UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

March 10, 1992

Docket Nos: 50-424 and 50-425

LICENSEE: Georgia Power Company, et al.

FACILITY: Vogtle Electric Generating Plant, Units 1 and 2

SUBJECT: SUMMARY OF NOVEMBER 14, 1991, MEETING REGARDING SUBSTITUTION OF FORGED FITTINGS

Background

During a field walkdown associated with a snubber reduction program, Georgia Power Company (GPC) found that several ASME Code Class 1 tees for Vogtle Unit 2 were forged rather than extruded, and contained structural discontinuities. The use of such tees deviated from the piping stress analyses which were based on extruded tees. Pursuant to the requirements of 10 CFR 21 and 50.55(e), on December 15, 1988, GPC reported this condition to the NRC. In its report, GPC indicated that all ASME Class 1 forged tees were reconciled into the piping system stress analyses with acceptable results, and that one forged tee had been replaced with an extruded tee. GPC attributed the root cause of the problem to a deficiency in the quality assurance (QA) program of the piping vendor.

Summary

On November 14, 1991, the NRC staff met at the Vogtle facility with GPC representatives to discuss the 10 CFR 50.55(e) report and GPC's resolution of the discrepant condition. Enclosure 1 lists the attendees. Enclosures 2 and 3 are copies of GPC's slide presentation.

Discussion

GPC opened the meeting with a statement of the issue, and a review of technical aspects of the issue.

Mr. W. Ramsey of GPC discussed GPC's discovery and subsequent evaluation of the issue (Enclosure 2). He also reviewed the structure and responsibilities of various organizations which existed during the design and construction phase of Vogtle Unit 2 (see Figure 1).

GPC stated that it functioned as the material supplier under a letter of authorization from an N-Stamp holder, the Bechtel Power Corporation (Bechtel). Thus, GPC procured piping components from two piping vendors: Pullman Power Products (PPP) in Williamsport, Pennsylvania; and Consolidated Pipe and Supports (CPS) in Birmingham, Alabama. PPP supplied large bore piping and CPS supplied small bore piping. The piping vendors supplied the materials in accordance with their 10 CFR 50 Appendix B QA programs which had been audited and approved by GPC. The piping materials were inspected and certified by the vendor's Authorized Nuclear Inspector (ANI).

The Bechtel Specification for Shop Fabrication of Nuclear Service Piping (Specification No. X4AQ01), and the Piping Material Classifications (Drawing No. AX4DR001) specified the requirements for piping material and fabrication. GPC stated that it discovered in May 1987, during implementation of a snubber reduction program for Vogtle Unit 2, that forged fittings instead of extruded fittings had been installed. This occurred without GPC's concurrence as required by Note 4 in the specification AX4DR001. Subsequently, GPC determined that the same condition existed in Vogtle Unit 1. GPC organized a team from Bechtel Power Corporation and Westinghouse to assess the impact of the forged fittings on the existing Vogtle Units 1 and 2 piping analyses, and to establish a definitive scope for necessary corrective action. After discussions with the piping vendors, and a technical expert, Mr. E. Rodabaugh, the team concluded that:

a) the fittings complied with ANSI B 16.9 requirements, and therefore, the ASME Section III Code stress intensification factors (SIF) and stress indices would be applicable,

b) ASME Code Class 2 and 3 piping analyses would not be affected because they do not involve thermal analyses for structural discontinuity and the ASME Code SIF are applicable to forged fittings, and

c) ASME Code Class 1 piping fatigue analyses would require reevaluation to address thermal transient stresses due to structural discontinuity of the forged tees.

On the basis of the team's evaluation, GPC established the scope for corrective action to include only ASME Code Class 1 piping.

GPC performed a drawing review to identify all ASME Code Class 1 tees and later performed a walkdown to identify locations where forged fittings were installed. The walkdown identified a total of 44 forged tees in Unit 2 and 45 in Unit 1. GPC stated that all ASME Class 1 piping where forged fittings had been installed were reanalyzed by Westinghouse.

