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314-621-3222

UNION ELECTRIC

June 9, 1997

U. S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Mail Station P1-137
Washington, D. C. 20555-0001

Gentlemen:

ULNRC-03596
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) K. M. Thomas ltr to D. F. Schnell dated April 28, 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 is submitted in response to the request for additional information transmitted by Reference 3. The significant hazards consideration determination, as previously transmitted in Attachment 4 of Reference 1, is still valid.

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.

APD1/1

ltr and
change - PDR 1 w/o pwp

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

Very truly yours,

Alan C. Passwater

WEK/

Attachments: 1) Proprietary Information Affidavit
2) Response to Request for Additional Information (Proprietary)
3) Response to Request for Additional Information (Non-Proprietary)

STATE OF MISSOURI)
) S S
CITY OF ST. LOUIS)

Alan C. Passwater, of lawful age, being first duly sworn upon oath says that he is Manager, Licensing and Fuels (Nuclear) for Union Electric Company; that he has read the foregoing document and knows the content thereof; that he has executed the same for and on behalf of said company with full power and authority to do so; and that the facts therein stated are true and correct to the best of his knowledge, information and belief.

By Alan C Passwater
Alan C. Passwater
Manager, Licensing and Fuels
Nuclear

SUBSCRIBED and sworn to before me this 9th day of June, 1997.

Patricia L. Reynolds

PATRICIA L. REYNOLDS
NOTARY PUBLIC—STATE OF MISSOURI
ST. LOUIS COUNTY
MY COMMISSION EXPIRES DEC. 22, 2000

cc: M. H. Fletcher
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James E. Galford
Framatome Technologies
155 Mill Ridge Road
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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 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 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. Cardona
Notary Public in and for the City
of Lynchburg, State of Virginia.

My Commission Expires July 31, 1999

EXHIBITS A & B

EXHIBIT A

"Proprietary" Responses in Support of Request for Additional Information Regarding Union Electric Company's April 12, 1996 Request for Technical Specification Amendment to Approve the Installation of Framatome Electrosleeves™ in the Callaway Plant Steam Generators (TAC No. M95204).

EXHIBIT B

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

Responses In Support of the Request For Additional Information (RAI) Regarding Union Electric Company's April 12 1996, Request For Technical Specification Amendment To Approve The Installation Of Framatome Electrosleeves™ In The Callaway Plant Steam Generators (TAC NO. M95204)

Framatome Technologies is pleased to provide the following information in response to the questions asked in the NRC letter from Kristine M. Thomas to Mr. Donald Schnell dated April 28, 1997. Additional information in the form of Attachments (see list below) is also provided in response to Questions raised during the NRC phone call on 4-14-97, and during the NRC visit to FTI on May 13 and 14 1997.

Attachments: Drawings: 1246536C
UT 750 By 043 Nickel Sleeve
Qualification Sample As-Built Drawing

1246362B
Unbonded Nickel Sleeve Sample

Report: Doc 1223311-00 Nickel Plated
Qualification

The following 10 questions are from the NRC's April 28,1997 letter from Kristine Thomas:

Q1. *Past experience with the materials of construction of the reactor coolant pressure boundary and in particular steam generator tubing has been that cracking has occurred in many of these materials even when not predicted to occur or not predicted to occur as early as observed. An argument advanced by Framatome with regard to the electrosleeving application is that cracks in the alloy 600 tubing will not propagate as cracks into an electrosleeve. It appears from our review of the electrosleeving documents that NDE detection (and sizing) of the postulated cracks in the sleeve is not addressed. This approach rests upon metallurgical arguments about the expected performance of the new material. This approach departs from the traditional approach of providing inspection techniques capable of detecting (and sizing, as necessary depending upon the application) postulated cracks in repairs. Provide a discussion of plans for addressing the staff's concern regarding your approach to NDE. In addition, provide a copy of the references with key information on nanocrystalline material that are not readily available to the NRC.*

R1. The response to this question is segregated into three portions. First the issue of resistance to cracking and second the NDE of postulated cracks by UT inspection, if crack like indications were to propagate into the Electrosleeve™ material, are discussed. The last portion presents references on nanocrystalline material with a brief summary of each reference.

1. Stress Corrosion Cracking (IGSCC) Resistance

During the January 15, 1997 meeting, the mechanics of corrosion of the Electrosleeve™ material was presented. The technical basis for that discussion is contained in the following references.

G. Palumbo, P.J. King, P.C. Lichtenberger, K.T. Aust, and U. Erb, "Grain Boundary Structure Control for Intergranular Stress-Corrosion Resistance," Mat. Res. Soc. Symp. Proc. Vol. 238, 1992, pages 311-316.

