HW-69000 V2A

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HW-69000 Vol. 2A

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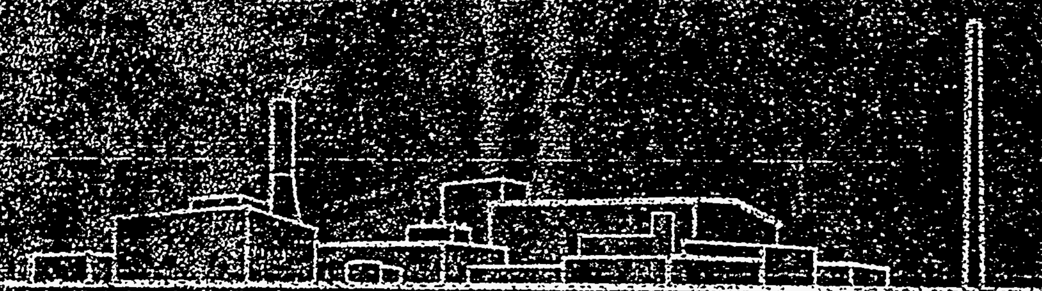
100-N TECHNICAL MANUAL

VOLUME 2A

SYSTEMS DESCRIPTIONS



N REACTOR DEPARTMENT

GENERAL ELECTRIC

HANFORD ATOMIC PRODUCTS OPERATION

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MASTER

AEC-GE RICHLAND, WASHINGTON

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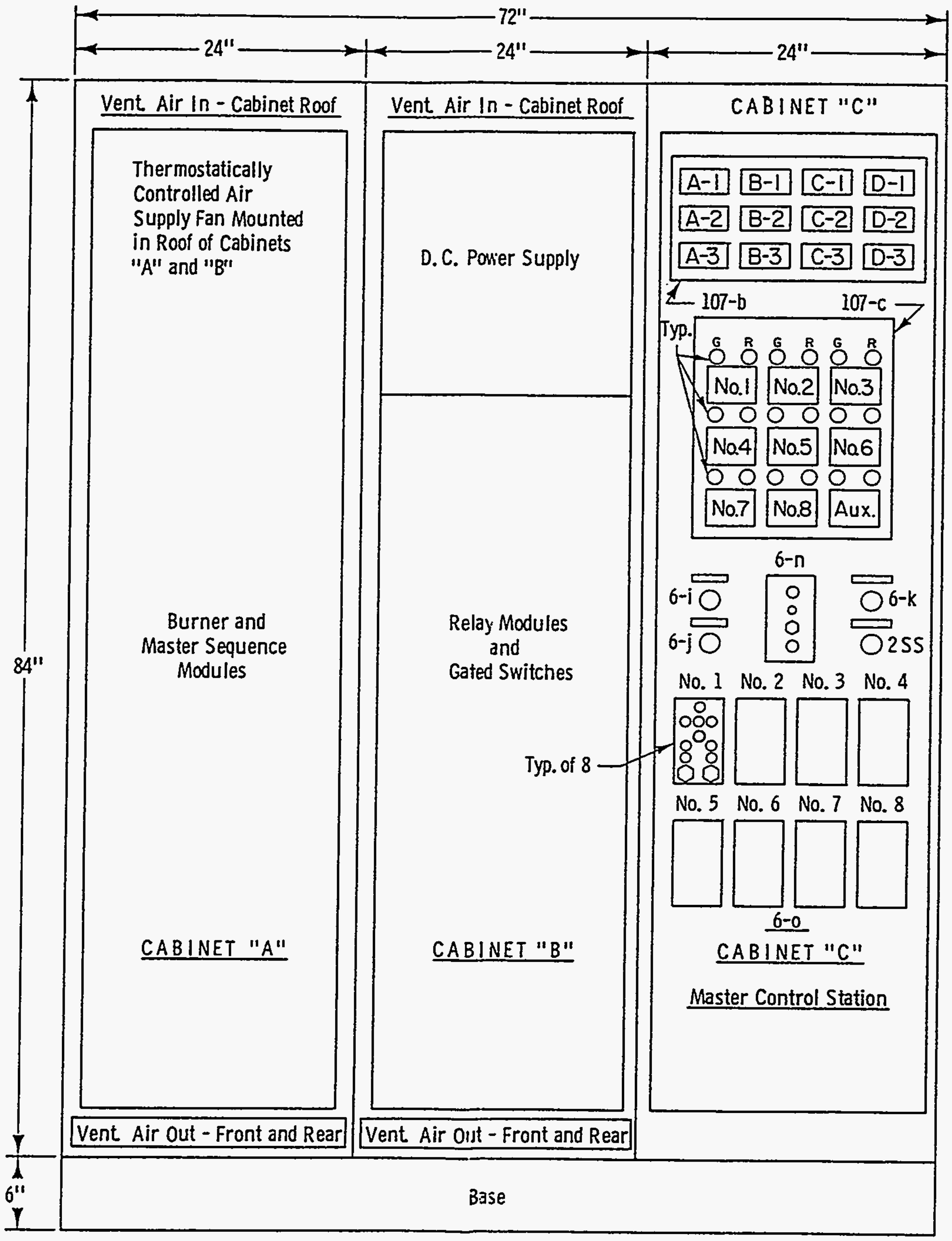
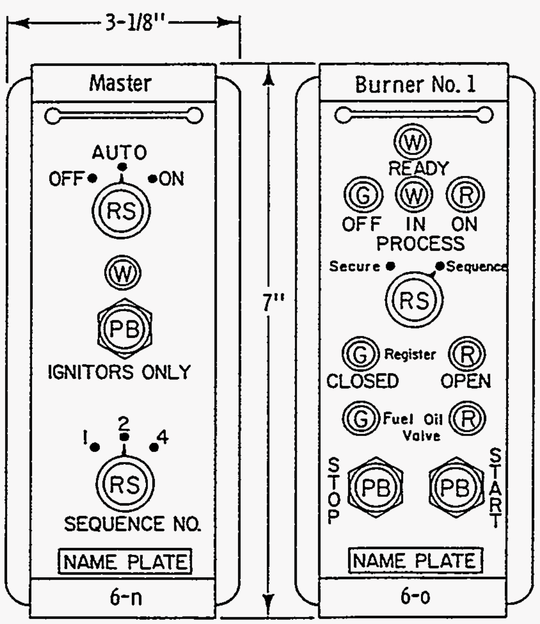

72"
24"
24"
24"
Vent. Air In - Cabinet Roof
Vent. Air In - Cabinet Roof
CABINET "C"
Thermostatically Controlled Air Supply Fan Mounted in Roof of Cabinets "A" and "B"
D. C. Power Supply
A-1 B-1 C-1 D-1
A-2 B-2 C-2 D-2
A-3 B-3 C-3 D-3
107-b
107-c
Typ.
G R G R G R
No.1 No.2 No.3
No.4 No.5 No.6
No.7 No.8 Aux.
6-n
6-i
6-j
6-k
2SS
84"
Burner and Master Sequence Modules
Relay Modules and Gated Switches
No. 1 No. 2 No. 3 No. 4
Typ. of 8
No. 5 No. 6 No. 7 No. 8
6-o
CABINET "A"
CABINET "B"
CABINET "C"
Master Control Station
Vent. Air Out - Front and Rear
Vent. Air Out - Front and Rear
6"
Base

LEGEND

Cabinet "C"		Fuel Oil System Annunciator - 107 - b
6-i & j-	Annunciator 107-b Acknowledgement and Test Pushbutton	A-1 Fuel Oil Low Pressure A-2 Fuel Oil Day Tank No. 1 Hi Level
6-k-	Annunciator 107-c Acknowledgement Pushbutton	A-3 Fuel Oil Day Tank No. 1 Lo Level B-1 Atomizing Air Lo Pressure
6-n	Master Control Station	B-2 Fuel Oil Day Tank No. 2 Hi Level
6-o	Individual Burner Control Stations	B-3 Fuel Oil Day Tank No. 2 Lo Level
107-b-	Fuel Oil System Annunciator	C-1 Atomizing Steam Low Pressure
107-c-	Main and Auxiliary Burners Flame Monitoring Annunciator	C-2 Fuel Oil Low Temperature C-3 Flame Detector Air Low Pressure
2 SS-	Auxiliary Burner Secure Button	D-1 Ignition Oil Lo Pressure
		D-2 Ignition Oil Day Tank Hi Level
		D-3 Ignition Oil Day Tank Lo Level



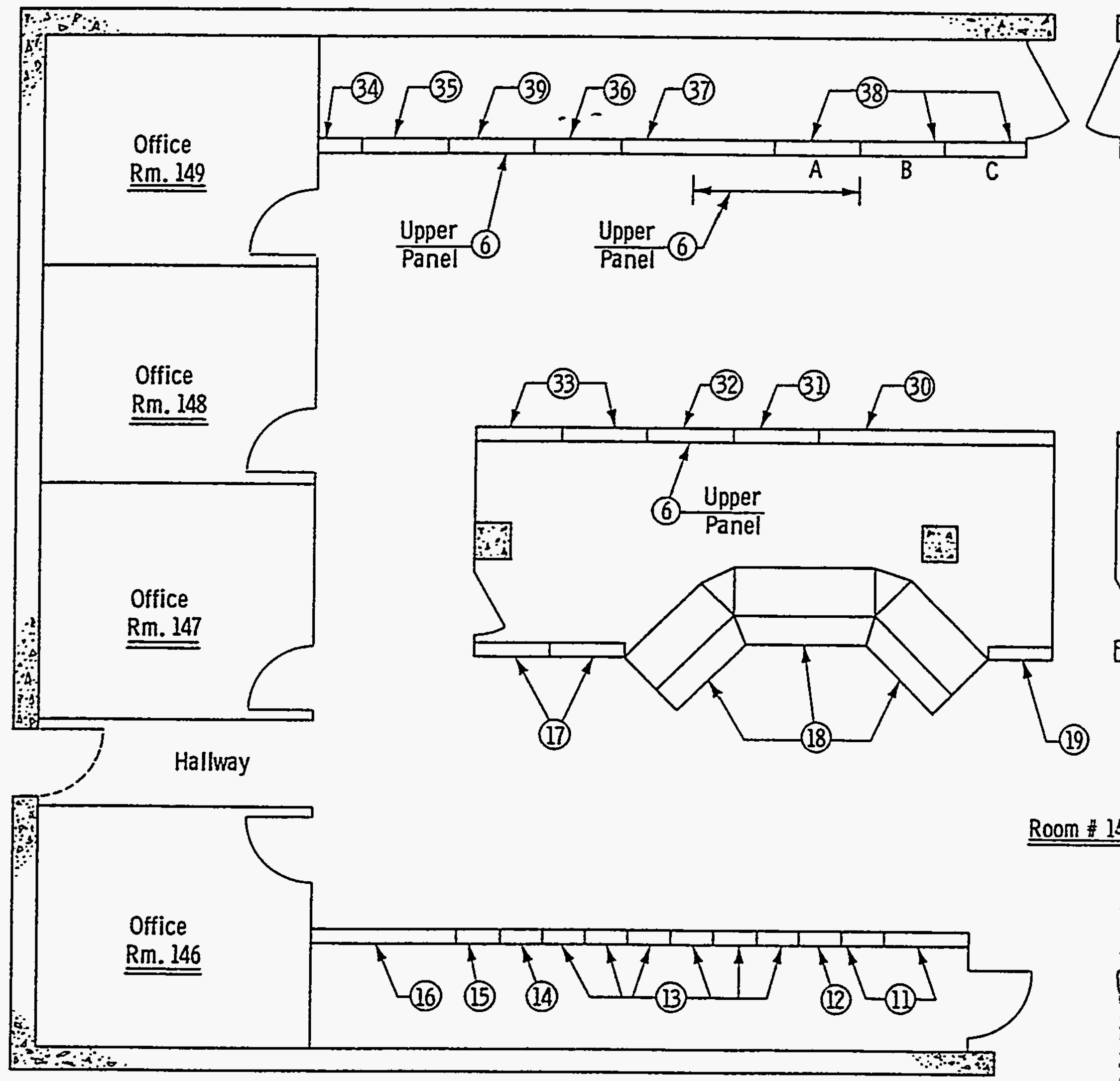
Master Control Station

Burner Control Station (Typical of 8)

Control Station Details

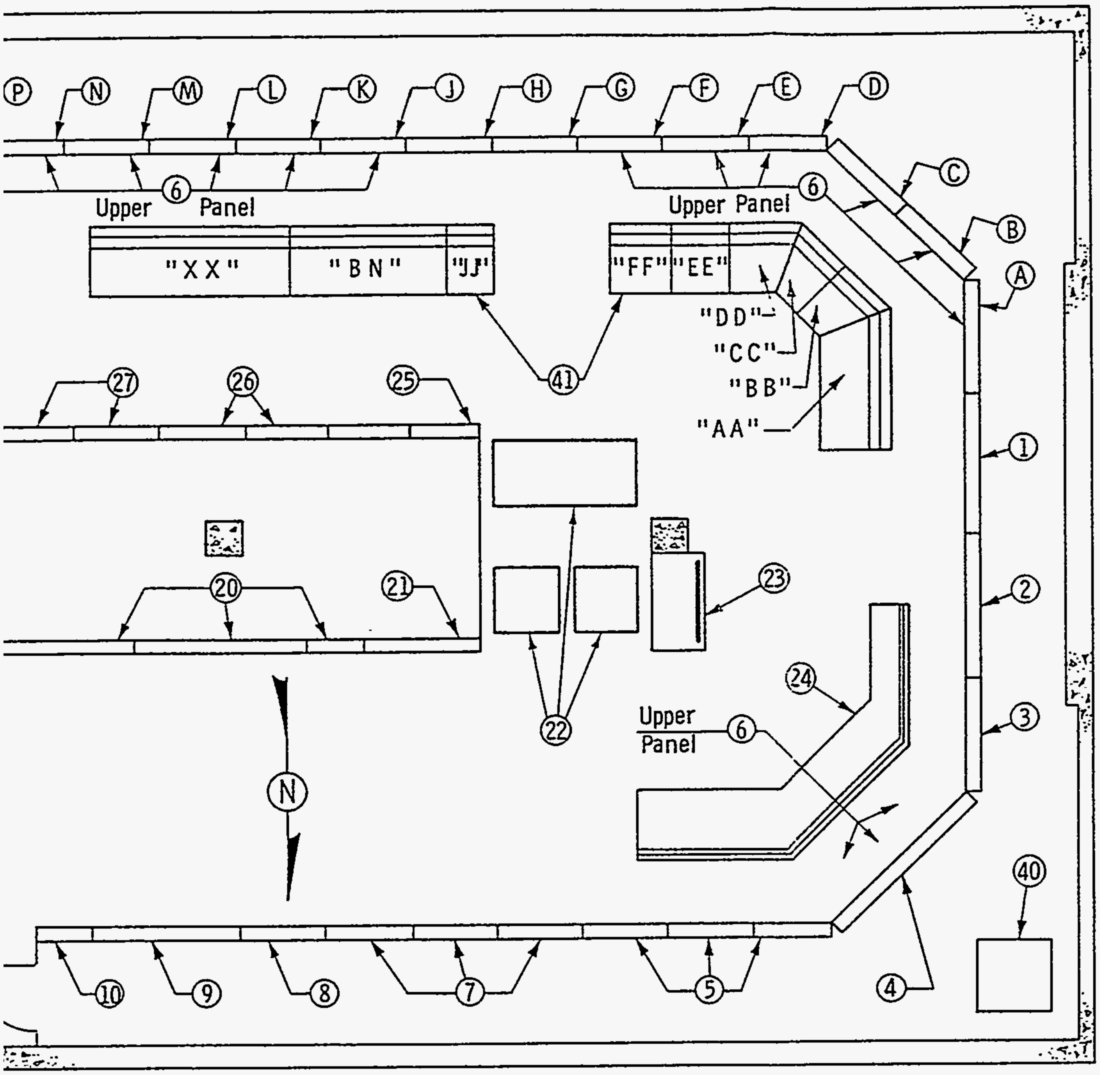
Control Stations Legend

RS-Rotary Switch
PB-Pushbutton
W- White Ind. Lamp
R - Red Ind. Lamp
G - Green Ind. Lamp



1. Primary Water Graphic
2. Safety Circuit
3. In-Core Flux Monitor
4. Reactor Control
5. High Level Nuclear
6. Annunciators
7. Subcritical and Intermediate Level Nuclear
8. Zone Temperature Monitor
9. Rod Service Selector Switch
10. Emergency Cooling Water
11. Reactor Thermocouple
12. Stack Air Monitoring
13. Space Monitoring
14. Zone I Exhaust Air Monitoring
15. Spare
16. Rod and Ball Control
17. Spare
18. Communications Center
19. Miscellaneous Electrical Control

Plant Control Center Ar



20. Flow Monitor
21. Flow and Temperature Data
22. Flow, Temperature and Central Data Loggers
23. Rod Data Enclosure
24. Reactor Control Console
25. Central Data
26. Gross Gamma Rupture Monitoring
27. Gamma Energy Rupture Monitoring
30. Process Tube Diversion
31. Rod and Shield Cooling Water
32. Graphite Coolant
33. Power Calculator and Bulk Coolant Flow
34. Spare
35. Pile Motion
36. 105 Confinement
37. 105 Heating and Ventilating
38. Pile Gas
39. 109 Confinement
40. Control Rod Display Cabinet
41. Heat Conversion Consoles

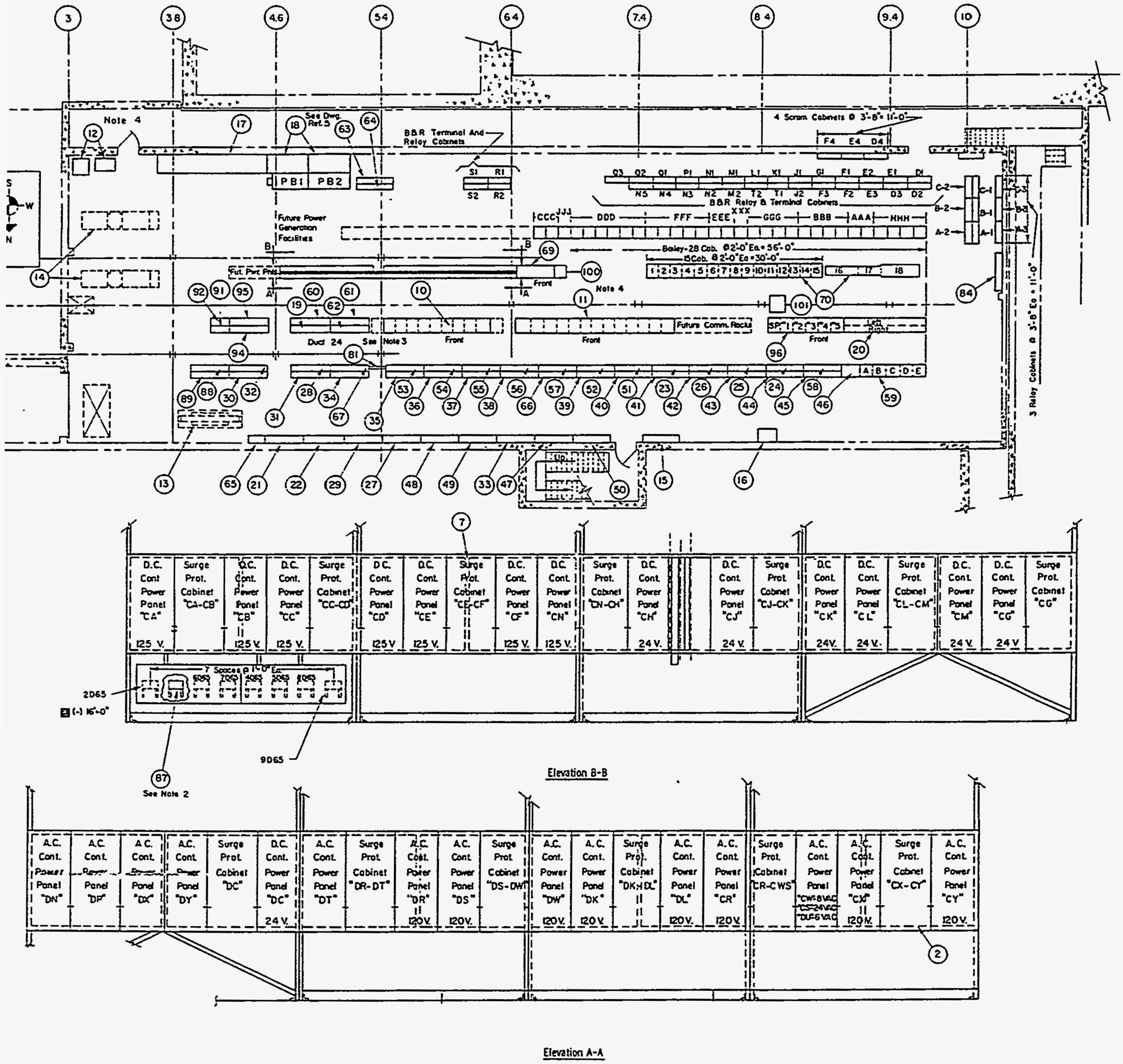
angement - 105-N

PT. NO.	DESCRIPTION		
1	Pile. Inst. & Elec. Equip. Room Arrgt.		
2	Surge Protection & T. B. Cabinet Assembly		H-1-32057-P1
10	Television Racks Assembly		H-1-31838-P2
11	Communications Racks Assembly		H-1-31838-P2
12	Pax Battery & Charger Rack		HWS-6971
13	40 Ton Air Cond. Compressor Unit		H-1-28127
14	112.5 KVA. XFMR & Distribution PNL		H-1-31517-P15, 16, 30, & 31
15	Fire Alarm Control Panel		H-1-31991
16	Cont. Rm. Emer. Ltg. Battery Charger		H-1-31908-P14
17	2-24 V. D. C., 556 Amp. Hr. Batt. Rack 2 Step, 2 Row		NICAD-JAU58
18	Rectifier, 24 V. D. C. Supply		
19	Relay PNL. Arr'gt. Conn. Diag. (PR 15)		H-1-32530
20	Flow Monitor Terminal Cabinets		H-1-27454
21	Relay PNL. Conn. Dia.	(PR21)	H-1-32609
22		(PR22)	H-1-32610
23		(PR13)	H-1-32601
24		(PR14)	H-1-32602
25		(PR28)	H-1-32616
26		(PR29)	H-1-32617
27		(PR35)	H-1-32583
28		(PR34)	H-1-32582
29		(PR26)	H-1-32614
30		(PR16)	H-1-32604
31		(PR17)	H-1-32605
32		(PR25)	H-1-32613
33		(PR47)	H-1-32628
34		(PR18)	H-1-32606
35		(PR19)	H-1-32607
36		(PR20)	H-1-32608
37		(PR30)	H-1-32618
38		(PR31)	H-1-32619
39		(PR32)	H-1-32620
40		(PR33)	H-1-32620
41		(PR40)	H-1-32623
42		(PR39)	H-1-32587
43		(PR38)	H-1-32586
44		(PR37)	H-1-32585
45		(PR36)	H-1-32584
46		(PR27)	H-1-32528
47		(PR48)	H-1-32628
48		(PR45)	H-1-32524-P2

NOTES:

1. For Control Power Panel Schedules, Size and Quantity of Breakers, See G. E. Dwgs. H-1-31888, 31889 and 31886.
2. For Elementary and Connection Diagram See G. E. Dwg. H-1-32096.
3. Elevation of Duct 24 Matches Wireways in Top of Panels PT53 and 67.
4. For Location of This Equipment See G. E. Dwg. H-1-31578.
5. For One Line Diagram, See G. E. Dwg. H-1-32699
6. See G. E. Dwg. H-1-32696

PT. NO.	DESCRIPTION		
49		(PR46)	H-1-32524-P3
50		(PR49)	H-1-32629
51		(PR23)	H-1-32611
52		(PR24)	H-1-32612
53		(PR8)	H-1-32596
54		(PR9	H-1-32597
55		(PR10)	H-1-32598
56		(PR11)	H-1-32599
57		(PR12)	H-1-32600
58	Relay PNL. Conn. Diag.	(PR44)	H-1-32524-P1
59	Ann. Print-Out Control Cabinet		
60	Relay PNL. Conn. Diag.	(PR41)	H-1-32624
61		(PR42)	H-1-32625
62		(PR43)	H-1-32626
63		(PR51)	H-1-32631
64		(PR50)	H-1-32630
65	Relay PNL. Arrgt.	(PR53)	H-1-32534
66	Relay PNL. Conn. Diag.	(PR54)	H-1-32620
67	Terminal Cabinet	(PR55)	H-1-32636 PT3
69	Shield Thermocouple Scanner		H-1-27496
70	Data System Cabinets		HWS-6518 & BPF
84	Terminal Cabinet	(PR56)	H-1-32636 PT2
87	Rectifier Stacks, Silicon, 143 Amp		
88	Terminal Cabinet	(PR59)	H-1-32636 PT5
89	Relay Panel	(PR60)	H-1-32523
91	Relay Panel	(Spare) PR-61	H-1-32517 PT1
92	Relay Panel	(Spare) PR-62	H-1-32517 PT1
93	Cycle Timer Cabinet (Index 253)		H-1-31733 PT2
94	Relay Panel Conn. Diag.	(PR65)	H-1-32633
95	Relay Panel	(Spare) (PR-66)	H-1-32517 PT2
96	Flow Monitor Power Supply	(PNL. D)	
100	Traveling Wire Flux Monitor Control Cabinet		
101	420~ Flow Monitor Power Supply Transformation Center		


Note 4
See Dwg. Ref. 5
PB1
PB2
B&R Terminal And Relay Cabinets
4 Scram Cabinets @ 3'-8" = 11'-0"
B&R Relay & Terminal Cabinets
Future Power Generation Facilities
Bailey-28 Cab. @ 2'-0" Ea = 56'-0"
Future Comm. Racks
Front
Duct 24
See Note 3
3 Relay Cabinets @ 3'-8" Ea = 11'-0"
D.C. Cont. Power Panel "CA" 125 V.
Surge Prot. Cabinet "CA-CB"
D.C. Cont. Power Panel "CB" 125 V.
D.C. Cont. Power Panel "CC" 125 V.
Surge Prot. Cabinet "CC-CD"
D.C. Cont. Power Panel "CD" 125 V
D.C. Cont. Power Panel "CE" 125 V.
Surge Prot. Cabinet "CE-CF"
D.C. Cont. Power Panel "CF" 125 V.
D.C. Cont. Power Panel "CN" 125 V.
Surge Prot. Cabinet "CN-CH"
D.C. Cont. Power Panel "CH" 24 V.
D.C. Cont. Power Panel "CJ" 24 V.
Surge Prot. Cabinet "CJ-CK"
D.C. Cont. Power Panel "CK" 24V.
D.C. Cont. Power Panel "CL" 24 V.
Surge Prot. Cabinet "CL-CM"
D.C. Cont. Power Panel "CM" 24 V.
D.C. Cont. Power Panel "CG" 24 V
Surge Prot. Cabinet "CG"
7 Spaces @ 1'-0" Ea.
2D65
9D65
See Note 2
Elevation B-B
A.C. Cont. Power Panel "DN"
A.C. Cont. Power Panel "DP"
A.C. Cont. Power Panel "DX"
A.C. Cont. Power Panel "DY"
Surge Prot. Cabinet "DC"
D.C. Cont. Power Panel "DC" 24 V.
A.C. Cont. Power Panel "DT"
Surge Prot. Cabinet "DR-DT"
A.C. Cont. Power Panel "DR" 120V.
A.C. Cont. Power Panel "DS" 120V.
Surge Prot. Cabinet "DS-DW"
A.C. Cont. Power Panel "DW" 120V.
A.C. Cont. Power Panel "DK" 120 V.
Surge Prot. Cabinet "DK-DL"
A.C. Cont. Power Panel "DL" 120V.
A.C. Cont. Power Panel "CR" 120V.
Surge Prot. Cabinet "CR-CWS"
A.C. Cont. Power Panel "CW-8VAC" "CS-24VAC" "DU-6VAC"
A.C. Cont. Power Panel "CX" 120V.
Surge Prot. Cabinet "CX-CY"
A.C. Cont. Power Panel "CY" 120V.
Elevation A-A

"J" PANEL LEGEND

Print Ref: H-1-40135 - H-1-40187

1. 184-N Boiler Non-Return Valve. HPV-105-1.
2. Block Valves HPV-106-2, 109-1 for HPV-108-1
3. Block Valves HPV-106-1, 109-2 for HPV-107-1.
4. Stm. Press. Cont. Valve HPV-107-1, from 184 Bldg.
5. Stm. Press. Cont. Valve HPV-108-1, from 184 Bldg.
6. Mn. Steam Isolation Valve HPV-103-1.
7. Block Valves HPV-106-3, 121-1 for HPV-112-1.
8. Press. Cont. Valve HPV-112-1 Stm. Supply to Deaerator.
9. Block Valves HPV-106-4, 102-1 for HPV-101-1.
10. Press. Cont. Valve HPV-101-1 Stm. Supply to Deaerator.
11. Main Stm. Isolation Between 184-N and 109-N HPV-203-1.
12. Press. Cont. Valves for LO-Press. Aux. Stm. HPV-227-1 and 2.
13. HPV-110-1 Bypass for Cont. Valve HPV-108-1.
14. HPV-110-2 Bypass for Cont. Valve HPV-107-1.
15. HPV-205-2 West Side Stm. Supply Shutoff to Dr. Turb. Hdr.
16. HPV-235-6 East Side Stm. Supply Shutoff to Dr. Turb. Hdr.
17. HPV-205-1 Dr. Turb. Hdr. Isolation Valve West Side.
18. HPV-243-1 Dr. Turb. Hdr. Isolation Valve East Side.
19. HPV-204-1 Mn. Stm. Hdr. No. -1 Aux. Supply Non-Return Valve.
20. HPV-204-2 Mn. Stm. Hdr. No. -2 Aux. Supply Non-Return Valve.
21. HPV-204-3 Mn. Stm. Hdr. No. -3 Aux. Supply Non-Return Valve.
22. HPV-204-4 Mn. Stm. Hdr. No. -4 Aux. Supply Non-Return Valve.
23. HPV-211-1 Mn. Stm. Hdr. No. -1 Backup Press. Cont. Valve.
24. HPV-211-2 Mn. Stm. Hdr. No. -2 Backup Press. Cont. Valve.
25. HPV-211-3 Mn. Stm. Hdr. No. -3 Backup Press. Cont. Valve.
26. HPV-211-4 Mn. Stm. Hdr. No. -4 Backup Press. Cont. Valve.
27. HPV-206-1 Isolation Valve for Mn. Stm. Hdr. No. 1 and 2.
28. HPV-224-1 Isolation Valve for Mn. Stm. Hdr. No. 2 and 3.
29. HPV-206-2 Isolation Valve for Mn. Stm. Hdr. No. 3 and 4.
30. HPV-210-1 Non-Return in St. Supply to Surge Tk. from Mn. Stm. Hdr. No. 2.
31. HPV-210-2 Non-Return in St. Supply to Surge Tk. from Mn. Stm. Hdr. No. 3.
32. HPV-240-1 and 2. Block Valves for HPV-214-1.
33. HPV-240-3 and 4 Block Valves for HPV-214-2.
34. HPV-240-5 and 6 Block Valves for HPV-214-3.
35. HPV-240-11 and 12 Block Valves for HPV-214-4.
36. HPV-214-1 Stm. to Surge Tk. Press. Cont. Valve.
37. HPV-214-2 Stm. to Surge Tk. Press. Cont. Valve.
38. HPV-214-3 Stm. to Surge Tk. Press. Cont. Valve.
39. HPV-214-4 Stm. to Surge Tk. Press. Cont. Valve.
40. HPV-233-1 Stm. to Surge Tk. Isolation Valve West Side.
41. HPV-233-2 Stm. to Surge Tk. Isolation Valve East Side.
42. HPV-241-1 and 2 Block Valves for HPV-234-1.
43. HPV-241-3 and 4 Block Valves for HPV-234-2.
44. HPV-241-5 and 6 Block Valves for HPV-234-3.
45. HPV-234-1 Vent Control from Surge Tk. Stm. Hdr. West Side.
46. HPV-234-2 Vent Control from Surge Tk. Stm. Hdr. Center.
47. HPV-234-3 Vent Control from Surge Tk. Stm. Hdr. East S
48. CONDV-201-1 Cond. Suct. Hdr. Isolation West Side.
49. CONDV-201-2 Cond. Suct. Hdr. Isolation East Side.
50. CONDV-204-1 Cond. Dischg. Hdr. Isolation West Side.
51. CONDV-204-2 Cond. Dischg. Hdr. Isolation East Side.
52. CONDV-205-1 and 2 Block Valves for CONDV-215-1.
53. CONDV-205-3 and 4 Block Valves for CONDV-215-2.
54. CONDV-215-1 Emerg. Spill Control Valve West Side.
55. CONDV-215-2 Emerg. Spill Control Valve East Side.
56. CONDV-244-1 and 2 Block Valves for CONDV-243-1.
57. CONDV-244-3 and 4 Block Valves for CONDV-243-2.
58. CONDV-244-5 and 6 Block Valves for CONDV-243-3.
59. CONDV-243-1 Norm. Level Cond. Makeup Cont. East Side.
60. CONDV-243-2 Norm. Level Cond. Makeup Cont. Spare for
61. CONDV-243-3 Norm. Level Cond. Makeup Cont. West Side
62. CONDV-217-1 Norm. Level Cond. Makeup Cont. Bypass Ea
63. CONDV-217-2 Norm. Level Cond. Makeup Cont. Bypass W
64. CONDV-227-1 and 2 Block Valves for CONDV-228-1.
65. CONDV-228-1 Turbine Cond. Diversion Control.
66. CONDV-226-1 Turbine Cond. Diversion Control Bypass.
67. FPSV-106-1 Deaerator Isolation Valve.
68. FPDV-113-1 Blr. Feed Pmp. Dischg. Cond. Return Shuto
69. MWV-562-1 Afterheat Pmp. Dischg. Back Press. Cont.
70. MWV-101-1 Emerg. Makeup and Deaerator Bypass Control.
71. MWV-105-1 Secondary System Emerg. Flooding Control.
72. MWV-106-1 Normal Makeup Cont. to Deaerator.
73. MWV-114-1 Backup Makeup Cont. to Deaerator.
74. MWV-201-3 and 4 Block Valves for MWV-203-2.
75. MWV-201-1 and 2 Block Valves for MWV-203-1.
76. MWV-203-2 Emerg. Makeup Cont. to Cond. Dischg. Hdr.
77. MWV-203-1 Emerg. Makeup Cont. to Cond. Dischg. Hdr.
78. Control Switch for FPDV-113-1.
79. Control Switch for HPV-203-1.

A. Cond. feed to Stm. Gen. 1-A and 1-B.
B. Cond. Feed to Stm. Gen. 2-A and 2-B.
C. Cond. Feed to Stm. Gen. 3-A and 3-B.
D. Cond. Feed to Stm. Gen. 4-A and 4-B.
E. Cond. Feed to Stm. Gen. 5-A and 5-B.
F. Main Stm. Hdr. Backup Press. Cont.
G. Emergency Spill.
H. Secondary Loop Normal Makeup.
I. Yard Stm. Press. Reducing Sta.
J. Afterheat Pmp. No. 1.
K. Afterheat Pmp. No. 2.
L. Afterheat Pmp. No. 3.
M. Secondary Loop Normal Makeup Pump No. 1

Legend for Graphic Panel

N. Secondary Loop Normal Makeup Pump No. 2.
O. Boiler Feed Wtr. Pmp. No. 1.
P. Boiler Feed Wtr. Pmp. No. 2.
Q. Boiler Feed Wtr. Pmp. No. 3.
R. Turb. Cond. Diversion.
S. Turb. Cond. Return.
T. High and Med. Press. Aux. Stm. Services.
U. AH Pmp. Discharge Back Press. Control.
V. Secondary System Emerg. Flooding.
W. Boiler Feed Pmp. Emerg. Supply.

"K-L-M-N" PANEL LEGEND

NDV-243-1 or 3.

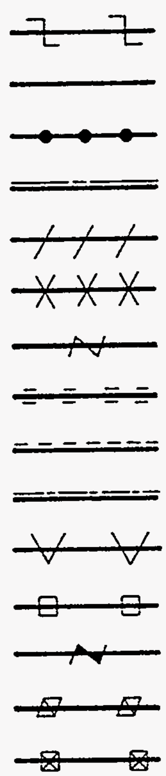
Print Ref: H-1-40136 Through H-1-40139

ide.
Side.

1. WWV-204 Wtr.-Wtr. to Dump Cond.
2. HPV-222 Mn. Stm. to Dump Cond.
3. RWRV-211 Circ. Wtr. from Dump Cond.
4. HPV-201 Mn. Stm. to Dump Cond.
5. MWV-207 Makeup Wtr. to Dump Cond.
6. CONDV-203 CONDV. from Dump Cond.
7. RWSV-211 Circ. Wtr. to Dump Cond.
8. CONDV-210 Dump Cond. Condensate Pump Dischg.
9. CONDV-202 Dump Cond. Condensate Pump Suction.
10. Dump Condenser Steam Admittance.
11. HPV-260 Main Steam to Stand Pipes.
12. Condensate Stand Pipes
13. CONDV-219 D. C. Cond. Recirc. Valve.
14. Wtr.-Wtr. Drain to Afterheat Tank.
15. Wtr.-Wtr. Drain to Pmp. Suct. Hdr.
16. Circ. Wtr. Pmp. #3 Disch.
17. Circ. Wtr. Pmp. #4 Disch.
18. Circ. Wtr. to High Lift Pmp. Hse.
19. Circ. Wtr. to Dr. Turbine Condensers.
20. Circ. Wtr. to #2 Disch.
21. Circ. Wtr. to #1 Disch.
22. Bus Selector for DT/COND.·CRW Supply Valves.
23. Circ. Water Supply Temperature.
24. Standpipe Level Indicators
25. RWSV-802-2
26. RWSV-801-2
27. RWSV-802-1
28. RWSV-801-1

t Side.
t Side.

Line Legend

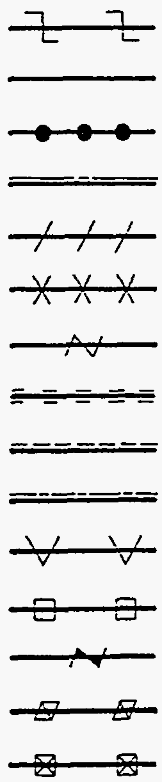


Primary Coolant to Reactor
Primary Coolant from Reactor
Main Steam
Condensate and Feedwater
Water to Water
Makeup Water
Injection Water and Seal Water
Circulating and Raw Water
Instrument Sensing
Instrument Loading
Diversion Water
Emergency Water
Spill Water
Emergency Seal Water
Vents

J, K, L, M, and N

PANEL LEGEND A

Line Legend



- Primary Coolant to Reactor
- Primary Coolant from Reactor
- Main Steam
- Condensate and Feedwater
- Water to Water
- Makeup Water
- Injection Water and Seal Water
- Circulating and Raw Water
- Instrument Sensing
- Instrument Loading
- Diversion Water
- Emergency Water
- Spill Water
- Emergency Seal Water
- Vents

1. Demineralized Storage Tank.
2. Diversion and Purity Blowdown from 10
3. Diversion Return to 105.
4. Charge Discharge fill Flow Control.
5. Injection Water to Recup. Heat Exchan
6. Recuperative Heat Exchanger #2.
7. Recuperative Heat Exchanger #1.
8. To River.
9. To Radioactive Valve Pit.
10. To Reactor Outlet Hdr.
11. To Crib/Chem. Waste via 16" Fl (LP).
12. Diversion Water to Recup. Heat Exchan
13. Charge Discharge Cold Spray Control V
14. Spill Flow and PCP Seal Return Flo√‾
15. Spill Cooler Temp. Control.
16. To Spill Wtr. Temp. Recorder Panel -P.
17. L.P. Raw Water Supply.
18. Pressurizer Backup Heater.
19. Pressurizer Startup Heater.
20. Pressurizer Cycling Heater.
21. Backup Spray Control.
22. Cycling Spray Control.
23. PRV-207-1 Spray Water to Pressurizer
24. PRV-207-2 Spray Water to Pressurizer
25. Inj. Pump Flo√‾ or Actuate CFA.
26. Lamp Test.
27. Raw Water Return to 66" RWR.
28. Emergency Dump Tank.
29. Valve FLV 852-1 from Dump Tank to Cri
30. IWV 251-1 P. C. Spill Flow to Spill Cool
31. HEV-202-3.
32. HEV-202-4.
33. PRV-213-2.
34. HEV-211-1.
35. HEV-203-5.
36. PCSV-206-1 Reactor Inlet Hdr.
37. Filtered Wtr. to Reactor Inlet Hdr. PCS
38. Pressurizer Isolating Valves. PRV-205-
39. Reactor Outlet Hdr. Sectionalizing Valv
40. FW to West and East Reactor Inlet HDRS.

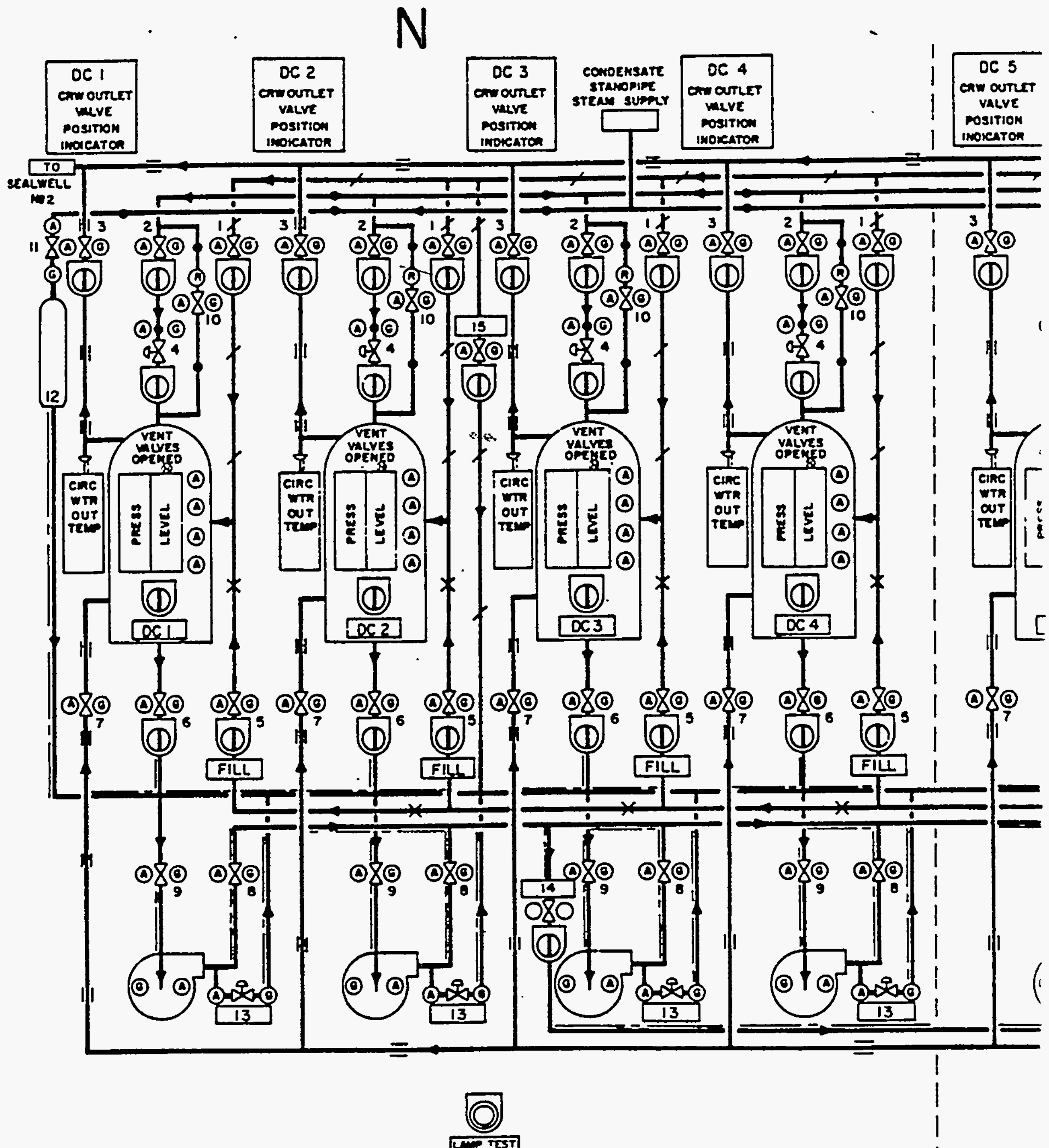
Legend for Graphic Panels P

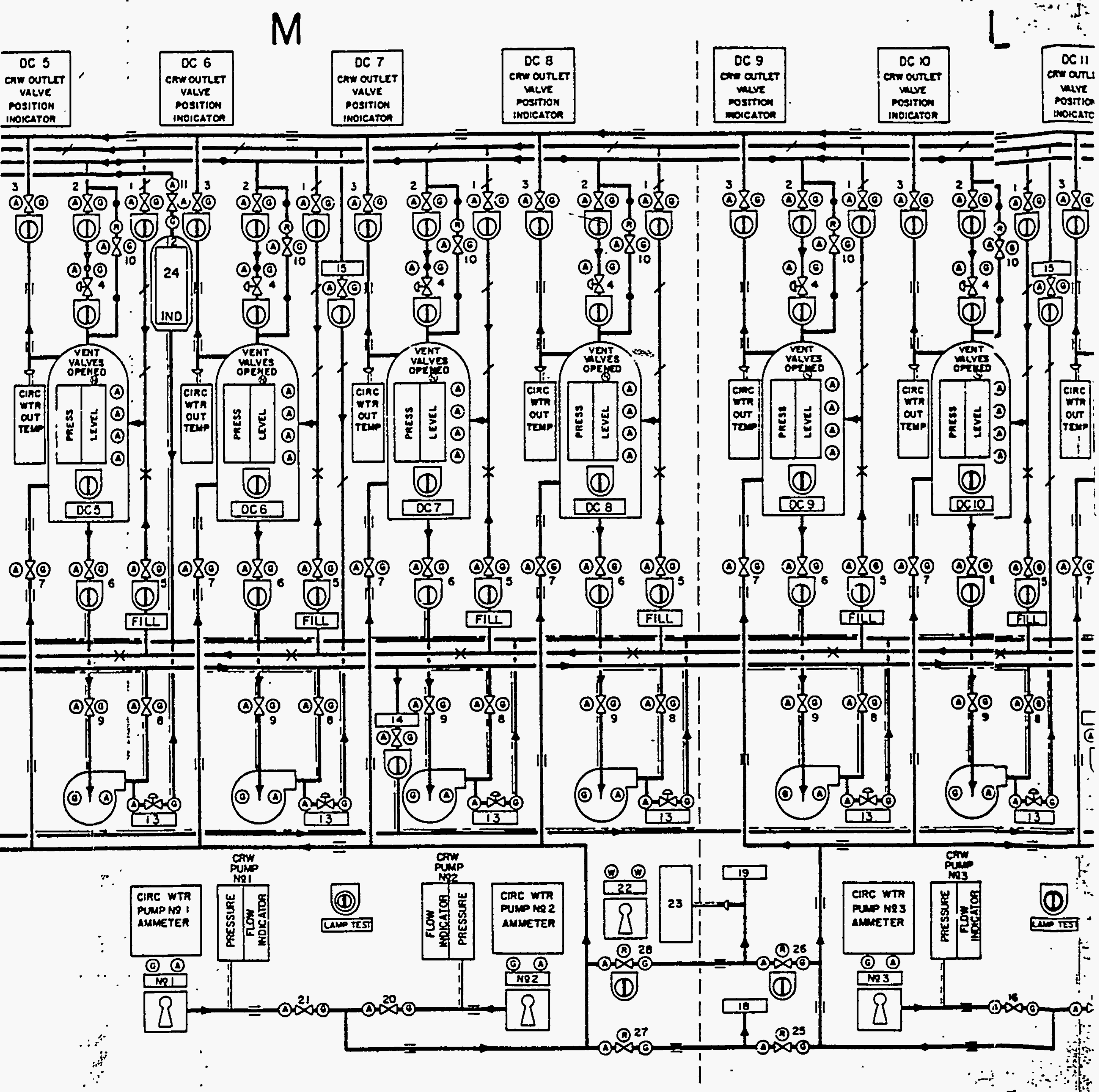
PANEL LEGEND B THRU F

Print Reference: H-1-40126 Thru H-1-40131

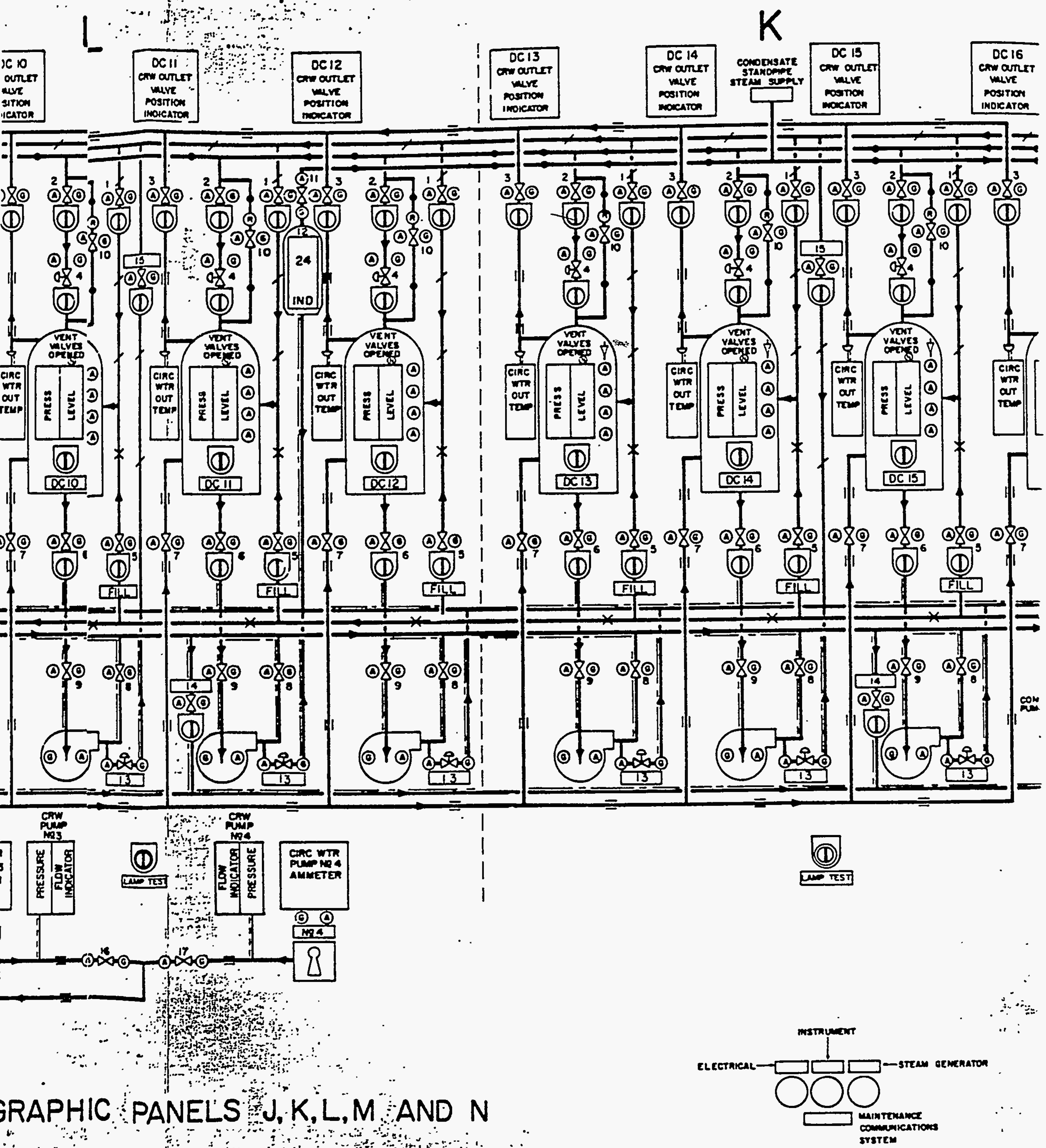
1. CONDV-213 Condensate Drain from Steam Generator B Water-to-Water.
2. WWV-202 Water-to-Water from Steam Generator B.
3. HPV-202 Main Steam from Steam Generator B.
4. HPV-202 Main Steam from Steam Generator B.
5. HPV-202 Main Steam from Steam Generator B.
6. HPV-202 Main Steam from Steam Generator B.
7. PCRV-202 Primary Coolant to Steam Generators.
8. HPV-202 Main Steam from Steam Generator A.
9. HPV-202 Main Steam from Steam Generator A.
10. HPV-202 Main Steam from Steam Generator A.
11. HPV-202 Main Steam from Steam Generator A.
12. WWV-202 Water-to-Water from Steam Generator A.
13. CONDV-213 Condensate Drain from Steam Generator A Water-to-Water.
14. PCRV-212 Primary Coolant to Steam Generator B (Bypassing #15).
15. PCRV-203 Primary Coolant to Steam Generator B
16. PCRV-212 Primary Coolant to Steam Generator A (Bypassing #17).
17. PCRV-203 Primary Coolant to Steam Generator A
18. CONDV-218 Steam Generator B Drain.
19. CONDV-218 Steam Generator B Drain.
20. MWV-208 Makeup Water to Steam Generator B.
21. CONDV-206 Condensate Feed to Steam Generator B.
22. CONDV-204 Primary Coolant Bypass at Steam Generators.
23. CONDV-218 Steam Generator A Drain.
24. CONDV-206 Condensate Feed to Steam Generator A.
25. MWV-208 Makeup Water to Steam Generator A.
26. CONDV-218 Steam Generator A Drain.
27. PCSV-204 Primary Coolant Pump Discharge Recirc. (Decontam. Only)
28. IWV-252 Injection Water to Primary Coolant Pump Suction.
29. PCSV-203 Primary Coolant Pump Discharge to Reactor.
30. IWV-268 Return from Primary Coolant Pump Seals.
31. IWV-267 Normal Seal Water to Primary Coolant Pump.
32. RWRV-213 Circ. Water From Drive Turbine Condenser.
33. RWSV-213 Circ. Water To Drive Turbine Condenser.
34. PCRV-201 Primary Coolant to Steam Generators (Bypassing 7).
35. PCRV-201 Primary Coolant Bypass at Steam Generators (Byapssing 22).
36. CONDV-216 Condensate Feed to Steam Generator B (Control Valve).
37. CONDV-216 Condensate Feed to Steam Generator A (Control Valve).
38. PCSV-211 Primary Coolant Pump Discharge (Bypassing 29).
39. IWV-265 Seal Water to Primary Coolant Pump (Control Valve).
40. CONDV-207 Condensate Feed to Steam Generator (Check Valve). B
41. CONDV-207 Condensate Feed to Steam Generator (Check Valve). A
42. IWV-264 Emergency Seal Water Shutoff

