Union Electric
Callaway Plant

PO Box 620
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February 24, 1998

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
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ULNRC-03741
TAC No. M95204

Ameren UE

Gentlemen:

CALLAWAY PLANT
DOCKET NUMBER 50-483
REVISION TO TECHNICAL SPECIFICATION
3/4.4 - REACTOR COOLANT SYSTEM

References: 1) ULNRC-03644 dated September 10, 1997
2) K. M. Thomas letter to G. L. Randolph dated December 18, 1997
3) B. C. Westreich letter to G. L. Randolph dated January 9, 1998

This letter provides additional information in support of the Callaway Plant amendment application that proposes the installation of electrosleeves in the Callaway Plant steam generators. The NRC staff in References 2 and 3 requested this information.

1/
A001

Framatome Technologies Inc. has determined that information associated with the installation process for electrosleeves is proprietary, and is thereby supported by an affidavit signed by Framatome, the owner of the information. The affidavit sets forth the basis on which the information may be withheld from public disclosure by the Commission and addresses with specificity the considerations listed in paragraph (b)(4) of 10CFR2.790. Accordingly, it is respectfully requested that the information that is proprietary to Framatome be withheld from public disclosure in accordance with 10CFR2.790.

Change Ltr ENCL
PDR 1 w/ PROP.

If you have any questions concerning this information, please contact us.

Very truly yours,

C. D. Naslund
Manager-Nuclear Engineering

WEK/

Enclosures:
1) Proprietary Information
2) Non-Proprietary Information

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AFFIDAVIT OF JOSEPH J. KELLY

A. My name is Joseph J. Kelly. I am Manager of B&W Owners Group Services for Framatome Technologies, Inc. (FTI), and as such, I am authorized to execute this Affidavit.

B. I am familiar with the criteria applied by FTI to determine whether certain information of FTI is proprietary and I am familiar with the procedures established within FTI to ensure the proper application of these criteria.

C. In determining whether an FTI document is to be classified as proprietary information, an initial determination is made by the Unit Manager, who is responsible for originating the document, as to whether it falls within the criteria set forth in Paragraph D hereof. If the information falls within any one of these criteria, it is classified as proprietary by the originating Unit Manager. This initial determination is reviewed by the cognizant Section Manager. If the document is designated as proprietary, it is reviewed again by me to assure that the regulatory requirements of 10 CFR Section 2.790 are met.

D. The following information is provided to demonstrate that the provisions of 10 CFR Section 2.790 of the Commission's regulations have been considered:

(i) The information has been held in confidence by FTI. Copies of the document are clearly identified as proprietary. In addition, whenever FTI transmits the information to a customer, customer's agent, potential customer or regulatory agency, the transmittal requests the recipient to hold the information as proprietary. Also, in order to strictly limit any potential or actual customer's use of proprietary information, the substance of the following provision is included in all agreements entered into by FTI, and an equivalent version of the proprietary provision is included in all of FTI's proposals:

"Any proprietary information concerning Company's or its Supplier's products or manufacturing processes which is so designated by Company or its Suppliers and disclosed to Purchaser incident to the performance of such contract shall remain the property of Company or its Suppliers and is disclosed in confidence, and Purchaser shall not publish or otherwise disclose it to others without the written approval of Company, and no rights, implied or otherwise, are granted to produce or have produced any products or to practice or cause to be practiced any manufacturing processes covered thereby.

Notwithstanding the above, Purchaser may provide the NRC or any other regulatory agency with any such proprietary information as the NRC or such other agency may require; provided, however, that Purchaser shall first give Company written notice of such proposed disclosure and Company shall have the right to amend such proprietary information so as to make it non-proprietary. In the event that Company cannot amend such proprietary information, Purchaser shall prior to disclosing such information, use its best efforts to obtain a commitment from NRC or such other agency to have such information withheld from public inspection.

Company shall be given the right to participate in pursuit of such confidential treatment."

(ii) The following criteria are customarily applied by FTI in a rational decision process to determine whether the information should be classified as proprietary. Information may be classified as proprietary if one or more of the following criteria are met:

a. Information reveals cost or price information, commercial strategies, production capabilities, or budget levels of FTI, its customers or suppliers.

b. The information reveals data or material concerning FTI research or development plans or programs of present or potential competitive advantage to FTI.

c. The use of the information by a competitor would decrease his expenditures, in time or resources, in designing, producing or marketing a similar product.

d. The information consists of test data or other similar data concerning a process, method or component, the application of which results in a competitive advantage to FTI.

e. The information reveals special aspects of a process, method, component or the like, the exclusive use of which results in a competitive advantage to FTI.

f. The information contains ideas for which patent protection may be sought.

The document(s) listed on Exhibit "A", which is attached hereto and made a part hereof, has been evaluated in accordance with normal FTI procedures with respect to classification and has been found to contain information which falls within one or more of the criteria enumerated above. Exhibit "B", which is attached hereto and made a part hereof, specifically identifies the criteria applicable to the document(s) listed in Exhibit "A".

(iii) The document(s) listed in Exhibit "A", which has been made available to the United States Nuclear Regulatory Commission was made available in confidence with a request that the document(s) and the information contained therein be withheld from public disclosure.

(iv) The information is not available in the open literature and to the best of our knowledge is not known by ABB CE, EXXON, General Electric, Westinghouse or other current or potential domestic or foreign competitors of FTI.

(v) Specific information with regard to whether public disclosure of the information is likely to cause harm to the competitive position of FTI, taking into account the value of the information to FTI; the amount of effort or money expended by FTI developing the information; and the ease or difficulty with which the information could be properly duplicated by others is given in Exhibit "B".

E. I have personally reviewed the document(s) listed on Exhibit "A" and have found that it is considered proprietary by FTI because it contains information which falls within one or more of the criteria enumerated in Paragraph D, and it is information which is customarily held in confidence and protected as proprietary information by FTI. This report comprises

AFFIDAVIT OF JOSEPH J. KELLY (Cont'd.)

