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

APR 27 1982

MEMORANDUM FOR: Thomas A. Ippolito, Chief
Operating Reactors Assessment Branch
Division of Licensing

FROM: Keith R. Wichman, Section Leader
Engineering Section
Operating Reactors Assessment Branch
Division of Licensing

SUBJECT: MEETING WITH B&W OWNERS GROUP ON STEAM GENERATORS

Attached is a summary of the subject meeting that was held on March 23, 1982 in Bethesda. The B&W Owners Group presented their views with respect to steam generator tube degradation and steam generator tube rupture accident management. A list of attendees and a copy of the slides shown are in the Enclosure to the summary.

Keith R. Wichman, Section Leader
Engineering Section
Operating Reactors Assessment Branch
Division of Licensing

Enclosure:
As Stated

8205210382

14.

APR 27 1982

MEETING SUMMARY DISTRIBUTION

NRC/PDR
Local PDR
H. Denton
E. Case
D. Eisenhut
R. Purple
B. Youngblood
A. Schwencer
F. Miraglia
J. Miller
G. Lainas
R. Vollmer
J.P. Knight
R. Bosnak
R. Schauer
R.E. Jackson
IE (3)
ACRS (16)
R. Tedesco
N. Hughes
V. Wilson
J. Reisland
R. Jacobs

NRC Participants:

T. Ippolito
D. Eisenhut
C. McCracken
W.J. Collins
A. Taboada
G. Lainas
W. Johnston
S. Bryon
R. Jacobs
T. Su
K. Wichman
W. Hazelton
C. Cheng

Other Attendees:

L. Conner

G. Lear
W. Hazelton
V. Benaroya
Z. Rosztoczy
W. Haass
D. Muller
R. Ballard
W. Regan
R. Mattson
P. Check
O. Parr
F. Rosa
W. Butler
W. Kreger
R. Houston
W. Gammill
L. Rubenstein
T. Speis
W. Johnston
S. Hanauer
T. Murley
F. Schroeder
D. Skovholt
M. Ernst
K. Kniel
G. Knighton
A. Thadani
D. Tondi
J. Kramer
D. Vassallo
P. Collins
D. Ziemann
F. Congel
J. Stolz
M. Srinivasan
W. Minners
C. Berlinger
E. Adensam

B&W Owners Group:

J. Taylor
C. Creacy
J. Olszewski
M. Bell
J. Kelly
G. Glei
R. Eaker
B. Lawson
J. Norris

SUMMARY OF MARCH 23, 1982 MEETING WITH BABCOCK & WILCOX

OWNERS GROUP REGARDING STEAM GENERATORS

On Tuesday, March 23, 1982, representatives of the Babcock & Wilcox (B&W) Owners Group met with members of the NRC staff to present their views with respect to steam generator tube degradation and steam generator tube rupture (SGTR) accident management. A copy of the slides used by the B&W Owners Group during the presentation and the attendance list are enclosed.

The B&W Owners Group was formed in 1978 with the following objectives: (1) maximize steam generator reliability/availability, (2) prolong steam generator life and (3) avoid power reduction and steam generator replacement. The organization and programs of the B&W Owners Group were described and it was emphasized that B&W is representing the Owners Group at this meeting. The once through steam generator (OTSG) configuration was presented; the OTSG has fifteen support plates and tubes that are fifty-six feet long. Four tube regions were defined for purposes of further discussion: (1) the periphery is the outer twenty tubes outside the tie rods, (2) the interior region is inside the tie rods, (3) the lane region consists of three rows of tubes on either side of the untubed inspection lane, and (4) the kidney shaped region is the centrally located, irregular shaped area excluding the lane region.

The B&W Owners Group described five continuing areas of concern regarding steam generator tube degradation. These were: (1) the lane region where corrosively initiated, fatigue propogated circumferential cracks at the fifteenth support plate and upper tubesheet occur, (2) outside diameter damage which is erosion mainly at the fourteenth tube support plate, (3) fretting wear that occurs at the tube/tube support plate in the lane region and at fifteenth tube support plate, (4) tube diameter distortions that are eddy current testing (ECT) "ding" indications primarily at the ninth, tenth and fifteenth tube support plates and (5) lower tubesheet indications which are ECT indications at the top of the lower tubesheet. A tabular summary related to the five areas of concern was presented:

	leaks	tubes pulled	tubes removed from service
1. lane regions	21	7	21
2. O.D. damage	4	3	~228
3. fretting wear	0	1	0
4. tube diameter distortions	0	0	0
5. lower T.S. indications	0	1	0
6. other causes	4	0	0
	29	12	249

The total number of tubes in nine domestic operating plants' OTSG's is 275,000.

The B&W Owners Group defined a new area of concern as "ΔP," which is an increase in pressure drop associated with deposits (magnetite) at the fifth and sixth tube support plates. Because of this problem, the potential for power reduction exists, possibly in the forseeable future for one plant. Chemical cleaning, in the final stages of development and testing, is one solution to the "ΔP" concern.

Feedwater specifications covering OTSG normal power operation, startup and hot functional testing were presented. OTSG water chemistry specifications during hot functional testing and for layup were also discussed. Finally, emergency feedwater chemistry requirements were delineated. Typical secondary systems were shown and it was emphasized that the feedwater heaters contain no Copper alloys and while some plants have Copper alloy condenser tubes, no Copper is present in the system downstream of the condensate polishers.

Anticipated transient operator guidelines (ATOG) strategy for the mitigation of steam generator tube ruptures (SGTR) was outlined. ATOG development, sponsored by the B&W Owners Group, is based on event trees, computer simulations, and feedback from plants (transient assessments). The SGTR procedure specifically covers the entire spectrum of tube leak to full rupture plus loss of offsite power and combinations of steam leaks and a SGTR in either steam generator. It was stated that draft ATOG guidelines have been written for all operating plants and that the final ATOG for Oconee will be submitted to the NRC for review in April 1982. Subsequently, each utility will write their emergency operating procedures using the final ATOG and operator training and implementation will commence.

Keith R. Wichman
Operating Reactors Assessment Branch
Division of Licensing

Enclosures:
As Stated

cc w/enclosures:
See next page

ATTENDANCE LIST

B&W OWNERS GROUP - STEAM GENERATOR MEETING

MARCH 23, 1982

NRC Participants

T. Ippolito, DL
D. Eisenhut, DL
C. McCracken, DE
W.J. Collins, IE
A. Taboada, RES
G. Lainas, DL
W. Johnston, DE
S. Bryon, DHFS
R. Jacobs, DL
T. Su, DST
K. Wichman, DL
W. Hazelton, DE
C. Cheng, DE

B&W Owners Group Participants

J. Taylor, B&W
C. Creacy, B&W
J. Olszewski, B&W
M. Bell, B&W
J. Kelly, B&W
G. Glei, B&W
R. Eaker, Duke Power Co.
B. Lawson, AP&L
J. Norris, Duke Power Co.

Other Attendees

L. Conner, Doc-Search Asso.

Industry Objective/Needs

MAXIMIZE SG RELIABILITY/AVAILABILITY, PROLONG SG LIFE, AVOID POWER REDUCTION AND SG REPLACEMENT

NEEDS TO RESOLVE PROBLEMS

(1) DETERMINE EXTENT & NATURE OF PROBLEM

- DEVELOP COMPLETE UNDERSTANDING OF "OLDER" PROBLEMS
- UNDERSTAND "NEW" PROBLEMS

EXAMPLES OF PROGRAMS/EXPERIENCE

VIBRATION DATA

- TMI-2 VIBRATION (EPRI)
- O-2 VIBRATION (EPRI)
- TVA IEOTSG FOAK (FUTURE)

OPERATING PLANT DATA

- WATER CHEMISTRY
- CONDENSATE POLISHERS (EPRI)
- OTSG OSCILLATIONS
- NDE-DEFECT/DEBRIS
- OUTAGE ENGINEERING SUPPORT

DAMAGE MECHANISM DATA

- 14th TSP DEBRIS (EPRI)
- O-1 LTS TUBE EXAM (EPRI)
- O-1/O-3 14th TSP TUBE EXAMS (EPRI)
- O-1/O-2/ANO-1 TUBE EXAMS
- FIBER OPTICS (EPRI)

(2) DETERMINE CAUSE

- TEST CAUSES TO DETERMINE MOST LIKELY CAUSE

LAB TESTING

- HEATED AIR MODEL/THEDA (EPRI)
- EXPANDED UTS CORROSION (EPRI)
- CORROSION FATIGUE TESTS (EPRI)

OPERATING PLANT EVALUATION

- SECONDARY SYSTEM REVIEW

ANALYSIS

- T/H AND STRESS
- ELIMINATE MOISTURE CONTAMINANTS
- CHEMICAL CLEANING (EPRI)
- REDUCTION OF ALTERNATING STRESSES
- 30 TUBE MODEL TESTS (EPRI)
- SLEEVING (STIFFENERS)

(3) IDENTIFY CORRECTIVE/PREVENTATIVE ACTION

- IDENTIFY ALTERNATIVES
- EVALUATE EFFECTIVENESS

(4) IMPLEMENT CORRECTIVE/PREVENTIVE ACTIONS

- DETERMINE EFFECTIVENESSES OF ACTIONS TAKEN.
- DETERMINE WHETHER ACTIONS ARE TEMPORARY

- TSV TESTING
- AFW INJECTION
- BYPASSING POLISHERS
- FEEDWATER CLEANUP
- INSTALL LANE FLOW BLOCKERS (FUTURE)
- SLEEVING (RG & E)
- REROUTING DRAIN SYSTEMS

I. INTRODUCTION — EAKER

II. OTSG OPERATING EXPERIENCE — OLSZEWSKI

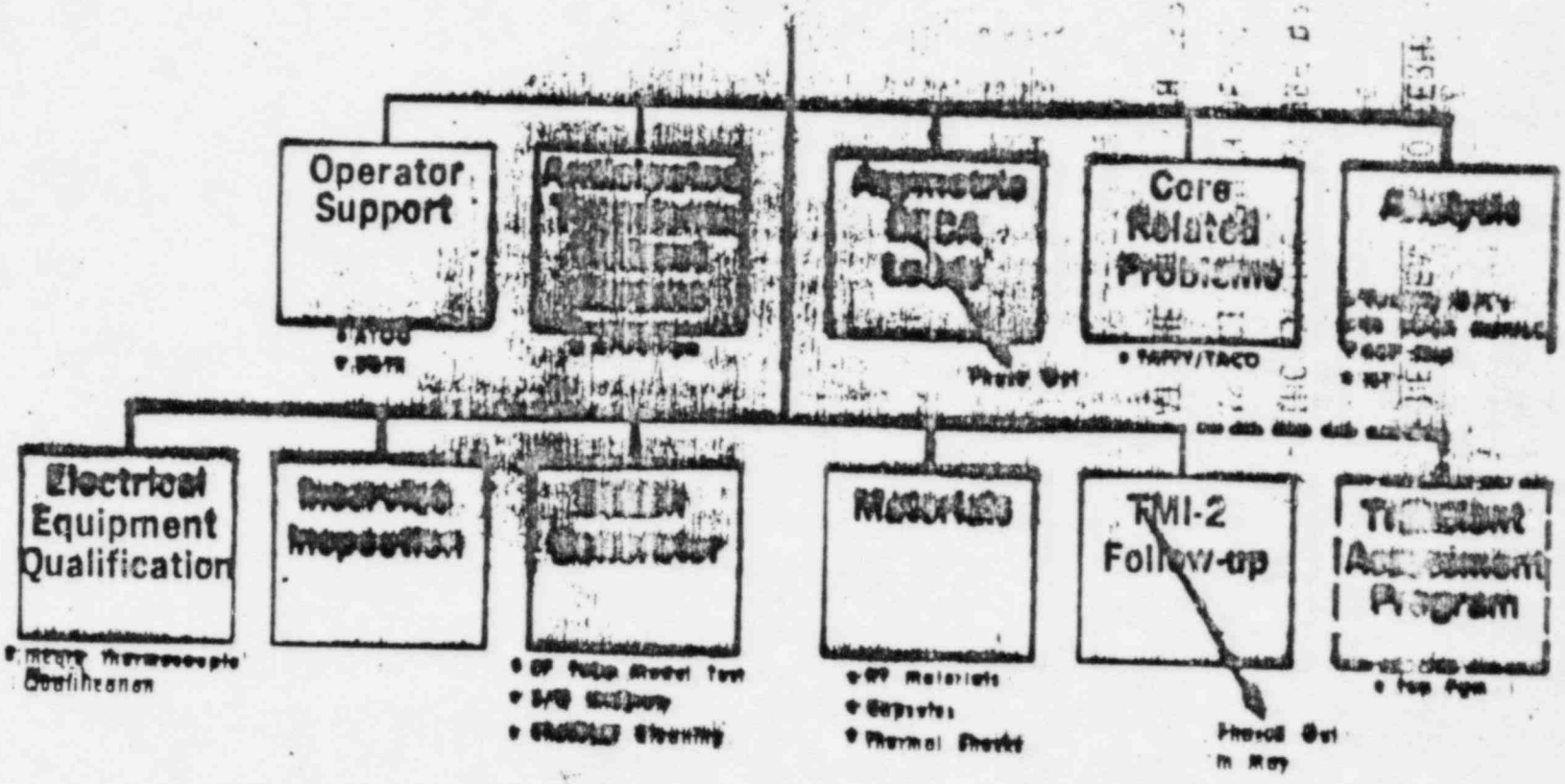
- OTSG CONFIGURATION & TERMS
- TUBE PLUGGING/LEAKER EXPERIENCE
- DAMAGE MECHANISMS
- SUMMARY