, A, B, C, D, E, and F

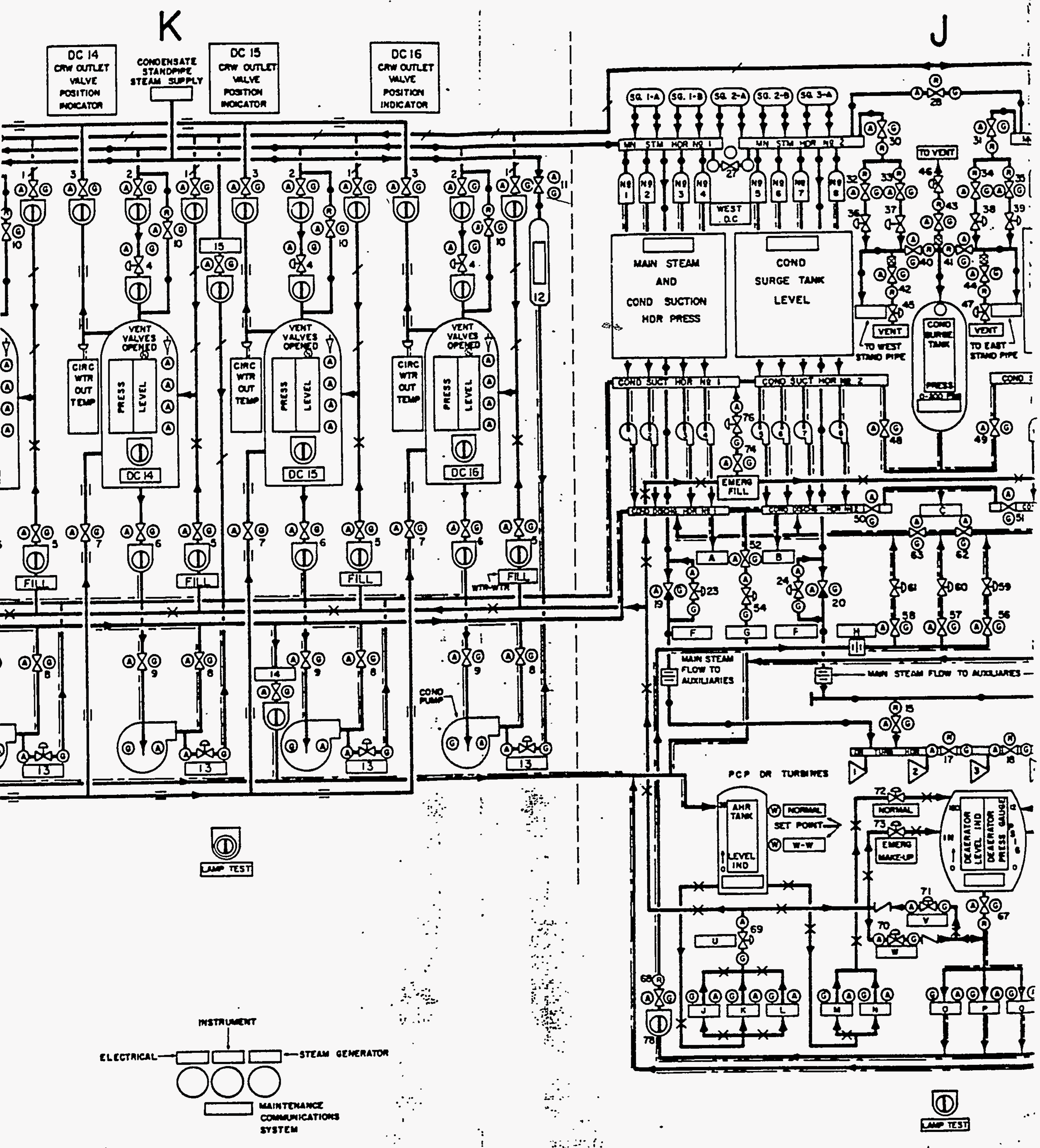

N
DC 1 CRW OUTLET VALVE POSITION INDICATOR
DC 2 CRW OUTLET VALVE POSITION INDICATOR
DC 3 CRW OUTLET VALVE POSITION INDICATOR
CONDENSATE STANDPIPE STEAM SUPPLY
DC 4 CRW OUTLET VALVE POSITION INDICATOR
DC 5 CRW OUTLET VALVE POSITION INDICATOR
TO SEALWELL №2
VENT VALVES OPENED
CIRC WTR OUT TEMP
PRESS
LEVEL
DC 1
DC 2
DC 3
DC 4
FILL
LAMP TEST

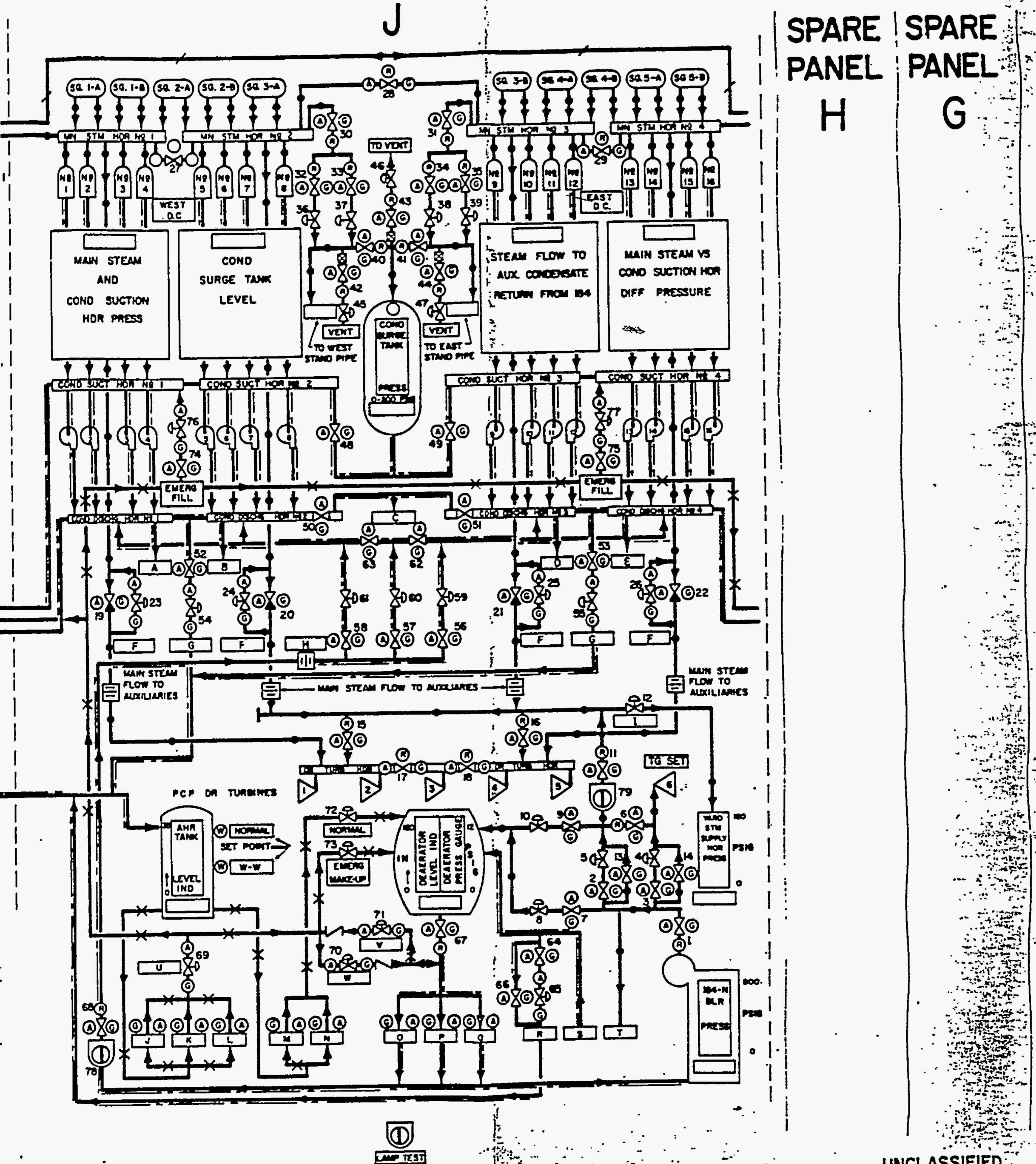

M
L
DC 5 CRW OUTLET VALVE POSITION INDICATOR
DC 6 CRW OUTLET VALVE POSITION INDICATOR
DC 7 CRW OUTLET VALVE POSITION INDICATOR
DC 8 CRW OUTLET VALVE POSITION INDICATOR
DC 9 CRW OUTLET VALVE POSITION INDICATOR
DC 10 CRW OUTLET VALVE POSITION INDICATOR
DC 11 CRW OUTL VALVE POSITIO INDICATO
VENT VALVES OPENED
PRESS
LEVEL
CIRC WTR OUT TEMP
DC5
DC6
DC7
DC 8
DC 9
DC10
24 IND
15
14
FILL
13
CRW PUMP Nº1
CRW PUMP Nº2
CRW PUMP Nº3
CIRC WTR PUMP Nº 1 AMMETER
CIRC WTR PUMP Nº 2 AMMETER
CIRC WTR PUMP Nº 3 AMMETER
PRESSURE
FLOW INDICATOR
LAMP TEST
Nº1
Nº2
Nº3
22
23
19
18
28
26
27
25
21
20
16

GRAPHIC PAN



GRAPHIC PANELS J, K, L, M AND N


K
J
DC 14 CRW OUTLET VALVE POSITION INDICATOR
CONDENSATE STANDPIPE STEAM SUPPLY
DC 15 CRW OUTLET VALVE POSITION INDICATOR
DC 16 CRW OUTLET VALVE POSITION INDICATOR
VENT VALVES OPENED
PRESS
LEVEL
CIRC WTR OUT TEMP
DC 14
DC 15
DC 16
FILL
COND PUMP
WTR-WTR
LAMP TEST
INSTRUMENT
ELECTRICAL
STEAM GENERATOR
MAINTENANCE COMMUNICATIONS SYSTEM
SG 1-A
SG 1-B
SG 2-A
SG 2-B
SG 3-A
MN STM HDR NO 1
MN STM HDR NO 2
WEST D.C
MAIN STEAM AND COND SUCTION HDR PRESS
COND SURGE TANK LEVEL
TO VENT
VENT
TO WEST STAND PIPE
TO EAST STAND PIPE
COND SURGE TANK
COND SUCT HDR NO 1
COND SUCT HDR NO 2
EMERG FILL
MAIN STEAM FLOW TO AUXILIARIES
PCP DR TURBINES
AHR TANK
LEVEL IND
NORMAL
SET POINT
W-W
EMERG MAKE-UP
DEARATOR LEVEL IND
DEARATOR PRESS GAUGE
IN



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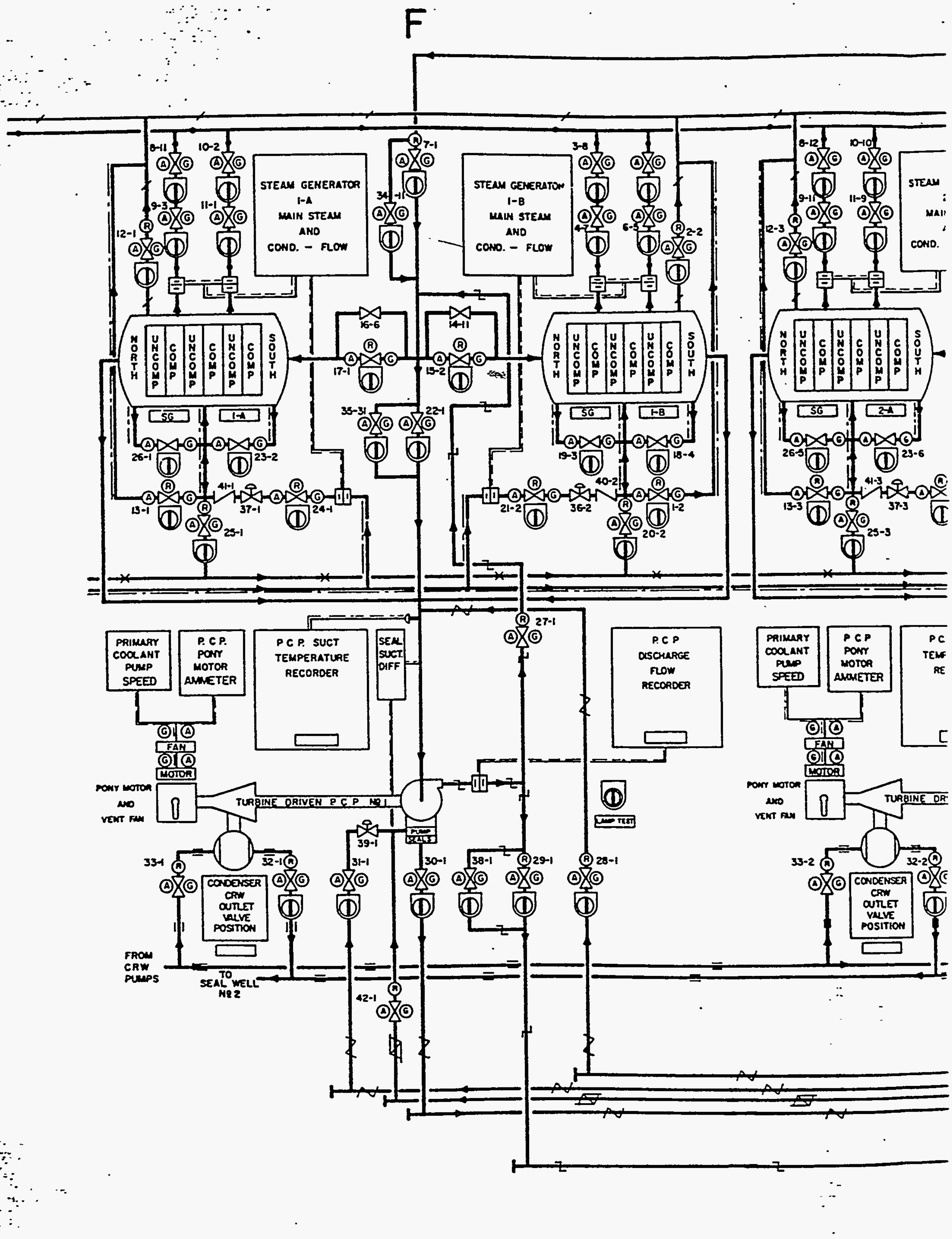
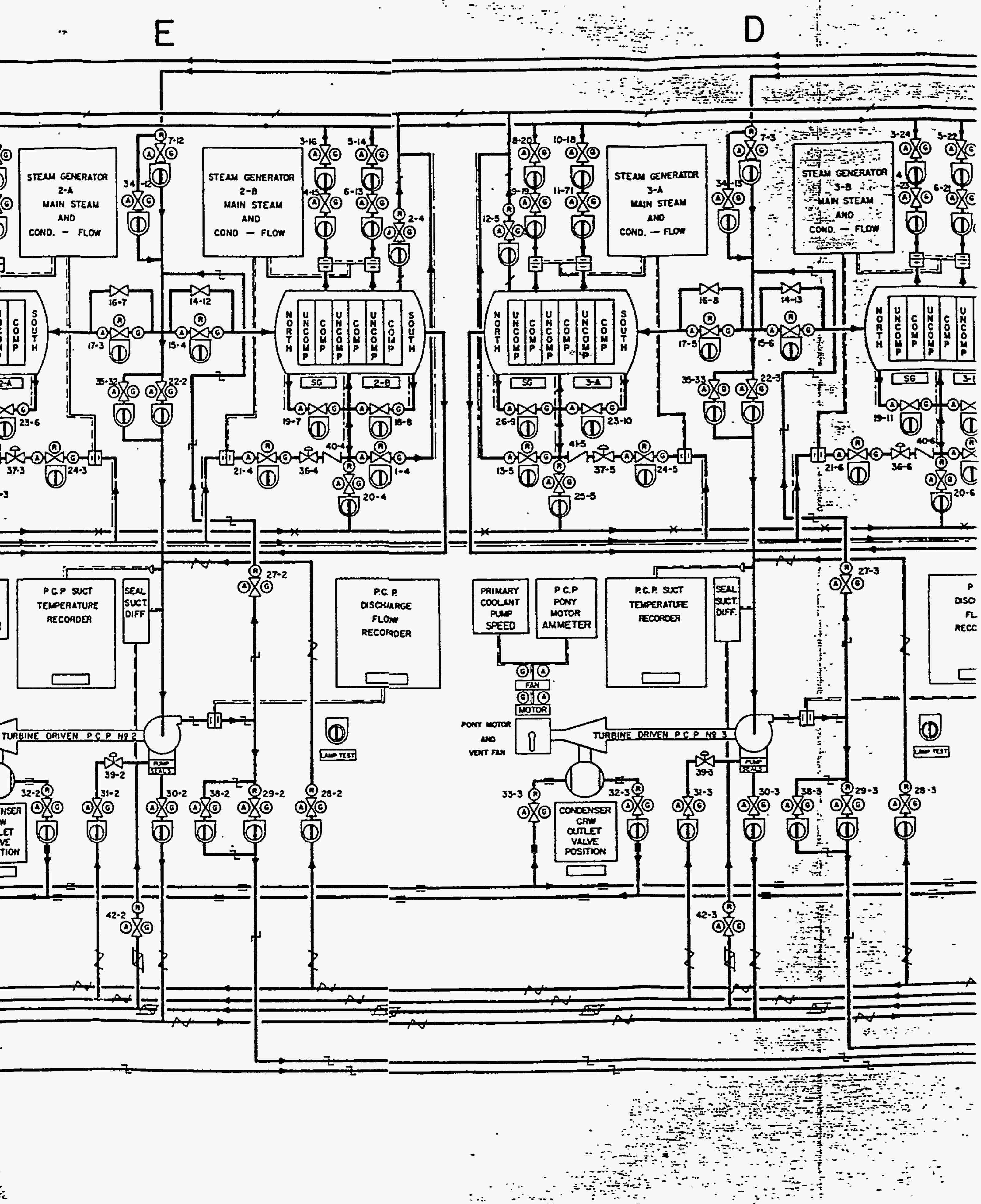
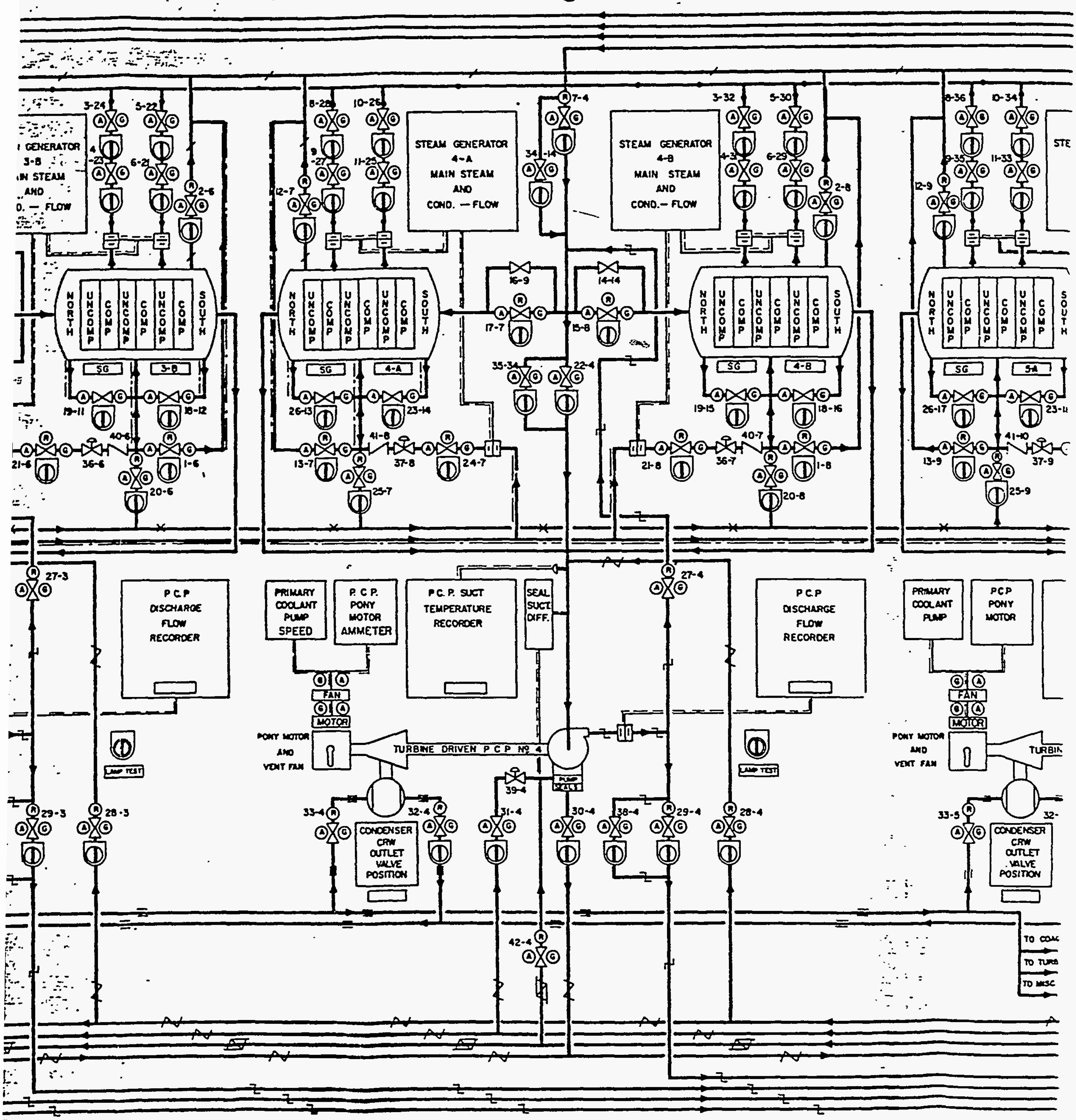


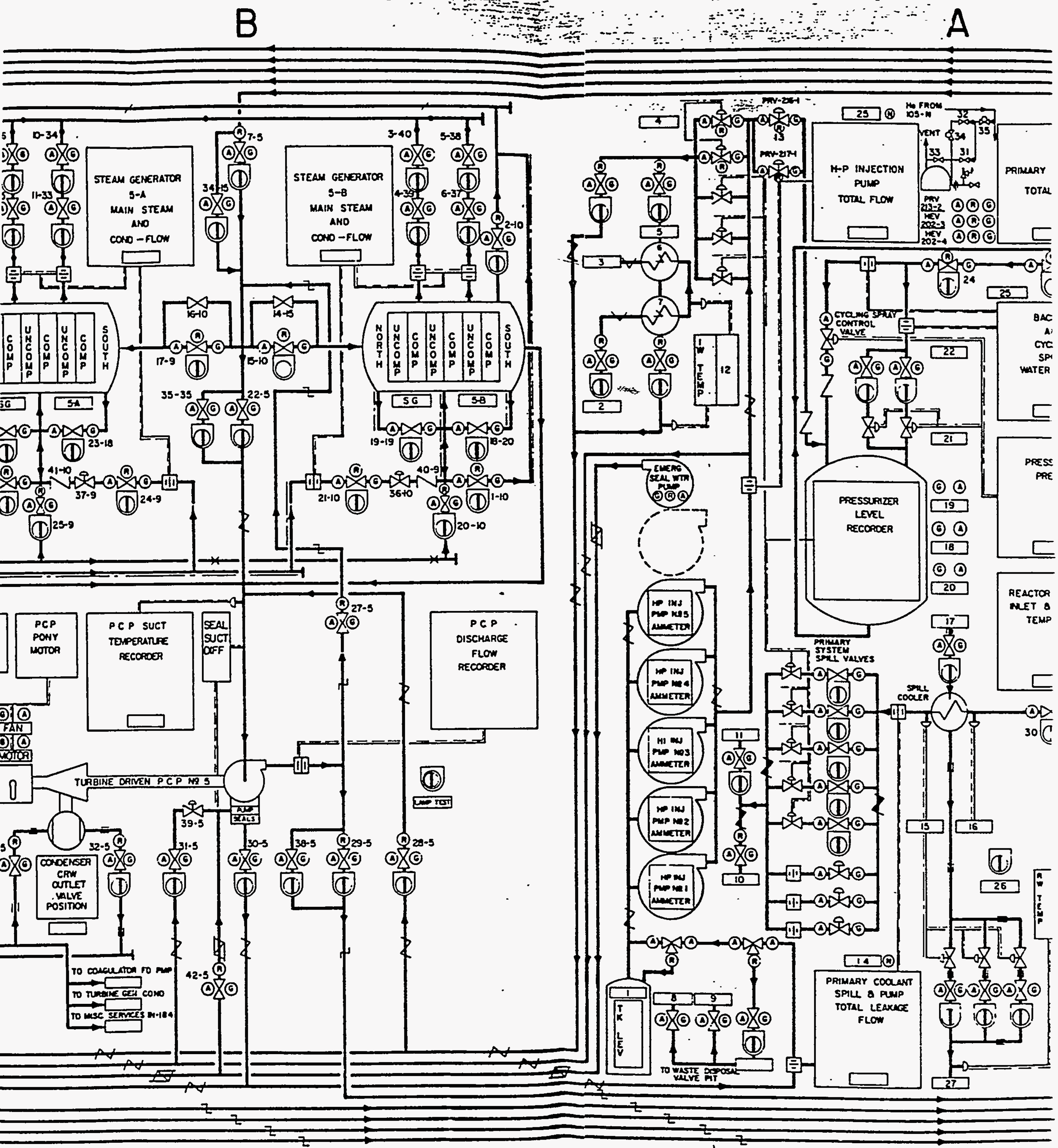


E
D
STEAM GENERATOR 2-A MAIN STEAM AND COND. — FLOW
STEAM GENERATOR 2-B MAIN STEAM AND COND — FLOW
STEAM GENERATOR 3-A MAIN STEAM AND COND. — FLOW
STEAM GENERATOR 3-B MAIN STEAM AND COND. — FLOW
NORTH
UNCOMP
COMP
SOUTH
SG
2-A
2-B
3-A
P.C.P SUCT TEMPERATURE RECORDER
SEAL SUCT. DIFF
P.C.P DISCHARGE FLOW RECORDER
PRIMARY COOLANT PUMP SPEED
P.C.P PONY MOTOR AMMETER
FAN
MOTOR
PONY MOTOR AND VENT FAN
TURBINE DRIVEN P.C.P Nº 2
TURBINE DRIVEN P.C.P Nº 3
PUMP SEALS
LAMP TEST
CONDENSER CRW OUTLET VALVE POSITION

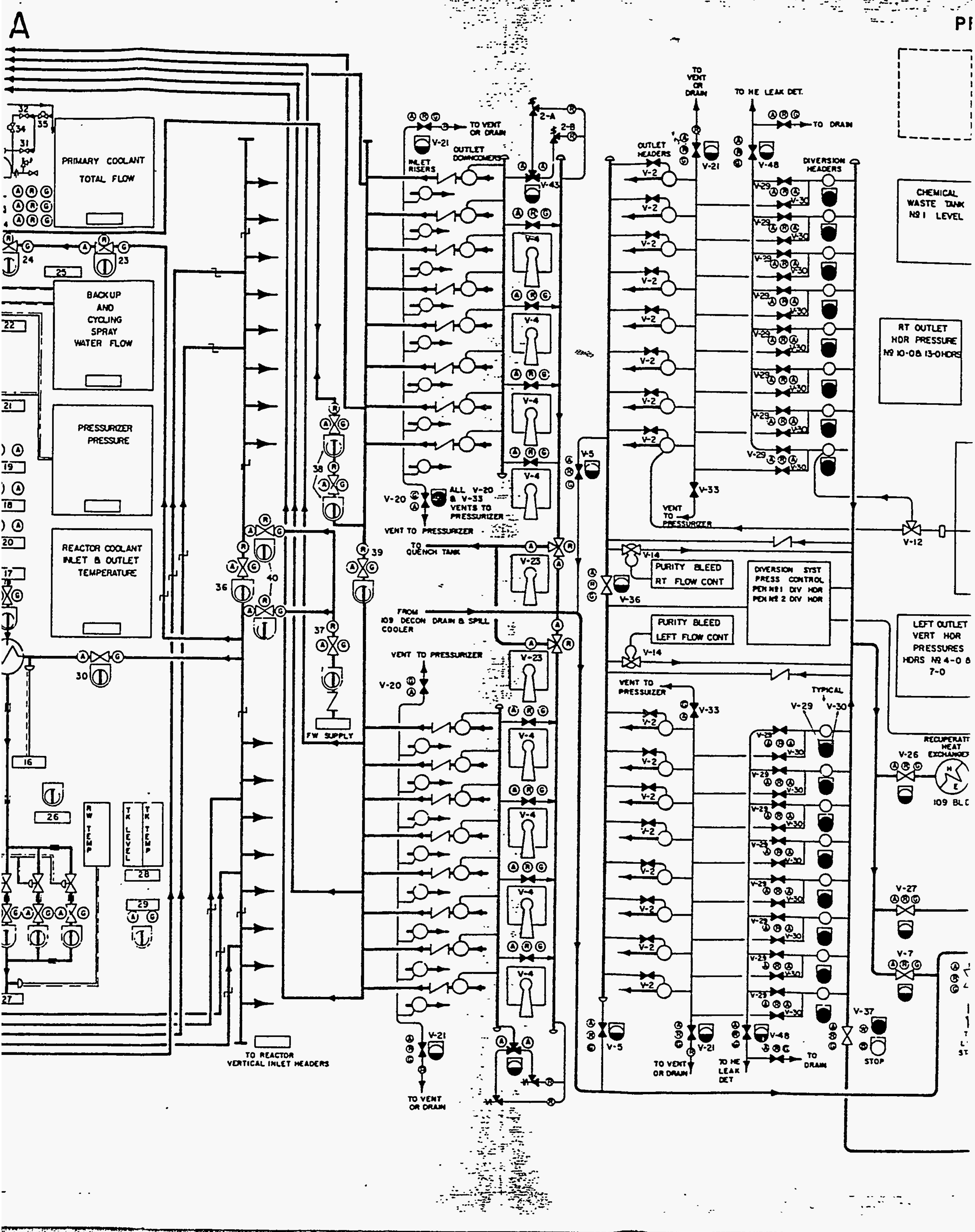
C



PRIMARY WATER (P-1) A,B,C,D,E, AND F GRAP

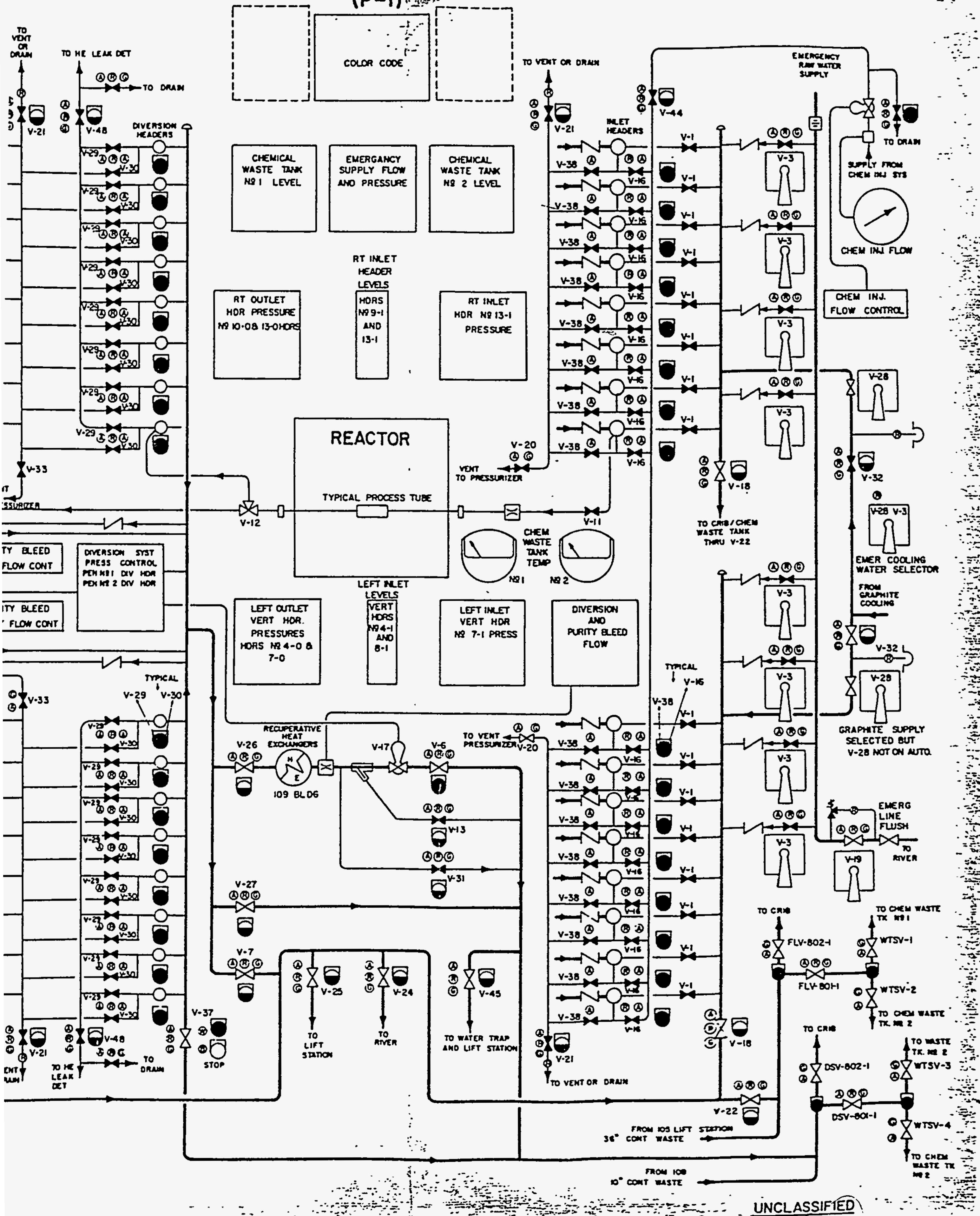


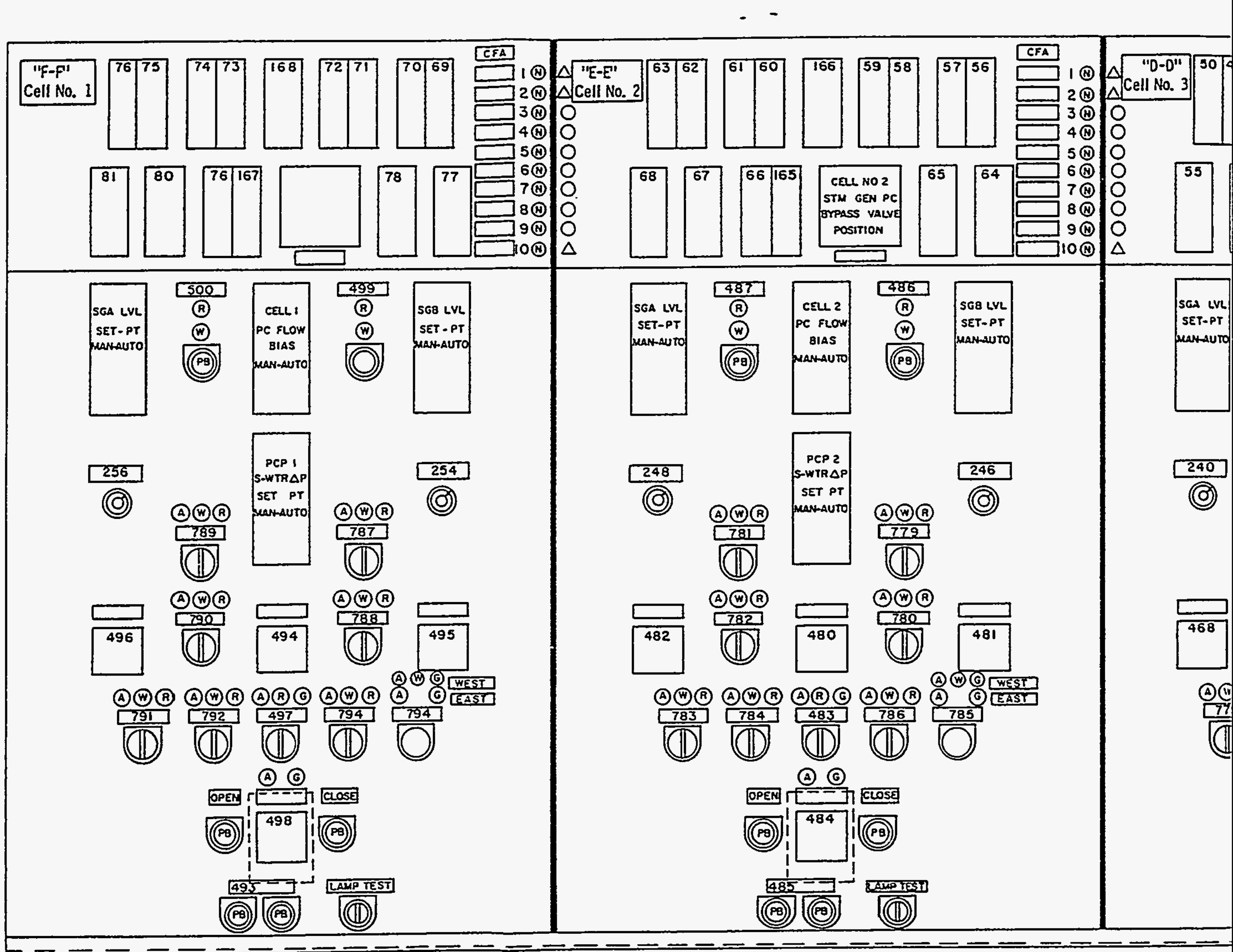
F GRAPHIC PANELS



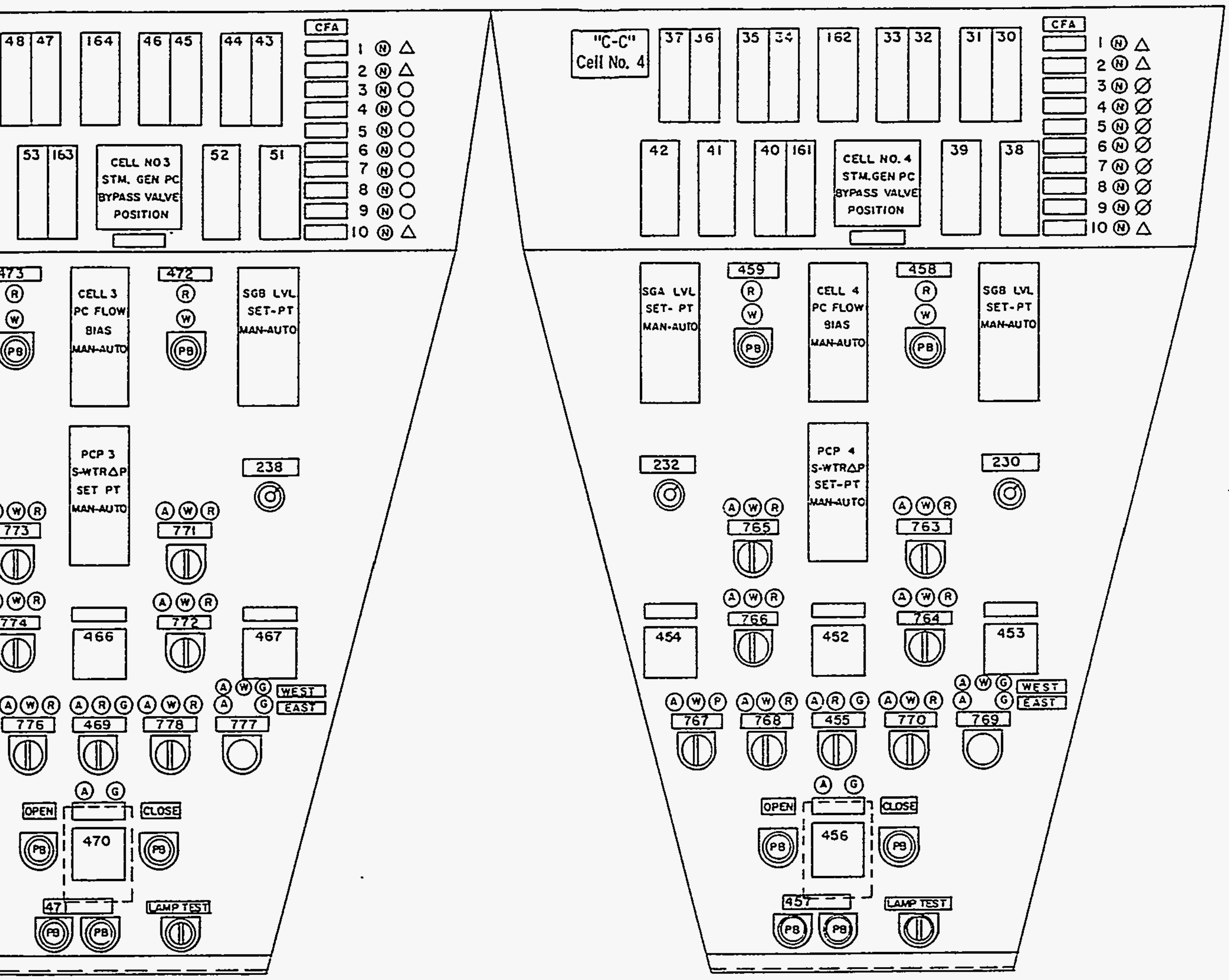
A
PI
PRIMARY COOLANT TOTAL FLOW
BACKUP AND CYCLING SPRAY WATER FLOW
PRESSURIZER PRESSURE
REACTOR COOLANT INLET & OUTLET TEMPERATURE
RW TEMP
TK LEVEL
TK TEMP
FW SUPPLY
TO REACTOR VERTICAL INLET HEADERS
TO VENT OR DRAIN
INLET RISERS
OUTLET DOWNCOMERS
2-A
2-B
V-21
V-43
V-4
V-20
ALL V-20 & V-33 VENTS TO PRESSURIZER
VENT TO PRESSURIZER
TO QUENCH TANK
V-23
FROM 109 DECON DRAIN & SPILL COOLER
TO VENT OR DRAIN
TO HE LEAK DET.
TO DRAIN
OUTLET HEADERS
DIVERSION HEADERS
V-2
V-29
V-30
V-48
V-33
V-5
V-14
V-36
V-12
PURITY BLEED RT FLOW CONT
PURITY BLEED LEFT FLOW CONT
DIVERSION SYST PRESS CONTROL PEN NO 1 DIV HDR PEN NO 2 DIV HDR
CHEMICAL WASTE TANK NO 1 LEVEL
RT OUTLET HDR PRESSURE NO 10-0 & 13-0 HDRS
LEFT OUTLET VERT HDR PRESSURES HDRS NO 4-0 & 7-0
TYPICAL
V-26
RECUPERATIVE HEAT EXCHANGER
109 BLD
V-27
V-7
V-37
STOP
TO HE LEAK DET

PRIMARY WATER (P-1)




"F-F" Cell No. 1
76 75
74 73
168
72 71
70 69
CFA
81
80
76 167
78
77
"E-E" Cell No. 2
63 62
61 60
166
59 58
57 56
CFA
68
67
66 165
CELL NO 2 STM GEN PC BYPASS VALVE POSITION
65
64
"D-D" Cell No. 3
50
55
SGA LVL SET-PT MAN-AUTO
500
CELL 1 PC FLOW BIAS MAN-AUTO
499
SGB LVL SET-PT MAN-AUTO
256
PCP 1 S-WTR△P SET PT MAN-AUTO
254
789
787
790
788
496
494
495
791
792
497
794
794
WEST
EAST
OPEN
CLOSE
498
493
LAMP TEST
SGA LVL SET-PT MAN-AUTO
487
CELL 2 PC FLOW BIAS MAN-AUTO
486
SGB LVL SET-PT MAN-AUTO
248
PCP 2 S-WTR△P SET PT MAN-AUTO
246
781
779
782
780
482
480
481
783
784
483
786
785
WEST
EAST
OPEN
CLOSE
484
485
LAMP TEST
SGA LVL SET-PT MAN-AUTO
240
468

Print Ref.



