0 INTRODUCTION

By letter dated March 28, 1996, the licensee, Commonwealth Edison Company, submitted Requests for Relief NR-19 for Byron Station, Units 1 and 2, and NR-24 for Braidwood Station, Units 1 and 2, regarding volumetric examination of the pressurizer surge nozzle-to-vessel weld and inside radius section for all four units. As a result of April 18, 1996, conference call, the licensee provided additional information in a letter dated April 23, 1996. The Idaho National Engineering Laboratory (INEL) staff has evaluated the information provided by the licensee in support of these requests for relief in the following section.

## 2.0 EVALUATION

The Code of record for the Byron/Braidwood, Units 1 and 2 first 10-year inservice inspection (ISI) intervals is the 1983 Edition, through Summer 1983 Addenda of Section XI of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. The information provided by the licensee in support of the requests for relief has been evaluated and the bases for disposition are documented below.

Request for Relief No. NR-19 (Byron 1 and 2) and NR-24 (Braidwood 1 and 2), Examination Category B-D, Items B3.110 and B3.120, Pressurizer Surge Nozzle-to-Vessel Weld and Inside Radius (IR) Section

Code Requirement: Section XI, Table IWB-2500-1, Examination Category B-D, Items B3.110 and B3.120, require 100% volumetric examination, as defined by Figure IWB-2500-7, for all pressurizer nozzle-to-vessel welds and nozzle inside radius sections.

Attachment

Licensee's Code Relief Request: The licensee requested relief from performing the Code-required volumetric examination of the Byron/Braidwood, Unit 1 and 2 pressurizer surge nozzle-to-vessel welds and inside radius sections.

Licensee's Basis for Requesting Relief (as stated):

"Byron [and Braidwood] Units 1 and 2 pressurizer nozzles are welded to the vessel heads (Attachment 1*). Each pressurizer has a single surge nozzle in the lower head. To perform UT examinations on these areas, the outside surface of the lower vessel head, which is the optimal scanning surface, must be accessible. This optimal scanning surface is made accessible by removing the lower pressurizer head insulation. The impact of removing the lower head insulation is discussed below.

"The lower head of the pressurizer is covered by 4 inches of multi-layered stainless steel mirror insulation. To remove the insulation, the 78 pressurizer heater cables would have to be disconnected (Attachment 2). In addition, each of the 78 convection stops, which are riveted to the insulation, would have to be cut so that the insulation could be removed (Attachment 3).

"Previous attempts to acquire this data have proven unsuccessful. During previous outages, attempts were made to modify the insulation on the lower head of the Byron Unit 2 pressurizer to allow inspection access without full insulation and heater cable removal. The insulation group worked three shifts per day for five days to remove this insulation. The groups used small grinders to cut the insulation from the nozzle to the first ring of the immersion heaters. After this work was completed, the bottom head insulation was lowered until stopped by the heater connections. These actions did not result in sufficient access to conduct the examinations. Further actions to provide access were determined to be impractical. The insulation was replaced and the cut areas were covered.

"Examinations of the nozzle-to-vessel weld and the nozzle inner radius would result in limited examination coverage. Even if the insulation were removed, full ultrasonic examination coverage of the surge nozzle-to-vessel weld can not be achieved. The pressurizer surge nozzle geometry limits transducer contact. Consequently, scanning on the nozzle side of the weld is impracticable. The heater penetrations obstruct scanning from the shell side of the weld. The estimated coverage would only be approximately 60% of the weld volume. Regarding the nozzle inner radius, only limited ultrasonic examination of the nozzle inside radius section would be achievable from the outside surface with the insulation removed. The complex geometry of the 'blend region' is not conducive to typical UT examination techniques. A limited examination would be

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* Licensee's attachments are not included in this report.

possible if ultrasonic scanning were conducted from the nozzle. However, due to the complex geometry of the nozzle, the resulting coverage would provide very limited data from which to assess the condition of the surge nozzle inside radius section. The limited data obtained from these examinations does not provide a compensatory increase in quality and safety to justify the hazards of personnel radiation exposure incurred to obtain the data.

