UNITED STATES
NUCLEAR REGULATORY COMMISSION
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SAFETY EVALUATION BY THE OFFICE OF NUCLEAR REACTOR REGULATION

RELATED TO AMENDMENT NO. 82 TO FACILITY OPERATING LICENSE NO. NPF-72

AND AMENDMENT NO. 82 TO FACILITY OPERATING LICENSE NO. NPF-77

COMMONWEALTH EDISON COMPANY

BRAIDWOOD STATION, UNIT NOS. 1 AND 2

DOCKET NOS. STN 50-456 AND STN 50-457

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1.0 INTRODUCTION

By letters dated August 19, 1996, as supplemented on February 5, March 13, April 29 and April 30, 1997, the Commonwealth Edison Company (ComEd or the licensee) submitted a request to renew the 1.0 volt and 3.0 volt bobbin coil probe steam generator (SG) tube interim plugging criteria (IPC) for outside diameter stress corrosion cracking (ODSCC) indications at tube support plate (TSP) intersections for both the Byron and Braidwood Stations. These IPC criteria are presently in the Byron, Unit 1, and Braidwood, Unit 1, Technical Specifications (TS), but were made applicable on November 9, 1995, for only one cycle for Braidwood, Unit 1, ending in spring 1997 and a cycle and a fraction for Byron, Unit 1, ending in fall 1997. In addition, ComEd proposed in its August 19, 1996, request for license amendments that certain administrative changes be made to the Byron, Unit 1, and Braidwood, Unit 1, TSs to clarify the application of the SG tube repair criteria and to include additional reporting requirements. Although these license amendment requests were for Braidwood and Byron Stations, Units 1 and 2, the requested amendments were only intended to be applicable to Braidwood and Byron Stations, Units 1. While there are no revisions to the TSs for either Byron 2 or Braidwood 2, the licenses for both units were to be amended to maintain the continuity of the amendment numbers. The February 5, March 13, April 29 and April 30, 1997, submittals provided clarifying technical information that did not affect the initial proposed no significant hazards consideration determination.

Subsequently, in its letter dated April 29, 1997, the licensee requested that the staff not issue the subject license amendments for the Byron Station which would have extended the applicability of the 1.0 volt and 3.0 volt IPC through Cycle 9 for Byron, Unit 1,. Accordingly, the staff's evaluation is limited to a review of the applicability of the 1.0 volt and 3.0 volt IPC to Braidwood, Unit 1.

On November 9, 1995, the NRC staff issued License Amendment No. 69 for Braidwood, Unit 1 [Reference 1] which revised the TSs to incorporate a modified voltage based IPC which approved 1.0 volt and 3.0 volt IPC methodologies through Cycle 6 ending in spring 1997. The 1.0 volt IPC is consistent with the NRC staff's position as described in Generic Letter (GL) 95-05, "Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking," dated August 3, 1995. The approach documented in GL 95-05 takes no credit for the TSPs preventing and/or reducing the likelihood of a SG tube bursting and/or leaking under postulated accident conditions. In essence, the methodology in GL 95-05 assumes that the ODSCC degradation affecting the SG tubes at the TSP elevations is in the SG tube freespan. Hence, the subject 1.0 volt IPC applicable to ODSCC flaws is referred to as the Freespan Model. The SG tube voltage-based repair limits in this Freespan Model are established to ensure a low likelihood of SG tube failure due to axially oriented through-wall burst. In addition to this structural analysis, an evaluation of the leakage from ODSCC indications is performed. A leakage integrity analysis is necessary since through-wall or near through-wall ODSCC flaws may be left in service as a result of this Freespan Model repair criteria.

The 3.0 volt IPC methodology is similar to the methodology in GL 95-05, but takes credit for the TSPs preventing and/or reducing the likelihood of tube burst and for reducing the amount of estimated leakage from SG tubes which attempt to burst, but are precluded from doing so by the presence of the TSPs. Hence, the 3.0 volt IPC is based on what is referred to as the Locked TSP Model. As one of the factors providing the basis for this model, ComEd hydraulically expanded selected SG tubes at a number of hot leg TSP intersections. The hydraulic expansion process creates bulges both above and below the TSPs which are larger than the holes drilled in the TSPs. These expanded SG tubes (locked SG tubes) are then removed from service by plugging. These expanded SG tubes essentially function as additional stayrods, thereby restricting TSP displacements under transient and postulated accident conditions. With minimal TSP displacements, ODSCC flaws at the TSPs have a negligibly low likelihood of an axial burst failure since the very small diametral gap between the SG tube and the TSP constrains the SG tubes from opening more than a relatively small amount, even if a SG tube ODSCC flaw would otherwise tend to burst in the freespan between TSPs. As a result, the SG tube voltage-based repair limit is established to ensure a low likelihood of SG tube failure due to axial tensile loading. An evaluation of the estimated leakage from the constrained ODSCC indications is also performed since through-wall or near through-wall flaws may be left in service as a result of this Locked TSP Model repair criteria.

2.0 PROPOSED STEAM GENERATOR TUBE VOLTAGE-BASED REPAIR CRITERIA

The vast majority of ODSCC indications at the TSP intersections in the Braidwood, Unit 1, SGs have been observed on the hot leg sides. Accordingly, the licensee proposed in its original request for Braidwood License Amendment No. 69 to use the Locked TSP Model only on the hot leg side of the Braidwood, Unit 1, SGs; in addition, SG tubes were expanded only on the hot leg side. Therefore, the Locked TSPs Model 3.0 volt IPC is applicable only to the hot leg TSP intersections, subject to certain restrictions. The 1.0 volt IPC are applicable primarily to the cold leg TSP intersections as described below. No SG tube voltage-based repair criteria are applied to ODSCC present in the following types of TSP intersections:

a. intersections where the SG tubes may potentially collapse or deform as a result of the combined postulated loss-of-coolant accident (LOCA) and safe shutdown earthquake loadings,

b. intersections with dent signals greater than 5.0 volts (as measured with the bobbin probe),

c. intersections with dent signals between 2.5 and 5.0 volts (as measured with the bobbin probe) with cracklike indications confirmed with a rotating pancake coil (RPC) probe,

d. intersections at which there are mixed residuals of sufficient magnitude to cause a 1.0 volt (as measured with a bobbin probe) ODSCC indication to be missed or misread,

e. intersections with interfering signals from copper deposits,

f. intersections at the flow distribution baffle plate,

g. intersections with primary water stress corrosion cracking (PWSCC) or circumferential cracklike indications, and

h. intersections not inspected by a 0.610-inch diameter bobbin coil probe.

Predominantly axially oriented ODSCC indications in the SG tubes at the TSP elevations which do not extend outside the thickness of the TSP are dispositioned as follows:

a. for hot leg TSP elevations, excluding intersections that do not pass a 0.610-inch diameter probe and adjacent intersections, the Locked TSP Model is applied as follows:

   i. all indications with bobbin voltages less than or equal to 3.0 volts are allowed to remain in service, and

   ii. all indications greater than 3.0 volts are either plugged or repaired.

b. for cold leg TSP elevations and for hot leg TSP intersections adjacent to intersections that do not pass a 0.610-inch diameter probe, the Freespan Model is applied as follows:

   i. all indications with bobbin voltages less than or equal to 1.0 volt are allowed to remain in service,

   ii. all indications with bobbin voltages greater than 1.0 volt, but less than or equal to the upper voltage repair limit are allowed to remain in service if an RPC probe, or equivalent, does not detect degradation. The upper repair limit is to be evaluated in accordance with the guidance in GL 95-05, and

   iii. all indications greater than the upper voltage repair limit and all indications between 1.0 volt and the upper voltage repair limit which were confirmed with the RPC probe, or equivalent, to be flaw-like are either plugged or repaired.