Information utilized by FTI in its business which afford FTI an opportunity to obtain a competitive advantage over those who may wish to know or use the information contained in the document(s).

JOSEPH J. KELLY

State of Virginia)
) SS. Lynchburg
City of Lynchburg)

Joseph J. Kelly, being duly sworn, on his oath deposes and says that he is the person who subscribed his name to the foregoing statement, and that the matters and facts set forth in the statement are true.

JOSEPH J. KELLY

Subscribed and sworn before me
this 20th day of February 1998.

Brenda C. Cardona
Notary Public in and for the City
of Lynchburg, State of Virginia.

My Commission Expires July 31, 1999

ULNRC-03741

ENCLOSURE 2

NON-PROPRIETARY INFORMATION

Request For Additional Information
Regarding Review of License Amendment Request
To Allow Framatome Electrosleeving of Steam Generator Tubes
Callaway Plant, Unit 1
Docket No. 50-483

The staff has reviewed Union Electric Company's license amendment request to allow installation of Framatome Electrosleeves in the Callaway Plant, Unit 1 steam generators and has determined that the following additional information is needed to proceed with the review.

Q1. Attachment 3 of the September 10, 1997,submittal contains a discussion of the lab grown ODSCC data sub-set. Fourteen of the samples contained flaws that were essentially 100 percent through the parent tube. Half of these samples were undersized more than the proposed 12 mil NDE uncertainty value. The other half were not. During the December 9, 1997 meeting, a technical basis was provided to the NRC staff for the UT sizing differences between the two subsets. Document the technical basis along with all supporting data. Be sure to include destructive examination data for all fourteen samples such as flaw extents (e.g., axial or circumferential) and descriptive photographs of etched samples that support the technical basis.

R1. The fourteen flaws of interest are listed in Table Q1.1. The next-to-last column in Table Q1.1 identifies the seven sample sub-set (with a • or ••) with an under-call error exceeding the [ ]^{b} uncertainty. Note that Table Q1.1 lists all sixteen of the laboratory samples. The two samples with less than 100% TW tube defects, 6B-2 and 1B-3, are not considered in the remaining discussion (per Question 1).

The technical basis for differentiation of the flaws under-called by UT versus the flaws UT called within the RMSE is a function of the size of the flaws. The qualitative and quantitative evaluation of size combines the length of the crack on the OD surface and the width of the crack along its route from OD to ID or from ID to OD, depending on the site of initiation.

The data for the technical basis is the source documentation used to prepare the January 15, 1997 presentation for sixteen (16) ODSCC flaws for UT sizing qualification (14 flaws are nominally 100% TW), and Table A3.1 of the September 10, 1997 submittal. A description of these fourteen laboratory samples was provided in Attachment 3 of the September 10, 1997 submittal.

Crack depth, length, and width measurements depend on spacing of the DE cutting. The original DE documentation provided crack depth measurements based on microscope measurements and limited snapshot metallographic photographs. For the information presented here, archived metallographic mounts were reviewed to provide the destructive

examination (DE) flaw extents of the samples. This data is provided in Table Q1.2. Additionally, sample photomicrographs are provided in Attachment 1.

Table Q1.1 Summary of Laboratory Corrosion Test Data

[

							]b

Note: 1. [

]b

2. "•" and "••" identify the seven sample subset with the UT error greater than [ ]b.

A review of the Flaw Depth columns in Table Q1.2 shows that the UT error can be divided into [ ]b subsets. UT accuracy (or error) is defined by comparison to the DE results (UT-DE). These subsets shown in Figure Q1.1 are:

[

]b

[

]b

[

]b

Table Q1.2. [ ]c UT [ ]c Lab Samples
[ ]c

[

]b,c

[

]b

[

]b

[

]b

[

]b

[

]b,c

[ ]c

[

]b

[

]b

[ ]b UT error within RMSE).
[

.]b,c The crack also appears continuous along the tube wall thickness. This crack is most likely the flaw that "leaked" and stopped the corrosion test.

Additional DE data was utilized to define the size (length) and to characterize the flaws listed in Table Q1.2. [

]c

Due to the short zone of high residual stress created by the mechanical roll and Explansion transitions, the length of the flaws were small, as expected. Only two circumferential flaws were denoted as having large extent. This flaw length data from Table Q1.2 is plotted in Figure Q1.2.

[

]b

Figure Q1.1 UT [ ]^{c}

[

]^{b,c}

The data in Figure Q1.2 contains both axial and circumferential flaws. The [three....]^{b} circumferential flaws [ ]^{b} support the UT accuracy improving as the flaw length increases. In addition, the trend is in agreement with the EDM notch qualification, namely larger flaws result in improved UT accuracy. [ ]^{c}

The data for the axial flaws [ ]^{b} are extremely short with an average length of [ ]^{b} inch or less. [

]^{b,c}

Figure Q1.2 UT [ ]^{c}

[

]^{b,c}

Summary

As discussed in the December 9, 1997 meeting, these flaws are small in extent. Figure Q.1.2 plots the flaw [ ]^{c} The circumferential flaws vary in length and support a trend of longer extent versus improved depth accuracy. The axial flaws are all short [

^{b,d}

[

]^{c,d}

Q2. Two examples of incorrect data being supplied to the NRC staff were recently identified. The NRC staff identified errors in Table 1.2 of the September 10, 1997 submittal. In addition, the licensee notified NRC staff in the September 10, 1997 submittal that some data previously submitted to NRC staff was incorrect. Discuss the quality assurance process (for both the licensee and the vendor), and how it meets 10 CFR50, Appendix B criterion. Discuss whether you have identified the cause of these errors. Submit a copy of your corrective action program relative to these issues. What are the implications this has for other electrosleeve submittals or other parts of the program?

R2. The response to this question consists of four parts.

1. "NRC staff identified errors in Table 1.2 of the September 10, 1997 submittal."

