July 31, 1986

Docket No. 50-395

LICENSEE: South Carolina Electric & Gas Company

FACILITY: V. C. Summer Nuclear Station

SUBJECT: SUMMARY OF MEETING WITH SOUTH CAROLINA ELECTRIC & GAS COMPANY

GENERAL

On June 27, 1986, the NRC staff met with the South Carolina Electric and Gas Company (SCE&G) to discuss the P-Star analysis for steam generators at the V. C. Summer Nuclear Station. The meeting was held in Bethesda, Maryland. A list of those persons who attended the meeting is included as Enclosure 1.

DISCUSSION

Attached as Enclosure 2 is the meeting agenda and non-proprietary viewgraphs shown during the meeting. The main topic of discussion was the definition of an intact tube. The utility agreed to submitt information regarding inspection of repaired tubes and the NRC staff agreed to review in more depth the analysis regarding friction retaining a tube in the tubesheet.

/S/

Jon B. Hopkins, Project Manager
PWR Project Directorate #2
Division of PWR Licensing-A

Enclosures:
As stated

cc w/enclosures:
See next page

DISTRIBUTION:

Docket File	OGC
JHopkins	EJordan
NRC PDR	BGrimes
Local PDR	ACRS (10)
PWR#2 Reading	NRC Participants
JPartlow	
LRubenstein	

PAD#2	PAD#2	PAD#2
DMiller/rad	JHopkins	LRubenstein
07/29/86	07/29/86	07/31/86

ENCLOSURE 1

MEETING ATTENDEES

June 27, 1986

NRC
JHopkins
DSellers
ESullivan
CCheng
JMuscara
JRajan

WESTINGHOUSE
RKeating
MProviano
CHirst
GWhiteman
JEsposito

SCE&G
PTroy
TEstes
DMalkmus
APaglia

DUKE POWER COMPANY
DMayes
JDay

ENCLOSURE 2

NRC MEETING

TUBE REPAIR AND P-STAR CRITERIA

BETHESDA, MARYLAND

JUNE 27, 1986

ITEM		PRESENTATION
1.	INTRODUCTION	SCE&G
2.	P* BASIS REVIEW	WESTINGHOUSE
3.	INTACT TUBE	SCE&G/WESTINGHOUSE
	a. Define Structural Limit b. Defects Below P* c. Post Plugging Tube Degradation d. Inspection Requirements e. Definition	
4.	INSPECTION OF REPAIRED TUBES	SCE&G
5.	SUMMARY	SCE&G

