Commonwealth Edison Company
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ComEd

March 8, 1996

Nuclear Regulatory Commission
Washington, D.C 20551

Attn: Document Control Desk

Subject: Response to Request for Additional Information Pertaining to the Application for Amendment to Facility Operating Licenses for Steam Generator Tube Sleeves

Byron Nuclear Power Station, Units 1 and 2
Braidwood Nuclear Power Station, Units 1 and 2
NRC Docket Numbers: 50: 454, 455, 456 and 457

References: 1. G. Dick letter to D. Farrar dated February 23, 1996, transmitting Request for Additional Information Pertaining to the Application for Amendment to Facility Operating Licenses for Steam Generator Tube Sleeves

2. March 6, 1996, Meeting with Commonwealth Edison and the Nuclear Regulatory Commission Pertaining to the CE Sleeve Amendment

In Reference 1 the Nuclear Regulatory Commission (NRC) transmitted a Request for Additional Information to the Commonwealth Edison Company (ComEd) pertaining to the pending Technical Specification Amendment Request for the application of the Combustion Engineering (CE) tungsten inert gas (TIG) welded sleeves at Byron and Braidwood. Attached is ComEd's response to that request.

At the Reference meeting, ComEd and the NRC discussed this amendment request and the pending application. The following clarifies ComEd's intention with regards to two open items.

- ComEd intends to perform 100% visual inspection of all steam generator tubes after brush cleaning, prior to the installation of the tube sleeve. This visual inspection will verify that the oxide layer has been removed and the inner tube surface is "bright shiny metal." ComEd recognizes that this action is necessary until additional information becomes available. ComEd will be evaluating this information and will inform the Staff of a change in this commitment if appropriate.

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- Currently, a qualified inspection technique to determine the location of the volumetric weld indication in relation to the pressure boundary is not available. CE is in the process of qualifying a technique. Until this technique is available, ComEd intends to plug all confirmed volumetric indications independent of their location during the upcoming Byron Unit 1 (B1R07) outage.

ComEd appreciates all of the Staff's efforts in reviewing this pending amendment request. If you need any additional information that will expedite the issuance of the Safety Evaluation, please contact this office .

Sincerely,

Denise M. Saccomando
Senior Nuclear Licensing Administrator

Attachment

cc: G. Dick, Byron Project Manager-NRR
R. Assa, Braidwood Project Manager-NRR
C. Phillips, Senior Resident Inspector-Braidwood
H. Peterson, Senior Resident Inspector-Byron
H. Miller, Regional Administrator-RIII
Office of Nuclear Safety-IDNS

ATTACHMENT

QUESTIONS

1. **Question**

Within the industry, which units have CE welded sleeves and how many are in service in each unit? What are the numbers of sleeves with and without post-weld heat treatment (PWHT) for each unit? What differences in PWHT temperatures or technique occurred between the various groups of heat treated joints?

Response

Table 1 and 2 contain the complete CE steam generator sleeve operating history and is an update to that which was previously transmitted on January 17, 1996 to the Regulatory Commission in proprietary document CEN-627-P. This table contains the type of sleeves installed, quantity of sleeves installed, sleeves with Post Weld Heat Treatment, effective full power years (EFPY) of operation and sleeves inspected with advanced eddy current technology (ECT) (I-coil or Plus Point) probes. It should be noted that there was no change in PWHT temperature or technique between the various groups of heat treated joints.

2. **Question**

Which units have had sleeve joint indications (circumferential or volumetric) that are similar to those found at Prairie Island? How many of the various indication types have been reported and what actions were taken? Provide root cause determinations (metallurgical examination reports) for each event.

Response

ABB CENO performs the baseline ECT examination on sleeves at Zion Units 1 & 2, Ginna and ANO Unit 2. Other vendors perform this service at Prairie Island Unit 1 (PI-1) and Kewaunee. To date, circumferential indications in the weld region similar to those being reported at PI-1 have not been reported by other vendors or by CE.

Several plants have reported "volumetric-type" indications in the weld region. Sleeves with "volumetric-type" indications associated with (that have been visually located within the pressure boundary) blow holes in the pressure boundary portion of the weld have all been taken out of service with the installation of plugs. The remainder of the sleeves with these "volumetric-type" indications have been left in service. An effort is currently underway by ABB CENO to determine the quantity of indications (by plant) and if they are similar to those being reported by Prairie Island. This information will be included in the ABB CENO Technical Report addressing the Prairie Island pulled tubes. The report will be issued to each applicable utility by March 18, 1996. The following preliminary information is available.