This reference presents the identification of "metallurgical means of alleviating intergranular stress corrosion cracking (IGSCC) susceptibility". This is accomplished by "processing considerations which result in (1) moderate increases of structurally 'special' grain boundaries and (2) refinement in grain size". Based on cross-sectional scanning electron micrograph examination of intergranular cracks in mill

annealed Alloy 600, the authors concluded that "intergranular crack arrest occurs primarily at triple junctions".

U. Erb, A.M. El-Sherik, G. Palumbo, and K.T. Aust, "Synthesis Structure and Properties of Electroplated Nanocrystalline Materials", NanoSTRUCTURED MATERIALS Vol. 2, 1993, pages 383-390.

This reference concentrates on electrochemical production methods, including D.C., electroplating, pulse plating, electroless plating and co-deposition processes to produce nanocomposite materials. According to this paper, nanocrystalline materials have a grain boundary microstructure which as the grain size decreases, the volume fraction of triple junctions increase dramatically. These "triple junctions are also believed to play an important role in the thermal stability of nanocrystalline materials." Another significant conclusion is the microstructure difference in materials produced by electroplating is "electroplating techniques produce materials which are essentially free of any porosity."

The observed degradation of the Electrosleeve™ material, in all environments tested, is localized general corrosion, with passivation of the surface layer. With the small grain size (approximately 100 nanometers), the mechanics of separation of a very small grain boundary results in material loss rather than observable crack propagation in the classical sense, thus the region of degradation exhibits a "pit like" indication when destructively examined.

Extensive testing has been performed to try to produce a crack in the sleeve material, by using an environment induced crack in the parent tube and continuing to monitor the tube crack to sleeve interface. The crack in the Alloy 600 will stop and a pit (may) form on the sleeve OD, if the

environment is aggressive enough to provide a means to attack the sleeve material at the crack tip. If a pit forms, it can be sized with UT. For ¾" tubing, a 0.043 inch tube wall with a 0.032 inch thick sleeve (0.075 inch combined thickness), the RMSE was , Table 2. This correlates to a % TW sizing error of % combined thickness. The maximum error was , which correlates to a % TW error of % combined thickness. These errors were determined from the sample set shown on Table 2. The sample set consisted of tubes with parent tube OD pits with no Electrosleeves™ installed.

2. NDE of Postulated Cracks in the Repairs.

The following addresses the staff's concern regarding the need for an evaluation of the crack propagating from the Alloy 600 tube into the sleeve material. Additionally, the qualification of UT detection and sizing of cracks in the Electrosleeve™ by using reference data for cracks in Alloy 600 is discussed. This information is summarized in Chart 1.

UT has shown the ability to size **SCC in Alloy 600 tubing containing an Electrosleeve™**. For the data set shown in Table 1, the **RMSE accuracy** was . This corresponds to is a for 11/16" tubing 0.040 inch tube wall and a . The maximum error was , which correlates to a % TW error of combined TW. The data set included lab grown parent tube SCC cracks with Electrosleeves™ installed.

Tubes pulled from an operating steam generator were also evaluated with UT. This **pulled tube crack sizing** information is presented in the data submitted in Attachment 3 of the February 5, 1997 RAI transmittal to NRC. The pulled tubes contained ODSCC operation induced flaws. UT demonstrated a POD of 30% to 48% TW, and a **RMSE accuracy** of **10% TW (0.005 inch)** of the tube wall. Since the UT method is essentially a length measurement, this data also demonstrates that UT can size ODSCC in a parent tube

The discussion provided in the following shows that combined TW, RMSE accuracy is sufficient to disposition crack like indications in the tube/sleeve combined wall thickness. The discussion shows that if crack like degradation has propagated into the sleeve, the sleeve still

has an acceptable structural margin to account for the RMSE accuracy.

Disposition of flaws detected by UT

The installed Electrosleeve™ has regions which require different evaluations relative to repair or plugging.

UT	Disposition
Two major distinctions must be evaluated in this region, given the fact that a flaw exists in the tube which precipitated the repair. Indications which clearly appear to be of the tube and UT indications which appear to represent degradation of the sleeve pressure boundary layer.	

Tube Indication,

If a
indication is detected that does not exceed
of the tube wall (
the accuracy of detection
and sizing of all of these flaws permits continued service with no further evaluation required.

indications > TW Tube Wall:

Note that this flaw

This demonstrates that a an additional margin of of the combined tube/sleeve wall thickness.

The actual structural capability of the tube/sleeve combined wall for a flaw is very high as shown on Chart 1.

The criteria for plug or repair for the sleeve wall thickness, as defined in the topical, results in the margins shown in Chart 1. For a structural allowable of the combined wall thickness, shown in Chart 1. For a structural allowable of in the combined wall thickness, the sleeve as shown in Chart 1.

