U. S. NUCLEAR REGULATORY COMMISSION

REGION V

Report Nos.	50-206/93-20, 50-361/93-20, and 50-362/93-20
Docket Nos.	50-206, 50-361, 50-362
License Nos.	DPR-13, NPF-10, NPF-15
Licensee:	Southern California Edison Company Irvine Operations Center 23 Parker Street Drive Irvine, California 92718
Facility Name:	San Onofre Units 1, 2, and 3
Meeting at:	Region V Office Walnut Creek, California
Prepared by:	B. J. Olson, Project Inspector
Approved by:	H. Wong, Chief Reactor Projects Section II — 7/14/93 Date Signed

Summary:

A meeting was held on July 1, 1993, to discuss the ongoing Unit 3 steam generator primary to secondary leak and plans for Unit 2 steam generator eddy current inspections. A copy of the slides used in the licensee's presentation is enclosed.

DETAILS

1. Meeting Attendees

Southern California Edison Company (SCE)

D. Rosenblum, Vice President, Engineering & Technical Services
R. Waldo, Manager, Operations
M. Short, Manager, Site Technical Services
J. Clark, Manager, Chemistry
G. Gibson, Supervisor, Generic Licensing
J. Mundas, Senior Engineer, Nuclear Engineering

Nuclear Regulatory Commission

K. Perkins, Director, Division of Reactor Safety and Projects
C. Serpan, Acting Deputy Director, Division of Reactor Safety and Projects
C. VanDenburgh, Chief, Reactor Projects Branch
H. Wong, Chief, Reactor Projects Section II
W. Ang, Chief, Engineering Section
J. Reese, Chief, Facilities Radiological Protection Branch
M. Fields, Project Manager, NRR
E. Murphy, Materials & Chemical Engineering Branch, NRR
J. Winton, Materials & Chemical Engineering Branch, NRR
C. Myers, Reactor Inspector
B. Olson, Project Inspector

2. Details

Mr. Perkins provided opening remarks and indicated that the NRC was interested in SCE's assessment of the ongoing primary to secondary leak in San Onofre Unit 3 and the eddy current inspection program that would be conducted during the current Unit 2 refueling outage. Mr. Rosenblum provided opening remarks for SCE and indicated that, in general, SCE considered the steam generators at San Onofre to be less vulnerable to the tube flaws that have been recently observed at Palo Verde. He also listed the topics that would be presented: (1) Unit 3 steam generator primary to secondary leakage, (2) Unit 2 steam generator eddy current inspection plans, and (3) a comparison of San Onofre and Palo Verde secondary characteristics.

a. Unit 3 Steam Generator Primary to Secondary Leakage

Mr. Waldo reviewed the history of an ongoing Unit 3 steam generator primary to secondary leak. The leak was first observed on May 11, 1993, and initially stabilized at approximately five gallons per day (gpd). The leak had slowly increased to approximately 15 gpd in the month and one-half period since developing. San Onofre's Technical Specifications require that primary to secondary leakage from one steam generator be limited to less than 720 gpd.

Mr. Waldo explained that the most likely source of the leak was through a Westinghouse steam generator tube plug known as a plug-in-plug. This design, of which there are 178 installed in the Unit 3 steam generators, incorporates a separate, internal plug and has developed leaks at other facilities. Westinghouse analysis indicated that the potential leakage past this type of plug is limited to approximately 15 gpd.

Mr. Waldo provided an overview of the methods used to monitor the leakrate and the actions that would be taken if the leakrate increased. He indicated that San Onofre uses activity measurements of the main condenser air ejector exhaust as the primary method for determining the leakrate. He also indicated that operating crews would perform a rapid plant shutdown if the leakrate increased by more than 60 gpd in one hour.

b. Unit 2 Steam Generator Eddy Current Inspection Plans

Mr. Mundas described the steam generator eddy current inspection plan which will be implemented during the current Unit 2 refueling outage. He indicated that 20% of the steam generator tubes will be inspected using an eddy current bobbin coil. This sampling percentage follows recommendations from the Electric Power Research Institute and exceeds the Technical Specification minimum inspection requirements. In addition, about 500 tubes per steam generator will be inspected just above the hot leg side of the tubesheet using an eddy current motorized rotating pancake coil (MRPC). Mr. Mundas stated that San Onofre had previously only used the more sensitive MRPC to perform inspections of areas where anomalies had been observed in bobbin coil signals.

Mr. Mundas described the actions being taken as a result of axial indications that have been recently observed in Palo Verde Unit 2 steam generators. He indicated that Combustion Engineering developed a thermal-hydraulic model of the San Onofre steam generators, and the model was used to determine areas where deposits may form on steam generator tubes. The model was developed after Palo Verde observed axial indications associated with tube deposits. Based on an evaluation of the deposit parameters from the San Onofre model, additional tubes would be inspected using the MRPC. Mr. Mundas said that approximately 400 additional tubes in each steam generator would be partially inspected using the MRPC, although the final evaluation was not complete. In addition to changes in the scope of inspection activities as a result of the Palo Verde findings, Mr. Mundas stated that the training program for the eddy current analysts had been modified to use actual data from indications observed at Palo Verde.

Mr. Murphy stated that the bobbin coil could inspect long tube sections faster than the MRPC and commented that SCE might want to consider using the bobbin coil to inspect more full length tube sections and use the MRPC to inspect more tubes at the top of the tubesheet. Mr. Mundas indicated that SCE was confident that any existing flaws would be found by inspecting 20% of the tubes with the bobbin coil and that the MRPC would be capable of finding flaws in the early stages of development. He added that the inspection plan would be evaluated if any flaws were found. Mr. Rosenblum said that SCE wanted a balanced perspective in developing the inspection plan; to have reasonable assurance of finding an existing flaw using the bobbin coil and to find early indications of flaw development using the MRPC.

c. Comparison of San Onofre and Palo Verde

Mr. Clark provided a comparison of San Onofre and Palo Verde secondary operating characteristics. He described differences in steam generator and balance of plant designs. He also described San Onofre design features which contribute to maintaining low concentrations of impurities in the steam generators.

d. Closing Remarks

Mr. Perkins thanked the SCE personnel and indicated that the presentations were very informative. He reiterated Mr. Murphy's comment that SCE might want to consider additional eddy current MRPC inspections in the steam generator tubesheet area. Mr. Rosenblum said that SCE was very sensitive to steam generator tube issues and would want to deal with any potential problems early. He added that Mr. Murphy's comment would be considered.

EFFLUENT WARRANTY VALUES
(Continued)

1.3 Moderate Condenser Leakage (200 ppb Cl Influent)

Sodium	0.1 ppb (max)
Chloride	0.2 ppb (max)
Sulfate	0.5 ppb (max)
Copper	2.0 ppb (max)
Silica	5.0 ppb (max)
Cation conductivity @ 25°C	0.10 µS/cm
Straight conductivity @ 25°C	0.10 µS/cm
Total Suspended Solids	10.00 ppb (max)
Total Iron	10.00 ppb (max)
pH @ 25°C.	6.5 to 7.5
Run length	60 hrs. (min)

1.4 Severe Condenser Inleakage (500 ppb Cl Influent)

Sodium	0.2 ppb (max)
Chloride	0.5 ppb (max)
Sulfate	1.0 pbb (max)
Copper	2.0 ppb (max)
Silica	5.0 ppb (max)
Cation conductivity @ 25°C	0.10 µS/cm
Straight conductivity @ 25°C	0.10 µS/cm
Total Suspended Solids	10.0 ppb (max)
Total Iron	10.0 ppb (max)
pH @ 25°C.	6.5 to 7.5
Run length	12 hours (min)

Steam Generator Inspection

San Onofre Units 2 and 3

Southern California Edison

SIGNIFICANT SONGS DESIGN FEATURES

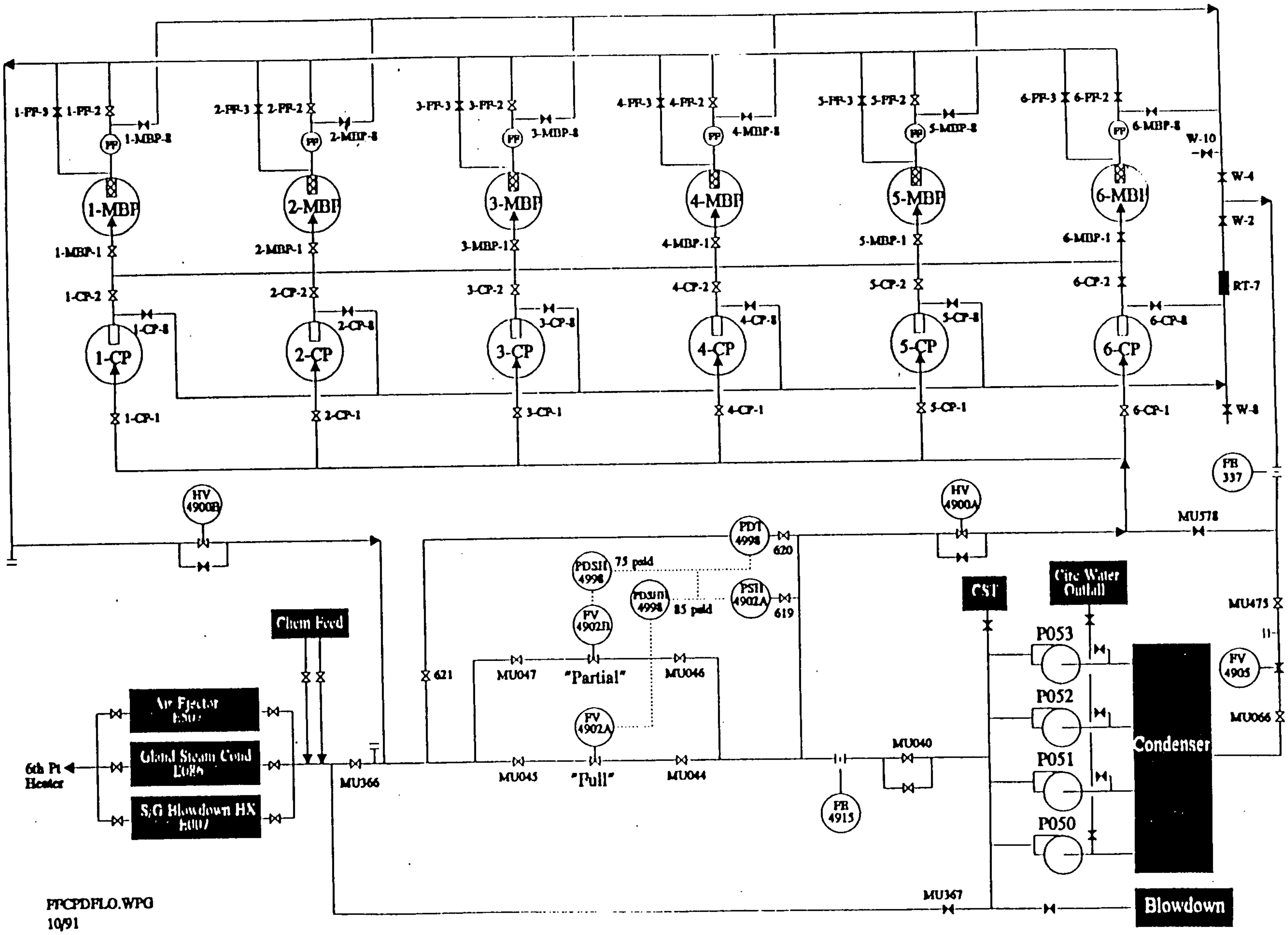
Steam Generator

Blowdown/Feedwater
Feedwater fed at the top of the shroud.
150 gpm/SG continuous and optimally located

Seawater Typical Chemistry

Chloride (ppm)	19,000
Calcium (ppm as calcium carbonate)	400
Sulfate (ppm)	2,650
Silica (ppm)	4

FFCPD



FFCPDFLO.WPG
10/91

SIGNIFICANT SONGS DESIGN FEATURES

Full Flow Condensate Polishing Demineralizer (FFCPD)

* Resin Fines Filters
  5 u fines filters down stream of resin beds. No resin leakage.

* Lead Cation Polisher (CPs)
  Six lead CPs, removes all ammonia and sodium in condensate.
  High sodium removal.

SECONDARY CHEMISTRY HISTORY

* Steam Generator Hideout Data

	Unit 2		Unit 3	
	Cycle 4	Cycle 5	Cycle 4	Cycle 5
Sodium (gm)	64	66	60	80
Sulfate (gm)	96	210	50	106
Chloride (gm)	54	52	16	12

These values are within Industry average.

* Steam Generator Molar Ratios

	Unit 2			Unit 3	
Cycle 4	Cycle 5	Present	Cycle 4	Cycle 5	Present
1.8	1.9	0.74	5.8	10.3	1.23

* Steam Generator Resin Intrusions

  None.

SECONDARY CHEMISTRY HISTORY

Typical Steady State Secondary Chemistry

* Steam Generator

	SONGS 1992/1989-1991	EPRI GUIDELINES	RATIOS GL/SONGS
Cation (uS/cm)	0.08/0.08	<0.8	10/10
Chloride (ppb)	0.3/0.3	<20	66.7/66.7
Sulfate (ppb)	0.1/0.3	<20	200/66.7
Sodium (ppb)	0.1/0.3	<20	200/66.7

* Condensate Demineralizer Effluent

Chloride (ppb)	0.002	NA	
Sulfate (ppb)	0.010	NA	
Sodium (ppb)	0.003	<3	1000
Cation (uS/cm)	0.057	<0.2	3.5

* Condenser Leaks

Leak detection @ 0.2 uS cat.cond.
No significant leaks,corrective action taken immediately
FFCPD in service to eliminate contaminants ingress to SG.