"The radiation exposure to plant personnel for insulation removal, surface preparation, and inspection is estimated to be 154 person-rem. To provide a basis for the dose estimates, a survey was conducted during the Braidwood A2R05 outage on March 16, 1996. This survey shows a 500mR contact dose rate on the lower head insulation with a general area rate of over 200mR. The primary work of disconnecting the heater cables, removing insulation, surface preparation and inspection would occur in an area approximately 1 foot from the surge nozzle. After the insulation removal, the rates shown in the survey would increase. Lead shielding would not be practicable because the shielding would have to be placed on the surfaces that require work.

**Estimated Dose for PZR Surge Nozzle and Nozzle Inner Radius Examination**

| Activity | Manhour Estimates[1] | Dose Rate (R/hr)[2] | Accumulated Dose (R) |
|---|---|---|---|
| Scaffolding | 98 | 0.150 | 14.7 |
| Cable Disconnection/Replacement | 412 | 0.250 | 203 |
| Insulation Removal/Replacement | 140 | 0.250 | 35 |
| Surface Preparation | 1 | 0.250 | 0.25 |
| Examination | 4 | 0.250 | 1 |
| Total | 655 | | 153.95 |

[1]Time estimates established by W. A. Pope Company, the primary contractor, and Raytheon Engineers & Constructors the inspection organization.
[2]Whole body dose rate estimates based on location of worker's trunk for specified work in required area at about 1 foot from surge line.

"Westinghouse Materials and Engineering has provided technical input to the basis for the exemption request for the nozzle to vessel weld and nozzle inside radius. The assessment discussed the structural integrity of the Byron [and Braidwood] Units 1 and 2 Pressurizer Surge Nozzle with respect to the nozzle to vessel weld and nozzle inner radius, and the need for the inservice inspection of these areas. The assessment includes three complimenting approaches of inspection history, fracture assessment, and risk assessment. Each approach arrives at the same conclusion, which is that the inservice inspection of the nozzle areas do not significantly improve the confidence in the structural integrity of the pressurizer.

"**Inspection History**: The surge nozzle inner radius for each pressurizer is subjected to a surface examination both before and after the deposit of the stainless steel cladding. The inspection before cladding included 100% UT. The inspection after cladding was performed after the manufacturer hydrotest and included a radiographic examination for both the nozzle inner radii and nozzle to vessel weld for acceptance to ASME Section III.

"For preservice inspection, a UT was conducted of the nozzle to vessel welds with no indications in excess of allowables in ASME Section XI table IWB-3512-1. The nozzle inner radii did not have a preservice UT conducted due to the fact that no technique was available. Preservice relief request NR-13 [Byron 1 and 2], 1NR4 [Braidwood 1] and 2NR4 [Braidwood 2] were granted for the nozzle inner radius.

"A survey was conducted by the Westinghouse Owners Group, where it was found that roughly half of the plants surveyed have sought and received relief from volumetric examinations for the aforementioned reasons. Those that have been carrying out surge nozzle inspections have not reported any indications. Specifically, 21 inspections have been completed, 9 by using UT methods, with no reported indications. While this finding in itself is not sufficient to prove there is no need for further inspection in these areas, it is consistent with the other findings here, in that no concerns are evident with flaws in this region at the beginning of service, and there are no known mechanisms for cracks to initiate during service."