Indications Tube Wall:

Chart 1 provides the acceptance limits,

This methodology for evaluation of UT indications considers the sizing and specific nature of the flaw. The acceptable degradation is based on alloy 600 tubes with real cracks and EDM notcnes.

The Chart 1 evaluation criteria shows for an

Clearly these flaw types in tubes have extensive margins as supported by over 12 years of experience in Europe (see references in Response 9 below) with very thin layers (0.006") of low strength nickel (15 ksi yield).

Summary

Even allowing for the error any UT indication can be evaluated to determine whether a sleeve remains acceptable for continued operation . For a crack which has propagated through an alloy 600 tube, pitting continues to be judged as the most likely sleeve degradation mechanism.

3. References:

Relative to providing "references"; the following bibliography presents papers which provide additional information on experience with nickel plating and technical details relative to nanocrystalline structured material.

R.W. Siegel, "Creating Nanophase Materials, The properties of these ultrafine-grained substances, now found in a range of commercial products, can be custom-engineered", Scientific American, December 1996, pages 74-79.

> This paper summarizes studies since 1985. A comparison of "grains in conventional materials range from microns to millimeters in diameter and contain several billions atoms, those (grains) in nanophase materials are less than 100 nanometers in diameter and contain fewer than tens of thousand of atoms. To put these sizes in perspective, a three-nanometer-diameter cluster contains about 900 atoms and is almost one million times smaller than the period at the end of this sentence-or about as small as a 40-foot sailboat is compared with the size of the earth." This paper also discusses deformation of materials that are conventionally very brittle, such as ceramics, but when made as nanophase materials the materials become ductile.

H. Teranishi, Y. Sawaragi, M. Kubota, and Y. Hayase, "Fine-Grained TP347H Steel Tubing with High Elevated-Temperature Strength and Corrosion Resistance of Boiler Applications," Sumitomo Metal USA Corporation, May 1989.

> This paper describes the benefit of smaller grain size. "A counter measure for steam-side corrosion in stainless-steel tubing is to reduce grain size."

The following technical papers were presented after the topical was submitted and are considered to be available in the public domain.

F. Gonzalez, A.M. Brennenstuhl, G. Palumbo, U. Erb, P.C. Lichtenberger, "Electrodeposited Nanostructured Nickel for

In-Situ Nuclear Steam Generator Repair", Proceedings of the 1995 International Symposium on Metastable Mechanically Alloyed and Nanocrystalline Materials, ISMANAM-95.

The electrosleeving repair methodology for nickel-copper 400 steam generator tubing is presented along with a summary of the mechanical properties, thermal stability, and corrosion resistance of the nickel material. A copy of this paper was made available for NRC review.

G. Palumbo, F. Gonzalez, A.M. Brennenstuhl, U. Erb, W. Shmayda, P.C. Lichtenberger, "In-Situ Nuclear Steam Generator Repair Using Electrodeposited Nanocrystalline Nickel".

Chemical characteristics of nanostructured material, >99.5% Ni, containing microalloyed phosphorous (<3000 ppm by wt.) is described. "The nanocrystalline material is shown to posses thermal stability and mechanical properties required for repair of steam generator tubing (strength, ductility, fatigue resistance), and promises to offer unique crack arrest and intergranular creep-cracking resistance not typically observed in conventional polycrystalline materials." A copy of this paper was made available for NRC review.

J.E. Galford, F. Gonzalez, G. Palumbo, M.G. Pop, "Steam Generator Tube Repair Using Nanocrystalline Microally Nickel Electrosleeves", ANS Winter Meeting, November 10-14, 1996.

This paper presents a summary of the demonstration installation of Electrosleeves™ in the Oconee Nuclear Station in November 1995.

ASME Section XI, Division 1, Code Case N-569, "Alternative Rules for Repair by Electrochemical Deposition of Class 1 and 2 Steam Generator Tubing", September 1996.

Q2. *Provide the crack size (in percent through wall of combined layer of parent tube and sleeve) that would be the limit for unacceptability at the Callaway Plant.*

R2. The method of disposition is presented in the Response 1. The criteria for an 11/16" OD x 0.040" wall tube with a 0.031" nominal thickness Electrosleeve™ installed has been presented in detail and Chart 1 summarizes the margins for specific degradation modes which exceed the tube wall thickness.

Q3. Provide the location of the defects (e.g., top of tubesheet, tube support plate, ect.) for the defects discussed in Attachment 1 (Table 1) of the September 24 1996, supplemental information.

R3. The location of each of the labeled defects are as follows:

The letter designation indicates a specific tube at the given plant.

Q4. Provide a copy of the EDM calibration standard drawing.

R4. Drawing number gives the location of the EDM notches used in the Topical.