III. SECONDARY PLANT CHEMISTRY — BELL

IV. ATOG — KELLY

V. SUMMARY — CREACY

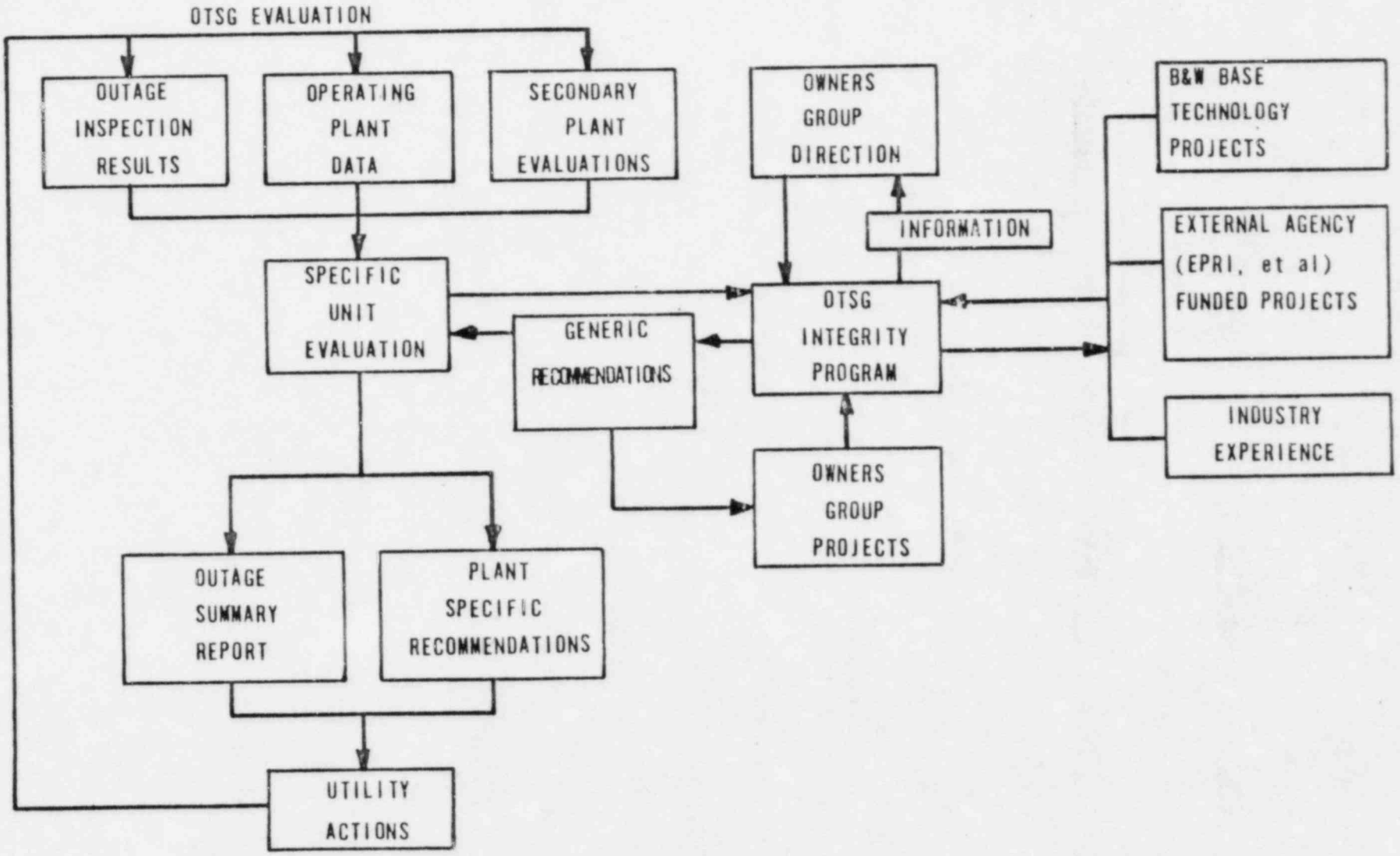
B&W FA Owners Group
- Executive Committee -



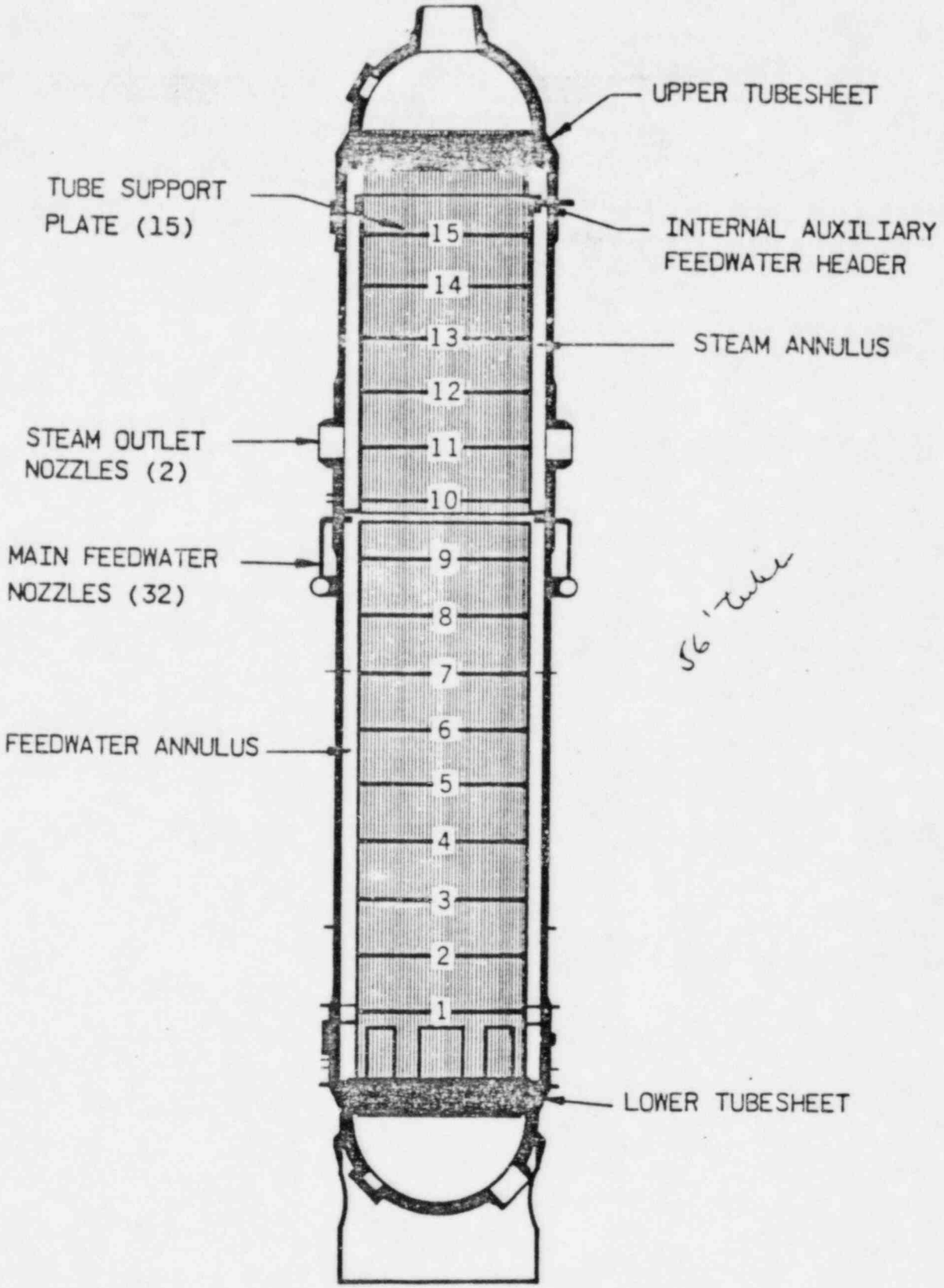
PLANT SPECIFIC

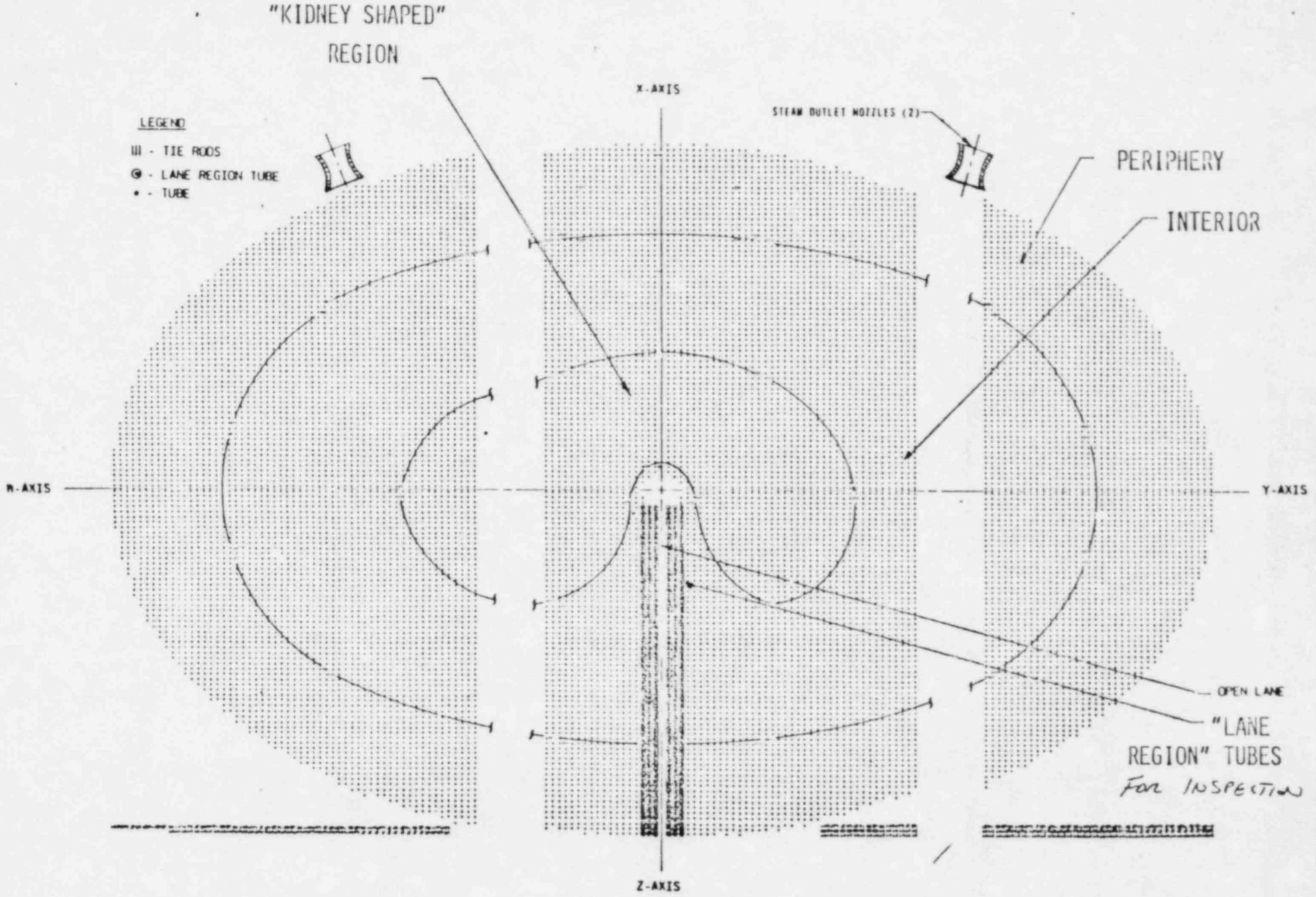
OTSG INTEGRITY PROGRAM

OTHER PROGRAMS



177FA ONCE-THROUGH STEAM GENERATOR (OTSG) LONGITUDINAL VIEW




"KIDNEY SHAPED"
REGION
X-AXIS
STEAM OUTLET NOZZLES (2)
LEGEND
III - TIE RODS
⊕ - LANE REGION TUBE
• - TUBE
PERIPHERY
INTERIOR
M-AXIS
Y-AXIS
OPEN LANE
"LANE
REGION" TUBES
FOR INSPECTION
Z-AXIS

OTSG Operating History

THROUGH DEC. 31, 1981 — THROUGH 3/16/82 (ONLY DOMESTIC) ONLY OPERATING)

$$\frac{\text{TOTAL NO. TUBES REMOVED FROM SERVICE}}{\text{TOTAL NO. TUBES IN OPERATING OTSG'S}} = \frac{(249)}{(275{,}000)} = 0.09\%$$

PLUGGING RATE = $<0.01\% \frac{\text{TUBES}}{\text{YEAR}}$

TOTAL NO. OF LEAKERS = 29

SUMMARY OF OTSG TUBES REMOVED FROM SERVICE

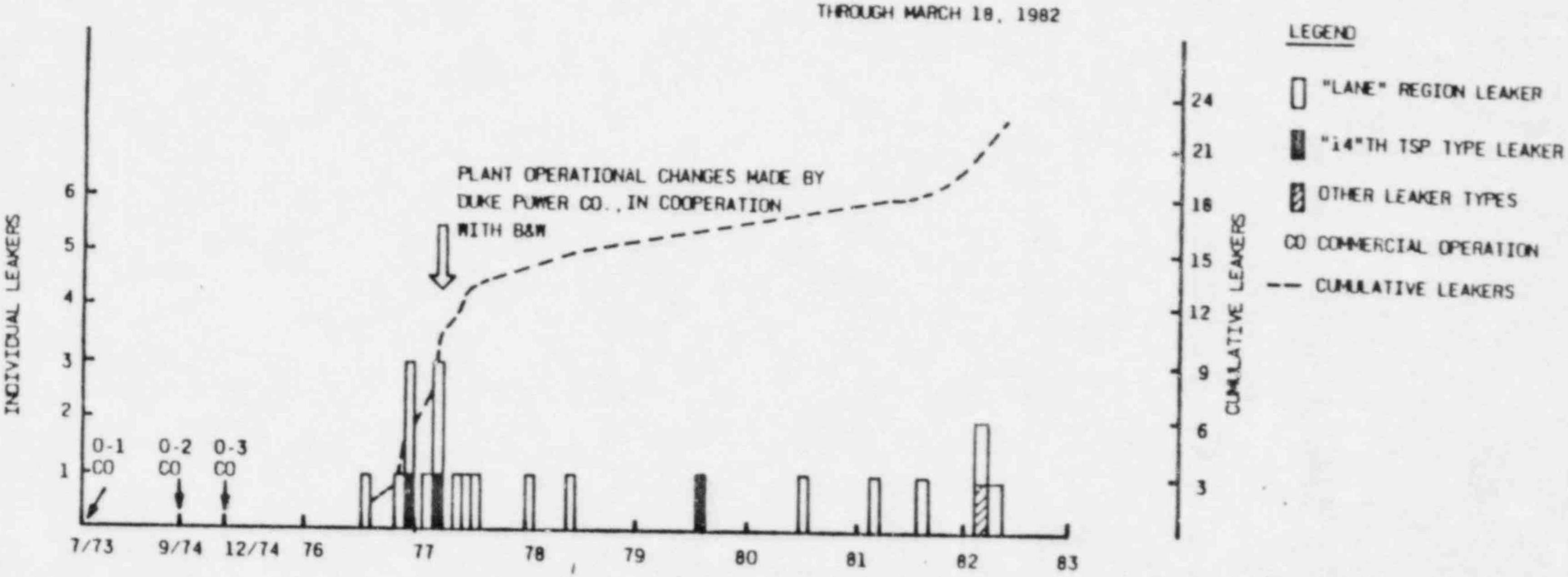
(THROUGH MARCH 18, 1982)