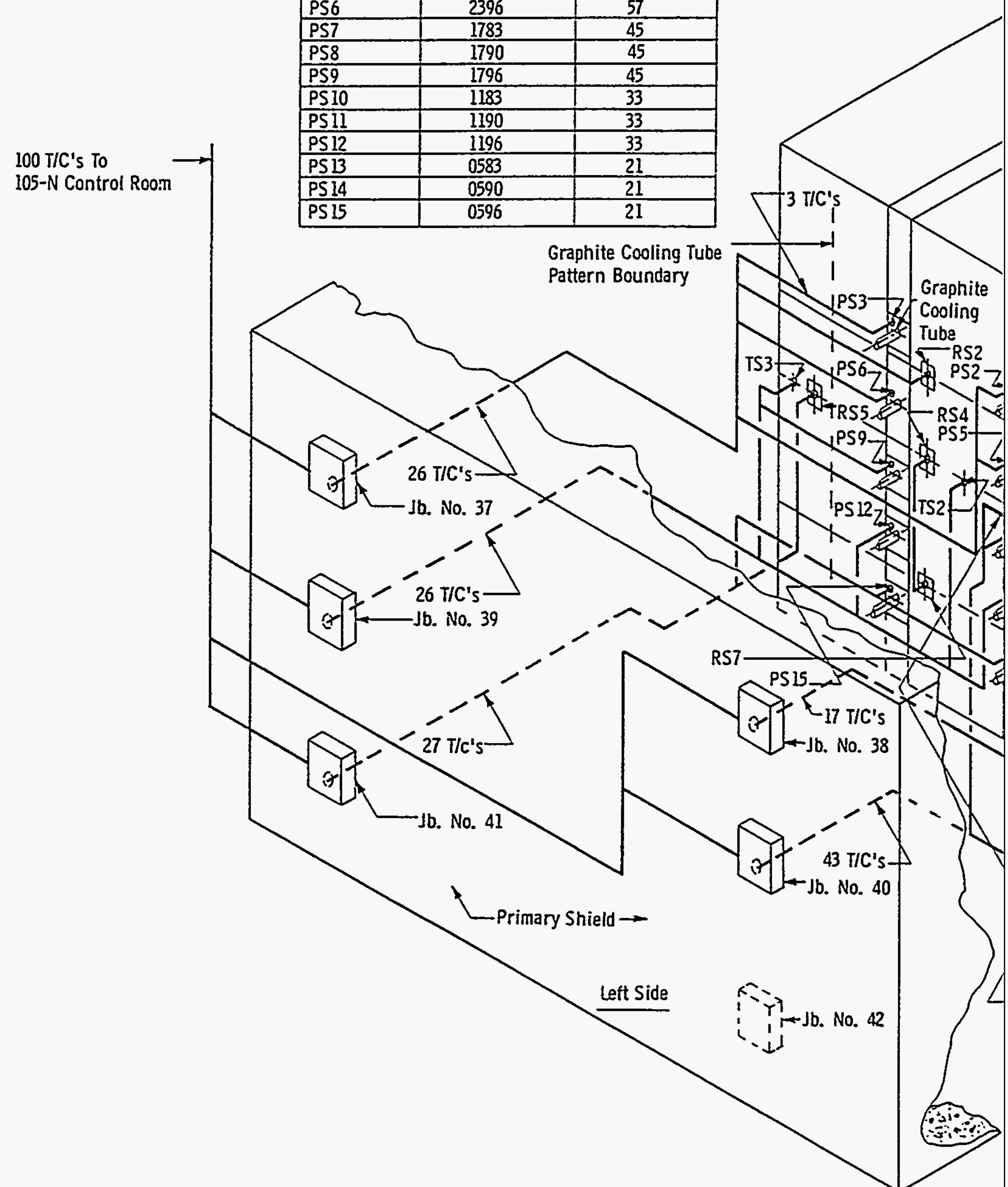
-I-40177

Print Ref. H-I-40177

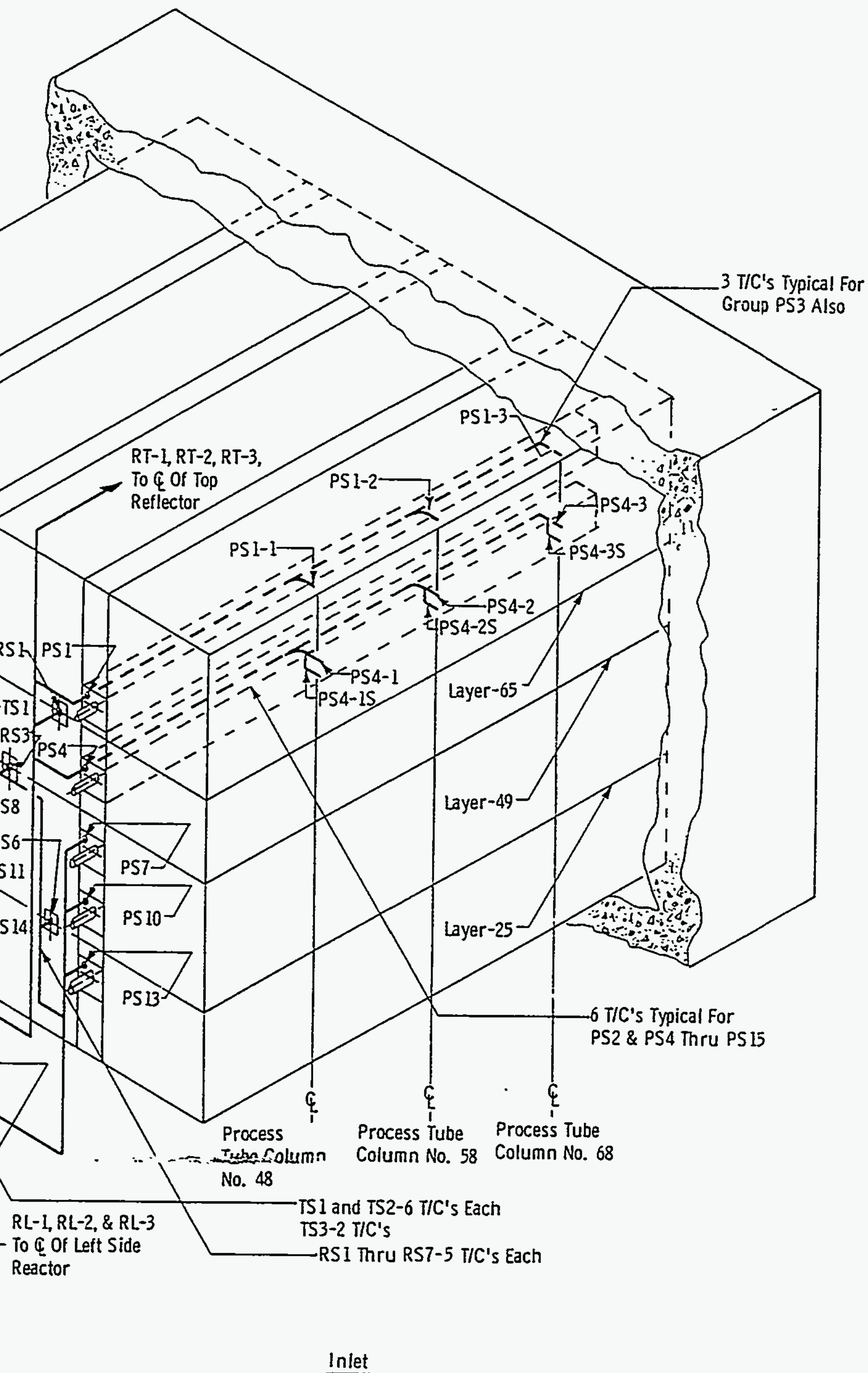
C, DD, EE, and FF

Graphite Cooling Tube Identification Table

T/C Group	Graphite Tube No.	Graphite Layer
PS1	2983	69
PS2	2990	69
PS3	2996	69
PS4	2383	57
PS5	2390	57
PS6	2396	57
PS7	1783	45
PS8	1790	45
PS9	1796	45
PS10	1183	33
PS11	1190	33
PS12	1196	33
PS13	0583	21
PS14	0590	21
PS15	0596	21



Graphite Thermocou


3 T/C's Typical For Group PS3 Also
PS1-3
RT-1, RT-2, RT-3, To ℄ Of Top Reflector
PS1-2
PS4-3
PS4-3S
PS1-1
PS4-2
PS4-2S
PS1
PS4-1
PS4-1S
Layer-65
PS4
Layer-49
PS7
PS10
Layer-25
PS13
6 T/C's Typical For PS2 & PS4 Thru PS15
℄
Process Tube Column No. 48
Process Tube Column No. 58
Process Tube Column No. 68
TS1 and TS2-6 T/C's Each
TS3-2 T/C's
RL-1, RL-2, & RL-3 To ℄ Of Left Side Reactor
RS1 Thru RS7-5 T/C's Each
Inlet

UNCLASSIFIED

CONTROL CONSOLE SECTION FF

DESIGNATION OF INDICATORS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
69	FI-219	SG No. 1B Steam Flow
70	FI-229	SG No. 1B Condensate Feed Flow
71	PG-1079	PCP No. 1 Suct. Press.
72	PG-1074	PCP No. 1 Disch. Press.
73	FI-238	PCP No. 1 Inboard Seal Leakage Flow
74	FI-239	PCP No. 1 Outboard Seal Leakage Flow
75	FI-218	SG No. 1A Steam Flow
76	FI-228	SG No. 1A Condensate Feed Flow
77	LI-259	SG 1B Level
78	TI-400	Cell No. 1 Primary Coolant Inlet Temp.
79	FI-203	Cell No. 1 Primary Coolant Inlet Flow
80	TI-389	PCP No. 1 Suct. Temp.
81	LI-258	SG No. 1A Level
167	FI-258	Primary Coolant Total Flow
168	FI-264	PCP No. 1 Seals Supply Flow

DESIGNATION OF CONTROLLERS

254	FC-221	SG B Steam/FDWTR Flow Ratio Adjust
256	FC-220	SG A Steam/FDWTR Flow Ratio Adjust

DESIGNATION OF SWITCHES

493	-----	Annunciator Acknowledge and Test
494	-----	Cell No. 1 Sump Pump
495	SS-212	SG "B" Level Signal Selector
496	SS-211	SG "A" Level Signal Selector
497	-----	RW Fill Valve for Sump No. 1
498	-----	Cell 1 Stm. Gen. Pc Bypass Valve
499	-----	Air Failure Reset
500	-----	Air Failure Reset

FF CONSOLE

ITEM	DESCRIPTION
787	Cell 1 React Discharge Temperature Cont. Signal Block
788	Cell 1 React Discharge Temperature I&R Signal Block
789	Cell 1 React Supply Temperature Cont. Signal Block
790	Cell 1 React Supply Temperature I&R Signal Block
791	Cell 1 PC Loop Zero Flow Signal Block
792	PCP 1 ESWP Actuate Signal Bypass
793	Drive Turbine Emergency Stop
794	PCP 1 Emergency Seal-Water Blocking Valve

CFA LEGEND FOR "FF"

1	PC Loop Flow Bias Power Supplies
2	PC Loop Scram Flow Set Power Supplies
3	PC Loop Flow Bias Control
4	PC Loop Flow Signal Square Root Ext.
5	SG "A" Level, Steam and FDWTR and Level Control
6	SG "A" Steam Flow and SF/WF Ratio Power Supplies
7	SG "B" Level Steam and FDWTR and Level Control
8	SG "B" Steam Flow and SF/WF Ratio Power Supplies
9	Seal Water Supply/PCP Suction Pressure Control
10	Cell 1 ESWP Start Signal

CONTROL CONSOLE SECTION EE

DESIGNATION OF INDICATORS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
56	FI-221	SG No. 2B Steam Flow
57	FI-231	SG No. 2B Condensate Feed Flow
58	PG-1080	PCP No. 2 Suct. Press.
59	PG-1075	PCP No. 2 Disch. Press.
60	FI-240	PCP No. 2 Inboard Seal Leakage Flow
61	FI-241	PCP No. 2 Outboard Seal Leakage Flow
62	FI-220	SG No. 2A Steam Flow
63	FI-230	SG No. 2A Condensate Feed Flow
64	LI-261	SG No. 2B Level
65	TI-901	Cell No. 2 Primary Coolant Inlet Temp.
66	FI-204	Cell No. 2 Primary Coolant Inlet Flow
67	TI-390	PCP No. 2 Suction Temp.
68	LI-260	SG No. 2A Level
165	FI-259	Primary Coolant Total Flow
166	FI-265	PCP No. 2 Seals Supply Flow

DESIGNATION OF CONTROLLERS

246	FC-223	SG "B" Steam/FDWTR Flow Ratio Adjust
248	FC-222	SG "A" Steam/FDWTR Flow Ratio Adjust

DESIGNATION OF SWITCHES

480	-----	Cell No. 2 Sump Pump
481	SS-214	SG B Level Signal Selector
482	SS-213	SG A Level Signal Selector
483	-----	RW Fill Valve for Sump No. 2
484	-----	Cell No. 2 Stm. Gen. Pc. Bypass Valve
485	-----	Annunciator Acknowledge and Test
486	-----	Air Failure Reset
487	-----	Air Failure Reset

EE CONSOLE

ITEM	DESCRIPTION
779	Cell 2 React Discharge Temperature Cont. Signal Block
780	Cell 2 React Discharge Temperature I&R Signal Block
781	Cell 2 React Supply Temperature Cont. Signal Block
782	Cell 2 React Supply Temperature I&R Signal Block
783	Cell 2 PC Loop Zero Flow Signal Block
784	PCP 2 ESWP Actuate Signal Bypass
785	Drive Turbine Emergency Stop
786	PCP 2 Emergency Seal-Water Blocking Valve

CFA LEGEND FOR "EE"

1	PC Loop Flow Bias Power Supplies
2	PC Loop Scram Flow Set Power Supplies
3	PC Loop Flow Bias Control
4	PC Loop Flow Signal Square Root Ext.
5	SG "A" Level, Steam and FDWTR and Level Control
6	SG "A" Steam Flow and SF/WF Ratio Power Supplies
7	SG "B" Level, Steam and FDWTR and Level Control
8	SG "B" Steam Flow and SF/WF Ratio Power Supplies
9	Seal Water Supply/PCP Suction Pressure Control
1C	Cell 2 ESWP Start Signal

Legend for Cell Control Consol.

CONTROL CONSOLE SECTION DD

DESIGNATION OF INDICATORS

INSTR. MARK NO.	DESCRIPTION
FI-223	SG No. 3B Steam Flow
FI-233	SG No. 3B Condensate Feed Flow
PG-1081	PCP No. 3 Suct. Press.
PG-1076	PCP No. 3 Disch. Press.
FI-242	PCP No. 3 Inboard Seal
FI-243	PCP No. 3 Outboard Seal Leakage Flow
FI-222	SG No. 3A Steam Flow
FI-232	SG No. 3A Condensate Feed Flow
LI-263	SG No. 3B Level
TI-902	Cell No. 3 Primary Coolant Inlet Temp.
FI-205	Cell No. 3 Primary Coolant Inlet Flow
TI-391	PCP No. 3 Suction Temp.
LI-262	SG No. 3A Level
FI-260	Primary Coolant Total Flow
FI-266	PCP No. 3 Seals Supply Flow

DESIGNATION OF CONTROLLERS

INSTR. MARK NO.	DESCRIPTION
FC-225	SG "B" Steam/FDWTR Flow Ratio Adjust
FC-224	SG "A" Steam/FDWTR Flow Ratio Adjust

DESIGNATION OF SWITCHES

INSTR. MARK NO.	DESCRIPTION
-----	Cell No. 3 Sump Pump
SS-216	SG Level Signal Selector
SS-215	SG Level Signal Selector
-----	RW Fill Valve for Sump No. 3
-----	Cell No. 3 Stm. Gen. Pc. Bypass Valve
-----	Annunciator Acknowledge and Test
-----	SG B Air Failure Reset
-----	SG A Air Failure Reset

CONTROL CONSOLE SECTION CC

DESIGNATION OF INDICATORS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
30	FI-225	SG 4B Steam Flow
31	FI-235	SG 4B Condensate Feed Flow
32	PG-1082	PCP No. 4 Suct. Press.
33	PG-1077	PCP No. 4 Disch. Press.
34	FI-244	PCP No. 4 Inboard Seal Leakage Flow
35	FI-245	PCP No. 4 Outboard Seal Leakage Flow
36	FI-224	SG 4A Steam Flow
37	FI-234	SG 4A Condensate Feed Flow
38	LI-265	SG 4B Level
39	TI-903	Cell No. 4 Primary Coolant Inlet Temp.
40	FI-206	Cell No. 4 Primary Coolant Inlet Flow
41	TI-392	PCP No. 4 Suction Temp.
42	LI-264$	SG No. 4A Level
161	FI-261	Primary Coolant Total Flow
162	FI-267	PCP No. 4 Seals Supply Flow

DESIGNATION OF CONTROLLERS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
230		SG B Steam/Fdwtr. Flow Ratio Adjust
232		SG A Steam/Fdwtr. Flow Ratio Adjust

DESIGNATION OF SWITCHES

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
452		Cell 4 Sump Pump
453	SS-218	SG B Level Signal Selector
454	SS-217	SG A Level Signal Selector
455		RW Fill Valve for Sump No. 4
456		Cell 4 Stm. Gen. pc Bypass Valve
457		Annunciator Acknowledge Test
458		SG B Air Failure Reset
459		SG A Air Failure Reset

DD CONSOLE

M	DESCRIPTION
1	Cell 3 React Discharge Temperature Cont. Signal Block
2	Cell 3 React Discharge Temperature I&R Signal Block
3	Cell 3 React Supply Temperature Cont. Signal Block
4	Cell3 React Supply Temperature I&R Signal Block
5	Cell 3 PC Loop Zero Flow Signal Block
6	PCP 3 ESWP Actuate Signal Bypass
7	Drive Turbine Emergency Stop
8	PCP 3 Emergency Seal-Water Blocking Valve

CFA LEGEND FOR "DD"

- PC Loop Flow Bias Power Supplies
- PC Loop Scram Flow Set Power Supplies
- PC Loop Flow Bias Control
- PC Loop Flow Signal Square Root Ext.
- SG "A" Level, Steam and FDWTR and Level Control
- SG "A" Steam Flow and SF/WF Ratio Power Supplies
- SG "B" Level, Steam and FDWTR and Level Control
- SG "B" Steam Flow and SF/WF Ratio Power Supplies
- Seal Water Supply/PCP Suction Pressure Control
- Cell 4 ESWP Start Signal

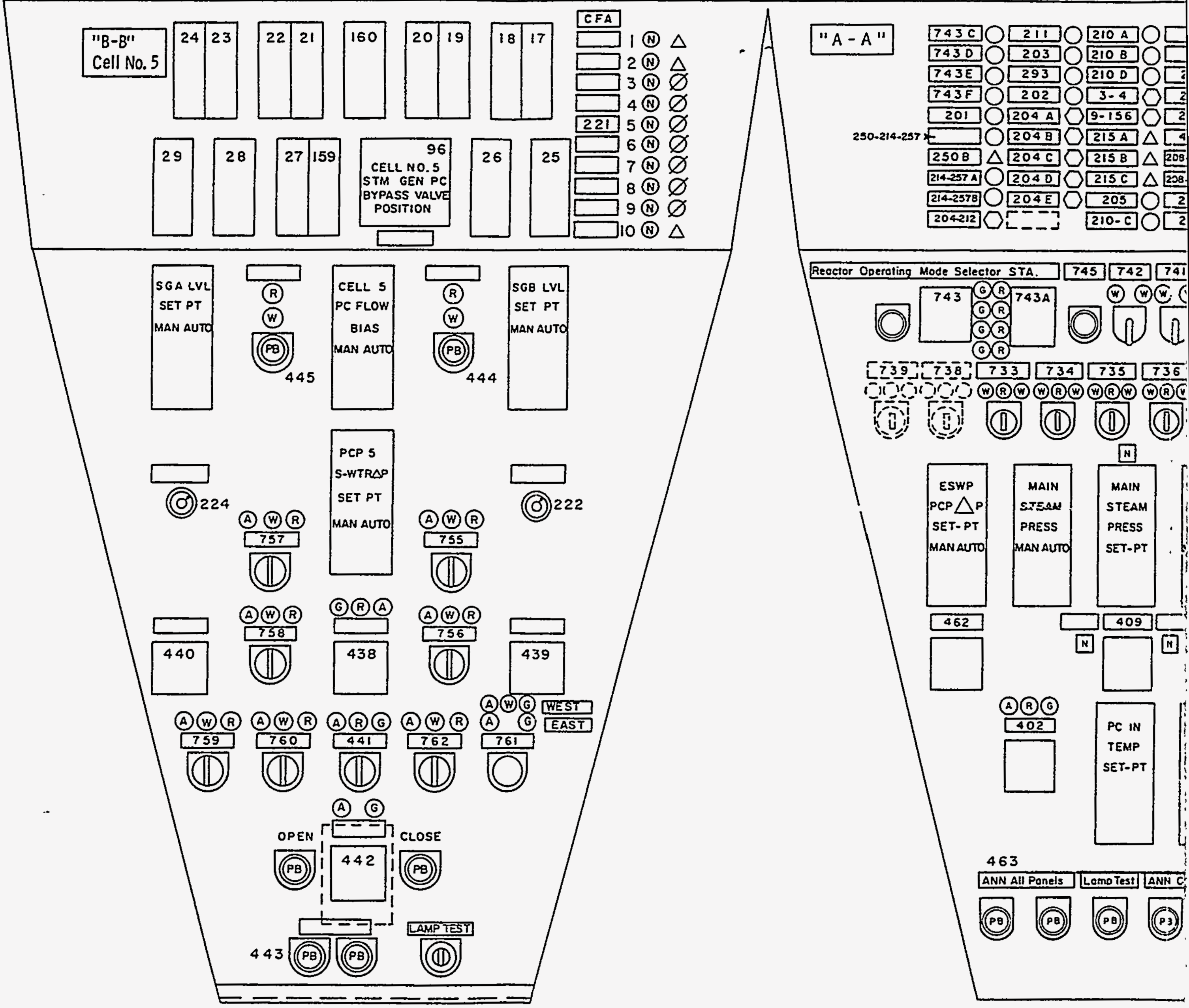
CC CONSOLE

ITEM	DESCRIPTION
763	Cell 4 React Discharge Temperature Cont. Signal Block
764	Cell 4 React Discharge Temperature I&R Signal Block
765	Cell 4 React Supply Temperature Cont. Signal Block
766	Cell 4 React Supply Temperature I&R Signal Block
767	Cell 4 PC Loop Zero Flow Signal Block
768	PCP 4 ESWP Actuate Signal Bypass
769	Drive Turbine Emergency Stop
770	PCP 4 Emergency Seal-Water Blocking Valve

CFA LEGEND FOR "CC"

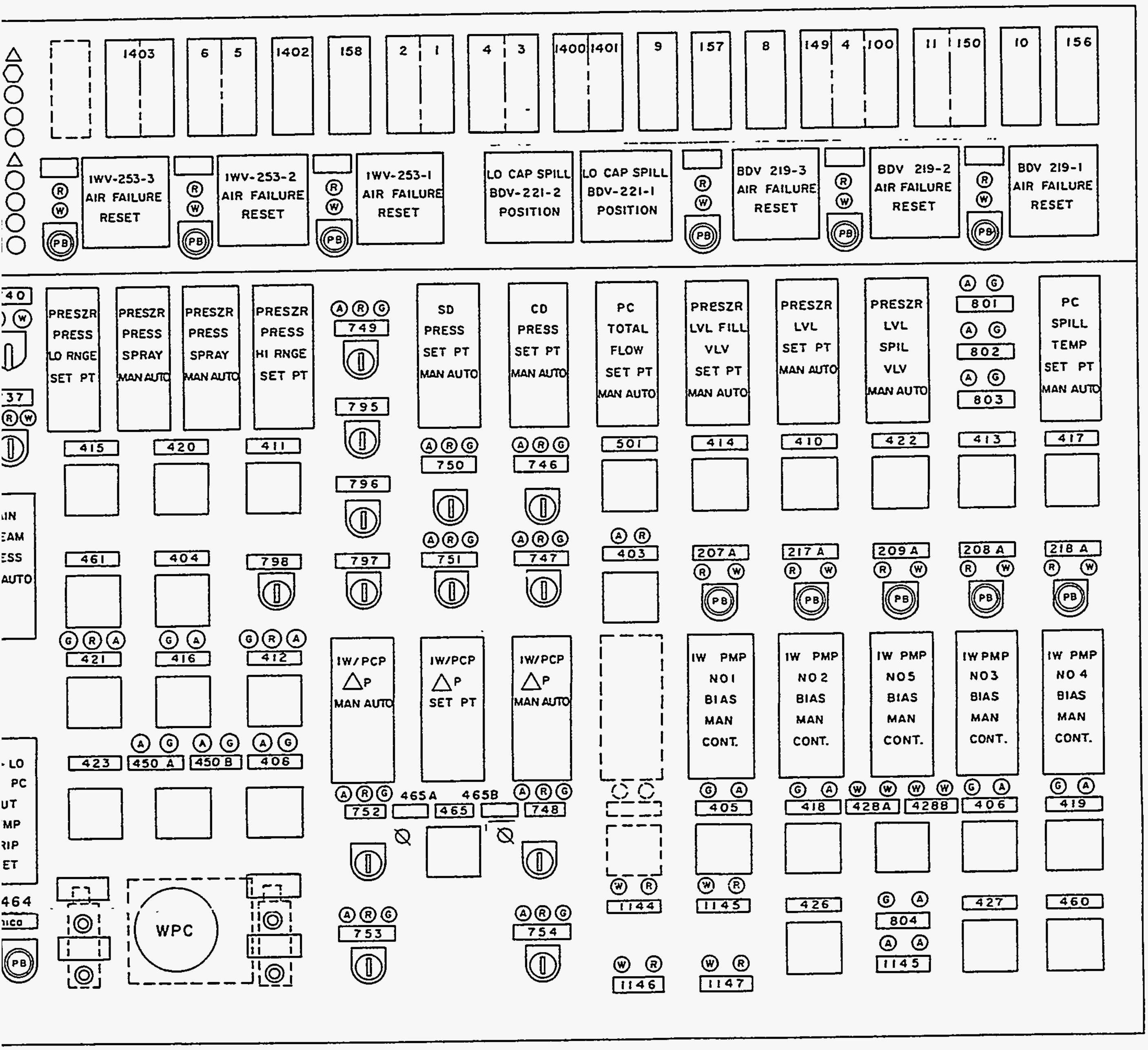
1. PC Loop Flow Bias Power Supplies
2. PC Loop Scram Flow Set Power Supplies
3. PC Loop Flow Bias Control
4. PC Loop Flow Signal Square Root Ext.
5. SG "A" Level, Steam and FDWTR and Level Control
6. SG "A" Steam Flow and SF/WF Ratio Power Supplies
7. SG "B" Level, Steam and FDWTR and Level Control
8. SG "B" Steam Flow and SF/WF Ratio Power Supplies
9. Seal Water Supply/PCP Suction Pressure Control
10. Cell 3 ESWP Start Signal

s CC, DD, EE, and FF



Ref. H-1-40177

Master Control Console AA ar



Ref. H-1-40176

Cell Control Console BB

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BB CONSOLE

DESIGNATION OF INDICATORS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
17	FI-227	SG 5B Steam Flow
18	FI-237	SG 5B Condensate Feed Flow
19	PG-1083	PCP No. 5 Suction Pressure
20	PG-1078	PCP No. 5 Discharge Pressure
21	FI-246	PCP No. 5 Inboard Seal Leakage Flow
22	FI-247	PCP No. 5 Outboard Seal Leakage Flow
23	FI-226	SG 5A Steam Flow
24	FI-236	SG 5A Condensate Feed Flow
25	LI-267	SG 5B Level
26	TI-904	Cell No. 5 Primary Coolant Inlet Temperature.
27	FI-207	Cell No. 5 Primary Coolant Inlet Flow
28	TI-393	PCP No. 5 Suction Temperature
29	LI-266	SG 5A Level
159	FI-262	Primary Coolant Total Flow
160	FI-268	PCP No. 5 Seals Supply Flow

DESIGNATION OF CONTROLLERS

222		SG B Steam/FDWTR Flow Ratio Adjust
224		SG A Steam/FDWTR Flow Ratio Adjust

DESIGNATION OF SWITCHES

438		Cell 5 Sump Pump
439	SS-220	SG Level Signal Selector
440	SS-219	SG Level Signal Selector
441		RW Fill Valve for Sump No. 5
442		Cell No. 5 Steam Generator PC Bypass Valve
443		Annunciator Acknowledge, Test
444		SG B Air Failure Reset
445		SG A Air Failure Reset

BB CONSOLE

ITEM	DESCRIPTION
755	Cell 5 React Supply Temperature Cont. Signal Block
756	Cell 5 React Supply Temperature Cont. Signal Block
757	Cell 5 React Discharge Temperature I&R Signal Block
758	Cell 5 React Discharge Temperature I&R Signal Block
759	Cell 5 PC Loop Zero Flow Signal Block
760	PCP 5 ESWP Actuate Signal Bypass
761	Drive Turbine Emergency Stop
762	PCP 5 Emergency Seal-Water Blocking Valve

CFA LEGEND FOR "BB"

1	PC Loop Flow Bias Power Supplies
2	PC Loop Scram Flow Set Power Supplies
3	PC Loop Flow Bias Control
4	PC Loop Flow Signal Square Root Ext.
5	SG "A" Level, Steam and FDWTR and Level Control
6	SG "A" Steam Flow and SF/WF Ratio Power Supplies
7	SG "B" Level, Steam and FDWTR and Level Control
8	SG "B" Steam Flow and SF/WF Ratio Power Supplies
9	Seal Water Supply/PCP Suction Pressure Control
10	Cell 5(4, 3, 2, 1) ESWP Start Signal

NAMEPLATE ENGRAVING-LEGEND CONSOLE "AA"

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
1	PG-1130	Pressurizer Pressure (High Range)
2	PG-1084	Pressurizer Pressure (Low Range)
3	FI-208	Pressurizer Cycling Spray Water Flow
4	FI-209	Pressurizer Backup Spray Water Flow
5	TI-394	Reactor Outlet Coolant Averaged Temperature
6	TI-395	Reactor Inlet Coolant Averaged Temperature
7	LI-256	Pressurizer Level (Wide Range)
8	FI-215	Primary Coolant Diversion Flow
9	FI-211	Total Seal Water Return Flow
10	FI-210	Injection Water Pumps Disch. Flow
11	PG-1085	Inj. Wtr./Prim. Coolant Pumps Suct. Diff. Pressure
100	TI-206	Pressurizer Temperature
149	LI-342	Pressurizer Level Narrow Range
156	FI-212	Primary Coolant Spill Flow
157	FI-213	Primary Coolant Total Flow
158	PG-218	Main Steam Pressure
150	PG-1092	Injection Water Disch. Header Pressure Indicator
1400	PG-1166	Reactor Rear Riser Hdr. Pressure
1401	TI-987	Reactor Rear Riser Hdr. Temp. Signal from G.E.
1402	PSG-201	Output From Modal Station
1403	FI-270&271	Filtered Water Flow
734B		Reactor Operating Mode Selector Station
734A #1		Start-Up Steady State Shutdown WTR-WTR
#2		
#3		
#4		
740		Main Steam Pressure Control Mode
741		Control Console Transfer Switch
742		Scram Action Bypass Switch
733 (Thru 739)		Cell 1 (2 Through 5) Master Isolation Switch
402		Emergency Seal Water Pump
403		Seal Water Return Diversion Valve
404		Pressurizer Backup Spray Valve Channel Selector
405		IW Pump No. 1 (5) Control Selector
406		IW Pump No. 3 (5) Control Selector
408		Pressurizer Cycling Spray Water Valve
409		Main Steam Pressure Control Selector
409A		"A"
409B		"B"
410		Pressurizer Level Control Range XMTR Selector
411		Pressurizer Press High Range XMTR Selector
412		Pressurizer Cycling Heater
413		PC System Constant Spill Valve Selector
415		Pressurizer Pressure Low Range EMTR Selector
416		Pressurizer Backup Heater
417		Spill Cooler RW Cont. Valve E/P Selector
418		IW Pump No. 2 (5) Control Selector
419		IW Pump No. 4 (5) Control Selector
420		Pressurizer Pressure Switch Bank and Control Selector
421		Pressurizer Startup Heater
422		High and Low Cap Spill Valve E/P Selector
423		Pressurizer RTD Selector for Comp. Level
426		IW Pumps 1 and 3 Start Sequence
427		IW Pumps 2 and 4 Start Sequence
428A		IW Pump 5 Sub for Pump 3* - Pump 1*

Legend for Master Control Console

AA CONSOLE

IW Pump 5 Sub for Pump 2*- Pump 4*

*(Number to Correspond with Light Layout)

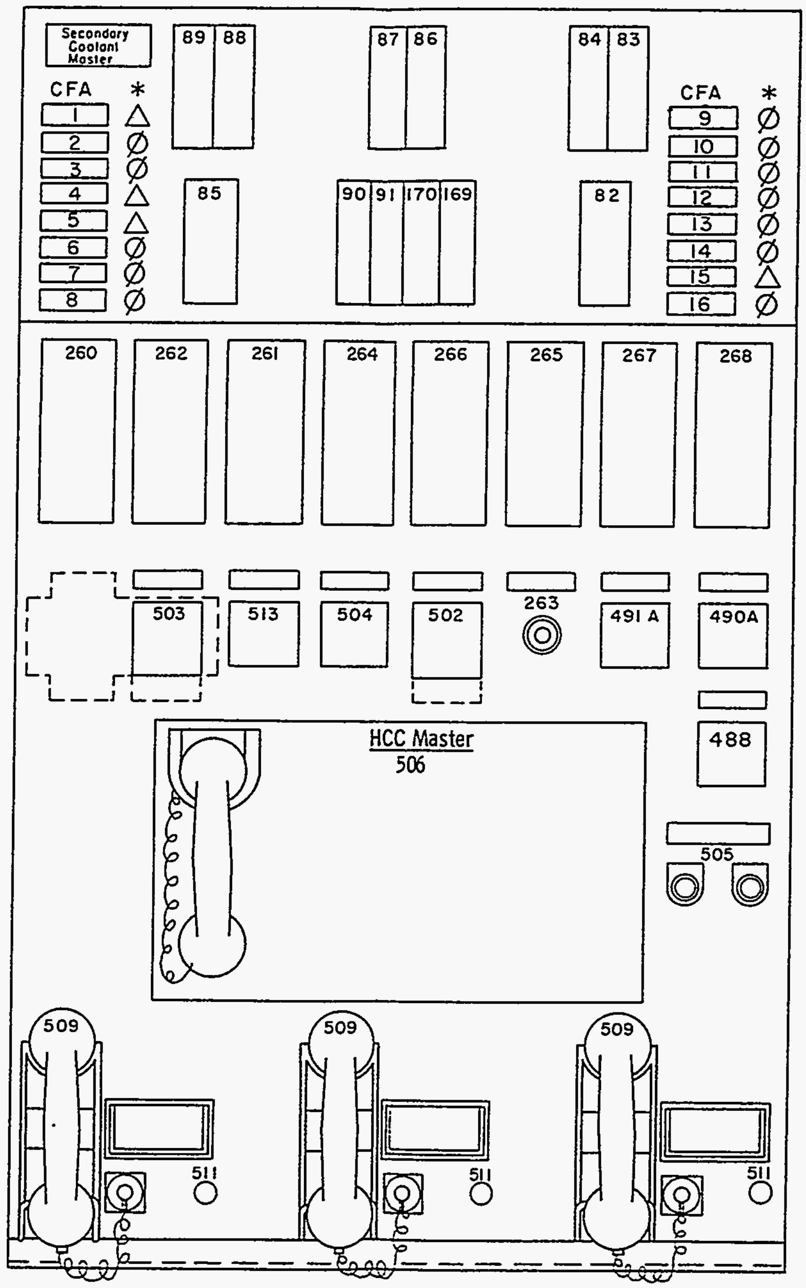
Pressurizer Vent Valve RVTV-203-1
Pressurizer Vent Valve RVTV-203-2
Spill Water RTD Selector
Pressurizer High/Low Pressure Signal Routing
ESWP Discharge/PCP Suction △P XMTR Selector
Injection Water Pump Speed Control Selector
"A"
"B"
LP and C/D Helium to Pressurizer ISOL Valve PRV-213-2
S/D Pressure XMTR Control ISOL Valve PRV-213-3
Cold Spray Valve PRV-216-1 ISOL Valve PRV-212-2
Cold Spray Valve PRV-217-1 ISOL Valve PRV-212-3
C/D Pressure Gage ISOL Valve PRV-213-4
C/D Helium to Pressurizer ISOL Valve HEV-202-4
LP Helium to Pressurizer ISOL Valve HEV-202-3
Pressurizer Pressure SD Range XMTR Selector
Pressurizer Cycling HTR Control Selector
Pressurizer Cold Spray Control Selector
Pressurizer Cycling HTR Low Level Bypass
Constant Spill Valve BDV-210-1
Constant Spill Valve BDV-210-2
Constant Spill Valve BDV-210-3
IW Pump 5 Running
Pressurizer Level Wide Range XMTR Selector
Master Control Console AA
IW Pump 5 Electric FD BPA-TG
C/D Low Flow Fill Valve IWV-287-1 Air Fail
C/D High Flow Fill Valve IWV-290-1 Air Fail
C/D Low Flow Fill Valve ISOL Valve IWV-291-1
C/D High Flow Fill Valve ISOL Valve IWV-292-1
IW Pump 1 Drive Air Fail Reset
IW Pump 3 Drive Air Fail Reset
IW Pump 5 Drive Air Fail Reset
IW Pump 2 Drive Air Fail Reset
IW Pump 4 Drive Air Fail Reset
Modal SW Reset
Scram Action Timer Bypass
Cold Spray Valve PRV-216-1 Air Fail
Cold Spray Valve PRV-217-1 Air Fail
Fill Valve Service
A NR #3, WR #1
B NR #2, WR #3
C NR #1, WR #2

AA CONSOLE CFA NAMEPLATES

7	Pressurizer Level Wide Range
213	Pressurizer Level Set-PT Control
205	Pressurizer Level Fill Valve Control
206	Pressurizer Level Spill Valve Control
210A	PC Total Flow Set-PT Control
210B	PC Pump Speed Limit Signal
210C	Any PC Loop Flow Square Root Ext.
210D	Loop Zero Flow Sign Power Supplies
743F	Second Steam Pressure Scram Set-PT Power Supplies
216	PC Spill Temperature Set-PT Control
9-156	PC Spill and Seal Water Return Flow Square Root Ext.
201	ESWP/PCP △P Set-PT Control
10	IW Flow Square Root Ext. and Pump Start
208-209A	IW/PCP △P "A" Channel Control
208-209B	IW/PCP △P "B" Channel Control
215C	IW/PCP △P Set-PT "B" Channel Power Supply
215B	IW/PCP △P Set -PT "A" Channel Power Supply
215A	IW/PCP △P Set-BY Channel FD-BK Power Supply
212-204	React Supply and Discharge Temperature Indicator and Recorder
743E	In Temperature Control Transfer FD-BK Power Supplies
743D	React Supply and Discharge Temperature Control Signals
743C	React Supply and Discharge Temperature Control Signals
211	Pressurizer Pressure Channel A
202	Pressurizer Pressure Channel B
203	Pressurizer Pressure Spray Channel A Valve Control
293	Pressurizer Pressure Spray Channel B Valve Control
413	S/U Heater and PRV-210-1 Intlk. and Const. Spill
3-4	Bk-UP and Cycling Spray Flow Square Root Ext.
214-257A	Main Steam Pressure Channel A Control
214-257B	Main Steam Pressure Channel B Control
250A	Main Steam Pressure Set-PT Rate Limiter
250B	Main Steam Pressure Set-PT Power Supply
204A	Steam Generator 1A and 1B PC Outlet Temperature Summing
204B	Steam Generator 2A and 2B PC Outlet Temperature Summing
204C	Steam Generator 3A and 3B PC Outlet Temperature Summing
204D	Steam Generator 4A and 4B PC Outlet Temperature Summing
204E	Steam Generator 5A and 5B PC Outlet Temperature Summing
292 (LC-212)	C/D Pressure Set-PT Control
291 (PC-250)	S/D Pressure Set-PT Control

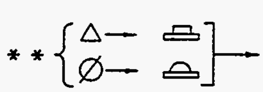
Ref. H-1-40176

A and Cell Control Console BB



CFA LEGEND

1 Total Steam Flow Signal
2 Surge Tank Press. A Chnl. Vlv.
3 Surge Tank Press. B Chnl. Vlv.
4 Srge. Tk. Press. ST-BY Chnl. FD-BK Pwr. Supply
5 Modal Sta. Set Pt. for Surge Tk.
6 Srge Tk. Press. Set-Pt. Power S
7 Srge Tk. Lvl. Signal A
8 Srge Tk. Lvl. Signal B
9 West Main Stm. HDR Signal
10 East Main Stm. HDR Signal
11 Main Stm. HDR Selected Sign
12 Srge Tk. HI-Lvl. Spill Set-Pt. Cc
13 Srge Tk. N-Lvl. Comp. Ckt. Pwr. Splys and Lvl. Set-Pt. Contlr.
14 Srge Tk. LO-Lvl. Fill Set-Pt. Co
15 Srge Tk. HI and LO Lvl. Switch I
16 Main Stm. HDR BK-UP Press Co



Shape of Control Component Failure Alarm (Neon) Lights

Print Ref. H-1-40173

DESIGNATION OF INDICATORS

Item No.	Mark No.	Service
82	PG-1131	Standby Boiler Steam Pressure
83	FI-217	Main Steam to Drive Turbines Flow
83	FI-216	Condensate From Standby Powerhouse Flow
85	PG-1088	Main Steam/Dump Condenser Condensate Pumps Suction Pressure Diff.
86	PG-1086	Main Steam From Heat Exchangers Pressure
87	PG-1087	Main Steam to Drive Turbines Pressure
88	LI-257	Condensate Surge Tank Level
89	PG-1089	Condensate Surge Tank Pressure
90	PG-1090	Dump Condenser Condensate Pumps 1 thru 8 Discharge Header Pressure
91	PG-1091	Dump Condenser Condensate Pumps 1 thru 8 Suction Header Pressure
169	PG-1143	Dump Condenser Condensate Pumps 9 thru 16 Suction Header Pressure
170	PG-1144	Dump Condenser Condensate Pumps 9 thru 16 Discharge Header Pressure

DESIGNATION OF CONTROLLERS

Item No.	Mark No.	Service
260	PC-241	Condensate Surge Tank Pressure
261	PC-246	Condensate Surge Tank Pressure
262	PC-247	Condensate Surge Tank Pressure Set Point Adjustor
–263	FC-209	Steam Flow-Cond Flow Ratio Adjuster
264	LC-211	Condensate Surge Tank Emergency Spill
265	LC-209	Secondary Coolant Makeup
266	LC-210	Condensate Surge Tank Emergency Fill
267	PC-242	Main Steam Header Press. Back Up Control
268	PC-243	Main Steam Header Press. Back Up Control

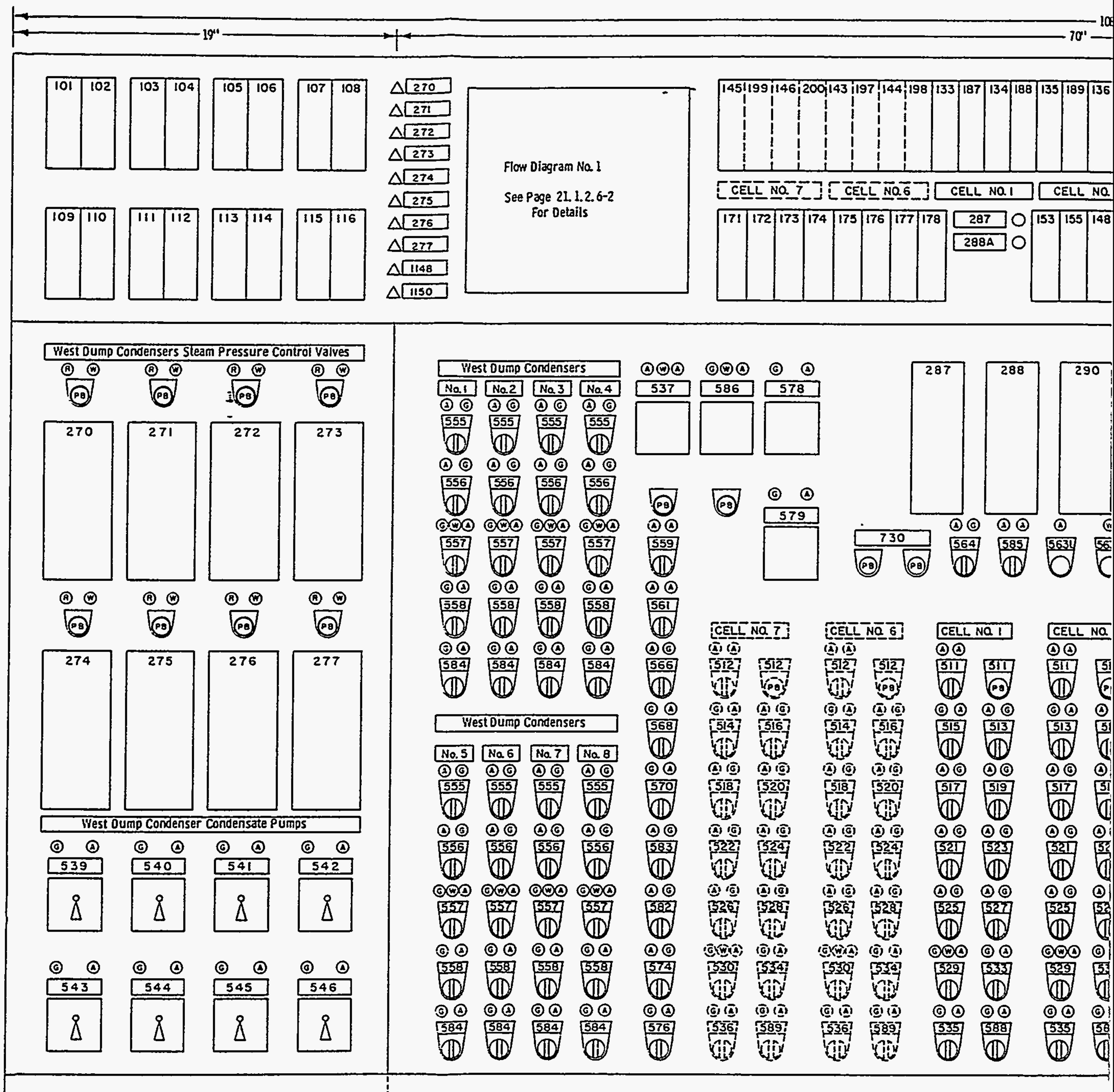
DESIGNATION OF SWITCHES

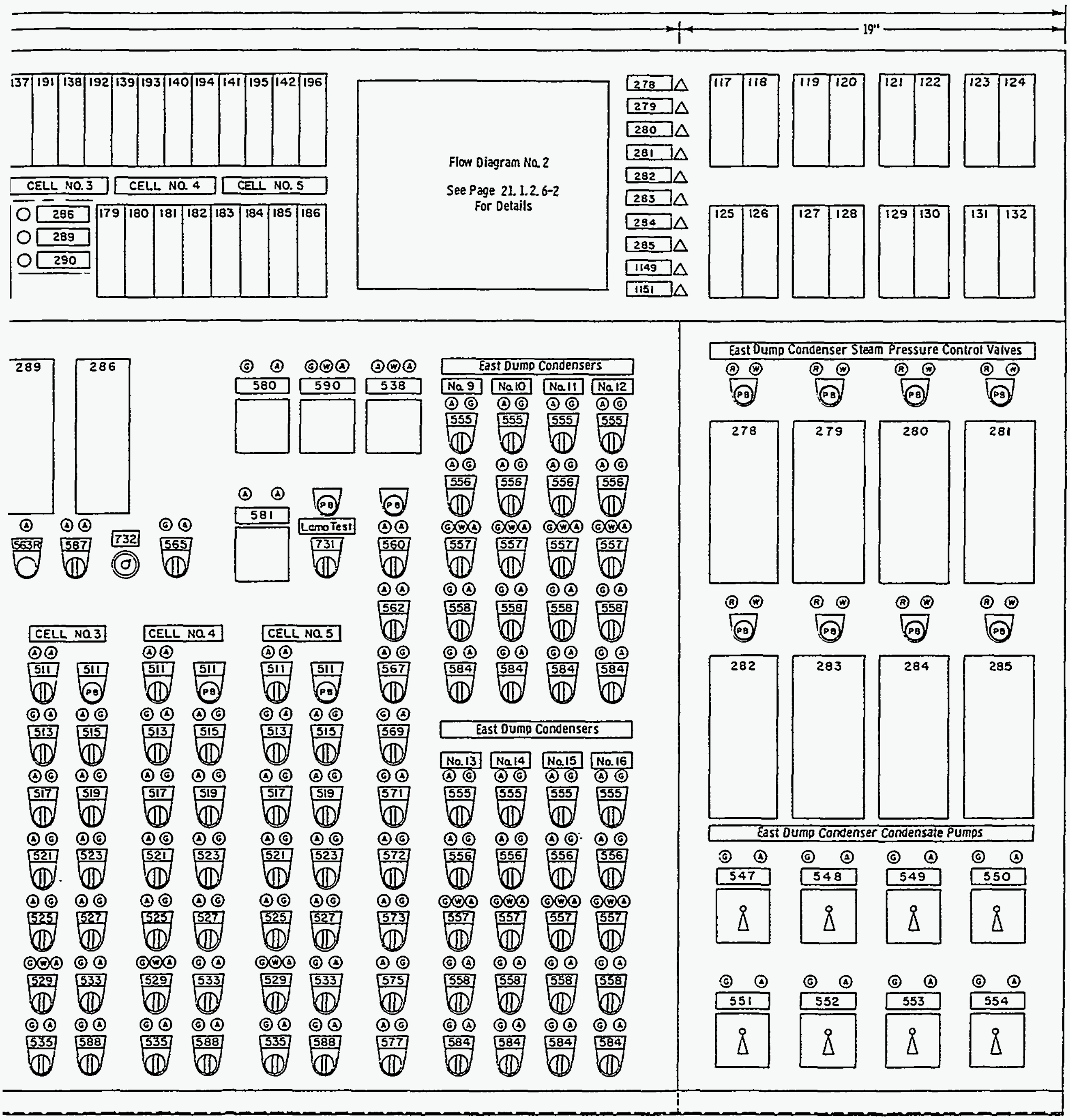
Item No.	Mark No.	Service
490 A	SS-227	Main Steam Header Pressure Transmitter Selector
491 A	SS-228	Dr. Turb. Steam Header Pressure Transmitter Selector
502	SS-229	Dump Condenser Condensate Pumps Suction Pressure Transmitter Selector
503	SS-246	Condensate Surge Tank Pressure Controller Selector
504	SS-247	Main Steam/ Condensate Pumps Suction Pressure Diff. ΔP Signal Selector
505	-------	Acknowledge, Test and Reset Pushbuttons for Annunciator Above Graphic Panel J
513		Surge Tank Level Control Signal Selector
488		Normal Makeup Valve Limiting Signal Bypass