TUBE PLUGGING CRITERION

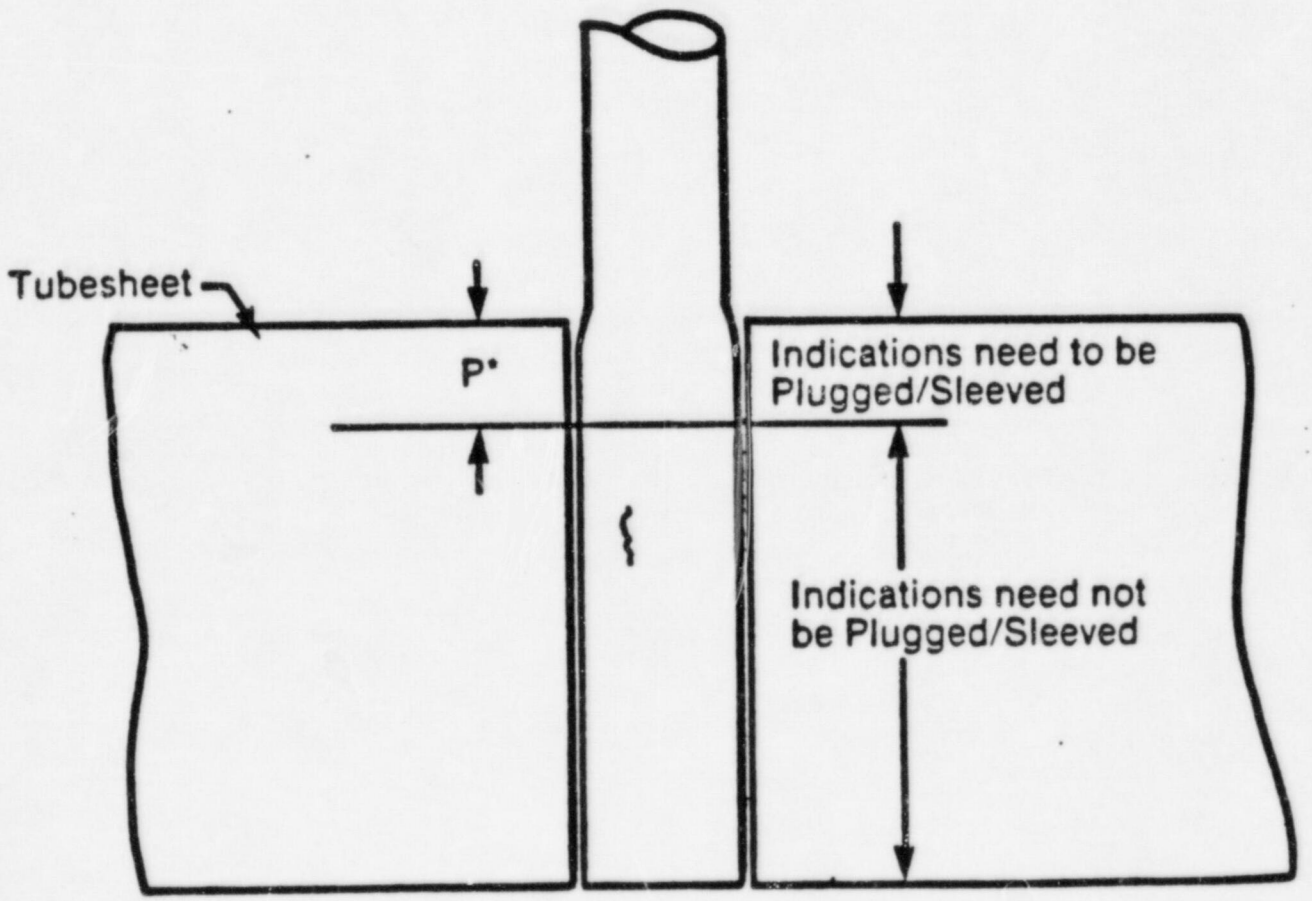
IN THE TUBESHEET REGION

-- TECHNICAL SPECIFICATION PLUGGING LIMIT APPLIES THROUGH THE TUBE LENGTH

-- ACCOUNT FOR THE CONSTRAINING EFFECT OF THE TUBESHEET

-- DEFINE A REGION WITHIN THE TUBESHEET IN WHICH NO PLUGGING REQUIREMENTS NEED APPLY

Tubesheet Plugging Criteria



PULLOUT CRITERION (P*) DEVELOPMENT

BRIEF OVERVIEW

-- ASPECTS

- O TUBE BURST WILL NOT OCCUR WITHIN THE TUBESHEET
- O TUBE COLLAPSE WILL NOT OCCUR WITHIN THE TUBESHEET
- O TECHNICAL SPECIFICATION LEAKAGE LIMITS APPLY