Q5. Provide the results (or a reference to a submittal) from the electrosleeve assembly leakage tests performed for 11/16 inch tubes.

R5. Leak testing was performed at room temperature on 11/16" tubes with an installed Electrosleeve™.

The pressure test was performed at room temperature conditions to provide the capability to check for visible leakage as the possibility of vaporization or steam is minimized.

No visible leakage was observed during the test tube/sleeve interface.

These test results are consistent with the design objectives of a "sealed" sleeve installation and also support the total bonding defined by the UT inspection.

Q6. *Provide additional information pertaining to the number of EDM defects used for UT qualification testing. Specifically, describe the makeup of the 77 and 99 EDM notches referenced on page 11-4 of the topical report (BAW-10219P, Rev 1, March 1996). Correlate these EDM defect groups to Attachment 2 (Table 2) of the September 24, 1996, supplemental information. In addition, revise the units from "percent throughwall" to "mils".*

R6. UT qualification has utilized the following data sets:

DATA SET	WHERE PRESENTED

The data was acquired and given to 2 separate analysts to analyze and make calls. The analysts had no prior knowledge disclosed to them of the defects in the samples.

DEFECTS USED IN SIZING:

DEFECTS USED IN SIZING:

Q7. *Provide the number of samples used to determine the thickness accuracy of +/- 2 mils.*

R7. The information presented in the Topical was based on a very detailed examination of sample. qualification testing was performed to provide additional verification of the thickness sizing accuracy.

Q8. *Page 11 of the February, 1997, supplemental information stated that axial ID initiated cracks had to be 100 percent throughwall of the parent tube to be detected by UT. Describe the sizes (length, depth) of these cracks.*

R8. The information on, not being able to detect ID SCC,

these defects became encapsulated within the tube/sleeve wall. The UT method used for crack detection requires a corner trap signal to determine whether the signal is ID or OD,

The Electrosleeve™ repair over the preexisting ID defects has been examined destructively to evaluate the geometry of the interface of sleeve and tube. The step used to clean the tube opens the ID crack and the fills in a few thousands (inch) of the interface crack with nickel.

When the crack reaches the OD, UT probability of detection is very high and the process of disposition is explained in Response 1.

Q9. *Provide a list of references to foreign experience with electrosleeves, including Canadian experience.*

R9. The experience in Canada is best described in material that was presented in Lynchburg.

At the time the topical was prepared in March 1996 the following articles provided information relative to the experience in Belgium using nickel plating.

The experience using nickel presented in of the topical has at least two additional installations in Europe. The May 28, 1996 presentation identified "Experience" with nickel. Bimetallic sleeves (Ni200 over I600), over 2000 roll transition repairs in Belgium from 1985 to present, the Canadian experience at Pickering 6, 8, 1, with installation of sleeves that remain in service at Unit 5, and the 1995 Electrosleeve demonstration at Oconee.

D.B. Darling, J.A. Richards III, "Nickel Plating of Pressurizer Heater Nozzles to Prevent PWSCC," Nuclear Power Plant Journal, November-December 1994, pg34 - 45.

> "A 10 mil layer of nickel was qualified for sealing a half inch through-wall crack for more than 120 fatigue cycles." "One hundred eighteen nozzles were plated to a thickness of 8 mils."