"**Fracture Assessment**: Westinghouse conducted fracture evaluations of the Byron [and Braidwood] surge nozzle inner radius and nozzle to vessel weld regions to determine the sensitivity of this region to the presence of a flaw. The full set of design transients was considered, and the most limiting event that was found to be the heatup and cooldown, which can involve insurges of cooler water into the bottom of the pressurizer. The cooler water has a higher density than was the water in the pressurizer before the insurge, and therefore mixing cannot be guaranteed. The worst case assumed, where no mixing occurs, and the maximum temperature difference between the loop and pressurizer of 320°F was assumed. Because the pressurizer is hot when the insurges occur, the fracture toughness value from the ASME Code Section XI $K_{IA}$ curve was found to be 200 ksi$\sqrt{in}$. The entire range of times during the insurge events was considered along with all the other design transients, and the stress intensity factor never exceeded the toughness, regardless of the size of the postulated crack. These results are summarized in Attachments 4 and 5, pages 8 and 9. Therefore, the structural integrity of the pressurizer will not be affected by flaws in the surge nozzle inner radius or nozzle to vessel weld."

"**Risk Assessment**: Westinghouse examined the effects of inservice examinations on the risk of failure due to cracking in the surge nozzle. From the fracture assessment it was determined that there is a very large tolerance for the presence of flaws in both the nozzle inner radii and the nozzle to vessel weld. Since the applied stress intensity factor does not exceed the fracture toughness, it could be argued that leakage would occur from a through wall flaw at the nozzle before any integrity problems would occur.

"There are no mechanisms of damage other than fatigue for the surge nozzle. Therefore, the only scenarios of concern are for a flaw which was not found in the fabrication and preservice examinations to grow during service, or for a flaw to initiate during service and grow.

"The surge nozzle forgings for Byron [and Braidwood] Units 1 and 2 were examined by both UT and MT prior to the cladding being applied. After cladding, the surge nozzles were required to be liquid penetrant tested to ensure the integrity of the cladding. The nozzle to vessel welds received both penetrant and volumetric (RT) during the fabrication and UT during preservice examinations. With these examinations, it is extremely unlikely that a flaw of any size would be missed. Fatigue crack growth from any such flaw would be very small, and the fatigue assessments carried out to certify the design acceptance ensure that the fatigue loads during service are unlikely to initiate a flaw. Therefore the risk of failure is very low, and is unchanged whether or not inservice UT inspections are conducted."

"**Conclusion**: The assessments discussed above have shown that there is no compensating increase in quality or safety from ultrasonic inservice inspection of the surge nozzle and nozzle to vessel weld. Inspections which have been performed have not identified any indications at all in the entire population of Westinghouse plants, and the fracture assessment showed that the nozzle and nozzle to vessel weld have a very large tolerance for flaws. There are no mechanisms for the development of flaws during service, so that the risk of failure is not decreased by inservice inspection. A VT-2 inspection at pressure along with Reactor Coolant System Leakage Detection Systems ensure that through wall flaws would be identified prior to pressurizer structural integrity being compromised."

In the letter dated April 23, 1996, the licensee stated, in part:

"The heater assembly is very susceptible to damage at the termination point. The lugs from the cable wires are bolted to lugs which, at the other end, are soldered to pins encased in ceramic insulators. These insulators are very fragile and highly susceptible to breakage. Should an insulator be inadvertently damaged, total heater replacement is required.

"Complete volumetric examination can be performed on the nozzle-to-safe end weld of the pressurizer surge nozzle. The inspection would be performed only from the safe end side of the weld. Limitations posed by the geometry of the nozzle preclude data acquisition from the nozzle side of the weld. Complete volumetric examination of pressurizer nozzle other than the surge nozzle can be performed. These examinations include inner radius UT, nozzle-to-vessel weld UT, and nozzle-to-safe end weld UT. Regarding other Class 1 vessel nozzles, complete volumetric examination can be completed on the reactor vessel nozzles and steam generator primary system nozzles. The applicable reactor vessel nozzle exams, for all 8 nozzles, are the inner radius UT, nozzle-to-vessel weld UT and nozzle-to-safe end weld UT. The applicable steam generator exams, for all nozzles, are the inner radius UT and the nozzle-to-elbow UT. It is estimated that 100% of the Code-required inner radius examination volume can be covered with a manual examination techniques utilizing six separate compound angles. However, performing the examination with compound angles will require a significant amount of time in a high dose field."

