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

APR 16 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 COMBUSTION ENGINEERING ON STEAM GENERATORS

Attached is a summary of the subject meeting that was held on March 18, 1982, in Bethesda. Combustion Engineering presented their views with respect to steam generator tube degradation and steam generator tube rupture accident management. A list of attendees is shown in Enclosure 1 to the summary.

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

Attachment:
As Stated

8205100084

XA

13.

ATTENDANCE LIST

COMBUSTION ENGINEERING - STEAM GENERATOR MEETING

MARCH 18, 1982

NRC Participants

D. Eisenhut, DL
G. Lainas, DL
C. McCracken, DE
T. Speis, DSI
E. Sullivan, DE
R. Vollmer, DE
P. Norian, DST
K. Wichman, DL
R. Martin, DL
R. Clark, DL
W. Kennedy, DHFS
T. Ippolito, DL
B. Shearon, DSI

Combustion Engineering Participants

G. Bischoff
V. Callaghan
H. Williams
E. Kennedy

Utility Participant

B. Lawson, AP&L

SUMMARY OF MARCH 18, 1982 MEETING WITH

COMBUSTION ENGINEERING REGARDING STEAM GENERATORS

On Thursday, March 18, 1982, representatives of Combustion Engineering (CE) 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 CE during the presentation and the attendance list are enclosed.

CE described the steam generator configurations and significant differences between their three models of steam generators, i.e., 2570 MWt, 3410 MWt, and System 80 (3817 MWt). Eight units are currently operating with 2570 MWt class steam generators and San Onofre Unit 2 which recently received a low power license, has 3410 MWt class steam generators. There are no operating plants with System 80 steam generators. All CE steam generators have full depth tube expansion in the tubesheet and full or partial eggcrate tube supports; however, the 2570 MWt class also has two partial drilled support plates where denting has occurred in two plants. In the bend region, batwing spacer assemblies in contact with the tubes in the 2570 MWt class, have evolved into "V" spacer assemblies with no U-bend contact for the other models of CE steam generators. The System 80 steam generators, in a major design change, incorporate an integral economizer (preheater) section. Ninety percent of feedwater flow is through the two main feedwater nozzles. Feedwater flow is directed down the shroud and does not impinge (e.g. no cross flow) on the steam generator tubes.

CE outlined the steam generator tube degradation experienced to date. Five tube leaks have occurred, four in one plant of which three took place in 1973. The tubes plugged in eight operating units due to inservice degradation is 5476 in a total of 129,131 tubes. The number of preventatively plugged tubes is 576. Generally, 40% tubewall degradation is allowed before plugging. CE stated that some loose parts have been found in certain steam generators in the past, but that CE has issued no specific advisories to their clients concerning loose parts. Four of the eight operating units with CE steam generators have loose parts monitoring systems with offline capability.

An overview of the CE operator guidelines (C-EOG) strategy to mitigate steam generator tube ruptures (SGTR) was presented and major differences between actions taken at Ginna and C-EOG SGTR specified actions were delineated. It was stated that CE guidelines and equipment may have

reduced challenges to steam generator safety valves, but that the Ginna plant response was not significantly different from that of a CE plant. CE emphasized that C-EOG guidance is generic and that utilities may choose to implement it in a manner different than specified.

K. R. Wichman

Keith R. Wichman
Operating Reactors Assessment Branch
Division of Licensing

Enclosures:
As Stated

cc w/enclosures:
See next page

MEETING WITH NRC STAFF

MARCH 18, 1982

AGENDA

I. EVOLUTION OF CE STEAM GENERATOR DESIGNS

II. STEAM GENERATOR LEAKAGE AND PLUGGING EXPERIENCE

III. STEAM GENERATOR CHEMISTRY RECOMMENDATIONS

IV. CE EMERGENCY OPERATOR PROCEDURE GUIDELINES FOR STEAM GENERATOR TUBE RUPTURE EVENTS

C-E STEAM GENERATORS

2570 MWT CLASS

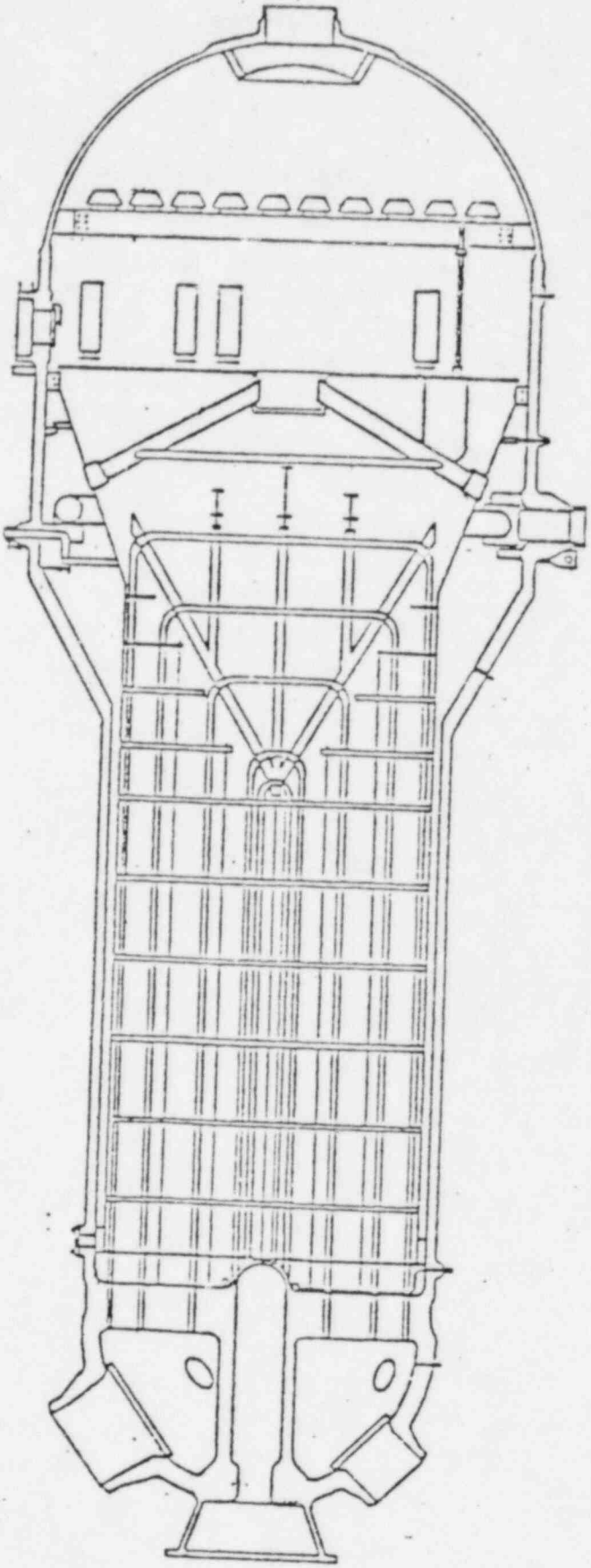
NUMBER OF TUBES:	8519
TUBE SIZE:	0.750" O.D. X 0.048" WALL
TUBE PITCH:	TRIANGULAR PITCH, 1" CENTERS
TUBE SUPPORTS:	SIX FULL DISK EGGCRATES TWO PARTIAL EGGCRATES TWO PARTIAL DRILLED SUPPORT PLATES BEND REGION - BATWING SPACER ASSEMBLIES WITH INTERLOCKING HORIZONTAL STRIPS.
BLOWDOWN ARRANGEMENT:	2" DIAMETER PIPE IN DIVIDER LANE

TUBE TO TUBESHEET JOINT:

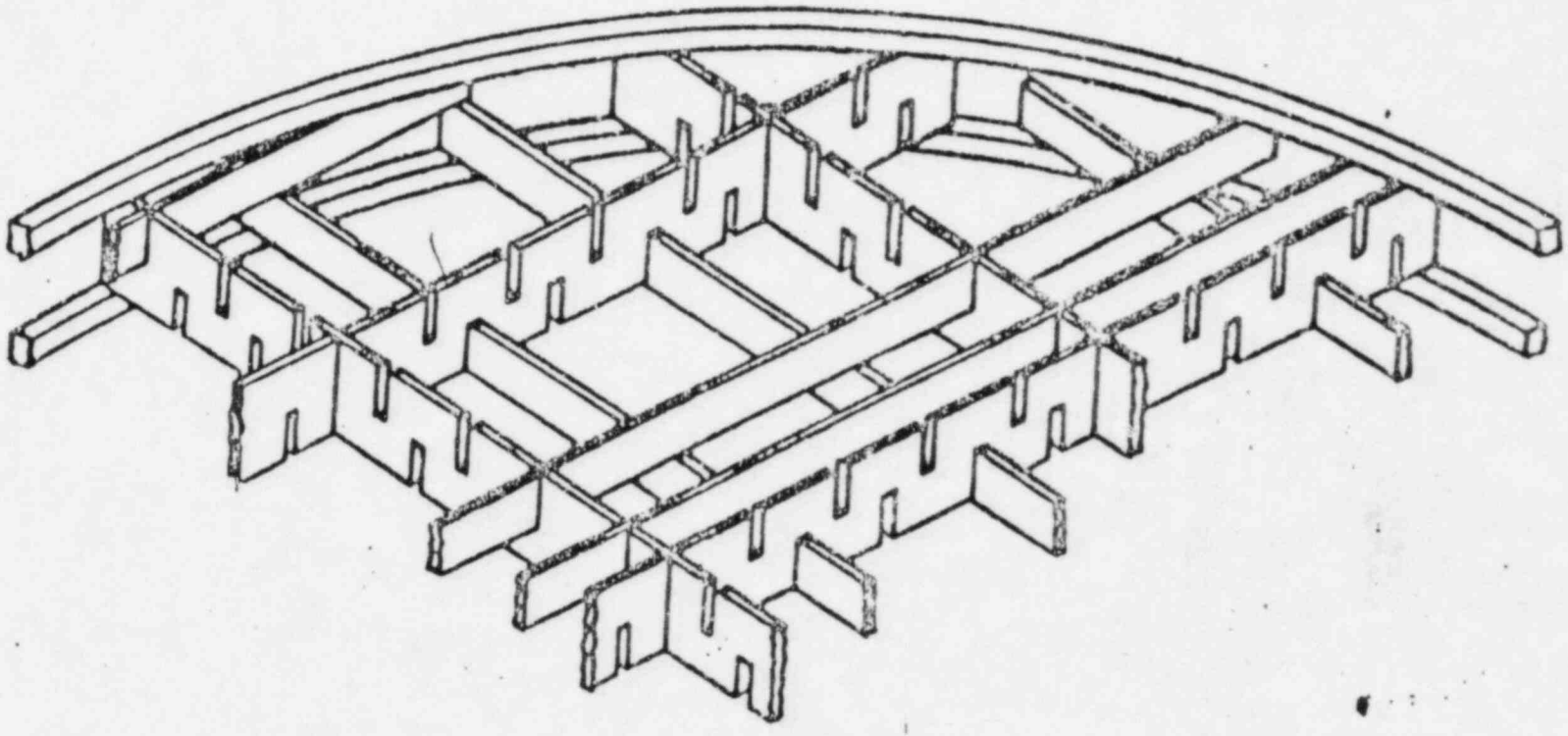
FULL DEPTH EXPANSION (EXPLANSION)
EDGE WELDED TUBE TO TUBESHEET WELD

NOMINAL OPERATING PARAMETERS:

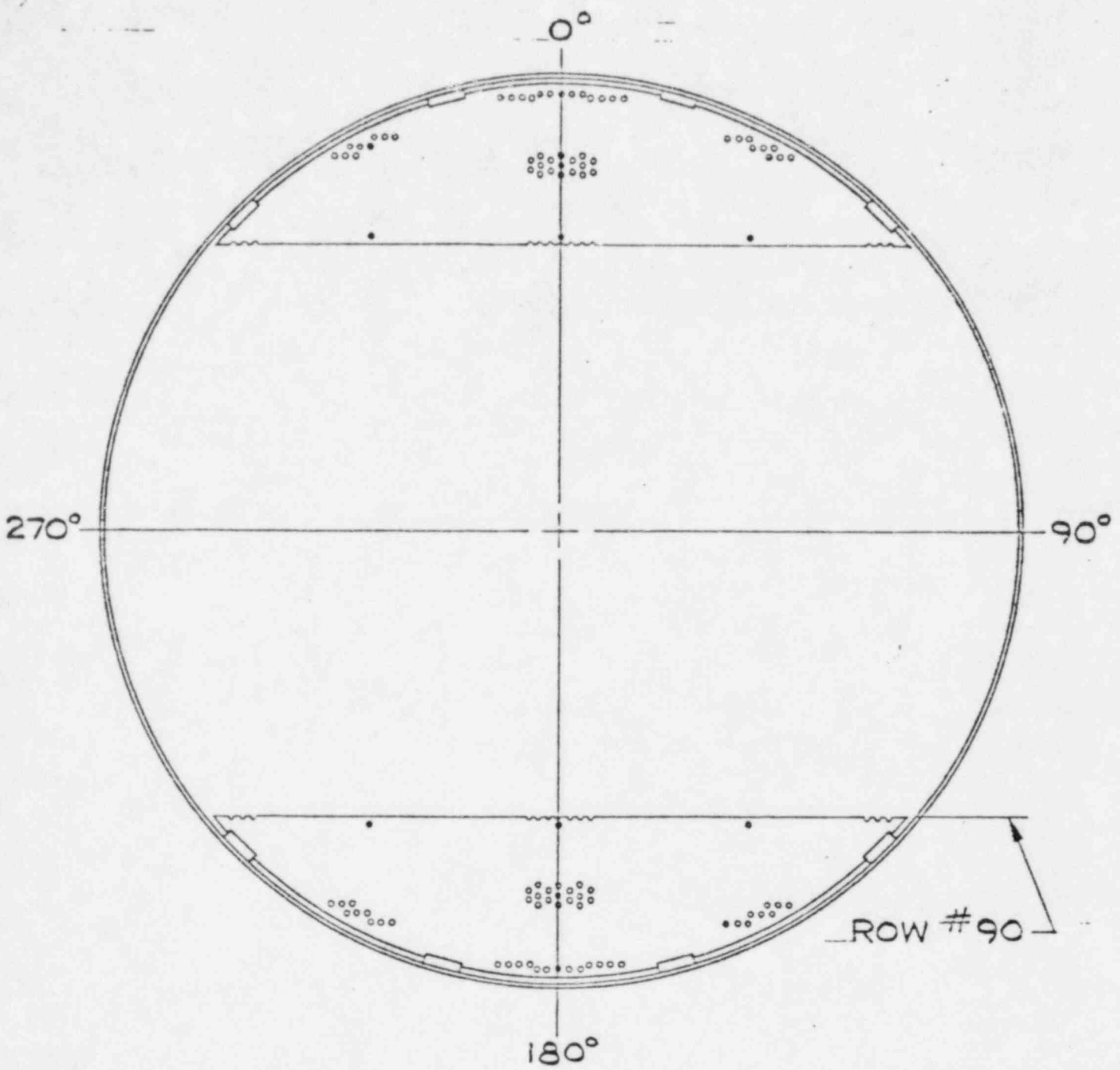
PRIMARY PRESSURE	-	2250 PSIA
SECONDARY PRESSURE	-	815 - 850 PSIA
PRIMARY TH	-	604°F
PRIMARY TC	-	550°F

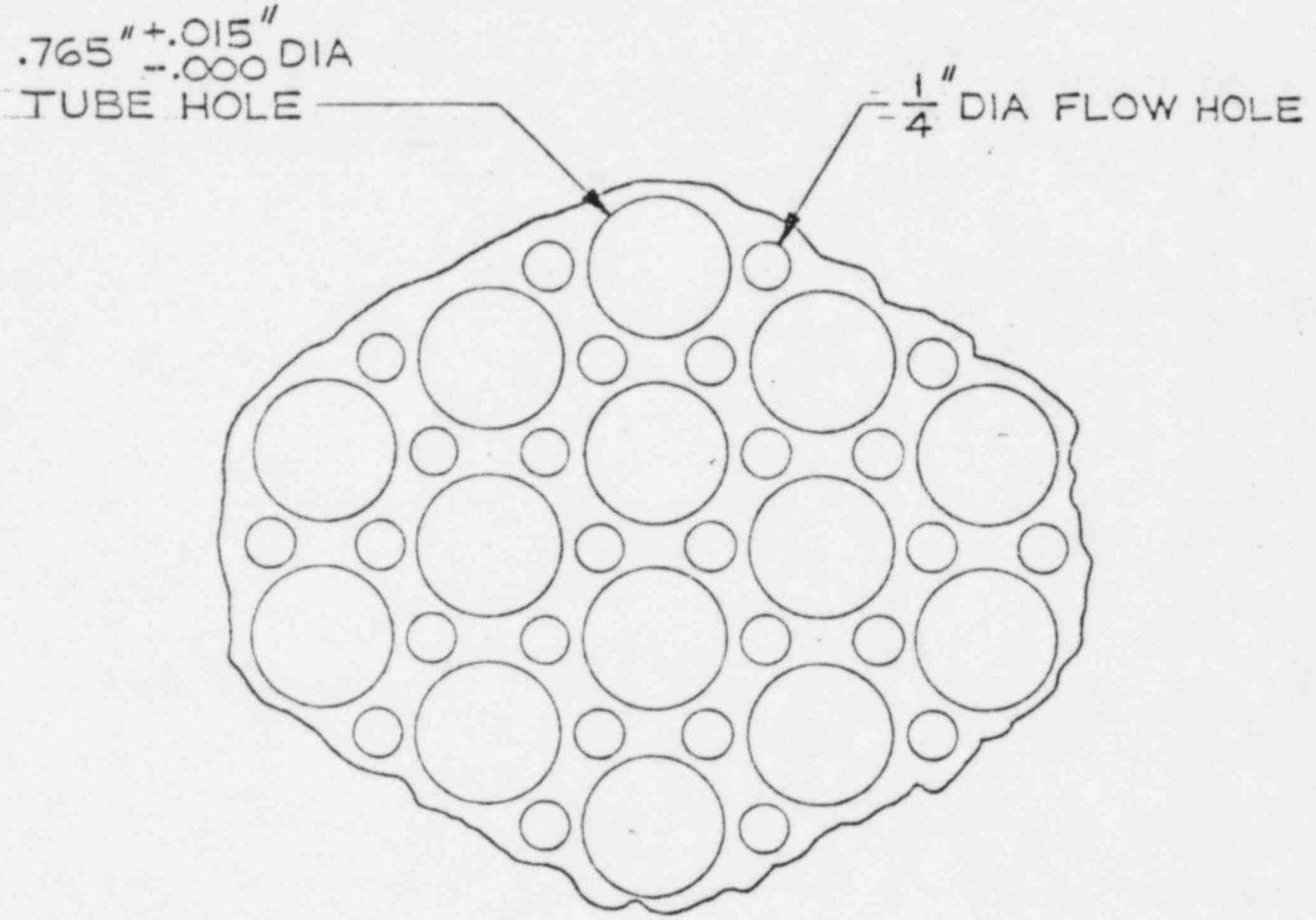


Open Flow Area - 69%
Flow-Through Design
Line Contact with Tubes

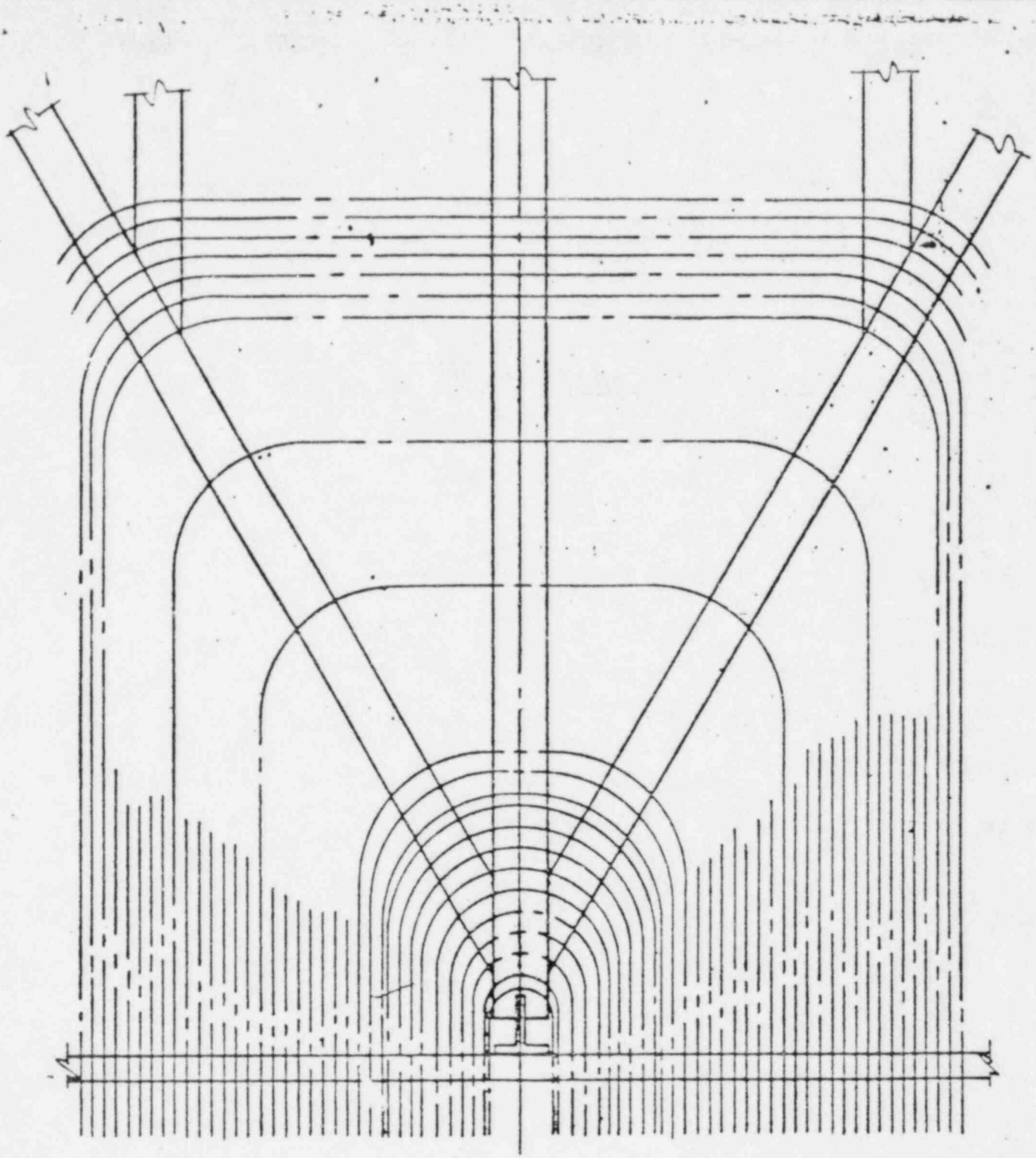


HORIZONTAL GRID
"EGGCRATE"
TUBE SUPPORT

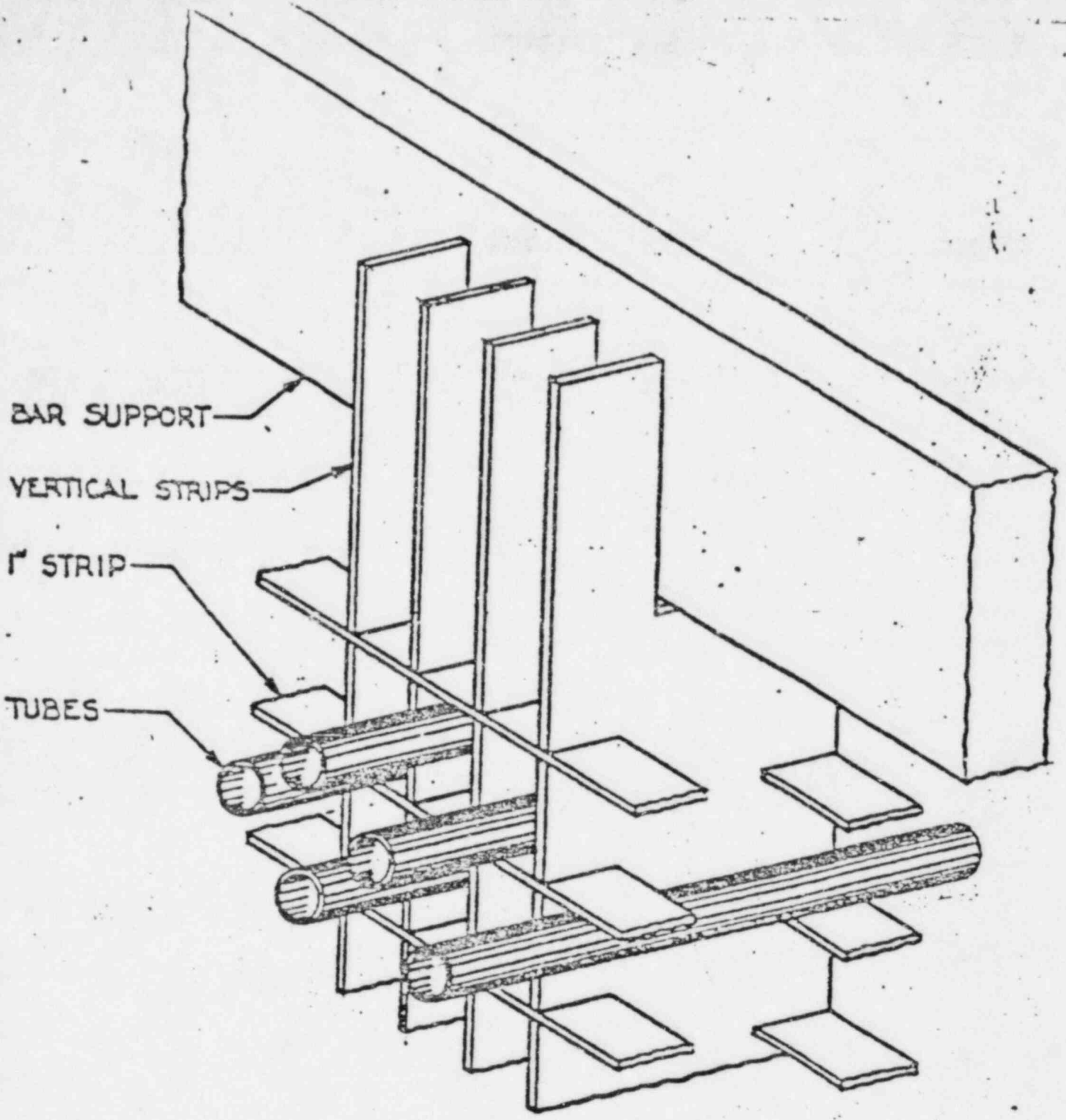

0°
270°
90°
180°
ROW #90



TYPICAL TUBE SUPPORT
PLATE PATTERN



ORIGINAL TUBE BUNDLE



TUBE SUPPORT

FROST

C-E STEAM GENERATORS

3410 MWT CLASS

NUMBER OF TUBES: 9350

TUBE SIZE: 0.750" O.D. X 0.048" WALL

TUBE PITCH: TRIANGULAR PITCH, 1" CENTERS

TUBE SUPPORTS:
SEVEN FULL DISK EGGCRATES
FOUR PARTIAL EGGCRATES
BEND REGION - "V" SPACER ASSEMBLIES INTERSECTING TUBES IN VERTICAL RUN BELOW BENT TANGENT POINT.