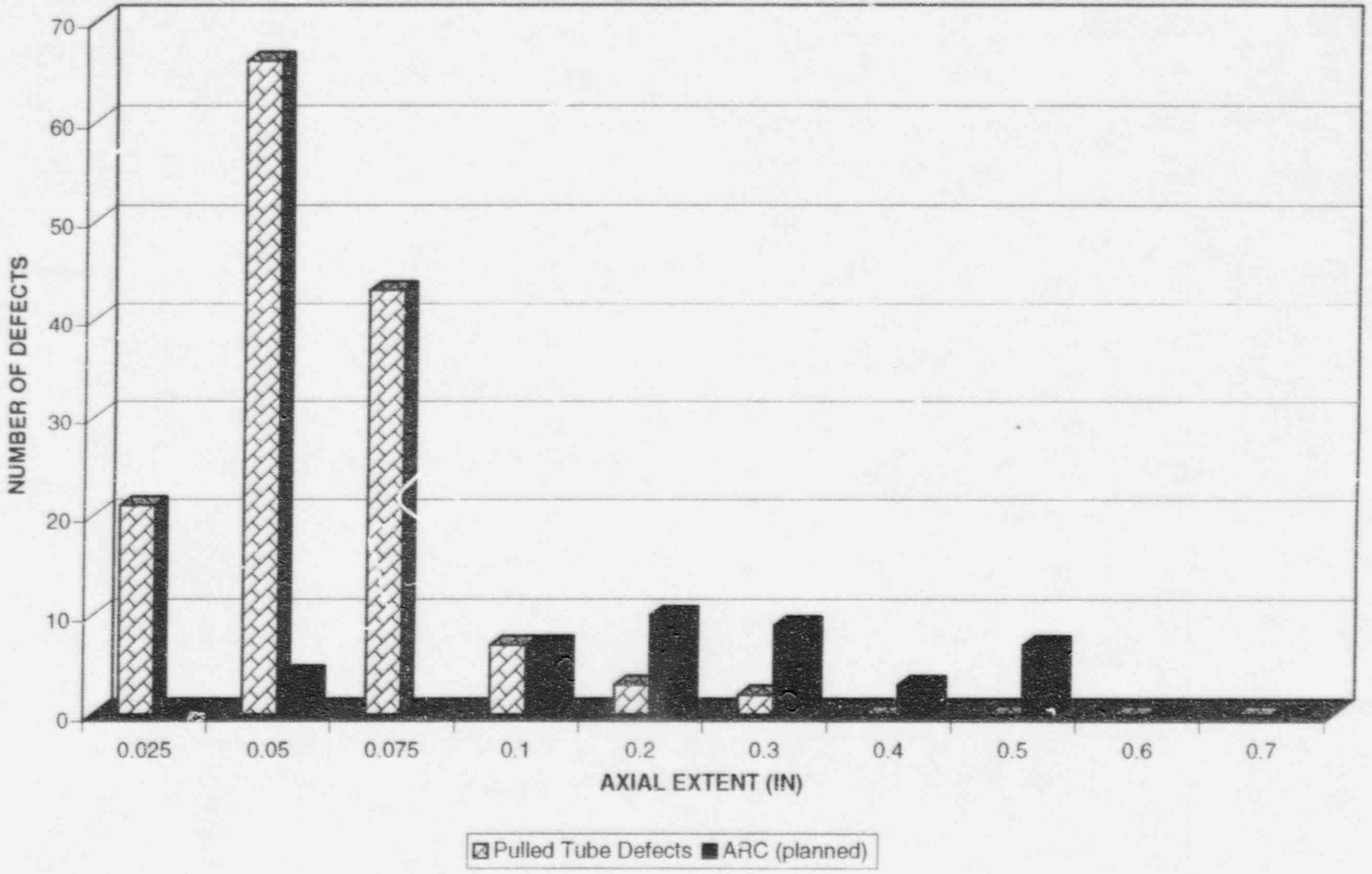
B. Michaut, F. Steltzlen, B. Sala, Ch. Laire, J. Stubbe, "Nickel Electroplating as a Remedy to Steam Generator Tubing PWSCC", Sixth International Symposium on Environmental Degradation of Materials in Nuclear Power Systems - Water Reactors, The Minerals, Metals, & Material Society, 1993.