Two entries reported in Table 1.2 were questioned by NRC on December 5, 1997. Based on a comparison of the data reported in Table 1.2, relative to the source documentation, we have concluded that the ODSCC data set from pulled tubes (without Electrosleeves installed) was not transferred into the table correctly. [

]^{b} Previous presentations to NRC and a previous response (Reference 5) support this evaluation. The reason for the wrong data is a typographical error relative to the source information. The plots, histograms and analysis presented used the proper data. The revised table was faxed to NRC on December 8, 1997 after a detailed review. The corrected table, reflecting review of all the data is presented in Table Q2.1 of this response to complete the documentation. [

]^{c}

2. "... licensee notified NRC staff in the September 10, 1997 submittal that some data previously submitted to NRC staff was incorrect."

The error identified in Attachment 3, (September 10, 1997 Submittal) was discovered [

]^{b,d}

3. "Discuss the quality assurance process (for both the licensee and the vendor), and how it meets 10 CFR 50, Appendix B criterion. Discuss whether you have identified the cause of these errors. Submit a copy of your corrective action program relative to these issues."

FTI's safety-related QA plan complies with the requirements of 10CFR50, Appendix B. This QA plan requires the documentation of all technical information transmitted as part of a licensing response. Periodic QA audits are performed by the QA department to assure

compliance with the QA program. The QA department was informed that an error was found and a "Corrective Action Request" (CAR) was initiated which documents the problem, requests a corrective action plan and subsequent QA disposition review. This QA review has been initiated and a copy is presented in Attachment 3.

Union Electric has initiated actions in our Quality Assurance Organization to not only monitor the corrective actions taken by FTI in response to this identified issue but to perform a Supplier Quality audit covering this and other areas.

4. "What are the implications this has for other electrosleeve submittals or other parts of the program?"

[

]^{b}

TABLE Q2.1: COMPLETE SCC DATA SET

[						
						][b]

TABLE Q2.1: COMPLETE SCC DATA SFT (CON'T.)

[						
						][b]

NOTES: NDD - No Defect Detected
N/A - Not Applicable
Bold Entries A1 through E3 correction to inches instead of "percent throughwall", December 5, 1997.

Q3. Section 4.3.2, "Structural Margin for Circumferential Part-TW Flaw," of Document 32-1264476-00 submitted on September 5, 1997, discusses the approach utilized to determine the structural limits for circumferentially-oriented flaws in electrosleeve repairs. The text cites two references as the source of an equation and associated empirical constants listed in the section. The staff has reviewed Reference 2.6 (Ranganath and Mehta. "Engineering Methods for the Assessment of Ductile Fracture Margin in Nuclear Power Plant Piping") and Reference 2.9 (Kurihara et al, "Estimation of the Ductile Unstable Fracture of Pipe with a Circumferential Surface Crack Subjected to Bending") and concluded that the equation and associated empirical constants referenced in Section 4.3.2 do not come from the noted references. Clarify the source of the equation and constants listed in this section, or provide the associated technical basis for the part through wall circumferential flaw limit.

R3. Reference 2.5 is a more suitable reference for information in Section 4.3.2 of Document 32-1264476-00. [

]^{b}

Q4. FTI procedure 54-ISI-168, Rev. 1 states that angle beam scanning for reflectors shall be performed from two opposing beam directions, where practical, or from one direction as a minimum. FTI stated at the December 5, 1997, meeting that they did collect data from tube specimens used in their September 10, 1997 submittal from two directions. However, the submittal contained the examination results from only one direction examinations. The data from seven tubes with lab generated flaws exhibited a large number of flaw under calls. Experience in UT indicates that examinations conducted from two directions provide more accurate results than one sided examinations. Provide a table that contains comparisons between destructive examination depths and UT examination depths derived from analyzing the data from two directions for the seven tubes.

R4. This question poses an issue associated with the basic design of the UT-Probe rather than evaluating the acceptability of the NDE qualification data. It is a well acknowledged practice to use transducers "aimed" in both directions when inspecting thick-walled piping which contains welds. These welds usually require extensive weld preparation and the associated angles create weld or heat affected zones which define a preferential flaw propagation. The experience in steam generator tubing failures indicates flaws are typically planer and perpendicular to the tubing axis or circumferential in nature. Thus additional transducers would have the possibility of improving the quality of the data but the orientation of the expected flaw relative to the transducer inspection angle would be similar rather than complementary as in the case of inspecting pipe welds. The additional transducers add significantly to the complexity of the signal electronics in steam generator

tubing and the increased data analysis would be a significant impact on the satisfactory installation of an Electrosleeve.

Data from the [ ]^{b} laboratory samples was collected in only one beam direction. [

]^{b}

The February 5, 1997 submittal presented a two-directional evaluation of UT detection in dent profiles. Additional two-directional evaluation [ ]^{b} provides assurance that the general flaw pattern is compatible. Attachment 4 presents this information. [

]^{b} The readings are very similar.

Finally, note that the requirements for the ASME code exam are specified in ASME Code Case N-569. Specifically; Paragraph 3.0 (d) (1) (b) states; "The examination shall be conducted with single axial and circumferential beam directions, provided meaningful indications are obtained from standard defects in the reference specimen". Thus the examination qualification has been performed in accordance with this Code Case.

Q5. In the September 10, 1997 submittal, FTI discusses the use of corner trap signals for depth sizing flaws. The submittal also mentions using tip diffraction signals for discerning flaws. Tip diffraction is considered an effective depth sizing technique. In the meeting on December 8, 1997, FTI stated that they have been unsuccessful with tip diffraction for depth sizing. Instead, for depth sizing, FTI relies on corner trap signals that walk up the flaw face. Provide an explanation with supporting physical data, if available, to explain the ineffectiveness of tip diffraction in sizing flaws in SG tubes. The explanations should include what techniques are available or being developed for discerning multiple tip signals (SCC) and low sound-to-noise ratios (tip vs corner trap).