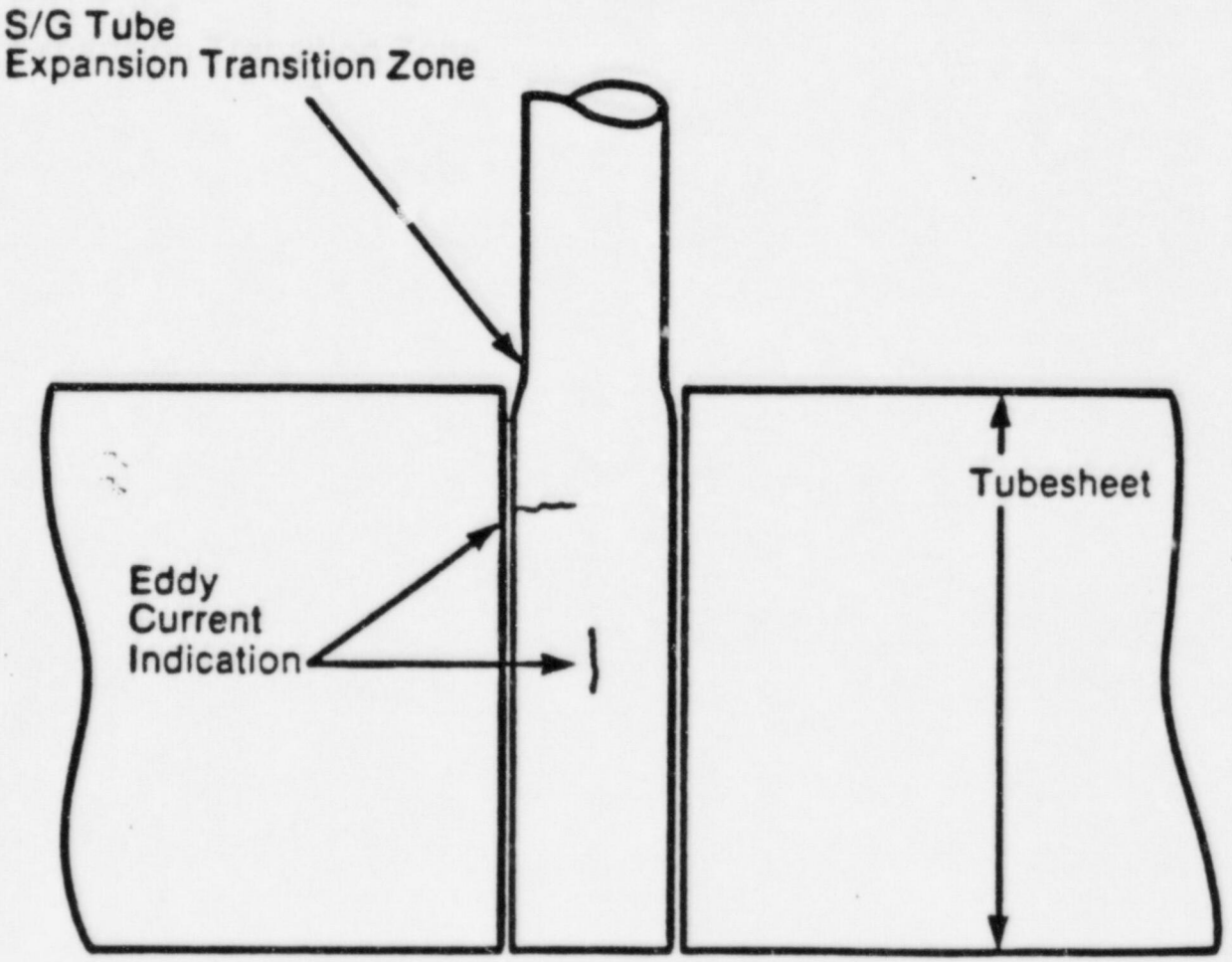
-- CONSIDERATIONS

- O A FIXED OR CAPTURED TUBE END IS MAINTAINED
- O PRIMARY-TO-SECONDARY LEAKAGE IS LIMITED
- O TUBE INTEGRITY IS MAINTAINED UNDER LIMITING CONDITIONS
- O TUBE INTEGRITY ABOVE P* IS DEMONSTRATED (BY CONTINUED ECT)
- O ECT AXIAL UNCERTAINTY

-- RESULTS

- O TUBE PULLOUT IS PRECLUDED
- O TUBES WITH INDICATIONS BELOW P* REMAIN IN SERVICE
- O P* CRITERION DOES NOT APPLY TO PERIPHERAL TUBES AND SOME INTERIOR TUBES

Potential Location of IDSCC



TREATMENT OF TUBESHEET TUBE INDICATIONS

PREMISE

THE BASIC PREMISE TO BE APPLIED IS THAT IF A SEVERED TUBE END IS CONSTRAINED SUCH THAT IT CANNOT BECOME CLEAR OF THE TUBESHEET THE INTEGRITY OF THE BUNDLE IS CONSERVED, AND IF LEAKAGE IS LIMITED THE SAFETY CONSEQUENCES OF LEAKAGE HAVE BEEN APPROPRIATELY ADDRESSED.

APPLICATION OF RG 1.121

IDENTIFICATION OF A DISTANCE, DESIGNATED P^*, BELOW THE TOP OF THE TUBESHEET FOR WHICH TUBE DEGRADATION OF ANY EXTENT WILL NOT RESULT IN A SEVERED TUBE END FROM BECOMING CLEAR OF THE TUBESHEET DURING NORMAL OR POSTULATED ACCIDENT CONDITIONS.