K. Chang of Westinghouse presented technical details for the analyses of forged fittings (Enclosure 3). He stated that Westinghouse's preliminary review of the fittings indicated that all ASME Code requirements would be met; however, additional break locations would have to be postulated. From its preliminary review, Westinghouse concluded that more refined analyses would be necessary to reduce additional break locations. Westinghouse stated that its refined analyses using representative finite element models showed that all the ASME Code requirements were met. Westinghouse also indicated that its results showed that few additional breaks would have to be postulated. GPC indicated that it performed hazard evaluations for these additional breaks and found that they did not require any plant hardware modifications.

Distribution:
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ACRS (10)
E. Mckenna
TChan
RPettis

After GPC's and Westinghouse's presentation, the NRC staff asked why the substitution of the forged fittings had not been discovered during any of three distinctive phases of construction of the plant, namely: 1) material receipt inspection, 2) development of the walkdown of as-built data for stress reconciliation, and 3) design reconciliation of the as-built data with the stress analyses. GPC indicated that the piping vendor's QA program and ANI certification programmatically ensured compliance with the specifications for piping fabrication and installation. Therefore, GPC's receipt inspection only confirmed that the fittings were certified by the ANI. GPC also stated that its walkdown procedures for development of as-built data did not include verification of the type of tees installed. Additionally, GPC indicated that the as-built walkdown was not performed by stress engineers but was performed by QA personnel who could not be expected to recognize that forged tees had been substituted for extruded tees. Consequently, the walkdown data did not identify the forged fittings, and the stress engineers performing the stress analysis reconciliation were not aware of the existence of forged fittings.

NRC requested GPC to provide the following additional documents:

1. Typical dimensions of extruded, and block and die forged tees,

2. Pullman Power Product Corporation letters dated May 29, 1987, and May 24, 1990,

3. Westinghouse letter V-SAMU-10660 dated January 26, 1989,

4. Westinghouse memorandum GTSD-VFDV-4528 dated October 3, 1986, including "As-Built Engineering Walkdown Guidelines, Phases 1 and 2,"

5. Vogtle finalization program attached to memo 2X7BD80-FP7 dated October 7, 1987,

6. Project Reference Manual, Section 17, "Final Design Verification for Safety-Related Piping Systems,"

7. Westinghouse design specification 955211, and

8. Westinghouse Analysis Packages for as-built reconciliation.

/s/

L. Raghavan, Project Manager
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Office of Nuclear Reactor Regulation

Enclosures and cc w/enclosures:
See next page

LPEB	EMEB	RVIB
EMcKenna	TChan	RPettis
3/3/92	3/24/92	3/2/92

LA:PDII-3	PM:PDII-3	PM:PDII-3	D:PDII-3
LBerry	LRaghavan	DHood	DMatthews
2/27/92	2/24/92	3/6/92	3/9/92