VERTICAL SPACER ASSEMBLIES (VENTILATED) WITH INTERLOCKING HORITONTAL STRIPS.

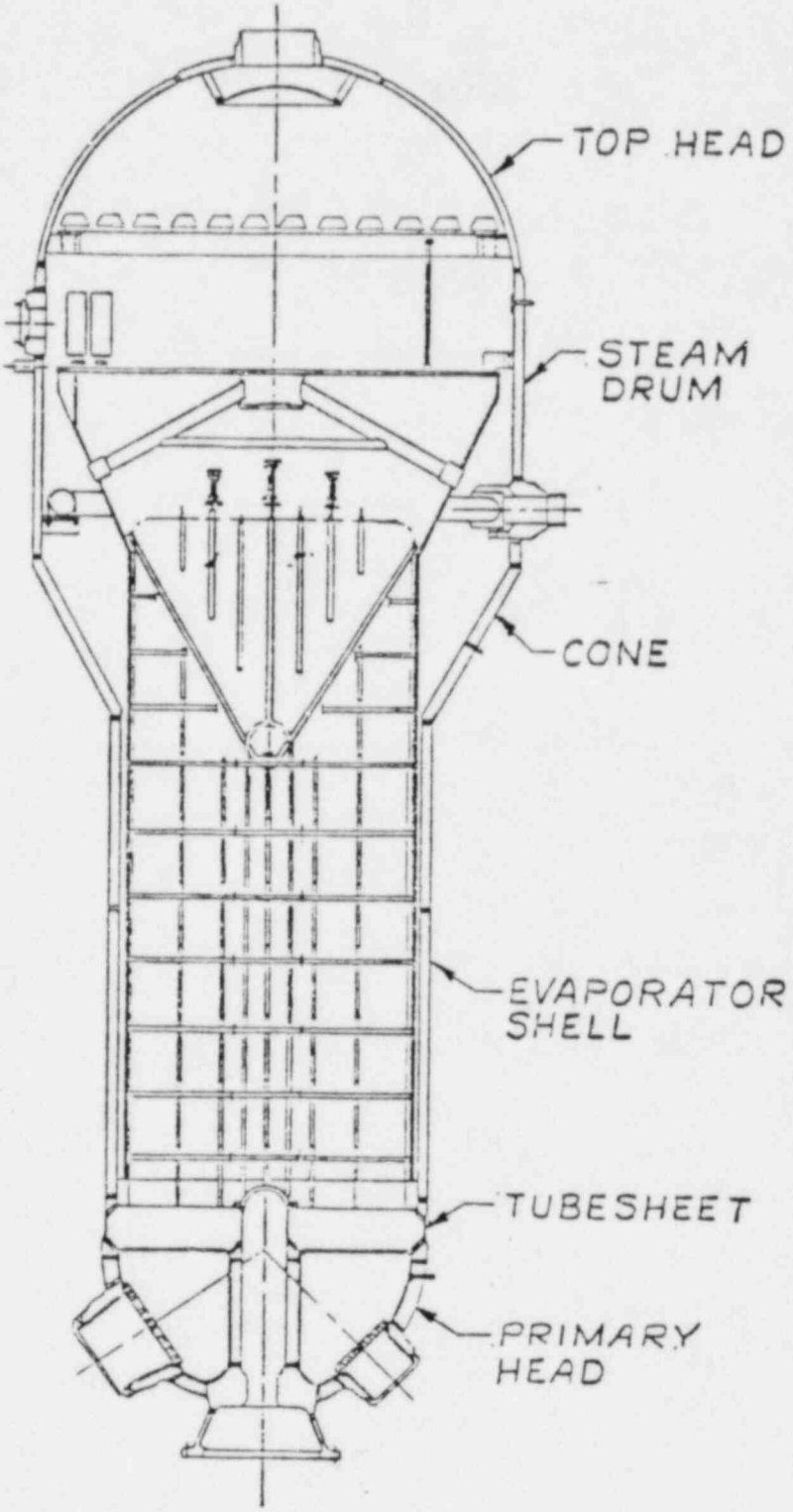
BLOWDOWN ARRANGEMENT: 2" DIAMETER PIPE IN DIVIDER LANE

TUBE TO TUBESHEET JOINT:

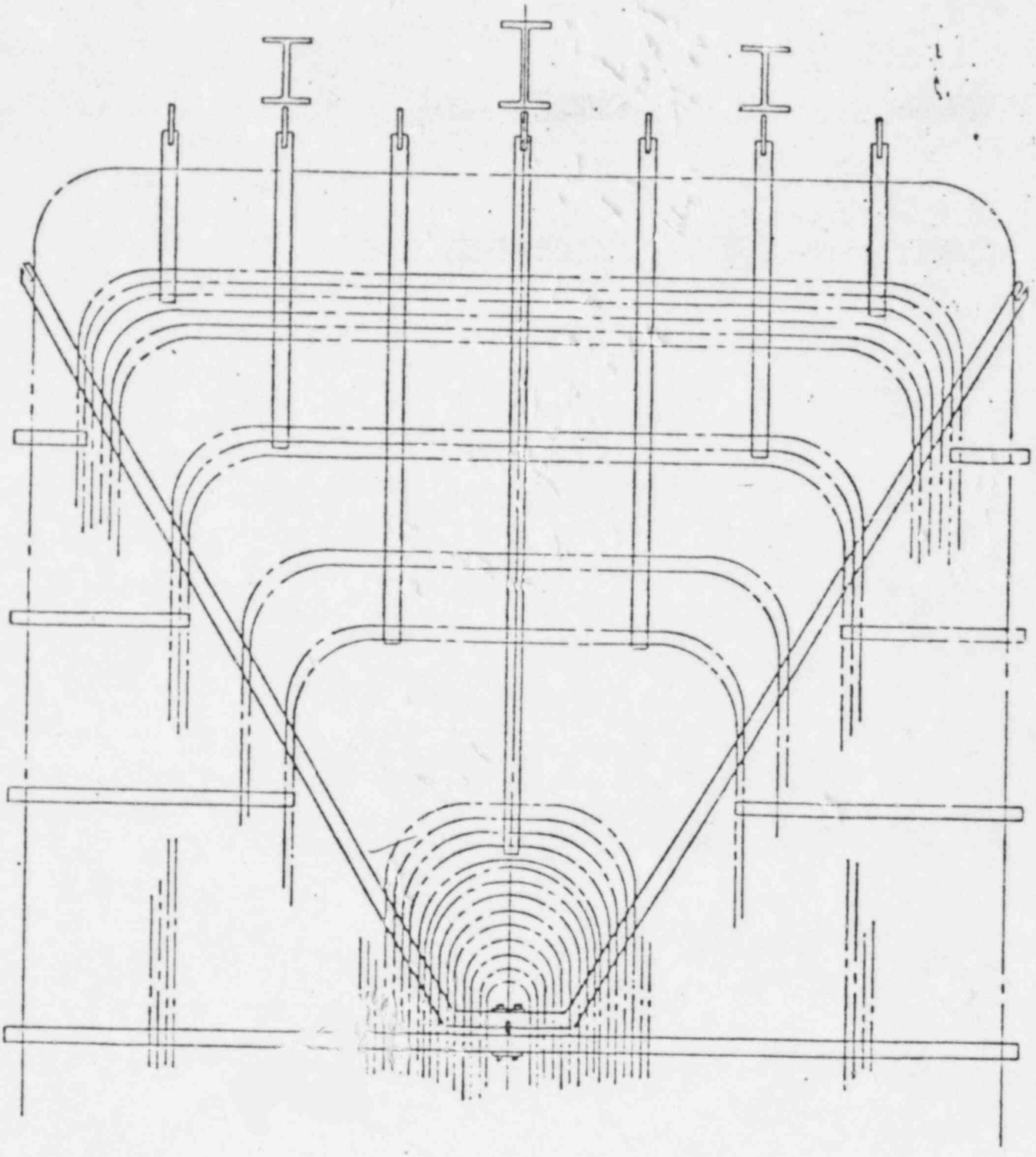
FULL DEPTH EXPANSION (EXPLANSION)
EDGE WELDED TUBE TO TUBESHEET WELD

NOMINAL OPERATING PARAMETERS:

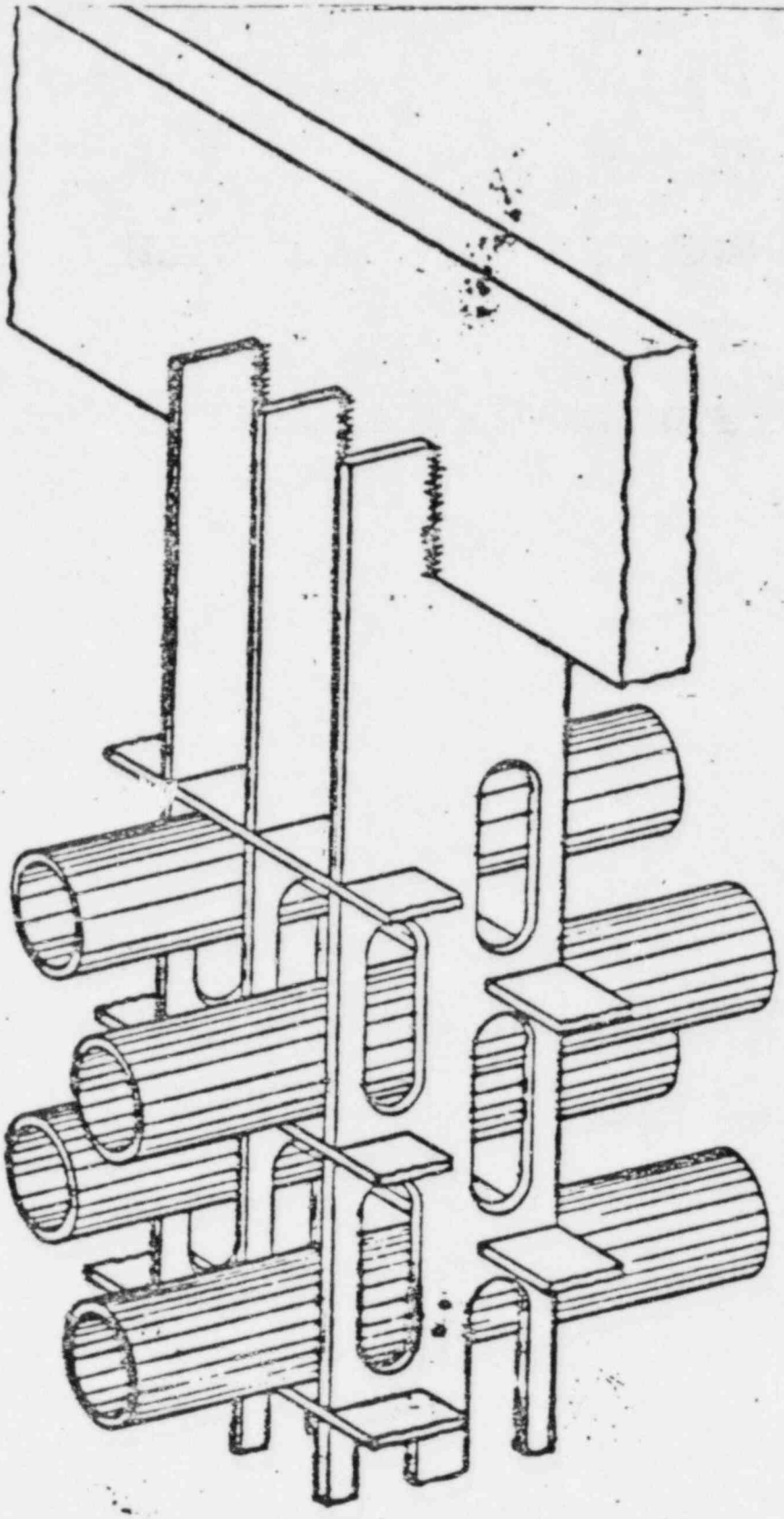
PRIMARY PRESSURE	-	2250 PSIA
SECONDARY PRESSURE	-	900 PSIA
PRIMARY TH	-	611°F
PRIMARY TC	-	553°F


TOP HEAD
STEAM DRUM
CONE
EVAPORATOR SHELL
TUBESHEET
PRIMARY HEAD

3,410 MWT.