SONGS SECONDARY SYSTEM CHEMISTRY

HISTORY AND DESIGN FEATURES

SAN ONOFRE/PALO VERDE COMPARISON

FACTORS AFFECTING SECONDARY IGA/IGSCC

- Operating Temperature (~ 532 deg F)
- Secondary Chemistry (Na ~0.1, Cl ~0.3, SO4 ~0.1)
- Thermal Hydraulic Conditions (Maximum Quality 53%)
- Tube Proximity to Other Tubes (Three partial supports)
- Fabrication Defects/Scars (None identified)
- Tube Vibration (Effect not known)

BALANCE OF PLANT DESIGN DIFFERENCES

	Palo Verde	San Onofre
Condensate Polishing Demineralizers	Mixed bed only	Lead cation bed + mixed bed + resin fines filt.
Continuous Blowdown Capacity (gpm)	36 - 50	100 - 150
Cooling Water	Processed "gray" water + cooling tower treatment	Seawater
Feedwater Heater Tubing Material	Stainless steel	Copper-Nickel

STEAM GENERATOR DESIGN DIFFERENCES

	Palo Verde	San Onofre
Type:	U-tube Recirc	U-tube Recirc
C-E Model:	System 80	3410 MWt
Number of Tubes:	11,012	9,350
Tube Diameter (in.)	0.750	0.750
Tube Wall Thickness (in.)	0.043	0.048
Tube Manufacturer:	Noranda (Units 1 & 2) Sandvick (Unit 3)	Sawhill
Tubing Material:	Alloy 600	Alloy 600
Annealing Temperature (degF):	1810-1850	1875
Tube Support Type:	Lattice Bar	Lattice Bar
Tube Support Material:	Stainless Steel *	Carbon Steel
Number of Partial Tube Supports	2	3

Special Features (Palo Verde):

- o Drilled stainless steel flow distribution plate
- o Feedwater preheater (economizer) on cold-leg side
  - Affects blowdown flow/concentrations
- o No handhole access to tubesheet
- o High capacity blowdown (short term)

Special Features (San Onofre):

- o Handhole access to tubesheet

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* Except for "scallop bars"

SAN ONOFRE UNIT 2 STEAM GENERATOR INSPECTION

SAN ONOFRE/PALO VERDE COMPARISON

- Steam Generator Design Differences
- Balance of Plant Design Differences
- Factors Affecting Secondary IGA/IGSCC
- Water Chemistry

EDDY CURRENT TESTING IMPROVEMENTS

- Improved MRPC Probe Signal Amplitude
- Optimized Combinations of Probes/Frequencies
- All MRPC Data to be Plotted on C-Scan
- C-Scan Plots Use Doubled Amplitude

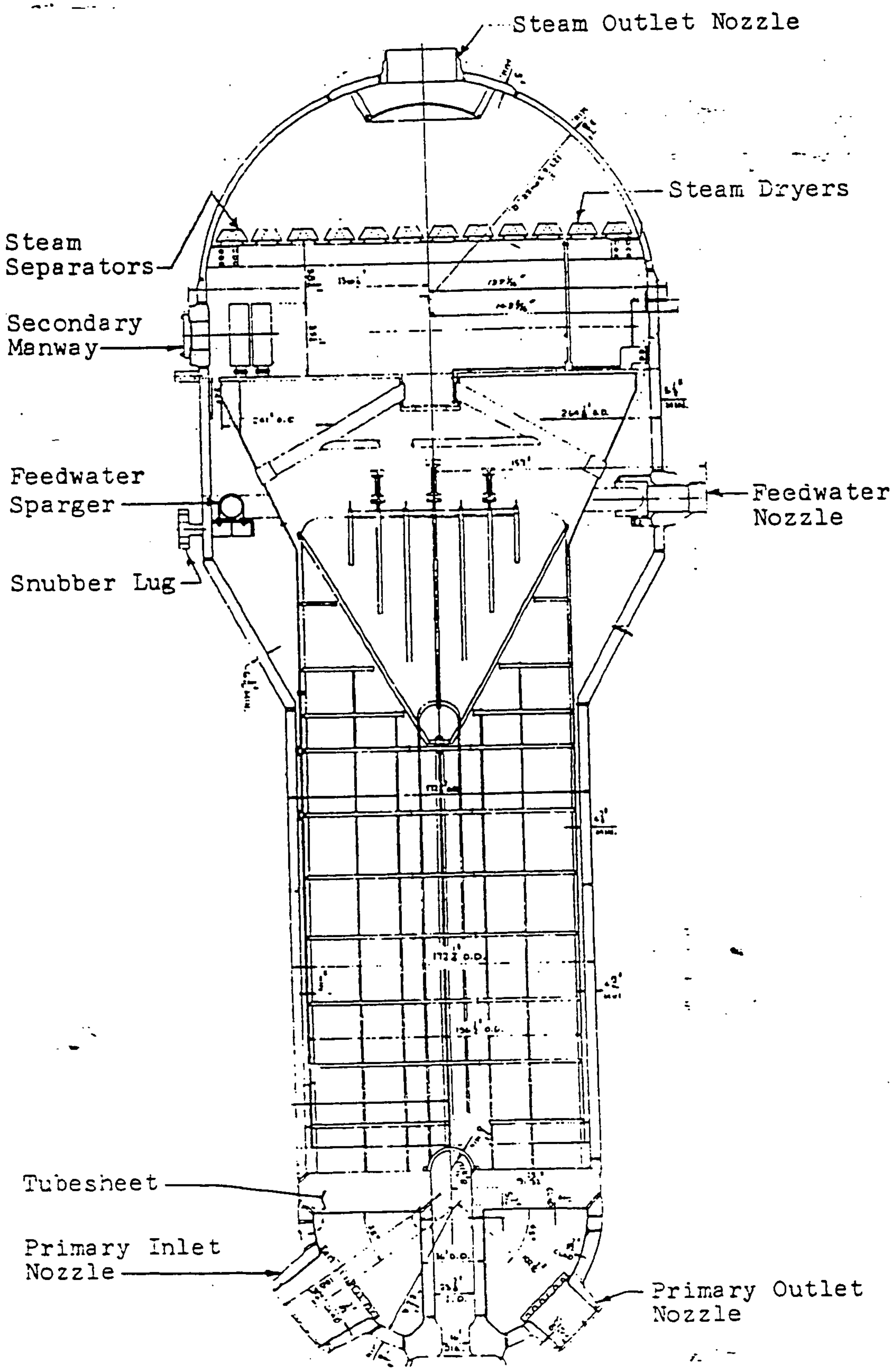
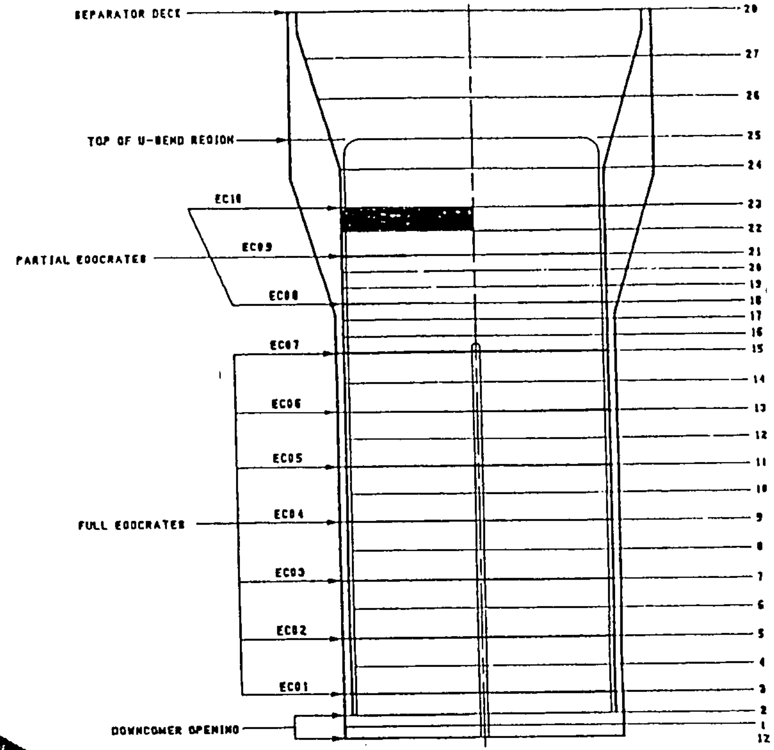


FIGURE 1. SCHEMATIC OF SONGS 2/3 STEAM GENERATORS

FIGURE 13 SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 23
(323 TO 338 IN. ABOVE TUBESHEET - HOT SIDE)



MAX. VALUE: 1.000

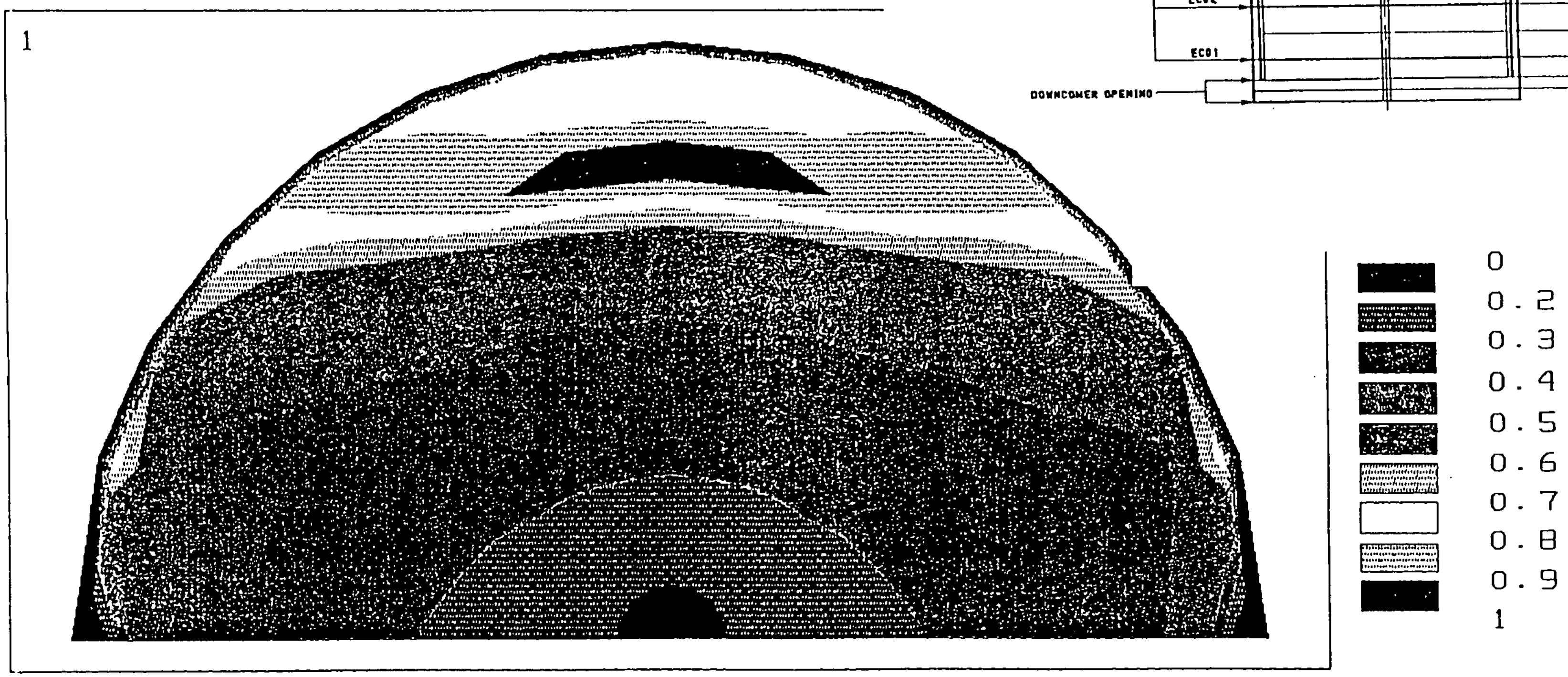
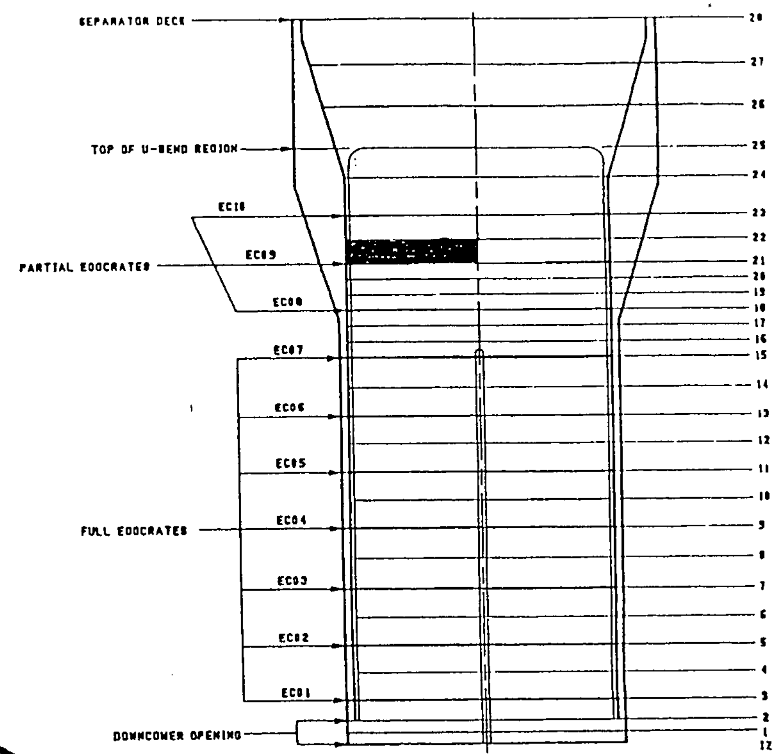


FIGURE 12   SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 22
(308 TO 323 IN. ABOVE TUBESHEET - HOT SIDE)