PLANT	WELDS WITH INDICATIONS	STATUS
Zion Unit 1	52	All plugged
Zion Unit 2	26	Reanalysis in progress
Ginna	8	Reanalysis in progress
ANO Unit 2	34	Reanalysis in progress
Kewaunee	1	Reanalysis in progress

3. **Question**

Which units have sleeves with welded lower joints, as opposed to rolled? How many of the sleeves with the welded lower joints have been installed?

Response

The sleeve design to be used for the Byron and Braidwood application use the hydraulically expanded "hard rolled" lower sleeve joint as opposed to the welded lower joint design.

Table 1 provides the complete ABB CENO steam generator sleeve installation history and is an update to that which was previously submitted to the Regulatory Commission in proprietary document CEN-627-P. The table contains the number and type of sleeves installed at each plant. In the table, Roll Transition Zone (RTZ) sleeves have a lower rolled joint. All other sleeves have a welded lower joint.

4. **Question**

Have instances of lower weld leaks occurred previously? If so, provide root cause determination and discuss remedial actions(s), with regard to both the individual events and process/inspection modifications.

Response

A visual examination is required for the sleeve lower weld joint. If an unacceptable weld is found with the visual examination tool during the installation process, the weld is repaired by refusing the sleeve to the tube lower end. A typical process induced defect which would cause an unacceptable weld would be a pin hole in the weld or an area with lack of fusion.

Over the greater than 10 year history of ABB CENO sleeving, two previously installed sleeves with leaking edge welds have been taken out of service. Small pin holes in the welds were discovered in subsequent visual examination programs during planned refueling outages. These were process induced defects which were not seen with the original visual inspection equipment. The discovery was made with improved visual inspection equipment that was not available during the initial installation. The new improved equipment will continue to be used during all future sleeve installation programs. The root cause of these defects can be attributed to contaminates (i.e., water, dirt) or inadequate fitup.

5. **Question**

During the licensee/staff conference call of January 18, 1996, the Prairie Island staff stated that the volumetric indications reported in about 28 welds were not duplicated in the mock-ups using the same welding parameters as the production welds. Discuss the reasons for, and implications of the difference. Expand upon this discussion to consider the total population of installed CE sleeves.

Response

Since the January 18 conference call, ABB CENO has been able to reproduce two samples on site at Prairie Island and one sample in the laboratory with volumetric indications similar to those found in the Prairie Island steam generator when examined with the Plus Point, Mag Bias Plus Point and Three-coil Pancake ECT probes. These samples are currently being subjected to a variety of NDE (ECT, VT, UT, Radiography) and destructive examinations. Preliminary results are as follows:

Sample 1

- Blow hole within the pressure boundary of the weld which was found with the visual examination equipment. If found in the steam generator, this tube would have been plugged due to the blow hole.
- Imperfection at the edge of the weld approximately 180° from the blow hole. This condition, similar to underfill in a butt weld, appears smaller on the lower edge of the weld in the pressure boundary portion of the sleeve than in the upper, non-pressure boundary section. This is most likely due to sagging of the weld bead.

Sample 2

- Underfill condition at the upper edge of the weld. This condition would not be a reason to plug since it is outside of the pressure boundary.

Sample 3

- Underfill condition at the upper edge of the weld. This condition would not be a reason to plug since it is outside of the pressure boundary.

Currently a qualified inspection technique to determine where the volumetric indication is in relation to the pressure boundary is not available. CE is in the process of qualifying a technique. Until this technique is available, ComEd intends to plug all confirmed volumetric indications independent of their location during the upcoming Byron Unit 1 (B1R07) outage.

6. **Question**

The Prairie Island steam generator sleeve weld nondestructive examination (NDE) indications have several features that suggest they could be artifacts of installation which escaped detection during the initial acceptance examinations. With this as an assumption, questions arise related to the integrity of previously installed sleeves and the staff consideration of outstanding sleeving amendment requests. Provide documents and discussion addressing the following outline of issues related to installation technique and initial acceptance inspections and criteria. Include discussion of the possible impact of the type of defects found at Prairie Island upon the structural integrity of previously installed sleeves and justification for continued operation (JCO). Discussion should not be restricted to only the items mentioned, should other issues emerge, nor are detailed descriptions necessary for items that may be revealed to be non-relevant.

a. **Discuss potential welding problems that may arise and their impact. Such areas include: (a) verification of adequate shielding gas and purity, (b) presence of moisture, both residual in the tube and introduced as an I inadvertent contaminant through the shielding gas or other, (c) current and voltage actually delivered at the torch head, (d) torch head travel speed, (e) review of upper joint tube expansion methods and results (gap) for present and previous installations, and (f) effects of sludge pile adjacent to a weld. Consider the potential for introduction of water during the expansion process, if hydraulic expansion is employed. Discuss how ambient containment /channel head atmosphere moisture is measured and controlled.**

Response

Byron and Braidwood do not have CE sleeves installed, therefore, justification for continued operation is inappropriate. ABB CENO is currently preparing a Technical Report which contains justification for continued operation (JCO). This JCO will consider all aspects of the sleeve installation and inspection processes which may effect weld quality and/or structural integrity. This JCO, which will consider all existing welded sleeves, will be provided to the licensees with these installed sleeves by March 18, 1996.

