1901 Chouteau Avenue
Post Office Box 149
St. Louis, Missouri 63166
314-621-3222

UNION ELECTRIC

June 9, 1997

Ms. Kristine M. Thomas
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
1 White Flint, North, Mail Stop 13E16
11555 Rockville Pike
Rockville, MD 20852-2738

Ms. Thomas:

ULNRC-03597
TAC No. M95204

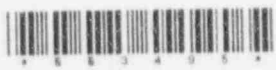
CALLAWAY PLANT
DOCKET NUMBER 50-483
REVISION TO TECHNICAL SPECIFICATION
3/4.4 - REACTOR COOLANT SYSTEM

References: 1) ULNRC-3358 dated April 12, 1996
2) ULNRC-3451 dated September 24, 1996
3) ULNRC-3596 dated June 9, 1997

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. This information was presented to the NRC staff in meetings on May 6 and May 13-14, 1997.

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 which is proprietary to Framatome be withheld from public disclosure in accordance with 10CFR2.790.

APO1



Chang: NRC PDR 1 ltr/pwp

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

Very truly yours,

Alan C. Passwater

WEK/

Attachments: 1) Information From 5/6/97 Meeting at Ontarion Hydro Technologies Laboratory in Toronto, Canada (Proprietary Information Affidavit attached)
2) Information From 5/13-14/97 Meeting at Framatome Technologies, Inc. Facilities in Lynchburg, Virginia (Proprietary Information Affidavit attached)

cc: M. H. Fletcher
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bcc: J. Brandt/A160.761
/QA Record (CA-758) W/a
E210.01
J. V. Laux
G. L. Randolph
R. J. Irwin
P. M. Barrett
J. D. Blosser
A. C. Passwater
D. E. Shafer
W. E. Kahl (2) W/a
S. Wideman (WCNOC)
A. J. DiPerna, (Bechtel)
H. D. Bono
NSRB (Patty Reynolds)
T. E. Herrmann W/a
A140.0001 (1180) W/a

May 6, 1997 Meeting Information

AFFIDAVIT OF JAMES H. TAYLOR

A. My name is James H. Taylor. I am Manager of Licensing 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 Licensing personnel and other management within FTI as designated by the Manager of Licensing Services 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 re. .ire; 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 Combustion Engineering, 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 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).

JAMES H. TAYLOR

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

James H. Taylor, 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.

JAMES H. TAYLOR

Subscribed and sworn before me
this 29th day of May 1997.

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

My Commission Expires July 31, 1999

AFFIDAVIT OF JAMES H. TAYLOR

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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.

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AFFIDAVIT OF JAMES H. TAYLOR (Cont'd.)

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).

JAMES H. TAYLOR

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

James H. Taylor, 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.

JAMES H. TAYLOR

Subscribed and sworn before me
this 29th day of May 1997.

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

My Commission Expires July 31, 1999

EXHIBITS A & B

EXHIBIT A

1. Proprietary Meeting Overheads and Technical Documents Regarding Electrosleeve NDE Review, May 13-14, 1997.

2. FTI Proprietary Document No. 51-1240246-00, ""Electrosleeve™ Fatigue Fracture Test Results Document," March 1997.

Note: Items 1+2 are proprietary in their entirety. No Non-proprietary version is provided.

EXHIBIT B

The above listed documents contain information which is considered Proprietary in accordance with Criteria b, c, and d of the attached affidavit.

EXHIBITS A & B

EXHIBIT A

1. Proprietary Meeting Overheads from May 6, ~~1996~~ 1997 Meeting. Dt 6/10/97

2. "Development of Electrosleeving as a Tube Repair for Pickering NGS B" (Pages 19 through 21), A. M. Brennenstuhl (presenter).

3. "Ultrasonic Inspection of Electrosleeves using TRUSTIE," (Pages 17 through 19), D. P. Jansen (presenter).

Note: Item 1 is a combination of Items 2 and 3.

EXHIBIT B

The above listed documents contain information which is considered Proprietary in accordance with Criteria b, c, and d of the attached affidavit.

May 6, 1997 Electrosleeve Mtg.

Ed Kahl	Union Electric	314-554-3806
Tim Herrmann	Union Electric	(573) 676-8241
Cheryl Beardslee	USNRC	(301) 415-2751
Geoff Horinseth	USNRC	301-415-2756
Alex Barnes	OHT	416 207 6690
George Wissbaum	Pick. G.S.	P24AB x4484
Gino Palumbo	OHT	416-207-5991
Stan Buhay	Spec. Insp. x Mtce - OHN	416-592-7215
Dion Jansen	OHT	416-207-5574
Mike Key	Framatome Tech.	(804) 832 3421
James E Galford	FTI	804 832 3338
J.C Lichtenberger	OHT	(416) 207-6175

Minutes for May13,14, 1997 Meetings
In Lynchburg With The NRC:

The following notes were taken during the presentations and demonstrations on May 13 and 14, 1997. A listing of attendees and copies of the handouts are attached for additional information.

May 13, 1997

An agenda for the meetings was reviewed and plans for the visit outlined.

The plugging criteria, as presented in the topical, was reviewed by Jim Galford. Removal of the tube wall and uniform thinning and the sleeve wall was used in the structural analysis to define the acceptable wall loss of the Electrosleeve™. This is the most conservative approach relative to an Electrosleeve™ due to the no tube represented over the repair length of the sleeve and no credit for the bonding over the entire length of the sleeve.

A review of the UT qualification data sets used in the evaluation of the UT system was presented by Scot Wilson. For clarification purposes, the UT RMSE error data was presented as inches instead of % TW.

A tour of the Electrosleeving system was given by Tom Moran. The installation probes, snorkels, distribution system, Woods, Strike, and Watts chemical supply systems were available during the tour.

A description of the UT acquisition system was provided by Mike Key. The system was used to acquire data on an EDM sample, 1246536C, with a detail explanation of the use of the sample and the UT analysis system. Examples of the analysis system with displays of different views was used to analyze the data. Analysis of the EDM sample was performed with reference to the reported data presented to NRC as part of the qualification.

May 14, 1997

Jim Galford expanded on the plugging criteria as presented in the topical and then defined the maximum allowable defects on a flaw definition basis. Thinning, pits, axial cracks, and circumferential cracks were evaluated by reference to EPRI and FTI burst tube data. The UT RMSE error on a flaw type basis was then compared to the

acceptable flaw size in a bar chart format to explain how "UT Flaw disposition" would be performed.

Mike key review the basics of UT probes, Computer displays, Beam refraction, target motion, Sizing methods, Defect responses, and analysis flow charts.

The remainder of the day covered two issues as requested, the references to the topical and detail analysis of crack qualification samples. Geoff Hornseth reviewed the references to the topical and some additional supporting documentation relative to foreign experience with nickel plating.

Cheryl Beardslee reviewed the analysis of UT qualification using data acquired from the sleeved alloy 600 tubes which were made by first exposed to autoclave environment to induced cracks and then installing the sleeve. Data for before sleeving and after sleeving was presented by Mike Key. These samples were the coupons that NRC had reviewed OHT's Laboratory on May 6 and 7, 1997. The following UT data records were analyzed by Mike and reviewed by Cheryl Beardslee.

TUBE# 49
RECORD # A6330_16.34.58 pre sleeve
A6350_12.39.53 post sleeve

Reviewed the Circ OD indication

TUBE # 57
RECORD # A6332_09.26.11 pre sleeve
A6350_12.31.45 post sleeve

Reviewed the ID pit that was formed during plating

TUBE # 5B
RECORD # A6194_11.00.41 pre sleeve
A6353_13.29.10 post sleeve

Reviewed the 3 axial defects that were 100% TW
Reviewed the circ ID and OD defects

TUBE # 120796-08
RECORD# A7009_15.30.33 post pit

Reviewed the pit call and found a pit depth to be .003 inches deep instead of .005 inches deep as report in the February RFI.

TUBE # 120596-02
RECORD# A7009_15.19.04 post pit

Reviewed the pit call.

MEETING SUMMARY

Geoff Hornseth and Cheryl Beardslee reviewed the information at the end of the day and provided the following summary.

A better understanding of UT qualification and methods of analysis was achieved. In addition the method of defining the UT error numbers had been explained.

Relative to the review of references, there were no show stoppers on the metallurgy.

Additional review of the new information on the UT error sizing in inches, and the consideration of cracks on the plugging criteria will be needed and FTI needs to present the information in the present in the response to the April 28, 1997 RAI.