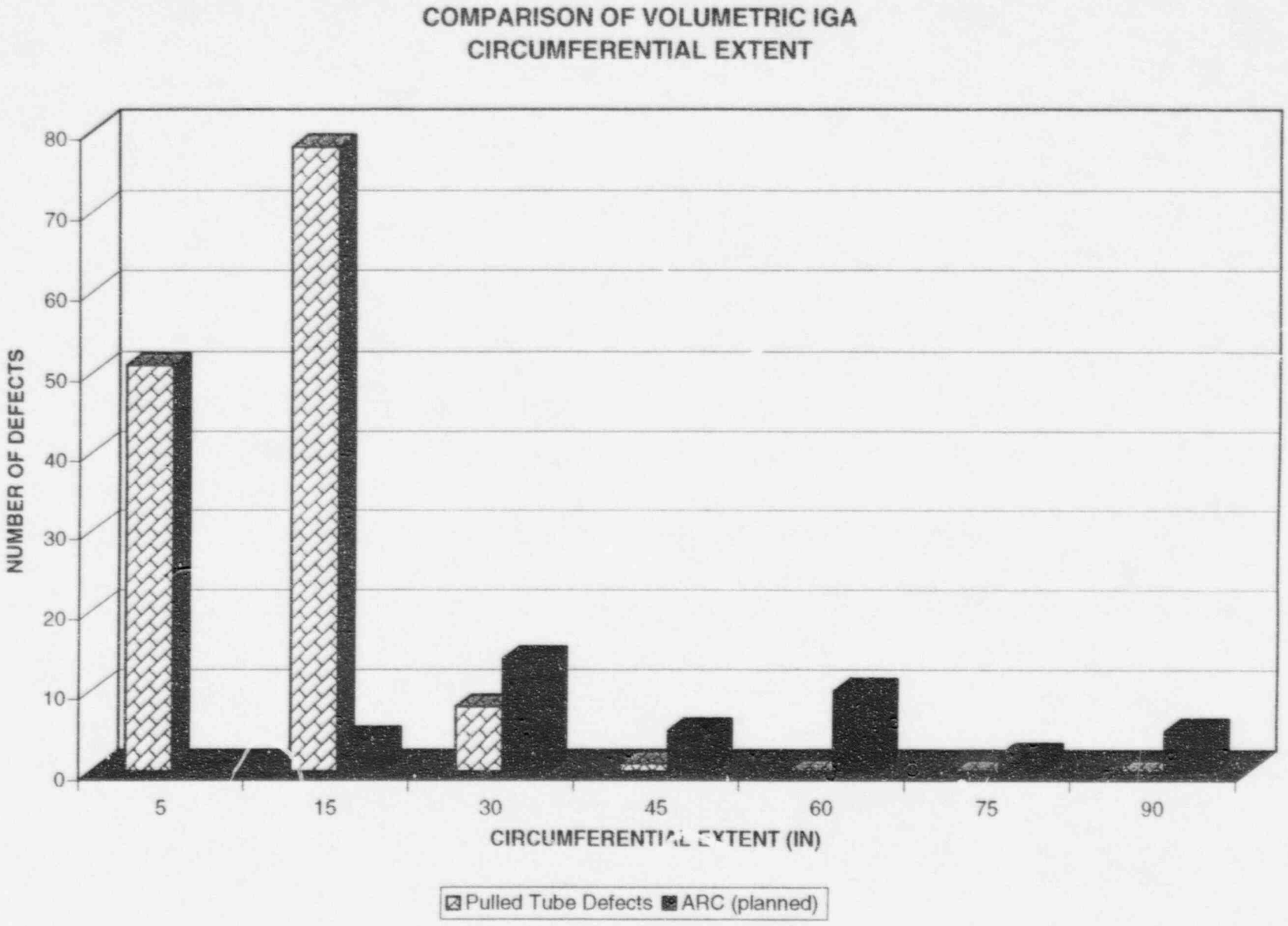
> This is Reference 12.39 in the topical and was available for review in Lynchburg on May 14, 1997. This "Remedy" was used over through wall cracks and UT inspection and destructive examination of pulled tubes after 9 months and 2 years operation verified satisfactory performance. Continued UT examination also verified good service. The UT was documented in an internal FTI document (Attached) which was also reviewed by NRC on May 14, 1997.

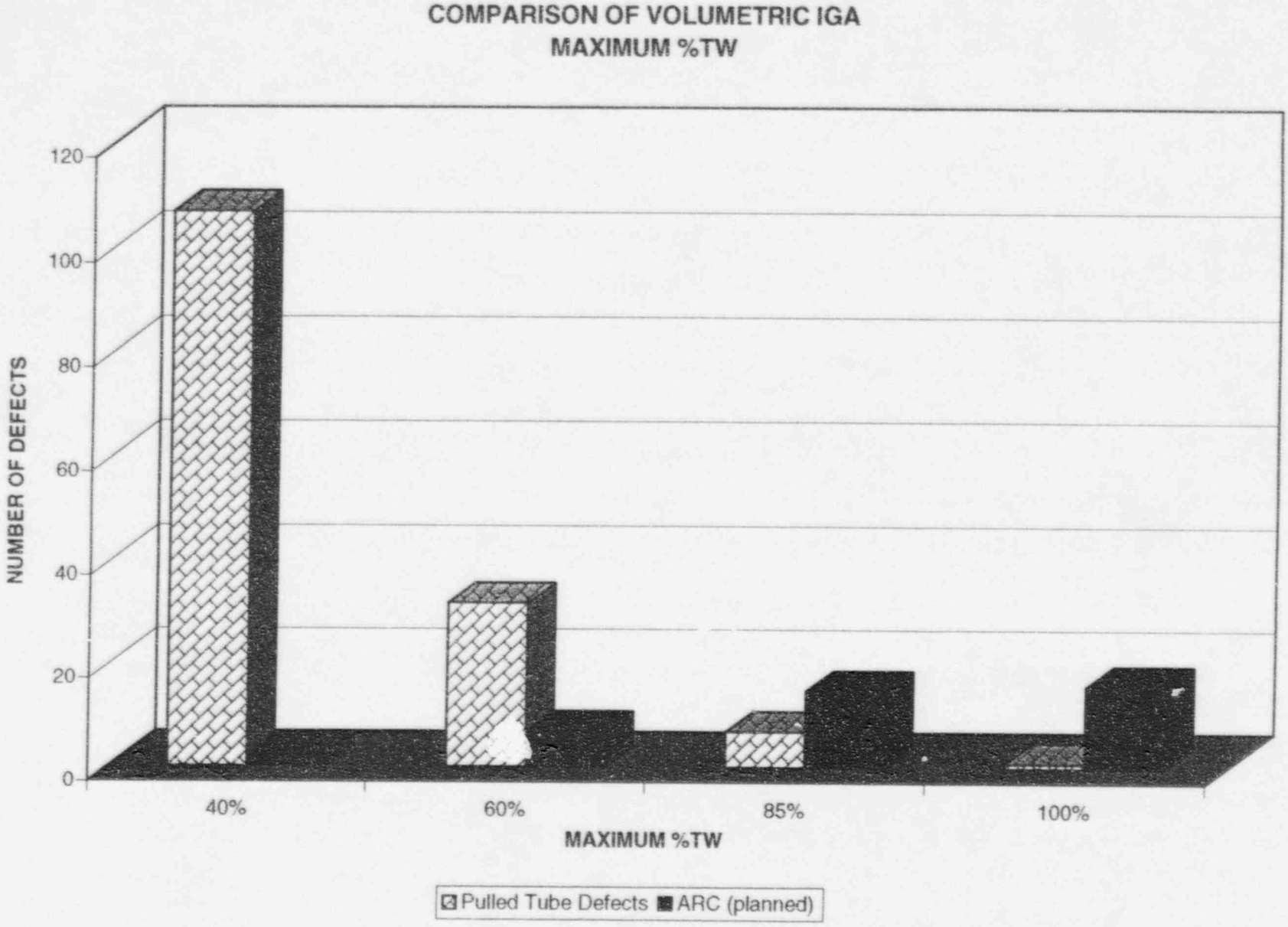
INITIAL PRODUCTION VOLUMETRIC IGA SPECIMENS