COMMUNICATIONS EQUIPMENT

Item No.	Mark No.	Service
506		HCC Master Station
508		HCC Master Station Terminal Box
509		DL Sound Power Telephone Hand Sets
510		DL Sound Power Magnetos
511		DL Sound Power Telephone Annunciator Lights
512		DL Sound Power Telephone Jacks

m Control Console JJ


19"
70"
Flow Diagram No. 1
See Page 21.1.2.6-2 For Details
CELL NO. 7
CELL NO. 6
CELL NO. 1
West Dump Condensers Steam Pressure Control Valves
West Dump Condensers
No. 1
No. 2
No. 3
No. 4
No. 5
No. 6
No. 7
No. 8
West Dump Condenser Condensate Pumps


19"
CELL NO. 3
CELL NO. 4
CELL NO. 5
Flow Diagram No. 2
See Page 21. 1. 2. 6-2
For Details
East Dump Condensers
No. 9
No. 10
No. 11
No. 12
East Dump Condenser Steam Pressure Control Valves
Lamp Test
East Dump Condensers
No. 13
No. 14
No. 15
No. 16
East Dump Condenser Condensate Pumps

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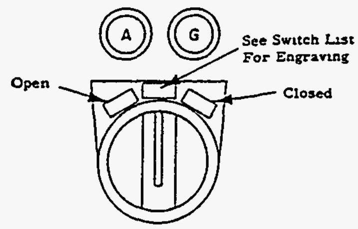
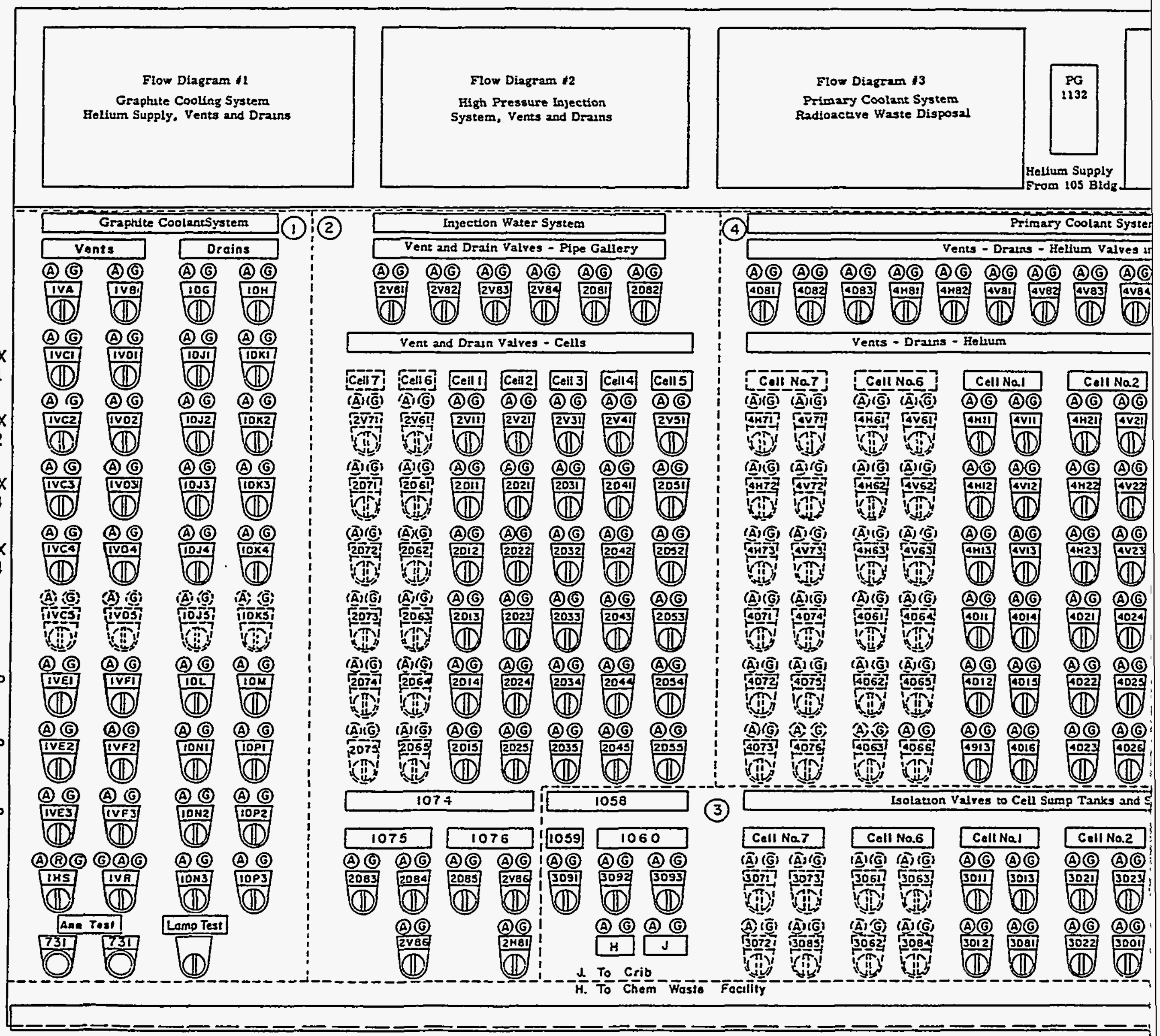
ITEM NO.	DESIGNATION OF INDICATING LIGHTS
698	Indicates Position of HPV-216-1, 3, 5, 7, 10, 12, 14, 16, 18, 20
699	(Future)
700	Indicates Position of HPV-216-2, 4, 6, 8, 9, 11, 13, 15, 17, 19
701	(Future)
702	Indicates Position of HPRV-201-21, 23, 25, 27, 30, 32, 34, 36, 38, 40
703	(Future)
704	Indicates Position of HPRV-201-22, 24, 26, 28, 29, 31, 33, 35, 37, 39
705	(Future)
706	Indicates Position of HPRV-201-1, 3, 5, 7, 10, 12, 14, 16, 18, 20
707	(Future)
708	Indicates Position of HPRV-201-2, 4, 6, 8, 9, 11, 13, 15, 17, 19
709	(Future)
710	Indicates Position of HPRV-201-41 thru 50
711	(Future)

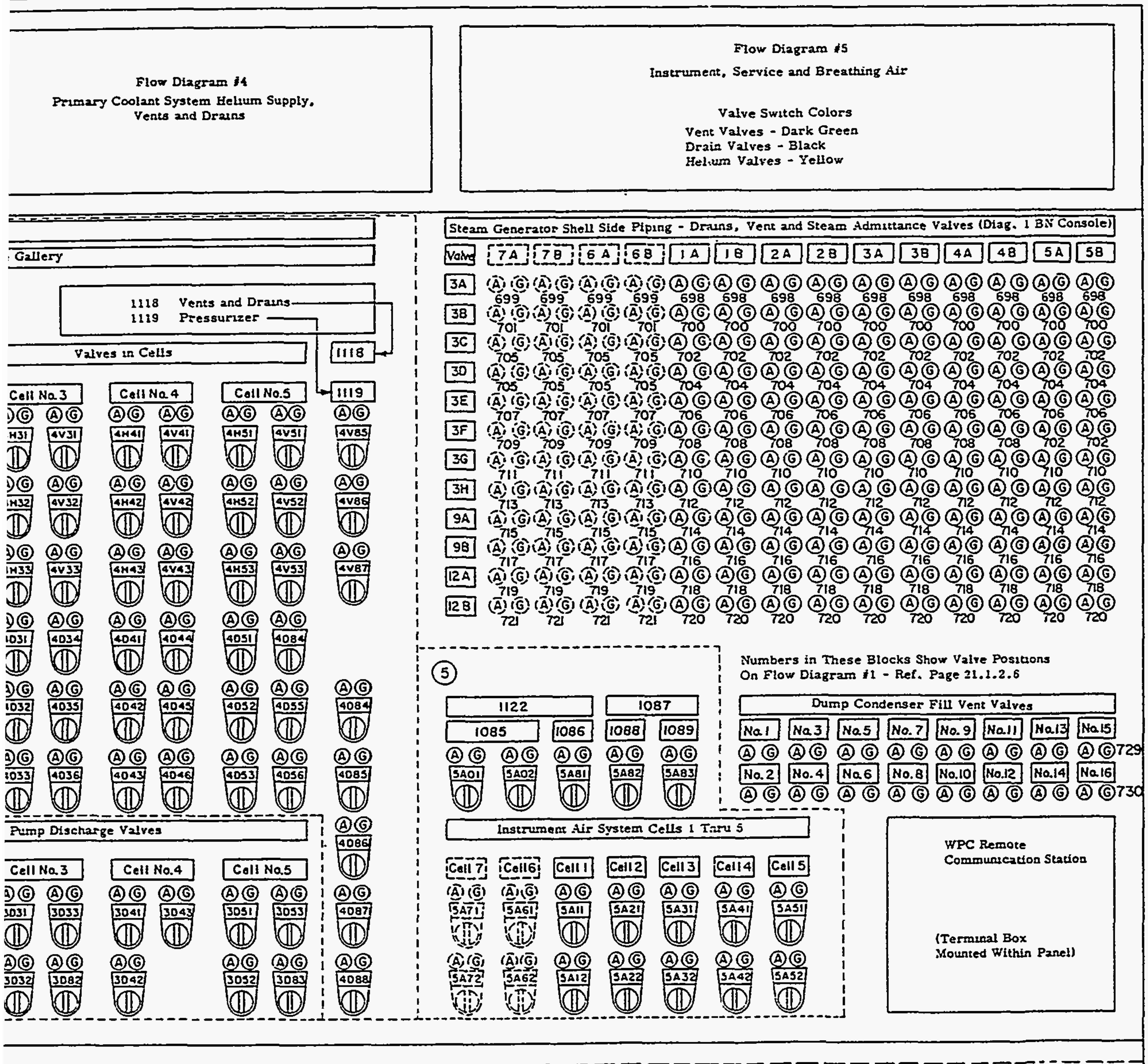


Detail "A"



1058	Radioactive Drain-Yard and Service Area
1059	Nuclear Service Area Sump Pump
1060	Yard Radioactive Valves and Valve Pit
1074	Valves for Spill Cooler and Recuperative Heat Exchanger
1075	Valves for Spill Cooler Drain and Vent
1076	Drains, Vent and Helium Supply Valve for Recuperative Heat Exchangers

ITEM NO.	DESIGNATION OF INDICATING LIGHTS
712	Indicates Position of HPRV-216-1 Thru 10
713	(Future)
714	Indicates Position of HPR-245-1, 3, 5, 7, 10, 12, 14, 16, 18, 20
715	(Future)
716	Indicates Position of HPV-245-2, 4, 6, 8, 9, 11, 13, 15, 17, 19
717	(Future)
718	Indicates Position of HPV-209-18, 20, 22, 24, 25, 27, 29, 31, 33, 35
719	(Future)
720	Indicates Position of HPV-209-17, 19, 21, 23, 26, 28, 30, 32, 34, 36
721	(Future)
722	Indicates Position of DSV-801-1 Radioactive Drains to Chem. Waste Facility at Block 1120
723	Indicates Position of DSV-802-1 Radioactive Drains to Crib, at Block 1121
729	Indicates Position of HPV-250-1, 3, 5, 7, 9, 11, 13, 15
730	Indicates Position of HPV-250-2, 4, 6, 8, 10, 12, 14, 16



Ref. H-1-40169 & 40170

1085	Auxiliary Cell
1086	Pipe Gallery
1087	Breathing and Service Air for Pipe, Gallery and Cells
1088	Breathing Air Header Shut-Off Valve CABV-203
1089	Service Air Header Shut-Off Valve SAV-203
1122	Instrument Air System for Auxiliary Cell and Pipe Gallery

VALVE LEGEND FOR FLOW DIAGRAM #1

Oper. GCRV-309-1 Vent Valve Surge Tank GCR Line	1VA
Oper. GCSV-305-5, 9 and GCRV-309-18 Vent Valves GCS and GCR Lines	1VB
Oper. 2 GCRV-309 Vent Valves per Graphite Cooling Heat Exch. Tube Side	1VC1 Thru 1VC4
(Future)	1VC5
Oper. GCSV-305 Vent Valve on GCS Pipe from Graphite Cooling Heat Exchanger	1VD1 Thru 1VD4
(Future)	1VD5
Oper. GCSV-305 Vent Valve Graphite Cooling Recir. Pump Discharge Pipe	1VE1 Thru 1VE3
Oper. GCSV-306 Vent Valve Graphite Cooling Recir. Pump Casing Vent	1VF1 Thru 1VF3
Oper. RVTV-207-1 Graphite Cooling Surge Tank	1VR
Oper. GCRV-304-5 Drain Valve GCR Pipe from Reactor	1DG
Oper. GCRV-304-6 Thru 10 and (One Future) GCR Header Drain Valves	1DH
Oper. 1-GCRV-304 Drain Valve per GCR Pipe to Graphite Heat Exchanger	1DJ1 Thru 1DJ4
(Future)	1DJ5
Oper. 2-GCRV-309 Drain Valves per Graphite Cooling Heat Exch. Tube Side	1DK1 Thru 1DK4
(Future)	1DK5
Oper. GCSV-310-7 Drain Valve from Emerg. Raw Water Supply to GCS	1DL
Oper. GCSV-310-8 Drain Valve Recir. Pump Disch. Header	1DM
Oper. GCSV-306 Drain Valve per Recir. Pump Casing	1DN1 Thru 1DN3
Oper. GCSV-310 Drain Valve per Recir. Pump Suction Pipe	1DP1 Thru 1DP3
Oper. GCRV-309-19 Graphite Cooling Surge Tank Helium Supply for Drain	1HS

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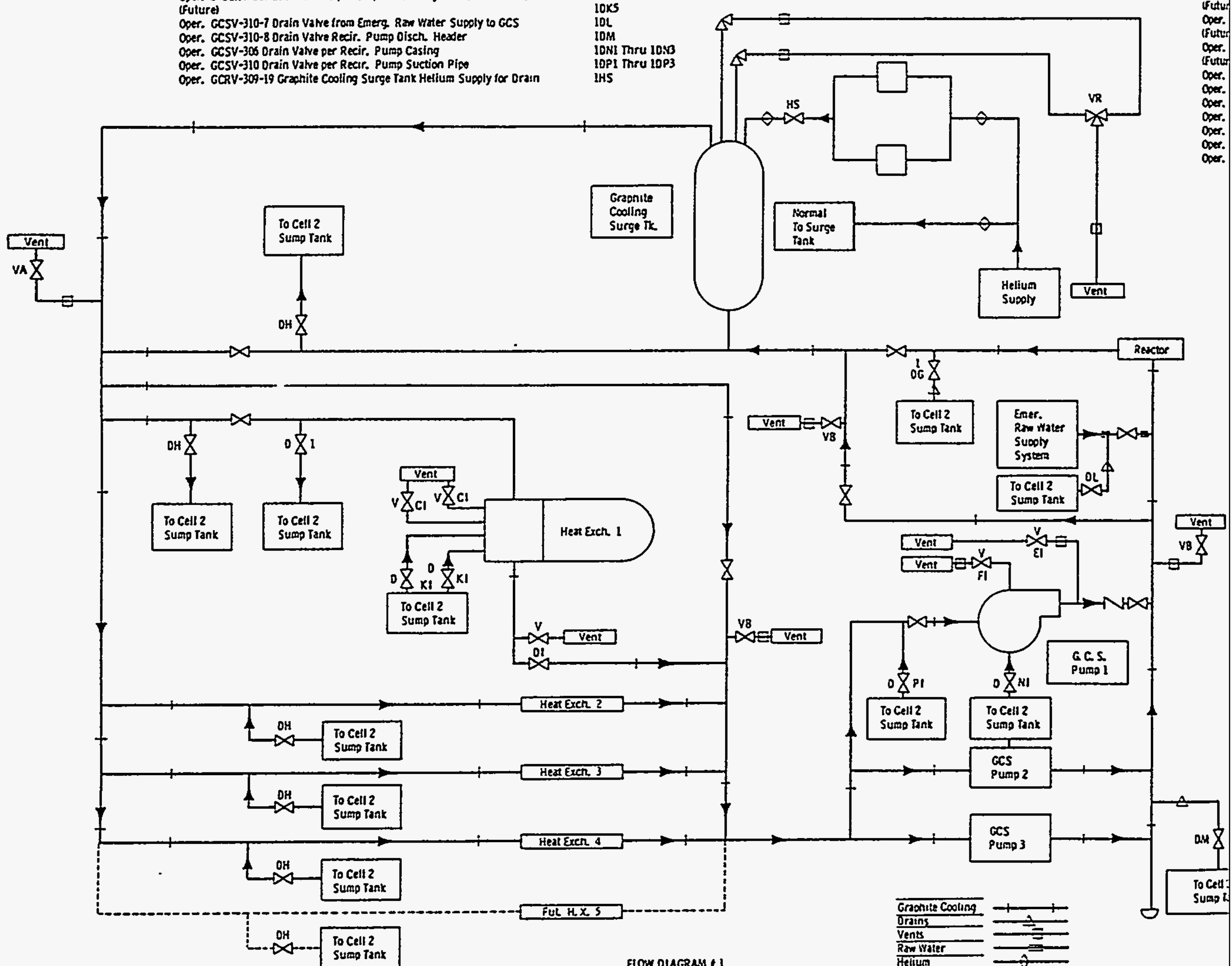
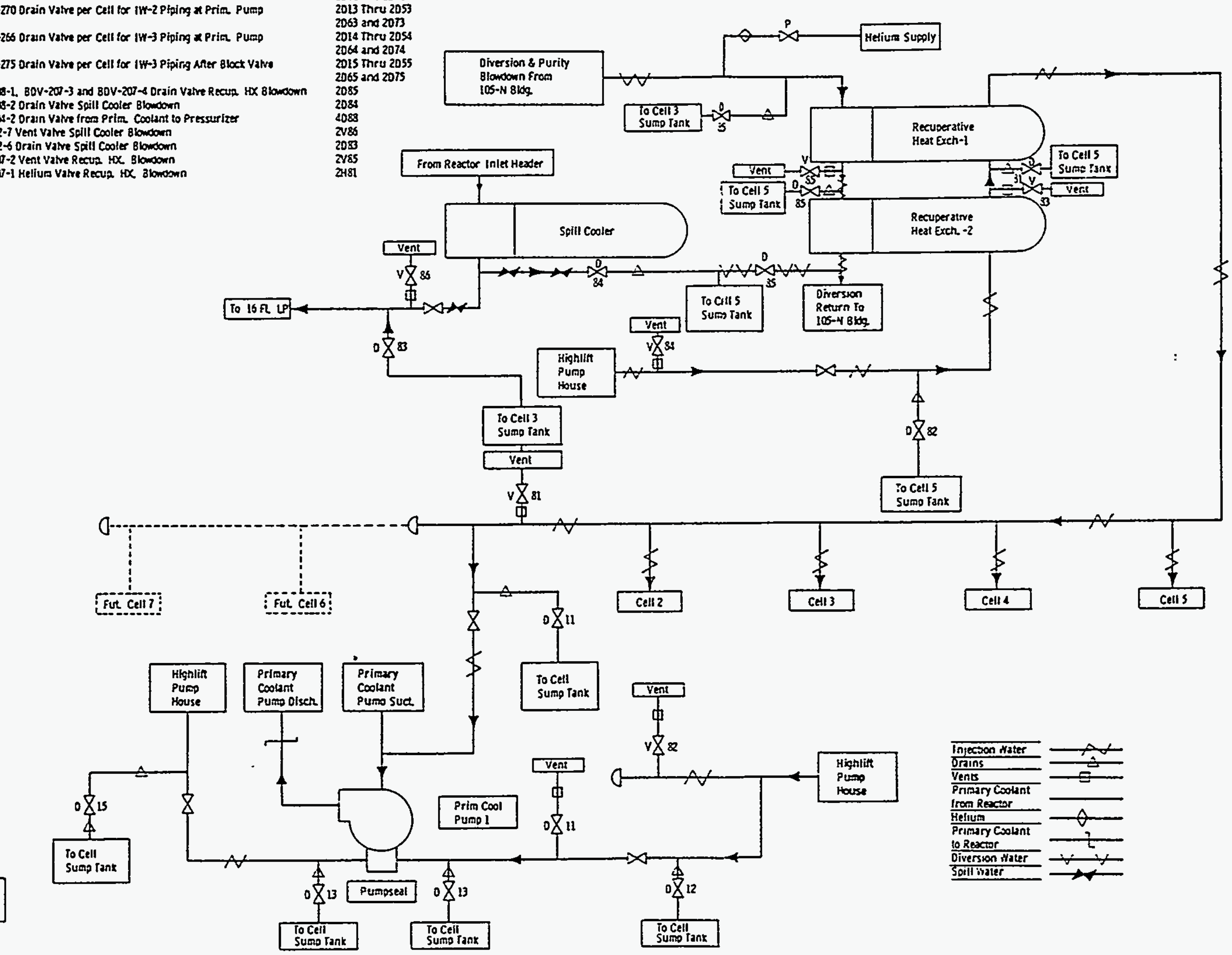


FLOW DIAGRAM # 1

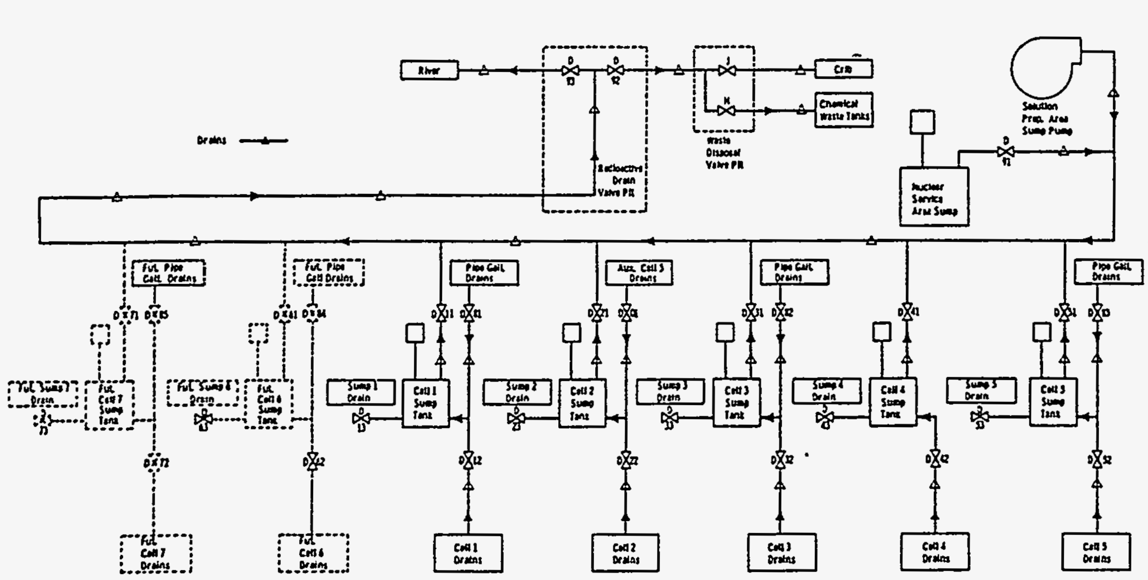
VALVE LEGEND FOR FLOW DIAGRAM #2

1-17 Vent Valve for IW-1 Header in Pipe Gallery	2V81
0-16 Vent Valve for IW-2 Header in Pipe Gallery	2V82
0-19 Vent Valve for IW-2 Piping Between Recup. Heat nd 2	2V83
0-17 Vent Valve for IW-2 Piping to Recup. Heat Exch. #2	2V84
0-18 Drain Valve for IW-2 Piping Between Recup. H.E. 1 and 2	2D81
0-18 Drain Valve for IW-2 Piping Between Recup. H.E. 1 and 2	2D81
0-20 Drain Valve for IW-2 Piping to Recup. H.E. #2	2D82
270 Vent Valve per Cell for IW-2 Piping to Prim. Pump Seals	2V11 Thru 2V51 2V61 and 2V71
261 Drain Valve per Cell for IW-1 Piping to Prim. Pump Suction	2D11 Thru 2D51 2D61 and 2D71
270 Drain Valve per Cell for IW-2 Piping Before Cell Block Valve	2D12 Thru 2D52 2D62 and 2D72
270 Drain Valve per Cell for IW-2 Piping at Prim. Pump	2D13 Thru 2D53 2D63 and 2D73
266 Drain Valve per Cell for IW-3 Piping at Prim. Pump	2D14 Thru 2D54 2D64 and 2D74
275 Drain Valve per Cell for IW-3 Piping After Block Valve	2D15 Thru 2D55 2D65 and 2D75
8-1, BDV-207-3 and BDV-207-4 Drain Valve Recup. HX Blowdown	2D85
8-2 Drain Valve Spill Cooler Blowdown	2D84
4-2 Drain Valve from Prim. Coolant to Pressurizer	4D83
2-7 Vent Valve Spill Cooler Blowdown	2V86
2-6 Drain Valve Spill Cooler Blowdown	2D83
7-2 Vent Valve Recup. HX. Blowdown	2V85
7-1 Helium Valve Recup. HX. Blowdown	2H81

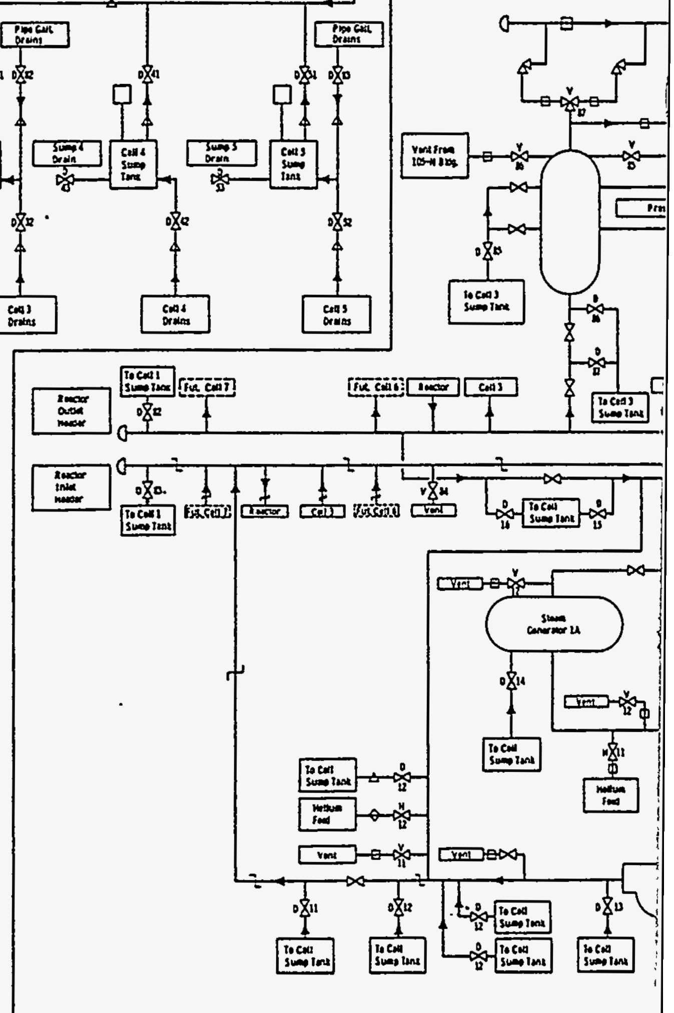


FLOW DIAGRAM #2

UNCLASSIFIED

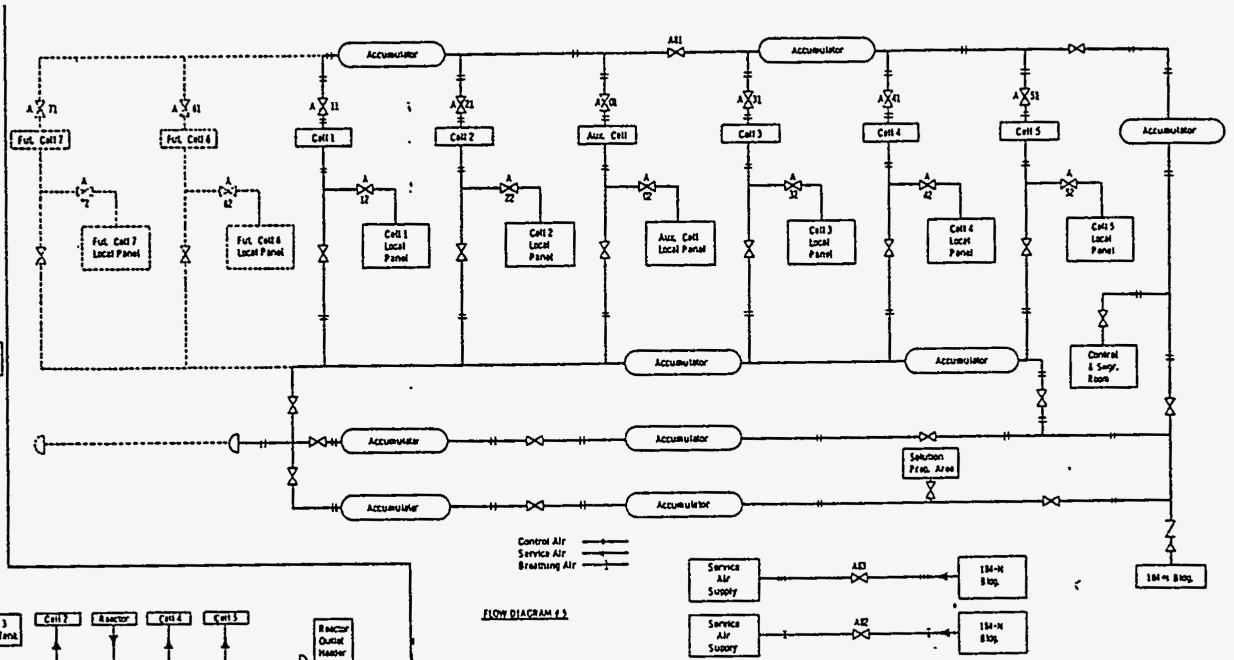


FLOW DIAGRAM #3



VALVE LEGEND FOR FLOW DIAGRAM #3

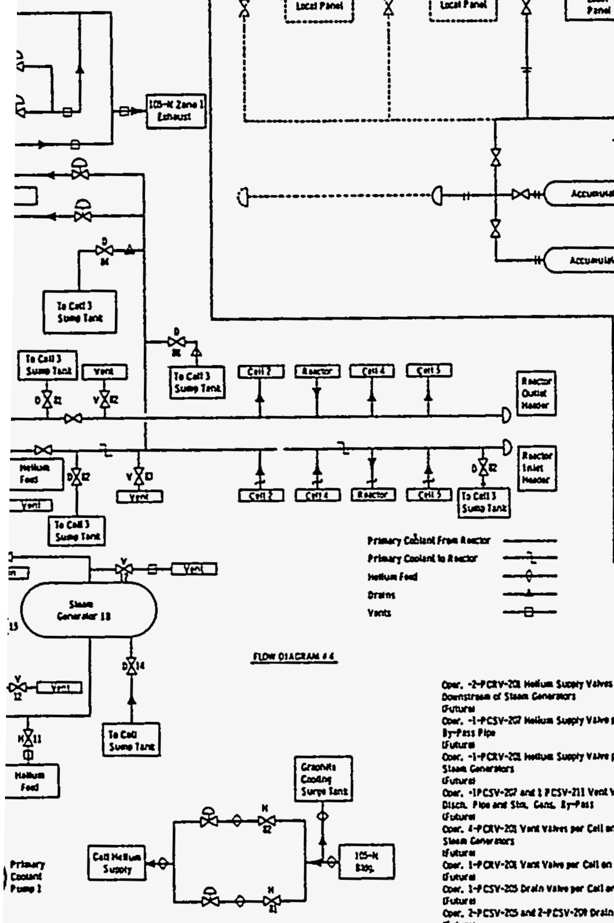
Oper. 1 RDRV-202 Process Sump Pump Disch. Valve per Cell (Future)	3011 Thru 3051 3061 and 3071
Oper. 1 RDRV-201 Cell Sump Drain Valve to Cell Sump Tank (Future)	3013 Thru 3053 3063 and 3073
Oper. RDRV-202-6 Pipe Gallery Drain Header Shut-Off Valve to Cell No. 1 Sump Tank	3031
Oper 1-RDRV-201 Cell Drain Header Shut-Off Valve per Cell to Cell Sump Tank (Future)	3012 Thru 3052 3062 and 3072
Oper. RDRV-202-7 Aux. Syst. Cell Drain Header Shut-Off Valve to Cell No. 2 Sump Tank	3021
Oper. RDRV-210-1 Pipe Gallery Drain Header Shut-Off Valve to Cell No. 3 Sump Tank	3032
Oper. RDRV-206-2 Pipe Gallery Drain Header Shut-Off Valve to Cell No. 5 Sump Tank	3033
(Future) Pipe Gallery Drain Header Shut-Off Valve to Future Cell Sump No. 6 and 7 Sump Tanks	3034 and 3035
Oper. RDRV-208-1 Disch. Valve from Nuclear Service Area Sump Pump	3091
Oper. RDRV-102-1 Drain Valve in Radioactive Drain Valve Pit to Waste Disposal Valve Pit	3092
Oper. RDRV-102-2 Drain Valve in Radioactive Drain Valve Pit to River	3093



FLOW DIAGRAM #5

VALVE LEGEND FOR FLOW DIAGRAM #5

Oper. CASV-212 Isolat. Valve at Each Cell and CASV-240 at Aux. Cell	SA11 Thru SA51, SA01
(Future)	SA61 and SA71
Oper. CASV-212 to Cell Local Panels and Aux. Cell Local Panel	SA12 Thru SA52, SA02
Oper. CASV-212 to Cell Local Panels (Future)	SA62 and SA72
Oper. CASV-213 Header Isolat. Valve in Pipe Gallery	SA81
Oper. CABV-203 Shut-Off Valve Breathing Air Header	SA82
Oper. SAV-203 Shut-Off Valve Service Air Header	SA83

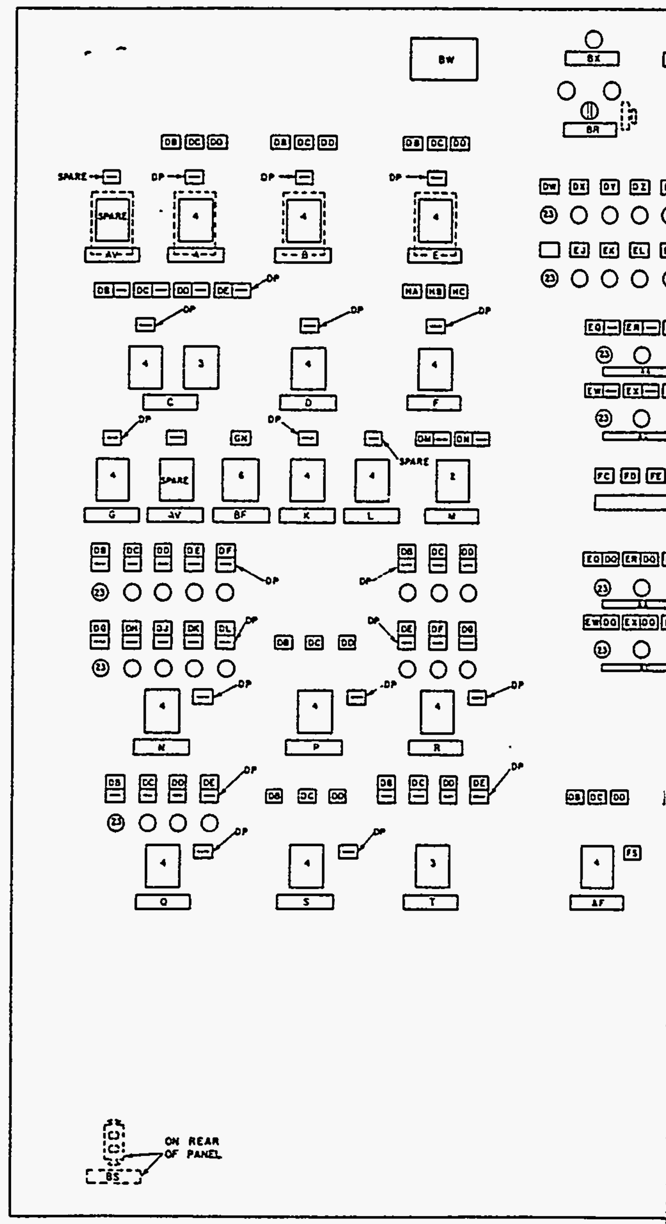


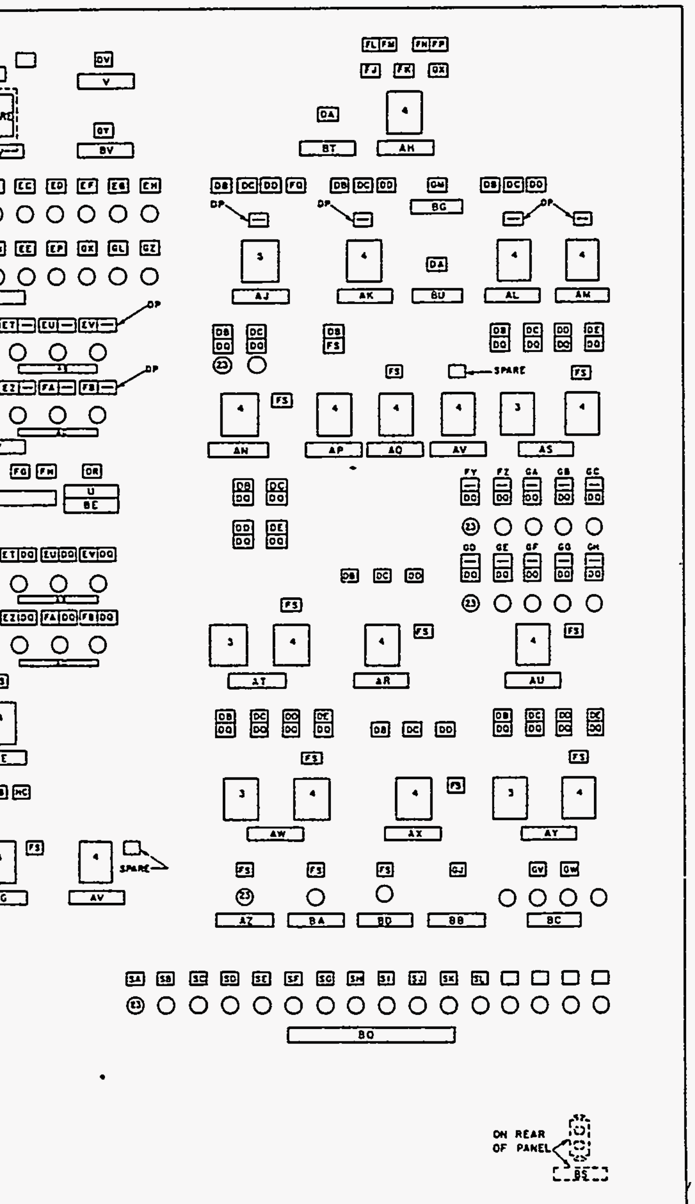
FLOW DIAGRAM #4

VALVE LEGEND FOR FLOW DIAGRAM #4

Oper. -2-PCRV-201 Helium Supply Valves per Cell to Prim. Coolant Piping Downstream of Steam Generators	4H11 Thru 4H51
(Future)	4H61 and 4H71
Oper. -1-PCSV-207 Helium Supply Valve per Cell to Stm. Gens. Prim. Coolant By-Pass Pipe	4H12 Thru 4H52
(Future)	4H62 and 4H72
Oper. -1-PCRV-201 Helium Supply Valve per Cell to Prim. Coolant Piping to Steam Generators	4H13 Thru 4H53
(Future)	4H63 and 4H73
Oper. -1PCSV-207 and 1 PCSV-211 Vent Valves per Cell on Prim. Cool. Pump Disch. Pipe and Stm. Gens. By-Pass	4V11 Thru 4V51
(Future)	4V61 and 4V71
Oper. 4-PCRV-201 Vent Valves per Cell on Prim. Cool. Piping to and From Steam Generators	4V12 Thru 4V52
(Future)	4V62 and 4V72
Oper. 1-PCRV-201 Vent Valve per Cell on Prim. Coolant Pipe to Stm. Gen.	4V13 Thru 4V53
(Future)	4V63 and 4V73
Oper. 1-PCSV-205 Drain Valve per Cell on Prim. Cool. Pump Disch. Pipe	4D11 Thru 4D51
(Future)	4D61 and 4D71
Oper. 2-PCSV-205 and 2-PCSV-209 Drain Valves per Cell on Prim. Cool. Supply	4D12 Thru 4D52
(Future)	4D62 and 4D72
Oper. 1-PCRV-201 Drain Valve per Cell on Prim. Coolant Pump Discharge Pipe	4D13 Thru 4D53
(Future)	4D63 and 4D73
Oper. 2-PCRV-209 Drain Valves per Cell on Stm. Generators A and B	4D14 Thru 4D54
(Future)	4D64 and 4D74
Oper. PCSV-207-16 Vent Valve on Reactor Inlet Header (Pipe Gallery)	4V84
Oper. PCSV-207-17 Vent Valve on Reactor Inlet Header (Pipe Gallery)	4V83
Oper. PRV-210-1 Vent Valve on Pressurizer	4V85
Oper. PCRV-201-48 Vent on Reactor Outlet Header (Pipe Gallery)	4V82
Oper. PCRV-201-36 Vent on Reactor Outlet Header (Pipe Gallery)	4V81
Oper. PRV-213-1 Vent Valve to Pressurizer from Bldg. 105-N	4V86
Oper. PCSV-205-17 Drain Valve on Reactor Inlet Header	4D83
Oper. PCSV-205-9 and 18 Drain Valves on Reactor Inlet Header	4D82
Oper. PCRV-209-19, 30, Drain Valves on Reactor Outlet Header	4D81
Oper. PRV-212-1 Drain Valve on Spray Water to Pressurizer	4D84
Oper. PRV-201-1 Drain Valve on Pressurizer Strong Back	4D85
Oper. PRV-210-2 Drain Valve from Pressurizer	4D86
Oper. PRV-211-1 Drain Valve Pressurizer Isolation Valve	4D87
Oper. RVTV-201-1 Radioactive Vent Valve from Pressurizer	4V87
Oper. 2-PCRV-209 Drain Valves per Cell on Prim. Coolant Return Downstream of Loop Shut-Off	4015 Thru 4055
(Future)	4065 and 4075
Oper. 1-PCRV-209 Drain Valve per Cell on Prim. Coolant Return Upstream of Loop Shut-Off	4016 Thru 4056
(Future)	4066 and 4076
Oper. HEV-202-1 Helium Supply from Norm. Open) Bldg. 105-N to Bldg. 109-N Supply Header (Pipe Gallery)	4H82
Oper. HEV-202-2 Helium Supply from Norm. Closed) Bldg. 105-N to Bldg. 109-N Supply Header (Pipe Gallery)	4H81

, and 5 for Control Console XX


BW
ON REAR
OF PANEL



t Panel (P-2)

NAMEPLATE LEGEND

N. P.	Inscription
A	Fast Period Intermediate Power Level
B	Excessive Neutron Flux Intermediate Power Level
C	Outlet Boiling
D	Zone Monitor High Temperature
E	Very High Average Power Level
F	Excessive Power Rise Rate
G	Process Tube High or Low Flow
K	Rod Cooling Water Low Flow
L	Fuel Element Rupture
M	Electrical Power Failure
N	Steam Generator Extremely Low Liquid Level
P	Extremely Low Pressurizer Level
Q	Circulating Water Low Flow
R	Primary Pump Low Steam Supply
S	Extremely Low Surge Tank Water Level
T	Primary Loop Extremely High Pressure
U	Excessive Number of Flux Monitors Bypassed
V	Timed Out After Rods are in for Ball Backup
X	Rod Scram Reset
Y	Excessive Neutron Flux High Power Level
Z	Maximum Number of Flux Monitors Bypassed
AA	Upper Rear
AB	Upper Front
AC	Lower Rear
AD	Lower Front
AE	Approaching Excessive Neutron Flux High Power Level
AF	Approaching Fast Period Intermediate Power Level
AG	Approaching Excessive Power Rise Rate
AH	Emergency Cooling Water Master Bypass
AJ	Reactor not Supercritical with Rods In
AK	High Flux Level After Scram'
AL	Seismoscope Bypass
AM	Ball Backup to Emergency Cooling Water System
AN	Fast Period Subcritical
AQ	Zone Monitor High Temperature
AR	Pressurizer High Water Level
AS	Approaching Outlet Boiling
AT	High Pressure Main Steam Header
AU	High and Low Reactor Inlet Coolant Temperature
AV	Spare
AW	Primary Loop Very Low Pressure
AX	High Surge Tank Water Level
AY	Primary Loop Very High Pressure
AZ	Fast Rod Withdrawl - Subcritical Period Less than 20-60 Sec.
BA	Fast Rod Withdrawl - Subcritical Count Rate Les
BB	Rod Withdrawl and Off Circuit Energized.
BC	Graphite Emergency Cooling System
AP	High Average Power Level
BD	Fast Rod Withdrawl Reactor Critical
BE	Push for Buzzer Test
BF	Ball Drain Valve Permissive Open
BG	Ball Back-Up Timer Inventer Operating
BQ	109 Bldg. Post Scram - Function Bypass
BR	Rod Scram Safety Ckt. Contacts Closed
BS	For Scram Transient Recording Instruments
BT	Emergency Cooling System Lamp Test
BU	Safety Circuit Lamp Test
BV	Time Delay After Trip Before Reset
BW	Lamp Barriers Gray - General White - Rod Safety Circuit Reset Rod - Rod Safety Circuit Master Bypass Black - Lamp or Buzzer Test
BX	Rod Safety Reset Circuit Contacts Closed

Part (23) - Keylocked Switch

ESCUTCHEON PLATE ENGRAVING

PLATE NO.	POSITION 1	2	3	4
2		B.P.A. U.V. Bypassed	Normal	Turbo U. V. Bypass
3	Inst. #1 Bypassed	Inst. #2 Bypassed	Normal	Inst. Bypas
4	———	———	Normal	Bypas
5	———	———	Rod Back-Up	Bypas
6	———	———	Negate Open	Permis Oper