AGENDA
For Th. NRC Electrosleeve NDE Review
May 13 &14, 1997

Tuesday	**5-13**	
1:30 to 2:00		**Welcome/review of plugging criteria**
2:00 to 3:00		**Review of the UT data sets presented to date**
3:00 to 4:00		**Tour of Electrosleeving system and NDE lab**
4:00 to 4:30		**Wrap up**

Wednesday	**5-14**	
8:00 to 9:00		**UT analysis overview**
9:00 to 10:00		**Disposition of UT data vs. plugging criteria**
10:00 to 12:00		**Review of DE vs. UT calls**
1:00 to 4:00		**UT data review / Questions**

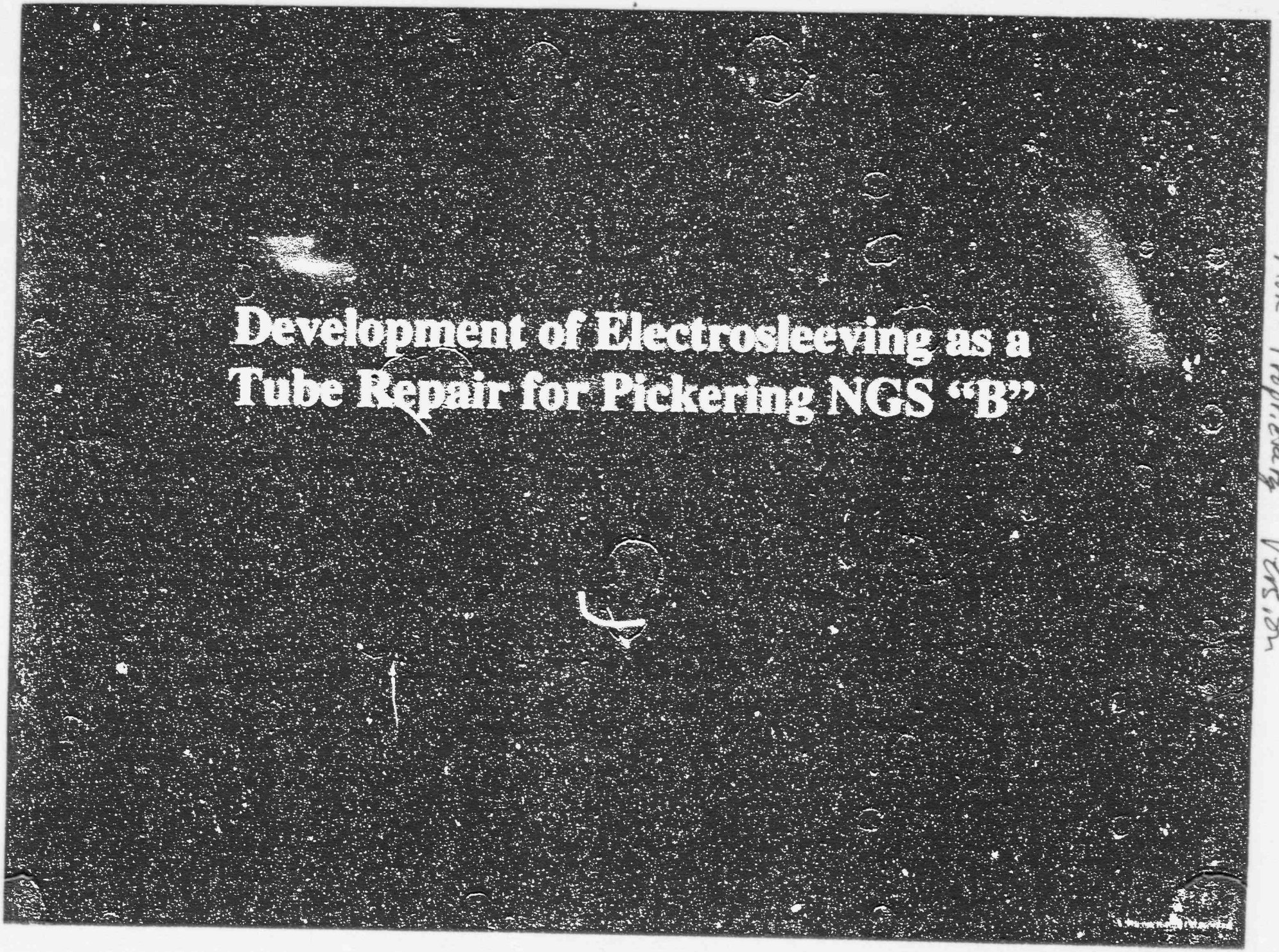
Attendance for 5/13/97 Electrosleeve Meeting

Ed Kahl	Union Electric	314-554-3806
Tim Herrmann	Union Electric	(573) 676-8241
Scot Wilson	FTI	164-48-0836
Geoff Hornseth	U.S. NRC	301-415-2756
Cheryl Beardsley	USNRC	301-415-2751
Greg Kammerdeiner	Duq. Light	412 393-5677
Reggie Pugh	FTI	(804) 832-3321
Randy Schaefer	FTI	804-832-4009
Paul Kirstein Bergen	ONT	(416) 207-6175
James E Galford	FTI	804 832 3338

NRC Meetings/RAIs

- Union Electric Tech Spec, April 12, 1996
- Topical overview with NRC May 28, 1996
- Demonstration in Lynchburg, July 2, 1996
- Presentation Material as RAI, July 18, 1996
- BG&E Tech Spec, July 26, 1996
- RAI Response, September 24, 1996
- HL&P Tech Spec, October 28, 1996
- UT Qual. Presentation , January 15, 1997
- Response to RAI on UT, February 5, 1997
- Maine Yankee Tech Spec, March 5, 1997
- Duquesne Light Co. Tech Spec, March 10, 1997
- NRC Meeting, Maine Yankee UT Issues, March 26, 1997
- NRC Telecon, NDE/UT Review, April 14, 1997
- NRC RAI, 10 Questions, April 28, 1997
- NRC Visited OHT, May 6 - 7, 1997
- NRC Visit, NDE Discussion, FTI, May 13 - 15, 1997

FRAMATOME TECHNOLOGIES



Non-Proprietary Version

NON-PROPRIETARY

Description of PNGS SG's

- 4 unit station - 500 Mw
- 12 SG/unit - 2753 tubes
- Alloy 400 - 1/2" OD
- SG - Design parameters

PRIMARY SIDE

- Pressure 1450 psig
- Temperature 521 F

SECONDARY SIDE

- Pressure 800 psig
- Temperature 521 F

Description of PNGS SG's
(cont'd)

- **SG - Operating Conditions**

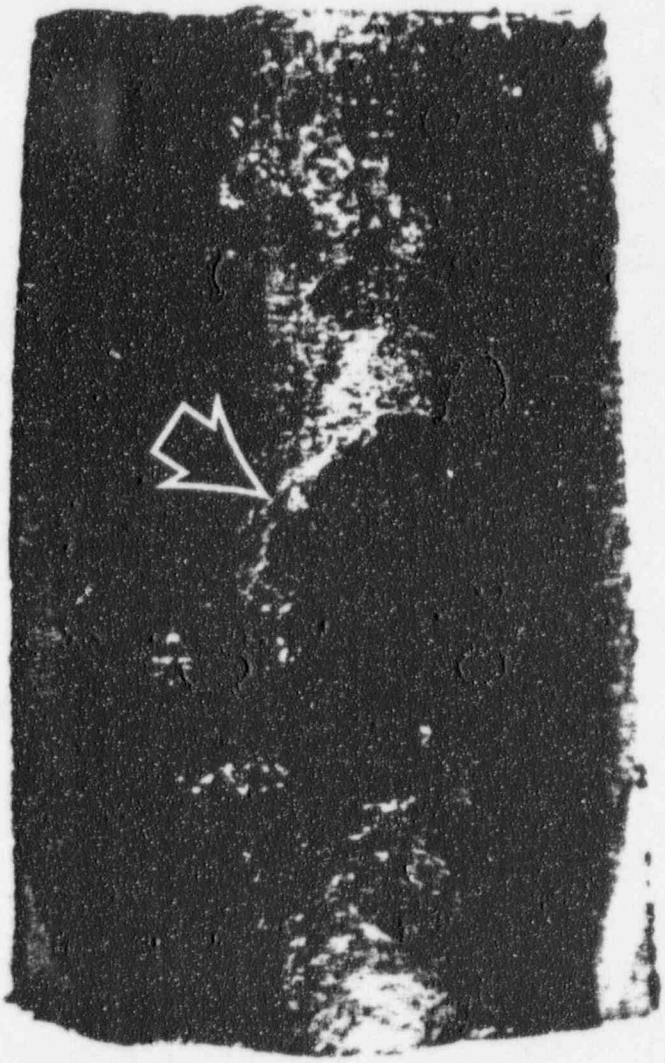
PRIMARY SIDE
- D_2O - pH 10.5 (LiOH)
- H_2 - 20 cc/kg

SECONDARY SIDE
- Cu bearing feedtrain
- Mechanical de-aeration
- Morpholine/hydrazine treatment
- pH - (8.5 - 9.5) 9.2

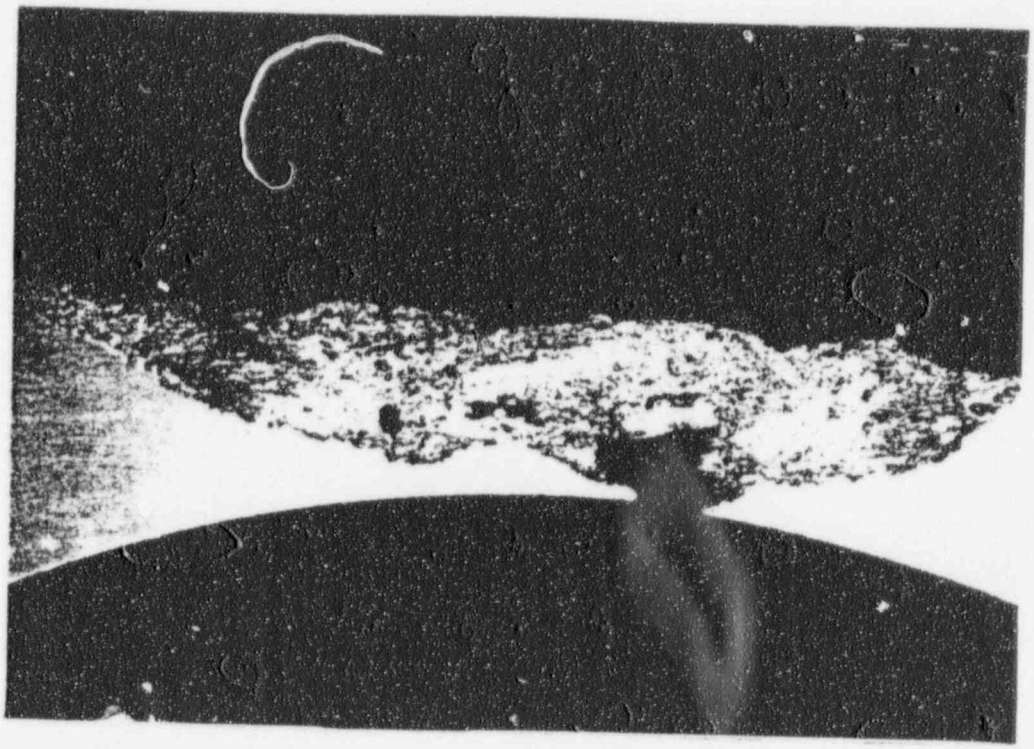
- **SG - Radiation Fields**
  - Operation 200 R/hr
  - Shutdown 300 mR/hr