3.0 EVALUATION

This safety evaluation (SE) focuses on issues discussed in the NRC staff's previous SE issued in conjunction with Braidwood, Unit 1, License Amendment No. 69; i.e., the 1.0 and 3.0 volt IPC methodologies. These subject issues are primarily associated with the Locked TSP Model as it applies to the extension of the 3.0 volt IPC for one additional operating cycle for Braidwood, Unit 1. This SE also discusses certain issues related to the long-term implementation of the 3.0 volt IPC methodology.

3.1 Steam Generator Internals

The presence of the TSPs is relied upon to ensure SG tube integrity during normal operating, transient and postulated accident conditions. As a result, reasonable assurance of the structural integrity of the TSPs and of the structures which maintain the TSPs in position, is necessary. The principal load path components supporting the TSPs are the stayrods, the vertical support bars and the tube bundle wrapper.

The licensee developed and conducted in 1995, an inspection plan using visual and eddy current (EC) techniques to verify the integrity of the TSPs as well as to provide reasonable assurance that the principal load path components responsible for limiting and maintaining the TSPs in their appropriate position are not significantly degraded. Results of these Braidwood, Unit 1, SG inspections of the SG internal structures were provided to the NRC staff in Reference 2.

Specifically, during the fifth refueling outage at Braidwood, Unit 1, in September 1995, the licensee visually inspected the following components in the 1A SG; (1) the top TSP near each of the antirotation devices and along the patch plate seam; (2) the stayrod nuts at the top TSP; and (3) the stayrod spacers between the 8th and 9th TSPs. The licensee observed no degradation. ComEd also visually verified acceptable wrapper alignment in the Braidwood, Unit 1, 1A SG In addition, a total of 89 vertical support bars and 157 vertical support bar welds were visually inspected in all four SGs. No indication of degradation of these SG internal structures was found during these inspections. ComEd also performed EC inspections at Braidwood, Unit 1, in the fall of 1995 to assess the integrity of the TSPs by: (1) inspecting the patch plate seams in the 1A SG; (2) inspecting 50 SG tubes at the top TSP around each of the three antirotation devices in all four SGs; and (3) verifying the presence of each SG tube/TSP intersection during the routine SG tube EC inspections in all four SGs. No indication of degradation was found during these fall 1995 Braidwood, Unit 1, inspections.

During the mid-cycle outage at Byron, Unit 1, in October 1995, the licensee also performed various visual and EC inspections to provide reasonable assurance of the integrity of key internal components. The scope and results of these inspections were provided in a ComEd submittal dated March 19, 1996, "Byron, Unit 1 Steam Generator Interim Plugging Criteria 90 Day Report" [Reference 4]. No indication of degradation of the internal structures was found during this Byron, Unit 1, inspection. Additionally, during the seventh refueling outage at Byron, Unit 1, in April 1996, the licensee visually inspected 24 vertical support bar welds beneath the flow distribution baffle in all four SGs and identified no weld degradation. ComEd also visually verified in the spring of 1996 Byron, Unit 1, SG inspection, acceptable wrapper alignment in all four SGs. The licensee also performed EC inspections of 50 SG tube/TSP intersections around each of the three antirotation devices in all four SGs and identified no degradation of the TSPs during this same Byron, Unit 1, SG inspection. ComEd also verified the presence of each SG tube/TSP intersection during this Byron, Unit 1, SG tube EC spring 1996 inspection in all four SGs. Since the Byron, Unit 1, and Braidwood, Unit 1, SGs both use Westinghouse Model D4 SGs, both of these Byron, Unit 1, SG inspections provide additional assurance that the SG internal structures at Braidwood, Unit 1, are not subject to any detectable degradation. To provide continued assurance of TSP integrity, the licensee has performed an EC inspection of 50 SG tubes adjacent to each antirotation device in all four SGs and 20 tubes along the patch plate seam in one SG during the present refueling outage at Braidwood, Unit 1, (A1R06). No indications were reported which would be detrimental to the structural integrity of the load path necessary to validate the Locked TSP Model. The licensee also verified the presence of each SG tube/TSP intersection. The forthcoming Braidwood, Unit 1, 90-Day Report will provide a summary of these latest inspection results.

The staff concludes that the acceptable inspection findings found during the fall 1995 visual and EC inspections and the inspection findings of SG structural internals, including TSPs, in the present Braidwood, Unit 1, refueling outage at the antirotation devices and patch plate seams, provide reasonable assurance of the integrity of the load path components and TSPs in the SGs at Braidwood, Unit 1, through the end of Cycle 7. The staff notes that for long-term implementation of the Locked TSP Model, it would be necessary to develop a plan to address the long-term integrity of these SG internal structural components.

3.2 Inspection of Expanded Tubes

In its prior submittals for Braidwood, Unit 1, License Amendment No. 69, ComEd proposed to reinspect a sample of the SG tubes expanded in the fall 1995 refueling outage after three cycles of operation and, if necessary, to increase the size of this sample based on the inspection results. The staff concluded in its SE issued on November 9, 1995, that there was reasonable assurance of the structural integrity of the expanded SG tube joints for the proposed operating time interval (i.e., one fuel cycle) over which Braidwood, Unit 1, License Amendment No. 69 was applicable. However, the staff stated in the SE cited above that additional information would be necessary to support the licensee's proposal to not inspect the expanded SG tubes during forthcoming SG inspections if the licensee were to request to continue operation of the Braidwood, Unit 1, SGs with the 1.0 volt and 3.0 volt IPC beyond the one operating cycle approved by Braidwood, Unit 1, License Amendment No. 69.

In its present submittals for the extension of the 1.0 volt and 3.0 volt IPC for one additional operating cycle for Braidwood, Unit 1, the licensee proposed to verify the integrity of the SG tube expansions during the spring 1997 refueling outage at Braidwood, Unit 1, (A1R06) by inspecting a 20 percent sample of the SG tube expansions. The criteria for selecting the SG tubes to be inspected, including the selected SGs, included: (1) selecting SGs which are representative of the total population of ODSCC indications and top of tubesheet (TTS) indications; (2) selecting SG tubes from each of the fourteen bundle regions where SG tube expansions were performed; and (3) selecting SG tubes containing both the minimum and maximum number of expansions per SG tube. These inspections were to be performed with an inspection method equivalent to, or better than, that used during the previous Braidwood, Unit 1, inspection outages. In addition, the locked SG tubes to be inspected were also to be inspected at the TTS using a plus point coil.