This question is related to the Prairie Island steam generator sleeve weld NDE indications and the integrity of previously installed sleeves.

6a/b Questions 6a and 6b are related to potential welding problems that may arise, their impact, and the metallurgical examination of weld mock-ups made with normal variable parameters.

6a(a) The argon gas has a dual purpose in the Gas Tungsten Arc (GTA) process. It is used to shield the weld puddle during the process. This eliminates oxidation on the sleeve I.D. surface and produces a bright shiny finish. Welds made with inadequate shield gas have a "dirty" oxidized appearance and can be seen with the visual inspection tool. Metallurgical examination of weld mock-ups made with inadequate shield gas confirm what is seen with the visual inspection tool.

The second purpose of the argon gas is to help "carry" the welding arc between the tungsten electrode and the work piece (sleeve I.D. surface). Inadequate shield gas would be seen by the welding operator as an increase in arc voltage. (Refer to 6.a(c) for discussion on voltage variations.)

Welding Grade argon is the shielding gas used during the GTA process. This is the highest quality gas that is generally available and is typically provided by the utility. A flow meter is used to control the amount of gas transmitted through the weld head to the work area (sleeve I.D. at the weld). Gas flow rates are set per the requirements of the qualified Weld Procedure Specification. A higher grade or quality argon was utilized at a utility during a recent sleeving program. No significant difference in weld quality or acceptance rate was seen. Therefore, Welding Grade argon will be used during the welded sleeve installation program at Byron/Braidwood.

6a(b) The presence of moisture anywhere on the sleeve/tube assembly could have an adverse effect on the quality of the weld. The most likely result would be a blow hole through the wall of the sleeve at the weld location. However, if a blow hole did occur, it would be detected with the required NDE (Ultrasonic Testing of the weld, Visual Inspection of the I.D. surface of the weld and ECT examination of the sleeve/tube assembly) inspection programs. The sleeved tube would then be taken out of service with the installation of a plug.

When moisture was added to the sleeve/tube interface prior to welding mock-up samples, a blow hole through the sleeve wall was seen during the metallurgical examination of the samples. The blow hole was also seen with the visual inspection equipment.

To prevent this condition, certain prerequisites are required by procedure prior to the initiation of sleeving. The secondary side of the steam generator must be drained. Primary side ventilation, pulling air through the tubes must be in place during the sleeving The ventilation is discontinued only during the welding and post weld heat treatment processes. To date, ambient containment/channel head atmosphere moisture is not measured.

Welding Grade argon is used to minimize inadvertent contamination through the shielding gas.

6a(c) The weld power supply employed during the sleeving process is a constant amperage machine. The voltage at the weld head is a function of the distance from the tungsten to the work piece (arc gap) and shielding gas compositioning. Both welding current and voltage are monitored during the welding process.

A change in welding power supply amperage output would have a direct impact on the penetration of the weld into the tube wall. Too little of an amperage output would result in no fusion, or bond between the sleeve and the tube. Too high of an amperage output would result in weld penetration through the tube wall. These results were verified during the metallurgical examination of the mock-up samples made with a variety of amperage settings.

6a(d) Weld head travel is preset per the requirements of the Welding Procedure Specification. Head speed is also monitored during the welding process.

Similar to the welding power supply amperage output, weld head speed travel had a direct impact on penetration of the weld into the tube wall. Traveling too fast would result in poor penetration into the tube wall or sleeve/tube lack of fusion. Traveling too slow could result in weld penetration through the tube wall. In addition, improper weld over lap may result in areas with sleeve/tube lack of fusion. These results were verified during the metallurgical examination of the mock-up samples made with a variety of weld head travel speed settings.

6a(e) Since 1985, a pressure controlled hydraulic expansion tool has been used to expand the sleeve into contact with the tube. Expansion pressure is monitored during the process. A final sleeve to tube diametrical gap of less than 0.001 inches is a result of sleeve springback. To minimize residual stress in the tube, tube diametrical gap is limited to 0.005 inches.