Background

- Pickering NGS "B"
- Unit 5 - SG tube leaks (1992)
- Localized attack
- High degree of fouling
- Operating chemistry practices
- Additional leaks - Units 5 and 6
- Large # of tubes plugged
- Need to de-rate

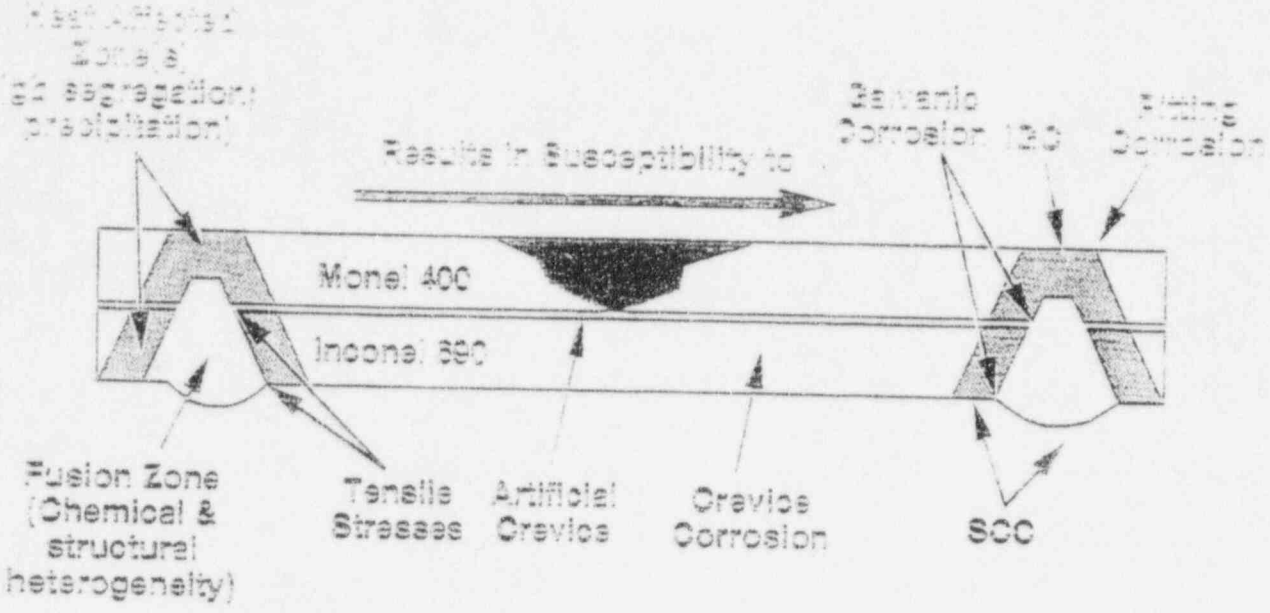


OD pit in the 'B' Monel 400

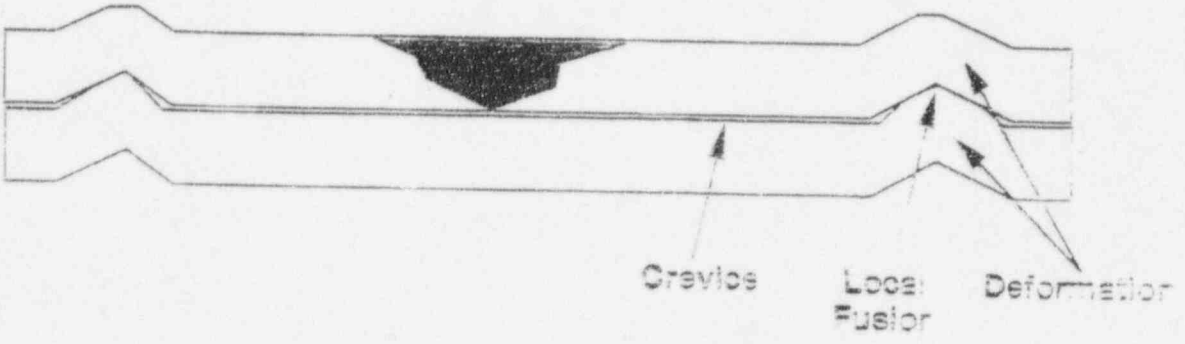


Cross-section through the pit in the 'B' alloy.

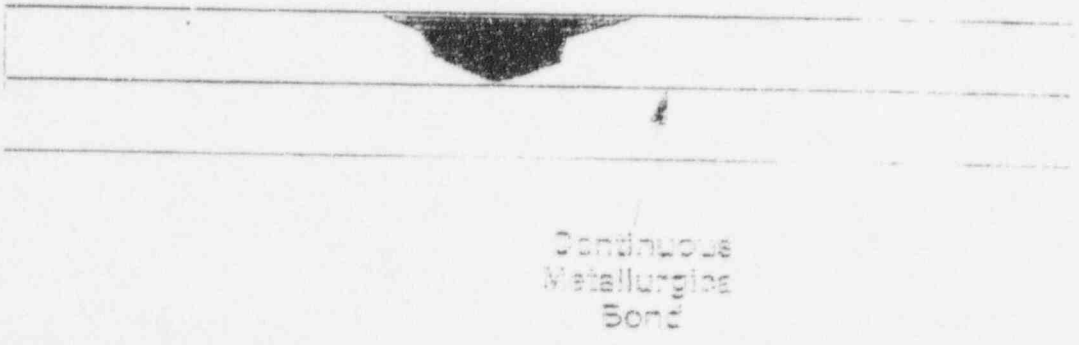
Detail of the degradation inside the pit, metal loss appears to be partly due to intergranular Corrosion.



Conventional Kinetically Bonded Sleeves



Electroformed Integral Sleeves



Results

- Total of 46 electrosleeves
  - 28 Witness
  - 18 In-steam generator
- 44 sleeves acceptable (95% success rate)
- 2 dispositioned (<5% total sleeved area disbonded)
- Witness samples were tested and met or exceeded mechanical and chemical requirements
- The remaining 14 in-steam generator sleeves possessed required properties for satisfactory service performance
- 14 electrosleeves have been in steam generator for 1 year and upon re-inspection have been found acceptable

after 1 yr

General Corrosion Testing

- ASTM G28 - "Susceptibility to IGA"
  - *No cracking*
- ASTM G35 - "Susceptibility to SCC-Polythionic"
  - *No cracking*
- ASTM G36 - "Susceptibility to SCC-Mg Cl_2"
  - *No cracking*
- ASTM G44 - "Susceptibility to SCC-NaCl"
  - *No cracking*
- ASTM G48 - "Susceptibility to pitting & crevice"
  - *No pitting*
  - *Slight C.C.*

Why 'Electrosleeve' M400 Boiler Tubes

1. Corrosion Damaged Tubes
   - Under-deposit pitting
   - Caused by aggresive (Cl^- $SO_4^{=}$) ion impurities, oxidizers
   - Leaks → forced outages
2. Life Management Remedial Measures
   - Cleaning
   - Cu removal
   - Optimized water chemistry
   - Enhanced inspection

   'cannot guarantee long life for all boiler tubes'
3. Options
   - Tube plugging
   - Reduce power
   - Replace boilers
   - Repair tubes

Why 'Electrosleeve' M400 Boiler Tubes

(cont'd)

4. Conventional Repair
   - 'Welded' sleeves (fusion, kinetic)
   - Established technology for (Fe-Ni-Cr) alloys
   - No experience with M400
5. Conventional Sleeving of M400
   - Kinetic: tube bulging, grain growth
   - Welding: burn-through, coring
   - Dissimilar metal welding: heterogeneity
   - Natural crevice formed: crevice corrosion
6. Pickering Monel Experience
   - P-A: 20 years service - (no serious degradation)
   - P-B: 6 years service - (leaks due to UDC)
   - UDC: deposits (CPT)
     : lake water contaminants
     : oxidizing conditions
     : alloy corrosion resistance

Advantages of Electrosleeving

- Electrosleeving can be done on small diameter tubing (1/2") as well as larger tubing.
- Electrosleeving has no adverse physical effects on tubes being sleeved (benign process).
- Electrosleeving is a continuous bond process, leaving no crevice at the ends of the sleeve between the tube and the sleeve and is therefore not vulnerable to crevice corrosion (smooth transition).
- Electrosleeving can be applied beyond (i.e. through) existing sleeves.
- Electrosleeving should be applicable in the U-bends of the tube.
- Electrosleeving can be applied in deformed tubing locations.
- Thinner sleeves can be used as a result of the superior properties of the electroformed material.