If either axial or circumferential indications were detected at the sleeved expanded joint or at the TTS, the licensee was to notify the NRC staff. In addition an assessment of the safety significance of any circumferential indications, particularly its effect on TSP displacement, was to be performed. (For axial indications at the TTS or at the expansions at the TSPs in the locked SG tubes, the licensee had previously determined that such indications will not result in the displacement of the TSP under postulated accident conditions by more than 0.100 inches.) In addition, the proposed inspection program for the locked SG tubes in the Braidwood, Unit 1, spring 1997 refueling outage was to be expanded to include 100 percent of the expanded SG tubes if either circumferential or axial indications were found in these tubes at: (1) the roll transition zone at the TTS; (2) the expansions (bulges) above and below the TSPs; or (3) in the sleeves installed in the expansion joints at the TSPs.

Subsequently, the licensee stated at a meeting with the staff in Rockville, Maryland, on April 30, 1997, that the EC inspections of the expanded SG tubes at Braidwood, Unit 1, for the A1R06 refueling outage are complete. ComEd inspected the 85 expanded tubes at the TSP expansions and at the TTS. The licensee found circumferential indications at the TTS in 49 of the 85 expanded SG tubes. However, no indications were found at the TSP expansions or in the expanded joint sleeves. The licensee performed several insitu pressure tests of the most severely degraded SG tubes to demonstrate that structural integrity of the locked SG tubes was maintained over the previous operating Braidwood, Unit 1, operating cycle.

As stated in its letter dated April 29, 1997, to address the issue of circumferential indications in the locked SG tubes at the TTS, ComEd will sleeve all expanded SG tubes at Braidwood, Unit 1, using the sleeving process described in Westinghouse topical report WCAP-13698, Revision 1, "Laser Welded Sleeves for 3/4 Inch Diameter Tube Feedring-Type and Westinghouse Preheater Steam Generators," dated May 1993. The staff previously approved the use of these sleeves at Braidwood, Unit 1, and Byron, Unit 1, in a letter dated March 4, 1994. This is the latest approved Westinghouse topical report applicable for both the Byron and Braidwood Stations. WCAP-13698 demonstrated that: (1) the Hybrid Expansion Joint (HEJ), the lower joint located in the tubesheet; and (2) the laser welded joint, the upper joint located in the freespan region above the tubesheet, are capable of carrying the loads imposed during normal plant operations or during postulated accident conditions. Both the HEJs and the welded joints can sustain axial loads well in excess of 500 pounds, which is the maximum load the expanded SG tubes would be required to carry during a main steamline break (MSLB) event [Reference 1].

The staff concludes that the licensee's proposed inspection plans for the present Braidwood, Unit 1, refueling outage are acceptable. Further, installing Westinghouse laser-welded sleeves at the TTS in all of the locked SG tubes in conformance with WCAP-13698, will repair the circumferential indications found at the TTS in an acceptable manner by restoring the original design basis of the expanded SG tubes (i.e., limit TSP displacements to less than 0.100 inches under postulated accident conditions).

On this basis, the staff finds that the repair of the locked SG tubes proposed by ComEd in its letter dated April 29, 1997, is acceptable. Therefore, the occurrence of the circumferential cracks at the TTS in the locked SG tubes does not preclude extension of the 1.0 volt and 3.0 volt IPC for one additional Braidwood, Unit 1, operating cycle. If the licensee were to request to continue operation of Braidwood, Unit 1, with the present 1.0 and 3.0 volt IPC beyond Cycle 7, additional SG inspections may be required to ensure the integrity of the expanded SG tubes.

3.3 Probe Wear

In the SE issued in conjunction with Braidwood, Unit 1, License Amendment No. 69, the staff accepted an exception to the probe wear guidance contained in GL 95-05. However, for future applications of the 3.0 volt IPC, the staff stated in this SE that ComEd should either: (a) submit an alternative probe wear methodology that provides detection and sizing capability equivalent to the probe wear guidance in GL 95-05; or (b) follow the GL 95-05 guidance with respect to probe wear.

In its submittal dated March 19, 1996 [Reference 3], the licensee proposed to use an alternative to the probe wear reinspection requirements of GL 95-05. The licensee's proposal is consistent with the industry approach developed through the Nuclear Energy Institute (NEI), and requires that if the amplitude from the probe wear standard prior to probe replacement exceeds the ±15 percent limit, all indications with voltage responses measured at 75 percent or greater of the lower voltage repair limit (i.e., 1.0 volt) must be reinspected with a bobbin probe satisfying the ±15 percent wear standard criterion. At Braidwood, Unit 1, all probe wear indications greater than 75 percent of the lower voltage repair limit were reinspected with a probe which satisfies the probe wear criterion, including hot leg indications to which a 3.0 volt repair criterion is applied. The voltages from this reinspection are used as the basis for SG tube repair. The NRC staff completed a review of the proposed alternative method for addressing probe wear and concluded the proposed approach is acceptable as documented in Reference 4.

In the NEI study supporting the alternative probe wear criteria, the correlation of worn probe voltages with new probe voltages shows that for all significant voltage levels, the worn probe voltages are never less than 25 percent of the new probe voltages. In contrast, in a Byron, Unit 1, 90-Day Report [Reference 3], a comparison was made between the worn probe voltage and the new probe voltage which resulted in two data points where the worn probe voltages were less than 25 percent of the new probe voltage. However, the staff notes that no pluggable SG tubes were missed due to probe wear considerations. The licensee concluded that the criteria to retest SG tubes with worn probe voltages above 75 percent of the repair limit is adequate and generally conservative due to the average trend for worn probe voltage measurements to exceed new probe voltages. A comparison of the actual and projected Byron, Unit 1, end-of-cycle 7 (EOC-7) voltages did not indicate anything unusual attributable to the alternate probe wear criteria. The staff concludes that the Byron, Unit 1, probe wear results do not indicate an immediate concern with the NEI alternative probe wear criteria. The staff will continue to closely monitor the 90-Day reports of licensees using the NEI approach to address the issue of probe wear.

3.4 Confirmation of Degradation Mechanism

Destructive metallurgical examination of the SG tubes at TSP intersections removed from Braidwood, Unit 1, and Byron, Unit 1, confirmed that the dominant degradation mechanism for the indications at the TSP elevations is axially oriented ODSCC and, thus, the voltage-based tube repair criteria for indications at the TSPs are applicable. Further evidence that the degradation morphology is consistent with that assumed in GL 95-05 will be obtained from the RPC examinations performed by the licensee during the present Braidwood, Unit 1, refueling outage and will be reported in the forthcoming Braidwood, Unit 1, 90-Day Report.

GL 95-05 provides a discussion on the purpose, frequency, and scope of removing SG tubes for destructive metallurgical examination. The licensee has committed to follow the guidance in GL 95-05 regarding SG tubes to be pulled. However, since GL 95-05 only addresses the Freespan Model in which axial tensile failure is not expected, this GL did not address whether testing was required to provide data for the axial tensile failure correlation database (i.e., the axial tensile force for SG tube severance versus the logarithm of the bobbin voltage correlation). As a result, the licensee committed to supplement the axial tensile failure database by performing tensile force tests on SG tube specimens removed from Braidwood, Unit 1, during the present refueling outage for the freespan axial burst tests. A minimum of one SG tube, with a minimum of two TSP intersections, will be pulled from Braidwood, Unit 1, during the present refueling outage.