MAX. VALUE: 0.888

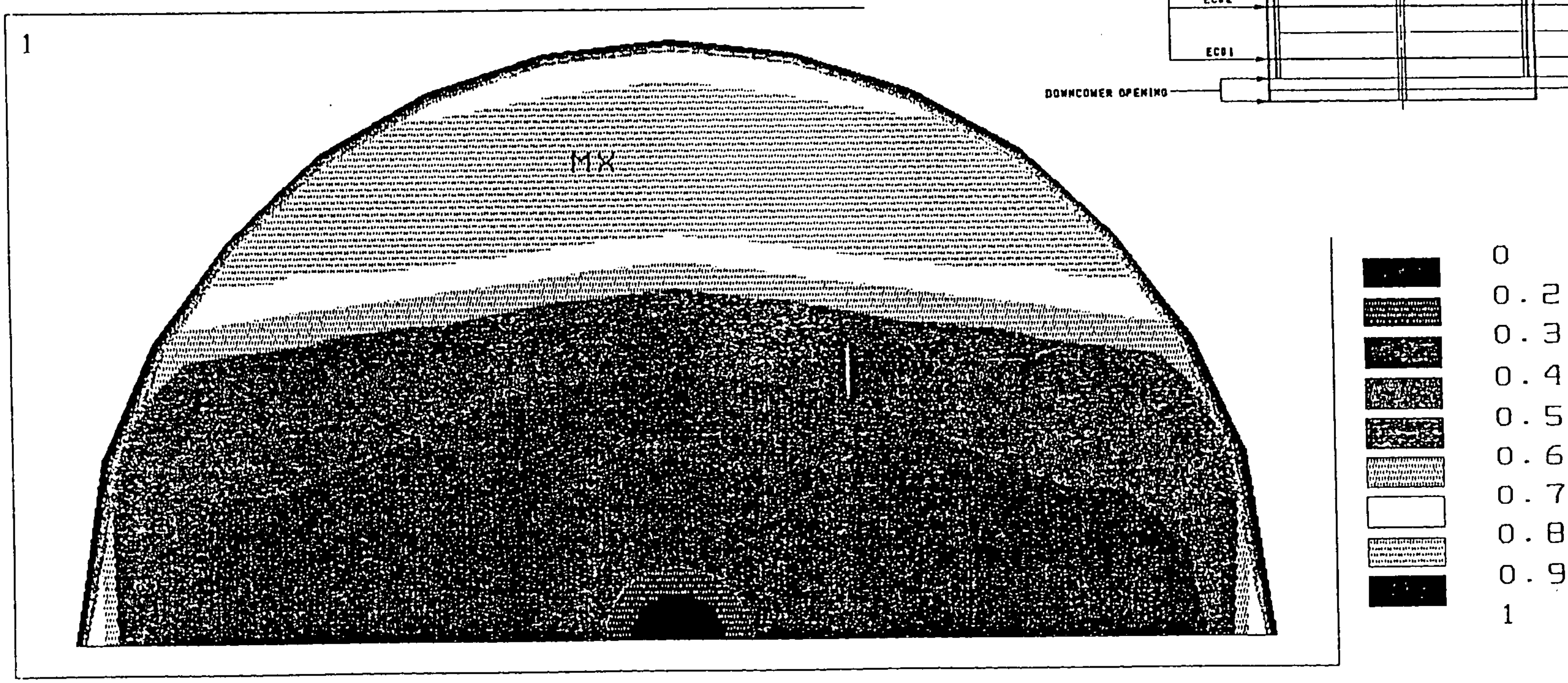
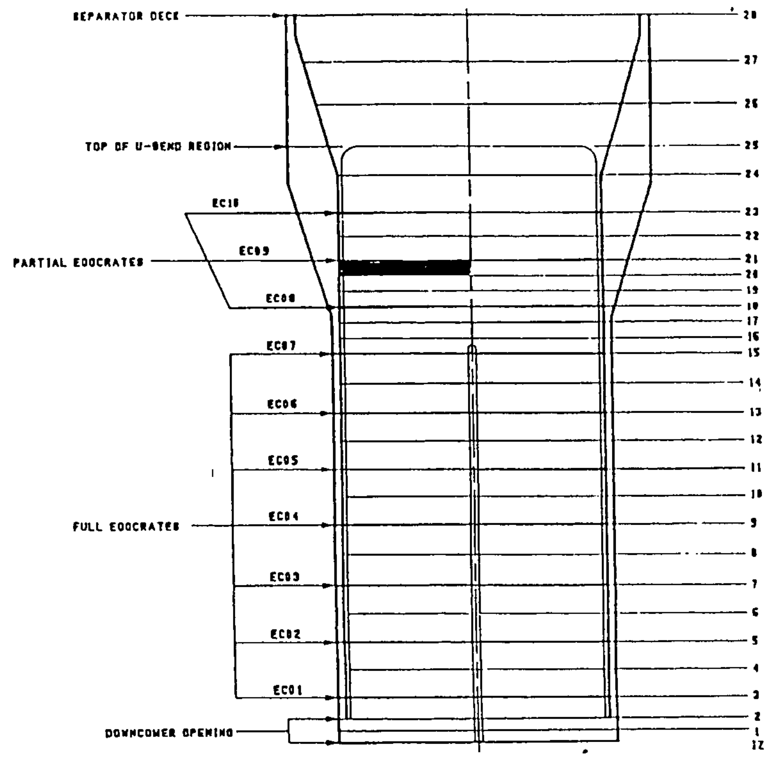


FIGURE 11 SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 21
(297 TO 308 IN. ABOVE TUBESHEET - HOT SIDE)

MAX. VALUE: 0.878



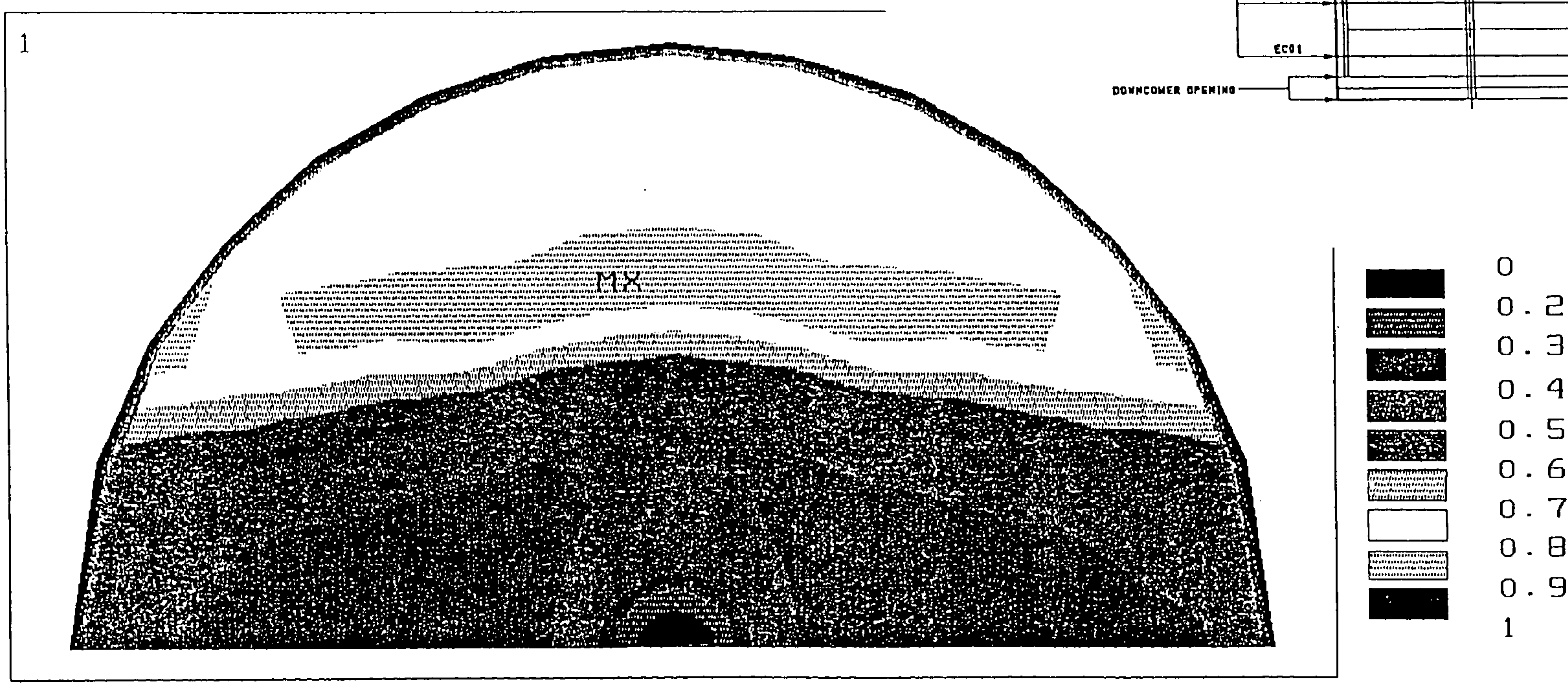
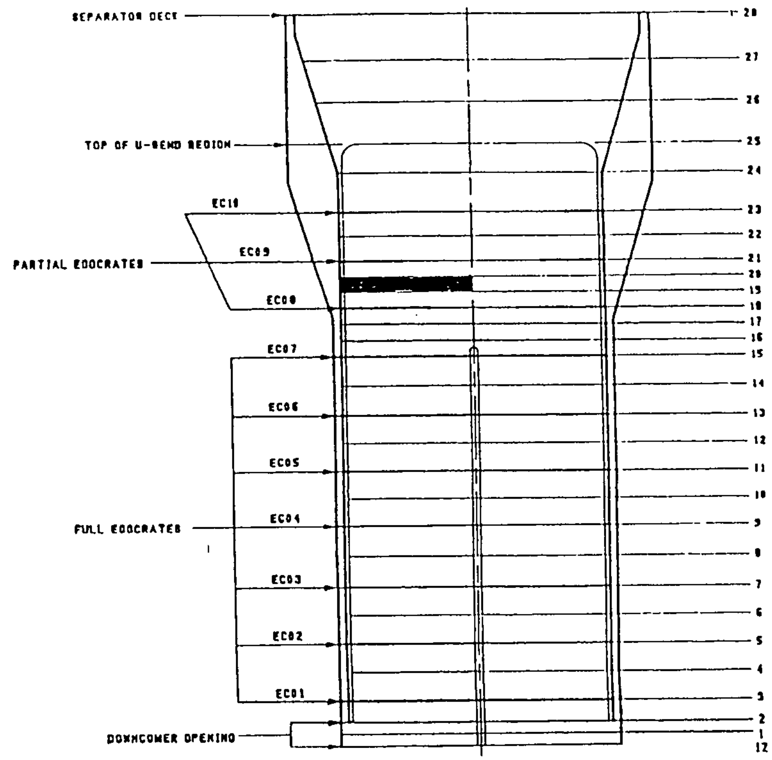


FIGURE 10 SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 20
(287 TO 297 IN. ABOVE TUBESHEET - HOT SIDE)



MAX. VALUE: 0.887

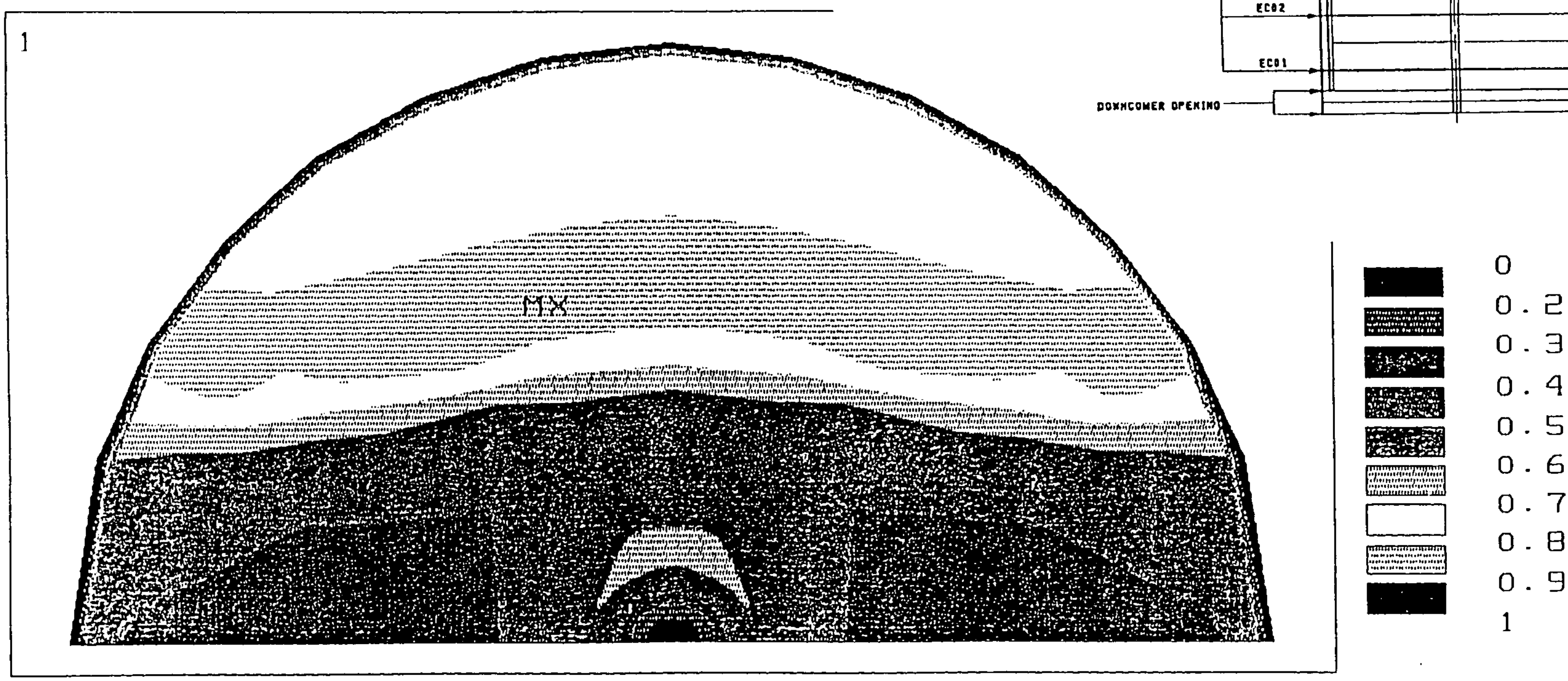
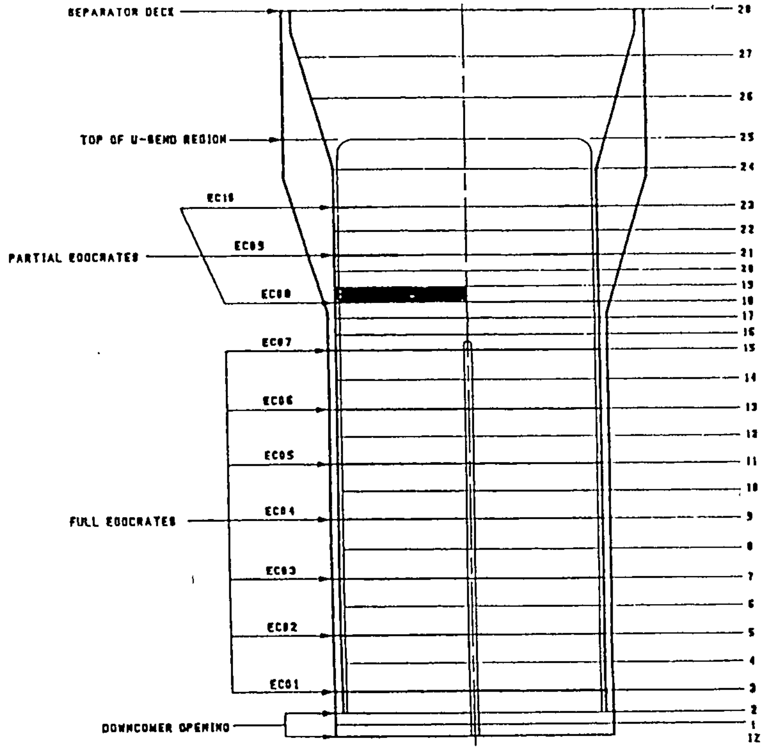


FIGURE 9 SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 19
(277 TO 287 IN. ABOVE TUBESHEET - HOT SIDE)