PLANT	COMM. OPER.	GENERATOR	CATEGORY* 1	2	3	4	TOTAL
PLANT 8	7/15/73	A	23	3	1	41	68
		B	166	10	9	59	244
PLANT 7	9/9/74	A	0	0	0	3	3
		B	4	3	3	17	27
PLANT 6	12/16/74	A	1	2	0	75	78
		B	6	4	14	1	25
PLANT 5	9/2/74	A	3	0	2	3	8
		B	1	0	7	3	11
PLANT 9	LATE 1978	A	0	0	0	14	14
		B	0	0	0	24	24
PLANT 4	12/19/74	A	9	3	4	0	16
		B	0	0	0	3	3
PLANT 3	4/17/75	A	4	0	5	0	9
		B	3	1	2	0	6
PLANT 2	3/13/77	A	0	1	1	4	6
		B	0	0	0	27	27
PLANT 1	11/20/77	A	0	2	0	0	2
		B	0	0	0	11	11
	TOTAL		220	29	48	285	582

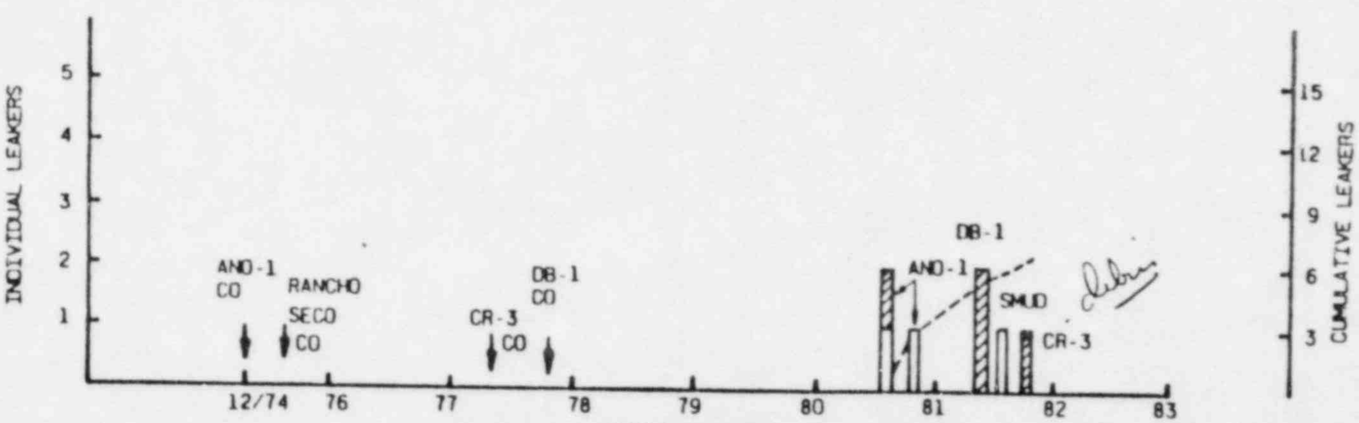
*CATEGORY	EXPLANATION
1	EXCEEDED >40% TUBE PLUGGING CRITERIA (NDE)
2	TUBE LEAKS
3	CUSTOMER OPTION (0-40% WALL METAL LOSS)
4	OTHER (PRIOR TO COMMERCIAL OPERATION, INSTRUMENTATION, TUBE PULL, ERROR, ETC.)

OTSG TUBE LEAK HISTORY

THROUGH MARCH 18, 1982



OCONEE LEAKERS



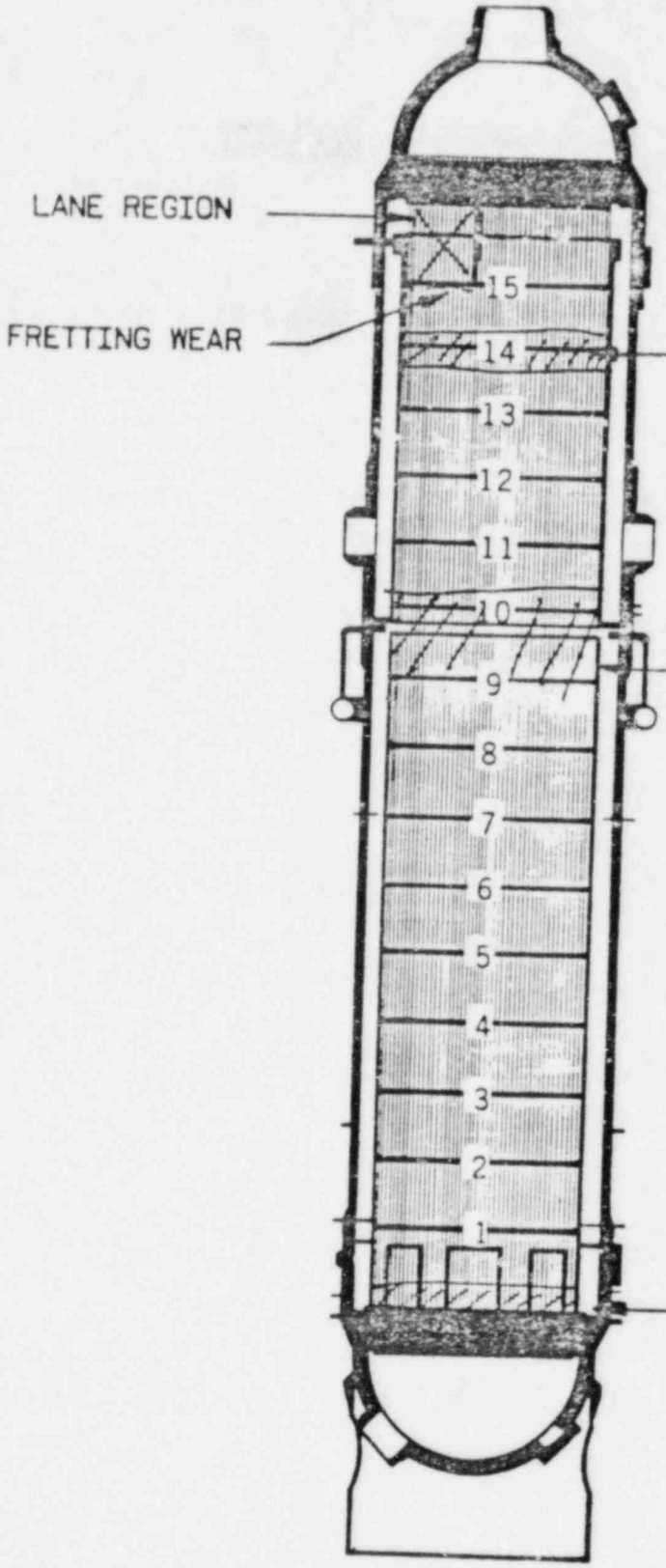
OTHER LEAKERS

LEAKER SUMMARY

UNIT	LANE REGION LEAKER	"14TH" TSP TYPE LEAKER	OTHER
O-1A	3	0	0
O-1B	7	3	0
O-2A	0	0	0
O-2B	3	0	0
O-3A	1	1	0
O-3B	4	0	0
ANO-1A	2	0	1
ANO-1B	0	0	0
DB-1A	0	0	2
SMUD-B	1	0	0
CR-3A	0	0	1
TOTAL	21	4	4

12 Tubes pulled

Five Continuing Areas Of Concern



OUTSIDE DIAMETER DAMAGE
(14th TSP OD'S)

TUBE DIAMETER DISTORTIONS
(DINGS)

LOWER TUBESHEET

Five Continuing Areas Of Concern

TUBES REMOVED % DEFECT

LEAKS

TUBE PULLED

21 • LANE REGION - CHEMICALLY INITIATED, MECHANICALLY PROPAGATED CIRCUMFERENTIAL CRACKS AT 15th TSP AND UTS — 21 — 7

228 • OUTSIDE DIAMETER DAMAGE - EROSION IN UPPER OTSG MAINLY AT 14th TSP — 4 — 3

≈ 0 • FRETTING WEAR - TUBE FRETTING WEAR AT TUBE/TSP IN LANE REGION AND PERIPHERY AT 15th TSP — 1

0 • TUBE DIAMETER DISTORTIONS - EC DING INDICATIONS MAINLY AT THE 9th, 10th AND 15th TSPS — 0

0 • LOWER TUBESHEET INDICATIONS- WIDESPREAD EC INDICATIONS AT THE SECONDARY FACE OF LTS — 1

249

OTHER 4

29

12

LANE REGION

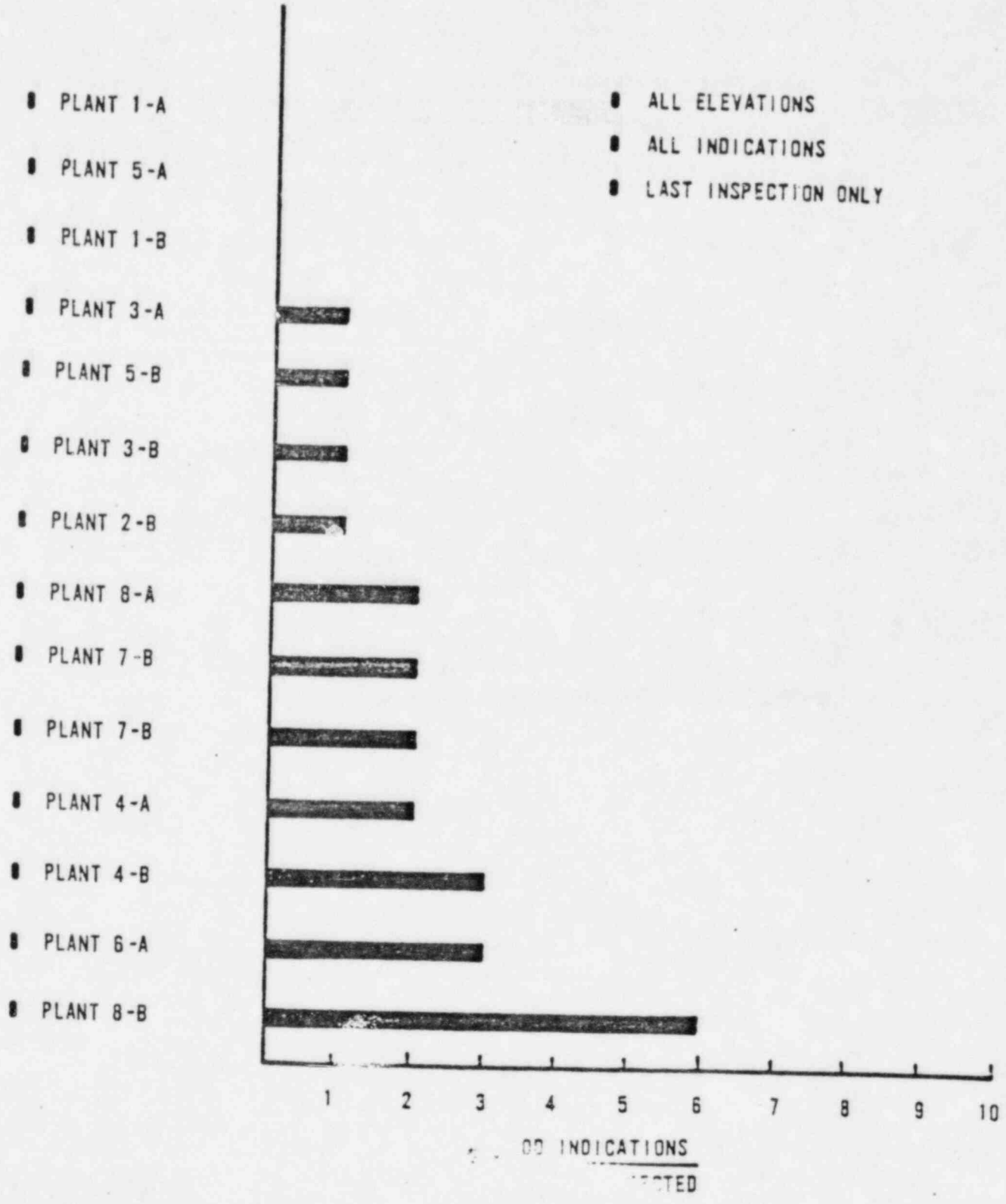
MECHANISM HYPOTHESIS

- CORROSION ATTACK DUE TO CONCENTRATED CHEMICAL SPECIES CARRIED BY MOISTURE, PROBABLY DURING ADVERSE SECONDARY SYSTEM CONDITIONS
- MICRO-CRACKS FORMED BY COMBINATION OF SURFACE DAMAGE DUE TO CORROSION AND BY NORMAL TUBE LOADINGS
- CRACK PROPAGATION CAUSED BY HIGH CYCLE FATIGUE AT LOW ALTERNATING STRESSES