3.5 Reporting Requirements

With the implementation of a voltage-based repair criteria, certain situations require NRC staff notification as discussed in GL 95-05. ComEd's proposed Braidwood, Unit 1, TSs are consistent with the GL 95-05 reporting requirements. In addition, the licensee proposed to add the following reporting requirements to the Braidwood, Unit 1, TSs in support of the extension of the 3.0 volt IPC:

The NRC staff was to be notified prior to returning the Braidwood, Unit 1, SGs to service if:

a. cracking is observed in the TSPs,

b. any SG tube which previously passed a 0.610-inch diameter bobbin coil EC probe currently fails to pass a 0.610-inch diameter bobbin coil EC probe, and

c. indications detrimental to the integrity of the load path necessary to support the 3.0 volt IPC are found.

In its meeting with the staff on April 30, 1997, the licensee addressed the issue of circumferential crack indications in the locked SG tubes at the TTS as discussed in Section 3.2 above, thereby satisfying this last reporting item.

3.6 Steam Generator Tube Structural Integrity

A SG tube can fail in one of two ways: (1) due to an axially oriented through-wall burst (referred to hereafter as an "axial burst failure"), or (2) due to severance of the tube caused by axial tensile loads (referred to hereafter as an "axial tensile failure"). The SG tube repair limits for the Freespan Model are based on limiting the potential for axial burst failures, since failures as a result of axial tensile loads are not expected. However, as the voltage-based repair limits are raised as is the case for ODSCC flaws in SG tubes where the 3.0 volt Locked TSP Model will be applied, the possibility that the SG tube degradation occurs over a larger portion of the circumference of the tube at a given TSP elevation is increased. As a consequence, the potential for axial tensile failure of a SG tube was increased and is considered in the development of the Locked TSP Model SG tube voltage-based repair limits. In addition to establishing deterministic tube repair limits, probabilistic assessments of the potential for axial burst failures and axial tensile failures are considered in the development of SG tube repair criteria. Deterministic and probabilistic structural integrity assessments for both the Freespan and Locked TSP Models were discussed in detail in Reference 1 and are described more generally below.

3.6.1 Deterministic Structural Integrity Assessments

3.6.1.1 Axial Burst Failure

Freespan Model

The Freespan Model voltage-based SG tube repair criteria are set deterministically to ensure that indications accepted for continued service will retain adequate structural integrity during the full range of normal, transient, and postulated accident conditions for the operational cycle proposed. The repair criteria include allowances for EC test uncertainty and flaw growth projected to occur during the next operating cycle. Because the voltage-based repair criteria address SG tubes with ODSCC flaws confined within the thickness of the TSPs during normal operation, the structural constraint provided by the TSPs ensures that all tubes to which the 3.0 volt criteria apply, will retain a margin of three with respect to burst under normal operating conditions, consistent with the guidance in Regulatory Guide (RG) 1.121. For a postulated MSLB accident, however, the TSPs may displace axially during blowdown such that a portion of a SG tube with an ODSCC flaw may no longer be fully constrained by the TSPs. Accordingly, the ODSCC affected regions of the SG tubes are considered free standing for the purpose of assessing burst integrity under postulated MSLB conditions.

The SG tube repair limits are based on a correlation relating SG tube burst pressure with the bobbin coil voltage. For the reasons discussed above, the SG tube burst pressures were determined without any constraining affect provided by a TSP. When these SG tube specimens were tested, all the SG tube failures were due to axially oriented through-wall bursts. The lower voltage repair limit for 3/4-inch diameter SG tubes was established at 1.0 volt; the upper voltage repair limit is developed as discussed in GL 95-05.

Locked TSP Model

As with the Freespan Model, the Locked TSP Model voltage-based repair criteria apply to SG tubes affected with ODSCC confined within the thickness of the TSPs. During normal operation, the structural constraint provided by the TSPs ensures that all SG tubes to which the 3.0 volt repair criterion applies, will retain a margin of three with respect to burst under normal operating conditions, consistent with the guidance in RG 1.121. Although axial displacement of a TSP can occur as a result of transients and postulated accident conditions, the TSP displacements are limited by expanding a number of SG tubes into selected TSPs (i.e., locked SG tubes). If no TSP displacement were to occur, axial bursts are extremely unlikely since, as for the normal operating case, the amount that a crack can open is limited by the small diametral gap between the outside diameter of the SG tube and the inside diameter of the TSP hole. This gap is sufficiently small to preclude SG tube axial burst failure although indications may attempt to burst, but are precluded from bursting as a result of the constraint provided by the TSP. With the SG tube expansion matrix proposed by the licensee, the TSP displacements are postulated to be no greater than 0.100 inches. As a result, only 0.100 inches of an ODSCC indication postulated to be 0.75 inches long would be exposed outside the TSP. The longest ODSCC indication to be considered is 0.75 inches since the thickness of the TSP is 0.75 inches and the 3.0 volt IPC does not apply to an ODSCC flaw which extends beyond a TSP.

Without the constraint provided by a TSP, a 0.75 inch long free span ODSCC indication in a SG tube with lower bound (95 percent/95 percent) material properties would have a burst pressure near the pressures anticipated during a postulated MSLB. However, if a TSP is covering 0.65 inches of a 0.75 inch long ODSCC indication, the burst pressure is much higher. In 1995, the licensee provided test results to support such a conclusion. These tests provided a direct comparison between the freespan burst strength and the TSP constrained burst strength. The test results confirmed that with a major portion of an ODSCC crack confined within the thickness of a TSP and an exposed length typical of the maximum postulated TSP displacement (i.e., 0.100 inches), such an exposed ODSCC flaw has a burst pressure much higher than the burst pressure corresponding to the total freespan length of the crack. In fact, the measured burst pressure was primarily a function of the exposed crack length rather than that of the total crack length. As a result, the burst pressure of an ODSCC crack (which is 0.75 inches long) of which only 0.100 inches is exposed outside the TSP, would be expected to have a burst pressure corresponding to a 0.100 inch long crack. This burst pressure is expected to be greater than 7000 pounds per square inch (psi) which is well above the pressure loading criteria provided in RG 1.121.

However, as the tube-to-TSP clearances increase (i.e., the diameter of the TSP hole is larger than nominal and/or the SG tube diameter is lower), some reduction in the burst pressure of an exposed ODSCC crack compared to a comparable freespan crack, is expected. This was observed in the 1995 tests cited above. For a 23 mil gap which is at the upper 95 percent confidence bound and the TSP displacements of interest (i.e., 0.100 inches), the reduction in burst pressure was less than 1000 psi. The resultant 6000 psi burst pressure capability is still well above the pressure loading criteria provided in RG 1.121. Thus, SG tube repair limits for the Locked TSP Model are not based on a correlation relating SG tube burst pressure with the bobbin coil voltage as is the case for the Freespan Model, since axial burst failure under normal and accident conditions is not credible. The staff concludes that the Locked TSP Model demonstrates that there is an acceptable margin against axial burst failure during normal operating, transient, and postulated accident conditions because the 3.0 volt IPC is applicable for an ODSCC indication within the confines of the TSP and the licensee has made modifications to the internal structures of the SGs which provides assurance that displacement of the TSPs is limited to less than 0.100 inches.