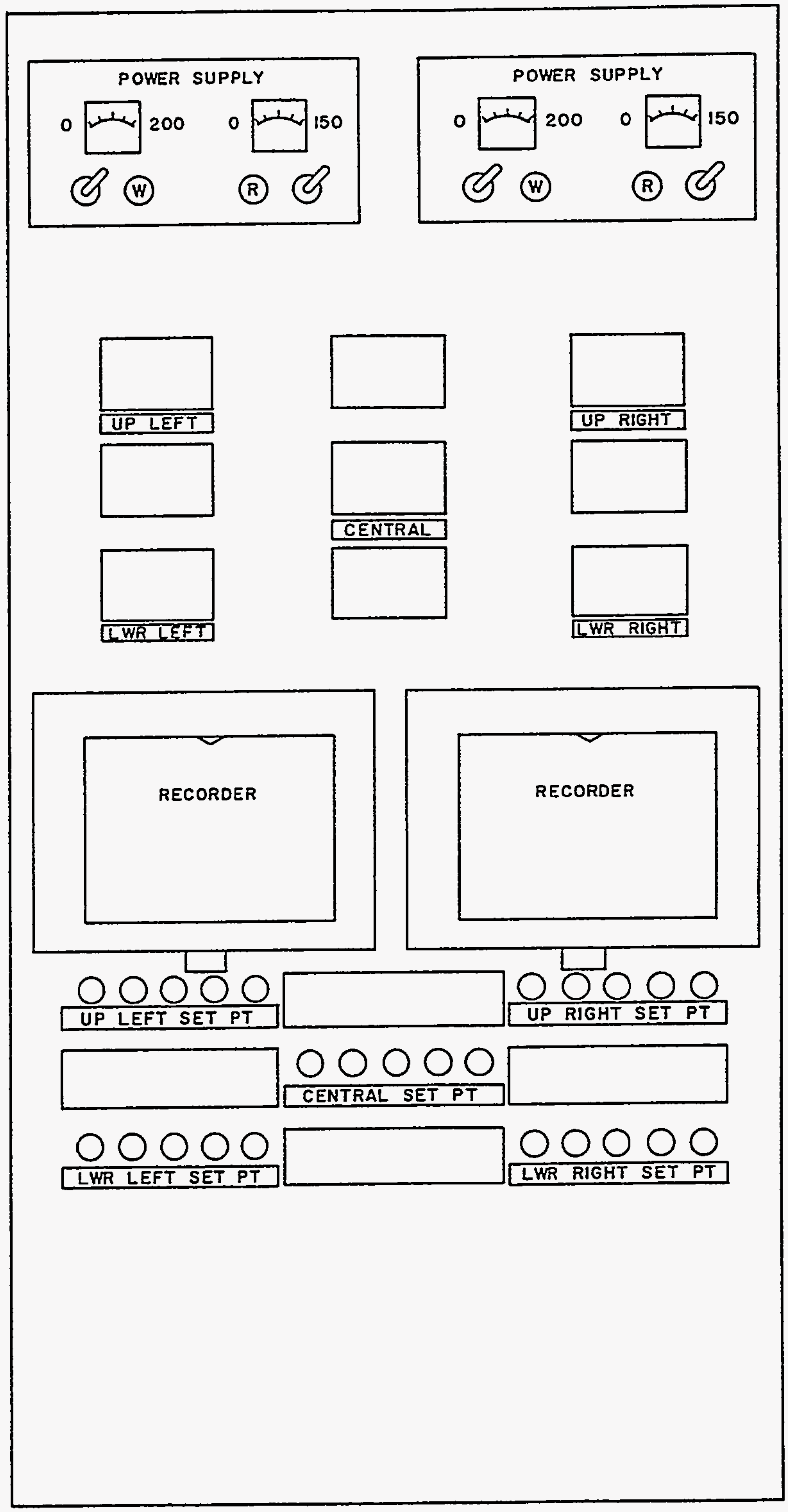
Legend for Safety Ci

an 10 Counts/Second

5
———
Inst. #4 Bypassed
———
Ball Drop
———

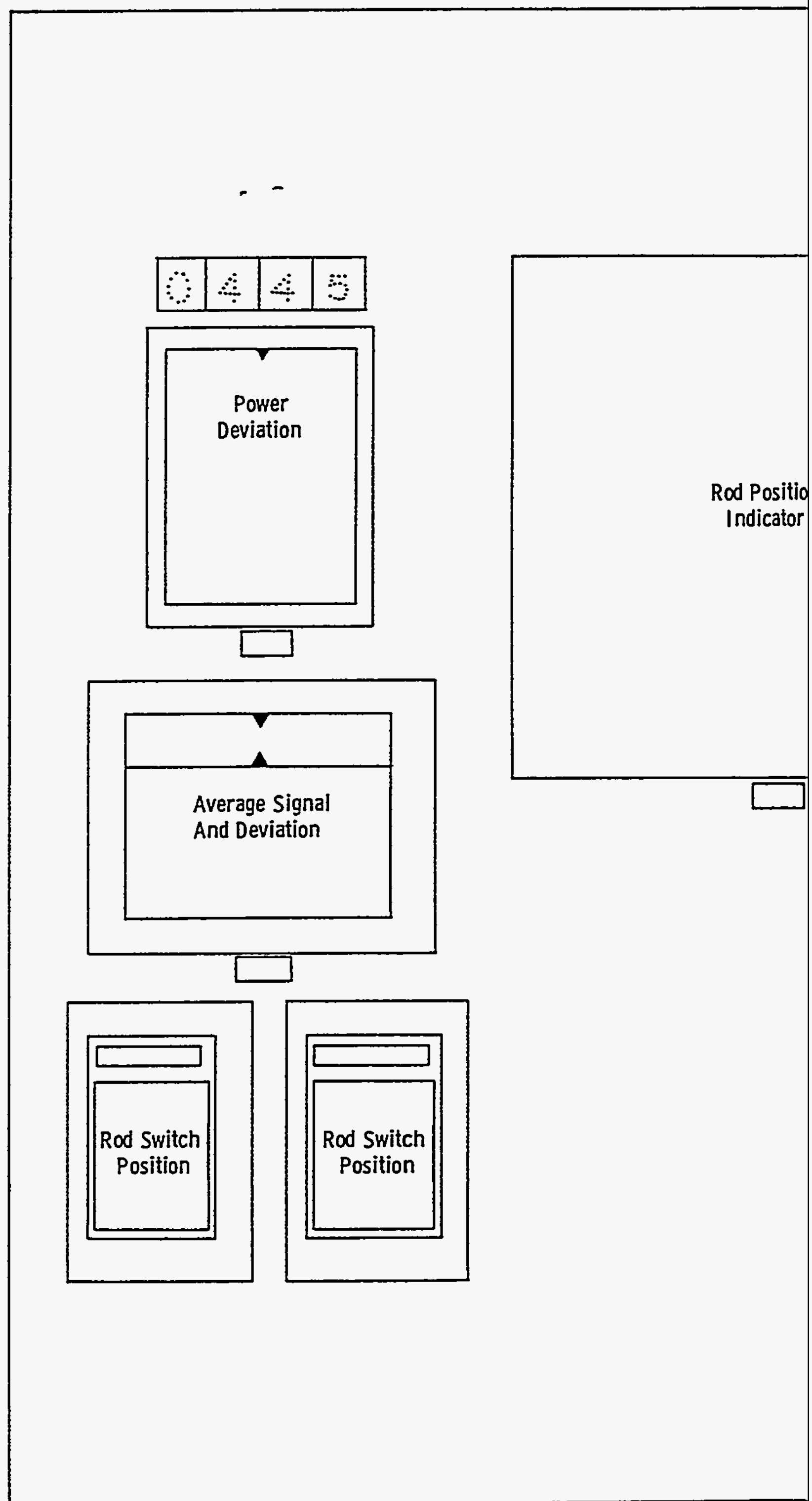
PUSHBUTTON ENGRAVING			
N. P.	Inscription	N. P.	Inscription
DA	Lamp Test	EY	#5B Tripped
DB	#1 Tripped	EZ	#2B Tripped
DC	#2 Tripped	FA	#1B Tripped
DD	#3 Tripped	FB	#6B Tripped
DE	#4 Tripped	FC	2 of 3 Bypassed Upper Front
DF	#5 Tripped	FD	2 of 3 Bypassed Upper Rear
DG	#6 Tripped	FE	2 of 3 Bypassed Lower Front
DH	#7 Tripped	FF	2 of 3 Bypassed Lower Rear
DJ	#8 Tripped	FG	2 of 4 Bypassed Right Side
DK	#9 Tripped	FH	2 of 4 Bypassed Left Side
DL	#10 Tripped	FJ	1 of 4 Input Trips Bypassed
DM	B. P. A. Under Voltage	FK	Master E. C. W. S. Bypassed
DN	Turbo Gen. Under Voltage	FL	System #1 Trip Bypassed
DP	Safe to Unbypass-Bypassed	FM	System #1 Tripped
DQ	Inst. Bypassed	FN	System #2 Trip Bypassed
DR	Excessive Number of Flux Monitors Bypassed	FP	System #2 Tripped
DV	Timed Out After Rods are In	FQ	PWR Over 1000 W Rods Not In
DW	V-5a	FS	Bypassed
DX	V-5b	FY	#1High Temp. /#1 Low Temp.
DY	V-7	FZ	#2 High Temp. /#2 Low Temp.
DZ	V-19	GA	#3 High Temp. /#3 Low Temp.
EA -	V-18a	GB	#4 High Temp. /#4 Low Temp.
EB	V-18b	GC	#5 High Temp. /#5 Low Temp.
EC	V-19	GD	#6 High Temp. /#6 Low Temp.
ED	V-22	GE	#7 High Temp. /#7 Low Temp.
EE	V-6	GF	#8 High Temp. /#8 Low Temp.
EF	V-23a	GG	#9 High Temp. /#9 Low Temp.
EG	V-23b	GH	#10 High Temp. /#10 Low Temp.
EH	V-24	GJ	Rod W/DWL and Off Circuit Energized
EJ	V-25	GK	All Ball Hoppers Locked
EK	V-26	GL	5 or More Hoppers Locked
EL	V-27	GM	Inverter On
EM	V-31	GN	Ball Drain Valve Open
EN	V-37	GV	Temp. Trip Bypassed
EP	Ball Drain Valves Bypassed	GW	Flow Trip Bypassed
HA	A Tripped	GX	Flow Trip(s) Bypassed
HB	B Tripped	GY	Timing
HC	Avg. Tripped	GZ	Rod Scram Hyd. Accum. Low Press.
EQ	#3A Tripped	SA	Lock in Fixed Main Steam Pressure
ER	#4A Tripped	SB	Reset Prim. Loop Flows at 25%
ES	#5A Tripped	SC	Open Stm. Gen. Pc. Bypass Vlvs.
ET	#2A Tripped	SD	Light Off Boiler Open Block Valves
EU	#1A Tripped	SE	Close Stm. Gen. Bd. Valves
EV	#6A Tripped	SF	Close Dump Cond. Vent Valves
EW	#3B Tripped	SG	Start All Afterheat Fill Pumps
EX	#4B Tripped	SH	Open Sec. Loop Norm. Makeup Valves
EY	#5B Tripped	SI	Open Sec. Loop Emerg. Fill Vlvs.
EX	#2B Tripped	SJ	Start All Hp. Inj. Pumps
		SK	Cut Off Preszr Heaters
		SL	Start All Boiler Feed Pmps.

uit Panel (P-2)

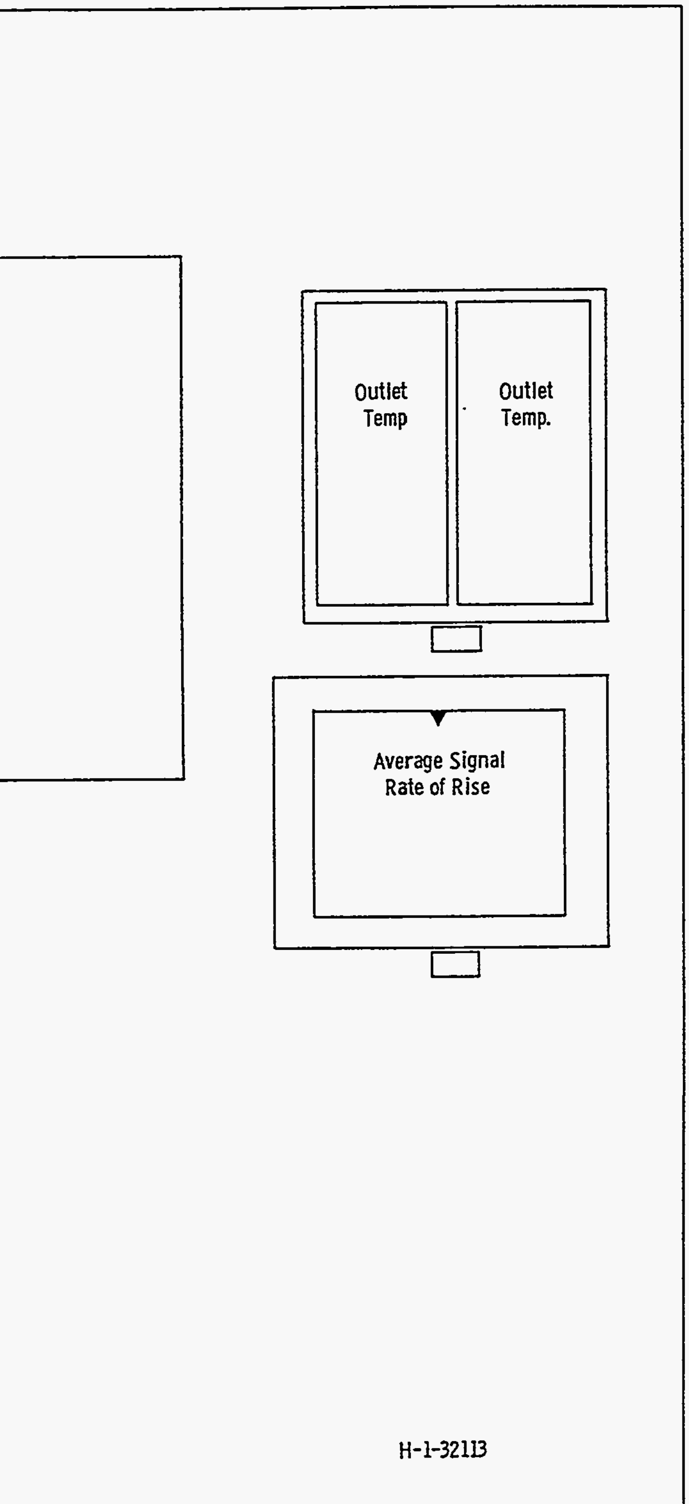


(Print Ref. H-1-27554)

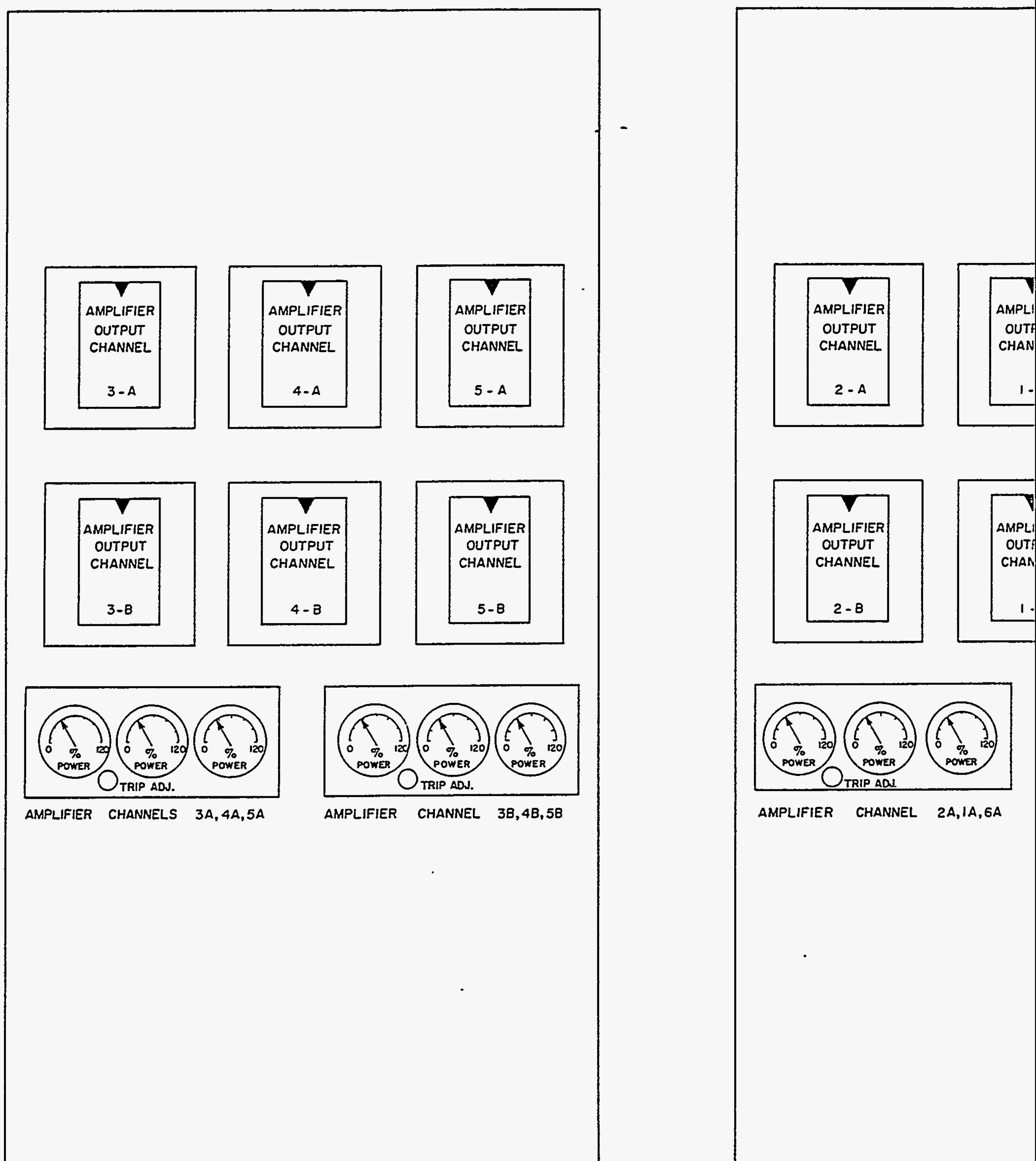
In-Core Flux Monitor Panel (P-3)

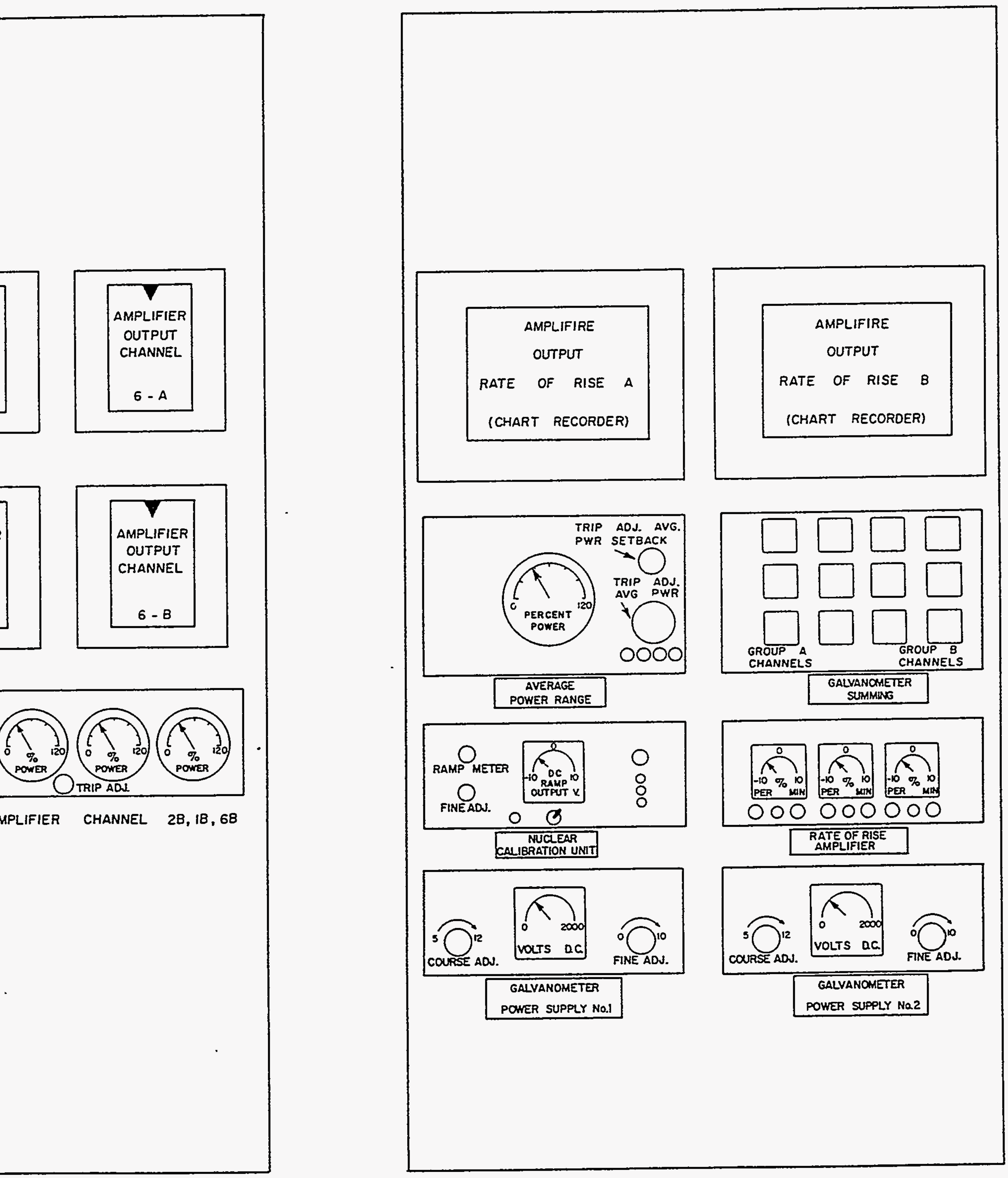


Reactor Control

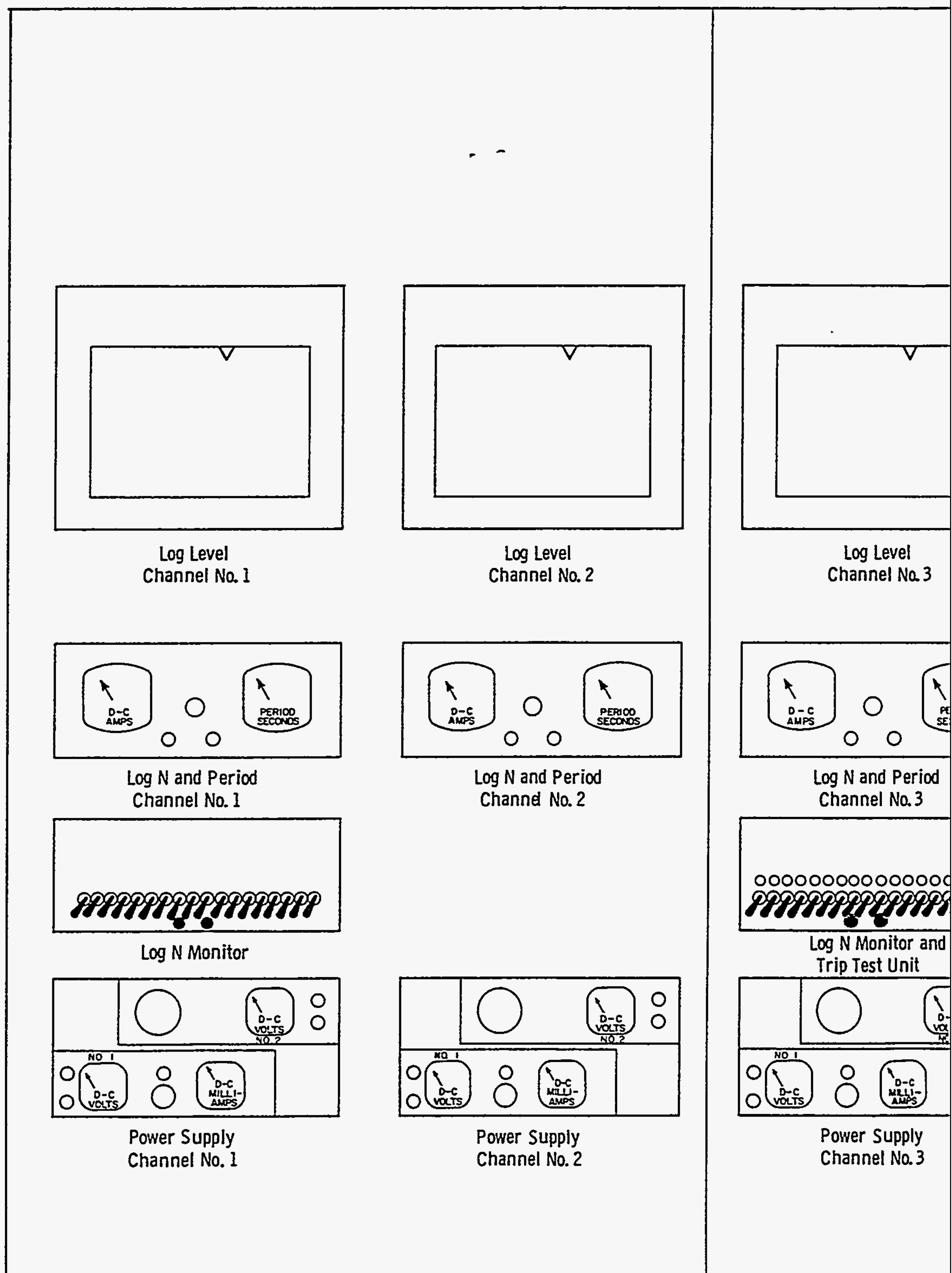

Outlet
Temp
Outlet
Temp.
Average Signal
Rate of Rise
H-1-32113

anel (P-4)


AMPLIFIER OUTPUT CHANNEL 3-A
AMPLIFIER OUTPUT CHANNEL 4-A
AMPLIFIER OUTPUT CHANNEL 5-A
AMPLIFIER OUTPUT CHANNEL 3-B
AMPLIFIER OUTPUT CHANNEL 4-B
AMPLIFIER OUTPUT CHANNEL 5-B
0 % 120 POWER
TRIP ADJ.
AMPLIFIER CHANNELS 3A, 4A, 5A
AMPLIFIER CHANNEL 3B, 4B, 5B
AMPLIFIER OUTPUT CHANNEL 2-A
AMPLIFIER OUTPUT CHANNEL 2-B
AMPLIFIER CHANNEL 2A, 1A, 6A

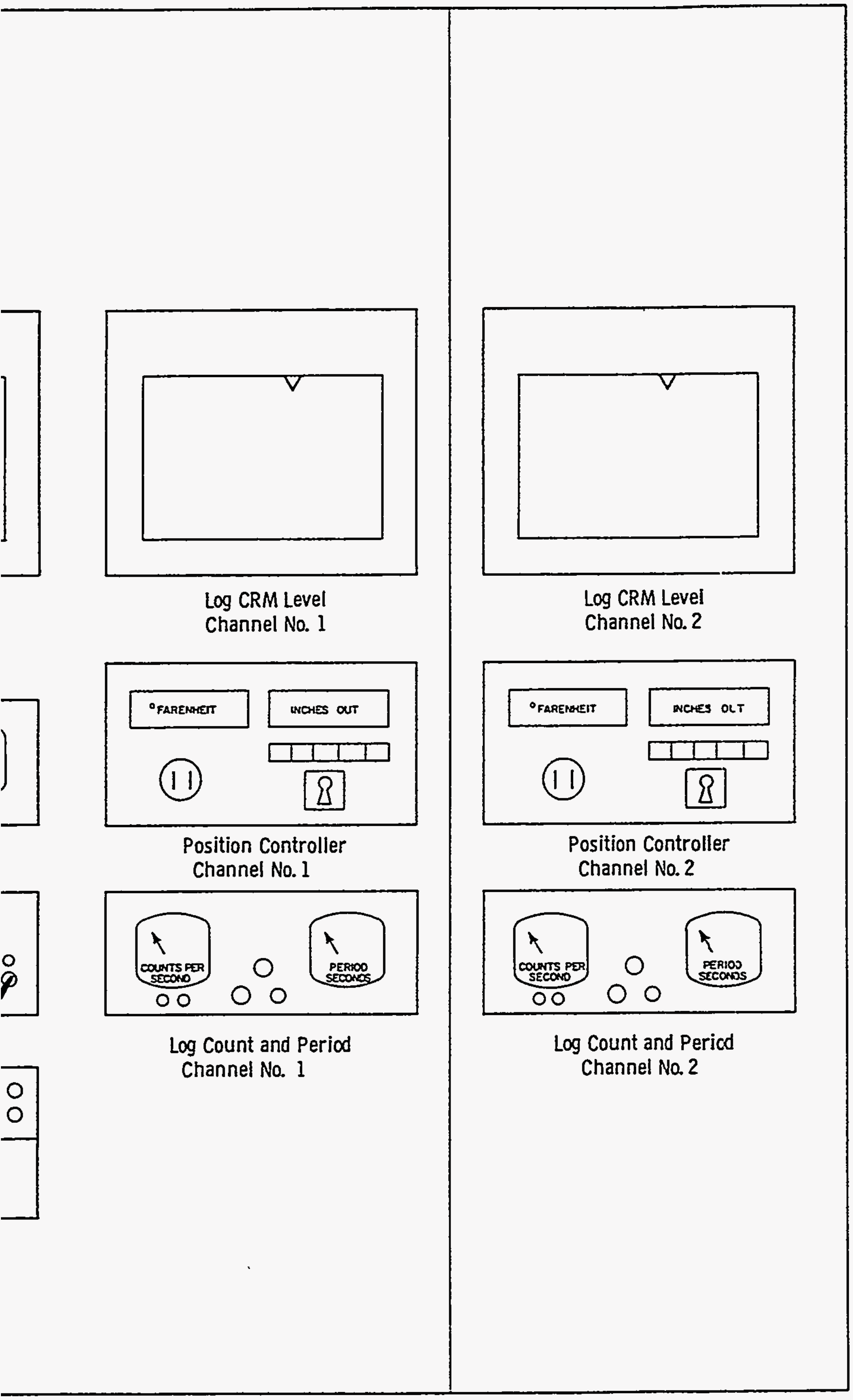

AMPLIFIER
OUTPUT
CHANNEL
6 - A
AMPLIFIER
OUTPUT
CHANNEL
6 - B
0 % POWER 120
TRIP ADJ.
MPLIFIER CHANNEL 2B, 1B, 6B
AMPLIFIRE
OUTPUT
RATE OF RISE A
(CHART RECORDER)
AMPLIFIRE
OUTPUT
RATE OF RISE B
(CHART RECORDER)
TRIP PWR
ADJ. AVG. SETBACK
TRIP AVG
ADJ. PWR
0 PERCENT POWER 120
AVERAGE POWER RANGE
GROUP A CHANNELS
GROUP B CHANNELS
GALVANOMETER SUMMING
RAMP METER
FINE ADJ.
-10 DC RAMP OUTPUT V. 10
NUCLEAR CALIBRATION UNIT
-10 % 10
PER MIN
RATE OF RISE AMPLIFIER
5 12 COURSE ADJ.
0 2000 VOLTS D.C.
0 10 FINE ADJ.
GALVANOMETER POWER SUPPLY No.1
GALVANOMETER POWER SUPPLY No.2

l Panels (P-5)

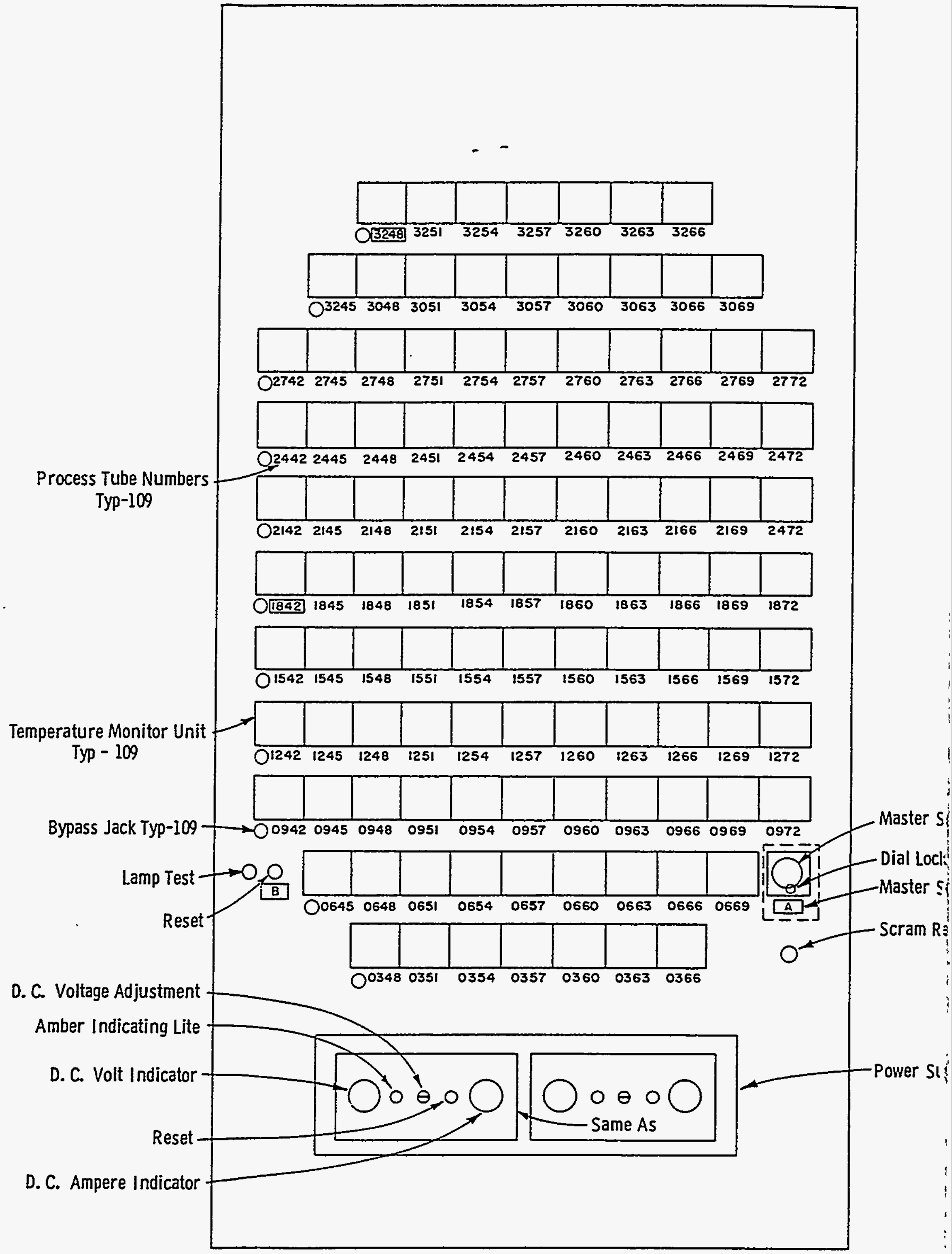


H-1-27552

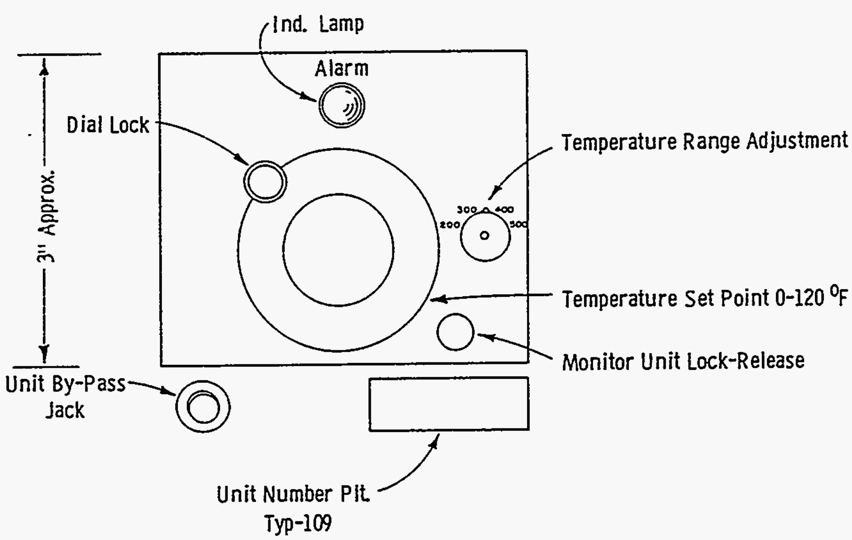
Intermediate and Subcritical N



lear Level Panels (P-7)


3248 3251 3254 3257 3260 3263 3266
3245 3048 3051 3054 3057 3060 3063 3066 3069
2742 2745 2748 2751 2754 2757 2760 2763 2766 2769 2772
2442 2445 2448 2451 2454 2457 2460 2463 2466 2469 2472
2142 2145 2148 2151 2154 2157 2160 2163 2166 2169 2472
1842 1845 1848 1851 1854 1857 1860 1863 1866 1869 1872
1542 1545 1548 1551 1554 1557 1560 1563 1566 1569 1572
1242 1245 1248 1251 1254 1257 1260 1263 1266 1269 1272
0942 0945 0948 0951 0954 0957 0960 0963 0966 0969 0972
0645 0648 0651 0654 0657 0660 0663 0666 0669
0348 0351 0354 0357 0360 0363 0366
Process Tube Numbers Typ-109
Temperature Monitor Unit Typ - 109
Bypass Jack Typ-109
Lamp Test
B
Reset
A
Master S
Dial Lock
Master S
Scram Ra
D. C. Voltage Adjustment
Amber Indicating Lite
D. C. Volt Indicator
Reset
D. C. Ampere Indicator
Same As
Power St

Ref. H-1-27436



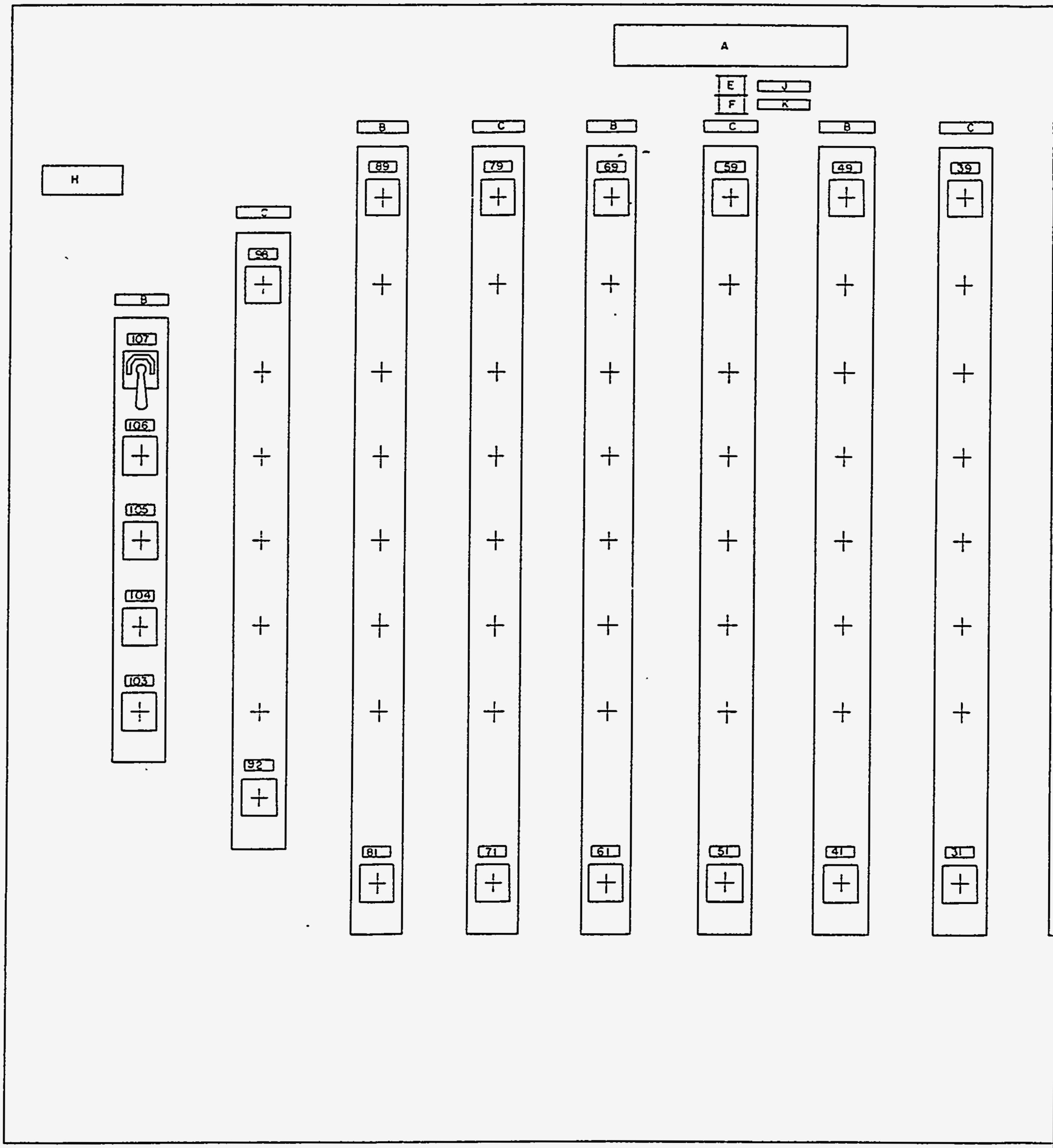
Temp. Monitor Unit
(Typical)

oint Adjuster ± 100 °F

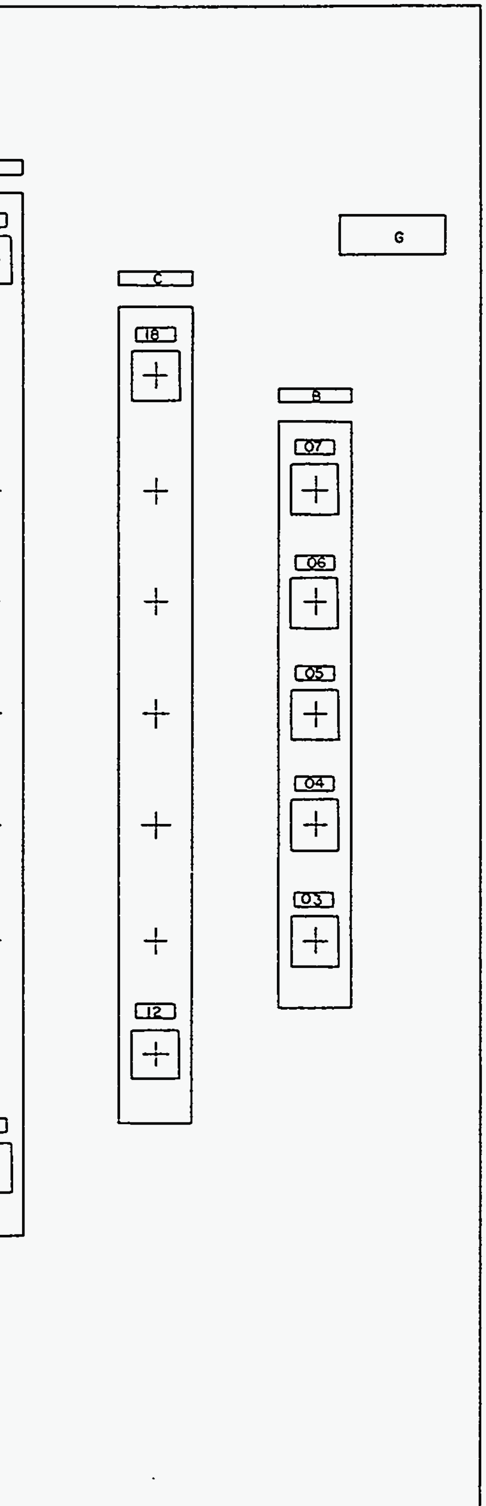
oint

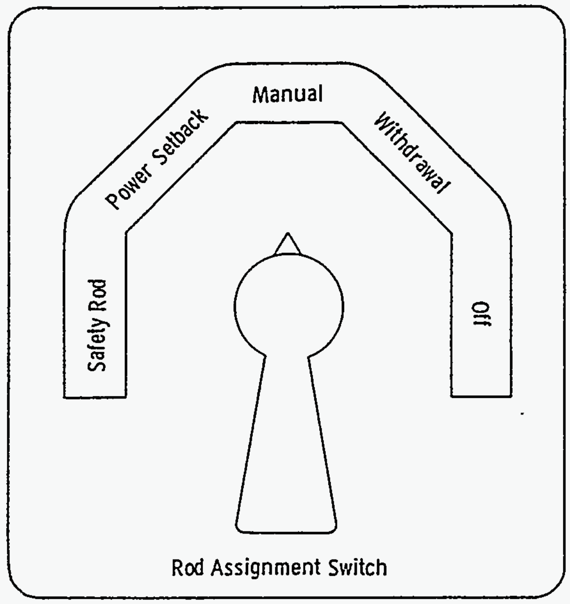
/ Meters and Controls

nitor Panel (P-8)



Rod Service Selector S



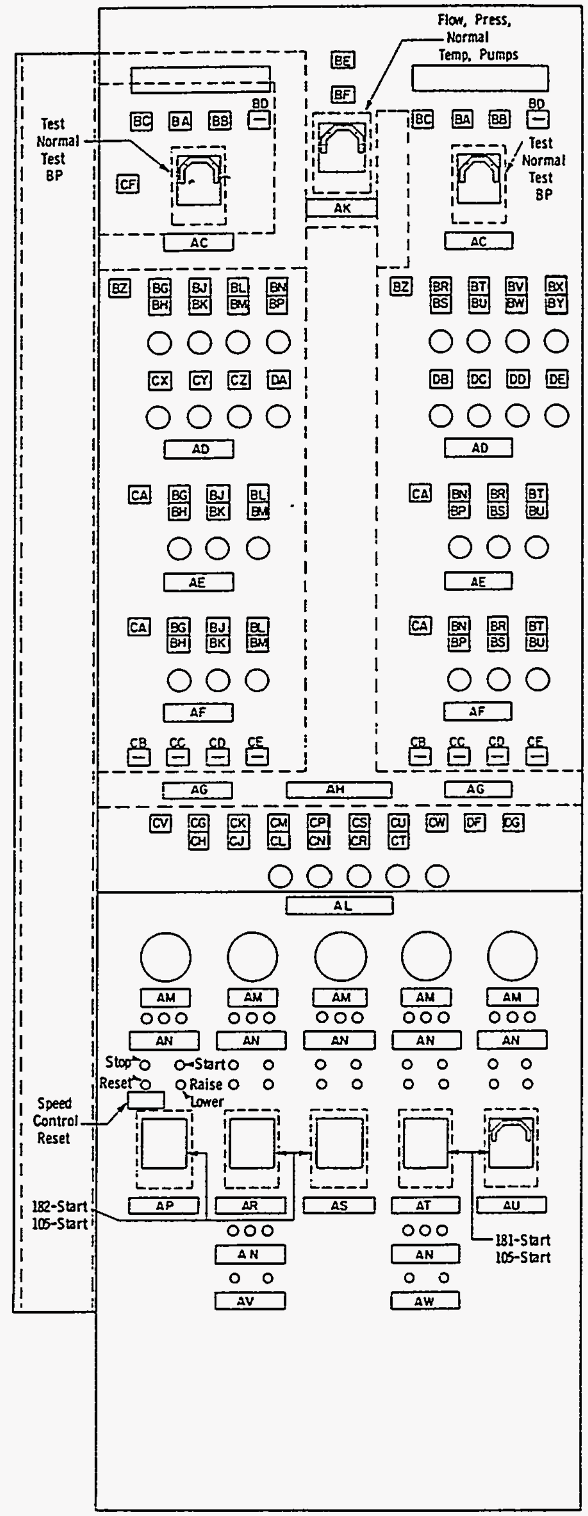


NAMEPLATE LEGEND

A. Rod Service Selector Switches
B. Right Side
C. Left Side
D. No.'s 03 Thru 107 as Indicated for Total of 87 Rods
E. Withdrwl or Off
F. Timed Out
G. Inlet
H. Outlet
J. Any Rod on Withdrawl or Off
K. Selector Switch Time Delay Elapsed

Ref. H-1-32519

tch Panel (P-9)



BA
BB
BC
BD
BE
BF
BG
BH
BJ
BK
BL
BM
BN
BP
BR
BS
BT
BU
BV
BW
BX
BY
BZ
CA
CB
CC
CD
CE
CF
CG
CH
CJ
CK
CL
CM
CN
CP

Pr

LIGHTED PUSHBUTTON LEGEND

Excluding Trip Bypass
Including Trip Bypass
em Trip Bypassed
em Activated Sys Not Activated
ter System Bypassed
4 Input Trips Bypassed
. #1 Trip
. #1 Test
. #2 Trip
. #2 Test
. #3 Trip
. #3 Test
. #4 Trip
. #4 Test
. #5 Trip
. #5 Test
. #6 Trip
. #6 Test
. #7 Trip
. #7 Test
. #8 Trip
. #8 Test
Out of Four Tripped
Out of Three Tripped
ise" PWR On
ise" PWR Tripped
en PWR On
en" PWR Tripped
td" PWR On
td" PWR Tripped
st" PWR On
st" PWR Tripped
p Test
tem #1 Pump Shaft Slow
tem #2 Pump Shaft Slow
np #1 Shaft
ation Test
np #1 Shaft
ation Trip
np #2 Shaft
ation Test
np #2 Shaft
ation Trip
np #3 Shaft
ation Test
np #3 Shaft
ation Trip

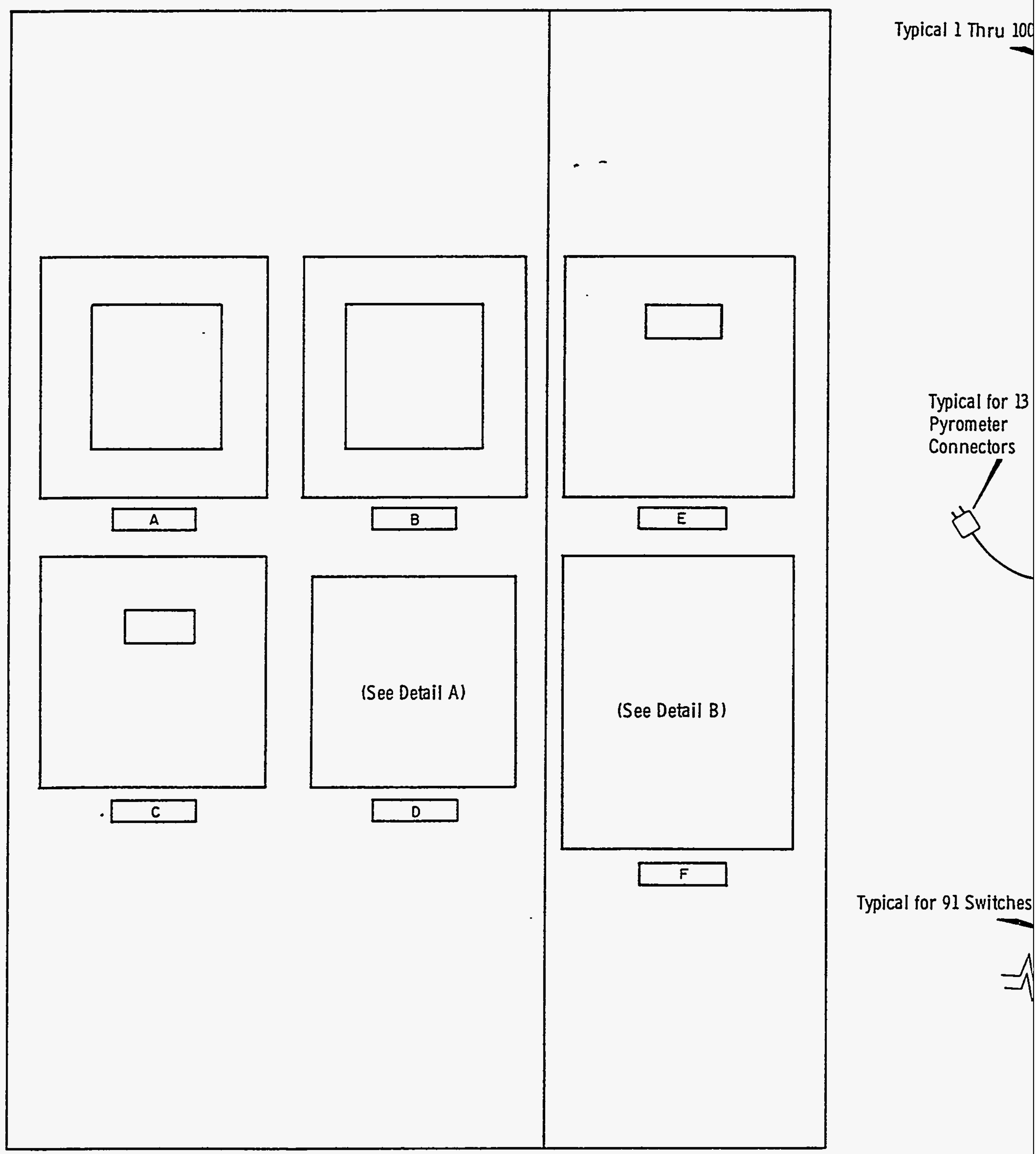
. H-1-32527

CR	Pump #4 Shaft Rotation Test
CS	Pump #4 Shaft Rotation Trip
CT	Pump #5 Shaft Rotation Test
CU	Pump #5 Shaft Rotation Trip
CV	V28's Selected
CW	Low Pressure Diversion Operated
CX	Inst. #1 Bypassed
CY	Inst. #2 Bypassed
CZ	Inst. #3 Bypassed
DA	Inst. #4 Bypassed
DB	Inst. #5 Bypassed
DC	Inst. #6 Bypassed
DD	Inst. #7 Bypassed
DE	Inst. #8 Bypassed
DF	Under 200 psi Sys. #2 Under 200 psi Sys. #1
DC	Under 250 °F Sys. #2 Under 250 °F Sys. #1