OUTSIDE DIAMETER DAMAGE MECHANISM HYPOTHESIS

- DEFECTS APPEAR TO BE INDICATIVE OF AN EROSION OR IMPINGEMENT PROCESS MOST PROBABLY ASSOCIATED WITH DEBRIS ACCUMULATION AND/OR MICRON SIZE PARTICLES.
- CORROSION INDUCED DAMAGE NOT EVIDENT FROM SAMPLES

Outside Diameter Damage Distribution Of Active Indications



FRETTING WEAR

MECHANISM HYPOTHESIS

- TUBE FRETTING WEAR DAMAGE AT TUBE/TSP LAND AREAS CAUSED BY LOW AMPLITUDE VIBRATION

15th in lane region

FRETTING WEAR

- ABOUT 200 TOTAL INDICATIONS TO DATE AT ALL PLANTS

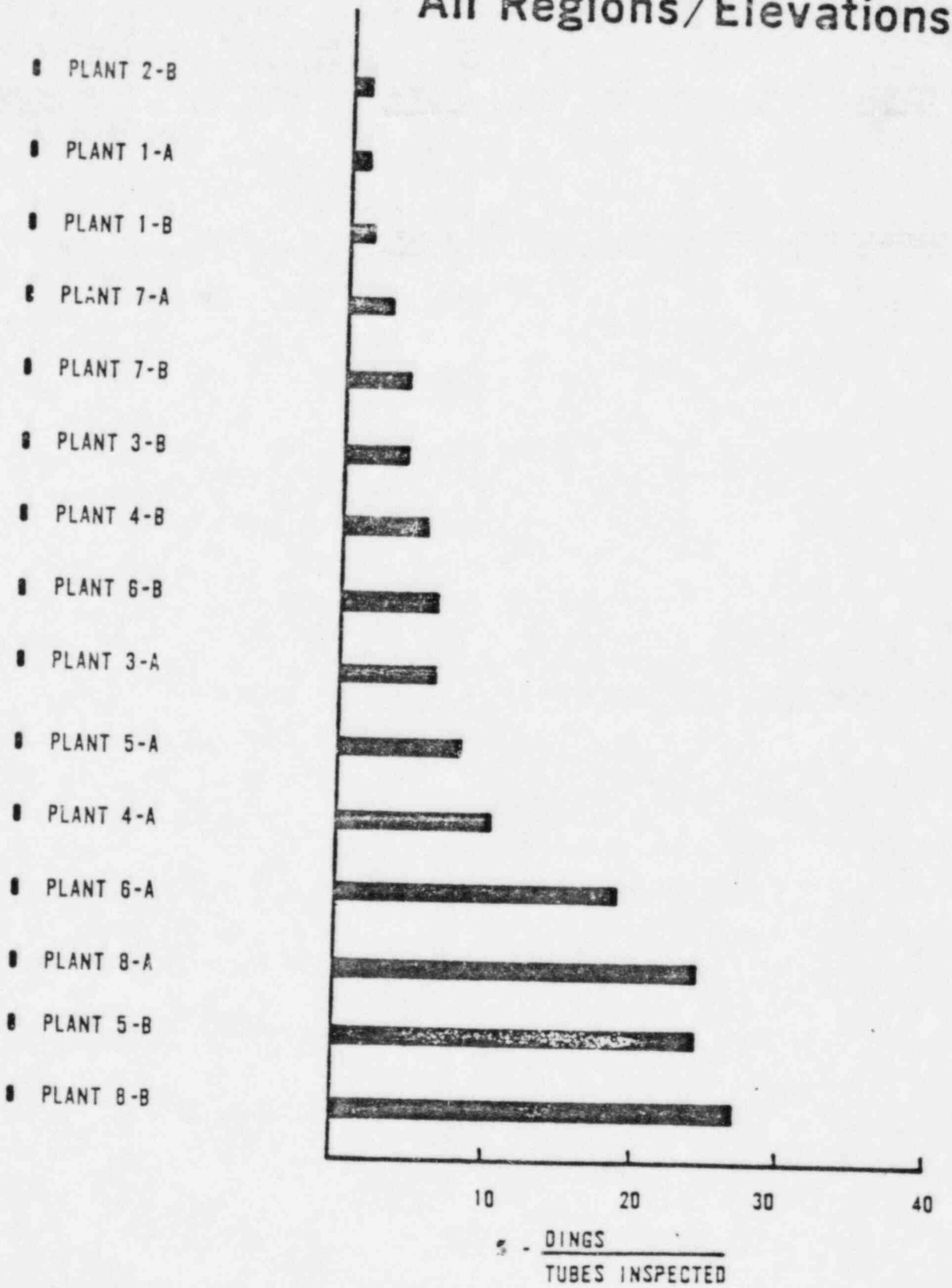
POSTULATED TUBE DIAMETER DISTORTIONS

MECHANISM HYPOTHESES

- TSP CORROSION - "DENTING"
- WATERHAMMER
- MECHANICAL DESIGN AND/OR THERMAL DEFORMATION

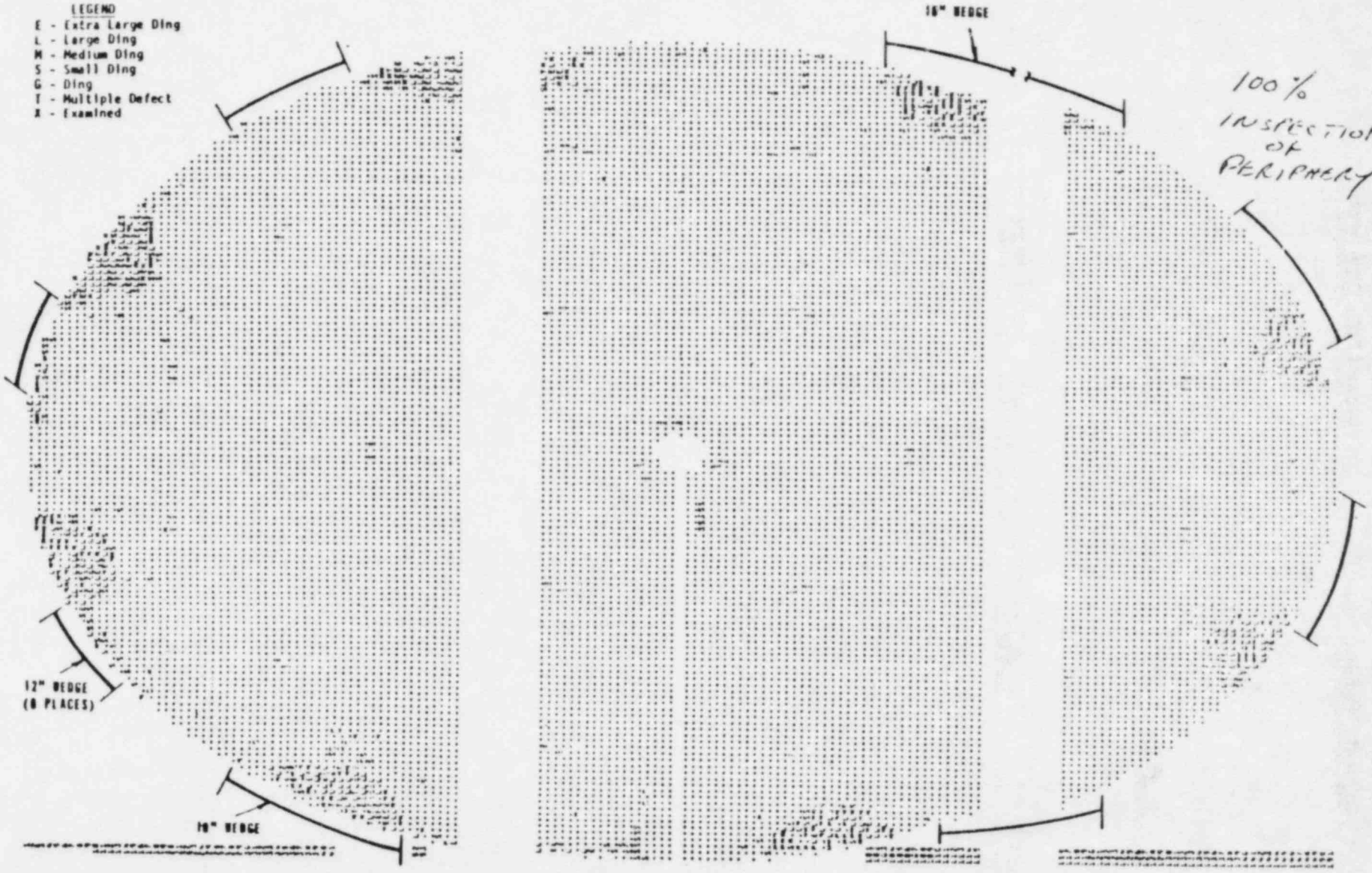
70 - 100% free span

Tube Diameter Distortions
All Regions/Elevations



PLOT OF 10TH TUBE SUPPORT PLATE

EDDY CURRENT "DING" INDICATIONS



LOWER TUBESHEET

- EDDY CURRENT INDICATIONS
  - C-TYPE
  - BANANA
  - DING
  - DEBRIS/SLUDGE

maybe an indication of sludge filling area

- TUBE LEAKS - NONE
- TUBES PLUGGED - NONE