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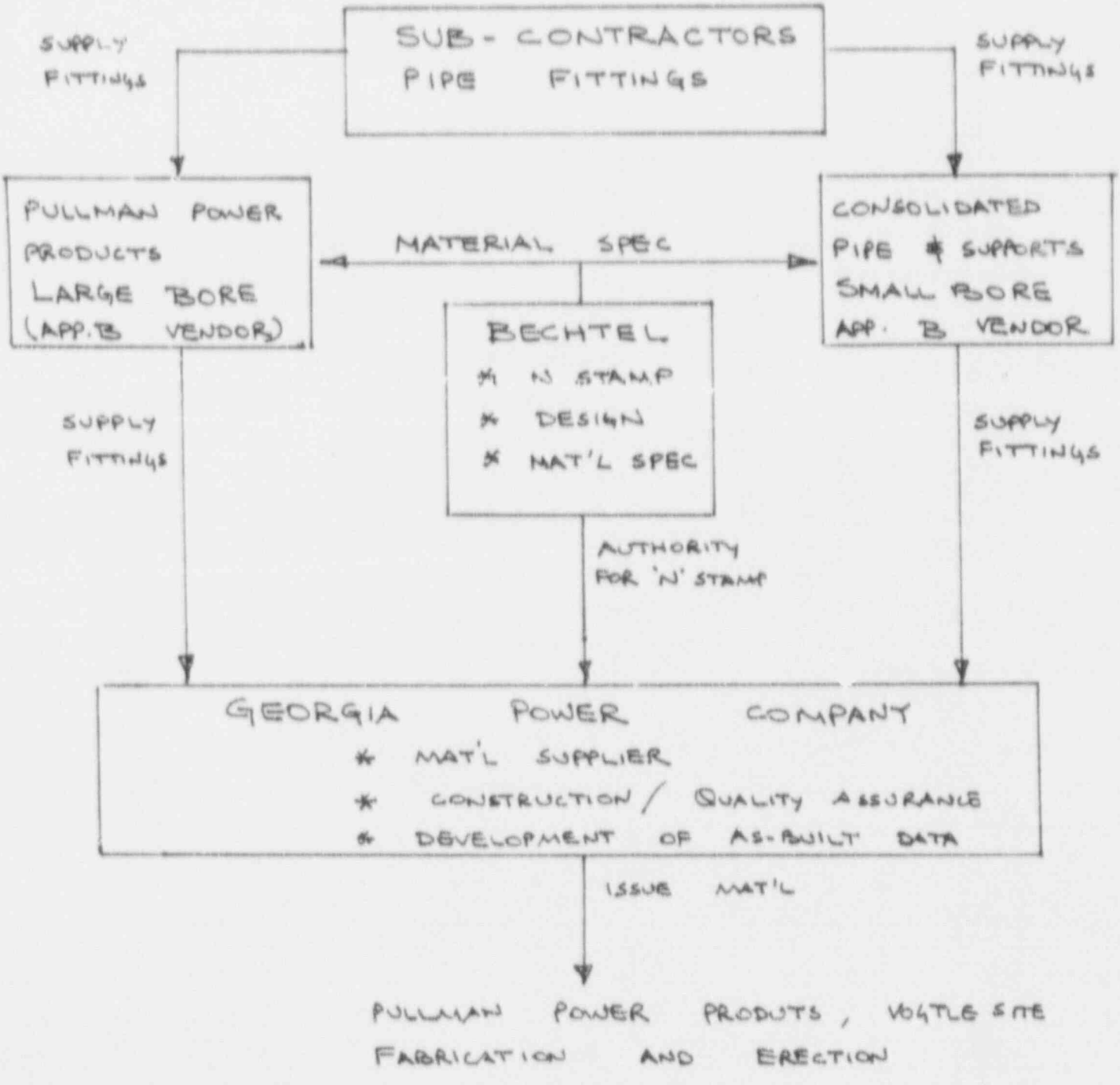
FIGURE 1


SUB - CONTRACTORS
PIPE FITTINGS
SUPPLY FITTINGS
SUPPLY FITTINGS
PULLMAN POWER PRODUCTS
LARGE BORE
(APP. B VENDORS)
MATERIAL SPEC
CONSOLIDATED PIPE & SUPPORTS
SMALL BORE
APP. B VENDOR
BECHTEL
* N STAMP
* DESIGN
* MAT'L SPEC
SUPPLY FITTINGS
SUPPLY FITTINGS
AUTHORITY FOR 'N' STAMP
GEORGIA POWER COMPANY
* MAT'L SUPPLIER
* CONSTRUCTION / QUALITY ASSURANCE
* DEVELOPMENT OF AS-BUILT DATA
ISSUE MAT'L
PULLMAN POWER PRODUTS, VOGTLE SITE
FABRICATION AND ERECTION

ENCLOSURE 1

MEETING BETWEEN GEORGIA POWER COMPANY, et al.
AND NRC STAFF - VOGTLE ELECTRIC GENERATING PLANT

ATTENDANCE LIST

Name	AFFILIATION
L. Raghavan	NRC/NRR
E. M. McKenna	NRC/NRR
J. A. Bailey	SONOPCO
P. A. Balmain	NRC
P. D. Grissom	SCS
K. C. Chang	Westinghouse
T. L. Chan	NRC/NRR
R. Pettis	NRC/NRR
W. C. Ramsey	SCS/Vogtle Project Engr.
M. McBrearty	NRC/NRR
S. J. Vias	NRC/RII