MAX. VALUE: 0.991

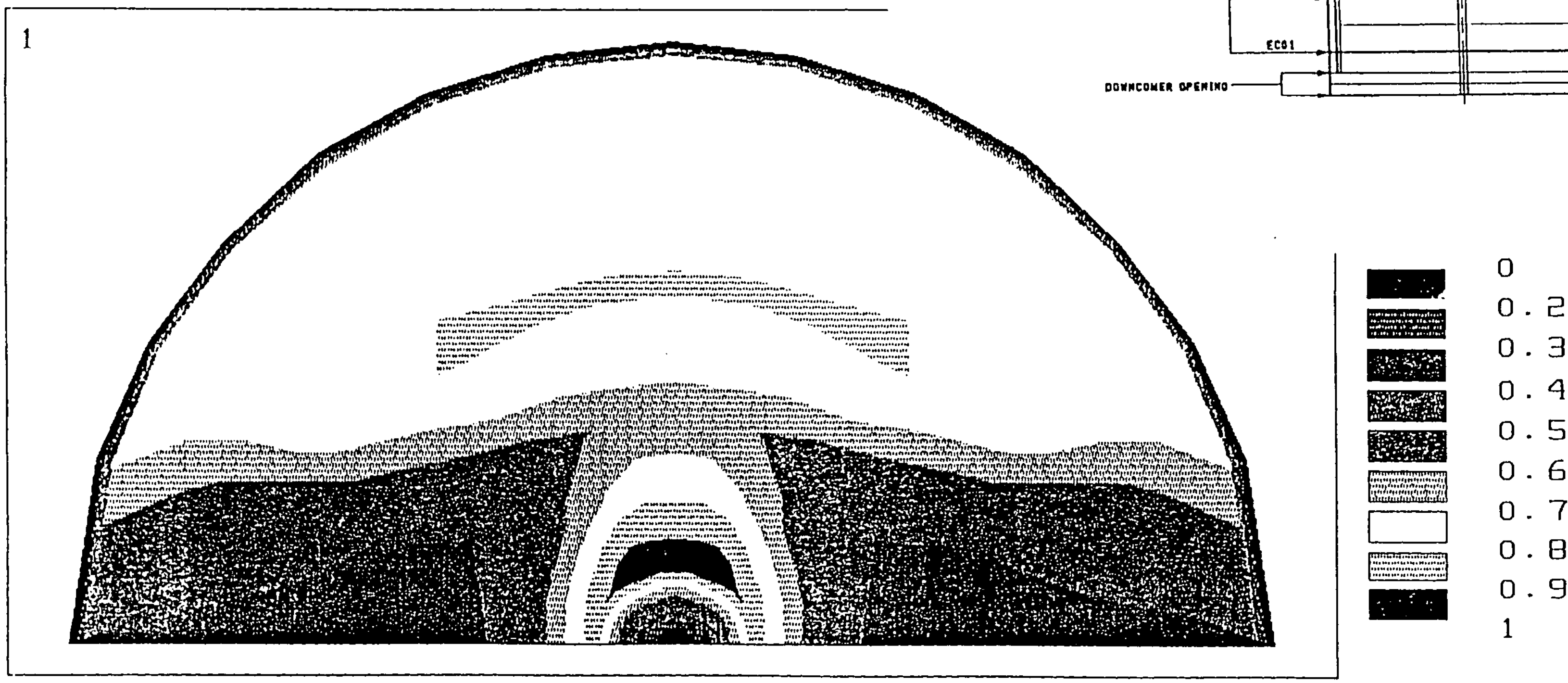
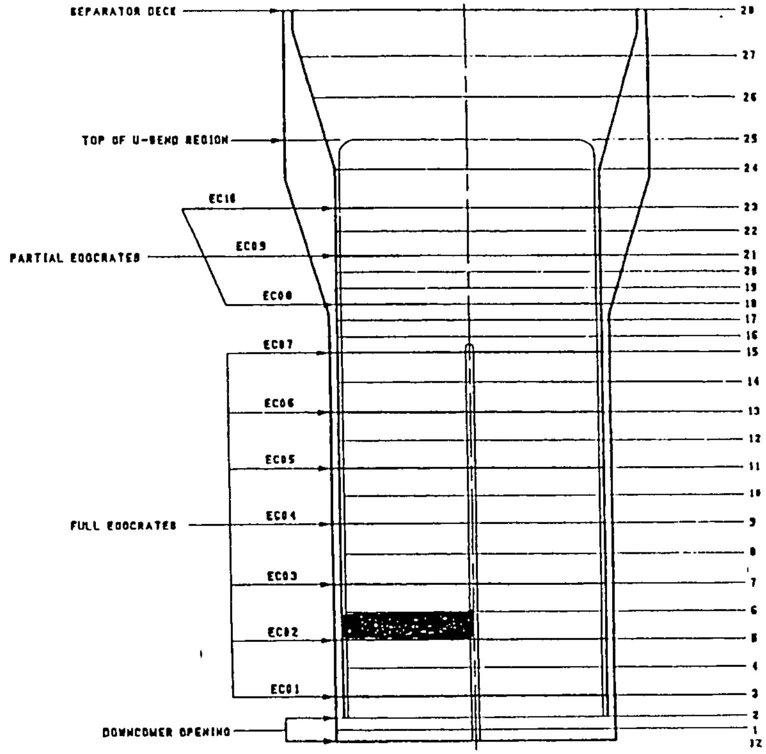
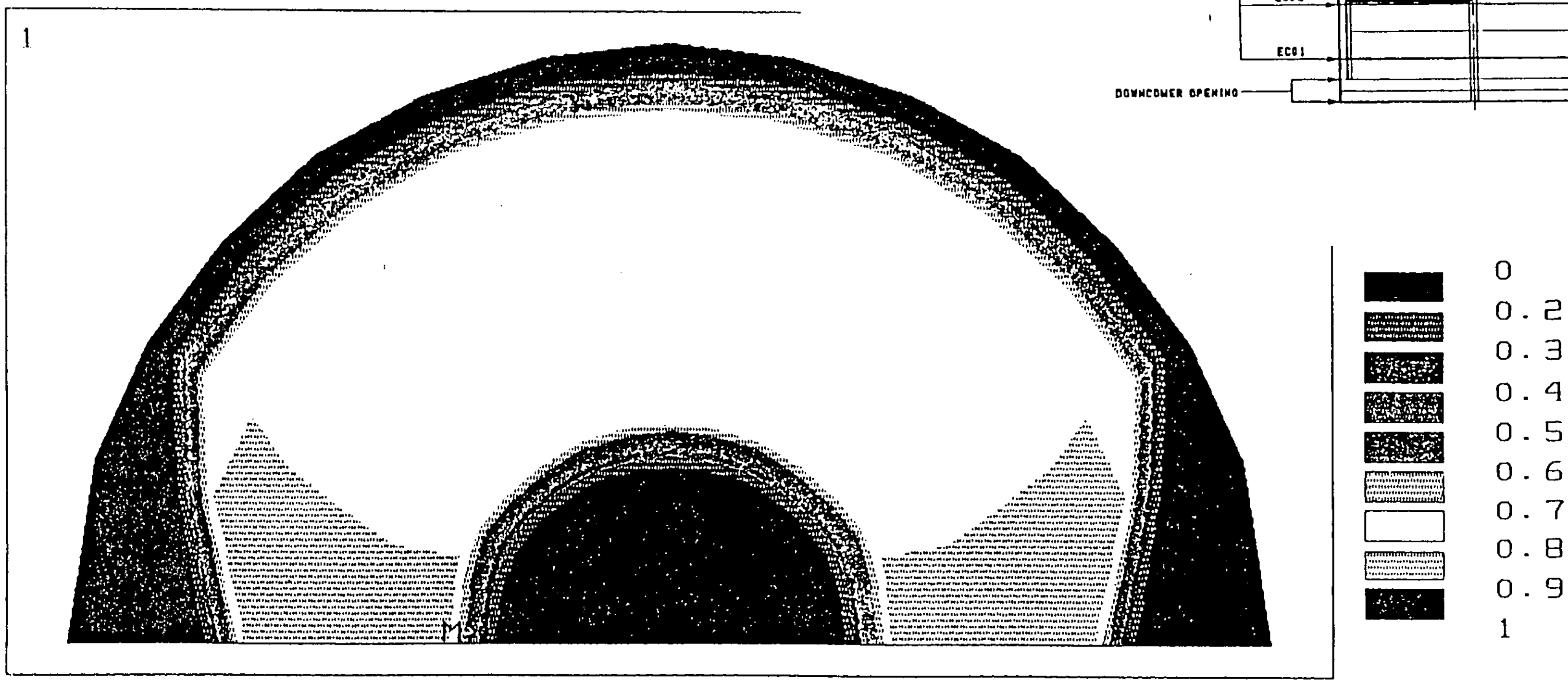
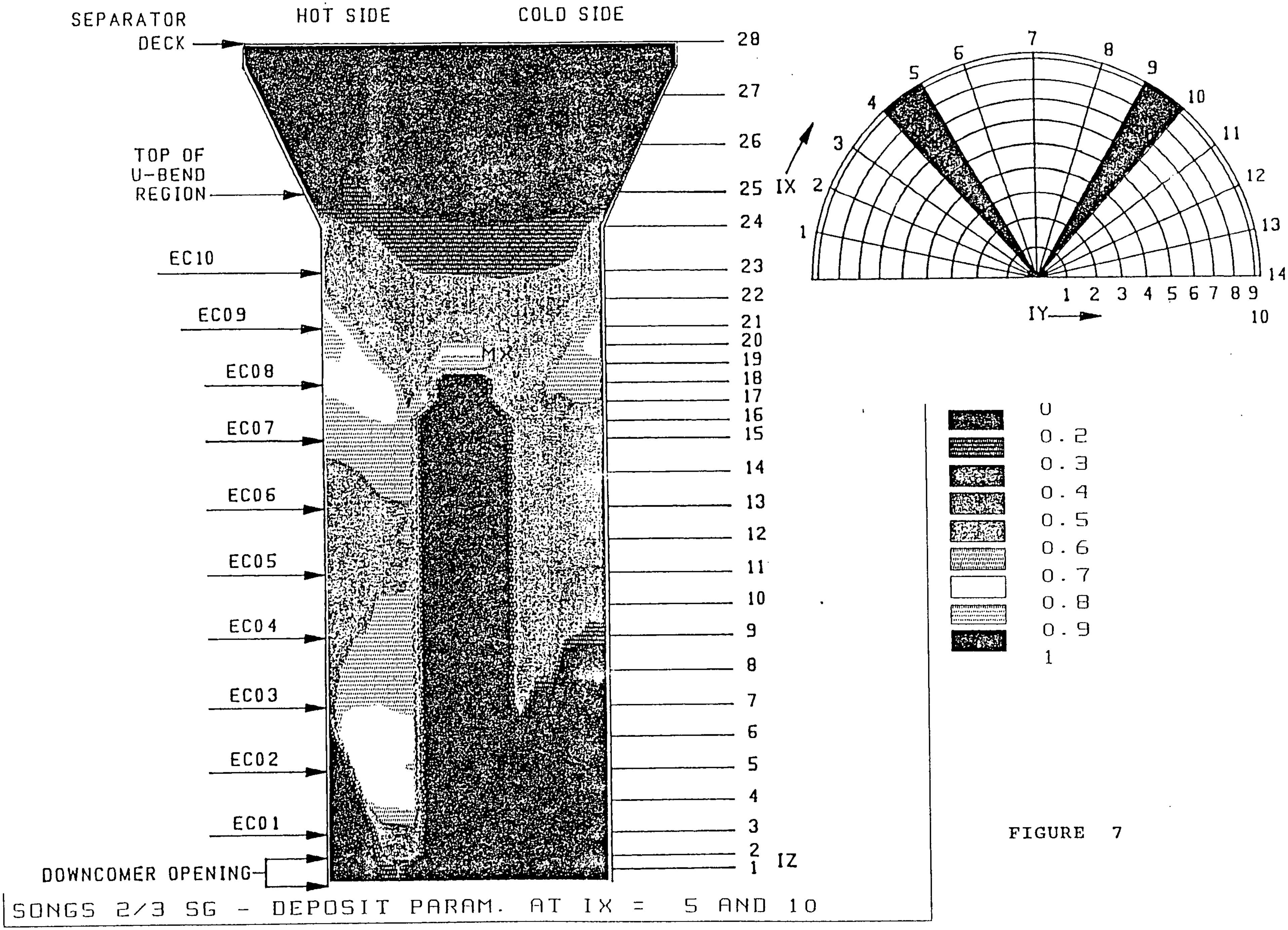


FIGURE 8 SONGS 2/3 SG DEPOSIT PARAMETER AT IZ = 6
(63 TO 81 IN. ABOVE TUBESHEET - HOT SIDE)



MAX. VALUE: 0.883




SEPARATOR DECK
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COLD SIDE
TOP OF U-BEND REGION
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EC08
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DOWNCOMER OPENING
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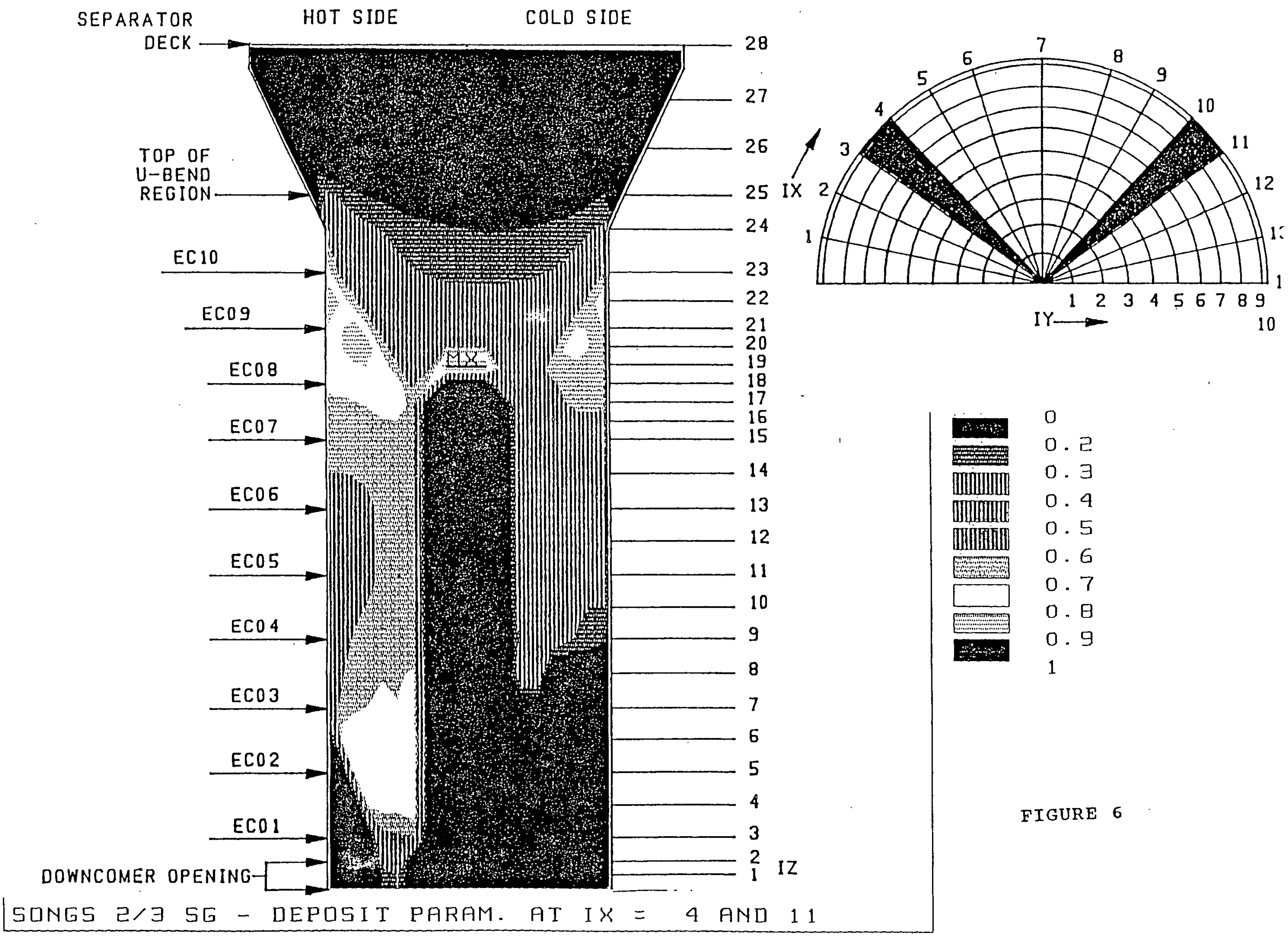
SONGS 2/3 SG - DEPOSIT PARAM. AT IX = 5 AND 10