U-BEND TUBE SUPPORT SYSTEM



TUBE SUPPORT

(SLIDE NO. 2)

NOTES

C-E STEAM GENERATORS

SYSTEM 80 (3817 MWT)

NUMBER OF TUBES: 11,000

TUBE SIZE: 0.750" O.D. X 0.042" WALL

TUBE PITCH: TRIANGULAR, 1" CENTERS

TUBE SUPPORTS:
TWO HALF EGGCRATES (ECONOMIZER ELEVATION)
THREE FULL DISK EGGCRATES
TWO PARTIAL EGGCRATES
BEND REGION - "V" SPACER ASSEMBLIES INTERSECTING TUBES IN VERTICAL RUN BELOW BEND TANGENT POINT.

VERTICAL SPACER ASSEMBLIES (VENTILATED) WITH INTERLOCKING HORIZONTAL STRIPS).

INTEGRAL ECONOMIZER (PREHEATER):

AXIAL COUNTERFLOW ARRANGEMENT
180° FEEDWATER DISTRIBUTION DISCHARGING VERTICALLY DOWNWARD
FLOW DISTRIBUTION BAFFLES, HOT AND COLD LEG

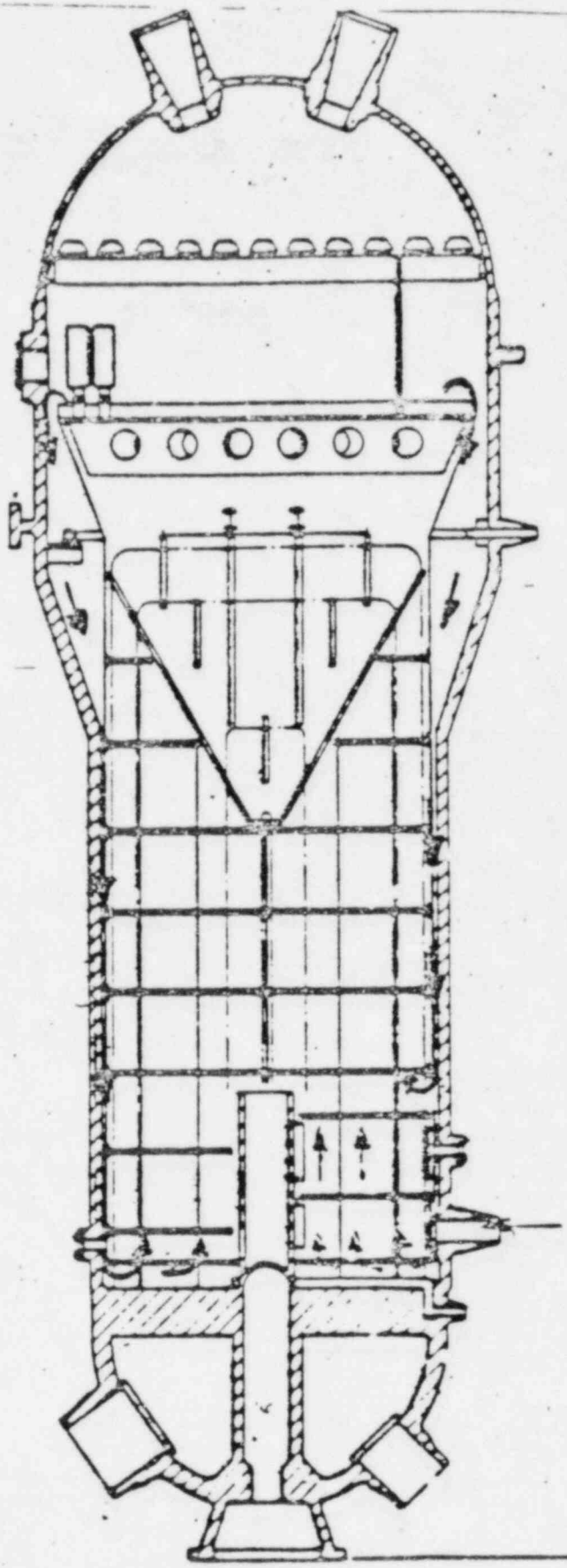
BLOWDOWN ARRANGEMENT: 3" X 6" DUCT, CENTER SUCTION PORTS
SEPARATE, HOT AND COLD LEGS

TUBE TO TUBESHEET JOINT:

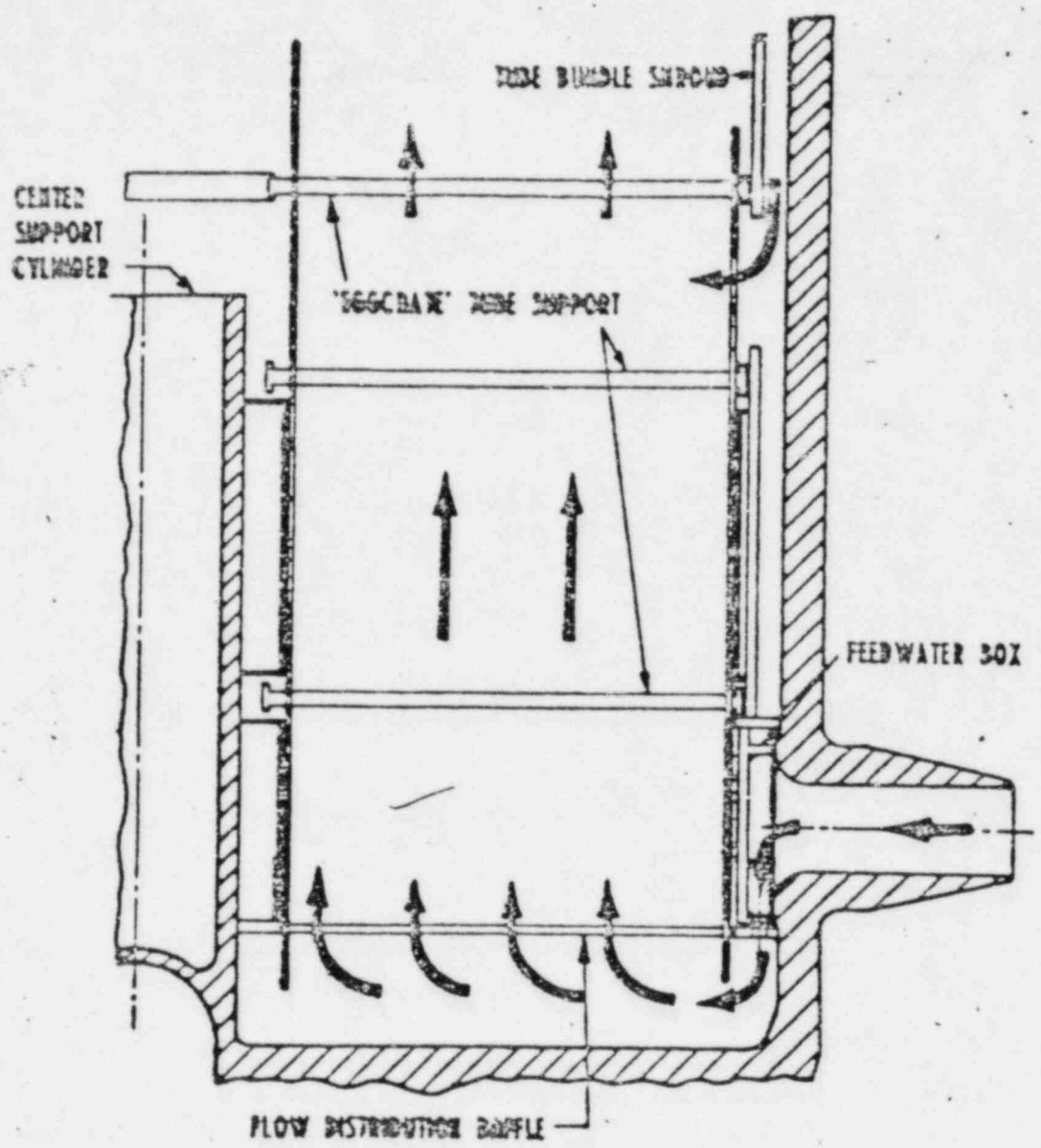
FULL DEPTH EXPANSION (EXPLANSION)
EDGE WELDED TUBE TO TUBESHEET WELD

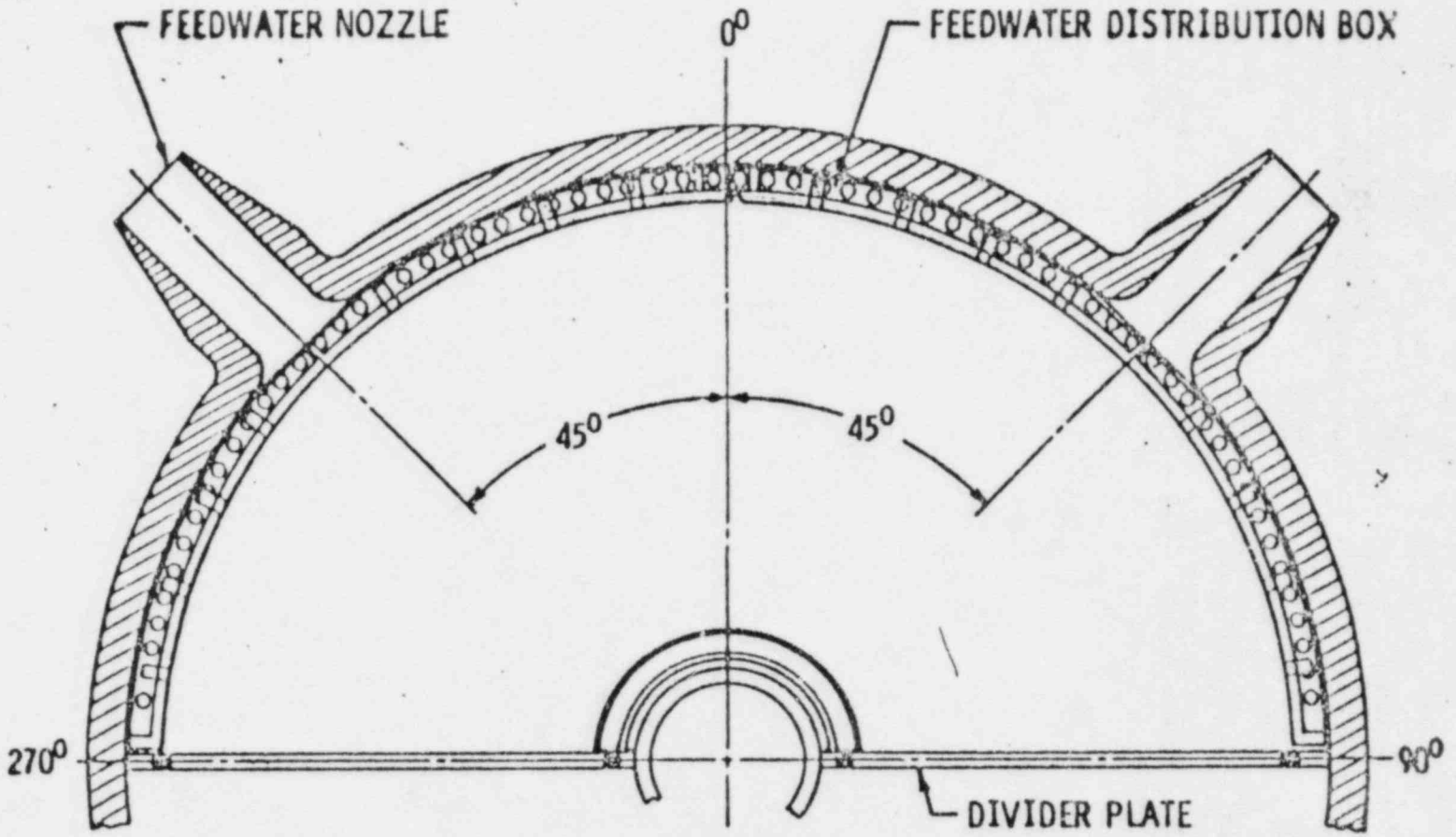
NOMINAL OPERATING PARAMETERS:

PRIMARY PRESSURE - 2250 PSIA
SECONDARY PRESSURE - 1070 PSIA
PRIMARY TH - 621°F
PRIMARY TC - 564°F

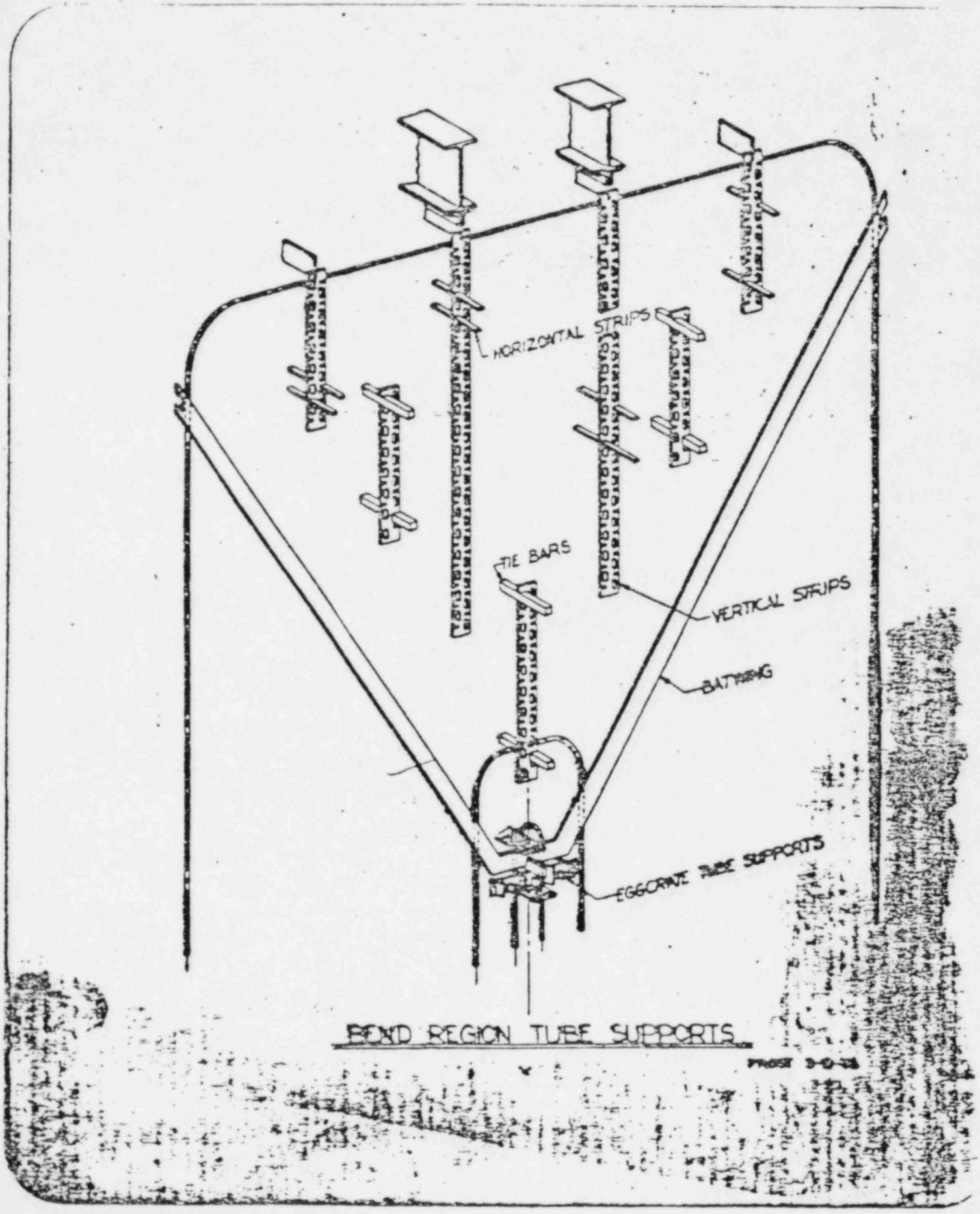


SYSTEM 80


CENTER
SUPPORT
CYLINDER
FEEDWATER BOX

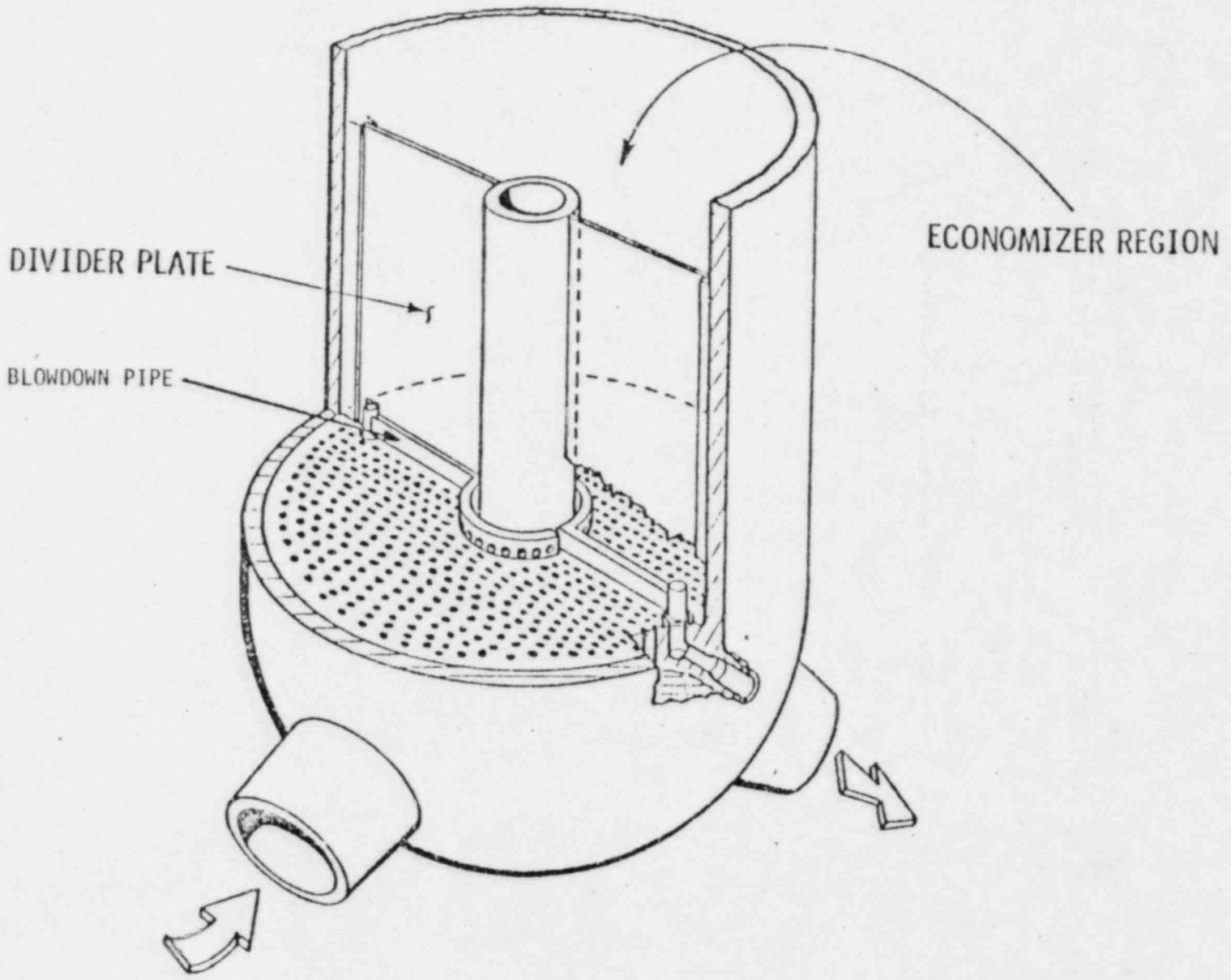


ECONOMIZER (PLAN VIEW)



BOND REGION TUBE SUPPORTS

ECONOMIZER REGION



C-E STEAM GENERATORS
TUBE LEAK TABULATION

PLANT	NO. S.G.'S	PLANT TOTAL TUBES	TUBE LEAKS				
			TUBE WASTAGE	TUBE CRACKING	TUBE DENTING	TUBE PITTING	VIBRATION/ WEAR
A	2	17038	3 (1973)	1			
B	3	17109					
C	2	10010					
D	2	17038					
E	2	17038					
F	2	17038		1 (?)			
G	2	17038					
H	2	16822					
TOTAL	17	129,131	3	2			

C-E STEAM GENERATORS
TUBE PLUGGING TABULATION

PLANT	NO. S.G.'S	TOTAL NO. TUBES	TUBES PLUGGED						
			WASTAGE	CRACKING	DENTING	PITTING	VIBRATION/WEAR	PREVENTATIVE	TOTAL
A	2	17038	3747		11				3758
B	3	17109						15	15
C	2	10010	3***					48	51
D	2	17038							
E	2	17038			331	731		437	1499
F	2	17038		77*				50	127
G	2	17038							
H	2	16822						26	26
TOTAL	17	129,131	3750	77*	331	731		576	5476

* CAUSE NOT SPECIFICALLY DETERMINED
*** THOUGHT TO BE MECHANICAL, NOT CONFIRMED

TUBE PLUGGING CRITERIA

BASIS: REGULATORY GUIDE 1.121
ASME CODE, SECTIONS III AND XI

TUBE PLUGGING LIMITS:

GENERALLY 40% TUBE WALL DEGRADATION ALLOWED.

GREATER DEGRADATION ALLOWED WHEN JUSTIFIED ON A PLANT BASIS USING SAME CRITERIA AND METHODOLOGY.

ALLOWABLE DEGRADATION OF 56% OR GREATER CAN BE JUSTIFIED FOR CURRENTLY OPERATING C-E PLANTS.

PLUGGING LIMIT FOR TUBE DENTING BASED ON "PLUG GAGE" (0.540" DIAMETER ECT PROBE) RELATED TO HOOP TENSILE STRAIN.

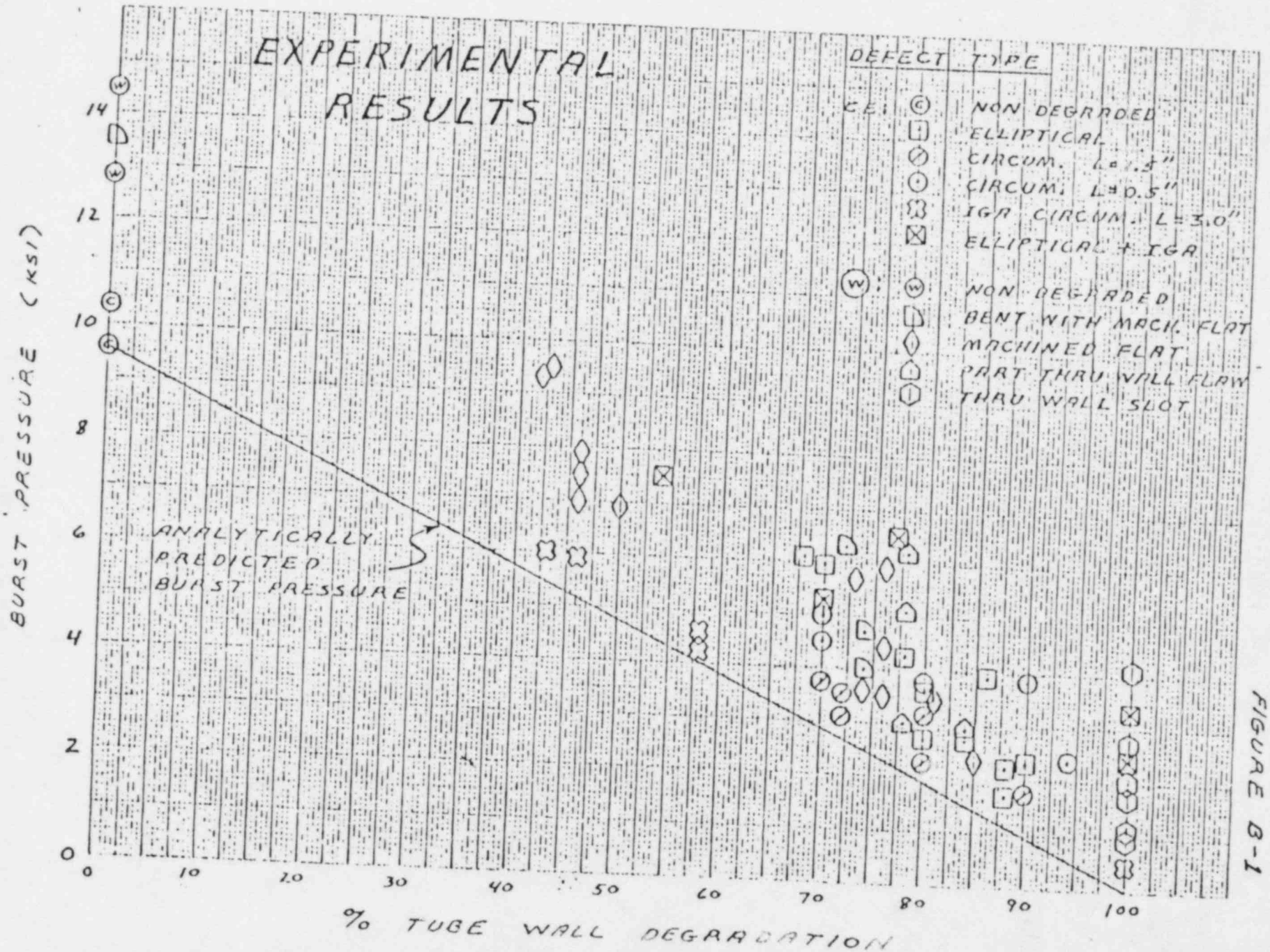

EXPERIMENTAL RESULTS
DEFECT TYPE
E: NON DEGRADED ELLIPTICAL
CIRCUM. L=.5"
CIRCUM. L=0.5"
IGA CIRCUM. L=3.0"
ELLIPTICAL + IGA
W: NON DEGRADED BENT WITH MACH. FLAT
MACHINED FLAT
PART THRU WALL FLAW
THRU WALL SLOT
ANALYTICALLY PREDICTED BURST PRESSURE
BURST PRESSURE (KSI)
% TUBE WALL DEGRADATION
0
2
4
6
8
10
12
14
0
10
20
30
40
50
60
70
80
90
100