Statement of Issue

- Organization and Responsibilities
- Discovery of Issue
- Scope Identification
- Evaluation Process
- Final Results

024108

Organization and Responsibilities

- Owner: Georgia Power Company
- Architect/Engineer:
  Bechtel Power Corporation
  Norfolk, California
- Stress Analysis:
  - Class 1 Westinghouse
  - Class 2 Westinghouse/Bechtel
- Construction: Georgia Power Co.
- Piping Vendors:
  - Large Bore - Pullman Power
    Williamsport, PA
  - Small Bore - Consolidated Pipe
    Birmingham, AL
- Class 1 Fitting Suppliers (Tees):
  - Custom Alloy
  - Ladish
  - Flowline
  - Taylor Forge
  - Babcock & Wilcox
  - Tubeline

Discovery of Issue

- Walkdown - Snubber Reduction

- Initial Findings

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Scope Identification

- Potential Scope
- Establish Definitive Scope
  - PPP - Williamsport Shop Insp.
  - Code Experts
- Root Cause Analysis
- Finalize Scope

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Evaluation Process

- Walkdown
- Code Analysis
- Stress Analysis
- Hazards Evaluation
- Reportability

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Final Results

- Physical Modifications to Plant
  - Replaced one tee on Unit 2
  - No other modifications required

- Forged Tees are in stress calcs for any future evaluations

- All new breaks on Unit 1 were in RTD piping which has since been removed

- Unit 2 calculations factored Forged Tees into original results

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ENCLOSURE 3

Technical Presentation

Stress and Fatigue Analysis on Non-Standard Fabricated Tees for Vogtle Units 1 & 2

K. C. Chang

November 14, 1991

Westinghouse Electric Corporation
Nuclear and Advanced Technology Division
P. O. Box 2728
Pittsburgh, PA 15230-2728

STRESS AND FATIGUE ANALYSES ON NON-STANDARD FABRICATED TEES

- Scope
  - Large Bore Lines
  - Small Bore Lines
  - Class 1/Class 2 & 3 Lines
  - Unit #1/Unit #2
- Preliminary Evaluation
  - Large Bore Lines
  - Small Bore Lines
- Final Qualification
  - Large Bore Lines
  - Small Bore Lines

SCOPE

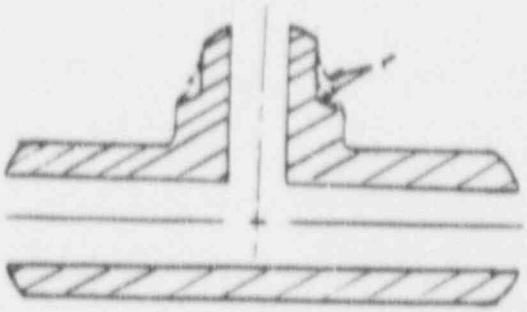
LARGE BORE LINES

- Block Forged
- 12" x 12" x 6" Tee - Loop 1 RHR
- 12" x 12" x 12" Tee - Loop 4 RHR
- 10" x 10" x 6" Tee - Accumulator Injection - All Loops