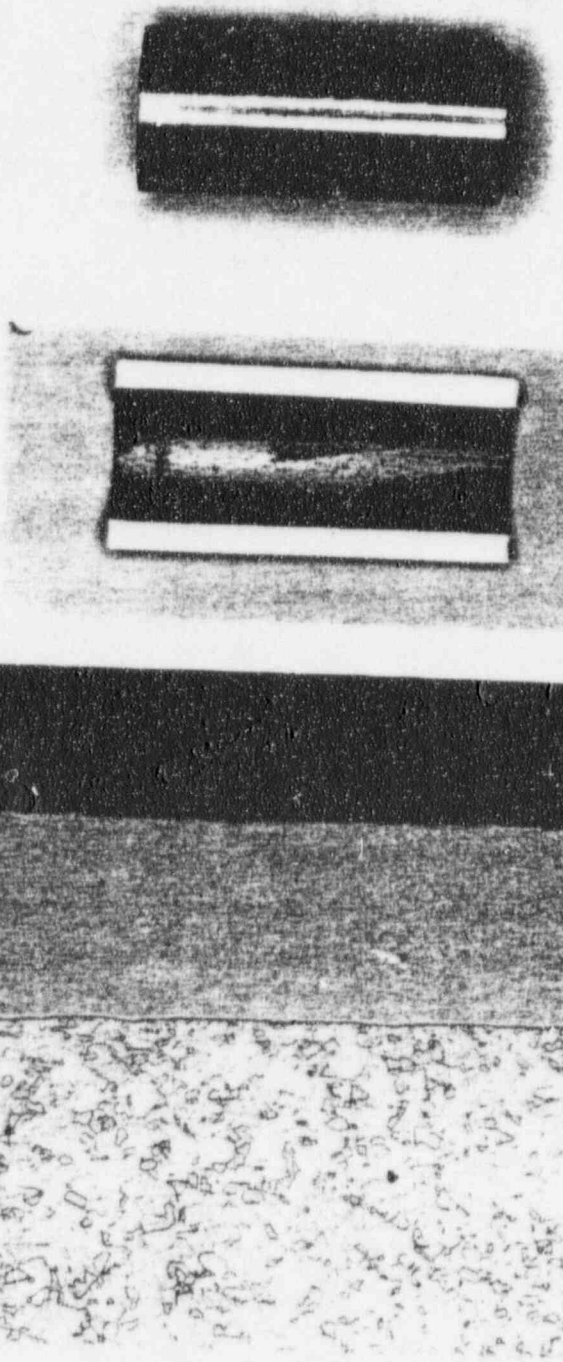
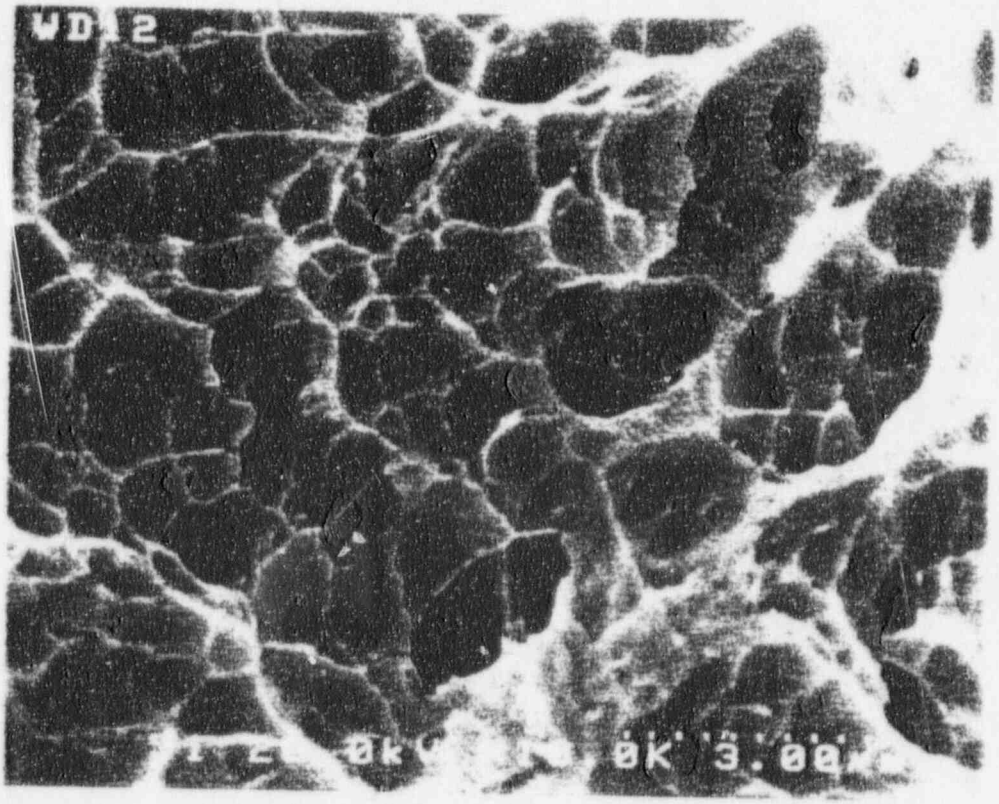
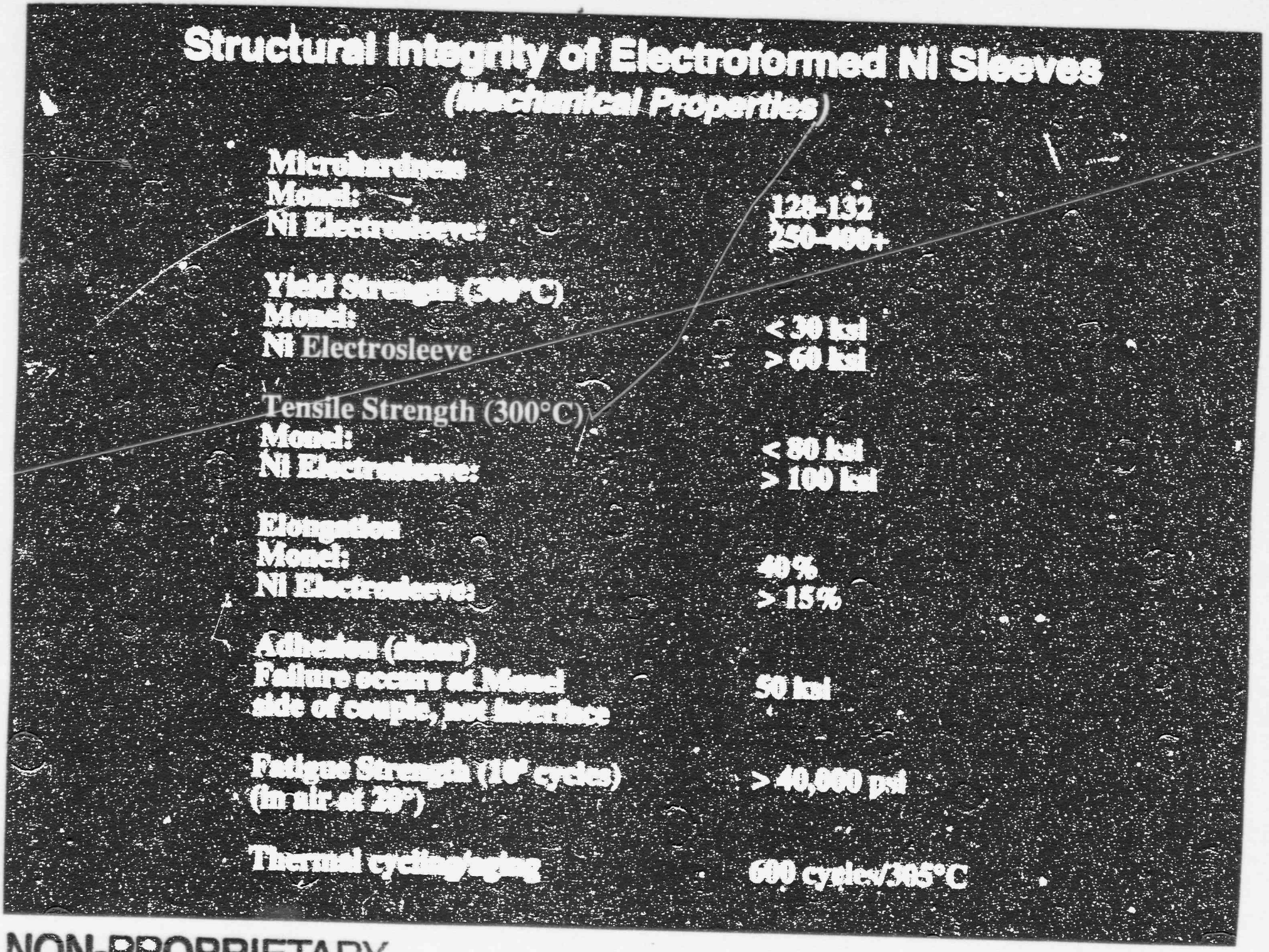


Figure 7 ElectrosleevedTM specimen supplied by Ontario Hydro using a pure Nickel sleeve. (a,b) OD and ID surface appearance. (c) Optical micrograph of an axial section. Magnification: 50X.


WD 2
0k
0k 3.00



Process Description :

Process Description

- Electrosleeve™ Technology based on the in-situ electroformation of a full structural/bonded sleeve on the ID of the tube spanning the defect locations(s)
- Descaling and cleaning are an integral part of the process

P8 Trial Objectives

- **Develop practical in-situ boiler experience**
- **Assess quality, reliability, repeatability under field conditions**

  → *field harden the process*

- **Obtain operating field experience**

Determine what can go wrong in field?

P8 Trial Results

- **Installed 3 sets of 4 sleeves in 2 boilers**
  - *9 in boiler*
  - *200' from rig*
  - *45' elevation*
- **UT inspection capability viable and verified by destructive examinations in lab**
- **All sleeves were defect free, showed some thickness variation and patches of surface roughness**
- **Target sleeve thickness (0.018") attained**
- **Three sleeves were well bonded to the tubes**

What Did We Learn from P8?

- **Need to stiffen probe alignment**
- **Need to improve production rate**
- **Need to simplify probe installation/removal**
- **Local post weld heat treatment produced a very stable and adherent surface oxide layer**

  → ***rigorous honing required***

P1 Trial Objectives

- **To demonstrate production capability**
  - *rate*
  - *sleeve quality*
  - *equipment reliability and robustness*
- **To validate UT measurements with destructive lab evaluations**

P1 Trial Results

- **Installed 2 sets of 4 sleeves in 1 boiler**
  Pulled 1 tube containing 1 sleeve from each batch

- **Probe installation < 15 min.**
  Process time < 6 hrs.