NAMEPLATE LEGEND

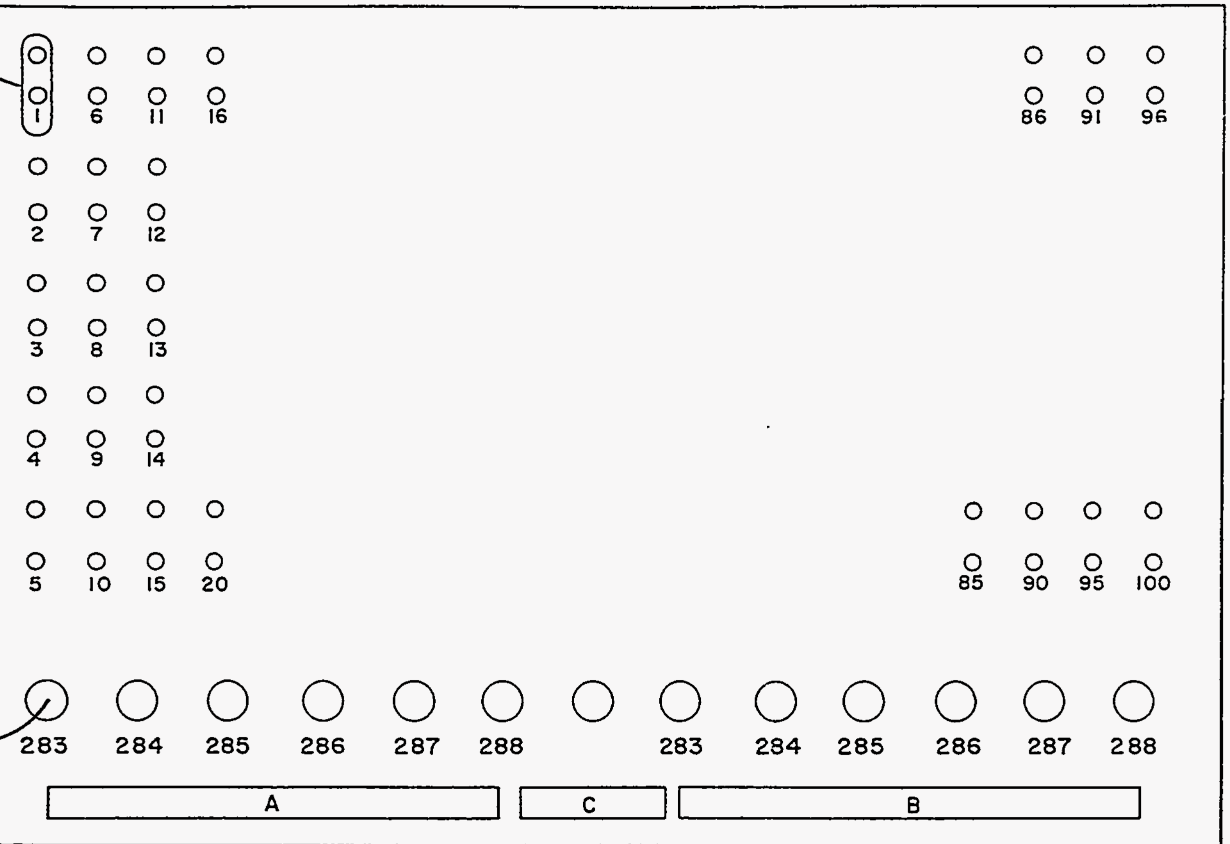
AA	Emergency Cooling Water System #1
AB	Emergency Cooling Water System #2
AC	Master Actuation
AD	Low Flow Sensing and Indication
AE	High or Low Pressure Sensing and Indication
AF	Primary Loop High Temperature Sensing and Indication
AG	Power Supply Indication
AH	System #1 and #2 Primary Pump Shaft Rotation Sensing and Indication
AK	Input Trip Bypass
AL	Emergency Cooling Diesel Control
AM	Engine RPM
AN	Running Man. Stopped
AP	High Lift #1
AR	High Lift #2
AS	High Lift #3
AT	River Diesel #1
AU	River Diesel #2
AV	Fog Spray #1
AW	Fog Spray #2

ater Panel (P-10)

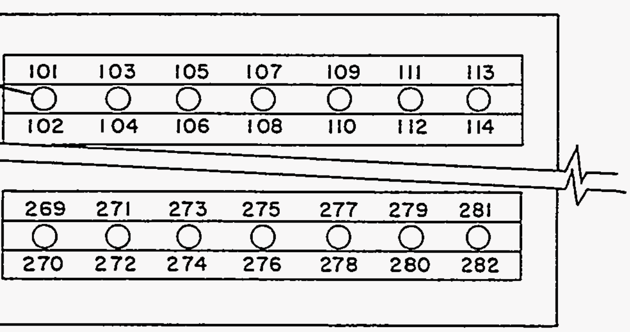


(Ref. H-1-27382

Reactor Thermocouple



Detail A



Detail B

Nameplate Legend

A - Graphite Temperature (Recorder No. 1)

B - Graphite Temperature (Recorder No. 2)

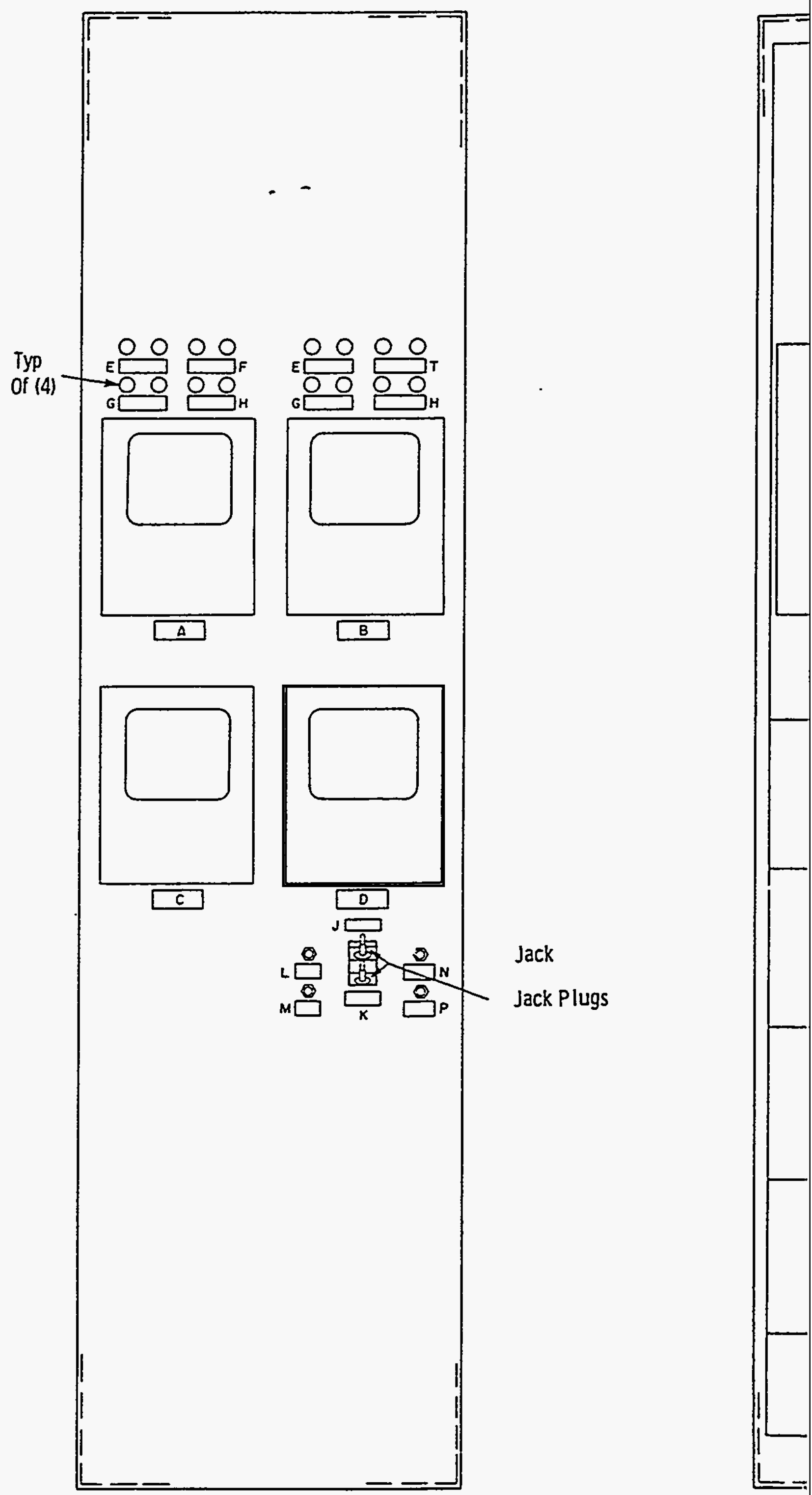
C - Graphite Temperature (Indicator)

D - Graphite Thermocouples

E - Shield Temperature (Indicator)

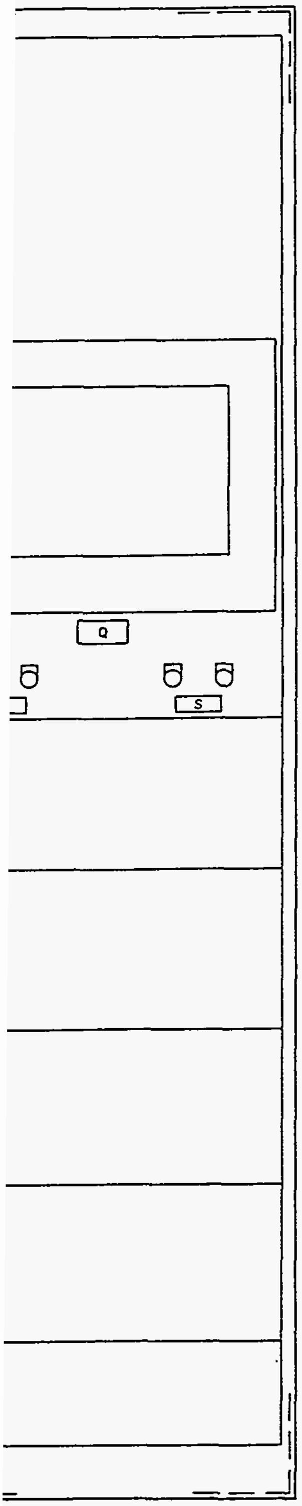
F - Shield Thermocouples

anel (P-11)



P-12

Stack Air and Zone I Exhaust Air

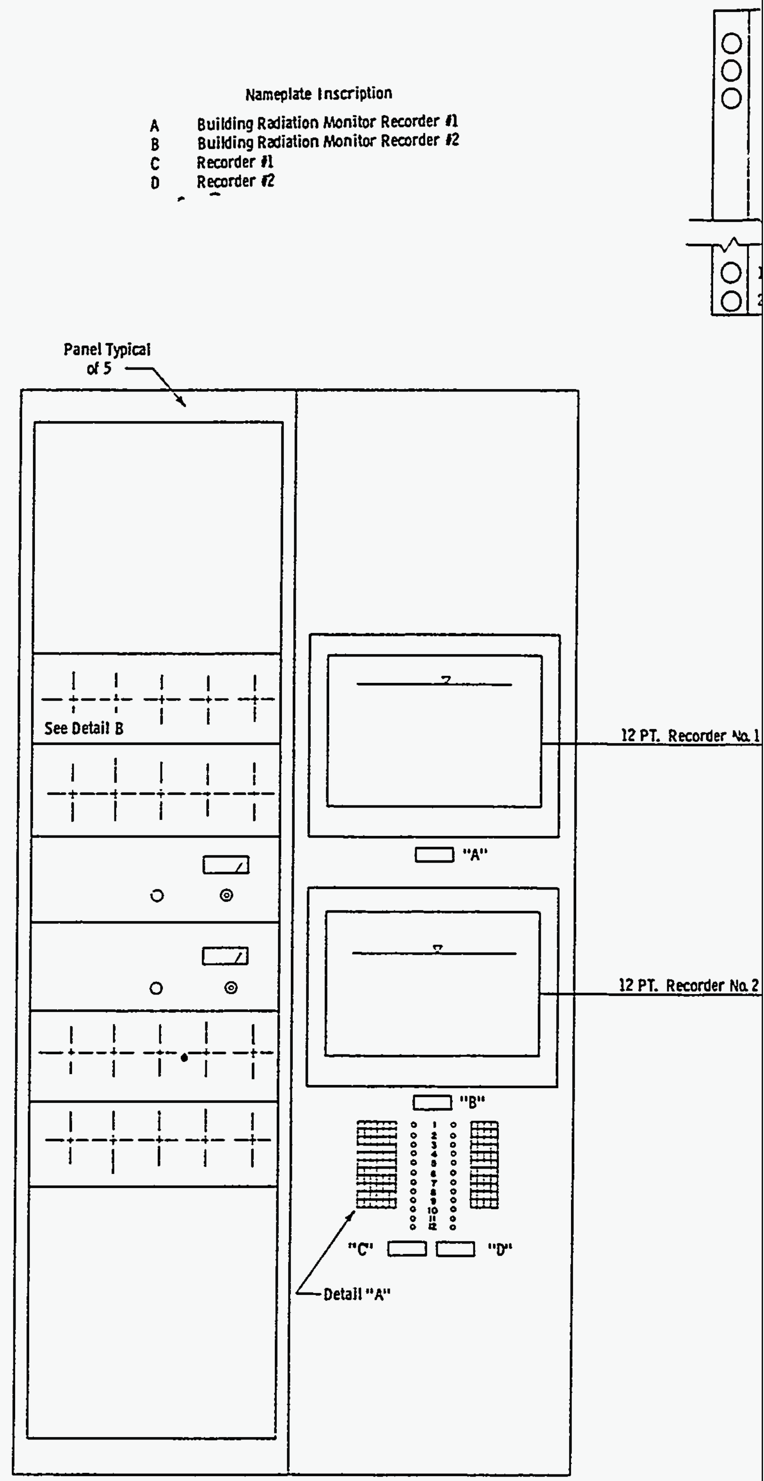


P-14

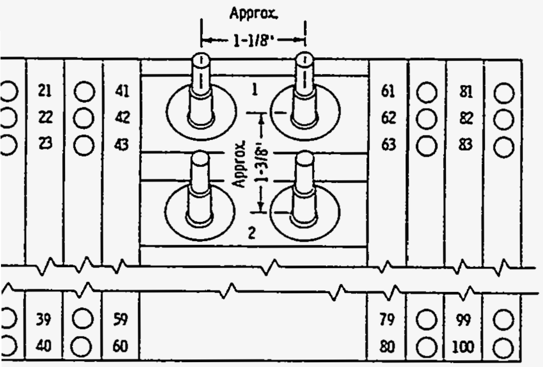
NAMEPLATE LEGEND

A Stack Particulate Sampler
Pen 1 - Zone I
Pen 2 - Zone II
B Stack Halogen Sampler
Pen 1 - Zone I
Pen 2 - Zone II
C Air Monitor
Pen 1 "C" Elevator
Pen 2 "D" Elevator
D Ion Chamber Station
E Vacuum Pump On
Zone I - Zone II
F High Filter Activity
Cell "A" - Cell "B"
G High Alarm
Zone I - Zone II
H Malfunction
Zone I - Zone II
J Pen No. 1
K Pen No. 2
L Station No. 1 I.R.R. - Left
M Station No. 2 I.R.R. - Right
N Station No. 3 Rear Face
P Station No. 4 Front Face
Q Zone I Exhaust Radiation Analyzer
R Vacuum Pump #1
S Vacuum Pump #2
T High Filter Activity
Cell "C" - Cell "D"

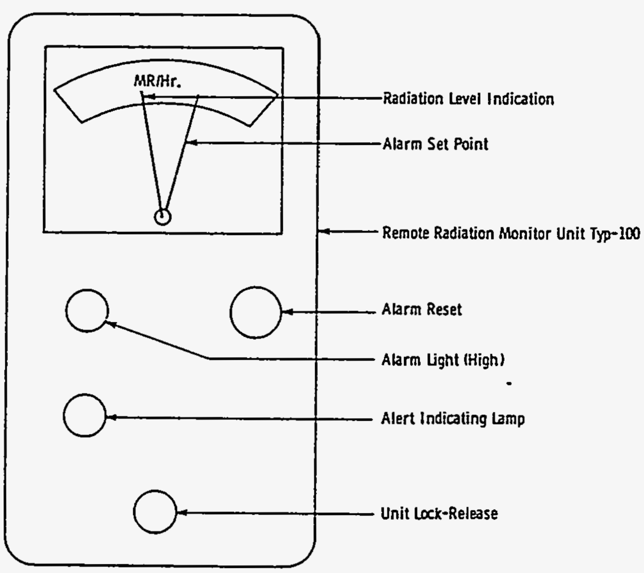
nitoring Panels (P-12 and P-14)



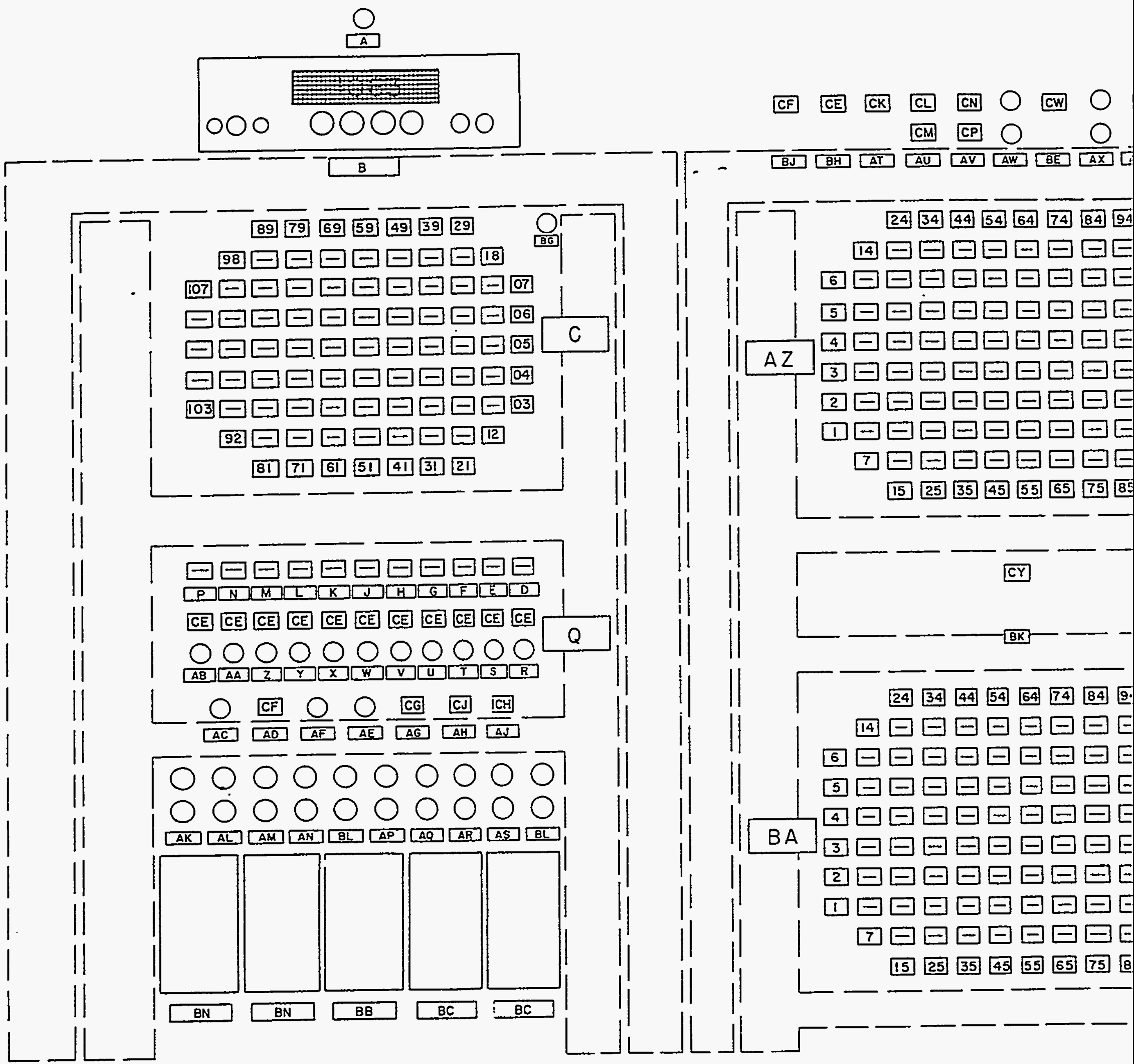
Building Space Monitor



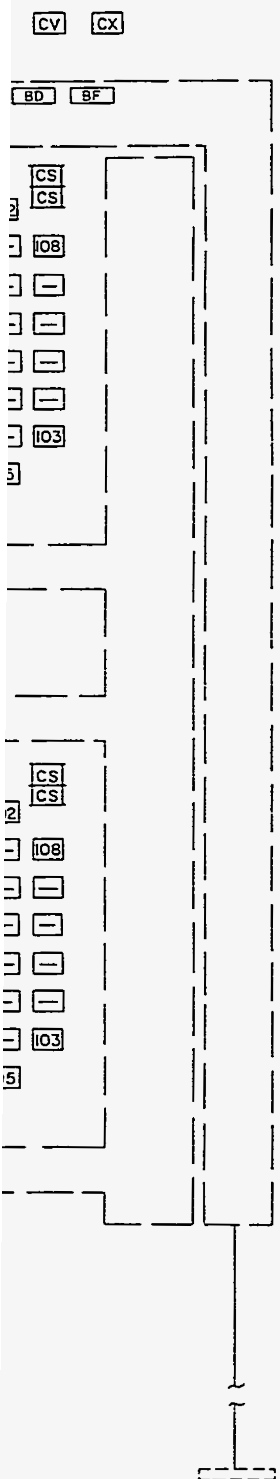
Detail "A"



Detail "B"



Rod and Ball Con



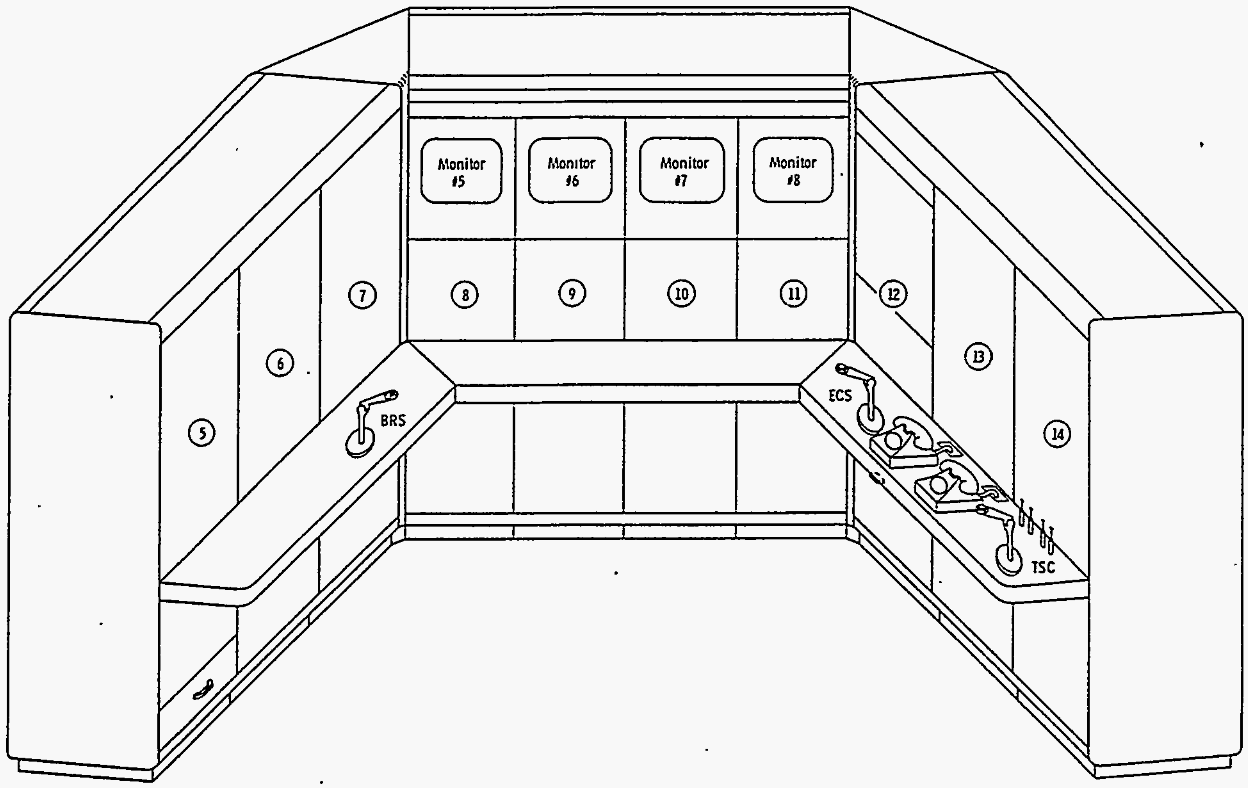
PUSHBUTTON LEGEND

CC	Rod #103 Timing / Rod #103 75% In
CD	One Slow Rod / Two Slow Rods
CE	Bypassed
CF	Power On
CG	3 Slow Rods In 1 Column / 4 Slow Rods In Reactor
CH	"75% In" Lamp Test
CJ	Power To 75% In Lamps
CK	Vacuum Power On
CL	Push To Open
CM	Push To Close
CN	Push for Ball Vacuum
CP	Push For Buidling Vacuum
CR	All Hoppers Locked
CS	Push For Lamp Test
CT	#108 Unlocked / #108 Closed
CU	Hopper #103 Low / #103 Open
CV	Hoppers Locked
CW	Hopper Full
CX	Any Hopper Switch Not Off
CY	Permit Drain Valve Open

NAMEPLATE LEGEND

PART NO.	NAMEPLATE	DESCRIPTION
20	A	Instrument Timing
21	B	Rod Scram Timer to 75% In
22	C	Rod Test and 75% in Indication
20	D	Rod Column #1 Right
↑	E	Rod Column #2 Left
	F	Rod Column #3 Right
	G	Rod Column #4 Left
	H	Rod Column #5 Right
	J	Rod Column #6 Left
	K	Rod Column #7 Right
	L	Rod Column #8 Left
	M	Rod Column #9 Right
↓	N	Rod Column #10 Left
20	P	Rod Column #11 Right
22	Q	Ball Drop Backup for Rod Scram-Bypass
20	R	Rod Column #1 Ball Row 1 and 2
↑	S	Rod Column #2 Ball Row 2 and 3
	T	Rod Column #3 Ball Row 3 and 4
	U	Rod Column #4 Ball Row 4 and 5
	V	Rod Column #5 Ball Row 5 and 6
	W	Rod Column #6 Ball Row 6 and 7
	X	Rod Column #7 Ball Row 7 and 8
	Y	Rod Column #8 Ball Row 8 and 9
	Z	Rod Column #9 Ball Row 9 and 10
	AA	Rod Column #10 Ball Row 10 and 11
	AB	Rod Column #11 Ball Row 11 and 12
	AC	Rod Test Power Switch
	AD	Rod Test Power On
	AE	Lamp Reset "One Slow Rod"
	AF	Lamp Reset "Two Slow Rods"
	AG	3 Slow Rods in Reactor
	AH	Push for Pwr. to 75% in Indication Lamps
	AJ	75% Indication Lamp Test
	AK	7-1/2 HP Left Rod Drive Hyd. Pump Index 171 (#1)
	AL	15 HP Left Rod Drive Hyd. Pump Index 172 (#2)
	AM	7-1/2 HP Left Rod Drive Hyd. Pump Index 173 (#3)
	AN	7-1/2 HP Left Rod Drive Hyd. Pump Index 174 (#4)
	AP	7-1/2 HP Right Rod Drive Hyd. Pump Index 175 (#1)
	AQ	15 HP Right Rod Drive Hyd. Pump Index 176 (#2)
	AR	7-1/2 HP Right Rod Drive Hyd. Pump Index 177 (#3)
	AS	7-1/2 HP Right Rod Drive Hyd. Pump Index 178 (#4)
	AT	Power to Vacuum System
	AU	Vacuum Collector Hopper Valve
	AV	Building or Ball Vacuum System
	AW	Vacuum Pump Motor
↓	AX	Bag Shaker Motor
20	AY	All Ball Hoppers Locked
22	AZ	Top Ball Hopper Indication
22	BA	Drain Valve and Hopper Level Indication
21	BB	Rod Insertion Timer
21	BC	Time Delay Before Scram After Loss of Rod Water
20	BD	Five or More Individual Ball Hoppers Locked
↑	BE	Vacuum Collector Hopper Level
	BF	All Hopper Locking Switches not Returned to Off
	BG	Rod Timer Reset
	BH	Automatic Ball Recovery System Bypassed
	BJ	Ball Recovery System Power On
↓	BK	Ball Drain Valve permissive Open
20	BL	Spare
20	BN	Ball Backup Timer

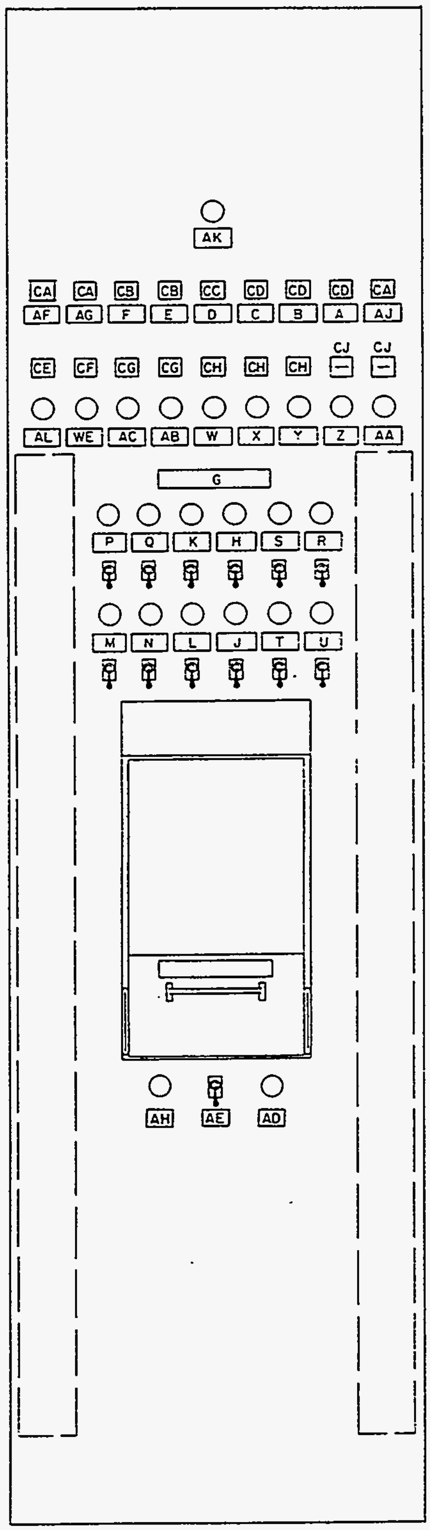
ol Panel (P-16)



PANEL SCHEDULE

Pnl. Pt. 5 Equip. Function	Pnl. Pt. 6 Equip. Function	Pnl. Pt. 7 Equip. Function	Pnl. Pt. 8 Equip. Function	Pnl. Pt. 9 Equip. Function	Pnl. Pt. 10 Equip. Function	Pnl. Pt. 11 Equip. Function	Pnl. Pt. 12 Equip. Function	Pnl. Pt. 13 Equip. Function	Pnl. Pt. 14 Equip. Function
WPC Intercom Master	MC Control & Patch Panel	BRS Speaker & Indicator Lamp	Camera Station Selector	Camera Station Selector	Camera Station Selector	Camera Station Selector	Door Control Panel	CAC Intercom Master	CAC Intercom Remote Jacks
WPC Intercom Handset		BRS Spkr. Volume	Auxiliary Equip. Controls	Auxiliary Equip. Controls	Auxiliary Equip Controls	Auxiliary Equip. Controls	Console Area Lighting	CAC Intercom Handset	HCC Intercom Remote Jacks
HCC Intercom Master		BRS Mike Outlet	Monitor	Monitor	Monitor	Monitor	Evacuation Alarm Signals	RTC Intercom Remote	TSC Speaker
HCC Intercom Handset			Audio Comm. Station	Audio Comm. Station	Audio Comm. Station	Audio Comm Station	Confinement Door Controls	ECS Speaker & Indicator Lamp	TSC Spkr. Volume
								ECS Spkr. Volume	TSC Mike Outlet
								ECS Mike Outlet	TSC Channel Selector Switch
									TSC Push To Talk Switch

Communications Console (P-18)



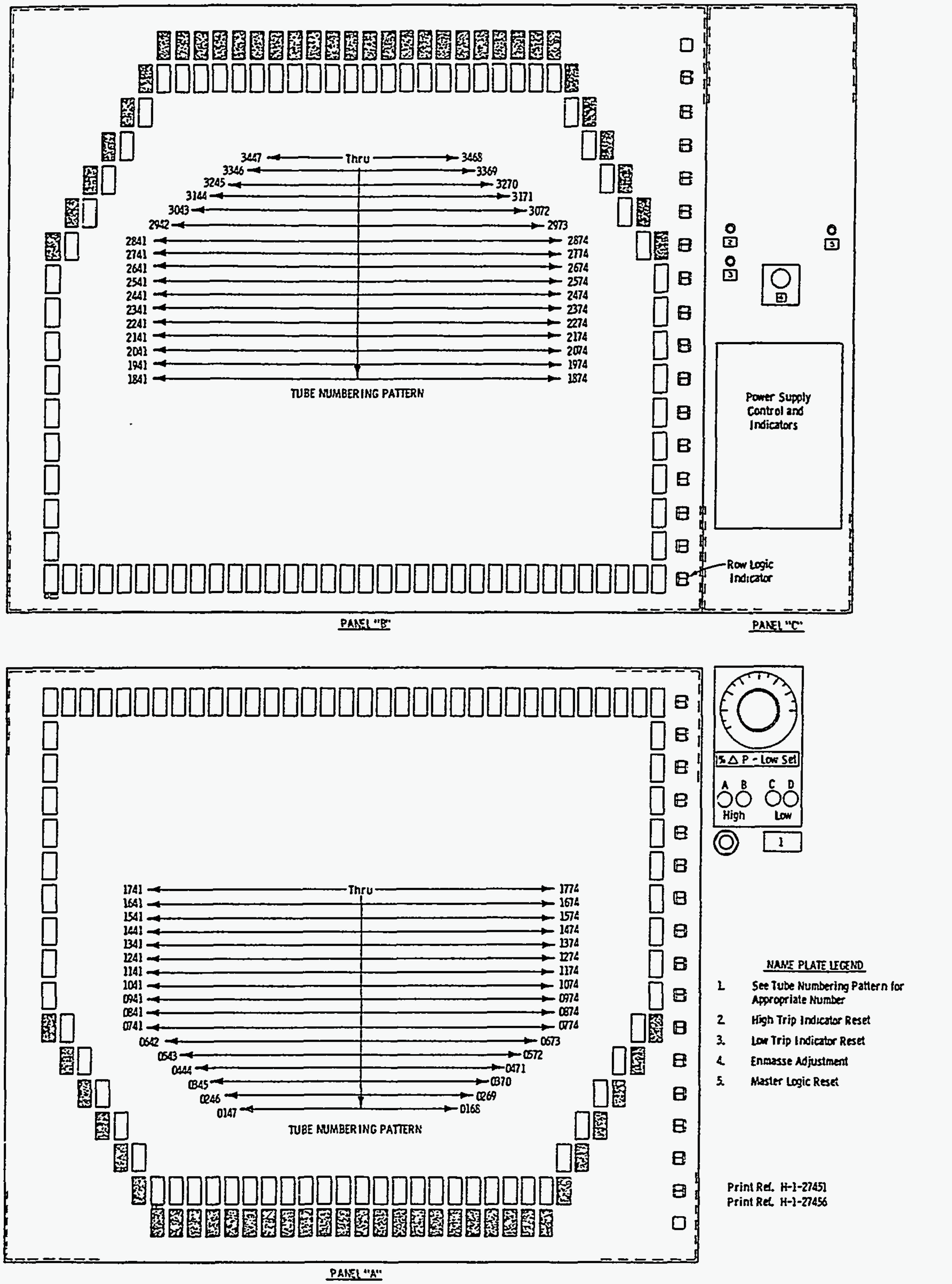
NAMEPLATE LEGEND

A	"D" Elevator Up	
B	Front Thermal Barrier Door Open	
C	Rear Thermal Barrier Door Open	
D	Rear Face Doors Open	
E	Far Charging Machine Control Power On	
F	Near Charging Machine Control Power On	
G	Zone 1 Lighting	On-Off Switches
H	Inlet Face	On-Off Switches
J	Outlet Face	On-Off Switches
K	"C" Elevator Platform	On-Off Switches
L	"D" Elevator Platform	On-Off Switches
M	Left Outlet Space	On-Off Switches
N	Right Outlet Space	On-Off Switches
P	Left Inlet Space	On-Off Switches
Q	Right Inlet Space	On-Off Switches
R	Top of Unit	On-Off Switches
S	"C" Elevator Pit	On-Off Switches
T	"D" Elevator Pit	On-Off Switches
U	Leave Blank	On-Off Switches
V	Annunciator Print Out	
W	"W" Elevator	
X	"C" Elevator	
Y	"D" Elevator	
Z	Far Charging Machine #1 Charge	
AA	Near Charing Machine #2 Charge	
AB	Far Charging Machine #1 Control Power	
AC	Near Charging Machine #2 Control Power	
AE	Print Out Light	
AF	Lamp Test	
AG	Panel Power On	
AH	Demand Print Out	
AJ	Irradiated Metal Handling System	
AK	Operate If Only 1 Mach on Elevator	
AL	Inlet Valve Rack Air Supply Valve	
AD	Reset Printout	

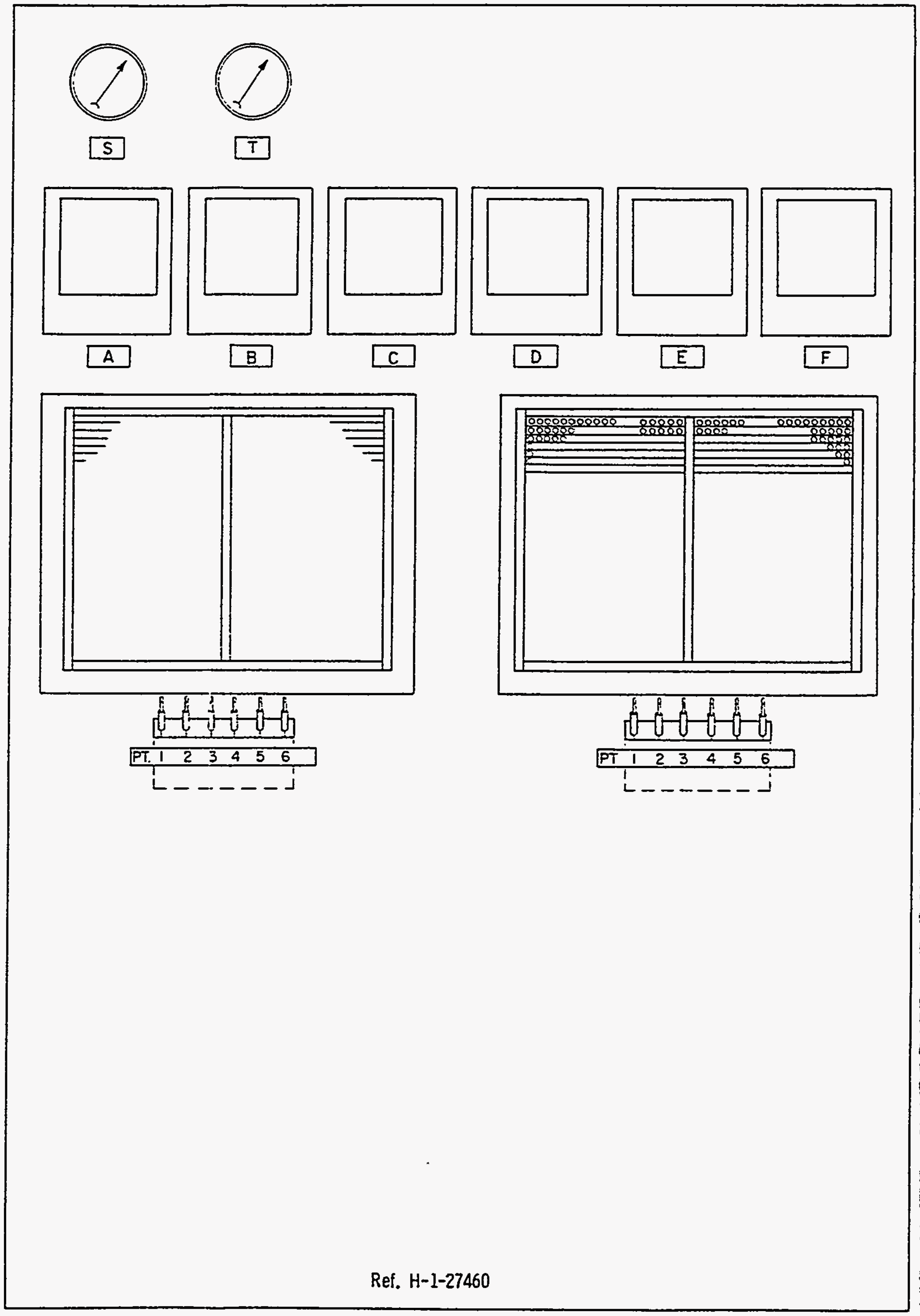
LIGHTED PUSHBOTTON LEGEND

CA	On	CD	Up	CG	Unlocked
CB	Machine Power On		(Leave Blank)	CH	Locked Out
CC	Open	CF	Bypassed	CJ	Unlocked Charging Permitted

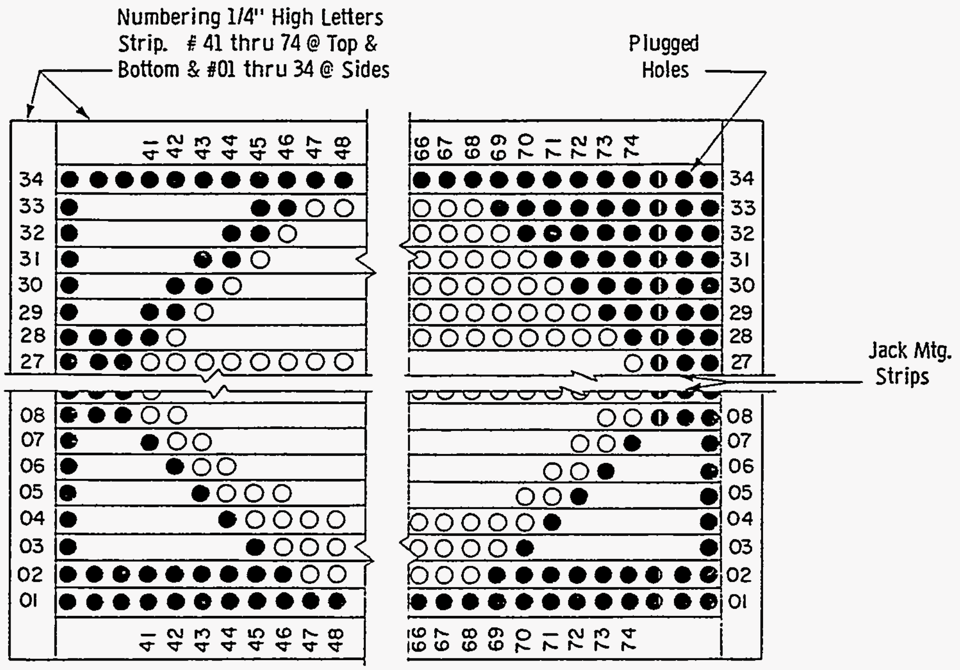
Miscellaneous Electrical Control Panel (P-19)



Process Tube Flow Monitoring Panels (P-20)

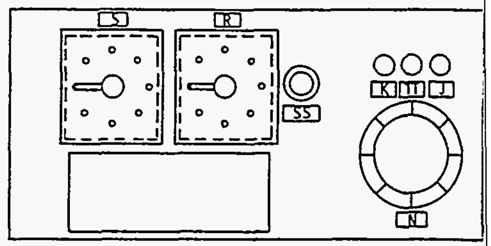


Process Tube Flow and Ten

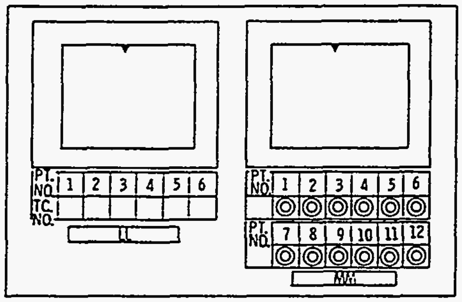


NAME PLATE LEGEND

A	Flow Pt. No. 1 and 2
B	Flow Pt. No. 3 and 4
C	Flow Pt. No. 5 and 6
D	Temp. Pt. No. 1 and 2
E	Temp. Pt. No. 3 and 4
F	Temp. Pt. No. 5 and 6
G	Tube Flow Patch Panel
H	Tube Outlet Temp. Patch Panel
S	Shutdown Flow Left Transducer Rm.
T	Shutdown Right Transducer Rm.