CONSIDERATIONS

1. DEVELOPMENT OF THE ENGAGEMENT DISTANCE REQUIRED TO MAINTAIN A FIXED TUBE END CONDITION IN THE TUBESHEET WITH A POSTULATED CIRCUMFERENTIAL INDICATION.

2. LIMITATION OF PRIMARY-TO-SECONDARY LEAKAGE CONSISTENT WITH ACCIDENT ANALYSIS ASSUMPTIONS.

3. MAINTENANCE OF TUBE INTEGRITY UNDER POSTULATED LIMITING CONDITIONS OF PRIMARY TO SECONDARY AND SECONDARY TO PRIMARY DIFFERENTIAL PRESSURE.

TUBESHEET EFFECTS RELATIVE TO THE PERFORMANCE OF DEGRADED TUBES

- BURST STRENGTH OF FULL DEPTH EXPANDED TUBES

THE BURST STRENGTH OF THAT PORTION OF A TUBE LOCATED WITHIN THE TUBESHEET IS REINFORCED TO THE EXTENT THAT THE PRESENCE OF THE TUBE MATERIAL IS NOT NECESSARY, I.E., TUBE BURST IS OBVIATED BECAUSE DEFORMATION BEYOND THE EXPANDED OUTER DIAMETER IS ESSENTIALLY PRECLUDED.

- COLLAPSE STRENGTH OF FULL DEPTH EXPANDED TUBES

THE COLLAPSE STRENGTH OF THAT PORTION OF THE TUBE LOCATED WITHIN THE TUBESHEET IS SIGNIFICANTLY INCREASED. COLLAPSE MODES WHICH ARE ACCOMPANIED BY LOCAL DEFORMATION BEYOND THE OUTER DIAMETER (GEOMETRICAL REACTION) ARE SIGNIFICANTLY RENGTHENED.

- LEAKAGE OF FULL DEPTH EXPANDED TUBES

NO ACTUAL LEAKPATH IS EXPECTED DUE THE HARDROLLING OF THE TUBES INTO THE TUBESHEET. LEAK RATE EFFECTS HAVE BEEN ASSESSED BY ASSUMING A LEAK PATH TO EXIST AND DETERMINING THE RELATIVE LEAKAGE WHICH WOULD OCCUR DURING POSTULATED ACCIDENT CONDITIONS.

DEVELOPMENT OF THE P* CRITERION

DEVELOPMENT OF THE P* CRITERION IS BASED ON ASSUMING THAT A TUBE HAS BEEN DEGRADED TO THE POINT OF SEVERENCE WITHIN THE TUBESHEET. THE SEVERED TUBE IS POSTULATED TO MOVE UPWARD TO A POSITION WHERE THE EXTRADOS SURFACE OF THE U-BEND APEX IS IN CONTACT WITH THE TUBE DIRECTLY ABOVE IT. UNDER OPERATING OR ACCIDENT CONDITIONS ADDITIONAL DISPLACEMENT MAY OCCUR. THE TOTAL AMOUNT OF UPWARD MOVEMENT HAS BEEN ADDRESSED BY THE FOLLOWING CONSIDERATIONS.

- MANUFACTURING CONSIDERATIONS

  A STUDY OF THE FABRICATION AND ASSEMBLY PROCESS WAS CONDUCTED WHICH INCLUDED CONSIDERATION OF NOMINAL GAP DIMENSIONS AND MANUFACTURING STEPS WHICH COULD RESULT IN VARIATIONS TO THE NOMINAL DIMENSIONS. A MAXIMUM AS-BUILT GAP VALUE WAS IDENTIFIED.

- THERMAL EXPANSION CONSIDERATIONS

  VERTICAL DISPLACEMENT OF A SEPARATED TUBE U-BEND WAS CONSIDERED TO BE THAT OF AN INTACT OUTBOARD NEIGHBOR TUBE U-BEND.

- PRESSURE ELONGATION CONSIDERATIONS

  AXIAL ELONGATION OF AN INTACT OUTBOARD NEIGHBOR TUBE U-BEND WAS CONSIDERED TO PERMIT ADDITIONAL UPWARD MOVEMENT OF A SEVERED TUBE U-BEND.

1. "OUTBOARD NEIGHBOR" STRUCTURAL LIMIT -

Minimum allowable wall to resist failure due loading of a postulated separated P* tube during a postulated SLB.