- **UT inspection of I/B tubes**

  - good plating uniformity
  - defect free
  - continuous metallurgical bond in 2nd set

- **Tubing in older generators has a thicker magnetite deposit which is more difficult to remove**

- **Lab inspection of pulled tube confirmed UT results**

P1 Trial Conclusions

- Sleeve quality such that we could have left the tubes (2nd set) in service
- Process times consistent with production rate requirements for P5
- Tube cleaning requirements for P5 expected to lay between P8 and P1

Pickering NGS "B"
- Electrosleeving Qualification -

- Electrosleeving was qualified as a repair for Pickering NGS Unit 5
  - ASME B&PV code was followed
  - Testing addressed
    - *mechanical properties*
    - *corrosion resistance*
    - *inspection capability*
  - Special approval from MCCR & AECB was obtained to leave electrosleeves™ in service
  - Large database produced which established variability of critical process parameters

Electrosleeve Design Requirements
(Qualification Program)

- Produced to ASTM B689, ASTM B322 and ASTM B450
- Chem. comp. (99.5% Ni with Co, Si & C each < 0.01%)
- Dimension, surface finish and deposit character (thickness > 0.012", target 0.018")
- Yield strength (> 60 ksi at RT and 305°C)
- U.T.S. (> 120 ksi at RT and 305°C)
- Elongation (> 10% elongation in bending)
- Hardness (> 200 VPN)
- Adhesion (> 8% tensile elongation)

Electrosleeve Design Requirements
(Qualification Program)
(*cont'd*)

- Fatigue (high & low cycle endurance ≥ M400 ASME B & PV code, Section III)
- Thermal cycling (>600 cycles)
- Helium leak test (<10^{-4} atm cc/s He with 1 bar He pressure in contact with the external surface at 305°C)
- Corrosion (ASTM G28-85, G35-88, G36-87, G44-88, G48-93, G61-48, capsule tests, refreshed autoclave tests

Structural Integrity of Electroformed Ni Sleeves
(Corrosion Tests)

SCC
- ASTM G35 (polythionic acid)
- ASTM G36 (boiling $MgCl_2$)
- ASTM G44 (NaCl)

Pitting/Crevice
- ASTM G48 ($FeCl_3$)
- ASTM G61 (cyclic polarization)

IGA
- ASTM G28 (H_2SO_4 + $Fe_2(SO_4)_3$)

Capsule
- Excellent resistance to neutral and alkaline environments

Autoclave
- Excellent resistance to:
  1) non-oxidizing low pH environments
  2) oxidizing & non-oxidizing neutral environments
  3) oxidizing & non-oxidizing caustic environments

Corrosion Testing
(Secondary Side)

- **Sludge & faulted chemistries**
  - **Bulk fluid**
    - *Condenser leakage*
    - *Acid excursion*
    - *Caustic excursion*
  - **Sludge**
    - *Cl^-, $SO_4^=$, Na^+, HN_4^+, Cu^{++}, Magnetite*
    - *12 combinations tested*
- **Capsule tests**
  - **24 tests**
  - **Various combinations**
    - *C_nCl_n, NaCl, Na_2SO_4, NaOH, H_2SO_4, NH_4, Pb, O_2*

P5 Sleeve Qualification

- Chemical composition will be established prior to and after installing each batch of sleeves
- The process parameters will be monitored independently for each sleeve during the installation
- Each sleeve will undergo non-destructive testing to determine the quality of the sleeve and its bond integrity with the host surface
- One witness tube will be produced with each batch of I/B sleeves and will undergo prompt mechanical analysis

Other Qualifications

- **Application to the CSA N285.6 Materials Standards Committee to include micrograin nickel as an alternative Class 1 pressure boundary material.**

- **Stress/fatigue analysis to demonstrate the sleeved tubes satisfy ASME Boiler and Pressure Vessel Code, Section III for the Design, Normal and Upset and Hydrostatic conditions expected in the boiler.**

Process Qualification

Purpose:

- **To form electrosleeves with reproducible material/corrosion resistance properties**
- **To eliminate the need to test the sleeves destructively**

Approach

1. **To correlate changes in sleeve properties with changes in process parameters.**
2. **To produce sleeves under QA with fixed process parameters and subject these samples to a broad spectrum of tests using independent and certified facilities.**
3. **To confirm material properties using one witness sample for every 7 tubes deposited in the boiler.**

Corrosion Tests

Guiding principles

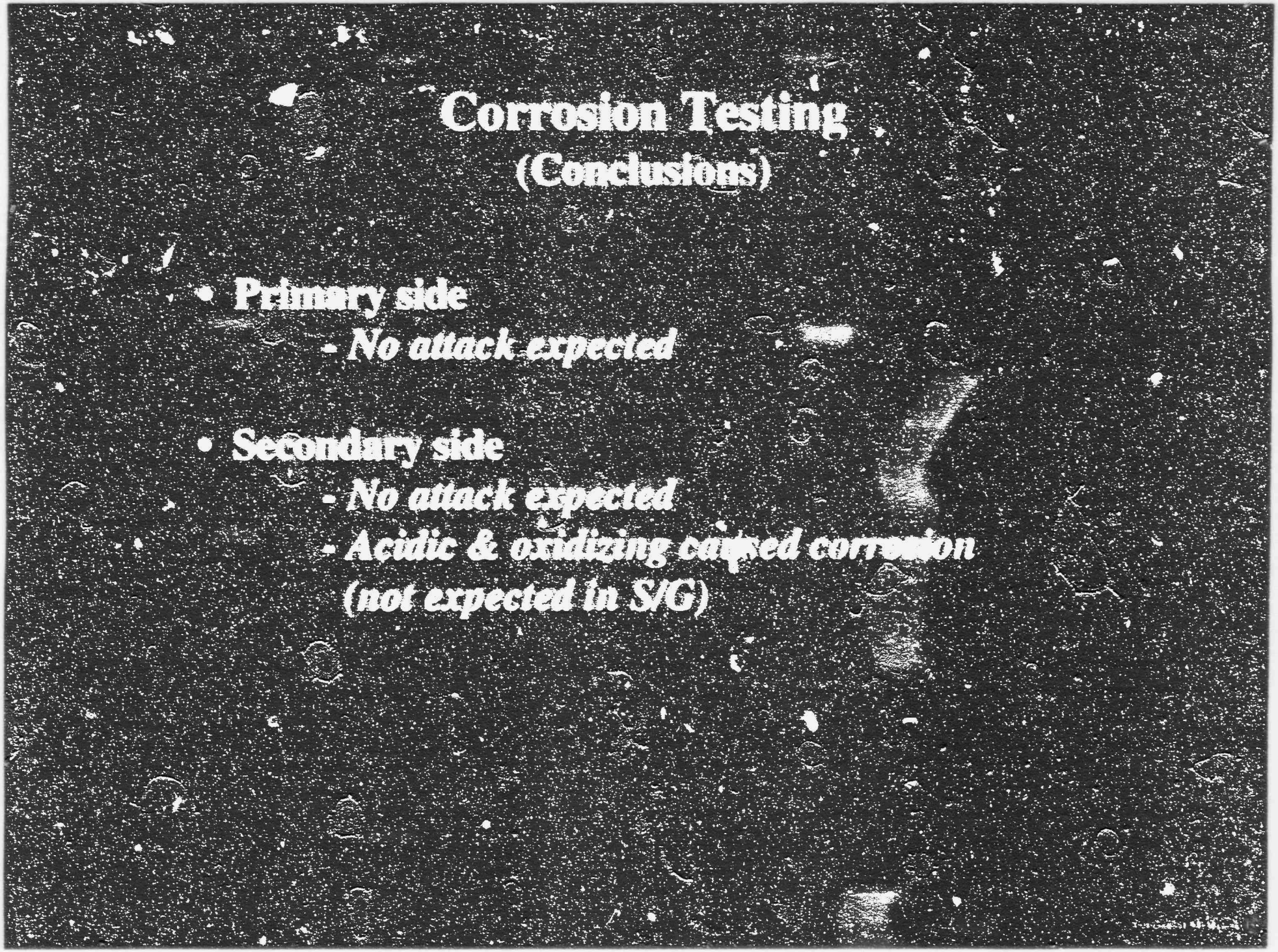
- **Standard ASTM tests selected to simulate expected corrosion conditions in boiler**
- **Tests selected to accelerate possible corrosion processes using high temperature and aggressive chemical conditions**
- **Tests to simulate geometry, fouling and thermohydraulic conditions in a S/G**

Corrosion Tests

- **Six standard ASTM tests:**
  ASTM G28, G35, G36, G44, G48, G61
- **18 high temperature aqueous environmental tests investigating REDOX, stress, & chemistry known to be detrimental to nickel**
- **Three long term corrosion tests simulating in-boiler conditions**
- **Sample size**
  - **standard ASTM test: 20**
  - **capsule furnace tests: 18**
  - **refreshed autoclave tests: 9**

Other P5 Sleeve Qualifications

- Operators will be trained and qualified on a full scale prototypic delivery system in accordance with the Sleeving Procedure Document
- Consumable supplies will be provided under the CSA Z299.2 QA Program
- I/B tube preparation will be in accordance with a qualified honing specification


Corrosion Testing
(Conclusions)
• Primary side
- No attack expected
• Secondary side
- No attack expected
- Acidic & oxidizing caused corrosion
(not expected in S/G)

Pickering NGS Unit 5 SG 12 Campaign

- April 25th - May 4th, 1994
- Campaign originally scheduled for 500-600 electrosleeves
- ECT examination results led to a reduced campaign (20 sleeves)
- Two electrosleeving rigs each capable of up to eight electrosleeves was available
- Electrosleeving rig used to half its available capability
- Full scale production [illegible] electrosleeves per day
- Witness and in-steam generator electrosleeves were produced