FIGURE 7



SEPARATOR
DECK
HOT SIDE
COLD SIDE
TOP OF
U-BEND
REGION
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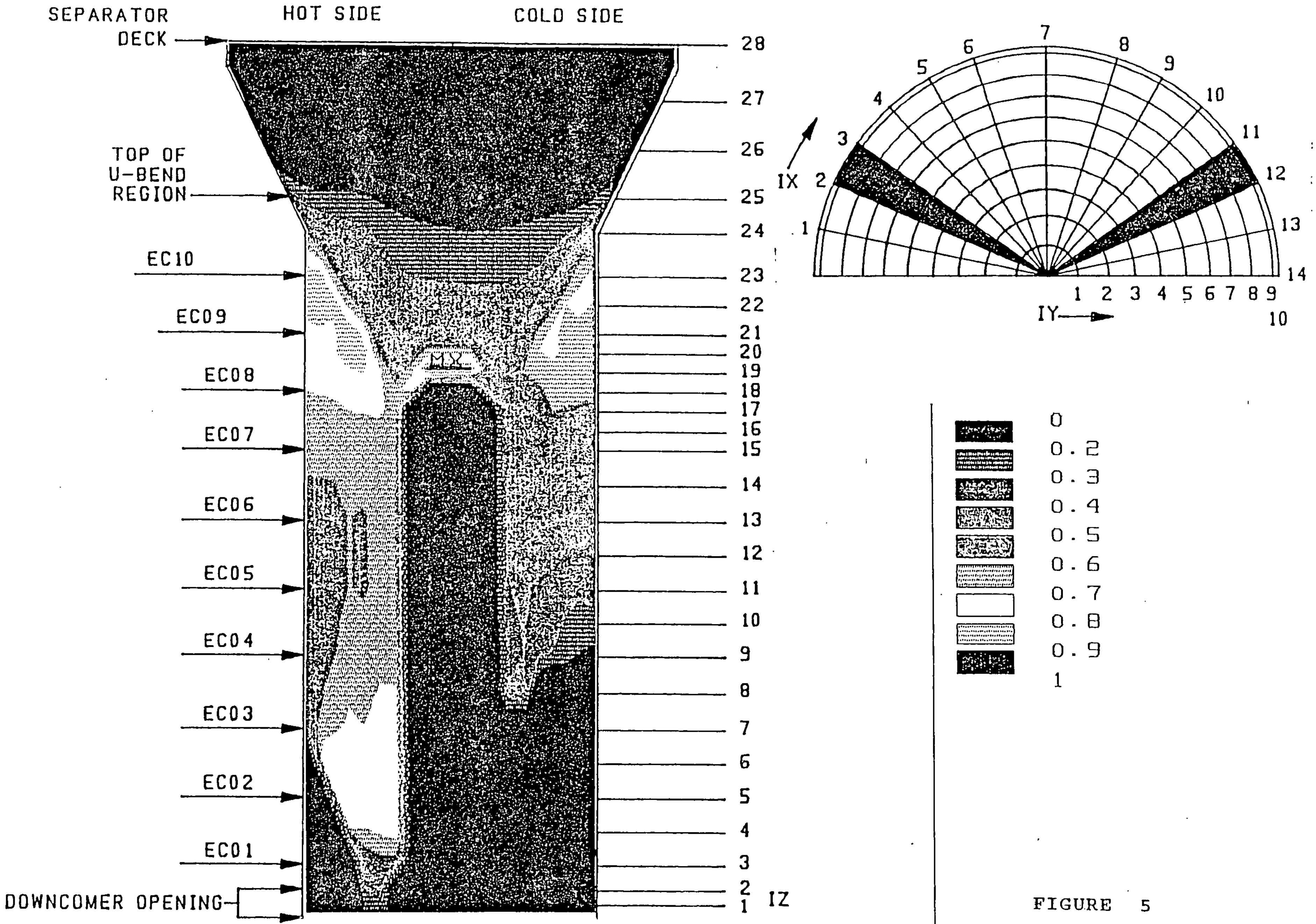
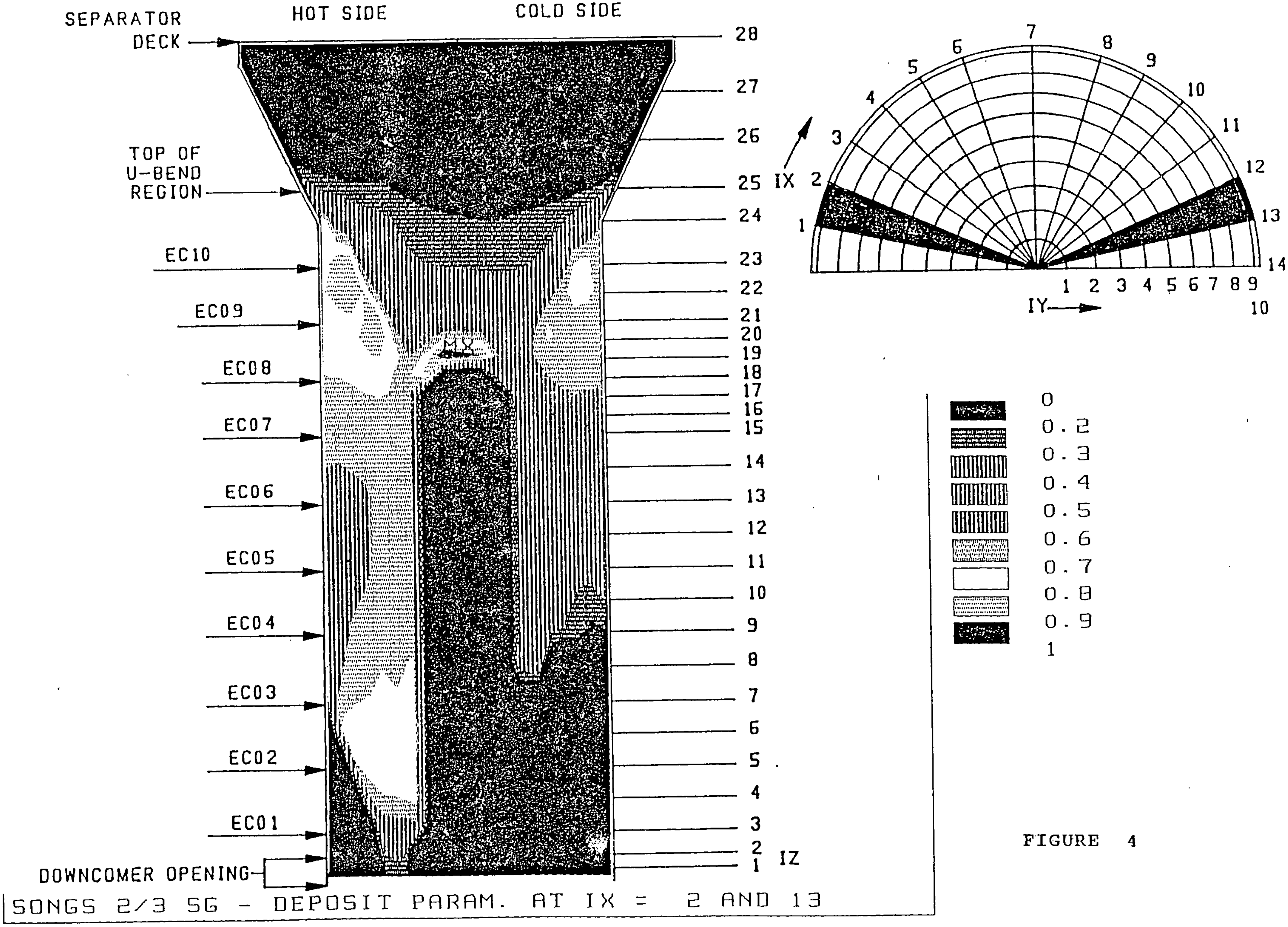
SONGS 2/3 SG - DEPOSIT PARAM. AT IX = 4 AND 11

FIGURE 6



SONGS 2/3 SG - DEPOSIT PARAM. AT IX = 3 AND 12

FIGURE 5



SEPARATOR DECK
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1 2 3 4 5 6 7 8 9 10
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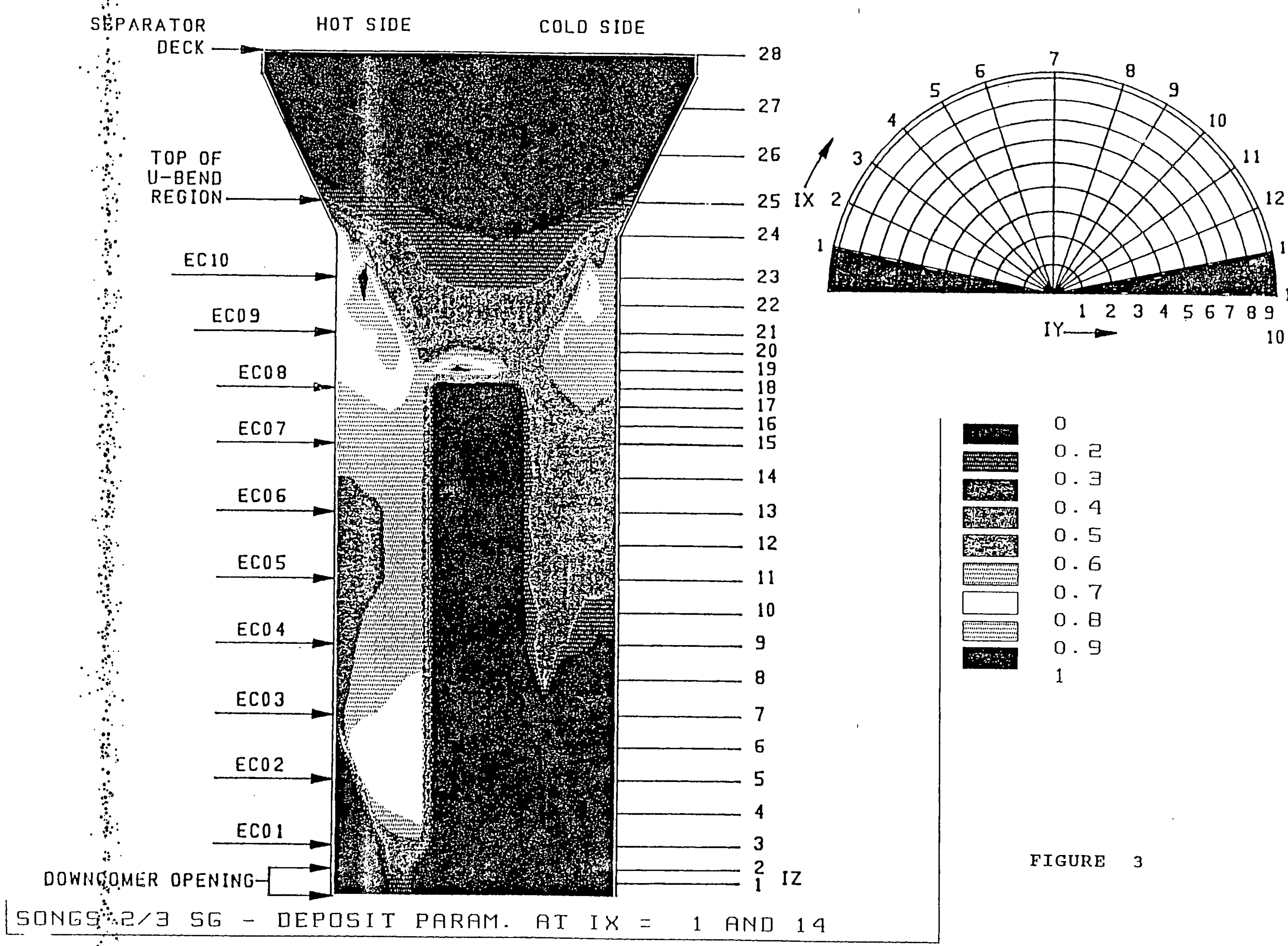
1
SONGS 2/3 SG - DEPOSIT PARAM. AT IX = 2 AND 13

FIGURE 4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SONGS 2/3 SG - DEPOSIT PARAM. AT IX = 1 AND 14

FIGURE 3

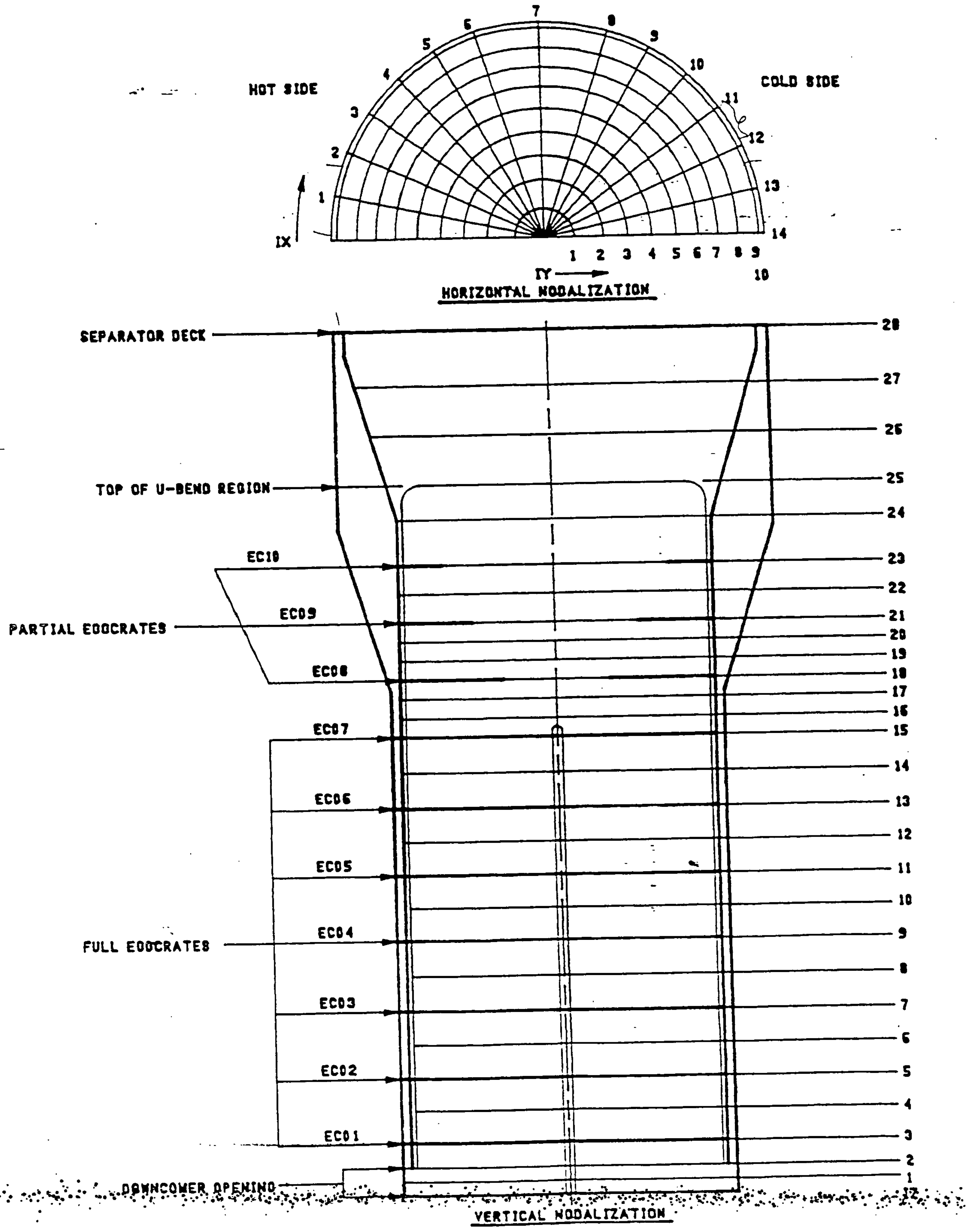


FIGURE 2. ATHOS II MODEL OF THE SAN ONOFRE STEAM GENERATOR

SAN ONOFRE UNIT 2 EDDY CURRENT TESTING PLAN

EDDY CURRENT TESTING IGA/IGSCC PROGRAM GOALS

- Use Best Available Eddy Current Test Techniques
- Indentify Mid-Span /Tube Support IGA/IGSCC
- Quantify/Maximize Signal/Noise Ratio
- Identify Detectable Deposits
- Establish Baseline for Future Inspections