FIGURE B-1

C-E STEAM GENERATOR

CHEMISTRY CONTROL SPECIFICATIONS

	NORMAL	ABNORMAL	IMMEDIATE SHUTDOWN
pH	8.2 - 9.2	7.5 - 8.2 9.2 - 9.5	10.5
CONDUCTIVITY (SPECIFIC)	< 7 µMHOS/CM*	7 - 15 µMHOS/CM	
SUSPENDED SOLIDS	< 1.0 PPM	1 - 10 PPM	
FREE HYDROXIDE	-------	-------	5 PPM
SILICA	< 1.0 PPM	1 - 10 PPM	
CHLORIDE	< 0.1 PPM	-------	-------

* SPECIFIC CONDUCTIVITY ALARM SET POINT 4 µMHOS/CM

JWK/3/82

0213b

PURPOSE

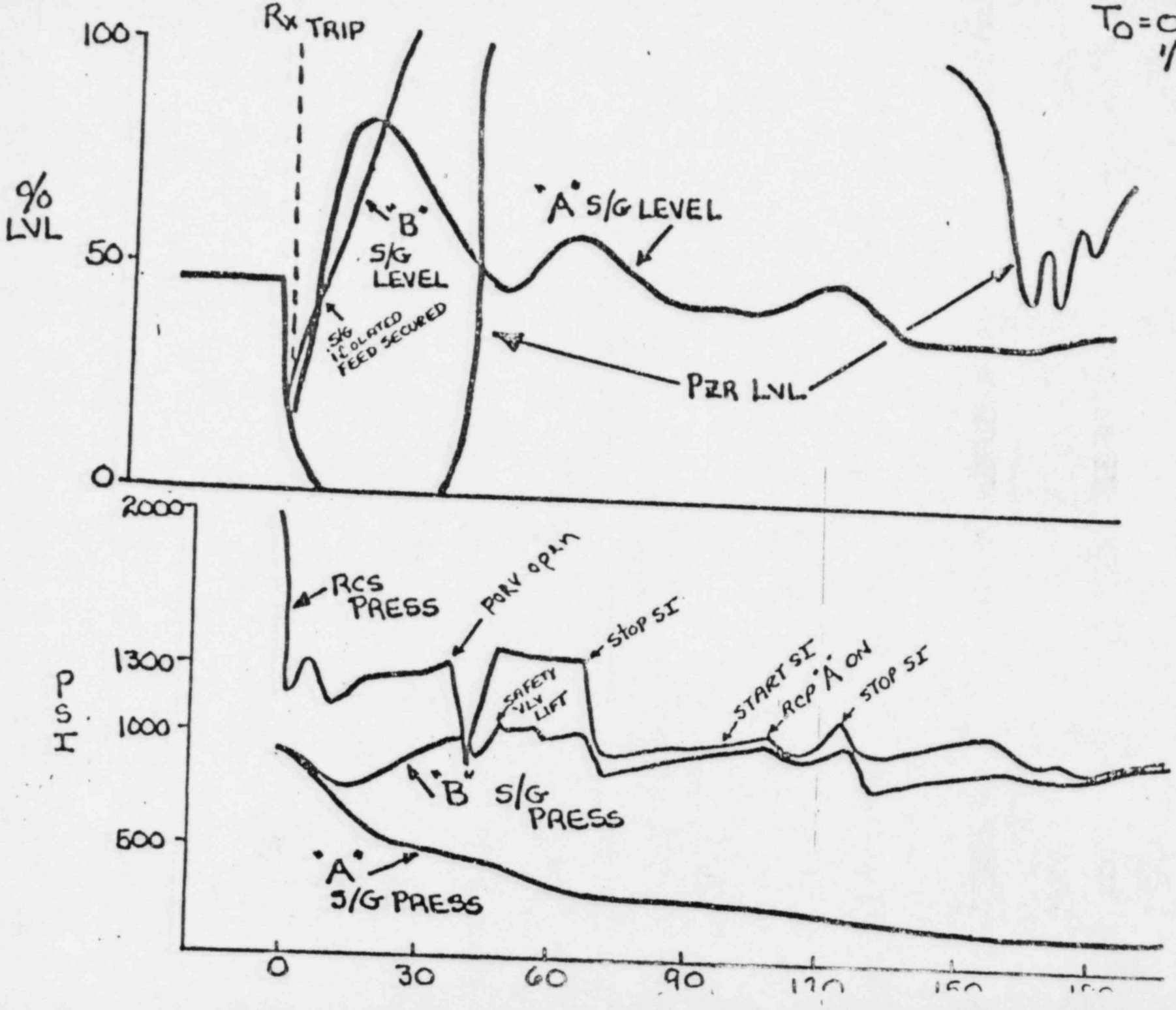
- PROVIDE AN OVERVIEW OF THE C-EOG STRATEGY TO MITIGATE SGTRs

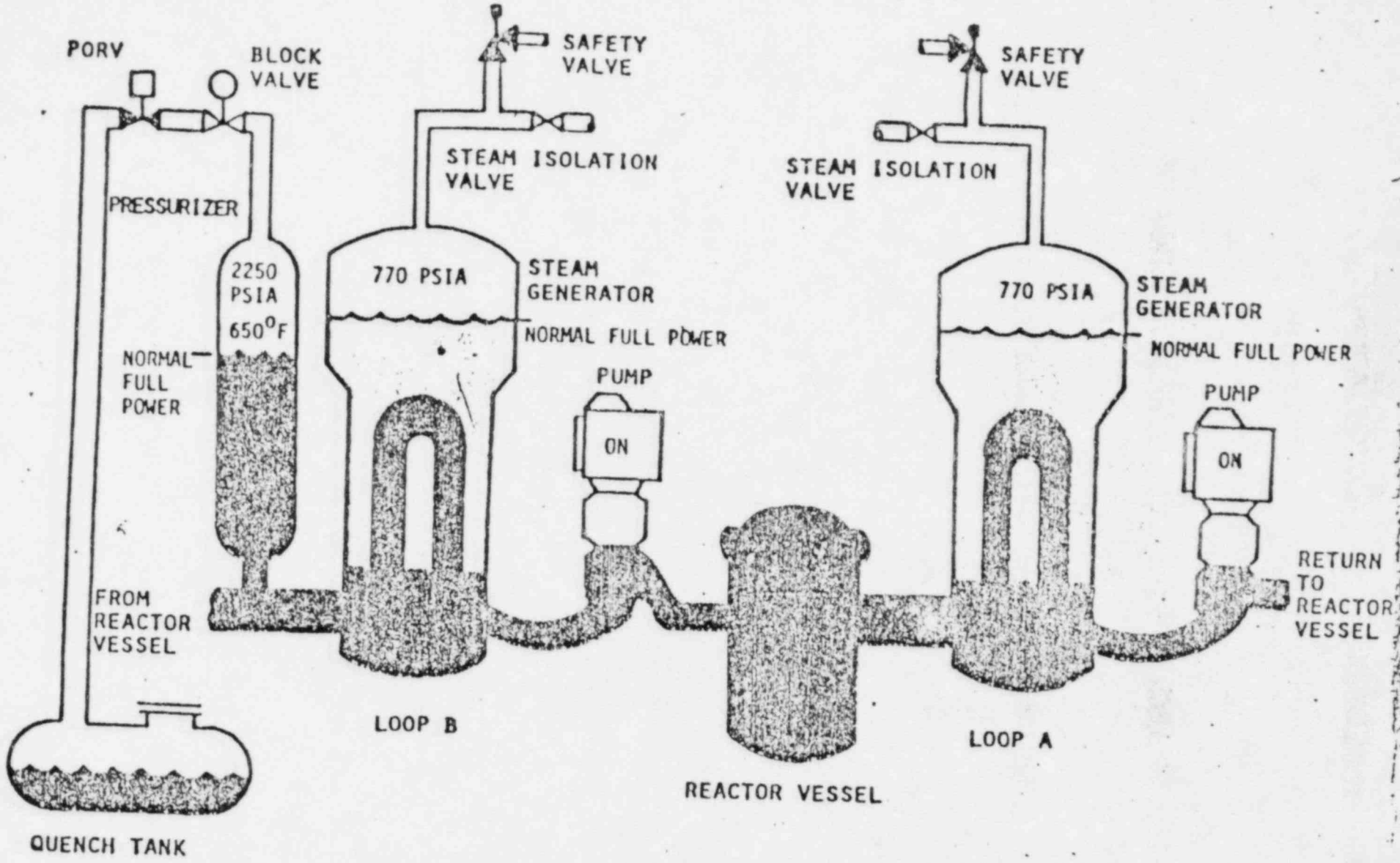
- POINT OUT MAJOR DIFFERENCES BETWEEN ACTIONS TAKEN AT GINNA AND ACTIONS SPECIFIED IN THE C-EOG SGTR GUIDELINE

- C-EOG GUIDANCE IS GENERIC

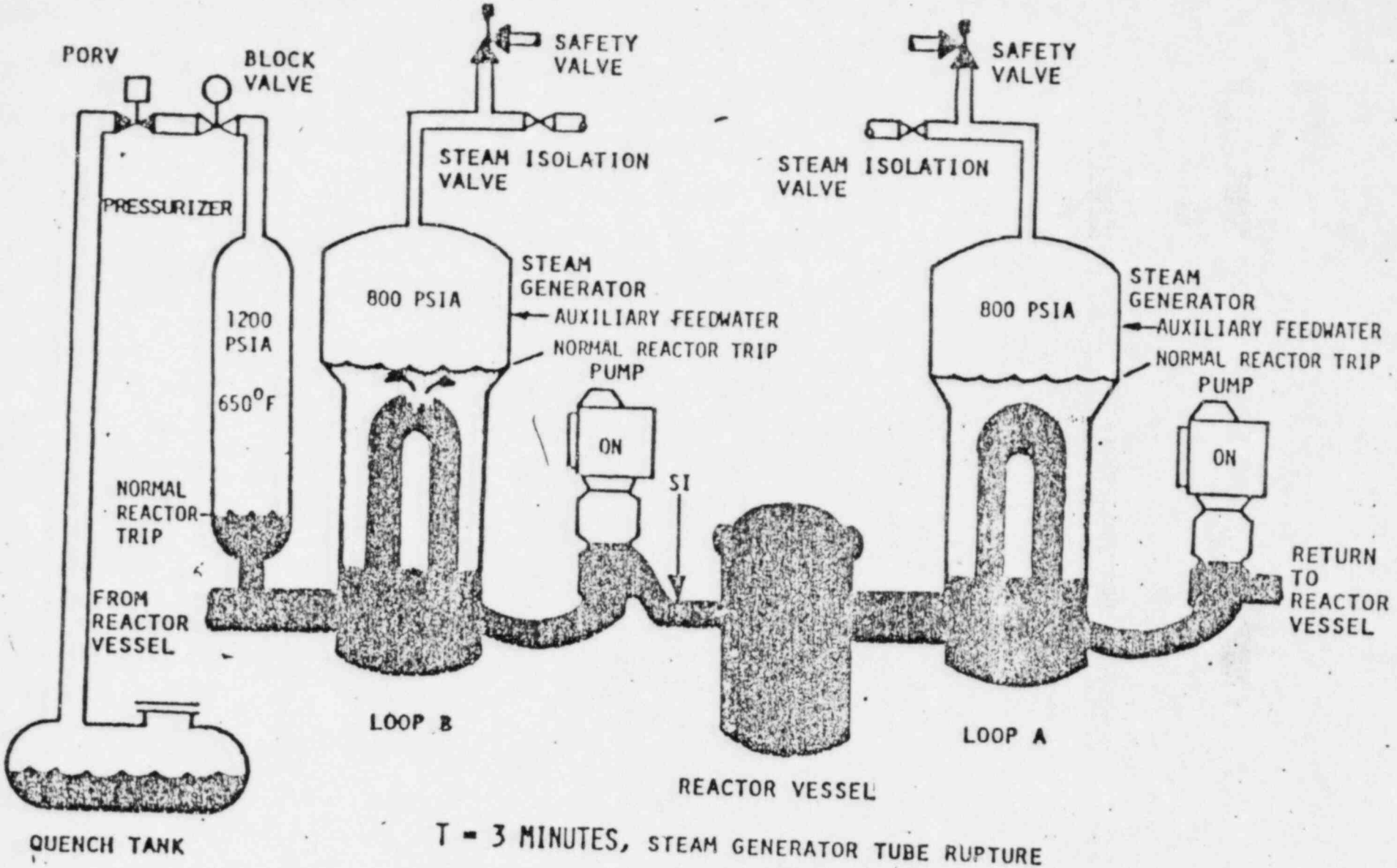
- UTILITIES MAY CHOOSE TO IMPLEMENT IT DIFFERENTLY THAN STATED

- C-E CANNOT SPEAK FOR UTILITIES


T_0 = 0928
1/25/82
Rx TRIP
100
50
0
% LVL
"B" S/G LEVEL
S/G ISOLATED FEED SECURED
"A" S/G LEVEL
PZR LVL
2000
1300
1000
500
PSIG
RCS PRESS
PORV OPEN
STOP SI
SAFETY VLV LIFT
START SI
RCP "A" ON
STOP SI
"B" S/G PRESS
"A" S/G PRESS
0
30
60
90