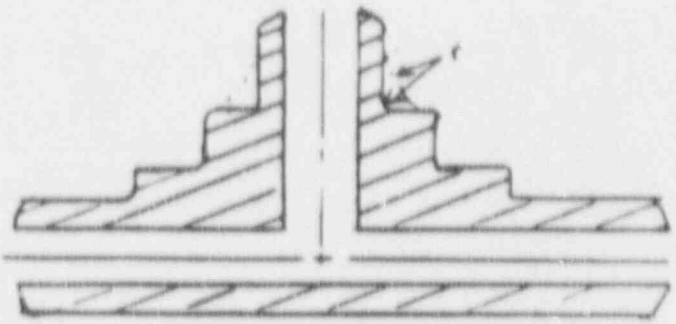
SCOPE

SMALL BORE LINES

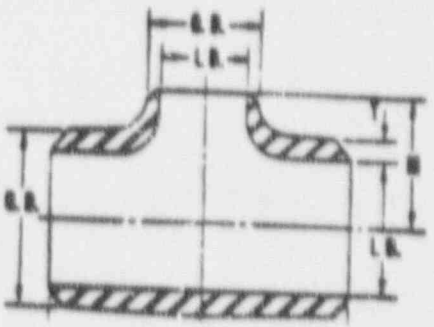
- Closed - Die Forged
- 3" x 3" x 2" Tee - RTD, All Loops
- 2" x 2" x 1" - RTD Cold Leg, All Loops
- 2" x 2" x 1" - RTD Hot Leg, All Loops
- 2" x 2" x 1" - Drain Loop 4
- 1.5" x 1.5" x 1" - BIT Loop 1
- 1.5" x 1.5" x 1" - BIT Loop 4
- 1.5" x 1.5" x 1" - SWI Loop 3



Closed-Die Forged



Modified
Closed-Die Forged



Typical Geometry

(Extruded)

Geometrical Comparison

SCOPE

CLASS 1 / CLASS 2 & 3 LINES

- Impact on Class 1 Lines
  - Dimensions Measured
  - Wall Thickness Variations
  - Finite Element Analysis
  - Fatigue Evaluation
  - Postulated Break Locations
- No Impact on Class 2 & 3 Lines
  - Dimensions Measured
  - ANSI B16.9 -1978 Requirements
  - Applicability of Stress Indices
  - E. C. Rodabaugh's Concurrence

SCOPE

UNIT #1 / UNITS #2

- Common to Units 1 and 2
  - Measurements
  - Thermal Transients
  - Material Properties
  - Transient Analysis
- Unit Specific - External Moment Loadings
- Documentation
  - Unit 1
    - ASME Section III Code Requirements were met
    - Additional Break Locations
    - Stress Report Revision
  - Unit 2
    - As-Built Stress Report Addresses Non-Standard Tees

PRELIMINARY EVALUATION

LARGE BORE LINES

- Conditions
  - Dimensions were available
  - A reference model available
  - Geometry meets ANSI B16.9 requirements
  - C_{2B} and C_{2r} from the ASME Code (with concurrence of Mr. E. Rodabaugh)
  - Doubled the stresses caused by structural discontinuity
  - Same K factor as standard tee (Radii at Conners)
- Results
  - All ASME Code requirements were met
  - Potential new break locations
  - Refined analysis to reduce break locations

PRELIMINARY EVALUATION

SMALL BORE LINES

- Conditions
  - Dimensions meet ANSI B16.9 requirements
  - ASME Section III stress indices are applicable
  - All tees are of closed-die forging or extruded
  - No special analysis was needed for straight tees
  - All 3-inch and smaller reducing tees were identified
  - Enveloping locations (geometry, transients, and moments)
    a. 3" x 3" x 2" - RTD
    b. 2" x 2" x 1" - RTD off crossover legs
    c. 2" x 2" x 1" - RTD off hot legs

PRELIMINARY EVALUATION
SMALL BORE LINES
(Continued)