FACTORS AFFECTING SECONDARY IGA/IGSCC

- Operating Temperature
- Secondary Chemistry
- Thermal-Hydraulic Conditions
- Tube Proximity to Other Tubes
- Fabrication Defects/Scars
- Tube Vibration

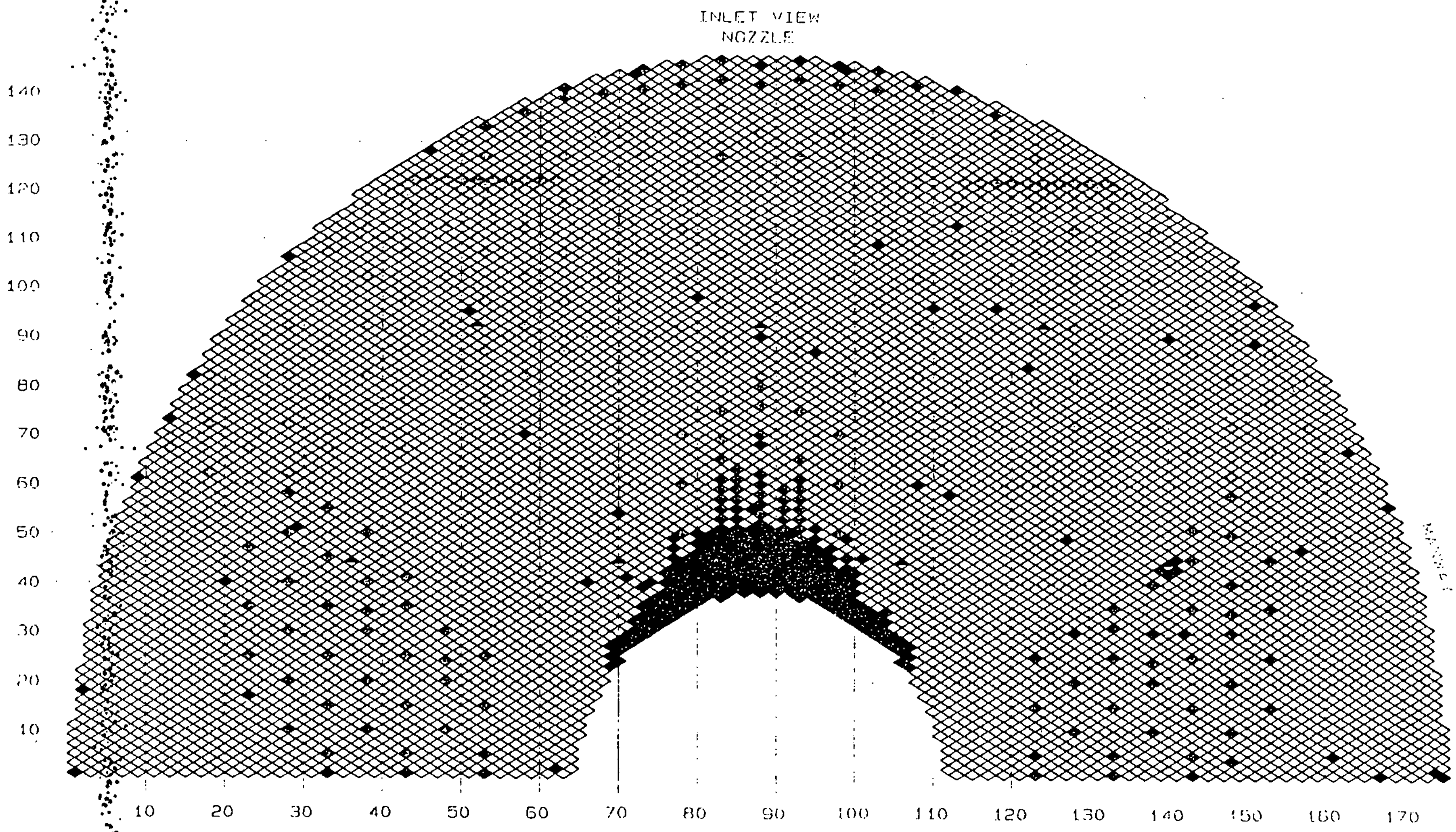
06/93, SOUTHERN CALIFORNIA EDISON, SAN ONOFRE, UNIT 2

STEAM GENERATOR: 88
PROC: SO23-XXVII-23.1
MRPC EXPANSION NUMBER 1
CRITERIA: TUBES TO BE EXAMINED IN GROUP(S) 13, 14, 15, 16, 17, 18, 19, 20

DATE: 06/29/93
TIME: 18:24:18

STAYS

PLUGGED 266 ◆ DBH-VSM 41 ◆ 10H-VH1 21 ◆ 09H-DBH 222 ◆ 02H-03H 74 ◆



CONAM NUCLEAR, INC. BW

06/93, SOUTHERN CALIFORNIA EDISON, SAN ONOFRE, UNIT 2

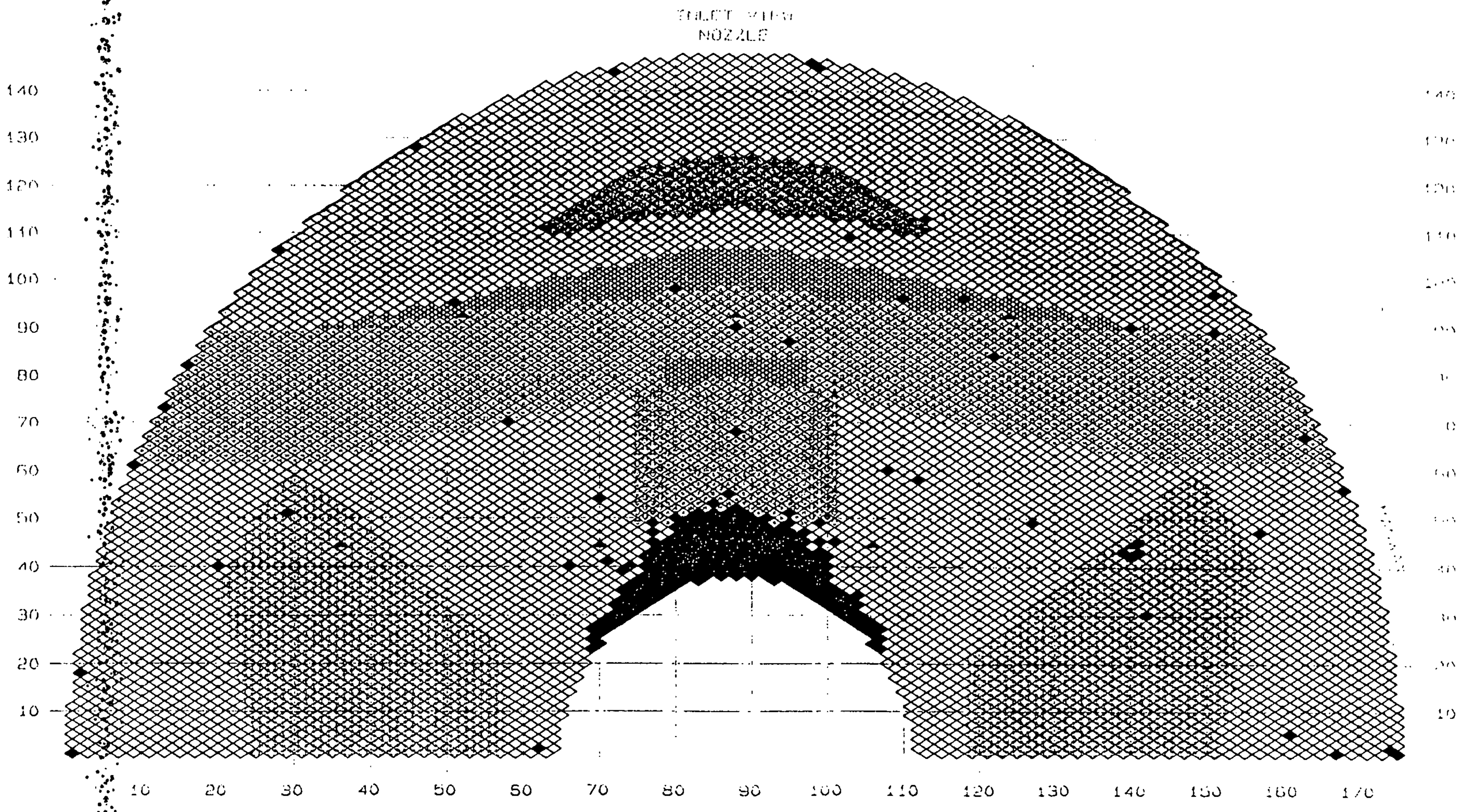
STEAM GENERATOR: 88
PROC: S023-XXVII-23.1

DATE: 06/29/93
TIME: 11:56:51

CRITERIA: TUBES TO BE EXAMINED IN GROUP(S) 1, 2, 3, 4, 5, 6

STAYS ▲

PLUGGED	208	◆	Group1	234	•	[illegible]			Group3	1742	✱	Group4	[illegible]	○	Group5	262	✱
MULTIPLE	319	×													Group6	108	∇



CONAM NUCLEAR, INC. BW

06/93, SOUTHERN CALIFORNIA EDISON, SAN ONOFRE, UNIT 2

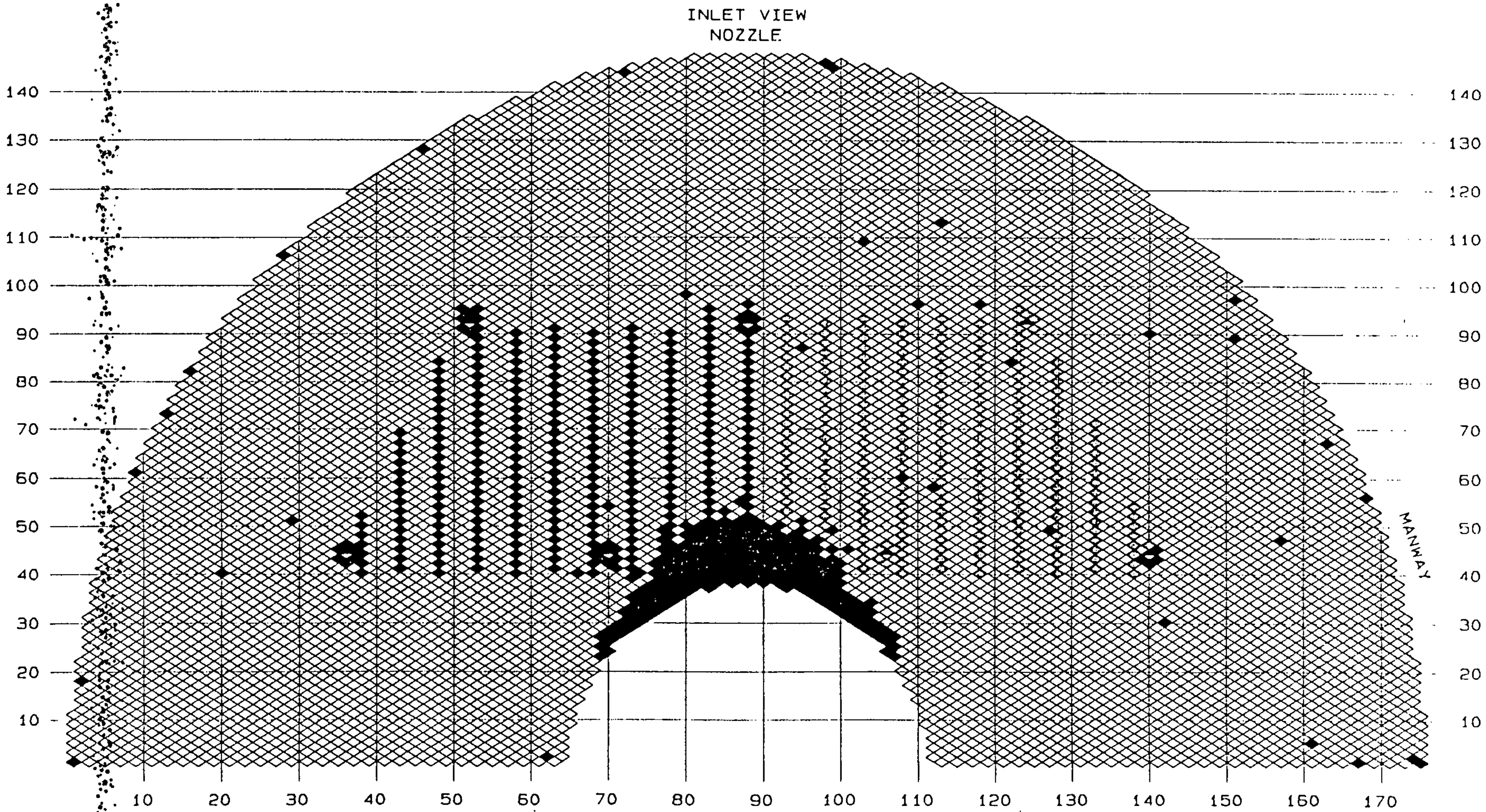
STEAM GENERATOR: 88
PROC: S023-XXVII-23.1