R5. UT inspection of thick walled tubing is widely accepted but steam generator tubing presents unique geometry problems due to the small tube OD and the relatively thin wall. Cracks in steam generator tubing originate at either the ID or OD surface and propagate perpendicular to the opposite surface. Perpendicular axial and/or circumferential flaws are depicted in many photomicrographs of pulled tube exams. As noted by Krautkramer (Referenced below), "Provided the crack tip is approximately parallel to the surface (i.e. perpendicular to the surface)... and has an appreciable extension in this direction, it can be detected from a remote face by using the edge wave generated by the tip." The detection

of the tip signal using the transmission transducer depends on wavelength of the propagated wave front and the width of the crack being illuminated. The current shear wave transducers operate at a frequency of [ ]^{c} in Inconel. When this wave front interacts with a planar reflector, the reflected wave front is composed of sound energy having essentially the same wavelength as the incident wave. This fact is important to remember when applying the tip diffraction sizing method. Tip diffraction methods, (Satellite Pulse Observation Technique (SPOT), Pulse Arrival Time Technique (PATT), etc.) rely on the analyst to properly detect and classify at least the tip signal and in the case of SPOT the corner trap as well. [

]^{b,c}

[ ]^{b} An increase in frequency would decrease the wavelength and thus render smaller cracks and tips detectable up to a certain limit. Per Krautkramer (p. 101), this limit is defined as "The sound pressure of the scattered wave ... is directly proportional to the third power of the reflector diameter and inversely to the square of the wavelength. Therefore very small reflectors cannot in practice be detected with certainty even by using more sensitivity and higher frequencies." This suggests that an increase in frequency does not have the potential of improving detection of the tip and in fact it could even reduce the overall detection capabilities due to reduced amplitude.

The surface finish imposes another limitation on the use of higher frequencies. [

]^{c}

Cracks in alloy 600 material appear to follow grain boundaries. This dictates the path and representative length as a function of the Inconel 600 grain size. The "zig zag" surface of the crack along the grain boundaries reduces the effective reflector surface in any one plane. A good analogy is presented in Krautkramer, page 93, using a crumpled aluminum foil object and a sharply defined search light beam.

Reference: Krautkramer, Josef and Herbert Krautkramer, Ultrasonic Testing of Materials, 4th Fully Revised Edition, Springer-Verlag Publisher, 1990.

FIGURE R5-1

[ ]b

FIGURE R5-2

[ ]b

FIGURE R5-3

[ ]b

FIGURE R5-4

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FIGURE R5-5

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FIGURE R5-6

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FIGURE R5-7

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]b

FIGURE R5-8

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]b

Q6. NRC has concluded that an electrosleeve tube pull program will be needed to provide confirmatory data to address potential degradation and NDE uncertainties. The tube pull program should be based both on length of "time-in-service" and condition-based (i.e. based on NDE indication of Electrosleeve degradation). Union Electric should propose a program for NRC staff review and commit to it through a TS change or license condition.

R6. The following is Union Electric's proposed tube pull program. A tube pull would be required:

1. if the results of the NDE examination indicates a sleeve has reached a degraded condition as presented in ULNRC-03596 (i.e. 20% through-wall flaw) Since there would be no identified degradation mechanism to account for that degradation, a tube pull would be required to determine root cause. The destructive examination would also allow NDE results to be verified. The above is in accordance with the draft EPRI Report GC-107621, Rev. A, "Steam Generator Integrity Assessment Guidelines". Tube pulls would occur for each unidentified mechanism. After root cause is determined no additional tube pulls would be required for that degradation mode.

2. if primary to secondary leakage forces a plant shutdown in accordance with administrative procedures. If the affected area of the tube were in an Electrosleeve, this tube would be pulled for destructive examination. This is in accordance with Appendix K of EPRI Report TR-107569-V1R5 "PWR Steam Generator Examination Guidelines, Rev. 5. The NDE results would be verified during this examination.

Additionally Union Electric endorses an FTI inservice time-based program. That is, as one of a group of plants which have Electrosleeved tubes, Union Electric will participate in a program to support tubes being pulled in a currently non-specified plant (which could be Callaway). The tube(s) would be pulled during the outage following completion of 5 EFPY of inservice duty. If Electrosleeved tubes have been pulled based on degradation at any other US plants prior to this time then this work will not be required.

Additional inservice time-based tube pull requirements would be based on the destructive examination results from this first group.

Q7. Union Electric Company's proposed technical specifications currently reference Revision 1 of the electrosleeving topical report. A substantial amount of additional work has been completed in support of the electrosleeving process since Revision 1 was issued in March 1996. Update the topical report to reflect new data and any necessary changes to Revision 1. For example:

- Types of parent tube degradation electrosleeves are or are not qualified to repair (e.g., IGA, stress corrosion cracking, pitting, etc.) and summary of respective UT qualification data.

- Limitations on locations electrosleeves can be applied (e.g., no application to UBends, dented intersections greater than a predetermined size [see Question 9 below], etc.).

- Additional discussion on flaw specific structural limits (i.e., the discussion of Issue 2 in the September 10, 1997, submittal describes flaw specific structural limits which differ from the structural limits described in Table 8.5.1 of Revision 1 of the topical report).

- Any changes to the topical report regarding material properties required to support the flaw specific structural limits.

- Summaries of UT qualification work (e.g., depth sizing qualification) updated since Revision 1 of the topical report was written.

In addition, modify the technical specifications accordingly to reference the updated version of the topical report.

R7. Pending review of the issues identified in this RAI, the format and scope of a revision is proposed as follows. Five significant technical responses are presented in the following table with a corresponding reference to the section in the Rev. 1 Topical and the RAI question number. A revision of the topical would reference statements in the applicable section of the topical to an appendix containing the question and response as submitted to NRC. The specific responses would be reviewed for any conflicts or additional data review that supersedes previous information. The text of the topical would be reviewed and a detailed record of revisions provided to clearly note any changes for review purposes.