Licensee's Proposed Alternative Examination (as stated):

"The option of examining the pressurizer surge nozzle-to-head weld and nozzle inside radius section from the inside surface has been addressed and determined to be impractical. The inside surface of the pressurizer surge nozzle is accessible only from the manway. Removal and reinstallation of the manway would incur significant radiation exposure to plant personnel, which is estimated to be approximately 2 person-rem (Byron 1 and 2 and Braidwood 2). Braidwood Unit 1 would incur more dose to gain access to the pressurizer due to a diaphragm seal welded in the manway. Most importantly, baffle plates internal to the pressurizer would prohibit access to the debris screen and the surrounding inside surfaces of the nozzle for a meaningful VT-1 examination.

"To ensure compliance with 10CFR50.55a(g)(3), continued periodic visual examination (VT-2) of the nozzle inner radius area and nozzle to vessel weld will be performed according to the requirements of ASME Section XI, Table IWB-2500-1, Examination Category B-P, including applicable Code Case(s)."

Evaluation: The Code requires 100% volumetric examination of the subject pressurizer nozzle-to-vessel welds and IR sections. However, access to the vessel surface is obstructed by multi-layered, stainless steel mirror insulation that is difficult to remove. As an alternative, the licensee proposes to perform a VT-2 visual examination during the Code-required pressure tests.

Initially, the licensee attempted to gain access to the subject examination area by modifying the insulation at Byron, Unit 2, but could not access the area after cutting away and lowering the insulation. Thus, to gain access for examination at the Byron and Braidwood plants, the insulation covering the pressurizer lower head has to be completely removed. To remove this insulation, disconnection of the heater assemblies is required, which is time and dose intensive. Disconnection of the heater assemblies could also cause damage to the heaters which are susceptible to damage at the termination points. Damage to an insulator would require total heater replacement. Based on survey results made during a Braidwood outage, the radiation exposure to remove the insulation, prepare the surface and perform a limited examination on the nozzles is estimated to be 154 man-rem. Therefore, compliance with the Code requirements would result in considerable hardship for the licensee.

The subject examination areas were examined during fabrication and prior to service and found to be acceptable. These examinations ensured the structural integrity of the pressurizer surge nozzles prior to service. The inservice operational readiness of these examination areas is provided by the performance of the Code-required pressure tests of the pressurizer and interconnected piping. Additional assurance is provided by the examination of the adjacent nozzle-to-safe end weld and other Examination Category B-D nozzles in the pressurizer, reactor pressure vessel and steam generators. These other areas do not experience conditions and stresses exactly the same as the pressurizer surge nozzle, but in many cases, conditions and stresses are similar. Therefore, the examination of the other Class 1 nozzles can be used as an indicator of generic degradation that could occur in the pressurizer surge nozzle and provide reasonable assurance of the structural integrity of the surge nozzle.

In summary, the subject examination areas are covered with insulation that would have to be removed to gain access for examination. Based on the burden associated with removing this insulation, the potential damage to the ceramic heater connections, and the assurances provided by the examination of other Class 1 nozzles and performance of the Code-required pressure tests, the INEL staff concludes that compliance with this requirement would result in a hardship without a compensating increase in quality and safety. Therefore, it is recommended that the licensee's proposed alternative be authorized pursuant to 10 CFR 50.55a(a)(3)(ii). However, since the licensee can examine approximately 60% of the nozzle-to-vessel weld and 100% of the nozzle inside radius section with the insulation removed, volumetric examination of these areas should be performed if the insulation is removed for any reason in the future.

## 3.0 CONCLUSION

The INEL staff has reviewed the licensee's submittal and concludes that compliance with the Code requirements for the pressurizer surge nozzle and inside radius sections would result in hardship without a compensating increase in quality and safety at the Byron and Braidwood plants. Therefore, it is recommended that the licensee's proposed alternative be authorized pursuant to 10 CFR 50.55a(a)(3)(ii).