3.6.1.2 Axial Tensile Failure

Freespan Model

As discussed in the preceding section, the Freespan Model SG tube voltage-based repair limits are based on a statistical correlation relating SG tube burst pressures with the bobbin coil voltage. During the testing performed by the nuclear industry to support the development of the SG tube voltage repair limits in GL 95-05, all of the observed SG tube failures were axial burst failures even for ODSCC indications with bobbin voltages as high as 20 volts. Since ODSCC degradation is predominantly axially oriented, axial tensile failure of the ODSCC indications to which the Freespan Model is applied is not expected. Thus, the deterministic voltage repair limit for addressing the potential for SG tube axial burst failures conservatively bounds any deterministic voltage-based repair limit which would be necessary for addressing the potential for axial tensile failure under normal operating, transient, and postulated accident conditions.

Locked TSP Model

For the Locked TSP Model with its higher voltage-repair limit, the circumferential involvement of the predominantly axially oriented ODSCC degradation is greater and the potential for axial tensile failure due to axial loads on a SG tube increases. The circumferential involvement arises due to the development of closely spaced ODSCC axial cracks and corrosion due to intergranular attack (IGA). The axial loads result from the internal pressures in the SG tubes. To ensure that the ODSCC indications (up to 3.0 volts, that are accepted for continued service using the Locked TSP Model) will have adequate margin during normal operating, transient and postulated accident conditions, ComEd provided two different statistical correlations to relate the axial load carrying capability of a predominantly axially ODSCC indication to the bobbin voltage. One correlation relates the residual cross-sectional (RCS) area with the bobbin voltage; the other correlation relates the axial tensile force for axial separation with the bobbin voltage. The structural limit was determined from these correlations by evaluating them at three times the normal operating pressure loading, the most limiting of the RG 1.121 criteria for Braidwood, Unit 1.

The first correlation was a linear first order equation between the nondegraded RCS area and the bobbin voltage determined by a standard least-squares linear regression analysis. From this regression relationship, a lower 95 percent prediction bound was determined for the non-degraded RCS area as a function of bobbin voltage amplitude. The lower 95 percent prediction interval was further reduced to account for temperature effects on the SG tube material properties. Using this reduced lower prediction interval curve, the structural limit was determined for a pressure loading corresponding to three times the normal operating internal pressure consistent with the structural limits in RG 1.121. This evaluation was done using lower tolerance limit material properties. With this approach, the licensee determined that a structural limit of about 35 volts was applicable.

The licensee also developed a second correlation between the axial load carrying capability of a predominantly axially oriented ODSCC indication and the bobbin voltage. The correlation between the axial rupture force and the logarithm (base 10) of the bobbin voltage was developed. Applying similar statistical analyses similar to those discussed above, the resulting structural limit was calculated to be in excess of 100 volts.

For the determination of the SG tube repair limit, the licensee adjusted the more conservative structural limit determined above (i.e., 35 volts) downward to account for the limited size of the database. This structural limit was further adjusted downward to account for potential flaw growth during an operating interval and to account for uncertainty in the non-destructive EC examination. The licensee concluded that a repair limit exceeding 10 volts was justified. However, the licensee further reduced the repair limit to 3.0 volts for added conservatism. Accordingly, all bobbin indications above 3.0 volts are repaired regardless of RPC EC examination data.

In summary, the correlations of nondegraded RCS area with the bobbin voltage and the correlation of axial rupture force with the logarithm (base 10) of the bobbin voltage, indicate structural limits above 35 volts. For long-term implementation of the Locked TSP Model, additional data are needed to better define this estimate of the structural limit. The correlation between the axial rupture force and the logarithm (base 10) of the bobbin voltage is the preferred approach. The staff noted in Reference 1 that uncertainty and potential non-conservatisms are introduced into these correlations through various sources. However, the staff also considered the current projections for indications greater than 10 volts at Braidwood, Unit 1. In 1996, ComEd projected a maximum voltage of 10.5 volts at Braidwood, Unit 1, at the EOC-7. This value is considerably less than the calculated structural limits discussed above. Taking into consideration this projected EOC-7 voltage and the observation that no SG tube specimens used in support of the Freespan Model failed as a result of axial tensile loads, even with bobbin voltages in excess of 20 volts for 3/4-inch diameter SG tubing, the staff concludes that a 3.0 volt repair limit is justified through one additional cycle at Braidwood, Unit 1.

3.6.2 Probabilistic Structural Integrity Assessment

A probabilistic analysis of the potential for SG tube ruptures, assuming an MSLB, must also be performed to supplement the deterministic analyses discussed above.

To determine the conditional probability of burst given an MSLB, the EOC distribution of indications must be determined. The methodology for determining the EOC voltage distribution is discussed in GL 95-05. The application of this methodology for the Freespan Model and the Locked TSP Model are similar. However, the licensee will determine separate EOC distributions for the SG tube/TSP intersections to which the Freespan Model and Locked TSP Model are applied. These separate EOC distributions will be projected from the growth rate distributions determined from the appropriate indications. However, if the Freespan Model is applied to a limited number of indications (i.e., less than 200 per GL 95-05), a bounding growth rate distribution will be used in the projection of the EOC voltage distribution.

Since two distinct models are employed to address the structural integrity of ODSCC indications at the TSP elevations in the SGs, two distinct models for calculating the probability of burst have been developed; i.e., one for the Freespan Model and one for the Locked TSP Model. Each model must assess the probability that an ODSCC indication can, under MSLB conditions, either fail due to axial burst or fail as a result of axial tensile loadings.

3.6.2.1 Axial Burst Failure

Freespan Model

For the Freespan Model, the methodology for calculating the conditional probability of one or more SG tubes failing due to an axial burst during an MSLB event is discussed in GL 95-05 and the staff's May 30, 1995, memorandum from Mr. Frank J. Miraglia to Mr. Edward L. Jordan titled, "Request for CRGR Review of Generic Letter 95-XX, Voltage-Based Repair Criteria for Westinghouse Steam Generator Tubes Affected by Outside Diameter Stress Corrosion Cracking." The licensee proposes to perform this calculation in accordance with GL 95-05.

Locked TSP Model

For the Locked TSP Model, the licensee assumed all hot leg SG tube/TSP intersections had a 0.75 inch long through-wall crack of which a portion of the crack was displaced outside the TSP by an amount equal to 0.100 inches. In addition, ComEd assumed that the diametral gap between the SG tube/TSP hole for all SG tube/TSP intersections was at the upper 95 percent confidence bound. This calculation utilized the burst pressure versus axial crack length correlation with an appropriate reduction in the burst pressure to account for the tube-to-TSP diametral gap. The result was that the probability of axial burst under MSLB conditions was negligibly low (i.e., less than 1×10^{-5}).

3.6.2.2 Axial Tensile Failure

Freespan Model

As discussed earlier, the Freespan Model SG tube voltage-based repair limits are based on a statistical correlation relating SG tube burst pressure with the bobbin coil voltage. During the testing performed to support the development of this correlation, all of the observed SG tube failures were axial burst failures even for ODSCC indications with bobbin voltages as high as 20 volts. Since ODSCC degradation at the TSPs is predominantly axially oriented, axial tensile failure of a SG tube to which the Freespan Model is applied is not expected for the voltage limits currently being implemented and for the voltages currently being observed in EC examinations of SGs. As a result, the probability of axial tensile burst, given an MSLB, would be expected to be negligible.