Subject	Question Number	Applicable Topical Section	Comments
RAI (7/2/96) RAI Response (7/18/96) Presentation Material Electrosleeve Overview			
"..thermal aging of Ni plating .."	1	[ ]b,d	]b
"..creep curves .. data scatter .."	2	[ ]b,d	*Data Provided*
"..photomicrographs .. fatigue creep-fatigue cracks.."	3	[ ]b,d	".. photos provided.. [ ]b
"..CANDU .. system parameters.. Pickering .. 1/2" alloy 400 .."	4	[ ]b,d	[" ....]b
"..installation defects ..unbonds .. small pinholes .. NDE method .."	5 & 6	[ ]b,d	]b
"..assessment of the severe accident on electrosleeved tubes .."	7	[ ]b,d	[ ]b

Subject	Question Number	Applicable Topical Section	Comments
RAI (7/25/96) RAI Response (9/24/96) Except UT of SCC tubes with sleeves.			
"..detection for SCC..masking"	1	[11.2]^{b,d}	"pulled tube data"
"..ability to depth size?"	2	[11.2]^{b,d}	[ ]^{b}
"..Eddy Current..Diverse inspection methods"	3	[11.2]^{b,d}	"ASME Code Case N569"
"..sleeve thickness measure?"	4	[11.2]^{b,d}	]^{b}
"..unbond regions..potential to expand .."	5	[6.3]^{b,d}	[ ]^{b,d}
"..cleaning/activation step .."	6	[6.3]^{b,d}	[ ]^{b}
"..third party reviewer?"	7	[3.0]^{b,d}	[ ]^{c}
"..cleanliness..current acceptable parameters .."	8	[6.3]^{b,d}	[ ]^{b,d}
"..effective commercial dedication.."	9	[10.1.4]^{b,d}	[ ]^{c,d}
"..acceptable..levels..containments"	10	[10.1.4]^{b,d}	[ ]^{d}
"..ongoing engineering evaluations"	11	[6.0]^{b,d}	"ASME Section XI Review"
RAI (7/25/96) RAI Response (2/5/97) UT of SCC tubes with sleeves provided.			
"..eddy current testing?"	1	[11.2]^{b,d}	"NDE done by UT"
"..plugging criteria?"	2	[11.2]^{b,d}	[ ]^{b,c}
"..tubes with SCC .."	3	[11.2]^{b,d}	[ ]^{b,c}
"..detect pits, nodules, defects?"	4	[11.2]^{b,d}	*data presented*
"..future ISI?"	5	[11.2]^{b,d}	"UT"
"..UT beam redirection"	6	[6.3]^{b,d}	[ ]^{b,c}
"..plugging criteria..depth sizing"	7	[11.2]^{b,d}	[ ]^{b,c}
RAI (4/12/97) RAI Response (6/9/97)			
"..cracks..will not propagate into Electrosleeve?"	1	[9.1 /11.2]^{b,d}	[ ]^{b,c}
"..crack size in %TW combined"	2	[8.5]^{b,d}	*data presented*
"..location of defects"	3	[11.2]^{b,d}	*data presented*
"..EDM calibration standard"	4	[11.2]^{b,d}	[ ]^{b}
"..leak tests 11/16" tubes?"	5	[6.3 /11.2]^{b,d}	[ ]^{b}
"..number of EDM defects?"	6	[11.2]^{b,d}	[ ]^{b}
"..number of samples..thickness?"	7	[11.2]^{b,d}	[ ]^{b}
"axial ID..100%TW..to be detected"	8	[11.2]^{b,d}	[ ]^{b}
"..foreign experience?"	9	[3.0]^{b,d}	"Canada 1994, DOEL pulled tubes"
"..flaw..in parent tube .. propagated into sleeve"	10	[11.2]^{b,d}	"Disposition of UT by flaw type"
RAI (8/13/97) RAI Response (9/10/97)			
"..crack depth sizing?"	1	[11.2]^{b,d}	[ ]^{b} pulled tube, Electrosleeved, DE .."
"..structural limits..revised limits"	2	[8.5]^{b,d}	[ ]^{b,c}
"..basis for utilizing non-sleeved samples"	3	[11.2]^{b,d}	"Velocities of..sound"
"structural significant flaws"	4	[11.2]^{b,d}	"Tube Pressure Boundary Regions"
"..data set..expansion..flaws"	5	[11.2]^{b,d}	*additional data provided*
"peer review on NDE?"	6	[3.0]^{b,d}	".. charter of peer review .."

Q8. The initial inspection scope, as described in Table 4.4-3 of the Technical Specifications, for future ISI inspections of SG sleeves should consist of a minimum of 20 percent of each type of installed sleeve. Revise the proposed technical specifications to reflect this.

R8. Union Electric submitted a new TABLE 4.4-3 to technical specifications titled "STEAM GENERATOR REPAIRED TUBE INSPECTION". This table was submitted as part of ULNRC- 3430 dated September 5, 1996. Table 4.4-3 requires a sample size of 20% and note 1 states that each repair method is considered a separate population. Therefore, Union Electric is already committed in Technical Specifications to the requested action. Based on this, no further change to the proposed Technical Specifications should be required.

Q9. The February 5, 1997, submittal discusses the ability to inspect dented intersections containing electrosleeves. It implies that there may be limits on the size of dents that can be reliably inspected. Please clarify if there are limits, what those limits are, and the size of dents which will be electrosleeved. Summarize the technical basis for these limits and how these limits were verified in the NDE qualification. Portions of previous submittals may be referenced if applicable. These limits and a summary of the technical basis should be documented in the next revision of the topical report (as discussed in Question #7 above).

R9. The limit is based on UT standoff and physical limits of the Electrosleeving probe. The February 5, 1997 submittal, page 24, identified a [ ]^{b,c} dent as the size threshold that affects the UT detection response using EDM flaws. Attachment 5 presents additional data on representative dents.