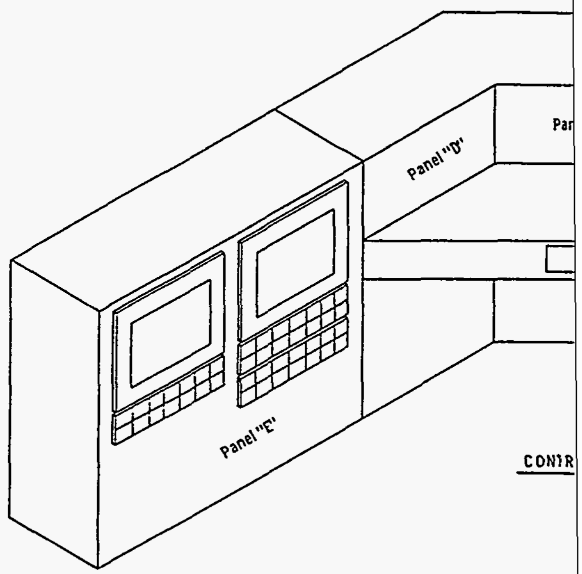
PANEL "D"

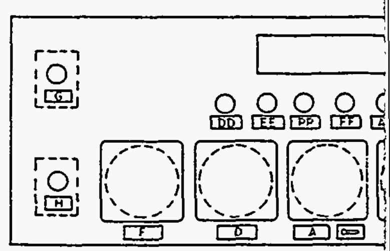


PANEL "E"

NAMEPLATE LEGEND

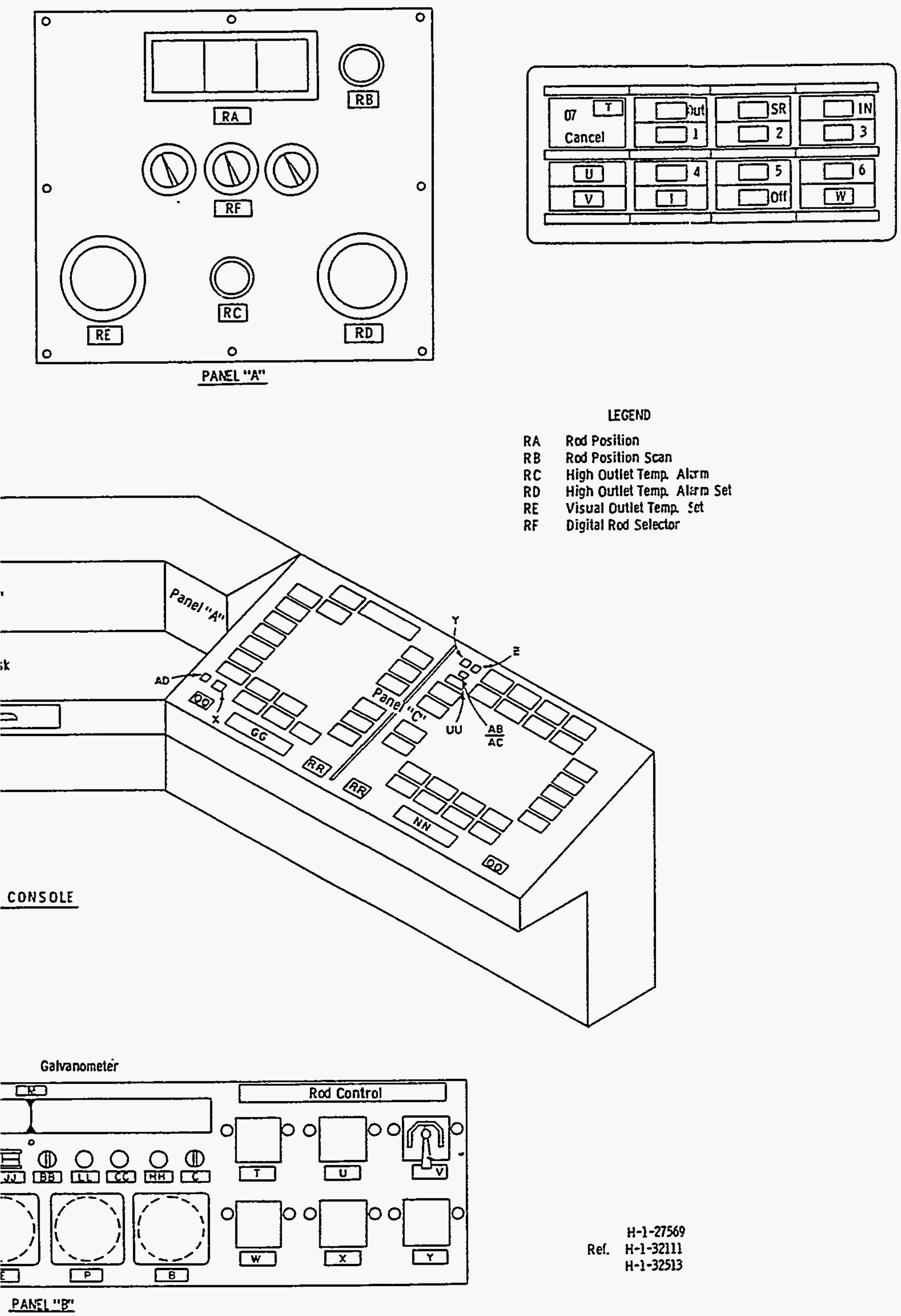
A	Log Level Channel 1, 2 and 3
B	Rate of Rise "C"
C	Rod Insertion Speed Selector
D	Log Period Fastest
E	Rate of Rise "A"
F	Source Range Period Fastest
G	Ball Safety Trip
H	Emergency Cooling Water Trip
J	Annunciator Test
K	Annunciator Demand Print Out
L	Rod Safety Reset No. 1
M	Power Level and Deviation
N	Power Level, Power Calculator
P	Rate of Rise "B"
R	Deviation Galvanometer Shunt
S	Total Galvanometer Shunt
AA	Rod Scram
BB	Power Setback (By-Pass, Normal, Actuate)
CC	Rod Safety Reset No. 2
DD	Ball Safety Reset No. 1
EE	Ball Safety Reset No. 2
FF	Seismoscope Reset
GG	Left Rod Selector
HH	Rod Insertion
JJ	Power Setback (Amber-Actuate-Red-Bypass)
LL	Graphite Temperature
MM	High Level Nuclear
NN	Right Rod Selector
PP	Emergency Cooling Water Reset
QQ	Outlet
RR	Inlet
SS	Deviation Bucking Voltage
TT	Annunciator Acknowledge and Reset
UU	Time Delay for Withdrawl - or Off to Allow Rods Time to Scram
T	Rod No. As Shown - #03 Thru #107
U	Con. S'B'K - Bypass
V	Rod Withdrawn
I	Cont'ld. Setback
W	Assigned Setback
X	Power To Rod Number Lights
Y	Assigned S.R. Full Out
Z	Assigned S.R. Not Full Out
AD	Lamp Test
AB	Withdrawl or Off
AC	Timed Out



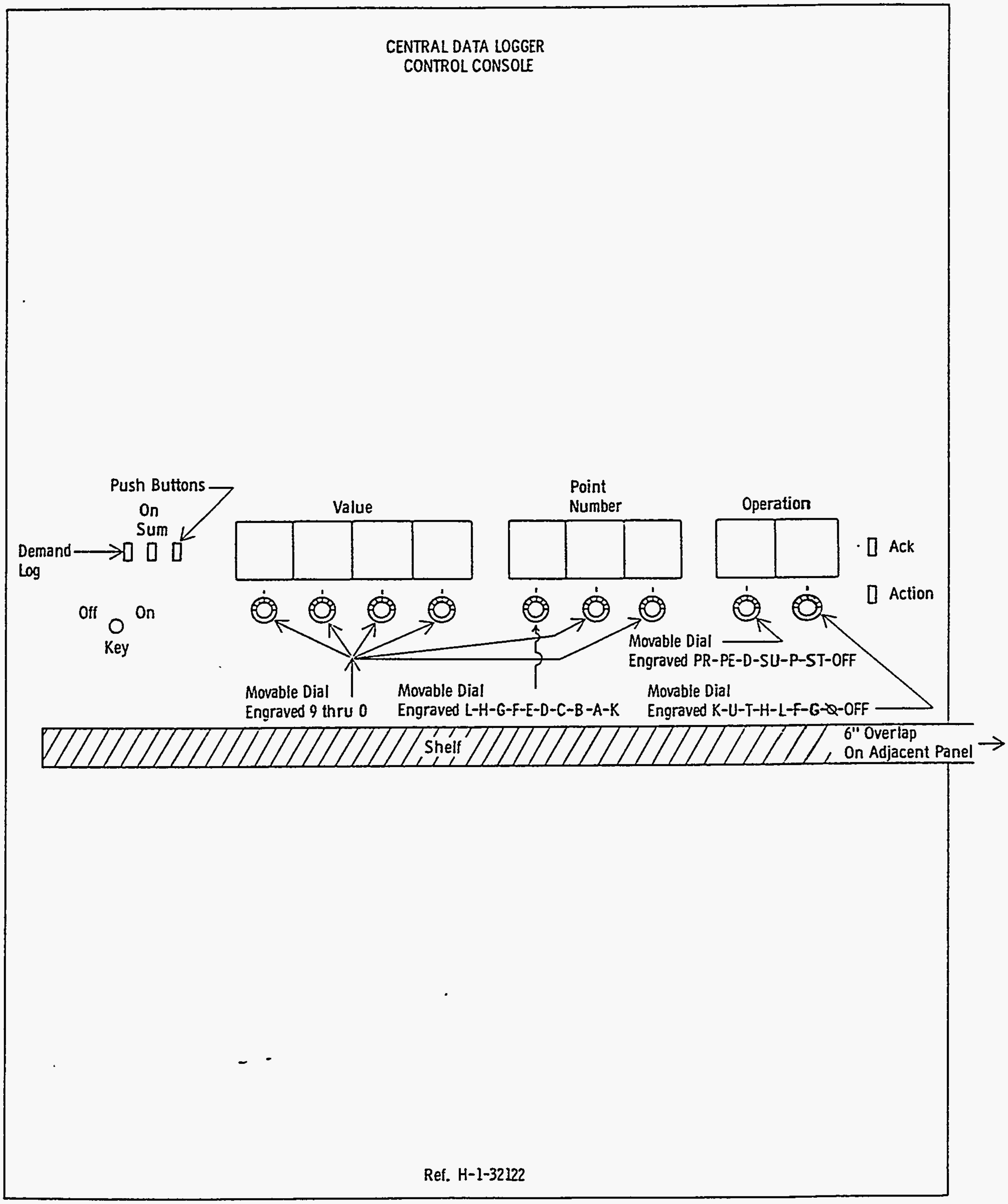


AEC-GE RICHLAND, WASH.

Reactor Control

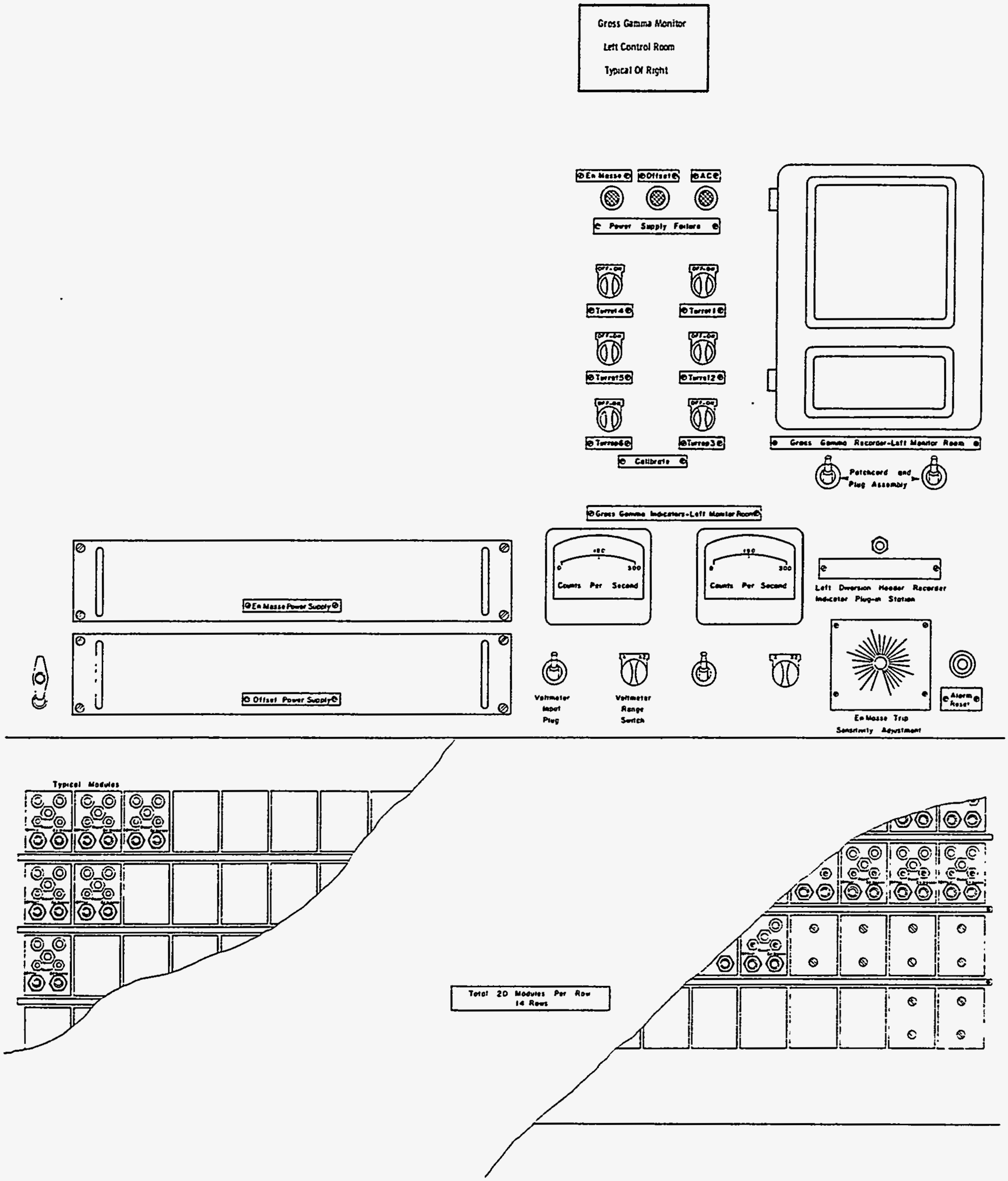

RA
RB
RF
RC
RE
RD
PANEL "A"
07 Cancel
T
Out
SR
IN
1
2
3
U
4
5
6
V
Off
W
LEGEND
RA Rod Position
RB Rod Position Scan
RC High Outlet Temp. Alarm
RD High Outlet Temp. Alarm Set
RE Visual Outlet Temp. Set
RF Digital Rod Selector
Panel "A"
Panel "C"
AD
QQ
X
GG
RR
Y
Z
UU
AB
AC
NN
CONSOLE
Galvanometer
Rod Control
JJ
BB
LL
CC
HH
C
T
U
V
W
X
Y
P
B
PANEL "B"
Ref. H-1-27569
H-1-32111
H-1-32513

onsole (P-24)



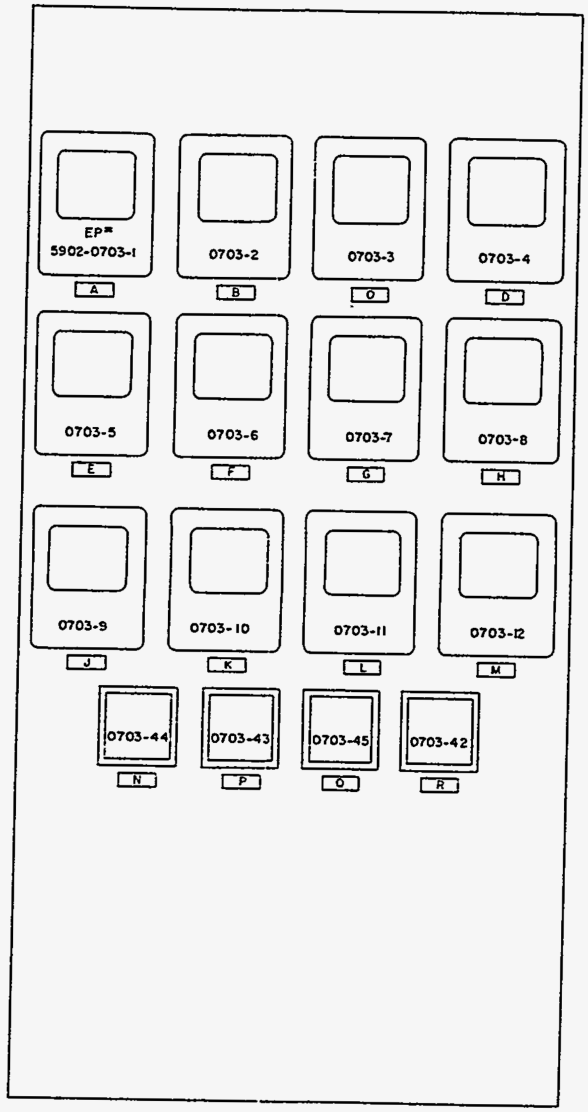
Central Data Panel (P-25)

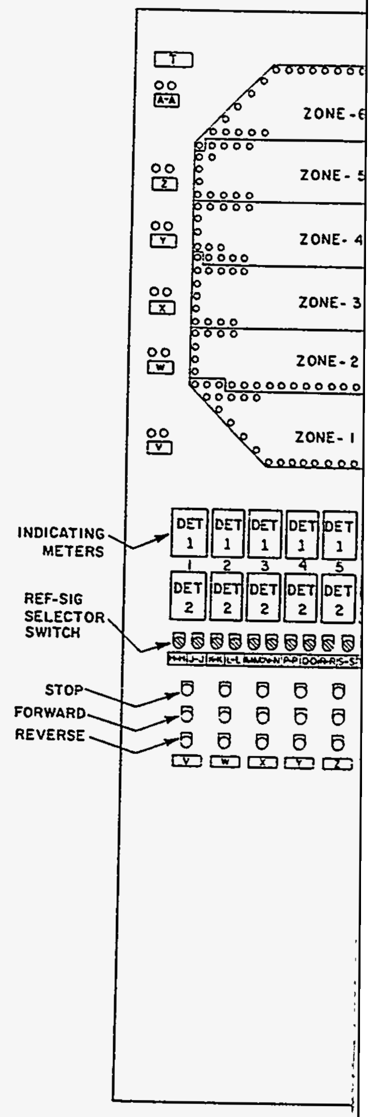
AEC-GE RICHLAND, WASH.

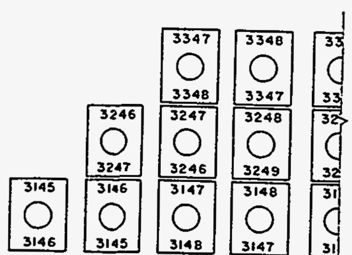


Gross Gamma Rupture Monitor Panels (P-26)

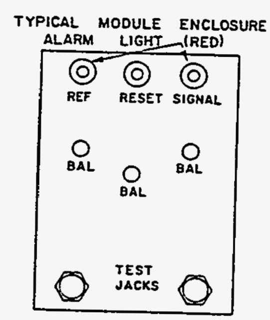
AEC-GE RICHLAND, WASH







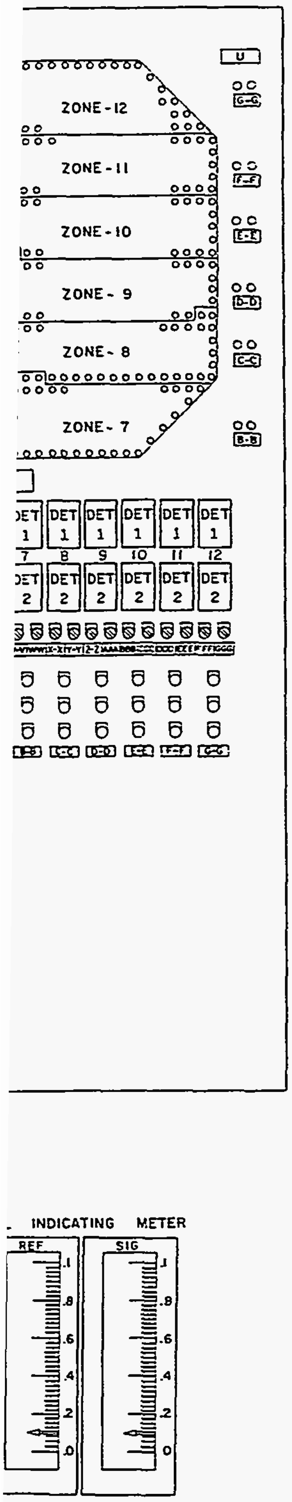
DETAIL I



DETECTOR

TYP

Gamma Energy Ruptu



NAMEPLATE LEGEND

A	Monitor No. 1 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
B	Monitor No. 2 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
C	Monitor No. 3 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
D	Monitor No. 4 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
E	Monitor No. 5 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
F	Monitor No. 6 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
G	Monitor No. 7 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
H	Monitor No. 8 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
J	Monitor No. 9 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
K	Monitor No. 10 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
L	Monitor No. 11 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
M	Monitor No. 12 Fission Product Activity PT #1 - No. 1 Detector and PT #2 - No. 2 Detector
N	Average Sample Temperature Left Side
P	Average Sample Temperature Right Side
Q	PT #1 - Bulk Cooling Water Inlet Temperature Sample Coolers PT #2 - Bulk Cooling Water Outlet Temperature Sample Coolers Left Side
R	Bulk Cooling Water Outlet Temperature Sample Coolers Right Side
S	Monitor Position Identification

LEFT	POSITION	RIGHT
Monitor #1	Red	Monitor #7
Monitor #2	Yellow	Monitor #8
Monitor #3	Green	Monitor #9
Monitor #4	Orange	Monitor #10
Monitor #5	Blue	Monitor #11
Monitor #6	Silver	Monitor #12

Number Above Light - Detector Head #1
Number Below Light - Detector Head #2

T	Standardization - Left Side
U	Standardization - Right Side
V	Turret #1 - Det. #1, Det #2, B-B - Turret #7 - Det. #1, Det. #2
W	Turret #2 - Det. #1, Det #2, C-C - Turret #8 - Det. #1, Det. #2
X	Turret #3 - Det. #1, Det #2, D-D - Turret #9 - Det. #1, Det. #2
Y	Turret #4 - Det. #1, Det #2, E-E - Turret #10 - Det. #1, Det. #2
Z	Turret #5 - Det. #1, Det #2, F-F - Turret #11 - Det. #1, Det. #2

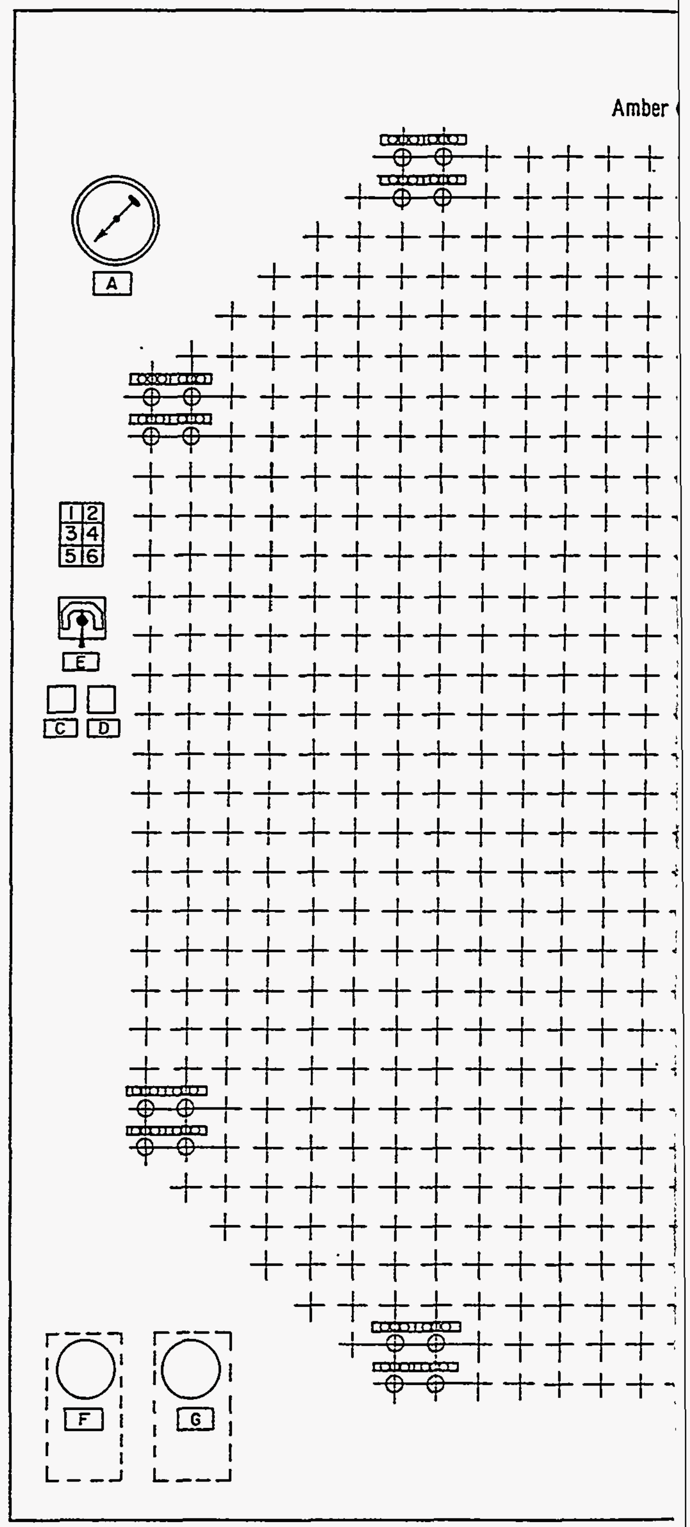
AA Turret #6 - Det. #1, Det #2, G-G - Turret #12 - Det. #1, Det. #2

H-H	Turret #1 - Det. #1	R-R	Turret #5 - Det. #1	7-7	Turret #9 - Det. #1
J-J	Turret #1 - Det. #2	S-S	Turret #5 - Det. #2	A-A-A	Turret #9 - Det. #2
K-K	Turret #2 - Det. #1	T-T	Turret #6 - Det. #1	B-B-B	Turret #10 - Det. #1
L-L	Turret #2 - Det. #2	U-U	Turret #6 - Det. #2	C-C-C	Turret #10 - Det #2
M-M	Turret #3 - Det. #1	V-V	Turret #7 - Det. #1	D-D-D	Turret #11 - Det. #1
N-N	Turret #3 - Det. #2	W-W	Turret #7 - Det. #2	E-E-E	Turret #11 - Det. #2
P-P	Turret #4 - Det. #1	X-X	Turret #8 - Det. #1	F-F-F	Turret #12 - Det. #1
Q-Q	Turret #4 - Det. #2	Y-Y	Turret #8 - Det. #2	G-G-G	Turret #12 - Det. #2

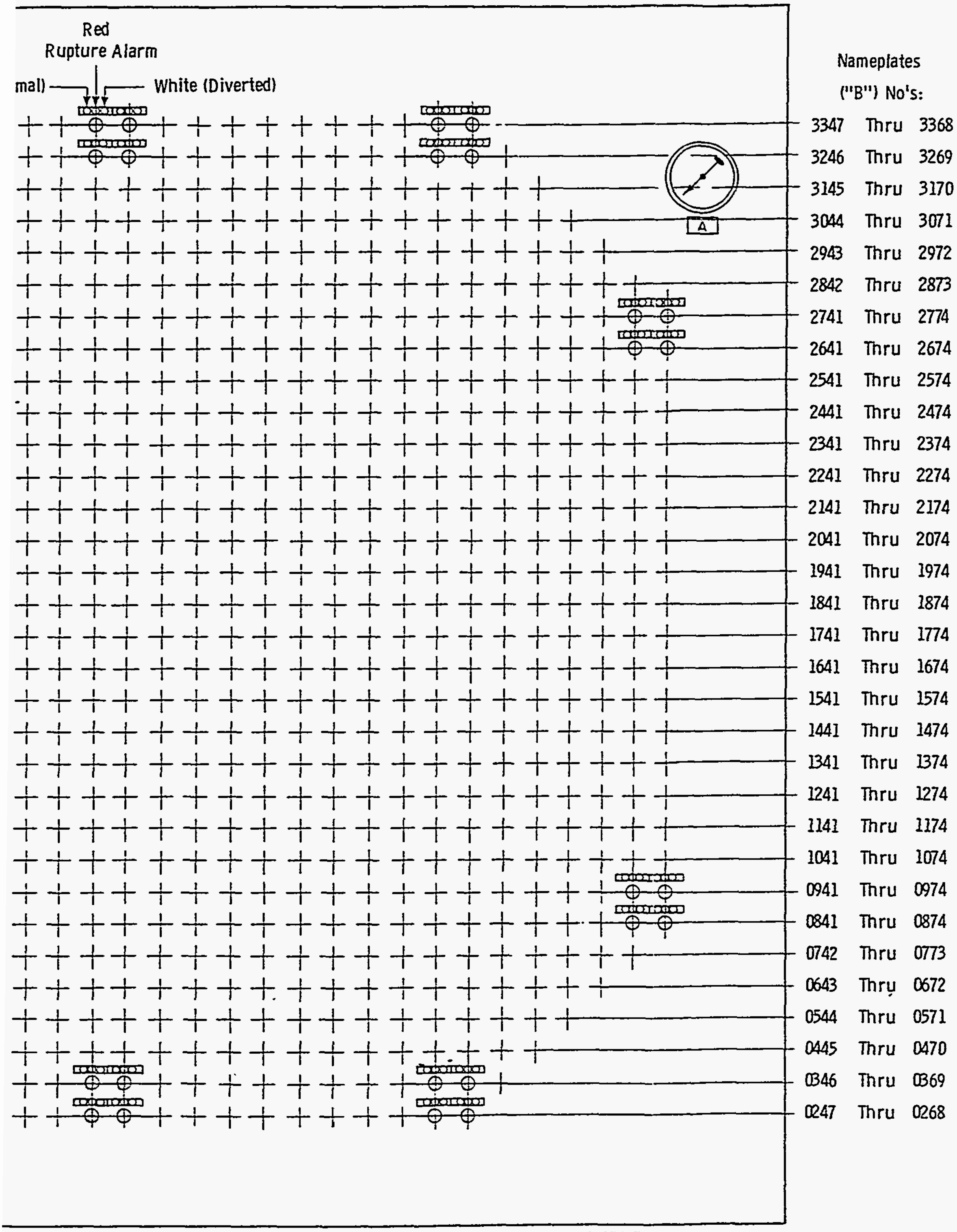
e Monitor Panels (P-27)

(W)	[1]	Pressure to Piston Exhaust Side
(W)	[2]	Pressure to Piston Inlet Side
(A)	[3]	Operate Master Switch
(A)	[4]	Return Valve to Normal
(R)	[5]	Master Operator Over Due
(R)	[6]	Valve Return Over Due

A	Diversion Header Flow
B	Numbered as Shown
C	Lamp Power Supply
D	Lamp Test
E	Master (Control Sw)
F	Master Control Sw. Operation Overdue
G	Valve Control Sw. Return Over Due

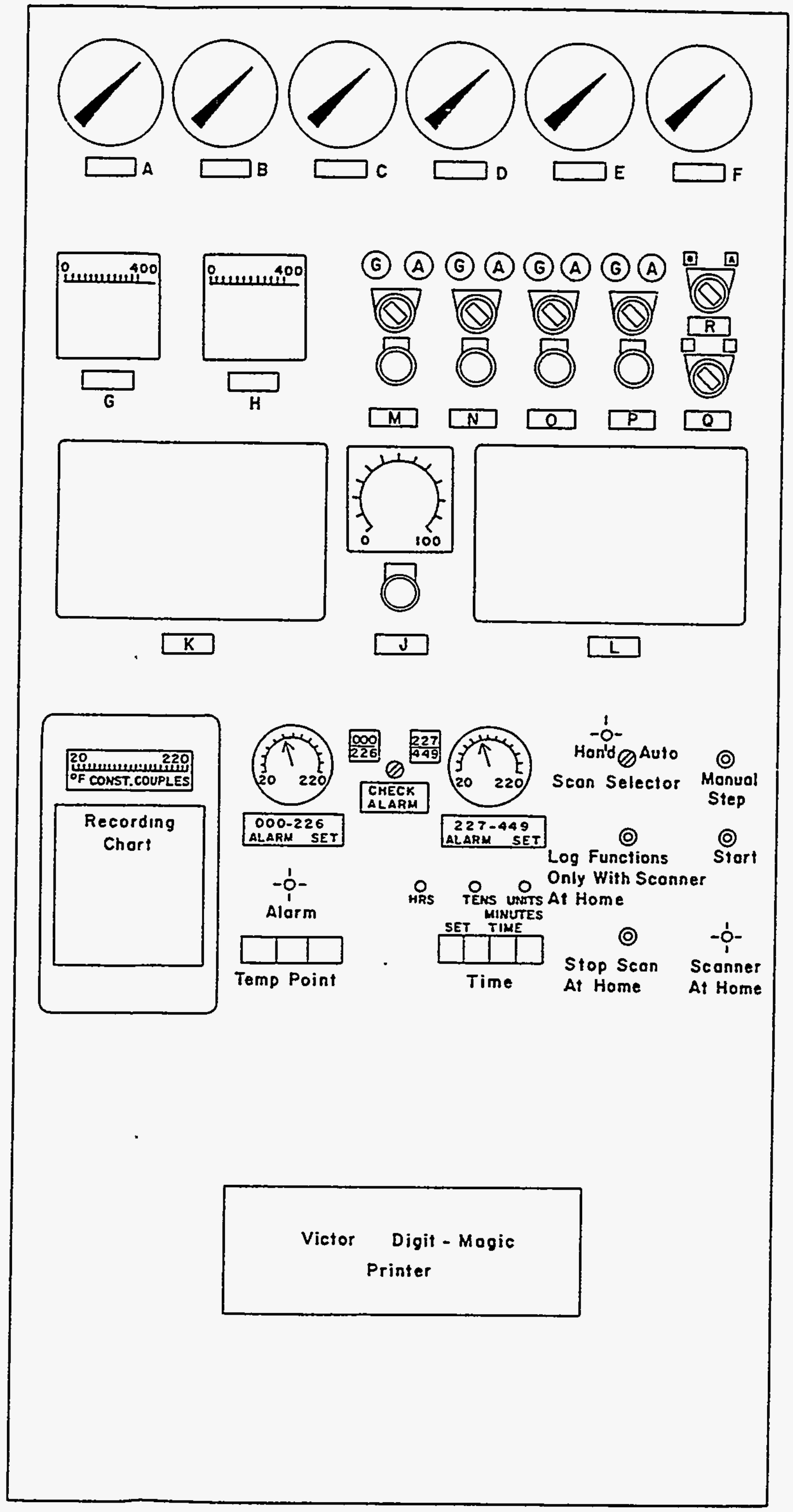


Process Tube Div

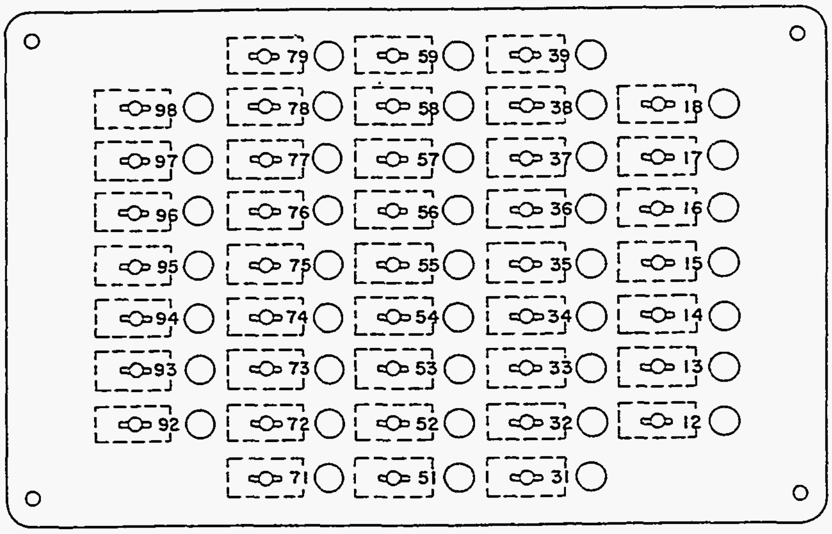


(Ref. H-1-27497)

·sion Panel (P-30)


A
B
C
D
E
F
G
0 400
G
H
M
N
O
P
R
Q
0 100
K
J
L
20 220
°F CONST. COUPLES
Recording Chart
20 220
000-226 ALARM SET
000 226
227 449
CHECK ALARM
20 220
227-449 ALARM SET
Hand Auto
Scan Selector
Manual Step
Log Functions Only With Scanner At Home
Start
Alarm
HRS
TENS UNITS MINUTES
SET TIME
Temp Point
Time
Stop Scan At Home
Scanner At Home
Victor Digit - Magic Printer

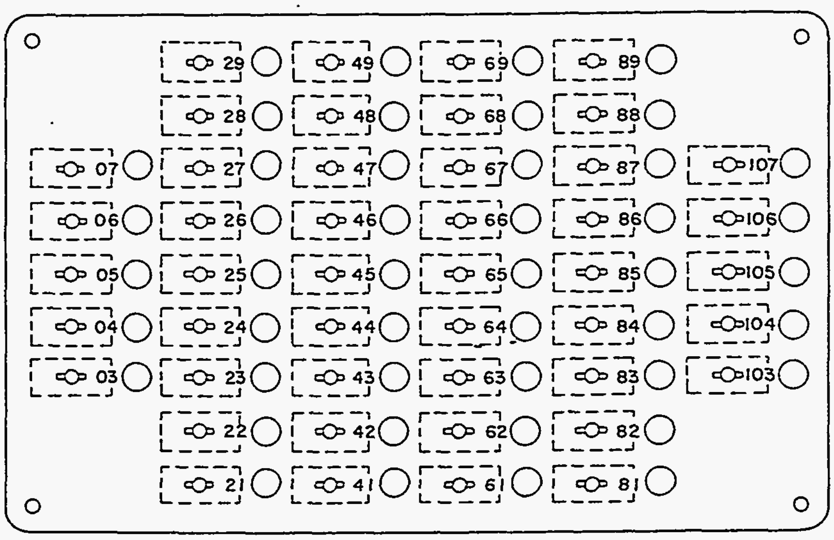
A
B
C
D
E
F
G



NAMEPLATES

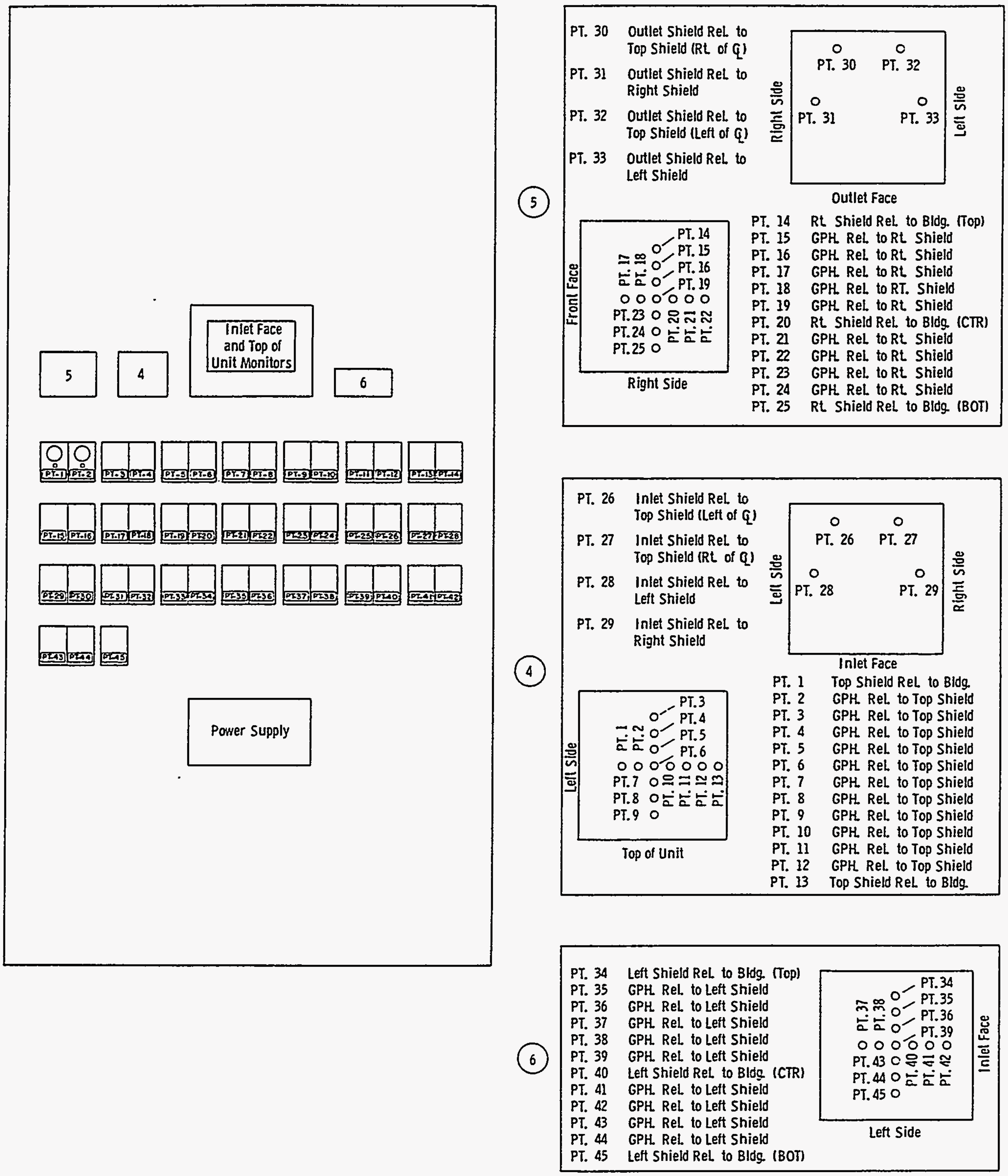
et Thermal Shield, Gas Seals,
veling Wire Flux Monitor Discharge
: Primary Shield Supply Flow
ht Primary Shield Supply Flow
tom Insulation Layer Supply Flow
Primary Shield Supply Flow
tlet Thermal Shield, Gas Seals Discharge and
veling Wire Flux Monitor Supply
ı #1 Left Thermal Shield Supply Flow
ı #2 Right Thermal Shield Supply Flow

H Pen #1 Top Thermal Shield Supply Flow
Pen #2 Bottom Thermal Shield Supply Flow
J Individual Rod Flow
K Left Side Rod Flow Selector
L Right Side Rod Flow Selector
M Rod Cooling Water Drain to Crib
N Rod Cooling Water Drain to Lift Station
O Rod Cooling Water Drain to River
P 36" Sump Drain to River
Q Lift Station Pump No. 1
R Lift Station Pump No. 2



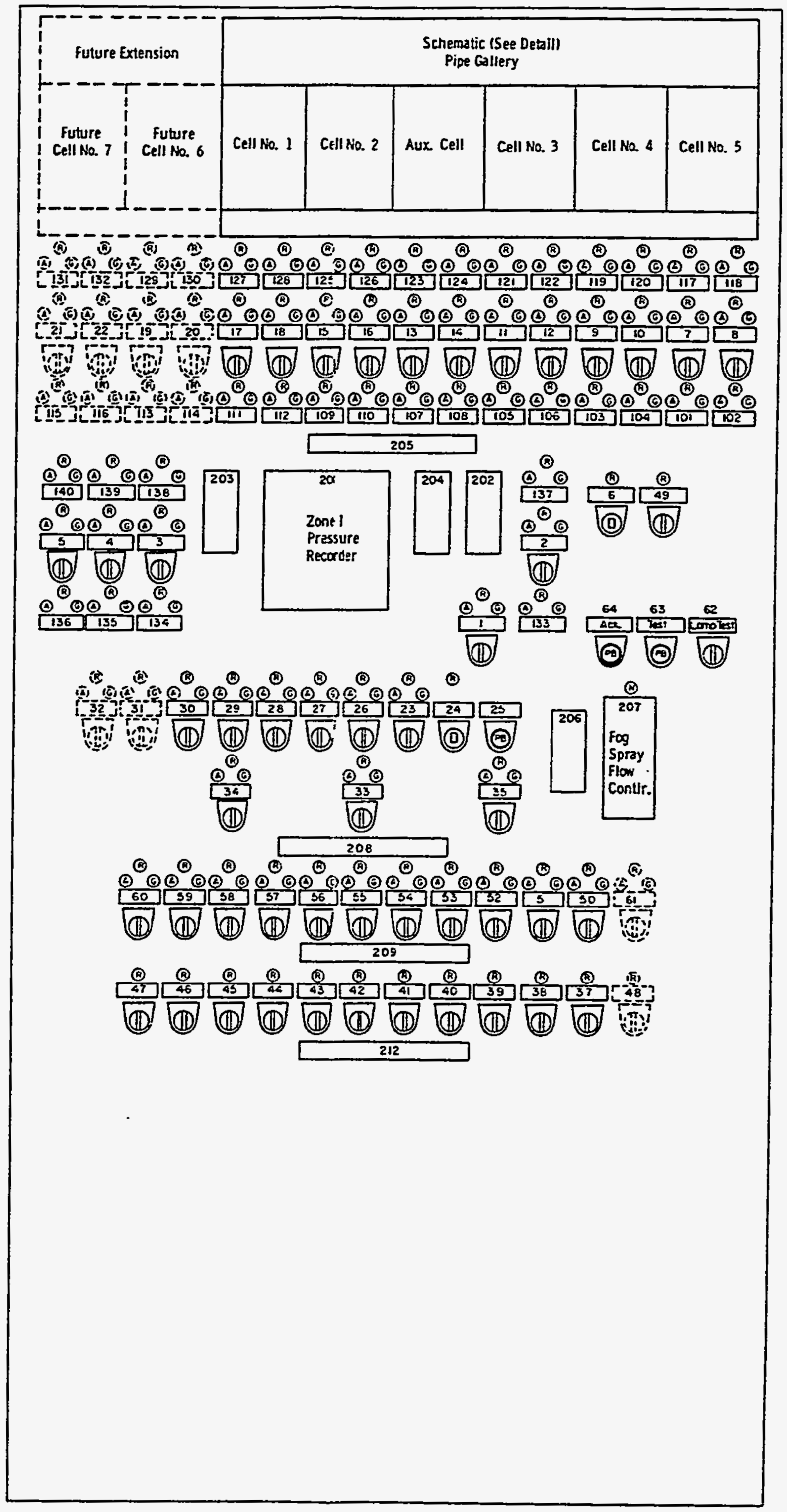
Ref. H-1-32153

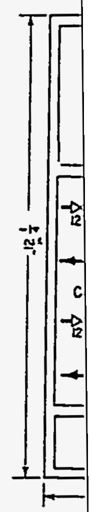
g Water Panel (P-31)



Ref. H-1-27483

Pile Motion Panel (P-35)

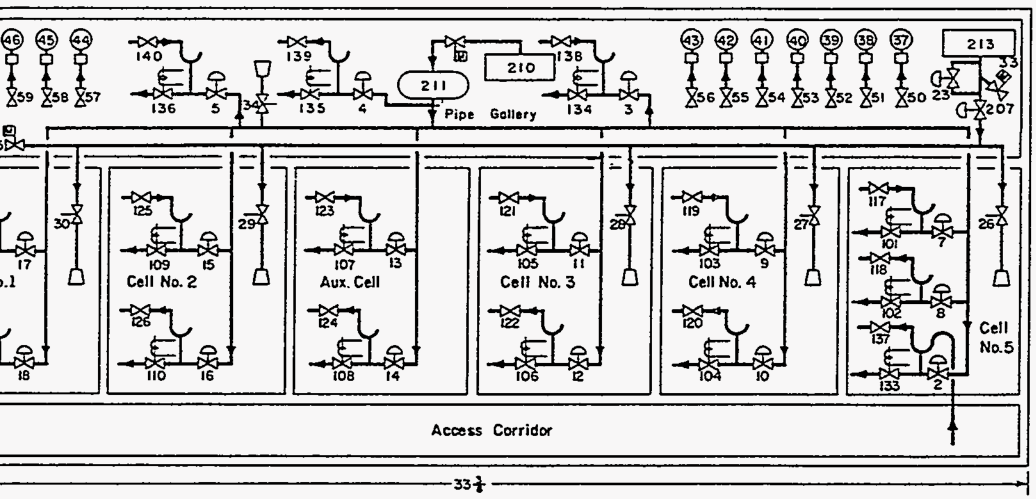




NAMEPLATE ENGRAVING F

ITEM NO.	
1	FW Storage Ta
2	Backup Seal F
3	Backup Seal F
4	Backup Seal F
5	Backup Seal F
6	Zone I Vent C
7	Backup Seal F
8	Backup Seal F
9	Backup Seal F
10	Backup Seal F
11	Backup Seal F
12	Backup Seal F
13	Backup Seal F
14	Backup Seal F
15	Backup Seal F
16	Backup Seal F
17	Backup Seal F
18	Backup Seal F
23	Fog Spray Stra
24	Fog Spray Mast
25	Fog Spray Rese
26	Cell 5 Fog Spra
27	Cell 4 Fog Spra
28	Cell 3 Fog Spra
29	Cell 2 Fog Spra
30	Cell 1 Fog Spra
33	Fog Spray Stra
34	Pipe Gallery Fo
35	Fog Spray Supp
37	Balloon Seal C
38	Balloon Seal C
39	Balloon Seal C
40	Balloon Seal C
41	Balloon Seal C

Flow Diagram



Print Ref. H-1-40194

CONFINEMENT PANEL

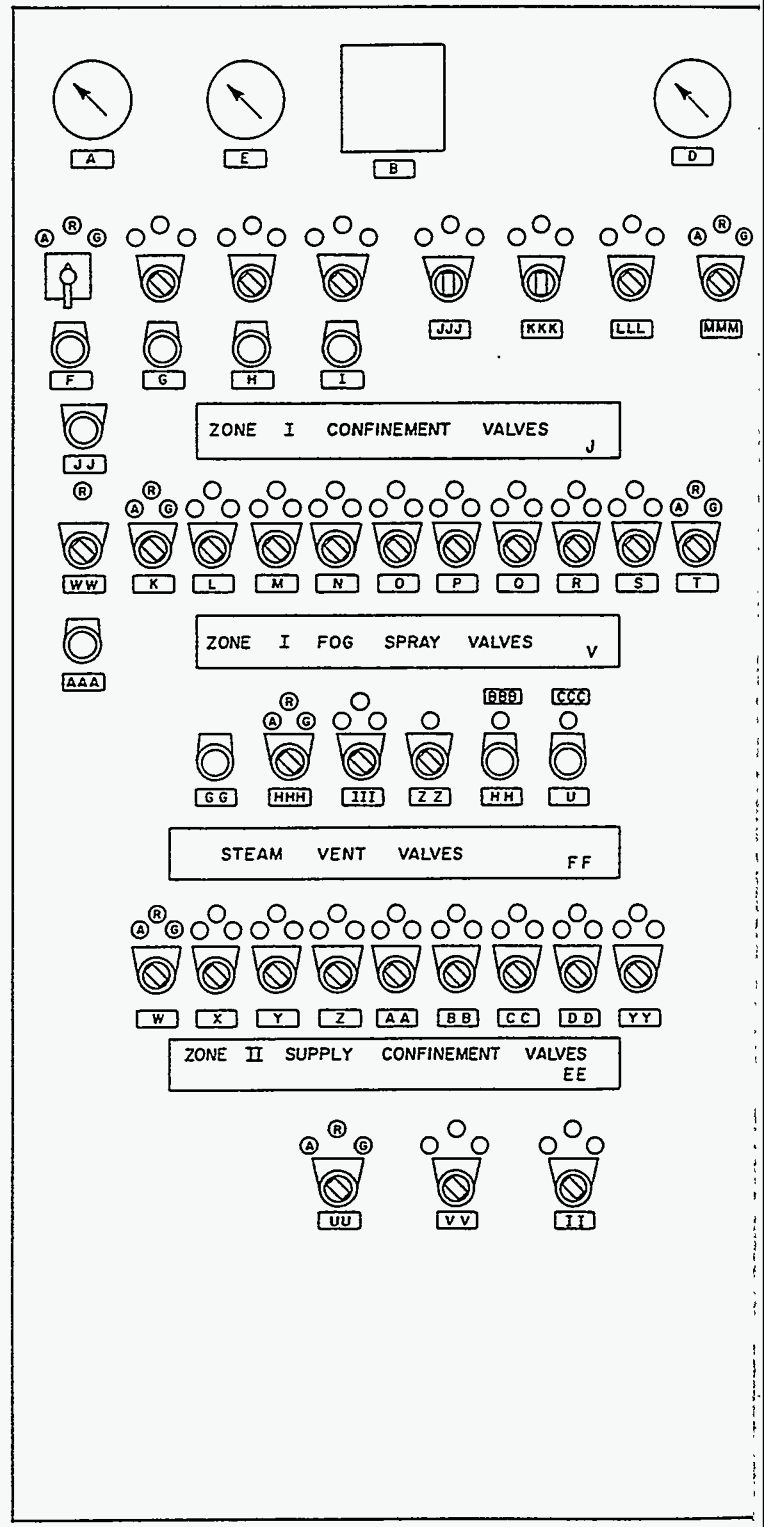
	ITEM NO.	
l Valve	42	Balloon Seal CVV-206-6
lve	43	Balloon Seal CVV-206-5
lve	44	Balloon Seal CVV-206-4
lve	45	Balloon Seal CVV-206-3
lve	46	Balloon Seal CVV-206-2
Permissive Bypass	47	Balloon Seal CVV-206-1
lve	49	Steam Vent Closure Bypass
lve	50	Steam Vent CVV-206-11
lve	51	Steam Vent CVV-206-10
lve	52	Steam Vent CVV-206-9
lve	53	Steam Vent CVV-206-8
lve	54	Steam Vent CVV-206-7
lve	55	Steam Vent CVV-206-6
lve	56	Steam Vent CVV-206-5
ve	57	Steam Vent CVV-206-4
ve	58	Steam Vent CVV-206-3
lve	59	Steam Vent CVV-206-2
ve	60	Steam Vent CVV-206-1
Bypass Valve	62	Lamp Test
ypass	63	Annunciator Test
	64	Annunciator Acknowledge
ve	101	Backup Seal Drain Valve
ve	102	Backup Seal Drain Valve
ve	103	Backup Seal Drain Valve
ve	104	Backup Seal Drain Valve
ve	105	Backup Seal Drain Valve
Flush Valve	106	Backup Seal Drain Valve
ray Valve	107	Backup Seal Drain Valve
eader Flush Valve	108	Backup Seal Drain Valve
06-11	109	Backup Seal Drain Valve
06-10	110	Backup Seal Drain Valve
06-9	111	Backup Seal Drain Valve
06-8	112	Backup Seal Drain Valve
06-7	117	Cell 5 Vent Supply Valve