AXIALLY ORIENTED INDICATIONS -

Expected case if degradation occurs in the VC Summer steam generators.

Through-wall indications could exist and still resist failure.

CIRCUMFERENTIALLY ORIENTED INDICATIONS -

Case 1 - Outboard Neighbor Plugged -

	Minimum Wall thickness
Normal	0.0036 inch, 8.4 %
Upset	0.0045 inch, 10.1 %
Faulted	0.0035 inch, 8.1 %

Evenly thinned 360 degrees around circumference.

Envelopes cracklike degradation .

Case 2 - Outboard Neighbor Active -

	Minimum Wall Thickness
Normal	0.007 inch, 16.8 %
Upset	0.009 inch, 20.1 %
Faulted	0.007 inch, 16.3 %

Evenly thinned 360 degrees around circumference.

Includes SLB pressure differential loading.

Leak-Before-Break expected apply.

4. "INTACT" NEIGHBOR DEFINITION -

Indications Above P* - Plant Technical Specification.

Currently Plugged - Considered as Intact.

Greater than 92 % for 360 Degrees - NOT Considered Intact.

Post Inspection Tube Remaining in Service - Considered Intact.

PLUGGED TUBE CORROSION CONSIDERATIONS

- O PRIMARY SIDE
  - TEMPERATURE
  - STRESS
  - HYDROGEN PARTIAL PRESSURE
- O SECONDARY SIDE
  - CONTAMINANT CONCENTRATION
  - TEMPERATURE
  - STRESS
  - CONTAMINANT REMOVAL
- O FIELD EXPERIENCE
- O DETECTION

SUMMARY

- O PRIMARY SIDE CORROSION RATES ARE EXPECTED TO BE MINIMAL AFTER TUBE PLUGGING
  - DRY ENVIRONMENT IS LIKELY
  - TEMPERATURES ARE LOWER IN INACTIVE TUBE
  - LACK OF HYDROGEN, IF TUBE IS WET, WILL RESULT IN VERY LOW CORROSION RATE.

- O SECONDARY SIDE CORROSION MAY CONTINUE AFTER TUBE PLUGGING IN SOME CASES BUT THE CORROSION RATE WILL BE SIGNIFICANTLY REDUCED.
  - LOWER TEMPERATURE OF PLUGGED TUBE
  - LACK OF HEAT FLUX WILL PRECLUDE FURTHER CONCENTRATION OF CONTAMINANTS
  - REMOVAL OF RESIDUAL CONTAMINANTS TO THE BULK ENVIRONMENT WILL OCCUR AT A RATE DEPENDENT UPON LOCAL GEOMETRY AND HYDRAULIC CONDITIONS.

SUMMARY (cont)

- O CONTAMINANT REMOVAL AND CORROSION INHIBITION ACTIONS MAY RESULT IN CESSATION OF CORROSION.

  OPTIONS:

  - SLUDGE LANCING
  - CREVICE FLUSHING/BUNDLE FLUSH
  - CHEMICAL CLEANING
  - BORIC ACID APPLICATION
  - ELIMINATION OF CONTAMINANT INGRESS

- O OPERATIONALLY INDUCED STRESSES ARE SIGNIFICANTLY LOWER IN A PLUGGED VERSUS AN ACTIVE TUBE. HOOP STRESS IS REDUCED TO A GREATER EXTENT THAN AXIAL STRESSES.

- O SEPARATION OF INCONEL 600 TUBING IS NOT KNOWN TO OCCUR IN PLUGGED TUBES BASED ON FIELD AND LABORATORY KNOWLEDGE.

INTACT TUBE

AN INTACT TUBE IS ANY TUBE THAT DOES NOT CONTAIN DEFECTS WHICH WOULD RESULT IN ITS INABILITY TO RESIST THE LOAD IMPOSED BY A SEPARATED TUBE. THE STRUCTURAL LIMIT IS MET BY ANY TUBE WITH A 360^{o} CIRCUMFERENTIAL INDICATION WITH LESS THAN 92 PERCENT WALL PENETRATION OR BY AN AREA OF WALL REMAINING EQUAL TO OR GREATER THAN 135^{o} OF NOMINAL WALL THICKNESS (WHICH CORRESPONDS TO A REMAINING CROSSECTIONAL AREA OF 0.034 IN^2).

INTACT TUBE DETERMINATION