Q10. The response to Issue #1 in the September 10, 1997, submittal indicates that six tubes from the Salem Unit 1 SG contained dents. Please describe the size of these dents and whether they are within the dent size limits as discussed in response to Question #9 above.

R10. Attachment 5 presents the information for the Salem Unit 1 SG pulled tubes that were sleeved for NDE qualification. UT Profilometry data for several additional tubes was reviewed and provided. Please note, there is no universal description of a dent but there are some physical parameters that define practical sleeve installation over a dent.

From Attachment 5, the dent size does not present a significant problem relative to the [ ]^{b,c} value evaluated for the probe.

Q11. It is not clear whether the licensee intends to repair tubes containing IGA or in locations susceptible to subsequent IGA. Please clarify. If Electrosleeves will be applied to such tube locations, provide a summary of the inspection qualification data that supports this application. In addition, the revised topical report (discussed in Question #7) should state whether Electrosleeving will be applied to SG tubes with IGA or in locations susceptible

to subsequent IGA. If Electrosleeving is to be applied to such tube locations, the summary of inspection qualification data requested above should also be included in the revised topical report. (Revised Question received 1/9/98.)

R11. The structural repair is qualified for application which assumes the tube is completely degraded. Both the laboratory corrosion samples and the Salem Unit 1 SG pulled tubes contained a mix of IGA and SCC. Thus the UT qualification data previously submitted includes IGA. Tube pull data provides information that OD degradation initiates as IGA which subsequently connects grain boundary flaws into "cellular cracking" or SCC. Again this morphology was included in the UT qualification.

Q12. Table 1.0 of the submittal dated February 5, 1997, states that the sleeve structural limit for locked tubes in the peripheral TSP wedge regions is lower than that for unlocked tubes. Clarify whether electrosleeving will be permitted in the peripheral TSP wedge regions where locking may be present. If electrosleeve repairs will be applied in these areas, discuss the basis for the structural limits for the Callaway plant. Otherwise, discuss how the currently proposed technical specifications exclude repairs for potentially locked tubes. Per discussions held in the meeting on November 20, 1997, the licensee indicated that the locking phenomenon did not apply to Westinghouse Model F steam generators. If this is the basis for not utilizing locked tube structural limits, provide the basis in writing for this assumption. Include in the response a discussion on the potential for secondary side corrosive degradation that could lead to tube support plate locking. Also discuss the results of secondary side steam generator inspections completed in these areas to verify these assumptions.

R12. The structural limits defined in the RSG Electrosleeve Topical Report and RAI responses assume all the tubes to be "locked". The wedge block locations reported to have a limit of [ ]^{b,c} % through wall are the areas of concern. The wedge blocks are the interface between the support plates and the tube bundle wrapper. They are at 90-degree intervals around the bundle for the Model-F steam generators. The affected tubes are mostly the periphery row of the bundle at these locations. Therefore, only about 100 tubes are excluded from the candidate list to be Electrosleeved.

While Union Electric does not consider the quatrefoil stainless steel support plates susceptible to the additional postulated "locked tube" loads, Union Electric will commit to not install an Electrosleeve in these periphery tubes near wedge supports. The locations of these affected peripheral tubes in the steam generator are not as susceptible to the currently identified degradation in the Callaway steam generators as the interior tubes, so this is a minor impact on long-term steam generator viability for the Callaway plant.

Background or Reference Information for Other Plant Designs. The history of TSP indications and consequently tube locking at a TSP has been associated with carbon steel TSPs with drill holes and secondary side chemistries that allowed corrosion buildup in the tube-to-TSP crevice. The design of installed steam generators after 1982 addressed these

TSP problems. The carbon steel TSPs were changed to stainless steel, the drilled TSP holes were changed to broached TSP holes, and additional secondary side chemistry controls were implemented. The TSP design for the Model-F steam generators at Callaway and the Series 44F and 51F replacement steam generators have these changes incorporated. A review of the operating history of these steam generator types from published information (e.g., EPRI web page) shows that these steam generators continue functioning with none of the problems associated with previous steam generator TSP designs.

The structural limits defined in the RSG Electrosleeve Topical Report and in the February 5, 1997 transmittal are the result of a conservative calculation methodology. [

]^{b,c}

The plugging criteria evaluation methodology discussed in the Electrosleeve Topical Report applies decreased limits on the allowed defect depth for postulated circumferential defects for affected tubes at the wedge locations. The interior or periphery tubes at wedge locations have the same axial crack plugging criteria, i.e., no decreased limits. However conservative and restrictive, the original structural limits remain in effect for the Electrosleeve. [

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Q13. At the meeting on December 9, 1997, it was stated that additional work was being performed as a result of feedback from the peer review of the UT process and qualification. Provide the results of the additional work (e.g., additional pit nd samples, etc.).

R13. Additional pit and disbond samples were fabricated for Appendix J qualification statistical requirements. Some pits that approach through-wall were produced to evaluate a full range of depth sizing. Preliminary results support previously reported capability to depth size pits with UT. The results of this work will be provided when completely documented.

Q14. In recent years, UT techniques have made large improvements in detecting and sizing flaws. FTI selected a basic 45 shear UT technique with computer assisted flaw analysis. This UT technique, however, exhibited limited effectiveness in sizing deep lab grown flaws. Explain FTI's evaluation/review (in more detail than FTI's February 5, 1997 submittal) of other UT techniques (divergent transducers, convergent transducers with

narrow band frequencies, computer focusing, surface waves with the detail on surface roughness discussed at the December 9, 1997 meeting), higher frequencies, and different transducer angles. Where test results supporting the above discussion are known, they should be summarized and referenced in the submittal. Note: the staff has no questions on the technique used for depth sizing with the 0 degree transducer.