- PROFILOMETRY

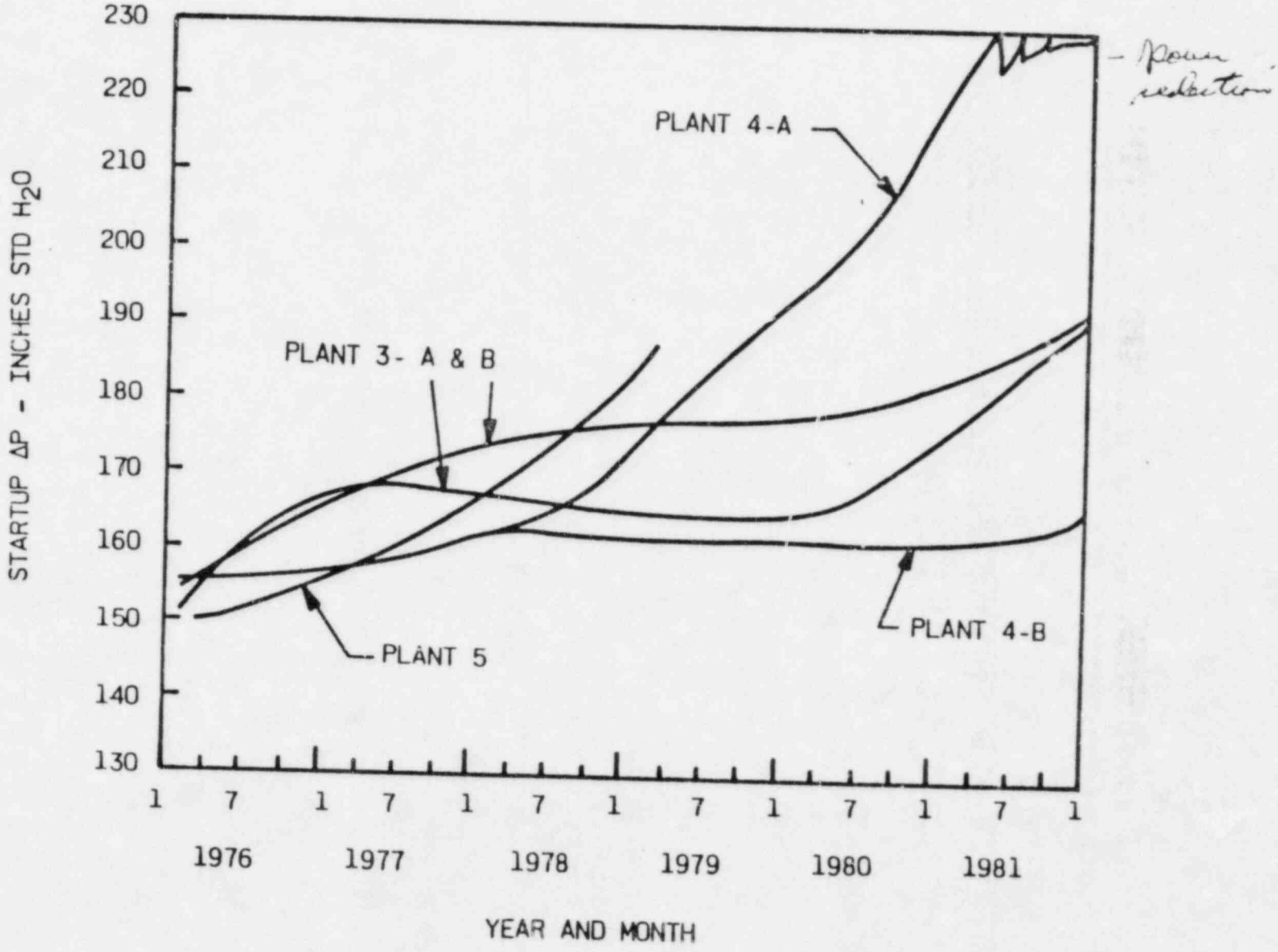
put a few rods in

Mayflower

NEW AREA OF CONCERN

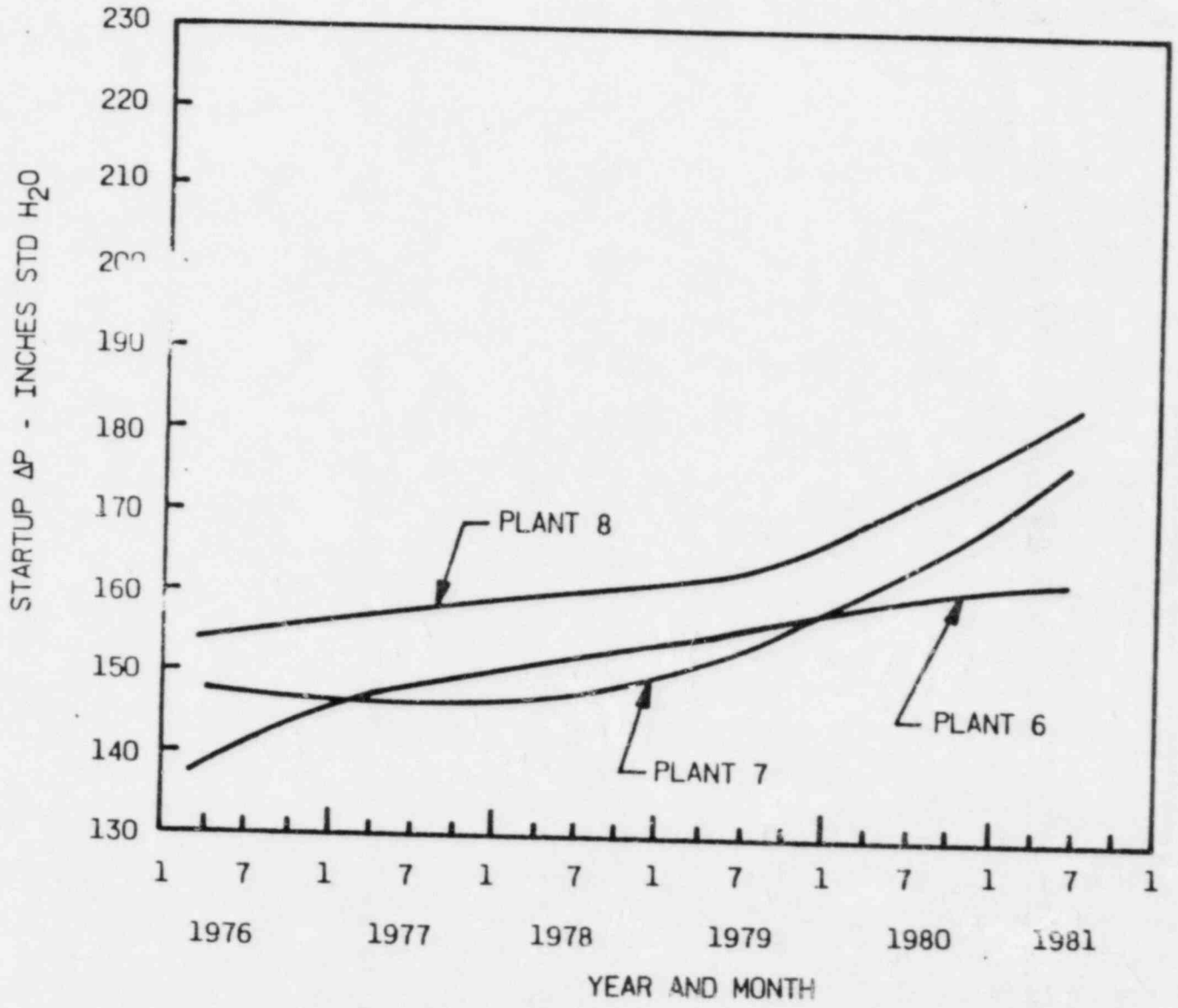
ΔP - INCREASING PRESSURE DROP
ASSOCIATED WITH DEPOSITS
AT THE 5TH AND 6TH TSPS

Pressure Drop History



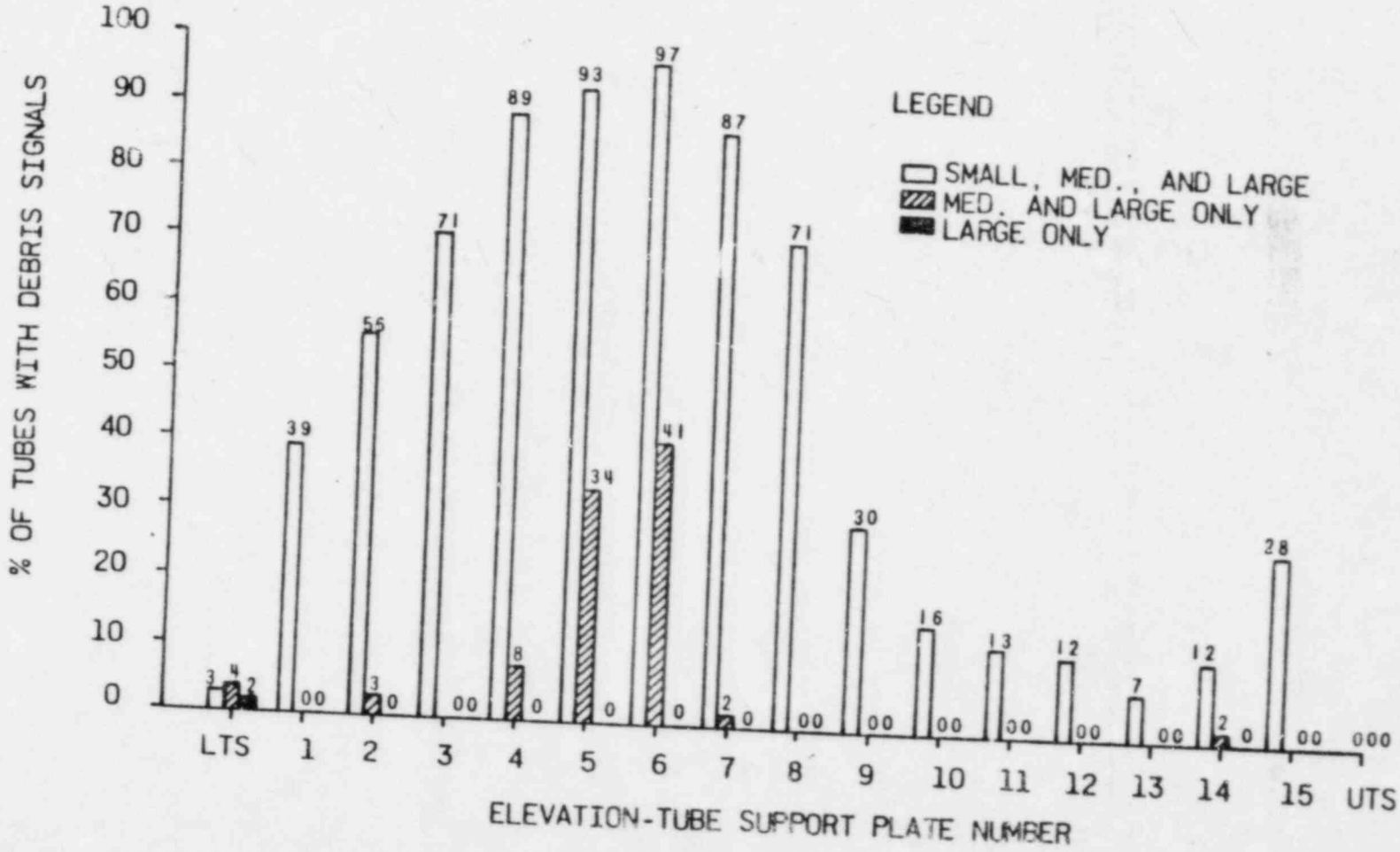
- Power reduction

Pressure Drop History



FREQUENCY OF OCCURRENCE DISTRIBUTION OF EDDY CURRENT "DEBRIS" SIGNALS BY TUBE SUPPORT PLATE

OTSG-A 61 TUBES
30 DEG. FROM Y-AXIS TOWARD X-AXIS



SUMMARY

- OTSG OPERATING EXPERIENCE HAS BEEN GOOD
- BUILD OTSG DATA BASE
  - OUTAGE SUMMARY REPORTS
  - DAMAGE MECHANISM DATA
- BUILD TOTAL SG DATA BASE
  - SECONDARY PLANT WATER CHEMISTRY
  - CONDENSATE POLISHER STUDY
- OWNER'S GROUP OTSG INTEGRITY PROGRAM
  - ADDRESS PROBLEMS LOGICALLY AND EFFICIENTLY
  - PLANT TO PLANT DATA COMPARISONS
  - EARLY RECOGNITION OF PROBLEMS
  - FOCUS ON IMPORTANT AS WELL AS URGENT PROBLEMS
  - TAKE PREVENTATIVE/CORRECTIVE ACTIONS BEFORE REMEDIAL ACTION IS NEEDED
- EXTREME IMPORTANCE OF SECONDARY PLANT OPERATION AND WATER CHEMISTRY HAS BEEN REINFORCED