T = 0, INITIAL CONDITIONS, NORMAL POWER



T - 3 MINUTES, STEAM GENERATOR TUBE RUPTURE

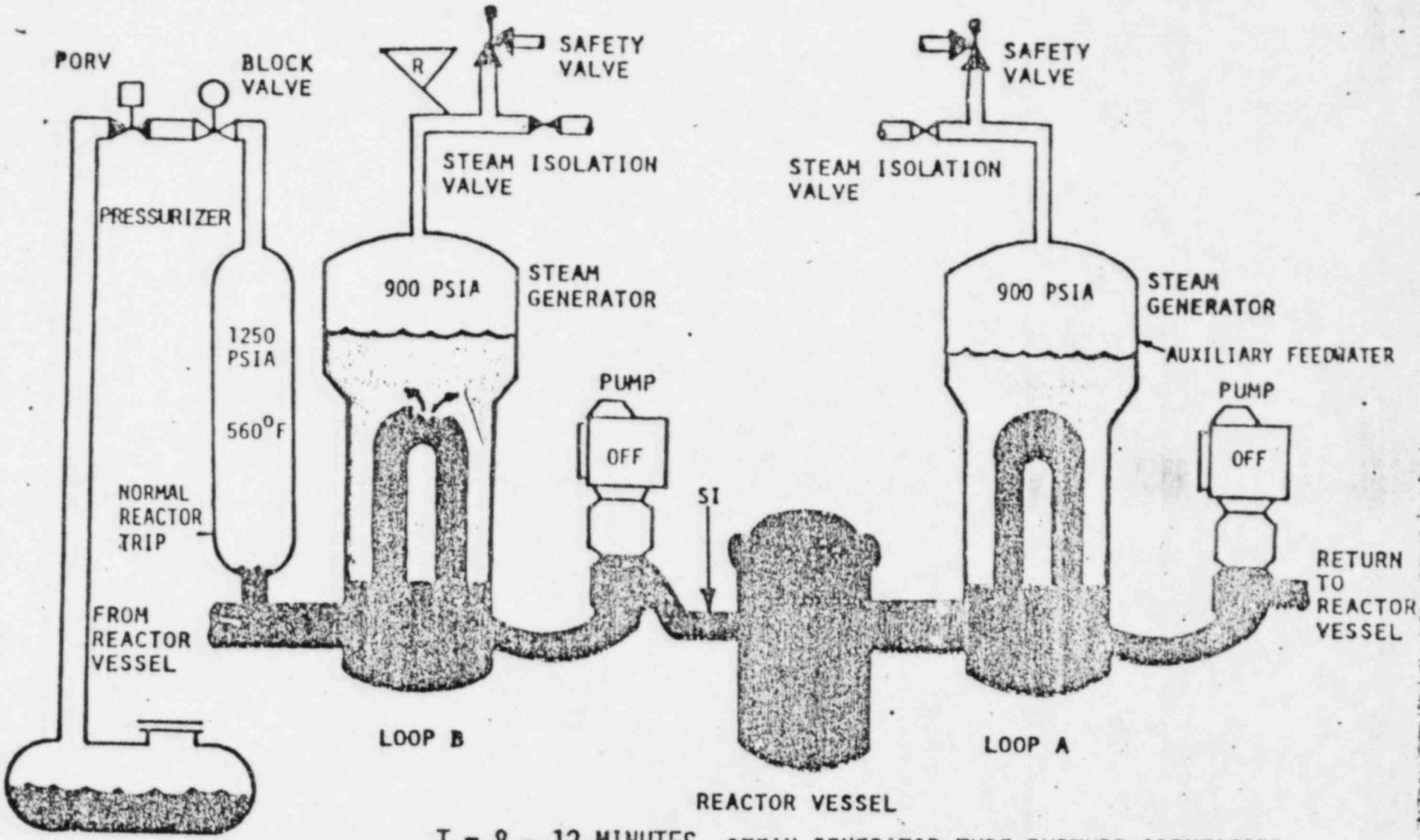
REACTOR TRIP, COOLANT PUMPS ON

SI ACTUATION

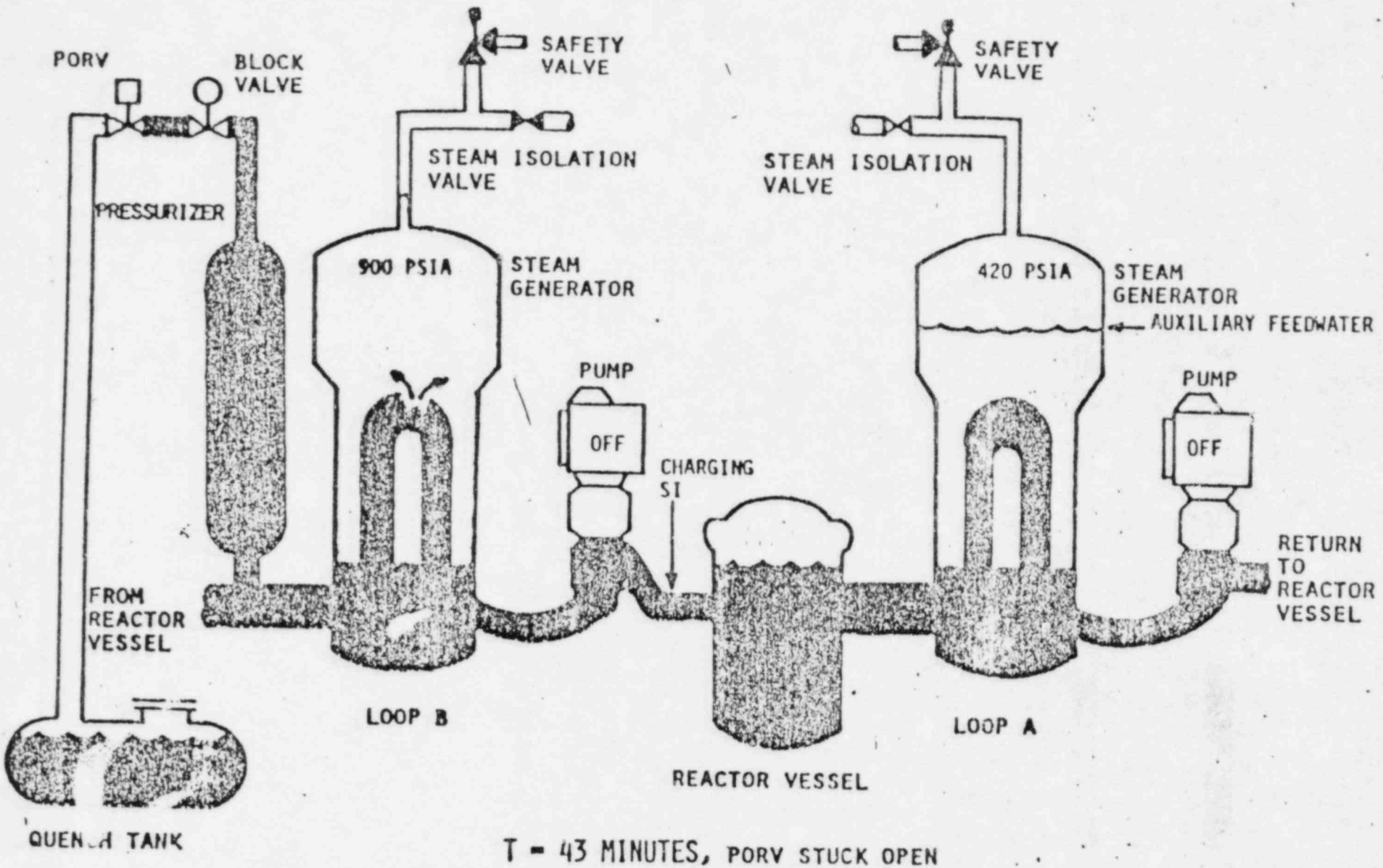
AUXILIARY FEEDWATER ACTUATION

PRESSURIZER LEVEL DEPLETED

STEAM GENERATOR LEVEL LOW



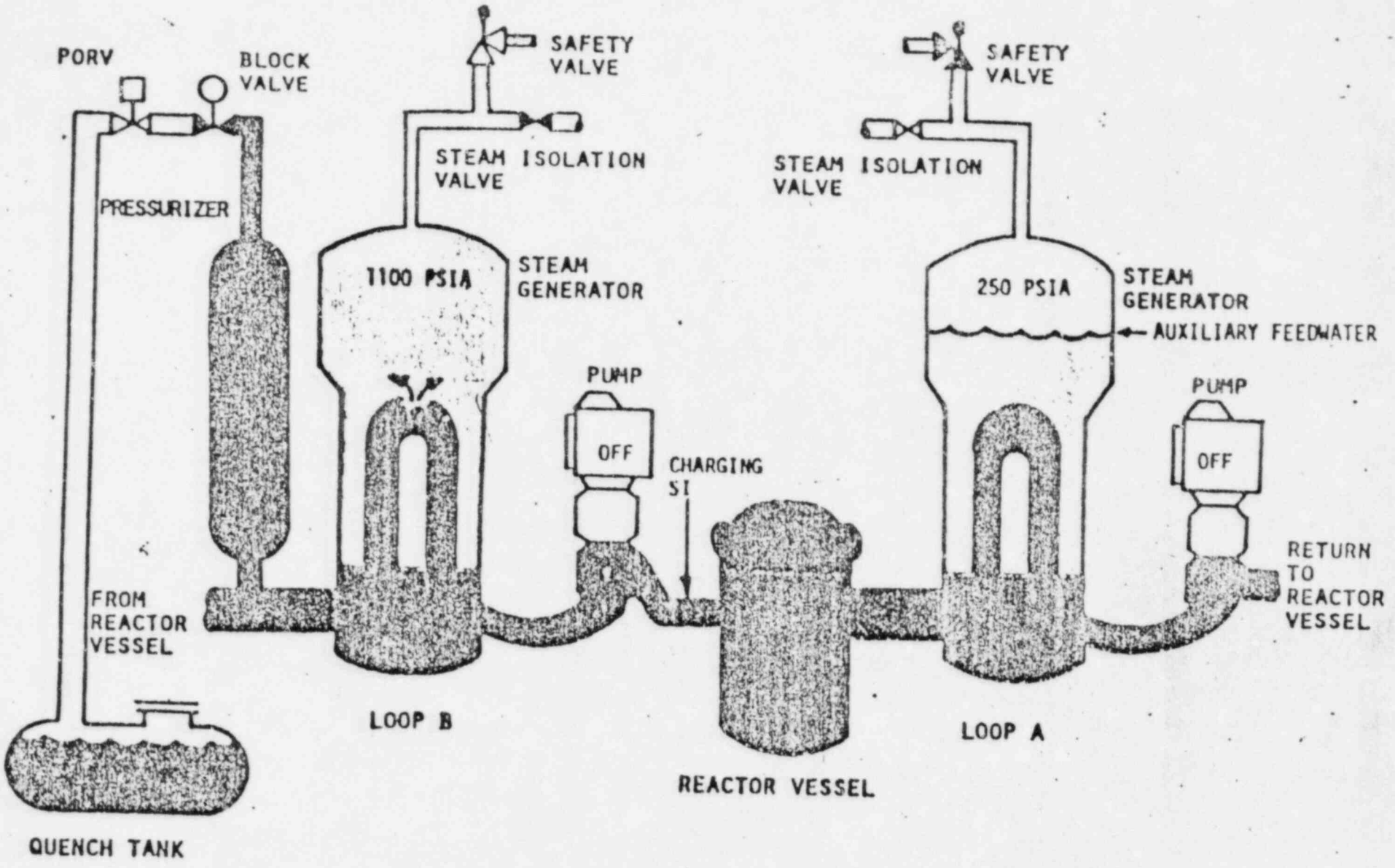
T - 8 - 12 MINUTES, STEAM GENERATOR TUBE RUPTURE IDENTIFIED
STEAM GENERATOR B LEVEL INCREASING FASTER THAN A
STEAM GENERATOR B ISOLATED
AUXILIARY FEEDWATER TO STEAM GENERATOR A
REACTOR COOLANT PUMPS OFF
HIGH RADIATION LEVELS ON "B" SG PIPING