R14. Ultrasonic inspection probes and software similar to those applied to the Electrosleeve NDE qualification have evolved over a period of several years starting in 1985. Steam generator UT inspections conducted by FTI have provided supplemental information and the results typically are reviewed in conjunction with a tube pull. The technology has continuously been improved and the ability to detect axial and circumferential cracks provide an experience base to decrease minimum detectable flaw size while maintaining or increasing a stable POD. The current design of the UT probe is based on earlier designs with changes focused on adapting the probe to the reduction in ID diameter due to the installation of an Electrosleeve™, while retaining the known inspection capability, and reducing the effects of surface roughness. Initial examination provided assurance that the probe would meet the detection requirements imposed. No other techniques have been formally considered or evaluated. As a background review:

1. FTI is not aware of data that demonstrates that UT techniques have made large improvements in detecting and sizing flaws in small extruded tubing applications. This first statement (in Q14) may be true in large structure or thick pipe/vessel examinations. However, small tube (< 1 inch diameter, thin wall) ultrasonics is a vastly different inspection, in terms of techniques and equipment.

2. The 45 degree shear was chosen for crack detection/disposition based on the following rationale.

    a. It was presumed that the majority of crack-like flaws would propagate perpendicular to the originating surface (supported by DE photomicrographs).

    b. For crack-like flaws the face is perpendicular to the tube surface, detection capabilities would degrade as the angle beam is directed shallower than 45 degrees (angles closer to perpendicular). This is intuitive as one can visualize the energy striking the reflector at more of a glancing blow and the result is less reflected energy. The limit of this can be realized since 0 degree waves (totally perpendicular) are completely blind to tight crack like flaws. While it is widely accepted that steeper angles result in poorer detection capabilities of crack-like flaws, some theories suggest depth sizing actually improves. This improvement occurs because the time of flight between the tip signal and the corner trap increases. This would seem to indicate that a suitable solution might be to use a 45 degree angle beam to detect and a steeper angle beam to characterize. Unfortunately, for the types of flaws encountered in small tubing, not enough useful energy is returned using the steeper angles to perform a detailed characterization.

c. As the angle beam is directed at angles greater than 45 degrees (closer to the tube's axis) , the signal path becomes significantly longer and this effect has two detrimental results. First, the capability to separate closely spaced flaws becomes degraded. Second, changes in tubing geometry (i.e. roll expansions, dents, etc.) would increase the distortion of a steeper inspection angle. In addition, steeper angle beams would be practically useless in the Electrosleeve transition regions.

d. The 45 degree angle was chosen as the best angle for detection and sizing of crack-like flaws that propagate perpendicular to the originating surface. Shear wave mode was chosen because it has better reflecting characteristic to crack-like flaws compared to longitudinal waves and the smaller wavelength inherent with shear waves.

The mean surface roughness of a [ ]^{b,c} thick Electrosleeve is [ ]^{c} as compared to an alloy 600 tube being [ ]^{b,c}. The UT inspection with this surface can be performed with complete "backwall" definition of the tube OD. Contingency plans do permit the use of a hone to improve the surface finish and thus the UT transmissibility into the sleeved tube.

Q15. The procedure 54-ISI-168 Rev 1, dated January 28, 1997, was in the process of being updated with the findings from the peer review. Provide the NRC staff with a copy of the updated procedure and the report containing the peer review findings and/or recommendations.

R15. Procedure 54-ISI-168 Rev 1, dated January 28, 1997 is acknowledged as needing revision based on the peer review and lessons learned. The procedures "loaned" on December 5, 1997 represent the procedures in place for the UT qualification data presented in previous submittals. [

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[

]^{a,d}

REFERENCES:

1. Letter to NRC Document Control Desk from C.D. Naslund, (Union Electric Company), dated September 10, 1997, Callaway Plant Docket Number 50-483, Revision to Technical Specification 1/4.4-Reactor Coolant System, (ULNRC-3644)(TAC No. M95204). "Information requested by NRC in a meeting on August 13, 1997."

2. Topical Report, BAW-10219P, Rev. 1, "Electrosleeving Qualification for PWR Recirculating Steam Generator Tube Repair", March 1996.

3. "RSG Electrosleeve™ Burst Pressure Margins", FTI Document 32-1264444, July 24, 1997. "Document provides margins to bursting for the Electrosleeve™ with respect to depth and length of an axial crack."

4. "Estimated 100% TW Limits for a Circumferential Flaw", FTI Document 32-1264476, September 8, 1997.

5. Letter to Kristine Thomas, RAI response February 5, 1997. "7 questions, 7 attachments".

6. Letter to NRC Document Control Desk from A.C. Passwater, (Union Electric Company), dated June 9, 1997, Callaway Plant Docket Number 50-483, Revision to Technical Specification 1/4.4-Reactor Coolant System, (ULNRC-03596)(TAC No. M95204). "Information requested by NRC in a meeting on August 13, 1997."

Attachments:

1. "LABORATORY GROWN SCC DE RESULTS SUMMARY DOCUMENT", FTI DOCUMENT 51-1264524-00, FEBRUARY, 1998. (This document presents photomicrographs of the flaws used in the qualification.)

2. - "LABORATORY GROWN SCC UT AND DE ANALYSIS OF 12/1996 RESULTS", FTI DOCUMENT 51-1264532-00, FEBRUARY, 1998. [

   ]^{b}

   - "LABORATORY GROWN SCC UT AND DE RE-ANALYSIS OF 1/1998 RESULTS", FTI DOCUMENT 51-1264522-01, FEBRUARY 12, 1998. [

   ]^{b}

3. FTI CORRECTIVE ACTION REQUEST, 98-02. (This information is the FTI internal QA procedure for identifying cause and corrective action for information not complying with QA procedures)

4. UT C-Scans for Transducer Orientation Evaluation, 7 pages.

5. "STUDY OF SALEM TUBE DENT PROFILES", FTI DOCUMENT 51-1264527-00, FEBRUARY 4, 1998. (This document presents a summary of measured dent profile geometry.)