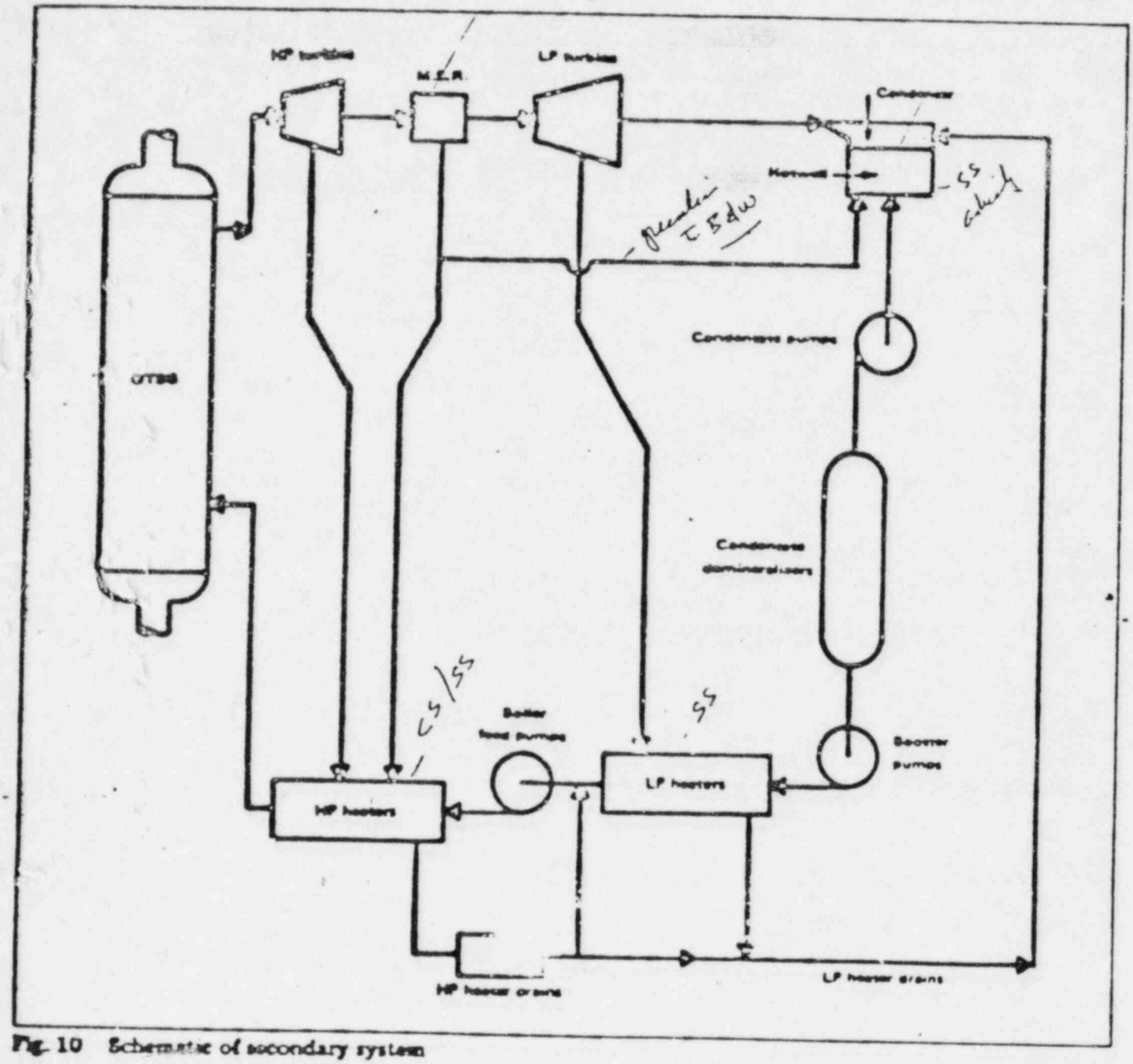


Fig. 10 Schematic of secondary system

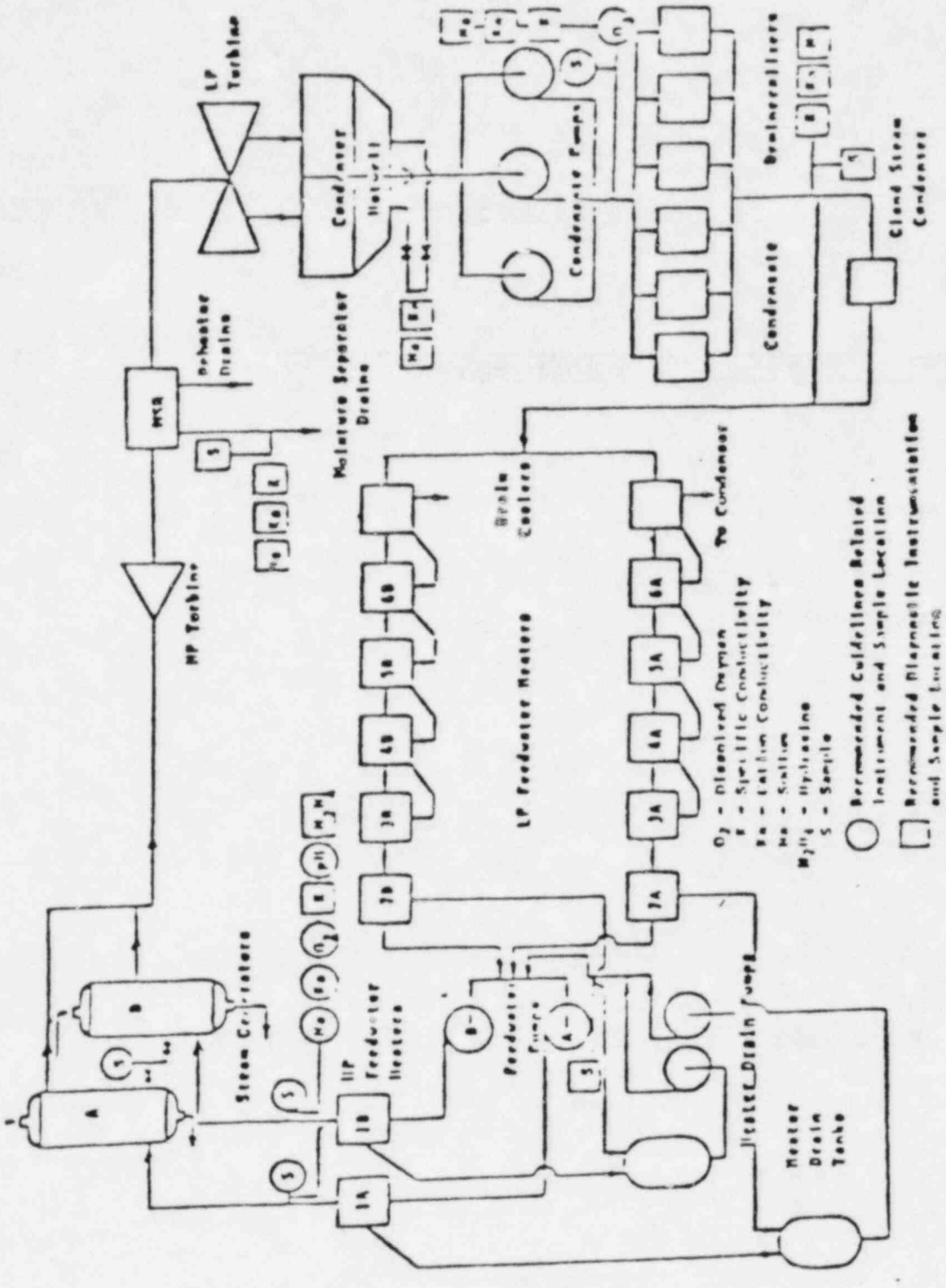
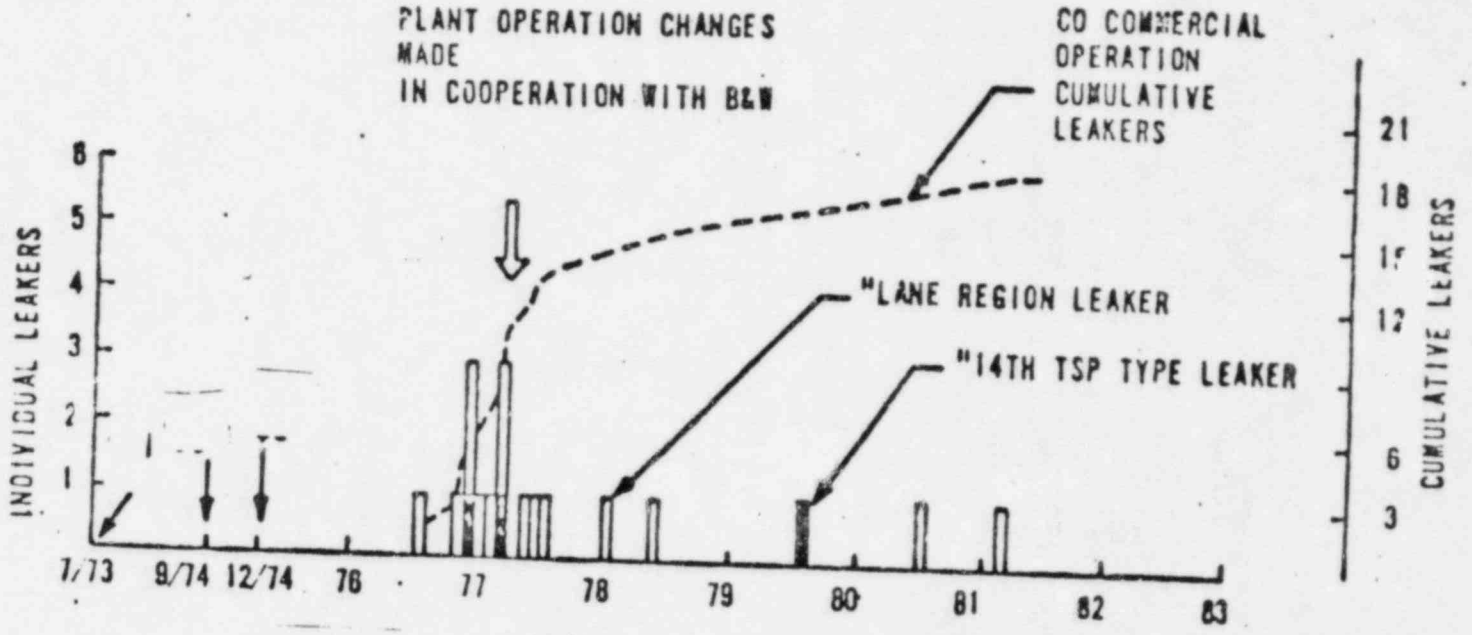


Figure 3-1. Typical Once-Through PWR Secondary System Schematic

Leaker History



OSTG feedwater specifications

Normal power operation

Total solids	50 ppb max
Cation conductivity	0.5 mhos/cm max
Dissolved oxygen as O_2	7 ppb max
[illegible]ine as N_2H_4	20–100 ppb
[illegible] SiO_2	20 ppb max
Total iron as Fe	10 ppb max
Total copper as Cu	2 ppb max
pH @ 77F	9.3–9.5 or 8.5–9.3
Lead as Pb	1 ppb max

Start up*

Total iron as Fe	100 ppb max
Cation conductivity	1.0 mhos/cm max
Dissolved oxygen as O_2	100 ppb max

*Established prior to loading OTSGs

Chemistry specifications—hot functional testing

OTSG feedwater	
pH @ 77F	9.3–9.5 or 8.5–9.3
Cation conductivity	0.5 mhos/cm max
Hydrazine as N_2H_4	20–100 ppb max
Total iron as Fe	100 ppb max
Dissolved oxygen as O_2	7 ppb max
Total copper as Cu	2 ppb max
Silica as SiO_2	20 ppb max

OTSG water	
Cation conductivity	10 mhos/cm max
Sodium as Na	2.0 ppm max
Chloride at Cl	1.0 ppm max

OTSG water chemistry specification—layup

Ammonia as NH_3	10 ppm nominal 2 ppm–20 ppm range
pH @ 77F	9.5–10.5
Hydrazine	200 ppm initial 50 ppm minimum
Sodium	1.0 ppm maximum
Cation conductivity	10 mhos/cm maximum

SOLVENT COMPOSITION:

	INITIAL	MAINTAIN*
EDTA (ETHYLENEDIAMINETETRACETIC ACID)	10.0%	> 3%
HYDRAZINE	1.0%	> 0.5%
SOLVENT pH (AT 77°F) (ADJUSTED WITH AMMONIA)	7.0	> 6.5
INHIBITOR (LOW SULFUR)	0.2%	---

*RENEWED AT EACH DRAIN AND ANALYSES.

OTSG EMERGENCY FEEDWATER CHEMISTRY REQUIREMENTS

pH at 77F	Same as normal requirement
Dissolved oxygen (O_2)	
OTSG at < 250F	100 ppb max
OTSG at > 250F	
Normal	7 ppb max
Upset	100 ppb max for a period not to exceed 1 week
Total iron	100 ppb max
Hydrazine	
Catalyzed hydrazine	
OTSG at < 250F	Added to at least 300% of stoichiometric oxygen concentration
OTSG at > 250F	20-100 ppb residual
Cation conductivity	1.0 µmho/cm, max for a period not to exceed 24 hours

B&W/INDUSTRY PROGRAMS

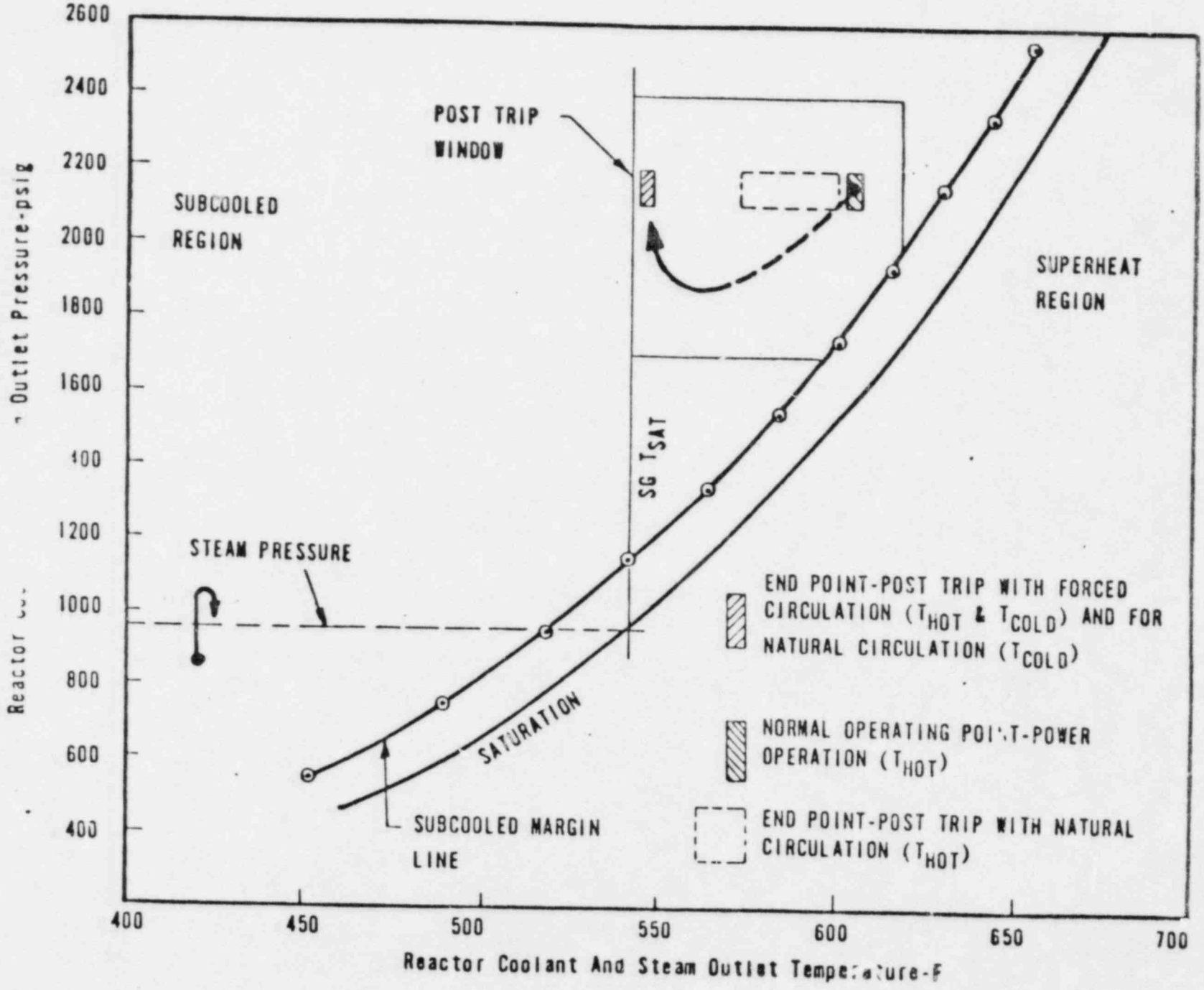
- DEPOSITION OF SALTS FROM STEAM - EPRI, RP1068-1
- STEAM GENERATOR CHEMICAL CLEANING - EPRI, S-127-1
- STATE-OF-THE-ART CONDENSATE POLISHING PERFORMANCE - EPRI, S-163-1
- RESIN LEAKAGE SAMPLING PROGRAM - EPRI, S-163-1 (EXTENSION)
- MECHANISM OF I.G.A. OF INCONEL 600 TUBING IN PWR STEAM GENERATORS, RP-1613-2
- CORROSION SALTS IN LWR SYSTEMS, RP-1167-2
- EXPANDED UPPER TUBE SHEET CORROSION TESTING, SGOG S-165
- SCC TESTING OF INCONEL 600 AND 690, SGOG S-192-2