Locked TSP Model

For the Locked TSP Model, the licensee reported that the conditional probability of axial tensile failure, given an MSLB, for a single indication using the following two different correlations: (1) the RCS area versus bobbin voltage correlation; and (2) the tensile force versus the logarithm (base 10) of the bobbin voltage correlation. The results indicated the conditional probability of axial tensile failure was on the order of 3×10^{-5} for the RCS area correlation and 3×10^{-6} for the tensile force correlation for a single 10 volt indication under MSLB conditions. For this probability to significantly contribute to the overall probability of SG tube failure in general, there would need to be a significant number of indications greater than 10 volts. Based on previously measured SG tube voltage distributions and growth rates, the licensee performed Monte Carlo projections of the voltage distributions for Braidwood, Unit 1, at EOC-7 (i.e., fall 1998). The number of ODSCC indications predicted to be greater than 10 volts is 0.3 for Braidwood, Unit 1, at EOC-7. Based on the low probabilities of axial tensile failure and the low number of predicted ODSCC indications greater than 10 volts, the staff concludes that the axial tensile failure conditional probability will not contribute significantly to the total SG tube failure probability when compared to the requirement in GL 95-05 that a total failure probability not exceed the threshold value of 1×10^{-2} per reactor year.

Nonetheless, the licensee proposes to calculate the conditional probability of axial tensile failure in accordance with the guidance in GL 95-05 and combine this probability with the conditional probability of axial burst failure if: (1) any indications with a voltage greater than or equal to 15 volts is identified; or (2) a large number of indications between ten and fifteen volts are identified (e.g., 250 indications). This information will be included in the forthcoming Braidwood, Unit 1, 90-Day Inspection Report. If either of these conditions were to be observed (i.e., a ≥15 volt indication or ≥250 indications), it could indicate potential non-conservatisms in the methodology for projecting the EOC voltage distribution. As a result, the probability of SG tube structural failure could be higher than expected since the number and size of indications may be estimated too low. If this were to occur, the licensee will compare in its forthcoming Braidwood, Unit 1, 90-Day

Report, the predicted with the actual EOC voltage distributions measured in the present Braidwood, Unit 1, refueling outage. If this comparison indicates that the field measurements (e.g., the number of indications, the size of the largest indications, and the distribution of indications) are greater than those predicted, then the NRC will be notified, a root cause determination will be performed, and the conditional SG tube failure probability will be calculated.

3.6.2.3 Summary of Probabilistic Structural Integrity Assessment

For ODSCC indications to which the Freespan Model will be applied, the methodology described in GL 95-05 will be implemented to calculate the conditional probability of an axial burst failure given an MSLB. The results of the probabilistic analyses will be compared to a threshold value of $1x10^{-2}$ as discussed in GL 95-05. If this threshold value is exceeded, the NRC staff will be notified and an assessment of the safety significance of this occurrence will be provided to the NRC staff prior to returning the SGs to service. As discussed above, the conditional probability of axial tensile failure given an MSLB, is considered by the staff to be negligible and need not be calculated for the one additional Braidwood, Unit 1, operating cycle in order to implement the proposed extension of the present 1.0 volt IPC

For ODSCC indications to which the Locked TSP Model will be applied, the licensee assumed all intersections had through-wall cracks extending throughout the 0.75 inch thickness of the TSP of which 0.100 inches would be exposed during a postulated MSLB. Based on the negligible probability which was calculated by the licensee using a very conservative assumption, the staff concludes that the probability of an axial burst failure under the Locked TSP Model conditions, given an MSLB, is extremely low. The conditional probability of an axial tensile failure, given an MSLB, is also considered by the staff to be insignificant based on the voltage repair limits being implemented and the EC voltages currently being observed in the field. As a result, calculation of the conditional probability of axial tensile failure need not be performed, provided that: (1) the EOC projections are found to be conservative in terms of the size and number of indications; (2) all indications detected are less than 15 volts; and (3) less than 250 indications above 10 volts are observed. The staff notes that the database and correlations need to be continually assessed as well as the EOC voltage distributions to ensure that the probability of axial tensile burst given an MSLB, will remain negligible. For long-term implementation of the Locked TSP Model, the staff concludes that: (1) calculations should be performed in accordance with the methodology described in GL 95-05 (i.e., a probabilistic Monte Carlo analysis; and (2) any future submittals proposing to use the Locked TSP Model should address a means of combining the axial burst and the axial tensile failure conditional probabilities.

3.7 Steam Generator Tube Leakage Integrity

The application of voltage-based SG tube repair criteria may result in SG tubes having, or developing, through-wall or near through-wall cracks during the forthcoming operational cycle, thus, creating the potential for primary-to-secondary SG leakage during normal operating, transient, or postulated accident conditions. Accordingly, the leakage integrity of these SG tubes, in addition to their structural integrity, must be assessed.

The staff finds that adequate SG leakage integrity during normal operating conditions is reasonably assured by the present Braidwood, Unit 1, TS limits on the allowable primary-to-secondary leakage. Adequate leakage integrity during transients and postulated accidents is demonstrated by showing that for the most limiting accident, assumed to occur at the end of the next operating cycle (i.e., Braidwood, Unit 1, Cycle 7), the estimated SG leakage will not exceed a rate which will result in offsite dose limits being exceeded. This will be demonstrated by the licensee in its forthcoming Braidwood, Unit 1, 90-Day Report.

3.7.1 Normal Operational Steam Generator Leakage

The licensee has previously incorporated a primary-to-secondary SG leakage limit in their Braidwood, Unit 1, TS of 150 gallons per day from any one SG. The staff finds that this limit on SG operational leakage is acceptable as documented in GL 95-05.

3.7.2 Steam Generator Leakage Under Accident Conditions

In the Freespan Model, the vast majority of ODSCC indications at EOC have freespan burst pressures above the MSLB differential pressure. However, there is a small, but finite probability that ODSCC indications may burst at a pressure less than the MSLB differential pressure. GL 95-05 provides guidance that if this conditional probability exceeds $1x10^{-2}$, it should be reported to the NRC. For the Locked TSP Model, however, the proposed extension of the larger voltage repair limits (i.e., 3.0 volts) for ODSCC indications increases the probability that an ODSCC indication may attempt to burst, but be precluded from axial burst as a result of the flanks of an ODSCC crack contacting the inside diameter of the TSP hole and, thereby, be restrained. Leakage from this type of constrained ODSCC indication may potentially exceed that obtained from the freespan leak rate correlation discussed in GL 95-05 since the testing used to establish the freespan leakages did not include SG tube specimens which start to burst at or below MSLB conditions. This type of potential SG tube leakage is referred to as an indication restricted from burst (IRB). The licensee performed laboratory testing in 1995 to determine the leak rate attributable to an IRB condition.

The licensee will calculate and report in its forthcoming Braidwood, Unit 1, 90-Day Report, the SG tube leakage from the faulted SG during a postulated MSLB using: (1) a model for predicting the leakage from ODSCC indications assuming that the indications are in the freespan; and (2) a model for predicting the leakage from IRBs.

The staff previously reviewed and approved the Freespan Model leakage methodology proposed by the licensee as documented in a license amendment issued for Braidwood, Unit 1, on August 18, 1994, "Issuance of Amendment (TAC No. M89697)." The approach documented in this evaluation is consistent with that in GL 95-05 and is acceptable to the staff.