IGA Dimensions		Circumferential length, inches							
axial length, inches	%tw	0.05	0.10	0.15	0.20	0.25	0.30	0.40	0.50
0.05	<40	2							
	40-60	2							
0.10	40-60		2				1		
	60-85		2			2			
	85-100								
0.15	40-60								
	60-85			2					
	85-100			2			1		
0.20	40-60								
	60-85								1
	85-100		2		2				
0.25	40-60								
	60-85		2			2			
	85-100					2			2
0.30	40-60								
	60-85								
	85-100			1					
0.40	40-60								
	60-85		1					2	
	85-100								
0.50	40-60					2			
	60-85				1				
	85-100				2				2

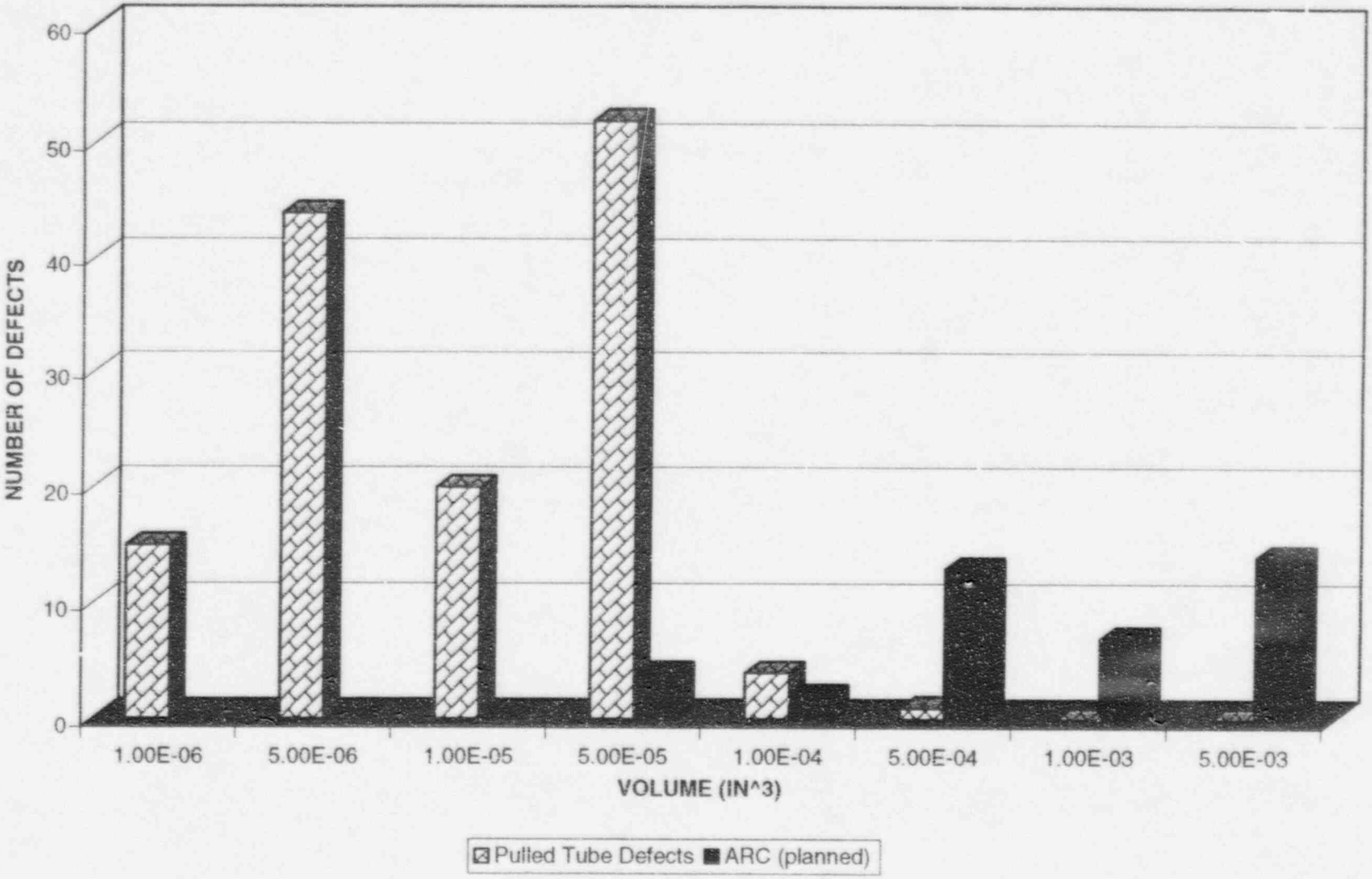
COMPARISON OF VOLUMETRIC IGA
AXIAL EXTENT