DATE: 06/30/93
TIME: 13:18:06

CRITERIA: TUBES TO BE EXAMINED IN GROUP(S) 11, 12

STAYS ▲

PLUGGED 266 ◆ Group11 260 ◆ Group12 212 ✦
MULTIPLE 0 ✱



CONAM NUCLEAR, INC. BW

06/93, SOUTHERN CALIFORNIA EDISON, SAN ONOFRE, UNIT 2

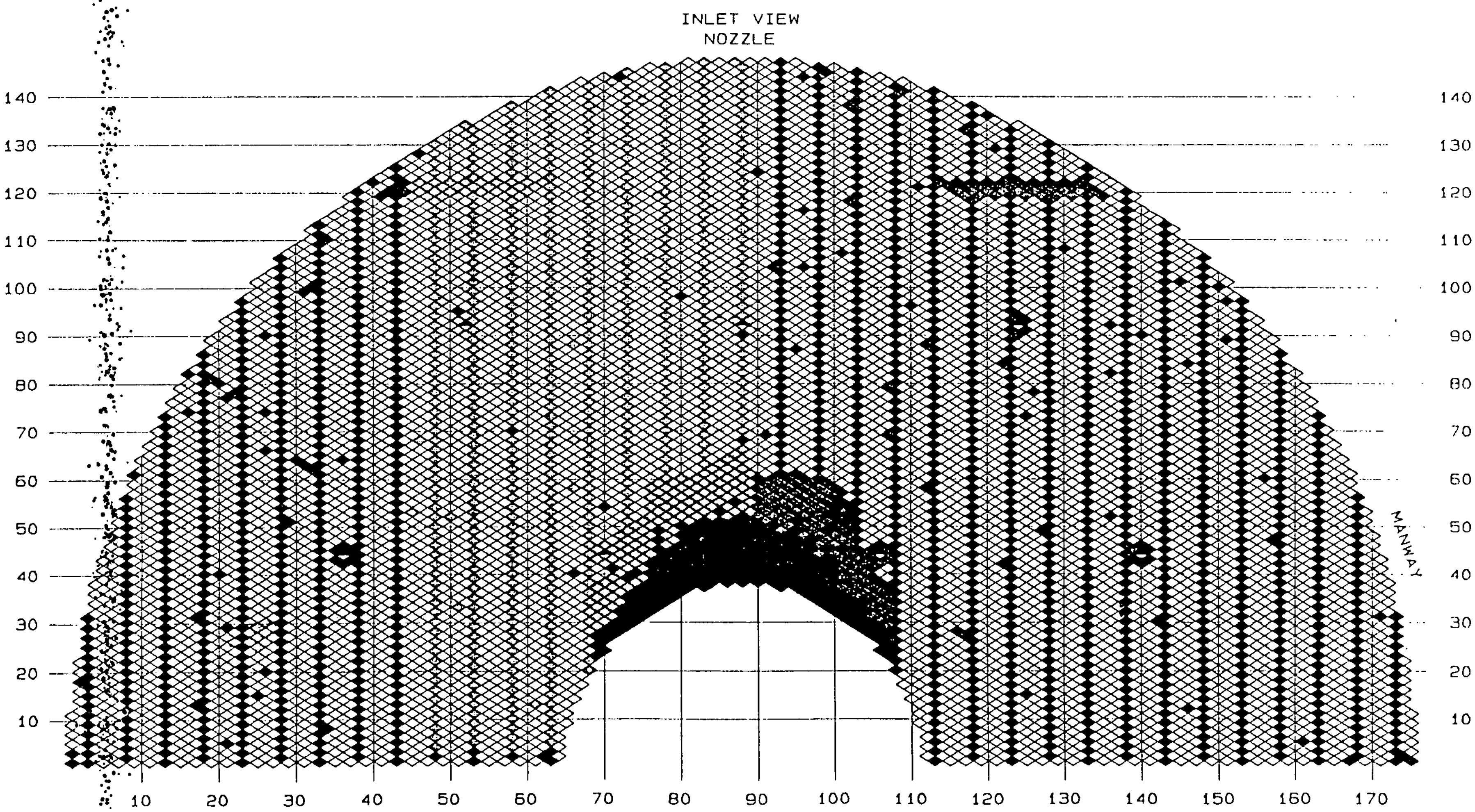
STEAM GENERATOR: 88
PROC: S023-XXVII-23.1

DATE: 06/30/93
TIME: 13:14:37

CRITERIA: TUBES TO BE EXAMINED IN GROUP(S) 1, 2, 3, 4, 5, 6

STAYS ▲

PLUGGED	266	◆	
MULTIPLE	0	X	
Group1	424	◆	
[illegible]	[illegible]	^	
Group3	705	◆	
Group4	337	◆	
Group5	20	◆	
Group6	21	◆	



CONAM NUCLEAR, INC. BW

BASES FOR EDDY CURRENT TESTING PROGRAM

- Technical Specifications - 3% + prior > 20% indications
- EPRI Recommendation - 20%
- Top of Hot Leg Tubesheet (MRPC) - 500 tubes/SG
  - o PWSCC
  - o Secondary IGA/IGSCC
- Profilometry - 100 tubes/SG
- Mid-Span/Tube Support IGA/IGSCC - under development

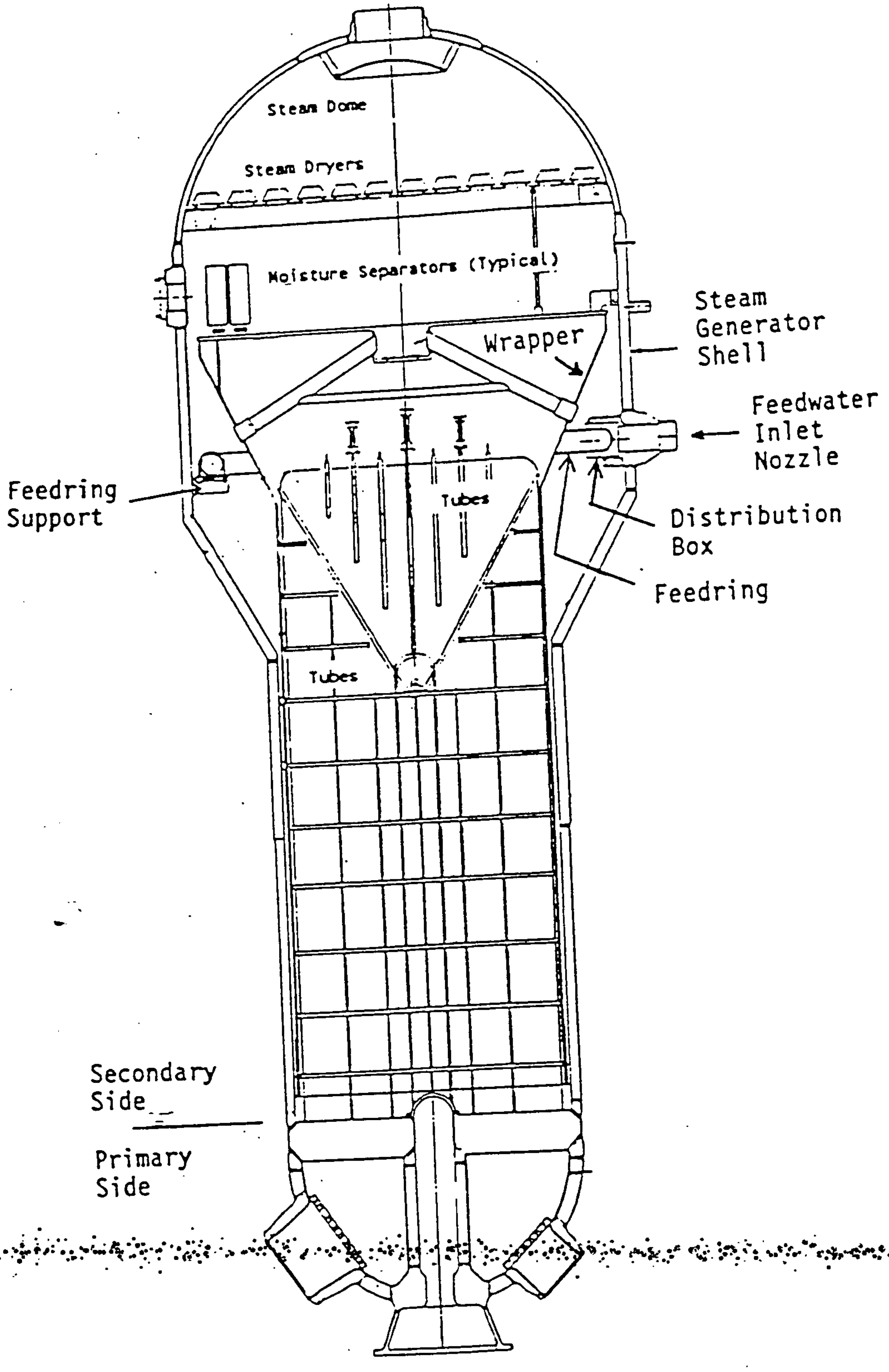
Steam Generator Status (con't)

	SO2	SO3
Tubes Plugged	614	555
Improper Annealing	62	24
Batwing Wear	460	459
Vertical Strap Wear	9	9
Loose Part Wear	3	15
Tie-Rod Denting	33	6
Pre-Service	21	35
Other Causes	26	7

Steam Generator Status

	SO2	SO3
Tubes Installed	18,700	18,700
Tubes Plugged	614	555
Tubes In Service	18,086	18,145

FIGURE 1: SIDE VIEW OF SONGS, UNITS 2 AND 3 STEAM GENERATORS



SAN ONOFRE UNIT 2 STEAM GENERATOR INSPECTION

EDDY CURRENT TESTING PLAN

- Steam Generator Characteristics/History
- Bases for Eddy Current Testing Program
- Factors Affecting Secondary IGA/IGSCC
- Preliminary Detailed Inspection Plan
- Eddy Current Testing Improvements