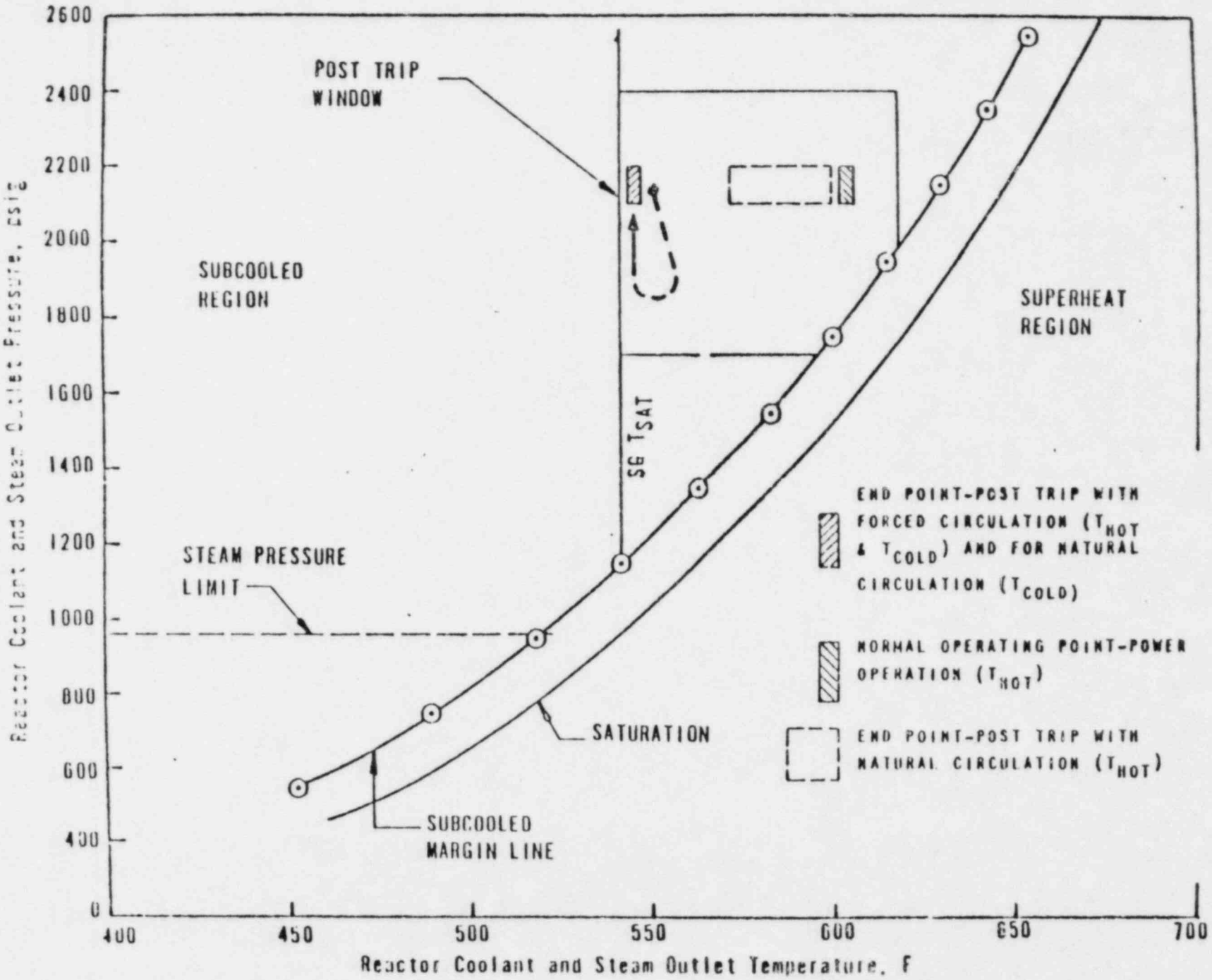
ATOG DEVELOPMENT

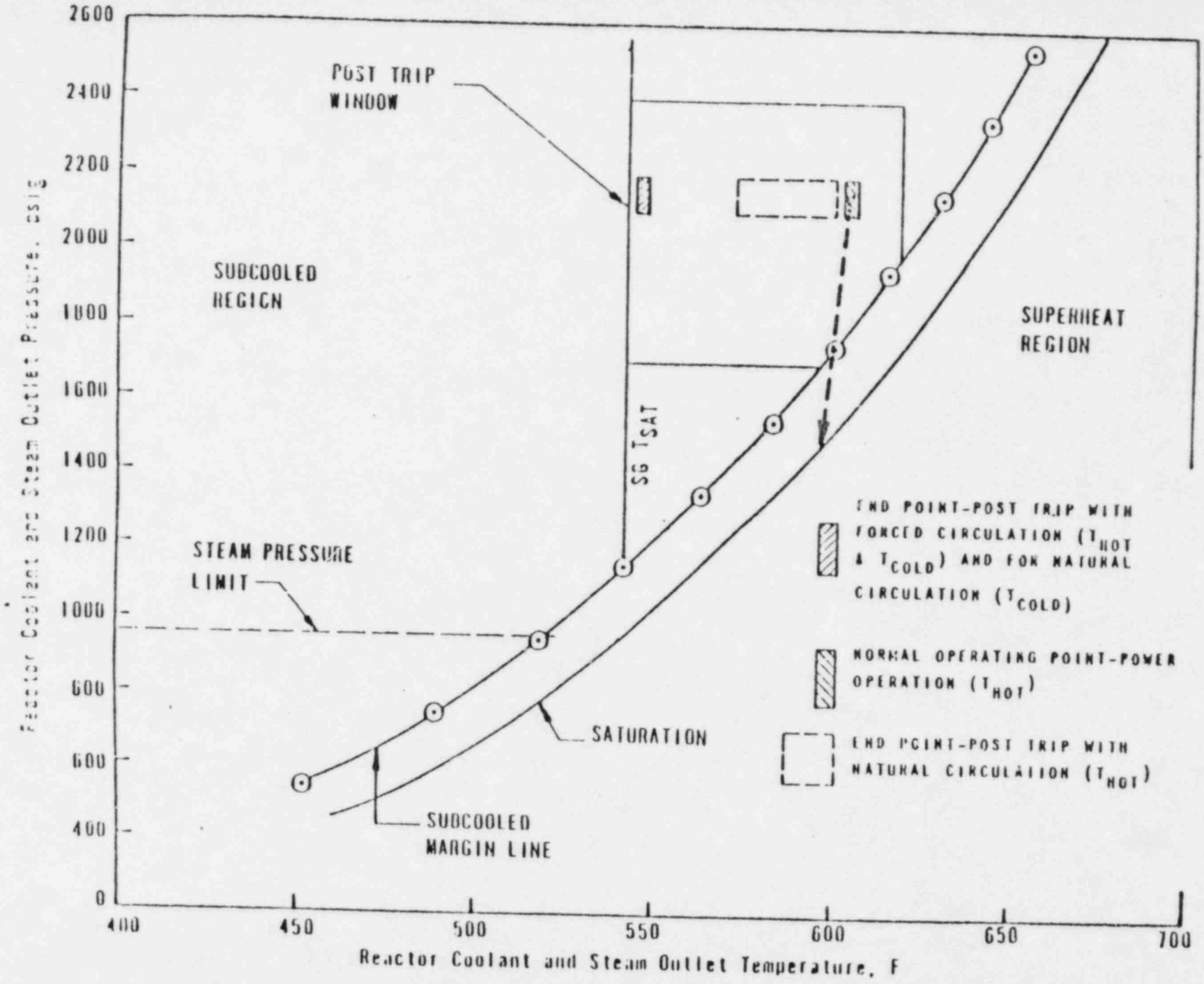
- EVENT TREES
- COMPUTER SIMULATIONS
- FEEDBACK FROM PLANTS (TRANSIENT ASSESSMENT PROGRAM)

OPERATOR ACTIONS DURING A TRANSIENT

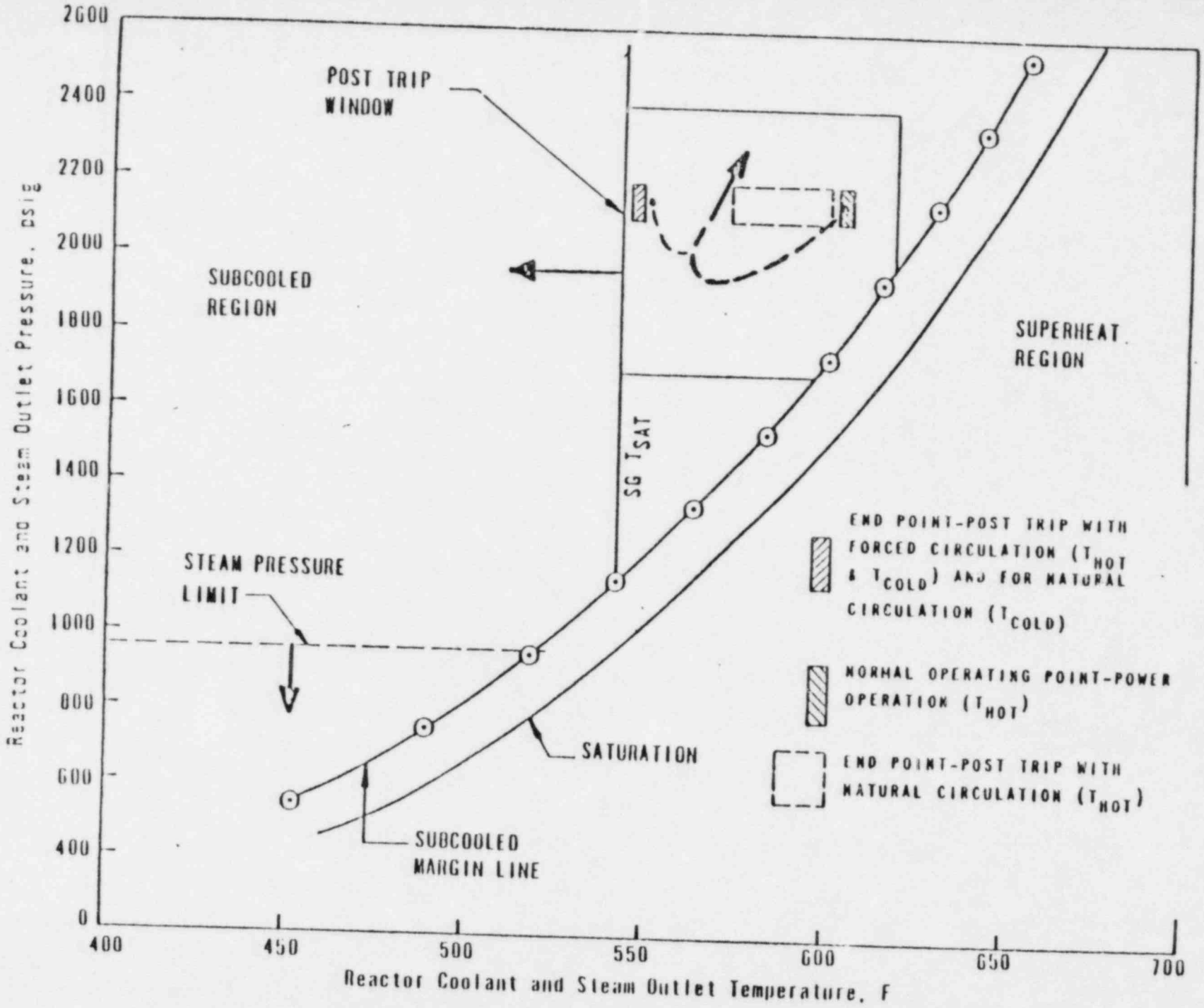
ACTIONS	TIME FRAME FOR ACTION	INSTRUMENT USED FOR VERIFICATION/ACTION
• MANUALLY TRIP REACTOR & TURBINE	1-2	--- ---
• VITAL SYSTEM VERIFICATION • REACTOR POWER DECREASING • • • FEEDWATER STATUS • SFAS ALARMS	1-3	
• CHECK FOR ADEQUATE SUBCOOLING	1-3	RC PRESSURE, TEMPERATURE SATURATION METERS, ATOG DISPLAY
• VERIFY THAT ADEQUATE PRIMARY TO SECONDARY HEAT TRANSFER EXIST	1-3	RC PRESSURE, TEMPERATURE SG LEVEL, PRESSURE FEEDWATER, AFW FLOW ATOG DISPLAY
• VERIFY THAT SECONDARY HEAT TRANSFER IS NOT EXCESSIVE	1-3	RC PRESSURE, TEMPERATURE SG LEVEL, PRESSURE FEEDWATER; AFW FLOW ATOG DISPLAY
• CHECK FOR STEAM GENERATOR TUBE LEAK	1-3	RADIATION ALARMS AND INDICATIONS IN STEAM LINES OR AIR EJECTOR


2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
Outlet Pressure-psig
POST TRIP
WINDOW
SUBCOOLED
REGION
SUPERHEAT
REGION
SG TSAT
STEAM PRESSURE
SATURATION
SUBCOOLED MARGIN
LINE
END POINT-POST TRIP WITH FORCED
CIRCULATION (T_{HOT} & T_{COLD}) AND FOR
NATURAL CIRCULATION (T_{COLD})
NORMAL OPERATING POINT-POWER
OPERATION (T_{HOT})
END POINT-POST TRIP WITH NATURAL
CIRCULATION (T_{HOT})
400
450
500
550
600
650
700
Reactor Coolant And Steam Outlet Temperature-F