The Locked TSP Model leakage methodology is essentially identical to the Freespan Model leakage methodology except that ComEd assigns a bounding 6.0 gallons per minute (gpm) leak rate to indications predicted to burst below the MSLB differential pressure (i.e., IRBs). The licensee then sums the Freespan Model leakrate values and the Locked TSP Model leakrate values to estimate the total leak rate for each SG. The total primary-to-secondary SG tube leakage under MSLB conditions due to the proposed extension of the 3.0 volt IPC application and any other approved alternate repair criteria, may not exceed the site allowable leak rate. The current site allowable leakage limit is 26.8 gpm for the Braidwood Station.

The staff concludes that for the extension of the 3.0 volt IPC for one additional operating cycle at Braidwood, Unit 1, the bounding 6.0 gpm leak rate for IRBs predicted to burst below MSLB differential pressure, is appropriate, based on various conservatisms discussed in the SE in Reference 1. However, the staff is still evaluating the acceptability of the IRB 6.0 gpm leak rate value for long-term implementation. The staff's review of this matter will determine if additional conservatisms should be applied to this 6.0 gpm estimate or if additional testing is required, based on: (1) the potential for the severity of the ODSCC degradation at the TSPs to increase over the long-term (e.g., the potential for multiple through-wall cracks to develop near the edges of the TSPs); (2) the staff's continuing review of the leakage adjustment procedure to MSLB conditions; (3) apparent anomalies in some of the laboratory data supporting the 6.0 gpm leakrate estimate; and (4) a review of industry data on this matter.

The staff also evaluated the licensee's proposed methodology for determining the total SG leakrate from indications at the TSP elevations by summing the contributions of the leakage values from the Freespan Model and Locked TSP Model. The staff concludes this is acceptable for only one additional Braidwood, Unit 1, operating cycle to which this proposed voltage-based repair criteria will be applied, given the limited number and severity of ODSCC indications to which the Freespan Model has historically been applied. However, the staff is still evaluating the need for a long-term approach to combine the leakage estimates from the Freespan Model and Locked TSP Model, including a contribution from ODSCC indications which burst under the Freespan Model, prior to ordering the total leakage values. The total SG leakrate would then be determined by evaluating the ordered array of leak rates at the 95th quantile at a 95 percent confidence level.

3.8 Summary of the Evaluation of the Steam Generator Tube Integrity

The staff concludes there is reasonable assurance that there is acceptable structural and leakage integrity of those ODSCC indications which will be allowed to continue in service under the proposed extension of the present 1.0 and 3.0 volt IPC in the Braidwood, Unit 1, TSs, for one additional operating cycle. The staff's approval of the proposed extension of the present Braidwood, Unit 1, voltage-based repair criteria for a full operating cycle is based, in part, on the licensee being able to demonstrate that the conditional probability of SG tube failure and the primary-to-secondary SG leakage during a postulated MSLB, will be acceptable. This confirmation will be submitted in the forthcoming Braidwood, Unit 1, 90-Day Report.

The staff notes that additional areas need to be addressed prior to approving the 3.0 volt IPC for a long-term application (i.e., for more than one cycle between inspections). These areas include, but are not necessarily limited to:

a. the long-term integrity of the SG internals including the TSPs,

b. the long-term integrity of the expanded SG tubes,

c. the effects on the burst pressure of multiple indications extending 0.100 inches outside the TSP,

d. the combining of the conditional probabilities of axial burst and axial tensile failures for both the Freespan and Locked TSP Models,

e. the long-term acceptability of the IRB leakage estimate, and

f. the methodology for combining the leakage estimates from the Freespan and Locked TSP Models.

3.9 Steam Generator Tube Support Plate Displacements

In the SE issued in conjunction with Braidwood License Amendment No. 69 on November 9, 1995, the staff provided an extensive evaluation in Section 4.4 of the licensee's structural analysis of the effect of expanding the 21 locked SG tubes per SG into the TSPs at various TSP elevations. This evaluation described the analytical model representing the Westinghouse Model D4 SG (Section 4.4.2). In Section 4.4.3 of this SE, the staff reviewed and found acceptable the licensee's analysis methodology. In Section 4.4.4, the staff reviewed and found acceptable, the number and locations of the locked SG tubes that the licensee selected for expansion. In Section 4.4.5, the staff reviewed and found acceptable, the licensee's proposal to provide redundancy at the most critical TSP locations in the event that a circumferential crack developed in service at a SG tube/TSP intersection with a subsequent loss of load carrying capability of the flawed expansion joint. Finally, in Section 4.4.6 of the SE cited above, the staff reviewed and found acceptable, the licensee's analysis of the influence of the proposed SG tube expansions (i.e., the locked tubes) on the structural integrity of the SG tube bundle assembly and its attachment to the SG shell.

This prior staff evaluation and findings related to the structural considerations arising from the installation of the locked SG tubes remains applicable to the proposed extensions of the 1.0 volt and 3.0 volt IPC which are presently in the Braidwood, Unit 1, TSs, with one exception. The staff had considered the possibility that an expanded SG tube might develop circumferential cracks in the vicinity of one of the expanded bulges at the SG tube/TSP intersections. However, the staff had made a finding in Section 4.4.5 of the SE issued on November 9, 1995, that there was reasonable assurance there was an acceptable level of redundancy in the number of expanded SG tubes so as to maintain the maximum displacement of any TSP less than 0.100 inches under postulated accident conditions in the event that such a failure mode occurred.

In the meeting held with the staff on April 30, 1997, on the preliminary results of the SG tube EC examination conducted during the present Braidwood, Unit 1, refueling outage, the licensee stated that while there was no detectable degradation (NDD) of the locked tubes or of the sleeves at the expanded joints at the SG tube/TSP intersections, 49 of the 85 locked SG tubes in the four Braidwood, Unit 1, SGs were found to have circumferential crack indications at the TTS in the roll transition zone. To resolve this issue for Braidwood, Unit 1, and restore the original design basis for the locked SG tubes, the licensee proposed in its letter dated April 29, 1997, to install Westinghouse elevated laser-welded sleeves in all 89 Braidwood, Unit 1, locked SG tubes. The staff found this proposal to install sleeves in the Braidwood, Unit 1, locked SG tubes at the TTS to be acceptable as stated in Section 3.2 of this SE.

On the basis of the acceptability of the sleeving installation discussed above, the staff finds that its prior acceptance, in the SE issued on November 9, 1995, of the licensee's structural evaluation of the installation of the 85 Braidwood, Unit 1, locked SG tubes remains applicable. Therefore, the licensee's prior structural analysis of the locked SG tube installation is acceptable for the proposed extension of the 1.0 volt and 3.0 volt IPC presently in the Braidwood, Unit 1, TSs for one additional Braidwood, Unit 1, operating cycle.

3.10 Hydrodynamic Loads on the Tube Support Plates

In Section 4.3 of the SE issued on November 9, 1995, the staff reviewed and found acceptable, the licensee's analysis of the hydrodynamic loads on the TSPs in the event of an MSLB. The staff finds that its prior conclusion in Section 4.3.5 of the SE cited above regarding the proposed values of the differential pressures across the TSPs, is still bounding. The staff does not expect the variation caused by multi-dimensional flow effects to cause this bounding TSP deflection to be exceeded as discussed below. On this basis, the staff finds that the licensee's prior estimate of the hydrodynamic loads on the TSPs under postulated accident conditions, remains acceptable for the proposed extension of the 1.0 volt and 3.0 volt IPC for one additional Braidwood, Unit 1, operating cycle.