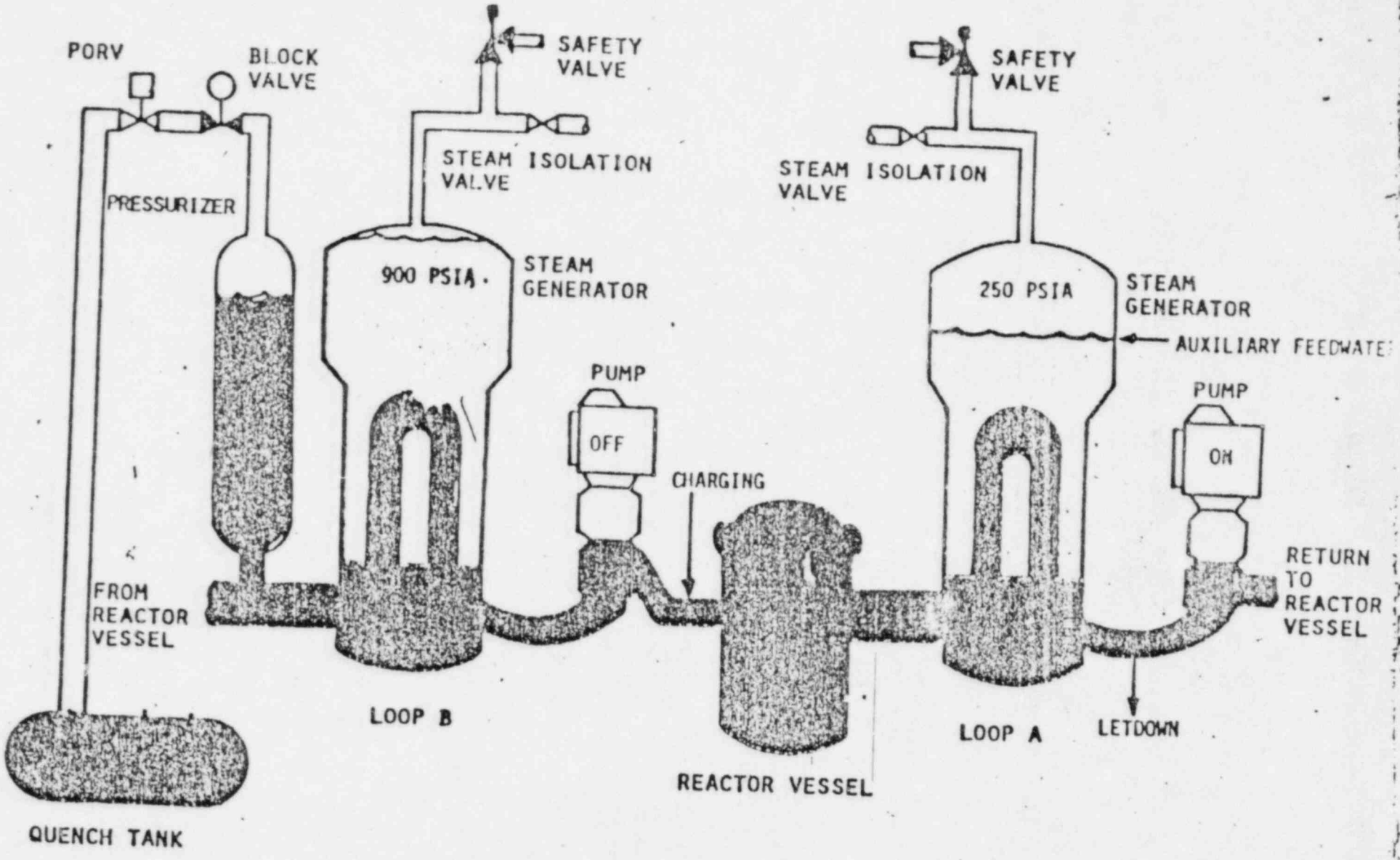
T - 43 MINUTES, PORV STUCK OPEN

VOID FORMS IN REACTOR VESSEL HEAD

PRESSURIZER LEVEL FULL



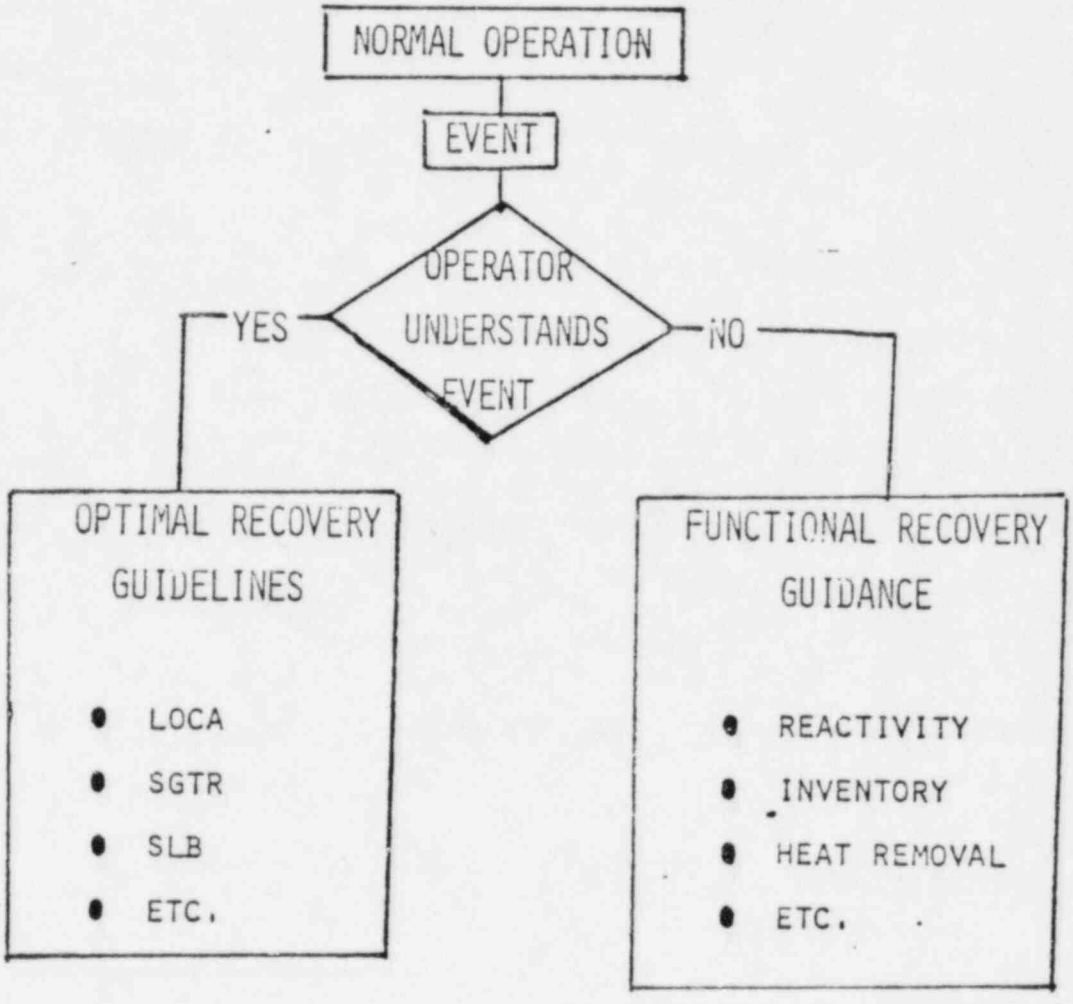
T - MINUTES, SI AND CHARGING LIFT STEAM GENERATOR B SAFETY VALVE



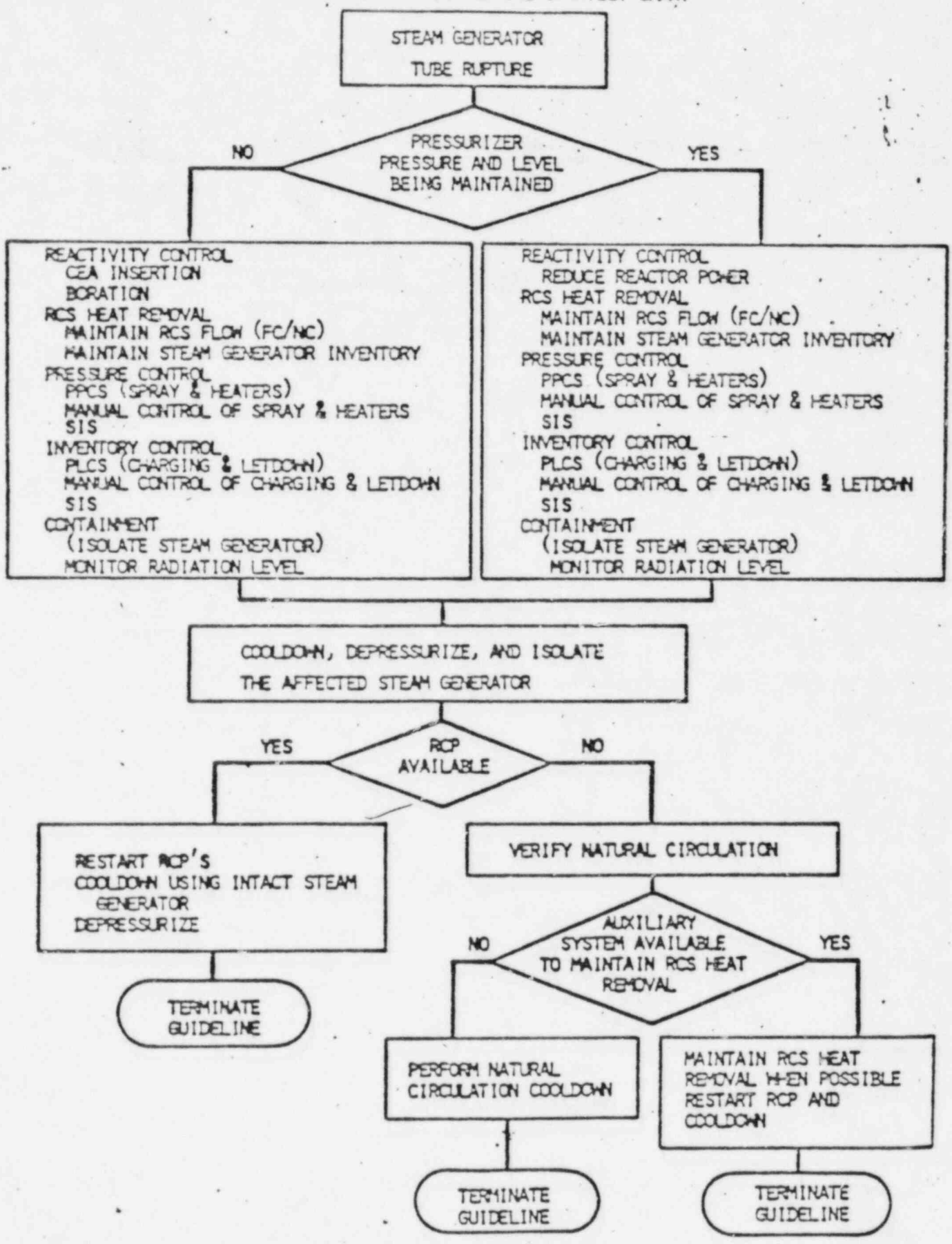
T - 155 MINUTES, BUBBLE IN PRESSURIZER
REACTOR VESSEL VOID CONDENSED
LETDOWN ESTABLISHED

C-EOG

EMERGENCY PROCEDURE GUIDELINE SYSTEM



STEAM GENERATOR TUBE RUPTURE STRATEGY CHART



	GINNA	CE	POTENTIAL IMPACT
RCS DEPRESSURIZATION	PORV	AUX. SPRAY	1) EARLIER DEPRESSURIZATION MIGHT BE ENCOURAGED 2) NO ADDITIONAL CHALLENGE TO RCS PRESSURE BOUNDARY INTEGRITY
RCP OPERATION	--	SPECIFIC RESTART CRITERIA PROVIDED	EARLIER RESTART OF RCPS - FORCED CIRCULATION COOLDOWN
HPSI PUMP TERMINATION	CRITERIA PROVIDED	CRITERIA PROVIDED	EARLIER DEPRESSURIZATION WOULD HAVE SATISFIED TERMINATION CRITERIA EARLIER - REDUCED CHALLENGE TO S.G. SAFETIES
S.G. LEVEL CONTROL	--	CRITERIA PROVIDED ON CONTROL ON AFFECTED S.G.	REDUCED CHALLENGE TO S.G. SAFETY VALVES

- GINNA PLANT RESPONSE NOT SIGNIFICANTLY DIFFERENT FROM CE PLANT

- CE GUIDELINES & CE EQUIPMENT MAY HAVE REDUCED CHALLENGES TO S.G. SAFETY VALVES