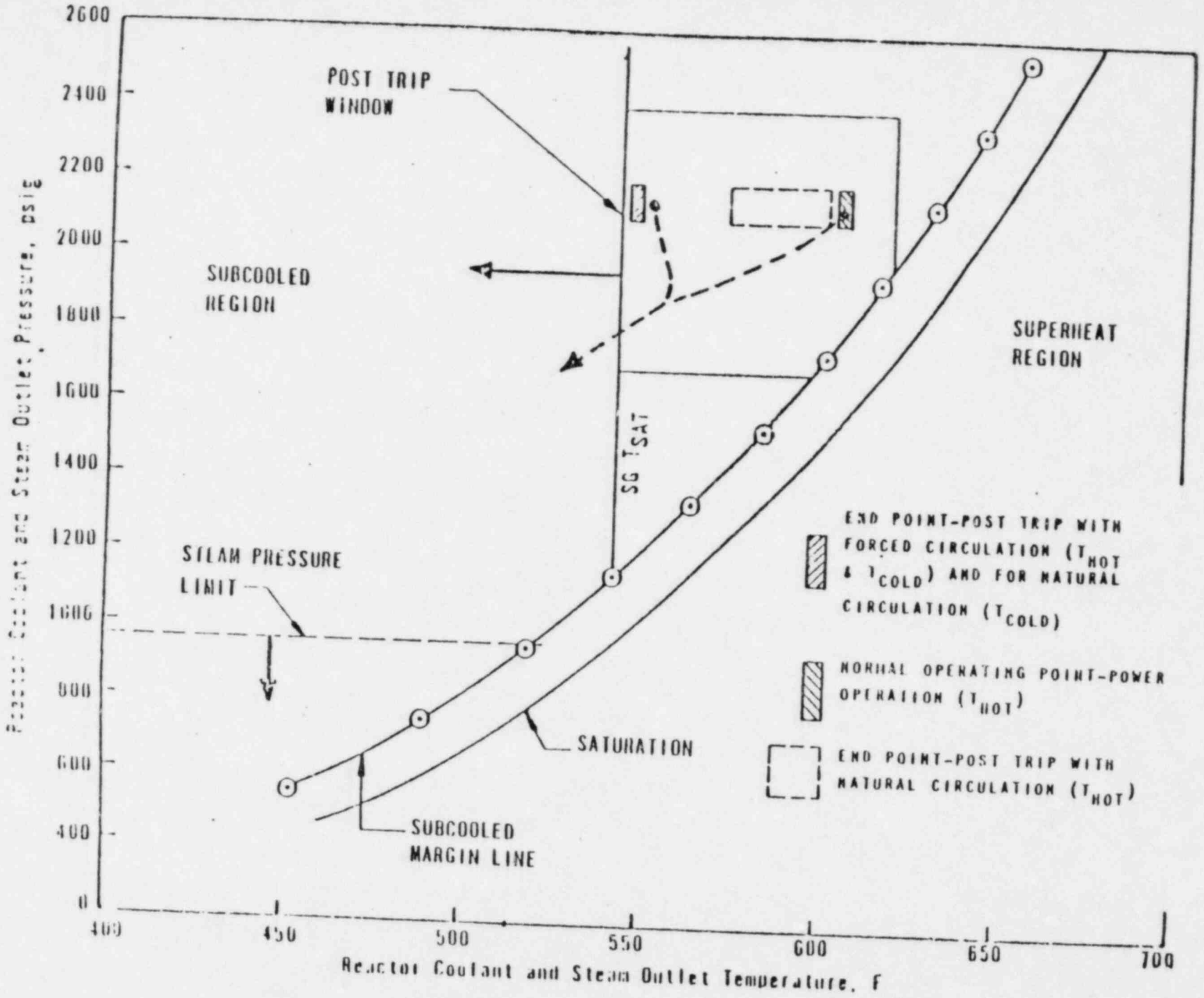

2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
0
400
450
500
550
600
650
700
Reactor Coolant and Steam Outlet Pressure, PSIA
Reactor Coolant and Steam Outlet Temperature, F
POST TRIP WINDOW
SUBCOOLED REGION
SUPERHEAT REGION
SG TSAT
STEAM PRESSURE LIMIT
SATURATION
SUBCOOLED MARGIN LINE
END POINT-POST TRIP WITH FORCED CIRCULATION (T_{HOT} & T_{COLD}) AND FOR NATURAL CIRCULATION (T_{COLD})
NORMAL OPERATING POINT-POWER OPERATION (T_{HOT})
END POINT-POST TRIP WITH NATURAL CIRCULATION (T_{HOT})



INADEQUATE SUBCOOLING MARGIN



LOSS OF PRIMARY TO SECONDARY HEAT TRANSFER



EXCESSIVE PRIMARY TO SECONDARY HEAT TRANSFER

Part I. Organization

SECTION I. Immediate actions

SECTION II. Vital system status verification

SECTION III.

A. Treatment of lack of adequate subcooling margin

B. Treatment of lack of primary to secondary heat transfer

C. Treatment of too much primary to secondary heat transfer

D. Follow up actions for OTSG Tube rupture

COOLDOWN PROCEDURES

- Large LOCA
- Normal
- Saturated RCS
- HPI cooling
- Solid water cooldown

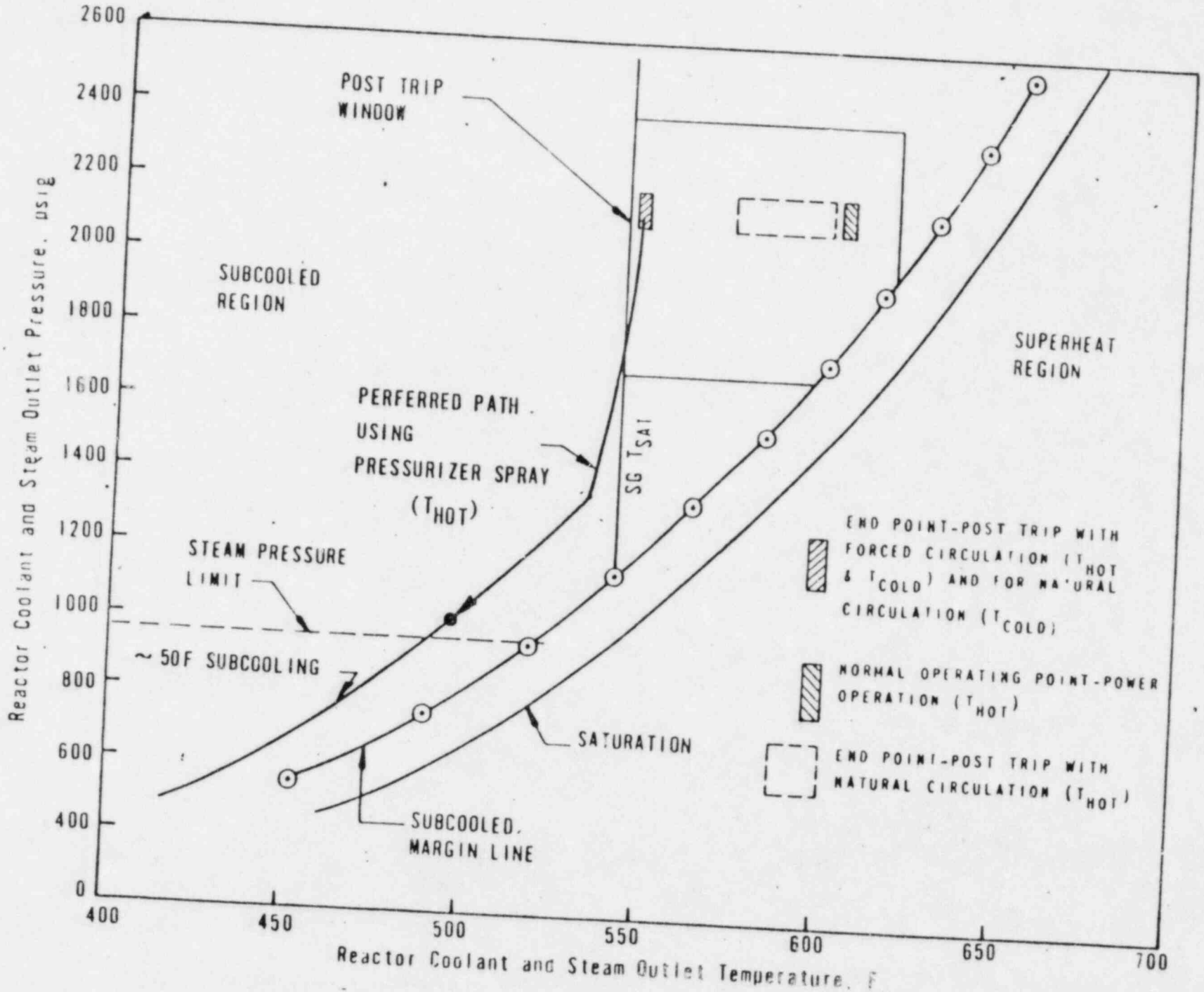
STEAM GENERATOR TUBE RUPTURE PROCEDURE

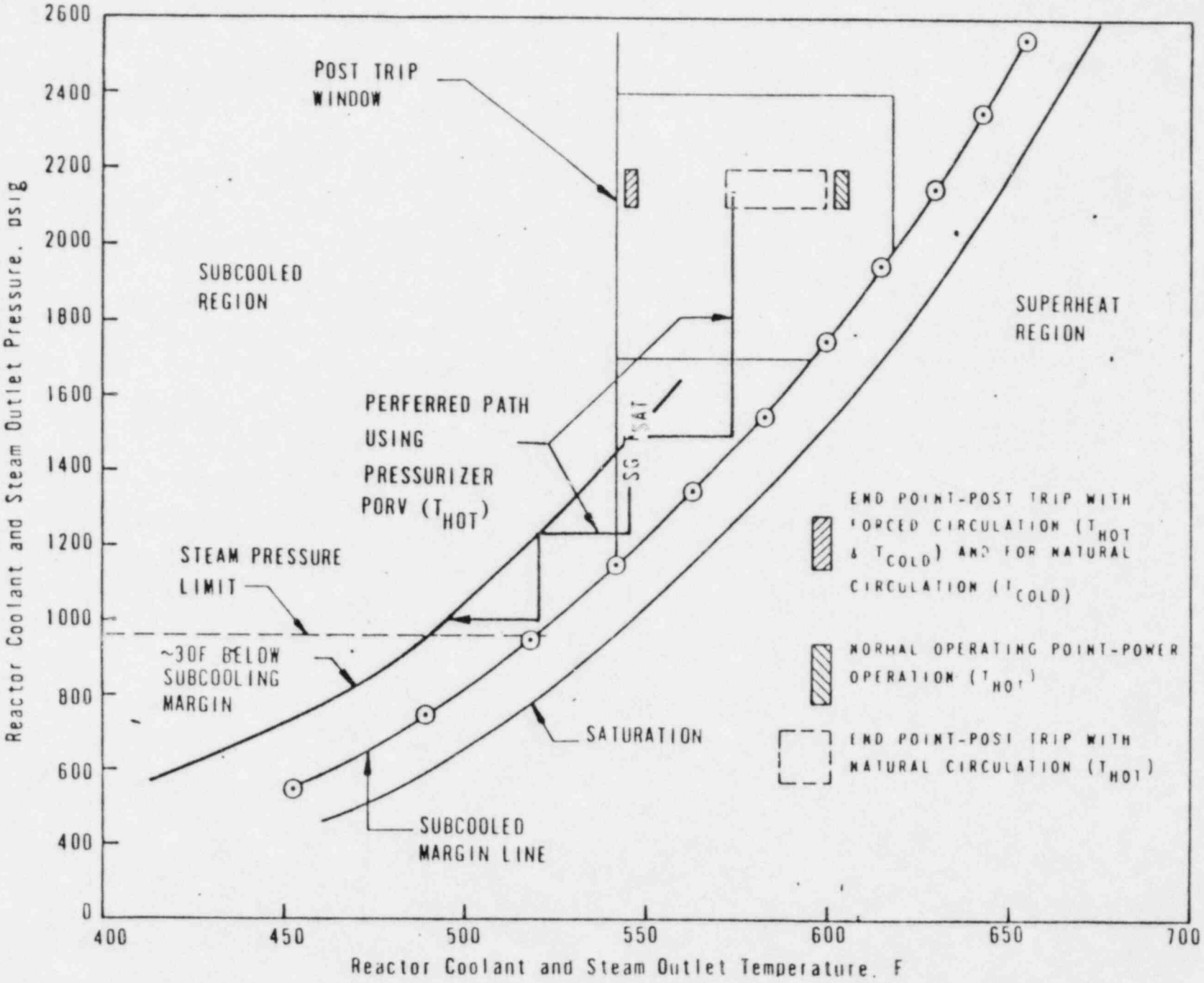
I. PHILOSOPHY (INTENT)

- MINIMIZE STEAM RELEASE
  - RUNBACK INSTEAD OF TRIP
  - SWITCH AFW TURBINE TO GOOD GENERATOR
  - ISOLATE BROKEN GENERATOR, IF KNOWN (STEAM IT IF LEVEL REACHES 95%, NATURAL CIRCULATION STOPS IN THAT LOOP OR OTHER GENERATOR IS NOT OPERABLE)
- TREAT OTHER ATOG SYMPTOMS
  - GAIN CONTROL OF PLANT
- MAXIMIZE COOLDOWN RATE
  - RAPID COOLDOWN (UP TO 240 F/HR) DOWN TO 500F
  - COOLDOWN AT 100 F/HR TO DHR
  - RUN RCP'S WHENEVER POSSIBLE
- MINIMIZE SUBCOOLING
  - DEPRESSURIZATION SCHEMES
- DRAIN RCS TO STOP LEAK

.OBJECTIVES: (1) MAINTAIN CORE COOLING

(2) MINIMIZE OFFSITE RADIATION RELEASE


2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
0
400
450
500
550
600
650
700
Reactor Coolant and Steam Outlet Pressure, psig
Reactor Coolant and Steam Outlet Temperature, F
POST TRIP WINDOW
SUBCOOLED REGION
SUPERHEAT REGION
PERFERRED PATH USING PRESSURIZER SPRAY (T_{HOT})
SG T_{SAT}
STEAM PRESSURE LIMIT
~ 50F SUBCOOLING
SATURATION
SUBCOOLED MARGIN LINE
END POINT-POST TRIP WITH FORCED CIRCULATION (T_{HOT} & T_{COLD}) AND FOR NATURAL CIRCULATION (T_{COLD})
NORMAL OPERATING POINT-POWER OPERATION (T_{HOT})
END POINT-POST TRIP WITH NATURAL CIRCULATION (T_{HOT})


POST TRIP WINDOW
SUBCOOLED REGION
SUPERHEAT REGION
PERFERRED PATH USING PRESSURIZER PORV (T_{HOT})
SG T SAT
STEAM PRESSURE LIMIT
~30F BELOW SUBCOOLING MARGIN
SATURATION
SUBCOOLED MARGIN LINE
END POINT-POST TRIP WITH FORCED CIRCULATION (T_{HOT} & T_{COLD}) AND FOR NATURAL CIRCULATION (T_{COLD})
NORMAL OPERATING POINT-POWER OPERATION (T_{HOT})
END POINT-POST TRIP WITH NATURAL CIRCULATION (T_{HOT})
Reactor Coolant and Steam Outlet Pressure, psig
Reactor Coolant and Steam Outlet Temperature, F
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
0
400
450
500
550
600
650
700

II. PROCEDURE COVERS

- ENTIRE SPECTRUM FROM "LEAK" TO FULL TUBE RUPTURE
- TUBE RUPTURE PLUS LOSS OF OFFSITE POWER
- COMBINATIONS OF STEAM LEAKS AND A SGTR (EITHER GENERATOR)

III. STATUS

- ATOG GUIDELINES WRITTEN FOR ALL OPERATING PLANTS (DRAFT)
- SUBMIT FINAL OCONEE ATOG TO STAFF IN APRIL
- CONVERT DRAFT GUIDELINES TO FINALS
- UTILITY WRITES EMERGENCY OPERATING PROCEDURES
- OPERATOR TRAINING AND IMPLEMENTATION