ATTACHMENT 1

The following document provides technical information needed to evaluate the qualification of UT examination of an Electrosleeve™.

"LABORATORY GROWN SCC DE RESULTS SUMMARY DOCUMENT", FTI DOCUMENT 51-1264524-00, FEBRUARY, 1998. (This document presents photomicrographs of the flaws used in the qualification.)

REFERENCE : TOPICAL BAW-10219P, "ELECTROSLEEVING QUALIFICATION FOR PWR RECIRCULATING STEAM GENERATOR TUBE REPAIR"

February , 1998

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FTI-20440-6 (11/89)

FRAMATOME TECHNOLOGIES

ENGINEERING INFORMATION RECORD

Document Identifier 51- 1264524-00 (NON-PROPRIETARY)

Title Laboratory Grown SCC DE Results Summary Document

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Signature P.M. Mastilovic Date 2/20/98

REVIEWED BY:

Name G.M. Pop

Signature Mike T. Pop Date 2/20/98

Technical Manager Initials: JEG

Reviewer is Independent.

NON-PROPRIETARY

Remarks:

1.0 INTRODUCTION

This document summarizes the destructive examination results of the laboratory grown flaws in Arkansas Nuclear One (ANO) and FTI samples as analyzed by Ontario Hydro Technologies (OHT) during the Summer of 1997 and used in the NDE qualification of the Electrosleeve™.

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ATTACHMENT 2

The following documents provide technical information needed to evaluate the qualification of UT examination of an Electrosleeve™.

1. "LABORATORY GROWN SCC UT AND DE ANALYSIS OF 12/1996 RESULTS", FTI DOCUMENT 51-1264532-00, FEBRUARY, 1998. [

]^{b}

2. "LABORATORY GROWN SCC UT AND DE RE-ANALYSIS OF 1/1998 RESULTS", FTI DOCUMENT 51-1264522-01, FEBRUARY 12, 1998. [

]^{b}

REFERENCE : TOPICAL BAW-10219P, "ELECTROSLEEVING QUALIFICATION FOR PWR RECIRCULATING STEAM GENERATOR TUBE REPAIR"

February , 1998

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Title Laboratory Grown SCC UT and DE Analysis of 12/1996 Results

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Technical Manager Initials: JEG

Reviewer is Independent.

NON-PROPRIETARY

Remarks:

1.0 INTRODUCTION

This document is intended to clarify and explore in greater detail the data originally presented in FTI document 51-1264428 (reference 7.1).

This document presents the results of the non-destructive re-examination in the form of ultrasonic testing (UT) and destructive examinations (DE) of twelve samples of laboratory grown stress corrosion cracks (SCC). The samples were UT examined, electroplated, examined by UT and then sent to Ontario Hydro Technologies (OHT) for DE. The data analysis was performed by one FTI UT analyst in December 1996. Of the twelve samples only eight developed flaws and a total of twelve flaw regions were identified for all the samples.

The original analysis of this data is presented in FTI document 51-1264428 (reference 7.1) and a detailed treatment of the DE results is in FTI document 51-1264524 (reference 7.2). The coupons from which the DE data is derived have been archived and can be re-examined.

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Title Laboratory Grown SCC UT and DE Re-Analysis of 01/1998 Results

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Technical Manager Initials: JEG

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NON-PROPRIETARY

Remarks:

1.0 INTRODUCTION

This document presents the results of the re-evaluation of the ultrasonic testing (UT) and destructive examinations (DE) of twelve laboratory grown stress corrosion crack(SCC)samples. The samples were UT examined, electroplated, re-examined by UT and then sent to Ontario Hydro Technologies (OHT) for DE. The UT data analyses contained in this document were performed by two FTI UT analysts in January 1998. The original analysis of this data was performed by a single UT analyst in December 1996. Of the twelve samples only eight developed flaws and a total of twelve flaw regions were identified for all the samples in this document. Sixteen defects were identified in the initially identified in the original data analysis. The difference results from analyzing the data as individual defects as in the initial analysis and analyzing it as defect regions as performed in this analysis.

The original analysis of this data is presented in FTI document 51-1264428 (reference 7.1). However, a more comprehensive and detailed of the original data analysis is presented in FTI document 51-1264532 (reference 7.1a). A detailed treatment of the DE results is presented in FTI document 51-1264524 (reference 7.2). The coupons from which the DE data is derived have been archived and can be re-examined.

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ATTACHMENT 3

The following documents provide technical information needed to evaluate the qualification of UT examination of an Electrosleeve™.

FTI CORRECTIVE ACTION REQUEST, 98-02,
(QA review of licensing transmittals), 12 pages

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ATTACHMENT 4

The following document provides technical information needed to evaluate the qualification of UT examination of an Electrosleeve™.

UT C-SCANS FOR TRANSDUCER ORIENTATION EVALUATION, 9 pages.

REFERENCE : TOPICAL BAW-10219P, "ELECTROSLEEVING QUALIFICATION FOR PWR RECIRCULATING STEAM GENERATOR TUBE REPAIR"

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[ ]^{b}

ATTACHMENT 5

The following document provides technical information needed to evaluate the qualification of UT examination of an Electrosleeve™.

"STUDY OF SALEM TUBE DENT PROFILES", FTI DOCUMENT 51-1264527-00, FEBRUARY 4, 1998. (This document presents a summary of measured dent profile geometry.)

REFERENCE : TOPICAL BAW-10219P, "ELECTROSLEEVING QUALIFICATION FOR PWR RECIRCULATING STEAM GENERATOR TUBE REPAIR"

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ENGINEERING INFORMATION RECORD

Document Identifier 51- 1264527.00

Title STUDY OF SALEM TUBE DENT PROFILES

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This document consists of 8 pages. With attachments following:

Figures 1-7 (7 PAGES)

Attachment 1 - A-E (5 PAGES)

Attachment 2 - A-E (5 PAGES)