COMPARISON OF VOLUMETRIC IGA
CIRCUMFERENTIAL EXTENT
NUMBER OF DEFECTS
80
70
60
50
40
30
20
10
0
5
15
30
45
60
75
90
CIRCUMFERENTIAL EXTENT (IN)
Pulled Tube Defects
ARC (planned)


COMPARISON OF VOLUMETRIC IGA
MAXIMUM %TW
NUMBER OF DEFECTS
120
100
80
60
40
20
0
40%
60%
85%
100%
MAXIMUM %TW
Pulled Tube Defects
ARC (planned)

COMPARISON OF VOLUMETRIC IGA
VOLUME = 3.14/6*(L*W*D)



LEAK TESTING

- Test Conditions
  - All Testing at Temperature
  - MSLB Transient is Limiting
  - Critical Parameters
    - » Pri-Sec Pressure
    - » Tensile Axial Load due to Tube-Shell delta-T
    - » Bending due to Cross-Flow
      - Applicable to Top and Bottom Spans Only

LEAK TESTING, CONT'D.

- Tubesheet Testing
  - Place Sample in Test Facility
  - Achieve Desired Temperature and Pressure
  - Apply Axial Load in Stages During Test
    - » Leak Test at Designated Hold Points
    - » Accounts for Variation in Axial Load Plant to Plant
  - Will Be Done Without a Simulated Tubesheet
    - » Applicable to Freespan Areas Away from Cross-Flow Regions

LEAK TESTING, CONT'D.

- Freespan Testing
  - Pre-bend Samples to Simulate Top Span Flow Load
    - » Bend Before Leak Test (Duration of Bending Load Very Short)
    - » Simulate Effect of Max Bending Load
  - Place Sample in Test Facility
  - Achieve Desired Temperature and Pressure
  - Apply Axial Load in Stages During Test
    - » Leak Test at Designated Hold Points
    - » Accounts for Variation in Axial Load Plant to Plant

LEAK TESTING, CONT'D.

- EDM Testing
  - Mechanical Simulation of IGA Patch
  - Use to Envelope Field Flaw Extent
  - Determine Threshold of Leakage
    - » Allow Use of Pulled Tube Flaws in Probability of Leak Database

OTHER TASKS IN PROGRESS

- Growth Rate Evaluation
  - Re-analysis of Previous Indications Confirmed Volumetric
  - Separate Evaluations for TSPs and Tubesheet Interface
- Probabilistic Model
- NDE Technique
  - Chose Mid-Range Bobbin for Detection & Correlation
  - Parameter to be Chosen After Leak and Burst Testing
- B&WOG Risk-Based Applications Working Group Calculating TCF to Address Severe Accident Issues.

LICENSING CONSIDERATIONS

- Lead Plant
  - ANO-1
- Submittal Schedule
  - Mechanism Morphology / Lab Samples 7/15/97
  - Tube Loads / Analysis 8/7/97
  - Correlations/Repair Limit (Tubesheet) 9/1/97
  - Correlations/Repair Limit (Total) 1/31/98