Non-Proprietary Version

Ontario Hydro TECHNOLOGIES

Ultrasonic Inspection of Electrosleeves using TRUSTIE

D.P.Jansen, W.K.Chan, M.D.C.Moles

Ontario Hydro Technologies

E.Choi, J.Huggins

Ontario Hydro Nuclear

NON-PROPRIETARY

The TRUSTIE* System

Tiny Rotating UltraSonic Tube Inspection Equipment

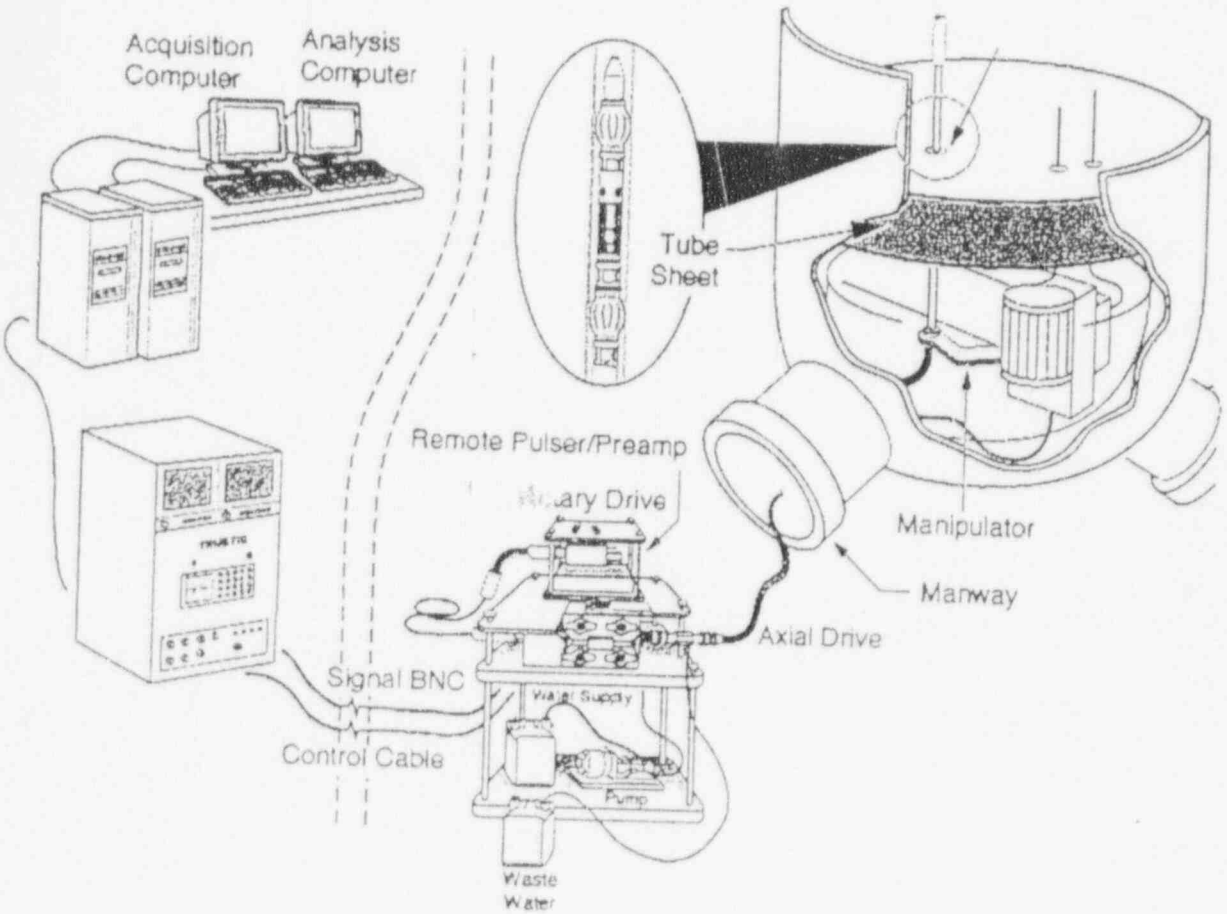
- OHT developed and operated
- Designed for 0.5" OD CANDU steam generators
- External rotary drive / driveshaft
- Windows 95 based data acquisition and analysis

TRUSTIE Specifications

- tube IDs from 0.310" to 1.3"
- tube lengths up to 50'
- ultrasonic inspection frequencies from 5 to 25 MHz
- rotation speeds up to 1000 rpm
- typical data collection speeds:
  - 600 rpm for 4 gate C-scans
  - 600 rpm for full waveform scans (at 0.2 mm by 1.5 deg. resolution)
- U-bend inspection on 16" radius for 0.5" OD tubes
- remote operation to 600'