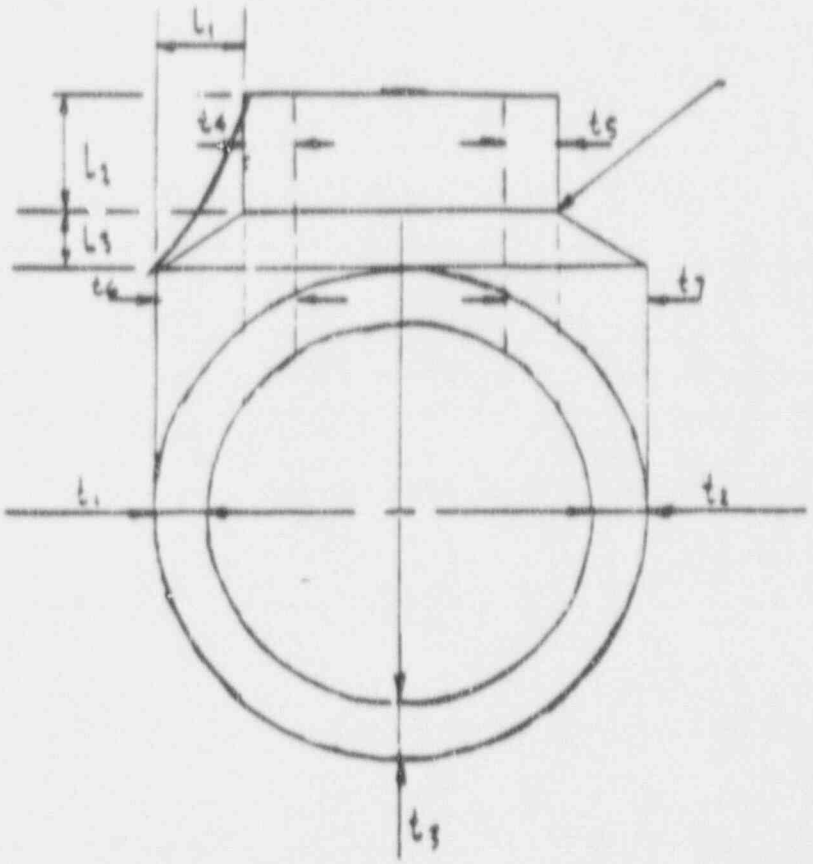
- Results
  - Primary stresses in stress report applicable
  - Equation 12 stresses in stress report applicable
  - Equation 13 stresses
    - Less than 3.0 S_m: all loops
    - Greater than 2.4 S_m: some loops
  - Cumulative usage factor
    - Less than 1.0: all loops
    - Greater than 0.1: some loops
  - Additional break locations
- Recommendation
  - 2-D finite element analysis
  - Verify assumptions

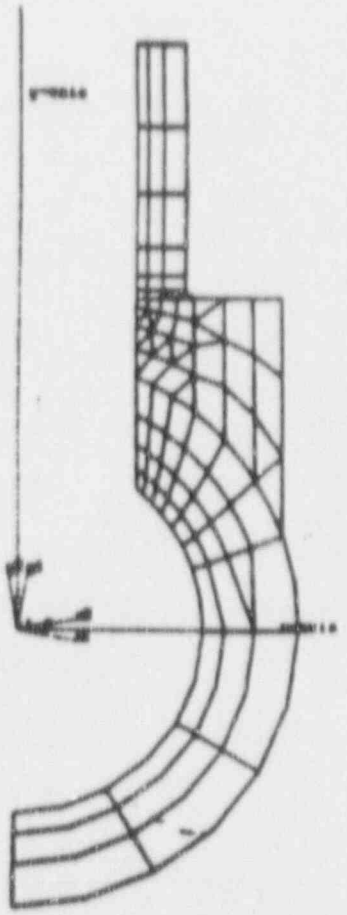
FINAL QUALIFICATION

LARGE BORE LINES

- One Finite Element Model for all 3 Tees
- Adjustment Factor developed based on 1-D Heat Transfer Analyses
- Results

Line/Component	ΣU	(EQ 13 (ksi)	$3 S_m$ (ksi)
12" x 12" x 6" RHR LP1	0.07	34.0	58.95
12" x 12" x 12" RHR LP4	0.08	24.0	58.95
10" x 10" x 6" Accumulator LP1	0.097	39.1	58.95
10" x 10" x 6" Accumulator LP2	0.097	37.6	58.95
10" x 10" x 6" Accumulator LP3	0.20	58.3	58.95
10" x 10" x 6" Accumulator LP4	0.097	34.5	58.95