An insufficient hydraulic expansion could result in a sleeve/tube gap which is greater than that which can be accommodated by this GTA process. The most likely result would be either areas with sleeve/tube lack of fusion or blow holes through the sleeve wall. These results were verified during the metallurgical examination of the mock-up samples made with an insufficient hydraulic expansion.

During the expansion process, an elastomeric bladder material is used to capture the de-ionized water and eliminate the inadvertent introduction of moisture onto the sleeve I.D. surface. If a bladder should fail during the expansion process, an immediate loss of pressure will be seen by the control station operator. By procedure, the sleeve/tube assembly in the weld area is dried with a resistance heater.

6a(f) The ABB CENO sleeve weld has not been designed or qualified to be made in the sludge pile region of the generator. Welding in the sludge pile would result in insufficient sleeve-tube fusion due to an increased heat sink on the O.D. surface of

the tube. Therefore, the sleeve length is chosen on a site specific basis to ensure that the center line of the weld is above any known sludge pile.

6b Discuss the metallurgical examination of weld mock-ups using normal parameters and variable such as those mentioned in item 1 above to verify the type and morphology of any welding induced artifacts, such as: blow holes, craters, hot tears, and shrinkage.

Response

6b Improper cleaning can have detrimental effects on the quality of the weld, such as; blow holes, lack of fusion and inclusions in the weld material. All of these conditions have been seen during the metallurgical examination of mock-up samples (made in dirty tubes) and the Prairie Island pulled tube samples. Refer to response 6a.

6c Provide verification that weld acceptance NDE techniques were capable of detecting the types of weld or heat affected zone defects that may arise in production. During qualification of initial acceptance NDE, what kinds of samples were used? Were the methods and probes used for method qualification capable of detecting the indications observed at Prairie Island? Compare NDE methods and qualification samples employed during the sleeving process development with those used subsequently for groups of welds with indications and those installed at other times which appear to be defect free.

Response

6c During the weld qualification programs completed in the mid 1980's, it was determined that the NDE techniques qualified for the CE sleeve were capable of detecting the types of weld defects that may arise during production work in tubes that have been properly cleaned. These defects include blow holes, weld lack of fusion and weld I.D. volumetric defects. Hot tears/cracking and shrinkage cracks have never been seen in the CE GTA weld process. It is CE's experience that the GTA process induces a heat input and cooling rate such that defects of these types are avoided. In hundreds of welds metallographically examined over the last ten years, no occurrence of hot or shrinkage cracking has ever been found.

Based on the NDE technology available in 1984, the Combustion Engineering sleeve was qualified for inspection using U.T. and V.T. to determine anticipated process induced defects in the weld area. The ECT crosswound probe was used for the sleeve baseline examination.

Recent events at Prairie Island have shown that the current NDE techniques may not be sufficient when a sleeve is welded into an inadequately cleaned tube. A Plus Point probe, a Plus Point with Mag Bias probe and a 3-Coil pancake probe were used to determine that "volumetric-type" indications were present in some sleeve welds. It was confirmed with metallurgical examination of pulled tube samples that improper tube cleaning resulted in sleeve welds containing oxide inclusions/film and areas with lack of fusion. As a result of these recent events, the following changes will be made to the ABB CENO sleeve installation NDE processes to ensure detection capability if this condition should occur during future sleeving campaigns. These process changes will be employed at Byron.

- A visual examination will be performed on the tube I.D. surface prior to sleeve installation to ensure proper cleaning until further testing/experience is obtained to justify the elimination or reduction of the inspection frequency.

- 100% of all sleeve welds will be visually inspected.

- Ultrasonic Testing analysis guidelines will be developed for an enhanced inspection system which is capable of detecting lack of fusion in welds made in tubes with inadequate cleaning.

- The Plus Point probe will be qualified per the requirements of EPRI Appendix H.

- ECT analysis guidelines will be developed for the Plus Point probe examination of the welded sleeve.

6d Provide a summary of the changes in welding equipment, process controls and procedures that have occurred. Discussed reasons for the changes and the results of confirmatory tests.

Response

6d The ABB CENO steam generator sleeve process qualification history has been submitted to the Regulatory Commission in proprietary document CEN-627-P. Essential variables associated with each process step are contained in the document. These variables are related to cleaning, sleeve expansion, welding and inspection.

Since 1985, ABB CENO has continuously pursued the procurement of new and improved tooling and equipment in order to produce the highest quality weld. Changes to the sleeve installation equipment and process are listed below.