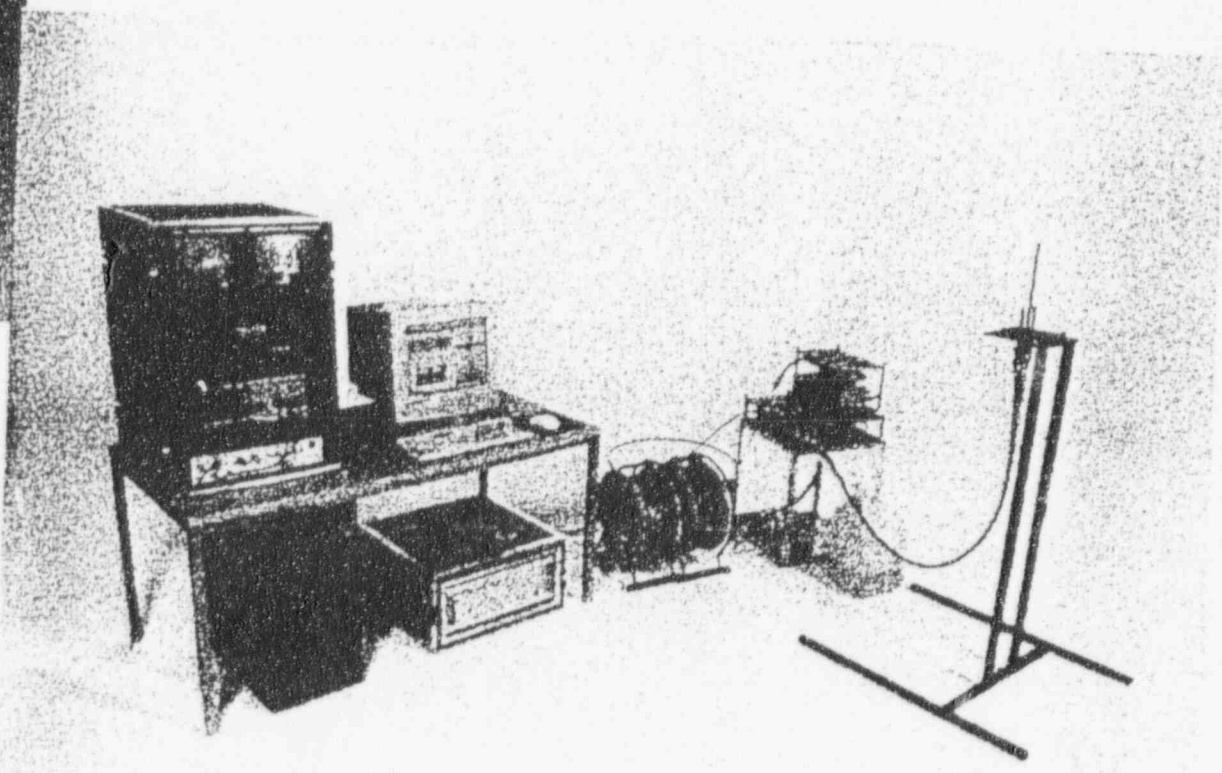
Ontario Hydro
TECHNOLOGIES

System Overview



Ontario Hydro
TECHNOLOGIES

TRUSTIE

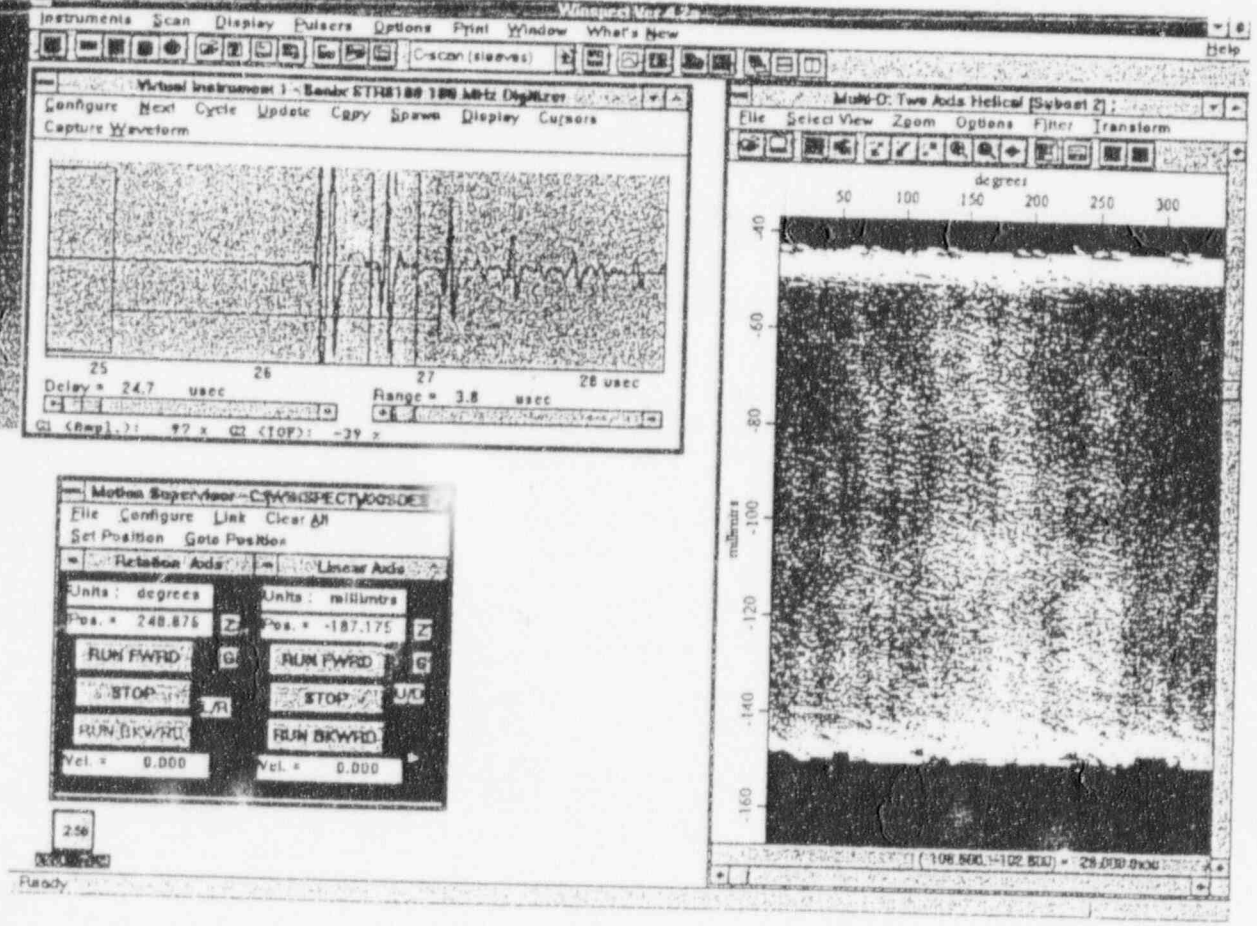


05-97

Inspection capability

- probe types :
  - normal beam (wall thickess/ profilometry)
  - axial facing shear wave (circumferential cracking+ ID profilometry)
  - multiple mode combination (normal beam + circ and axial shear waves)
  - others
- analysis methods:
  - A, B, C and waveform scans
  - line plots, colour plots, isometrics
  - echodynamics
  - integrated signal processing (e.g. filtering, spectral analysis)

Winspect tm



- *integrated motion control, data acquisition and data analysis*

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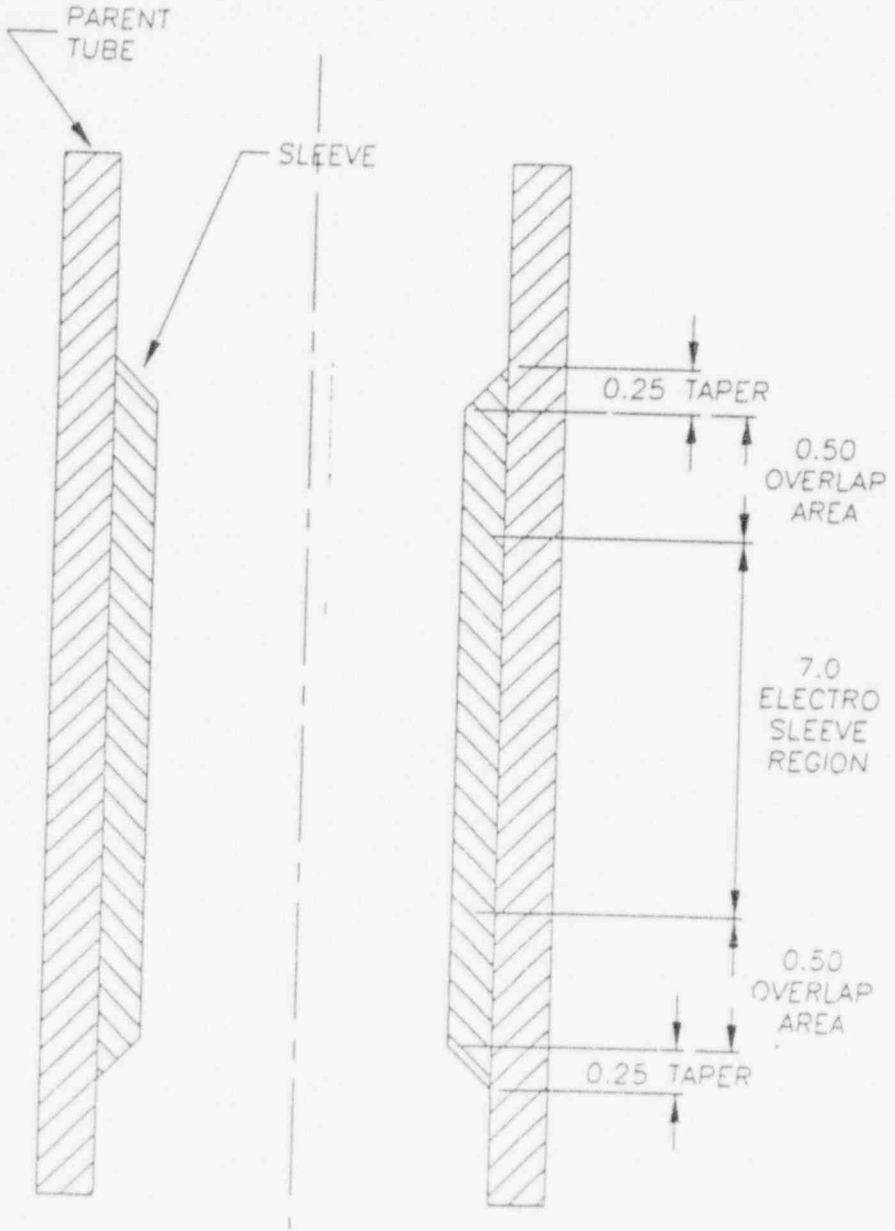
TECHNOLOGIES

Electrosleeve Inspection



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TECHNOLOGIES

Inspection Requirements

- *Nickel sleeve:*
  - *Thickness > 0.014"*
  - *Defects > 20% TW reported, any defect > 40% TW dispositioned*
  - *Disbonding < 5mm square in area*
  - *OD defect located in this region*
- *Overlap area of Monel Tube:*
  - *Defects > 20% TW reported, any defect > 40% TW dispositioned*
  - *No OD pits > 71% TW*
  - *No detectable disbonds*
- *Damaged area of Monel Tube:*
  - *OD defects monitored*
  - *Through wall defects acceptable*

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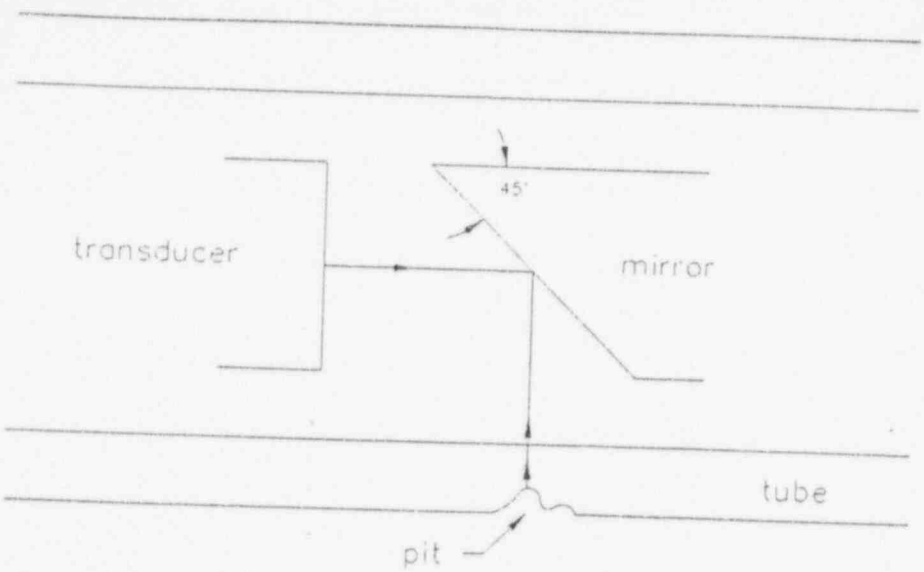
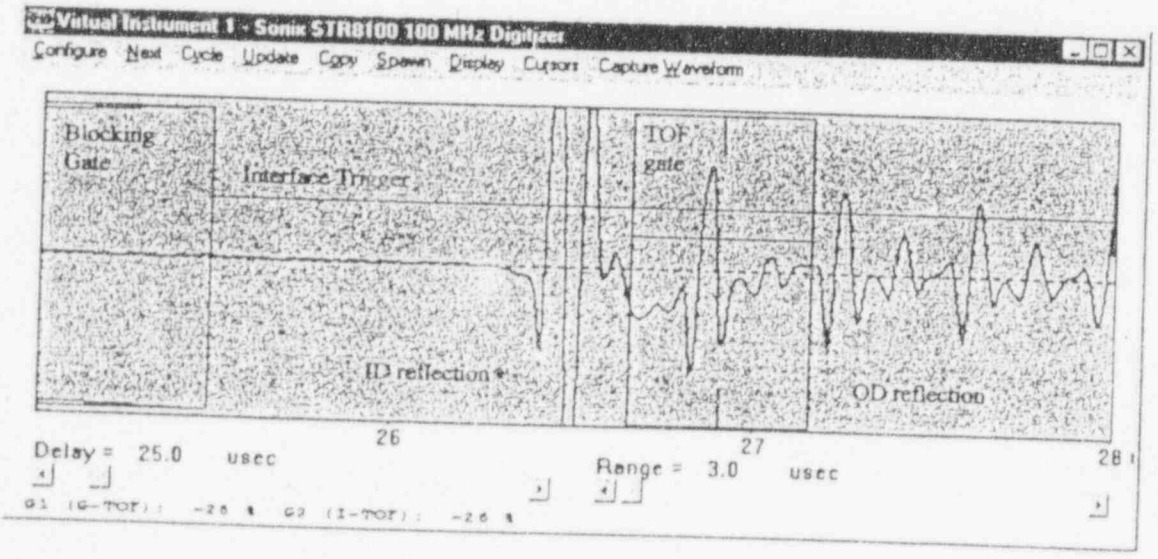
TECHNOLOGIES