In a meeting in mid-1996 with a subcommittee of the Advisory Committee on Reactor Safeguards (ACRS) subsequent to issuing Braidwood, Unit 1, License Amendment No. 69, some members of the ACRS Subcommittee stated a concern relating to the use of a one-dimensional code (i.e., RELAP5 MOD3) to calculate the hydrodynamic loads on the TSPs. The specific concern of these ACRS members was that the effect of a two-dimensional flow distribution above the topmost TSP would give rise to a radial variation in the hydrodynamic pressure loading on the topmost TSP.

The staff stated in response to this issue that it believed there was sufficient conservatism~~s~~ in each facet of the licensee's analysis of its locked SG tube proposal to amply account for the effect of any variations in TSP pressure loadings across the TSP radius. However, the staff committed to evaluate this effect on the TSP displacements under postulated accident conditions. This effort is continuing and the results will be presented in a separate SE to be issued at a later date.

The staff approval of the extension of the 1.0 volt and 3.0 volt IPC for one additional operating cycle at Braidwood, Unit 1, is subject to confirmation by the licensee in its forthcoming 90-Day Inspection Report that the concern of the ACRS Subcommittee members cited above, does not cause the TSP displacements under postulated accident conditions to exceed the postulated maximum displacement of 0.100 inches.

3.11 Radiological Consequences

In Section 4.6 of the SE issued in conjunction with Braidwood License Amendment No. 69 on November 9, 1995, the staff provided its evaluation of the radiological consequences of the licensee's proposal to adopt the 1.0 volt and 3.0 volt IPC. This radiological evaluation was performed using the licensee's proposal to maintain the then existing TS value of the maximum permissible primary coolant dose equivalent (DE) iodine-131 concentration of 0.35 microcuries per gram of coolant. The licensee stated that its Braidwood Station site allowable primary-to-secondary SG tube leakage from a faulted SG and the other three SGs assuming this DE iodine-131 concentration, was 26.8 gpm. This value of site specific SG leakage rate would thereby result in a 2-hour Exclusion Area Boundary (EAB) thyroid dose of about 12 rem.

In proposing to extend the applicability of the 1.0 volt and 3.0 volt IPC presently in the Braidwood, Unit 1, TSs, the licensee has not proposed to revise the present iodine-131 DE primary coolant concentration. Accordingly, the prior staff evaluation of the radiological consequences of the 1.0 volt and 3.0 volt IPC presented in Section 4.6 of the prior SE issued on November 9, 1995, remains applicable to the proposed extension of the voltage-based repair criteria. In that the estimated two-hour EAB thyroid dose of 12 rem and the relatively small whole-body radiation exposure (i.e., less than 0.3 rem) are still small fractions of the radiation exposure guideline values in 10 CFR Part 100, we find that the radiological consequences of extending the 1.0 volt and 3.0 volt IPC in the Braidwood, Unit 1, TSs for one additional operating cycle, are acceptable. This finding is based on the staff's acceptance criteria for radiation exposure of 30 rem to the thyroid and 2.5 rem for whole-body exposure as shown in Table 1 of the SE issued on August 18, 1994, for Braidwood, Unit 1.

Based on the foregoing considerations, the staff concludes that the radiological consequences outside containment for a postulated MSLB for Braidwood, Unit 1, are acceptable. This finding is based on the projected primary-to-secondary SG tube leakage not exceeding 26.8 gpm at Braidwood, Unit 1, at EOC-7. Confirmation that the regulatory requirements for allowable dose exposures are satisfied will be submitted in the forthcoming Braidwood, Unit 1, 90-Day Inspection Report.

4.0 APPROVAL OF TECHNICAL SPECIFICATION REVISION

The only substantive change proposed for TS Section 4.4.5.2 is to extend the applicability of the 1.0 volt and 3.0 volt IPC from the end of the Braidwood, Unit 1, operating Cycle 6 to the end of Cycle 7 (i.e., fall 1998). As discussed above in Section 3.0, the staff finds that this extension of the 1.0 volt and 3.0 volt IPC which is presently in the Braidwood, Unit 1, TSs, for one additional operating cycle of Braidwood, Unit 1, is acceptable.

The other proposed changes to TS Section 4.4.5.2 involve the addition of certain definitions. Specifically, the licensee has proposed adding the definition of the Freespan Model and the Locked TSP Model and defined certain exclusions where the latter methodology may not be applied.

The proposed changes to TS Section 4.4.5.2 also add to the Braidwood, Unit 1, reporting requirements, certain information regarding the structural and leakage integrity of ODSCC flaws. In that the addition of definitions and reporting requirements are administrative in nature, we find them to be acceptable. Other proposed administrative changes involve a renumbering of the various TS subsections to reflect the additions cited above. Finally, TS Bases Section 3/4.4.4.5 is revised to eliminate the terminology "cold leg IPC" and replace it with the phrase "Freespan Model." Similarly, the phrase "hot leg IPC" is replaced by "Locked TSP Model."

In summary, the staff finds that all of the proposed changes to the Braidwood, Unit 1, TSs, as discussed above, are acceptable.

5.0 STATE CONSULTATION

In accordance with the Commission's regulations, the Illinois State official was notified of the proposed issuance of the amendments. The State official had no comments.

6.0 ENVIRONMENTAL CONSIDERATION

The amendments change a requirement with respect to the installation or use of a facility component located within the restricted area as defined in 10 CFR Part 20 and change surveillance requirements. The NRC staff has determined that the amendments involve no significant increase in the amounts, and no significant change in the types, of any effluents that may be released offsite, and that there is no significant increase in individual or cumulative occupational radiation exposure. The Commission has previously issued a proposed finding that the amendments involve no significant hazards consideration, and there has been no public comment on such finding (62 FR 6570). Accordingly, the amendments meet the eligibility criteria for categorical exclusion set forth in 10 CFR 51.22(c)(9). Pursuant to 10 CFR 51.22(b), no environmental impact statement or environmental assessment need be prepared in connection with the issuance of the amendment.

7.0 CONCLUSION

The Commission has concluded, based on the considerations discussed above, that: (1) there is reasonable assurance that the health and safety of the public will not be endangered by operation in the proposed manner, (2) such activities will be conducted in compliance with the Commission's regulations, and (3) the issuance of the amendments will not be inimical to the common defense and security or to the health and safety of the public.

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Date:

References

1. Letter from M.D. Lynch (NRC) to D.L. Farrar (ComEd), "Issuance of Amendments," dated November 9, 1995.

2. Letter from T.J. Tulon (ComEd) to NRC Document Control Desk, "Braidwood Station Unit 1 Steam Generator Interim Plugging Criteria 90 Day Report," dated March 5, 1996.

3. Letter from D.M. Saccomando (ComEd) to NRC Document Control Desk, "Additional Information Regarding Commonwealth Edison Company's Implementation of 3.0 Volt Interim Plugging Criteria Probe Wear Criteria," dated March 19, 1996.

4. Letter from B.W. Sheron (NRR) to A. Marion (NEI), Regarding Eddy Current Probe Replacement Criteria for Use in ODSCC Alternate Repair Criteria, dated March 18, 1996.