- In an effort to increase coverage, a change was made in 1992 to the coupling between the brush head and the delivery tool of the tube cleaning system used during the sleeve installation program. In 1995, the brush head itself was changed due to manufacturer availability. The recent events at Prairie Island has shown that a periodic tube cleaning problem exists with the present system. It was determined that the quality control of the new brush heads was poor, leading to inconsistent cleaning. In addition, the new coupling may be contributing to the periodic inadequate cleaning. As a result, the old brush design will be duplicated for future sleeving programs (including Byron) and the old coupling system will be re-employed. As discussed, in 6c, a visual inspection program has been developed to verify adequate cleaning prior to welding.

- As previously described in 6c, improvements to the CE sleeve installation NDE processes and acceptance criteria are underway and will be in place prior to the upcoming Byron outage.

TABLE 1
INSTALLATION HISTORY OF ABB CENO WELDED SLEEVE

PLANT	DATE	SLEEVE QUANTITY INSTALLED*
Prairie Island 1	01/96	253
ANO 2	10/95	627 RTZ
Zion 1	10/95	911
Zion 2	01/95	162
Prairie Island 1	05/94	117
Zion 1	11/93	61
KRSKO 1	06/93	164 RTZ 16 TSP
Ginna	04/93	51
Zion 2	12/92	170
Prairie Island 1	11/92	158
ASCO 1	06/92	49 RTZ 5 TSP
Ginna	04/92	178 63 curved
Zion 1	04/ 92	124
Kewaunee	03/92	16 curved
Ringhals 3	07/91	46 RTZ 22 TSP
Ginna	04/91	183 29 curved

TABLE 1
INSTALLATION HISTORY OF ABB CENO WELDED SLEEVE
(Continued)

PLANT	DATE	SLEEVE QUALITY INSTALLED*
Ginna	04/90	198 48 curved
Zion 2	04/90	82
Prairie Island 1	01/90	62
Zion 1	09.89	445
Ginna	04/89	408 107 curved
Prairie Island 1	09/88	73
Ringhals 2	05/87	571
Praire Island 1	04/87	27
Ginna	02/87	104
Zion 1	10/86	128
Ringhals 2	05/86	599
Ginna	02/86	36
Ringhals 2	05/85	59
Ringhals 2	05/84	18
	Totals	5,441 TS 43 TSP 886 RTZ

* Straight tubesheet sleeves unless otherwise noted

RTZ - Roll Transition Sleeve
TSP - Tube Support Plate Sleeve
TS - Tubesheet Sleeves

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TABLE 2

ABB-CENO S/G Sleeve Operating History (to January 1996)

Plant	Hot Leg Temp (F)	Sleeve Type (1)	<1	1	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5	TOTAL
			Estimated EFPY of Sleeve Operation (2)															
Ringhals 2	610	STAW			16													
	600	STAW				571	599		59	16								1245
Ginna	601	STAW				51	178		183	198		408			104		36	1158
		PTAW					63		29	48		107						247
Prairie Island 1 (4)	590	STAW													73		27	100
		STHT	253		117		158					62						590
Kewaunee (4)	590	PTAW					16											16
Zion 1 (4)	594	STAW	911		61	124			445				128					1669
Zion 2 (4)	594	STAW		162	170				82									414
ANO 2 (4)	611	RTHT	627															627
Ringhals 3 (4)	610	RTHT							46									46
		SPHT							22									22
KRSKO (4)	619	RTHT			164													164
		SPHT			16													16
Total			1791	162	328	746	1014	0	866	262	0	577	128	0	177	0	63	6314
Cumulative Total			6314	4523	4361 (3)	3833	3087	2073	2073	1207	945	945	368	240	240	63	63	

Notes:

(1) Sleeve Type designations and their totals are as follows:

		Totals
STAW	StandardTubesheet sleeves where the welds are in the As Welded condition	4586
PTAW	Peripheral (Initially Curved) Tubesheet sleeves where the welds are in the As Welded condition	263
STHT	StandardTubesheet sleeves where the upper weld has been Post Weld Heat Treated	590
RTHT	Roll Transition sleeves where the weld has been Post Weld Heat Treated	837
SPHT	Support Plate sleeves where the welds have been Post Weld Heat Treated	38

(2) EFPY of operation is based either on data received from the plant or calculated from the load factor published in Nuclear Engineering International for the period during which the sleeves have been in place. Operating time is rounded to the neares 0.1 EFPY as of 1 July 1995

(3) 16 Sleeves which ran for a year at Ringhals.5 before T hot was reduced are included in totals for 600 F

(4) Plants inspected with I-coil or Plus Point ECT probe