Normal beam ultrasonics





Inspection technique

- RF signal split into two channels, one 10 dB attenuated
- 4 gates:
  - OD TOF (wall thickness)
  - OD amplitude (defect detection)
  - ID TOF (ID profilometry)
  - ID amplitude (surface finish)
- Scan resolution: 1.5 degree by 0.2 mm

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Inspection Procedure

- *Axial B-scan encompassing sleeve and upper rolled joint*
- *C-scan inspection encompassing entire sleeve plus 15 mm either side*
- *Locate and record sleeve and parent tube defect locations*
- *Collect full waveforms over all noted defects*
- *Calibration scans at start and finish of each shift*
- *analysis: CGSB Level II in UT*

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TECHNOLOGIES

Inspection Qualification

- *Verify size and depth of machined defects on calibration tube*
- *DE to verify sleeve thickness*
- *Cross-check of visual - UT - mechanical testing of sleeve test runs*
- *Independent 3rd party review of inspection system*

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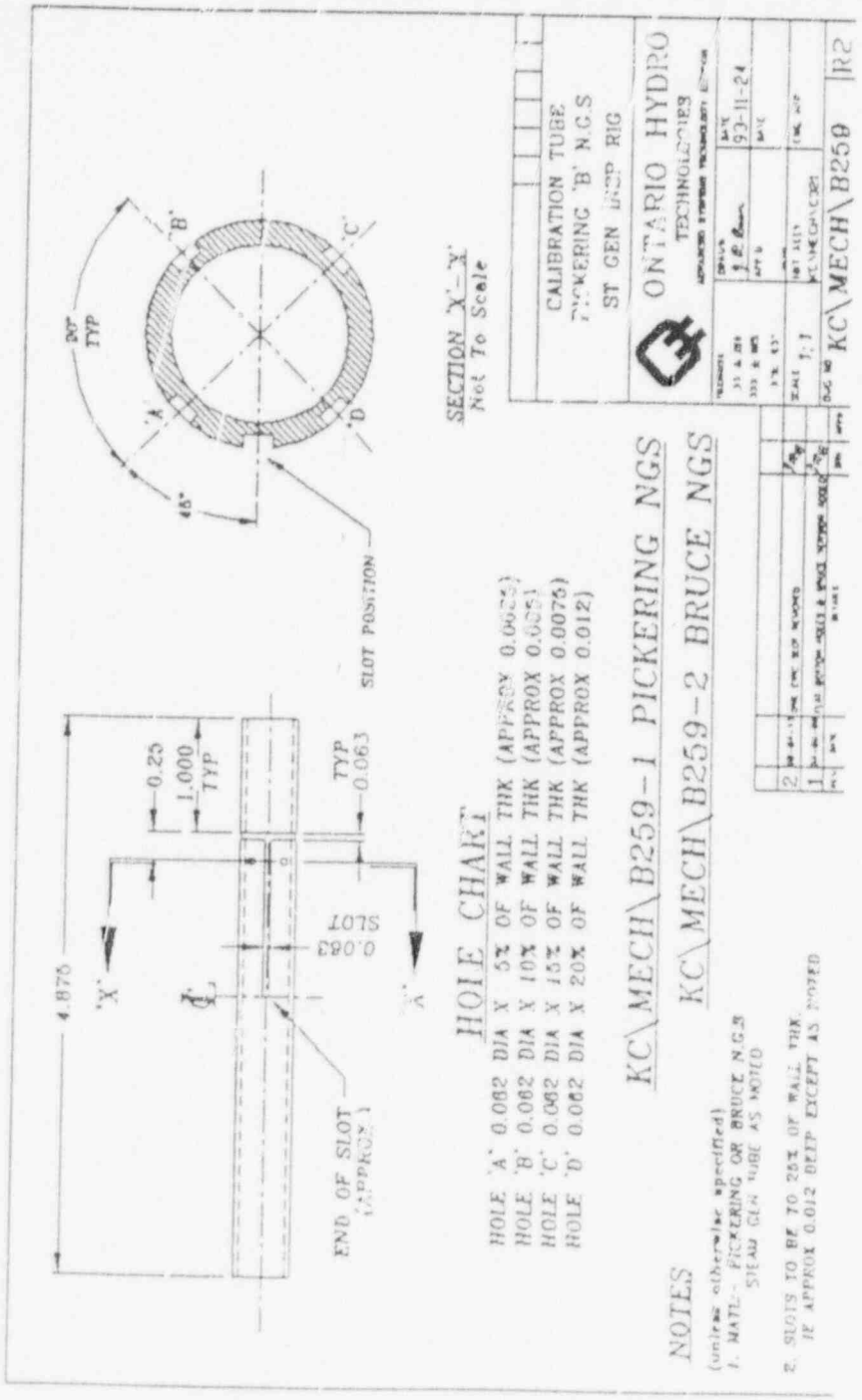
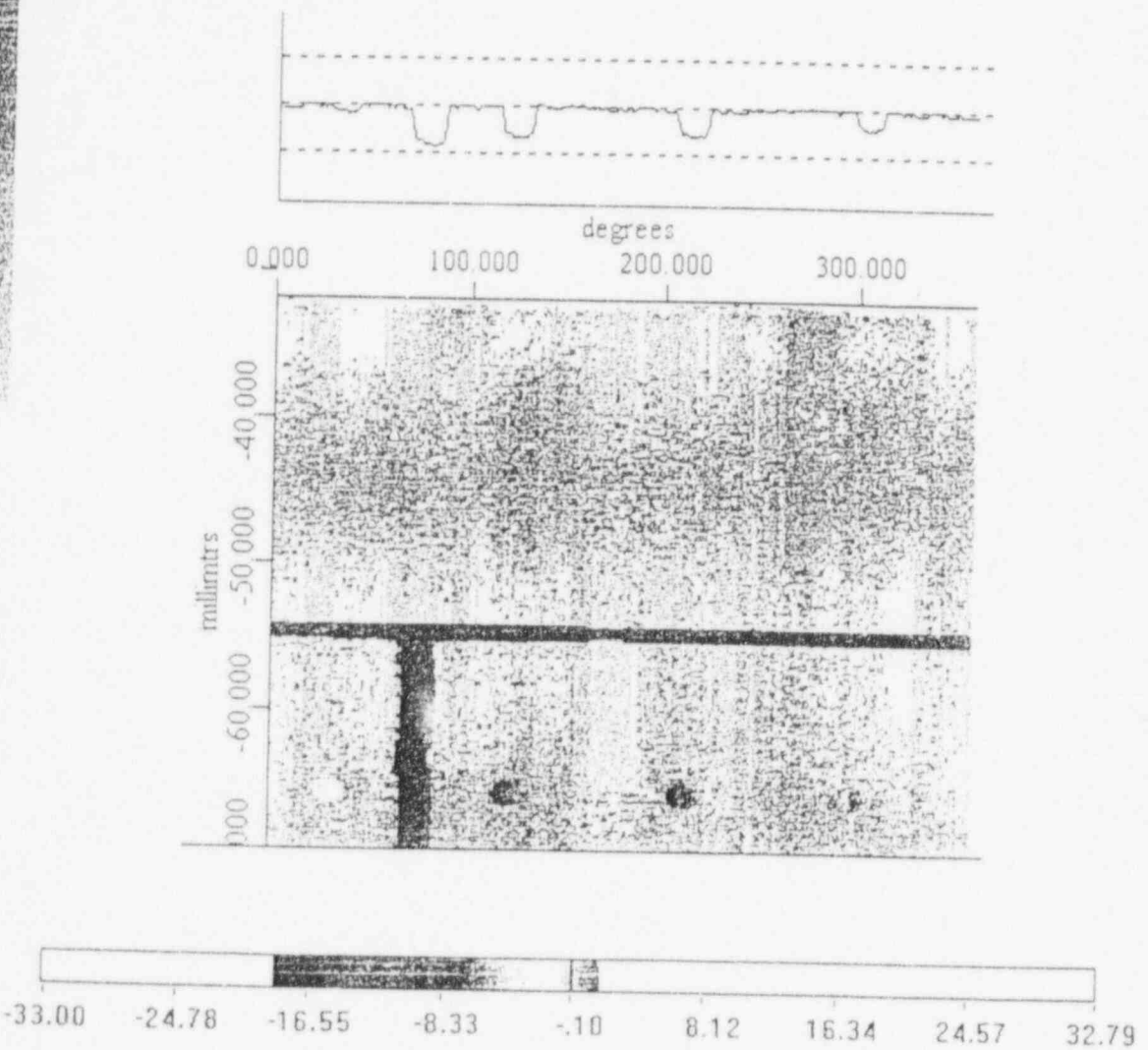
Calibration tube



Calibration tube C-scan



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TECHNOLOGIES

Inspection Records

Pickering NGS Unit 5 Electrofusion Sleeving UT Report Sheet

Date: MAY 3/94

Data Number (Rec/Cal): 33043

Batch ID number: C:\DACES\BATCH#6

F

Tube #	Area																Saved file name
	Upper sleeve		Tubesheet		Unsupported, upper and lower (2)				Blueprinting zone								
	Ind. type	Measurement	Ind. type	Measurement	Ind. type	Measurement	ECT pull?	Thickness	Ind. type	Measurement							
1							yes	0.050 23									BLUEC1
									ODpit								
2							yes		ODpit								BLUEC2
																	BLUEC3

TOP OF SLEEVE - 599
SLEEVE LENGTH - 206

Is this above acceptable ? (Y/N): YES

If not acceptable, which indication(s) caused the rejection : _____

Notes :

Analyzed by: _____

Over Expansion : _____

Sleeve Re-inspection

Formation of Unbonded Area

Unbonds Left in Service

May 13-14, 1997 Meeting Information