Dimensions - Vogtle

$t_1 = t_2 = 0.57"$

$t_4 = T_5 = 0.343"$

$t_6 = T_7 = 1.04"$

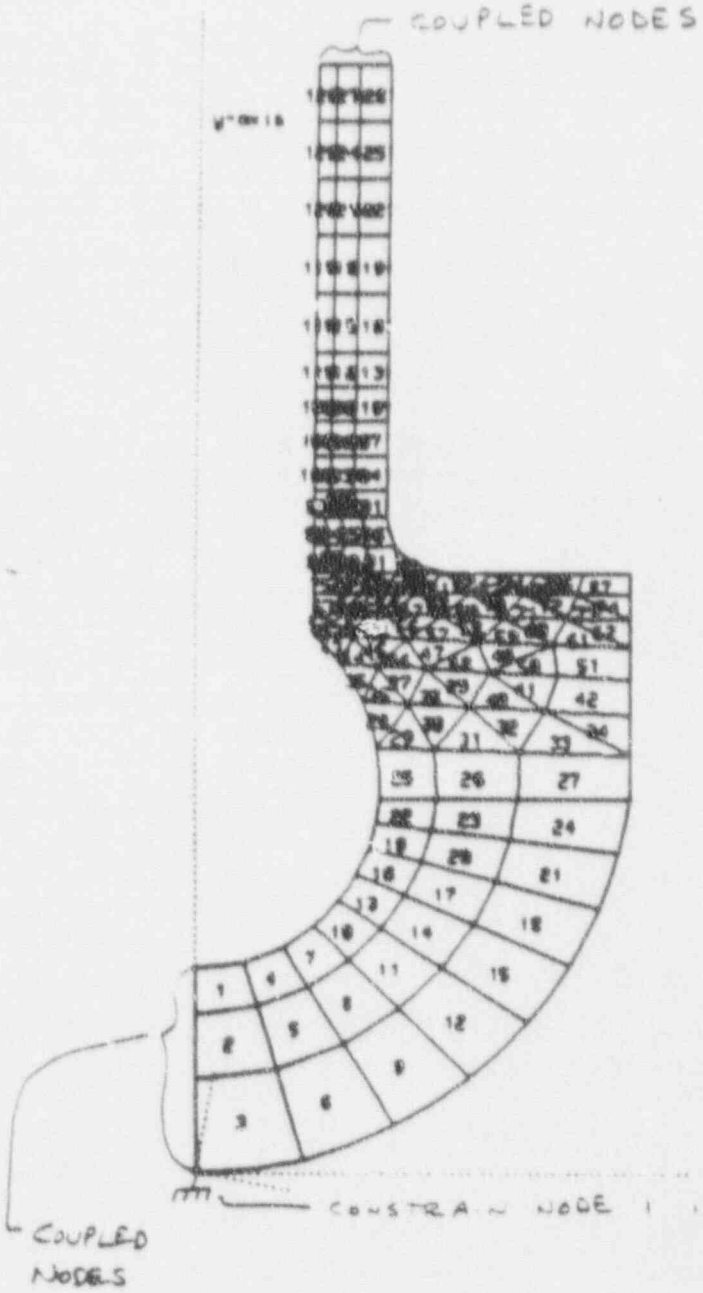
Dimensions - Reference Module

$t_1 = t_2 = 0.688$

$t_4 = t_5 = 0.343"$

$t_6 = t_7 - 1.04"$

Dimensional Comparison



BOUNDARY CONDITIONS FOR

STRESS ANALYSIS

FINAL QUALIFICATION

SMALL BORE LINES

- Reference Model for 3" x 3" x 2" tee
- New finite element model for 2" x 2" x 1" tee
- Several stress cuts evaluated
- RTD Tees

3" x 3" x 2"	ΣU	EQ 13 (ksi)	3 S_m (ksi)
LP1	0.5	28.0	41.0
LP2	0.5	27.0	41.0
LP3	0.5	29.0	41.0
LP4	0.5	28.0	41.0
2" x 2" x 1" (cold leg)			
LP1	0.95	42.5	43.0
LP2	0.95	42.5	43.0
LP3	0.95	42.5	43.0
LP4	0.95	37.3	43.0
2" x 2" x 1" (hot leg)			
LP1	0.2	38.4	41.0
LP2	0.08	32.8	41.0
LP3	0.08	32.1	41.0
LP4	0.2	30.7	41.0

FINAL QUALIFICATION

SMALL BORE LINES

Line/Component	ΣU	(EQ 13 (ksi)	3 S_m (ksi)
Drain LP4	0.35	41.8	43.0
BIT LP1	0.01	24.5	43.0
BIT LP4	0.01	28.5	43.0
SWI LP3	0.006	27.4	43.0
Straight Tees	No Revisions		