SONGS 2E088 TUBE LEAK

3/1/88

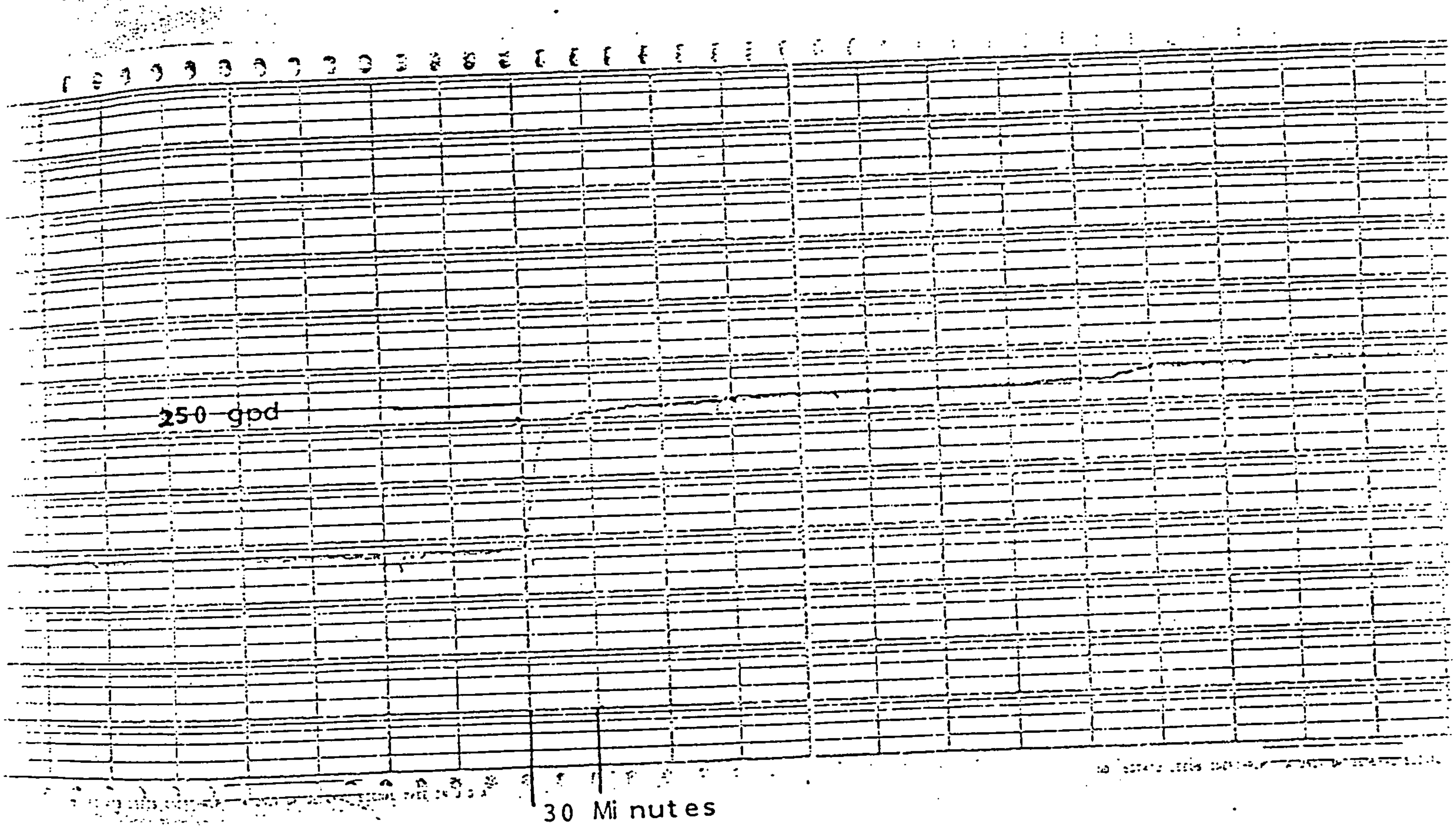
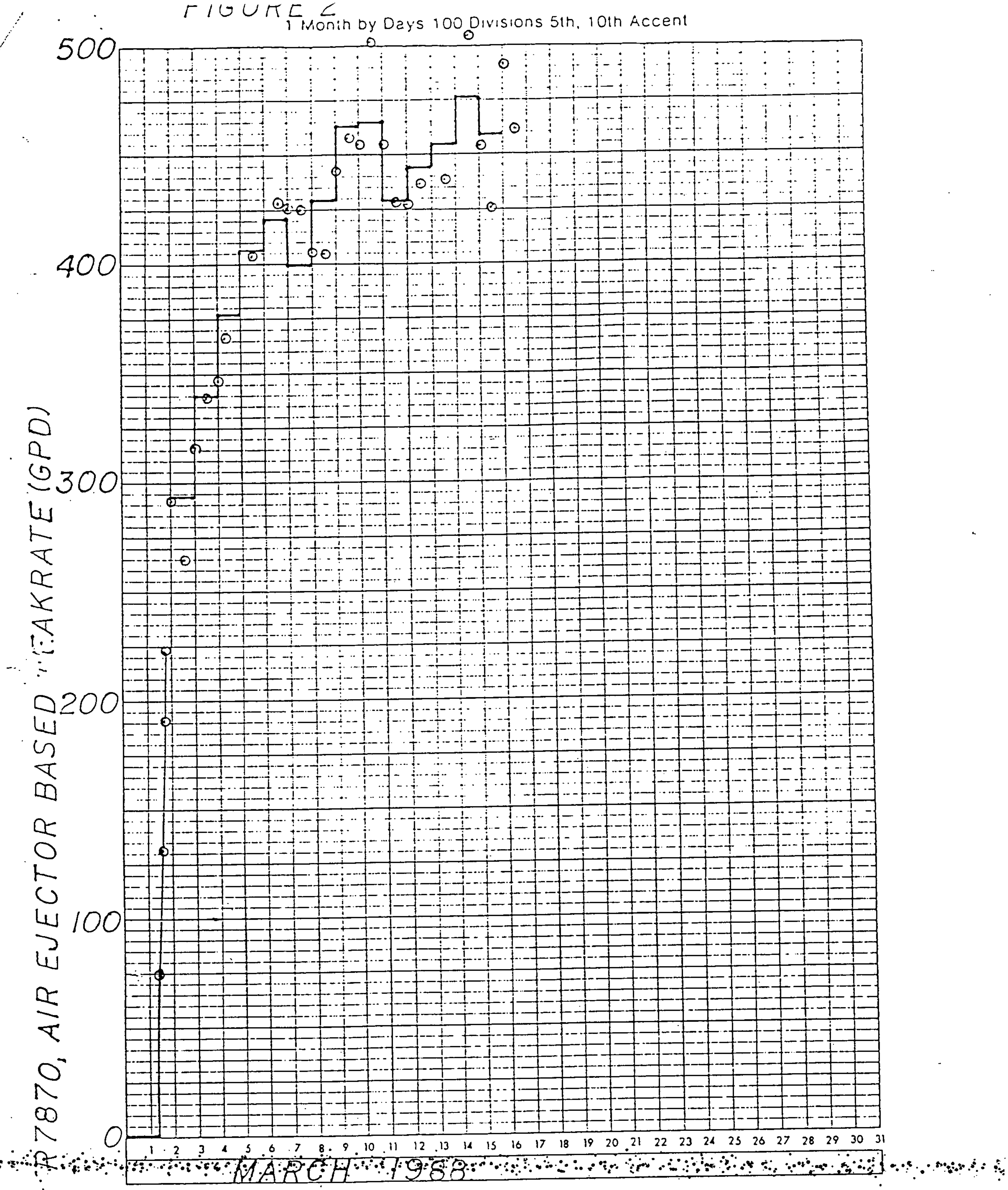
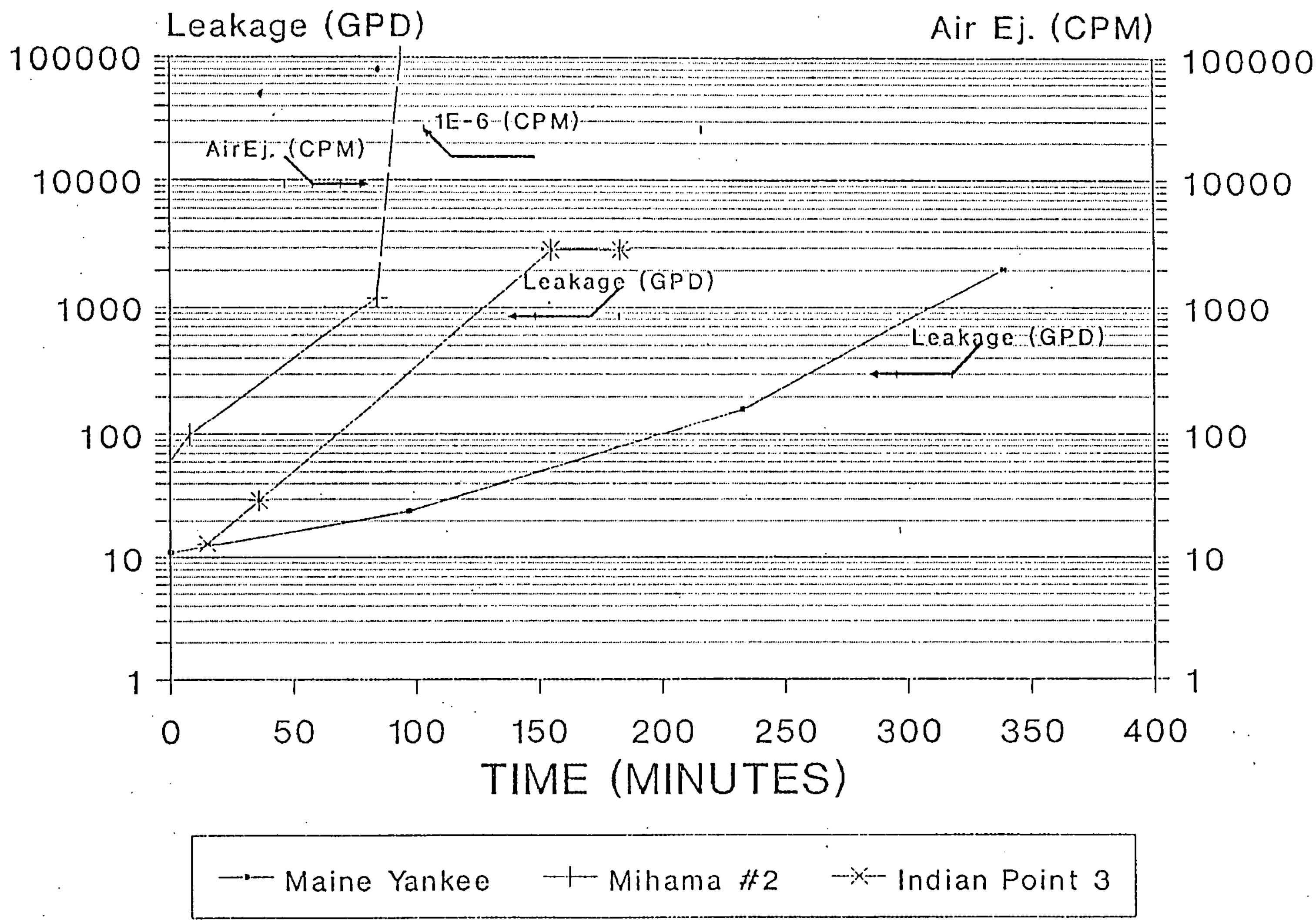


FIGURE 2


1 Month by Days 100 Divisions 5th, 10th Accent
R7870, AIR EJECTOR BASED LEAKRATE (GPD)
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31
MARCH 1988

STEAM GENERATOR TUBE LEAKS

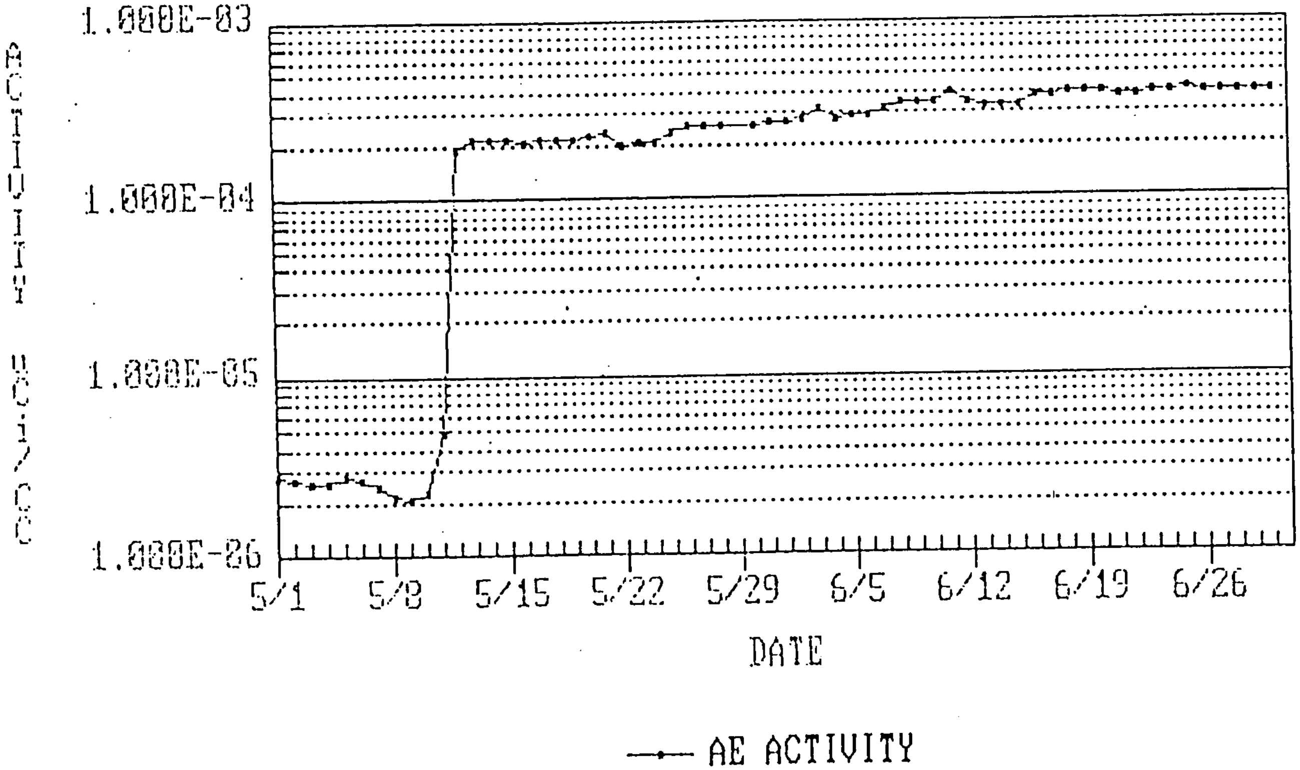


RESPONSE TO INDICATION OF TUBE LEAKAGE

(SO123 - III - 2.22.23 & SO23 - 13 - 14)

- BLOWDOWN is sampled every 72 hours Air Ejector is sampled once per week.
- Upon indication of tube leakage Chemistry leak rate determinations increase to every 72 hours.
- Upon exceeding 10gpd leakage, Chemistry leak rate determinations increase to daily.
- Upon reaching the Air Ejector Alarm Setpoint (30 gpd) Operations begins logging RE-7870 readings.
- If RE-7870 indicates leakage has increased by more than 60gpd in any 1 hour period, verify the monitor response is real and sustained (by checking blowdown). If valid, then commence a rapid shutdown at 1% to 5% power per minute.
- For large leaks we would utilize our EOIs. A Mihama type of tube rupture event was run last year in simulator training. All 15 crews isolated the affected generator within 32 minutes.

AIR EJECTOR MONITOR 3-7870
ACTIVITY



DAILY AVE.(read early morning,past 1hr)

STEAM GENERATOR TUBE LEAKAGE MONITORING

LOCATION	TYPE	FREQUENCY	LLD (AT Current RCS Activity)
Air Ejector	Monitor	Continuous	< 1 gpd
Air Ejector	Alarm	Continuous	30 gpd
Air Ejector	Grab	Weekly	~ 0.1 gpd
Blowdown	Monitor	Continuous	~ 5 gpd
Blowdown	Alarm	Continuous	~1000 gpd
Blowdown	Grab	Every 72 Hours	< 1 gpd
Steamline	N-16	As needed (new)	~ 1 gpd
Steamline	Monitor	Continuous	~3000 gpd
Feedwater	Tritium	As needed	~ 0.3 gpd

Unit 3 Tube Leakage - Likely Causes

W tube plug - 178 PIP's installed in Unit 3

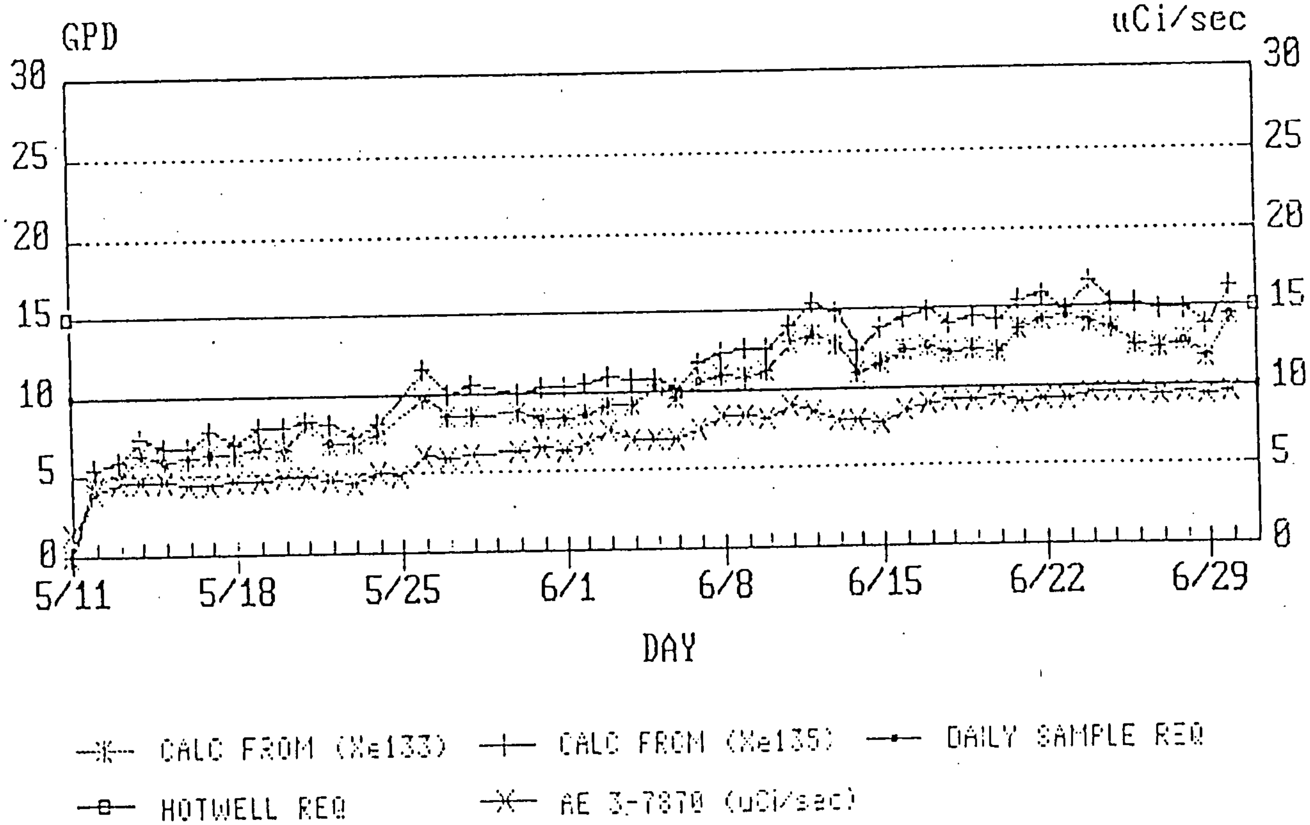
CE tube plug

Tie-rod denting

Vertical strap or batwing wear

PRIMARY TO SECONDARY LEAK RATE

MAY / JUNE 1993



UNIT 3

Vulnerability Assessment

Secondary Chemistry	less vulnerable
Thermo-Hydraulics	less vulnerable
Tube Support Structure	less vulnerable
Operating Temperature	less vulnerable

Agenda

Introduction

Unit 3 Steam Generator Tube Leakage

- Leakage Progression
- Suspected Cause
- Operational Capabilities

Unit 2 Steam Generator Inspection

- Background
- Inspection Program

Comparison of PVNGS and SONGS

- Mechanical and Plant Design
- Chemistry Program

Summary