ITEM NO.	
118	Cell 5 Vent Exhaust Valve
119	Cell 4 Vent Supply Valve
120	Cell 4 Vent Exhaust Valve
121	Cell 3 Vent Supply Valve
122	Cell 3 Vent Exhaust Valve
123	Aux. Cell Vent Supply Valve
124	Aux Cell Vent Exhaust Valve
125	Cell 2 Vent Supply Valve
126	Cell 2 Vent Exhaust Valve
127	Cell 1 Vent Supply Valve
128	Cell 1 Vent Exhaust Valve
133	Backup Seal Drain Valve
134	Backup Seal Drain Valve
135	Backup Seal Drain Valve
136	Backup Seal Drain Valve
137	Access Corridor Vent Exhaust Valve
138	Pipe Gallery East Vent Supply Valve
139	Pipe Gallery Vent Exhaust Valve
140	Pipe Gallery West Vent Supply Valve
202	FW Storage Tank Level
203	Pipe Gallery Water Level
204	Zone I/Zone III Diff. Pressure
205	Vent Valves; Backup Seal Fill and Drain Valves
206	Fog Spray Flow
208	Zone I Fog Spray
209	Steam Vent Valves
212	Steam Vent Balloon Seals

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
202	LI-209	Filtered Water Storage Tank Level Indicator
203	LI-208	Pipe Gallery Water Level Indicator
204	PG-1134	Zone I/Zone III Diff. Pressure Indicator
205	-------	Nameplate - Ventilation Backup Seals
206	FI-269	Fog Spray Flow Indicator
208	-------	Nameplate - Zone I Fog Spray
209	-------	Nameplate - Steam Vent Valves
210	-------	Nameplate - Filtered Water Supply
211	-------	Nameplate - Filtered Water Storage Tank
212	-------	Nameplate - Steam Vent Ballon Seals
213	-------	Nameplate - Raw Water Supply

"(N)" Red Neon Component Failure Alarm Light

nt Panel (P-39)



105-N Confiner

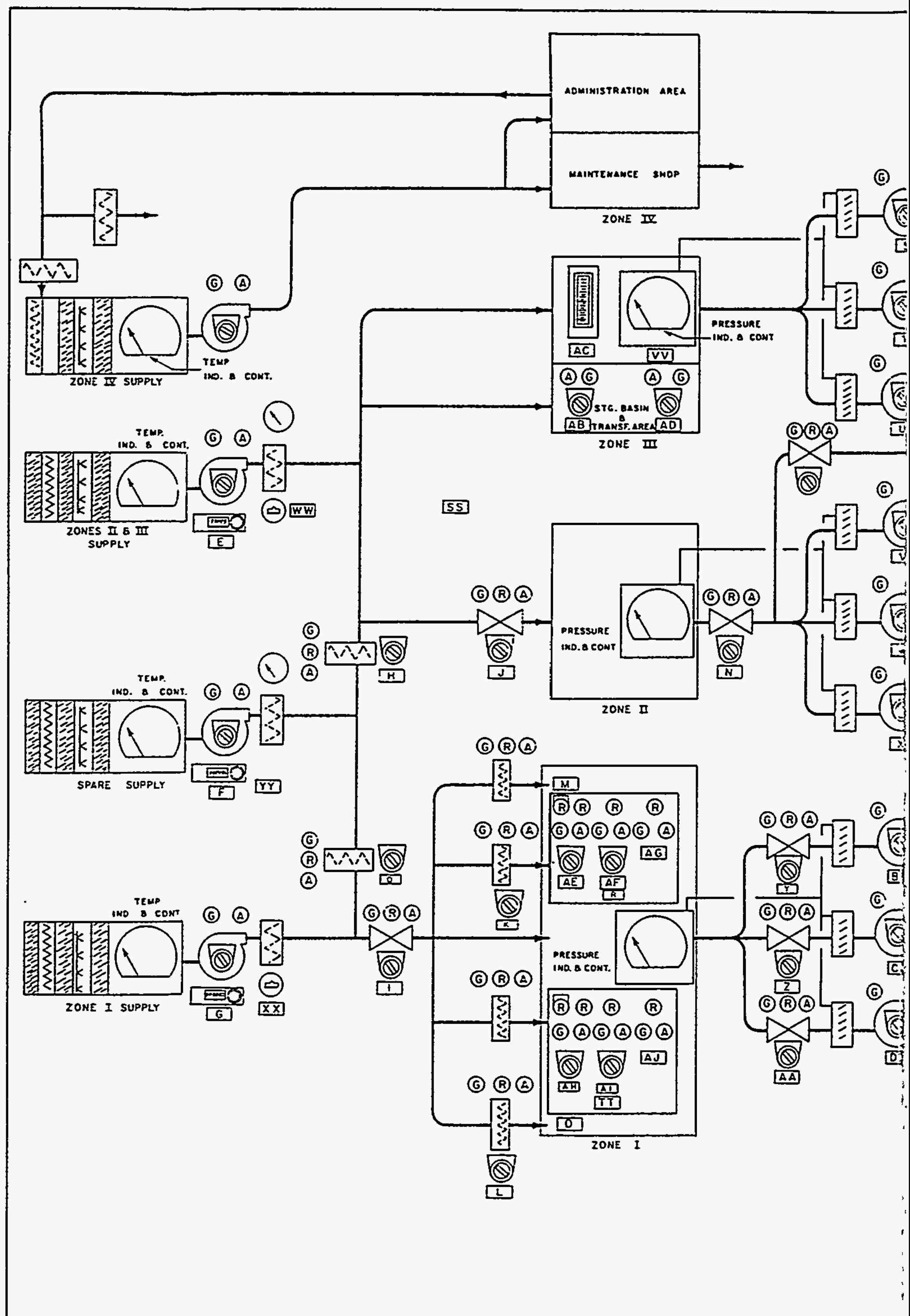
NAMEPLATES

A. Zone I Water Level Left Outlet Pipe Space
B. Pen #1 - Zone I Pressure Left Inlet Pipe Space
D. Fog Spray Header Pressure
E. Zone I Water Level Left Inlet Pipe Space
F. 36" Pipe Space Drain Valve
G. 4" In-Out Pipe Space X-Connection Tunnel Drain VLV
H. 4" Ball Wash Drain
I. 12" C-Elevator Drain
J. Zone I Confinement Valves
K. Left Outlet Heavy VLV #3
L. Left Outlet Fine VLV #1
M. Outlet Space Medium VLV #2
N. Right Outlet Heavy VLV #5
O. Center and Right Outlet Fine - VLV #4
P. Top and Right Inlet Medium VLV-9
Q. Top and Left Inlet Medium VLV-6
R. Top and Center Inlet - Heavy VLV-#8
S. Top and Left and Center Inlet - Fine VLV #7
T. Right Inlet - Fine VLV - #10
U. 105 - Right Steam Vent Valve Balloon Backup
V. Zone I Fog Spray Valves
W. Gas Sample Hood Exhaust
X. Dryer Room No. 1
Y. Dryer Room No. 2
Z. Left Rupture Monitor Room
AA Right Rupture Monitor Room
BB Outer Rod Room Left Side
CC Outer Rod Room Right Side
DD Zone I Exhaust Fan Room
EE Zone II Supply Confinement Valves
FF Steam Vent Valves
GG Steam Vent Closure Manual Reset
HH 105 Left Steam Vent Valve Balloon Backup
II Zone V Inlet Damper Control
JJ Zone I High Pressure Confinement Manual Reset
UU Reactor Gas Emergency Diversion to Stack
VV Reactor Gas Emergency Diversion to Outlet Pipe Space
WW Fog Spray Valves Master Control
YY Hydrogen Equipment Room
ZZ Master Steam Vent Automatic Closure By-Pass
AAA Zone I Fog Spray Manual Reset
BBB Left Balloon Seal Pressurized
CCC Right Balloon Seal Pressurized

HHH Steam Vent Valve - Left Front
III Steam Vent Valve - Right Front
JJJ Supply Backup Valve Zone I Confinement
KKK Exhaust Backup Valve Zone I Confinement
LLL (Spare)
MMM Cross Vent on Zone I to Bldg. 109-N

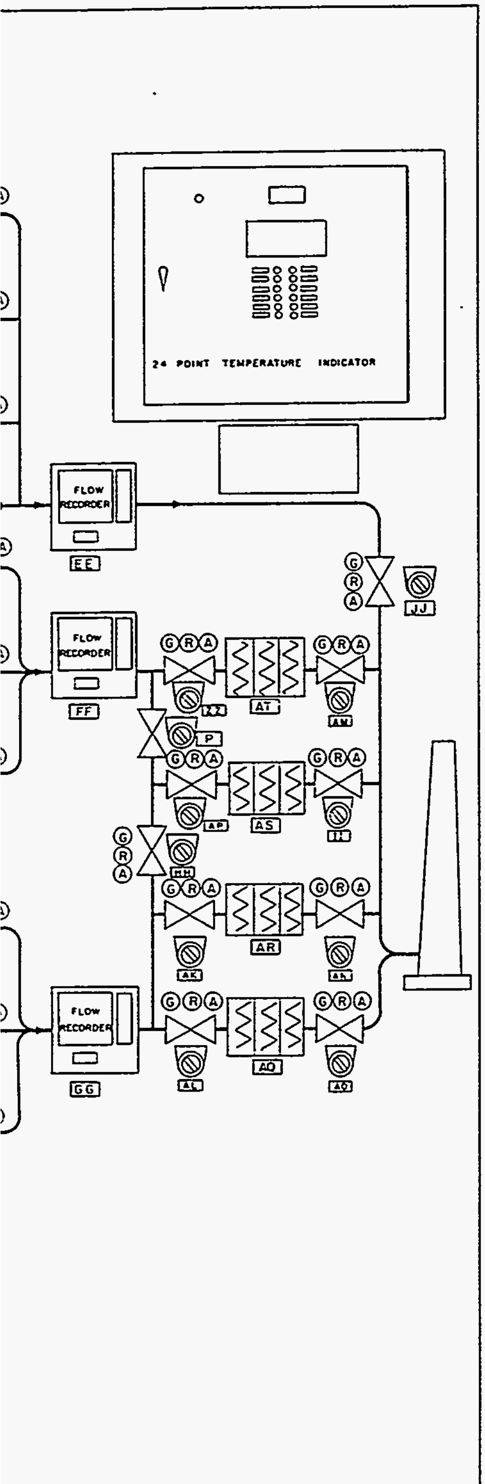
(Ref. H-1-32120)

ent Panel (P-36)



AEC-GE RICHLAND, WASH.

105-N Heating and Ve

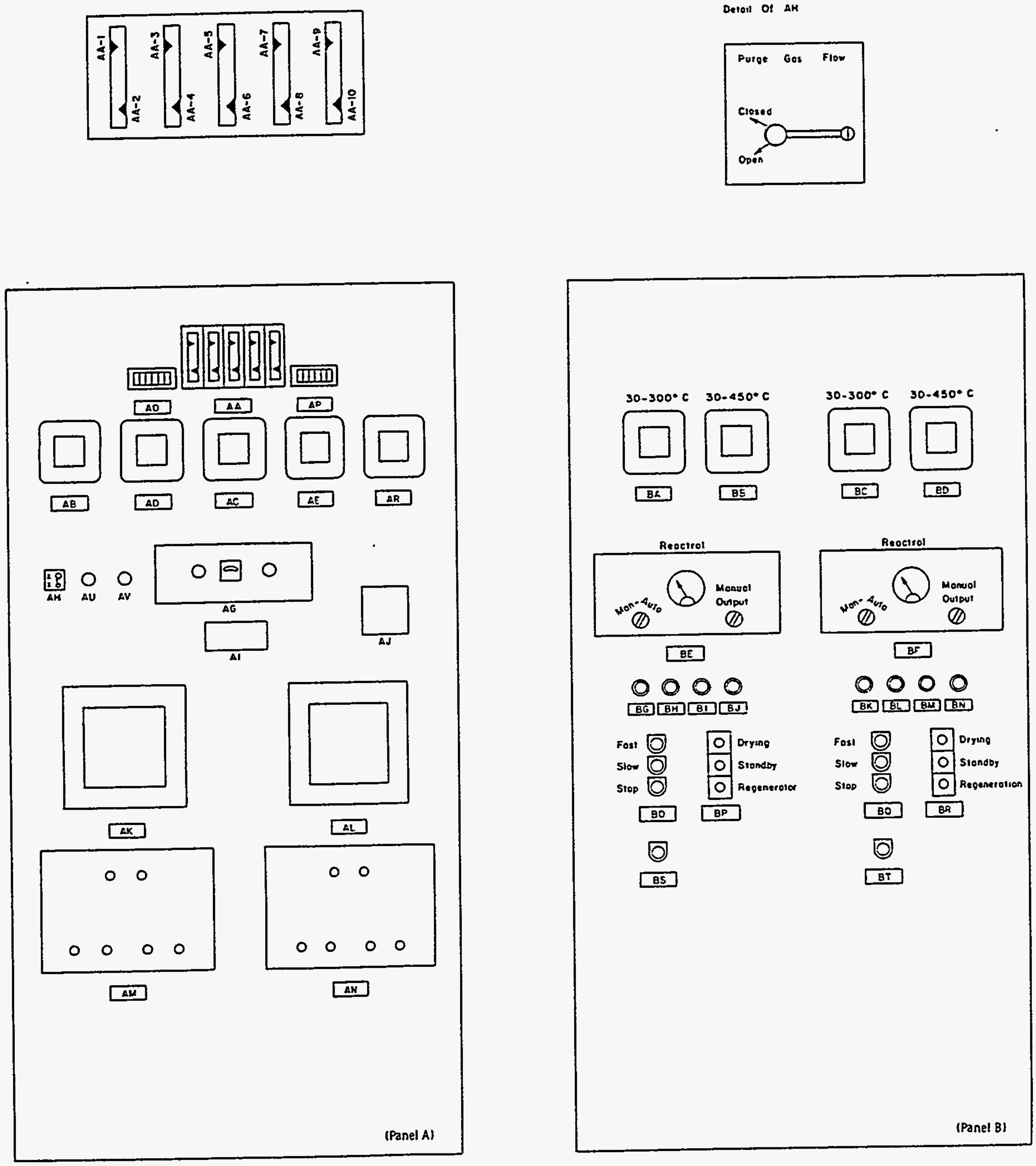


NAME PLATE LIST

AT "C" Cell
AS "D" Cell
AR "B" Cell
AQ "A" Cell
AP "D" Cell Inlet Valve
AO "A" Cell Outlet Valve
AN "B" Cell Outlet Valve
AM "C" Cell Outlet Valve
E Zone II and III Fan Speed Control
F Spare Fan Speed Control
G Zone I Fan Speed Control
H Damper - Spare Fan To Zones II and III
I Confinement Valve Zone I Ventilation Supply
J Confinement Master Valve Control Zone II Vent Supply
K Inlet Thermal Barriers Purge
L Outlet Thermal Barriers Purge
M Inlet Pipe Space
N Confinement Valve Zone II
O Outlet Pipe Space
P Zone II Duct Valve
Q Damper - Spare Fan To Zone I
R Inlet Thermal Barrier
S Zone III Exhaust Fan No. 1
T Zone III Exhaust Fan No. 2
U Zone III Exhuast Fan No. 3
V Zone II Exhaust Fan No. 1
W Zone II Exhaust Fan No. 2
X Zone II Exhaust Fan No. 3
Y Confinement Valve No. 1 Zone 1 Exhaust
Z Confinement Valve No. 2 Zone I Exhaust
AA Confinement Valve No. 3 Zone I Exhaust
BB Zone I Exhaust Fan No. 1
CC Zone I Exhaust Fan No. 2
DD Zone I Exhaust Fan No. 3
EE Zone III Exhaust Flow
FF Zone II Exhaust Flow
GG Zone I Exhaust Flow
HH Zone I Duct Valve
II "D" Cell Outlet Valve
JJ Zone III Exhaust Valve
KK Zone III To Zone II Bypass Valve
LL Air Temperatures
PL 1 Left Inlet Thermal Barrier El. (+) 15 Feet
PL 2 30
PL 3 Right 15
PL 4 30
PL 5 Left Outlet 15
PL 6 30
PL 7 Right 15
PL 8 30
PL 9 Left Inlet Pipe Space 15
PL 10 30
PL 11 Right 15
PL 12 30
PL 13 Left Outlet 15
PL 14 30
PL 15 Right 15
PL 16 30
PL 17 Top 46
PL 18 Inner Rod Room Left
PL 19 Inner Rod Room Right
PL 20 "W" Elevator Area El (+) 7' - 0"
PL 21 "W" Elevator Area El (+) 20' - 0"
SS Light Sequence
Green - Valve Closed - Motor Stopped
Amber - Valve Open - Motor Running
Red - Abnormal Condition
TT Outlet Thermal Barrier
VV Normal Access Area
WW Zones II & III Supply Fans Discharge Dampers
XX Zone I
YY Spare
AB Zone III Plenum Booster Fans High Speed - Slow Speed
AC Zone III Plenum Pressure
AD Zone III Confinement
AE Bottom Door Control
AF Front Face Door Control
AG Top Door Control
AH Bottom Door Control
AI Rear Face Door Control
AJ Top Door Control
ZZ "C" Cell Inlet Valve
AK "B" Cell Inlet Valve
AL "A" Cell Inlet Valve

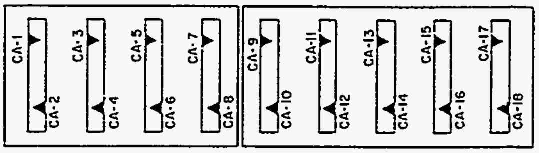
Ref. H-1-32129

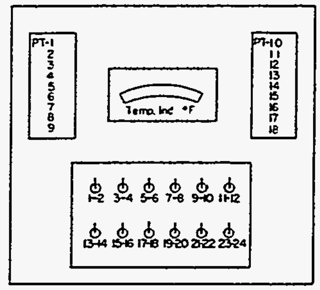
...ilating Panel (P-37)



(Ref. H-1-32108)

Pile Gas





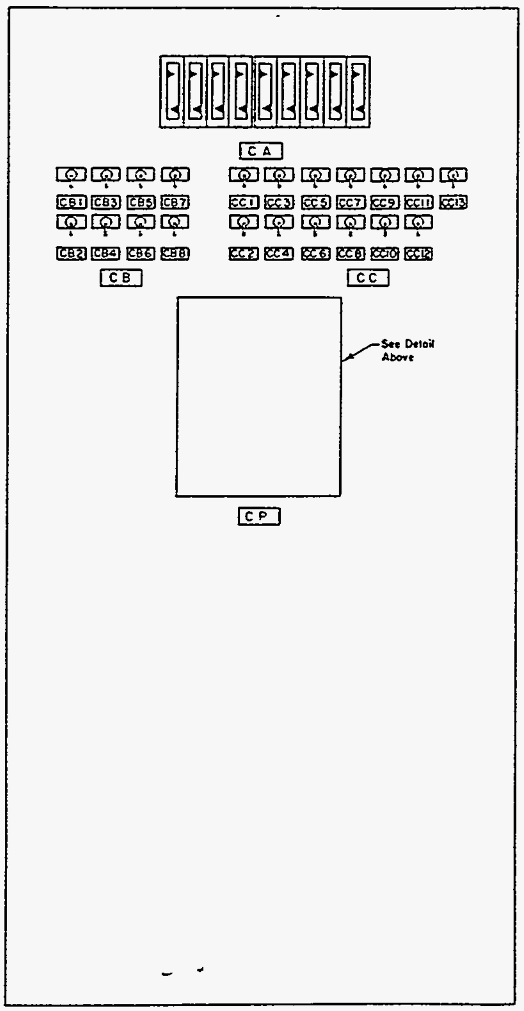
Detail

NAME PLATES FOR PANEL "B"

Gas Outlet No. 1 Gas Dryer - Temperature °F
Gas Inlet No. 1 Gas Dryer - Temperature °F
Gas Outlet No. 2 Gas Dryer - Temperature °F
Gas Inlet No. 2 Gas Dryer - Temperature °F
Gas Heater No. 1 Control Unit
Gas Heater No. 2 Control Unit
Blower No. 1 Lube Oil Cooling Waterflow
Heater Cooler No. 1 Cooling Water Flow
Regenerator Condenser No. 1 Cooling Water Flow
Heater Cooler No. 1 - Brine Flow
Blower No. 2 Lube Oil Cooling Water Flow
Heater Cooler No. 2 Cooling Water Flow
Regeneration Condenser No. 2 Cooling Water Flow
Heater Cooler No. 2 - Brine Flow
Blower No. 1 Control Station
Dryer Room No. 1 Control
Blower No. 2 Control Station
Dryer Room No. 2 Control
Oil Pump Blower No. 1
Oil Pump Blower No. 2

NAME PLATES FOR PANEL "A"

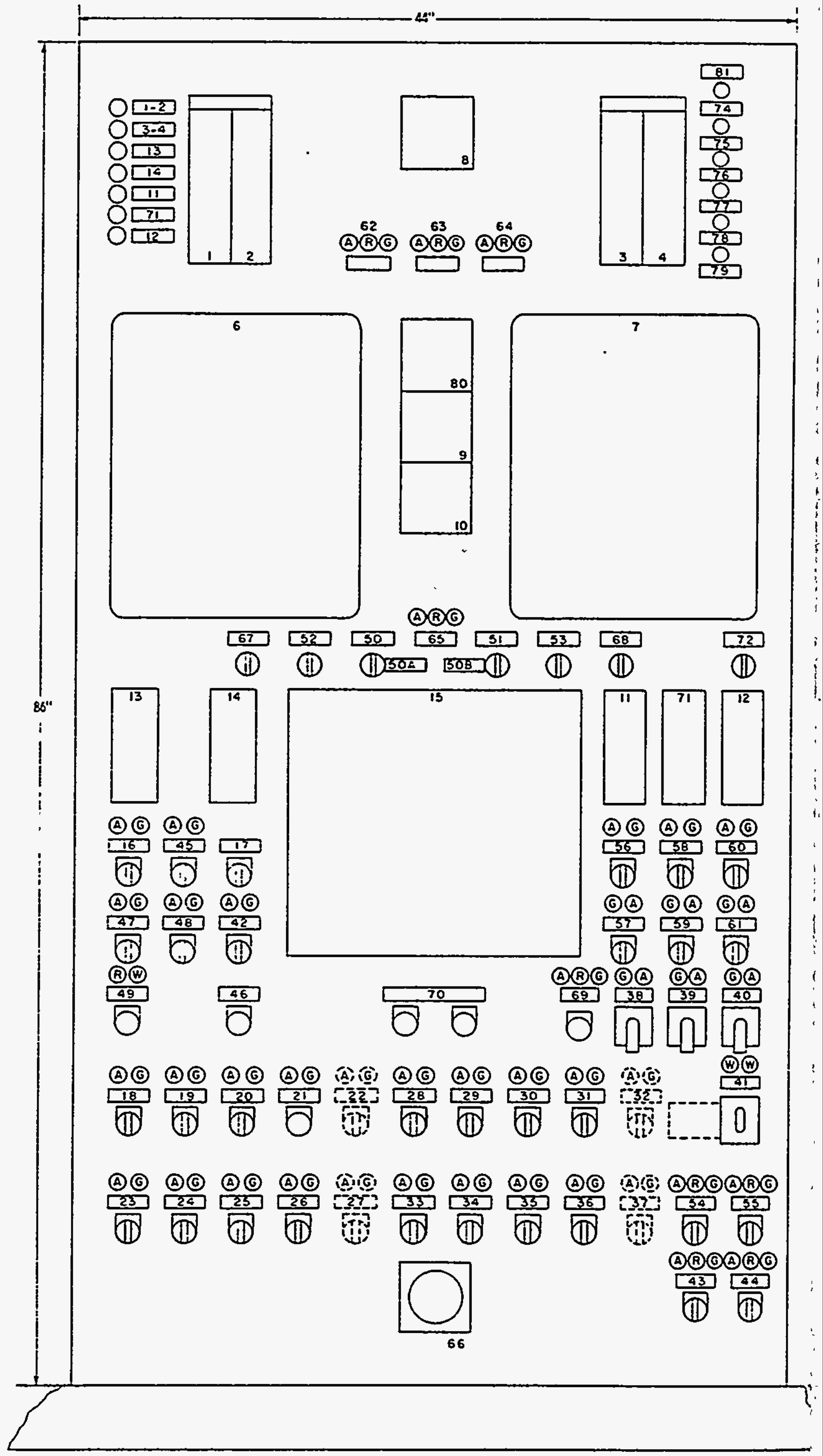
Pressure and Diff. Press
No. 1 Blower - Diff. Press - Inches Water
No. 2 Blower - Diff. Press - Inches Water
No. 1 Blower - Suction - Inches Water
No. 2 Blower - Suction - Inches Water
No. 1 Dryer - Diff. Press - Inches Water
No. 2 Dryer - Diff. Press - Inches Water
Inlet Filter - Diff. Press - Inches Water
Outlet Filter - Diff. Press - Inches Water
Inlet Hdr. Press - Inches Water
Outlet Hdr. Press. - Inches Water
Reactor Outlet Hdr. - Radiation Level
Pen 1 Reactor Inlet Gas Press - Inches Water
Pen 2 Reactor Outlet Gas Press - Inches Water
Purge Gas Flow - CFM
Make-Up Gas Flow - CFM
Main Cond. Outlet Gas Temperature - °F
Radiation Analyzer
Purge Gas Flow
Moisture Analyzer Stream Selector
Inlet and Outlet Gas Moisture - PPM
Inlet and Outlet Gas - CO, CO_2, O_2 and N_2 - PPM
Inlet and Outlet Gas - H_2 - PPM
Gas Analyzer Control
Gas Analyzer Control
Purge Gas Total Flow - MCF
Make-Up Gas Total Flow - MCF
Annunciator Test
Annunciator Acknowledge and Reset



Ref. H-1-27572

CA	LIQUID LEVEL
CA1	LEFT SIDE OUT. HDR.
CA2	RIGHT SIDE OUT. HDR.
CA3	RTR. OUT. HDR. CELL
CA4	RTR. IN HDR. CELL
CA5	RTR. OUT. HDR. DIV. CELL
CA6	RTR. OUT. HDR. DIV. CELL
CA7	RTR. IN HDR. DIV. CELL
CA8	RTR. IN HDR. DIV. CELL
CA9	VACUUM SEAL TANK
CA10	(SPARE)
CA11	NO. 1 HEAT COOL CELL
CA12	NO. 2 HEAT COOL CELL
CA13	NO. 1 REGEN. COND.
CA14	NO. 2 REGEN. COND.
CA15	PRESS. SEAL TANK
CA16	(SPARE)
CA17	MAIN EFF. COND. HOLD TANK
CA18	(SPARE)
CB	MAIN GAS VALVES
CB1	INLET HEADER PURGE VALVE
CB2	OUTLET HEADER PURGE VALVE
CB3	INLET HEADER VENT VALVE
CB4	OUTLET HEADER VENT VALVE
CB5	GAS VENT VALVE - LEFT SIDE
CB6	GAS VENT VALVE - RIGHT SIDE
CB7	INLET HEADER DIVISION VALVE
CB8	OUTLET HEADER DIVISION VALVE
CC	DRIP CELL DRAIN VALVES
CC1	LEFT SIDE OUTLET HEADER
CC2	RIGHT SIDE OUTLET HEADER
CC3	REACTOR OUTLET HEADER
CC4	REACTOR INLET HEADER
CC5	REACTOR OUTLET HDR. DOWNSTREAM DIV. VA.
CC6	REACTOR OUTLET HDR. UPSTREAM DIV. VA.
CC7	REACTOR INLET HDR. DOWNSTREAM DIV. VA.
CC8	REACTOR INLET HDR. UPSTREAM DIV. VA.
CC9	NO. 1 HEATER COOLER
CC10	NO. 2 HEATER COOLER
CC11	NO. 1 REGEN. COND.
CC12	NO. 2 REGEN. COND.
CC13	MAIN EFFL. GAS COND. HOLDUP TANK
CP	TEMPERATURE INDICATOR
CQ	REACTOR LEFT SIDE OUTLET GAS - HIGH TEMP. ALARM RELAY
CR	REACTOR RIGHT SIDE OUTLET GAS - HIGH TEMP. ALARM RELAY
CS	COOLING WATER OUTLET MAIN CONDENSER - HIGH TEMP. ALARM RELAY

PL 1	HEATER COOLER #1 BRINE INLET °F
PL 2	HEATER COOLER #2 BRINE INLET °F
PL 3	HEATER COOLER #1 BRINE OUTLET °F
PL 4	HEATER COOLER #2 BRINE OUTLET °F
PL 5	SPARE
PL 6	SPARE
PL 7	REACTOR INLET GAS °F
PL 8	BLOWER # 1 SUCTION GAS °F
PL 9	BLOWER # 2 SUCTION GAS °F
PL 10	SPARE
PL 11	SPARE
PL 12	SPARE
PL 13	SPARE
PL 14	SPARE
PL 15	REACTOR LEFT SIDE OUTLET GAS °F
PL 16	REACTOR RIGHT SIDE OUTLET GAS °F
PL 17	GAS OUTLET MAIN CONDENSER °F
PL 18	COOLING WATER OUTLET MAIN CONDENSER °F



Graphite Coola

NAMEPLATE LEGEND

ITEM	NAMEPLATE
16	Spill Contr. Station West Isolation Valve
17	Surge Tank Level Transmitter Selector
18	Heat Exchanger No. 1 Coolant Inlet Valve
19	Heat Exchanger No. 2 Coolant Inlet Valve
20	Heat Exchanger No. 3 Coolant Inlet Valve
21	Heat Exchanger No. 4 Coolant Inlet Valve
23	Heat Exchanger No. 1 Coolant Outlet Valve
24	Heat Exchanger No. 2 Coolant Outlet Valve
25	Heat Exchanger No. 3 Coolant Outlet Valve
26	Heat Exchanger No. 4 Coolant Outlet Valve
28	Heat Exchanger No. 1 CRW Inlet Valve
29	Heat Exchanger No. 2 CRW Inlet Valve
30	Heat Exchanger No. 3 CRW Inlet Valve
31	Heat Exchanger No. 4 CRW Inlet Valve
33	Heat Exchanger No. 1 CRW Outlet Valve
34	Heat Exchanger No. 2 CRW Outlet Valve
35	Heat Exchanger No. 3 CRW Outlet Valve
36	Heat Exchanger No. 4 CRW Outlet Valve
38	Graphite Coolant Pump No. 1
39	Graphite Coolant Pump No. 2
40	Graphite Coolant Pump No. 3
41	GC Pump No. 3 Bus Selector
42	Makeup and Pump Seal DW Supply Shutoff
43	Graphite Coolant Reactor Return Valve
44	Graphite Coolant Reactor Supply Valve
45	Spill Control East Isolation Valve
46	Lamp Test
47	Makeup Control North Isol. Valve
48	Makeup Control South Isol. Valve
49	Makeup Contr. Valves Air Failure Reset
50	Helium Supply Contr. Valve Shutdown
50A	A: REL-231 HEV-210-1 REL-241 HEV-210-2 B: REL-231 HEV-210-2 REL-241 HEV-210-1
51	Helium Vent Contr. Valve Selector
51A	A: REL-257 HEV-209-1 REL-258 HEV-209-2 B: REL-257 HEV-209-2 REL-258 HEV-209-1
52	Surge Tank He Supply E/P and Vlv. Seltr.
53	Surge Tank He Vent E/P and Vlv. Seltr.
54	Once Thru Coolant Supply Valve
55	Graphite Coolant Dump Valve
56	GC Pump No. 1 Suction Valve
57	GC Pump No. 1 Discharge Valve
58	GC Pump No. 2 Suction Valve
59	GC Pump No. 2 Discharge Valve
60	GC Pump No. 3 Suction Valve
61	GC Pump No. 3 Discharge Valve
62	Graphite Coolant Sys. Decont. Supply Valve
63	Graphite Coolant Sys. Decont. Return Valve
64	Graphite Coolant Recirc. Valve
65	Helium Fill Shutoff Valve
67	Spill Flow Control Signal Selector
68	Makeup Flow Control Signal Selector
69	GC HX Bypass Block Valve
70	Annunciator Acknowledge Test
72	Coolant Sys. Pressure Transmitter Selector
73	Spill Contr. Valves Air Failure Reset
74	High Temp. Trip
79	High Temp. Trip Timed Out
75	Low Flow Trip, 2/3
76	Low Flow #1
77	Low Flow #2
78	Low Flow #3
81	Once-Thru Cooling Actuate Circuit

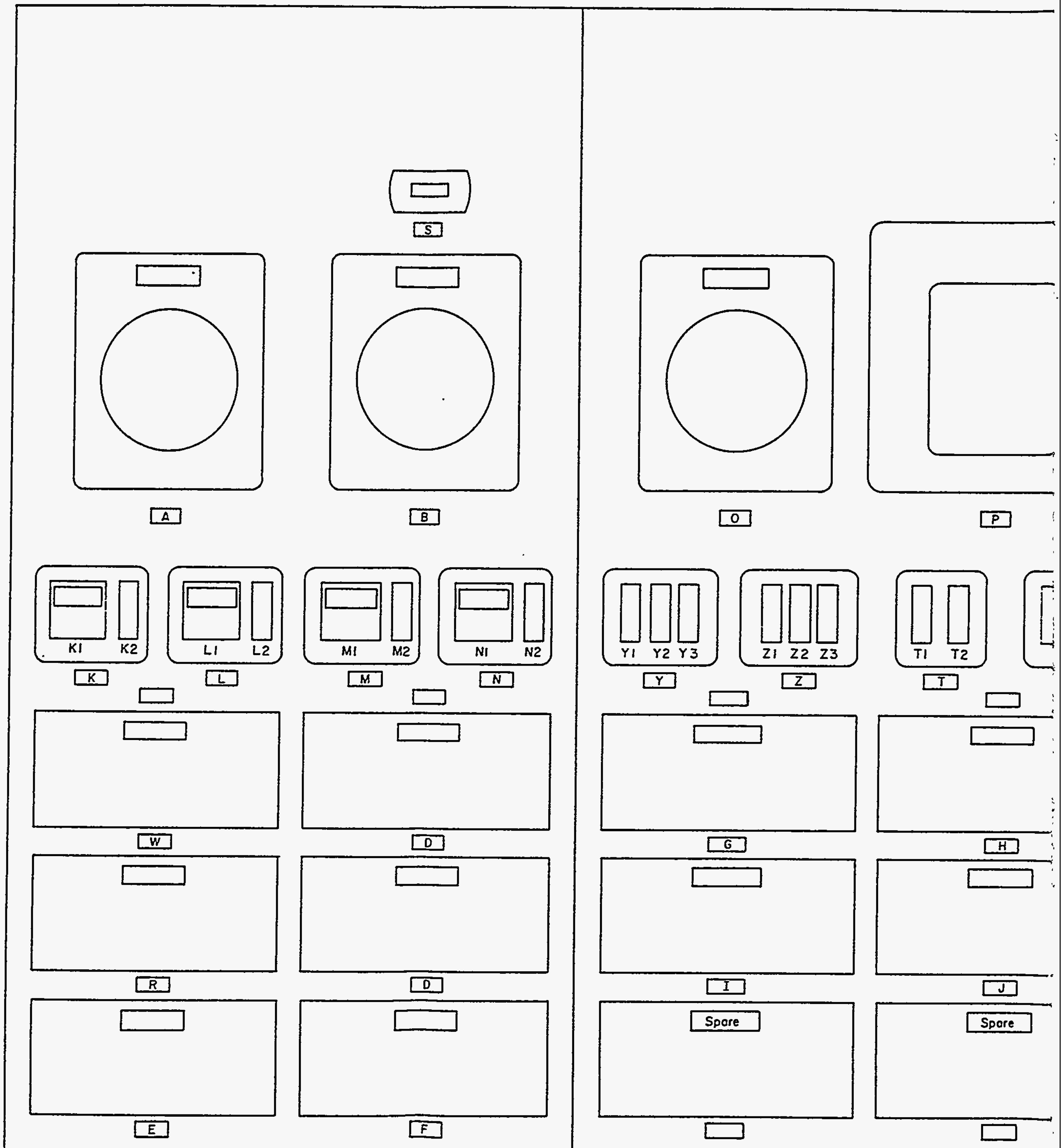
CFA LIGHTS

ITEM	NAMEPLATE
1-2	Spill Flo. or Srge. Tk. Lvl. Indicator
3-4	System Press. or Coolant Supply Temp. Ind.
13	Spill Flow Sq. Root Ext. and Set-Pt. Contlr.
14	Surge Tank Level Set-Pt. Contlr.
11	Coolant Supply Temp. Set-Pt. Contlr.
71	He Supply Valve Set-Pt. Contlr.
12	He Vent Valve Set-Pt. Contlr.

DESIGNATION OF RECORDERS - CONTROLLERS - INDICATORS

ITEM NO.	INSTR. NO.	DESCRIPTION
1	FI-214	Graphite Coolant Spill Flow Indicator
2	LI-268	Graphite Coolant Surge Tank Level Indicator
3	TI-399	Graphite Coolant Supply Temperature Indicator
4	PG-1108	Graphite Coolant System Press Indicator
6	FR-242	Graphite Coolant Spill Flow Recorder
	LR-205 & LS-201	Graphite Coolant Surge Tank Level Recorder & Hi & Lo Alarm Switch
7	PR-210 & PS-400	Graphite Coolant System Press. Recorder & Hi & Lo Alarm Switch
	TR-256 & TS-280	Graphite Coolant Supply Temperature Recorder & Hi & Lo Temperature Alarm Switch
8	------	Graphite Coolant Recirc. Pumps Bearing Temperature Monitor Indicator
9	------	Graphite Coolant Recirc. Pumps Bearing Temperature Monitor Indicator
10	------	Graphite Coolant Recirc. Pumps Bearing Temperature Monitor Indicator
11	TC-261	Graphite Coolant System Temperature Control Station
12	PC-245	Graphite Coolant System Pressurizing Control Station
13	FC-233	Graphite Coolant System Spill Control Station
14	LC-233	Graphite Coolant Surge Tank Level Control Station
15	TR-257	Graphite Coolant Heat Exchange No. 1 Coolant Exit Temperature Recorder
	TR-258	Graphite Coolant Heat Exchange No. 2 Coolant Exit Temperature Recorder
	TR-259	Graphite Coolant Heat Exchange No. 3 Coolant Exit Temperature Recorder
	TR-260	Graphite Coolant Heat Exchange No. 4 Coolant Exit Temperature Recorder
	PR-211	Graphite Coolant Recirc. Pump Suction HDR Press. Recorder
	PR-212	Graphite Coolant Recirc Pump No.1 Disch. HDR Press. Recorder
	PR-213	Graphite Coolant Recirc Pump No. 2 Disch. HDR Press. Recorder
	PR-214	Graphite Coolant Recirc Pump No. 3 Disch. HDR Press. Recorder
	TR-261	Graphite Coolant Heat Exchanger #1 Raw Cooling Water Outlet Temperature Rec.
	TR-262	Graphite Coolant Heat Exchanger #2 Raw Cooling Water Outlet Temperature Rec.
	TR-263	Graphite Coolant Heat Exchanger #3 Raw Cooling Water Outlet Temperature Rec.
	TR-264	Graphite Coolant Heat Exchanger #4 Raw Cooling Water Outlet Temperature Rec.
	TS-281	Graphite Coolant High Temperature Alarm for TR-261 thru 264
	TR-267	Graphite Coolant From Heat Exchanges
	TR-268	Graphite Coolant R. W. S. to G. C. Heat Exchanges
	TR-269	Graphite Coolant R. W. R. from G. C. Heat Exchanges
71	PC-249	Graphite Coolant G. C. System Depressurizing Control Station
80		Graphite Coolant Recirc. Pumps Bearing Temp. Monitor Indicator

t Panel (P-32)


S
A
B
O
P
K1 K2
L1 L2
M1 M2
N1 N2
Y1 Y2 Y3
Z1 Z2 Z3
T1 T2
K
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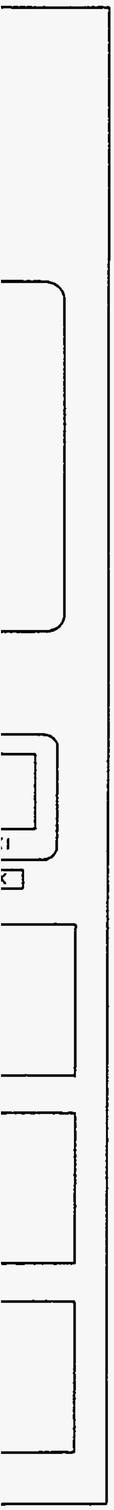
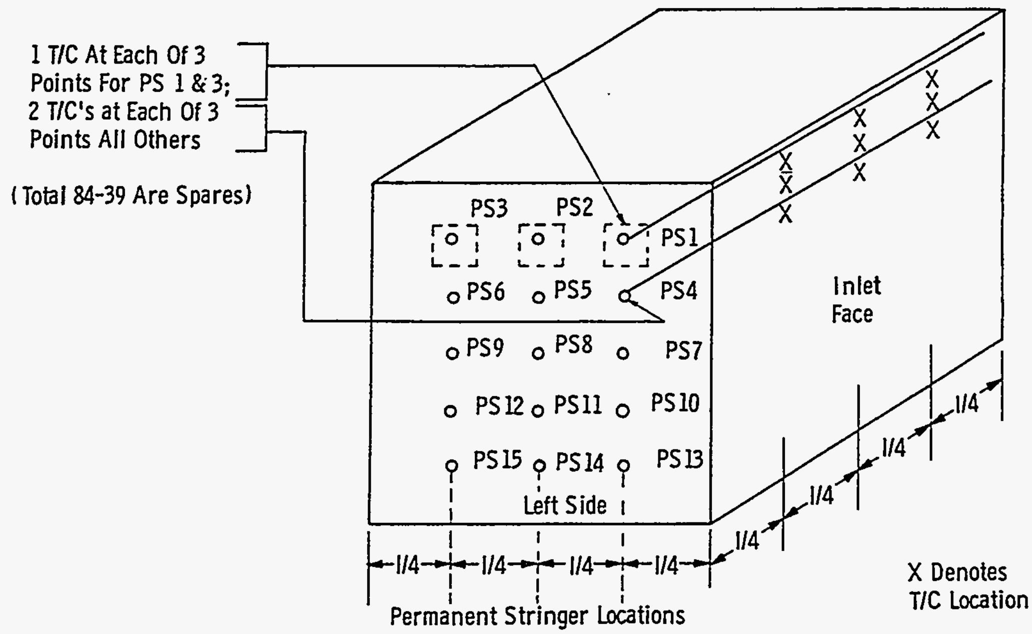
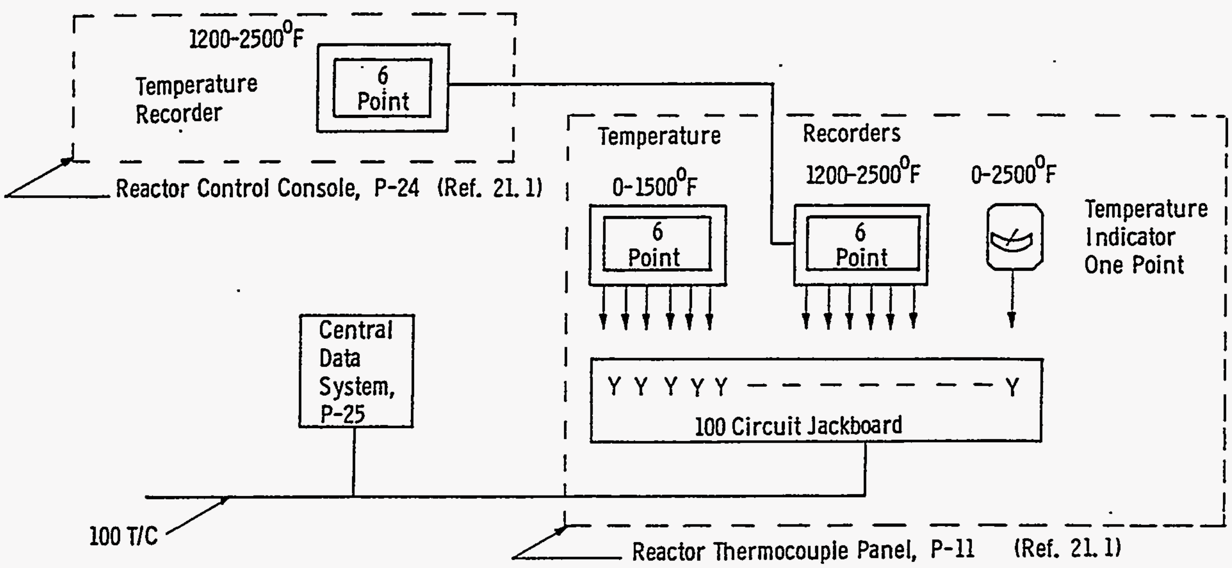


D Power Totalizer
E Power Calculator Channel #1
F Power Calculator Channel #2
G Power Calculator Channel #3
H Power Calculator Channel #4
I Power Calculator Channel #5
J Power Calculator Graphite Loop Channel #6
K Boiling Point Outlet Header #4-0
L Boiling Point Outlet Header #8-0
M Boiling Point Outlet Header #9-0
N Boiling Point #13-0
R Power Calculator Power Supply
S Total Power
T Graphite Loop Bulk Water Temp. Monitor
W Flow Totalizer and Flow Switch
X Rod and Shield Flows
Y Emergency System Temp. Monitor Headers 4-0, 6-0, and 8-0
Z Emergency System Temp. Monitor Headers 9-0, 11-0 and 13-0
A Primary Loop Total or Individual Header Flow
B Total Power Level
O Graphite Loop Flow
P Rod Shield and Graphite Loop Bulk Water Temp.

K_1 Deg. Fahrenheit
K_2 Setback and Shutdown Circuits
L_1 Deg. Fahrenheit
L_2 Setback and Shutdown Circuits
M_1 Deg. Fahrenheit
M_2 Setback and Shutdown Circuits
N_1 Deg. Fahrenheit
N_2 Setback and Shutdown Circuits
T_1 Graphite Loop Bulk Water Temperature Alarm
T_2
X_1 (RD) Right Side Rod Flow
(GN) Left Side Rod Flow
(BL) Thermal Shield Total Flow
Y_1 #4-0 Circuit #1
Y_2 #6-0 Circuit #1
Y_3 #8-0 Circuit #1
Z_1 #9-0 Circuit #2
Z_2 #11-0 Circuit #2
Z_3 #13-0 Circuit #2

r Panel (P-33)





Control Room Instrumentation-Schematic

Graphite Thermocouple System - 105N

GRAPHITE THERMOCOUPLE SYSTEM - 105N

The reactor thermocouple system is provided for the measurement and presentation of temperatures sensed in the graphite packing. These temperatures are necessary to insure that graphite temperature limits are not exceeded, and to furnish data required for routine operation of the reactor.

There is a total of 139 thermocouples in this system. These are divided into the following four groups and locations:

1. Thirty-five thermocouples are located in seven replaceable stringers (RS-1 through RS-7) with five thermocouples per stringer. Three of these stringers are located so that replaceable thermocouples are installed as near the "cells" (defined in No. 2 below) as possible. The other four stringers are located in the four quadrants as viewed from the left side of the reactor. Three of the five thermocouples in each of these stringers are located near the three flux monitor chambers in the corresponding locations. All of these stringers are installed in uncooled side to side graphite filler layer blocks.

2. Fourteen test stringer thermocouples are installed for initial calibration of an anolog heat flow model; six thermocouples in each of two "cells" which are typical of the graphite packing within the cooling tube zone, and two thermocouples in a single "cell" which is typical of the graphite packing outside of the cooling tube zone. These three cells are located on the reactor front to rear center line in packing layer 49 and are installed with three permanent test stringers (TS-1 through TS-3). These "cell" thermocouples are near the process tubes and are not expected to last.

3. Six nonreplaceable thermocouples (RT-1 through 3 and RL-1 through 3) are located in the reflector portions of the graphite, three near the center line in each of the left and top graphite reflectors.

4. Eighty-four nonreplaceable (permanent stringer) thermocouples are located in the graphite cooling tube blocks, directly above or below the process tube bearing blocks. Thirty-nine of these eighty-four thermocouples are spares and terminate in junction boxes in the left inner rod room. These 39 duplicate measurements of the remaining forty-five thermocouples which are located in three vertical support tiers positioned at approximately the quarter points of the active zone from side to side. These couples enter the left side of the reactor in 15 locations and are numbered PS-1 through PS-15. Each location monitors three points from side to side. PS-1 and PS-3 have one couple at each location (total of 6); and PS-2, and PS-4 through 15 have two couples at each location (total of 78).

   These thermocouples are installed with permanent stringers and are numbered according to the stringer and thermocouple, as well as to the nearest process tube column number and graphite cooling tube number. For example: PS-6-3 (68-2396). These are the numbers that appear in the nameplate legend in the control room.

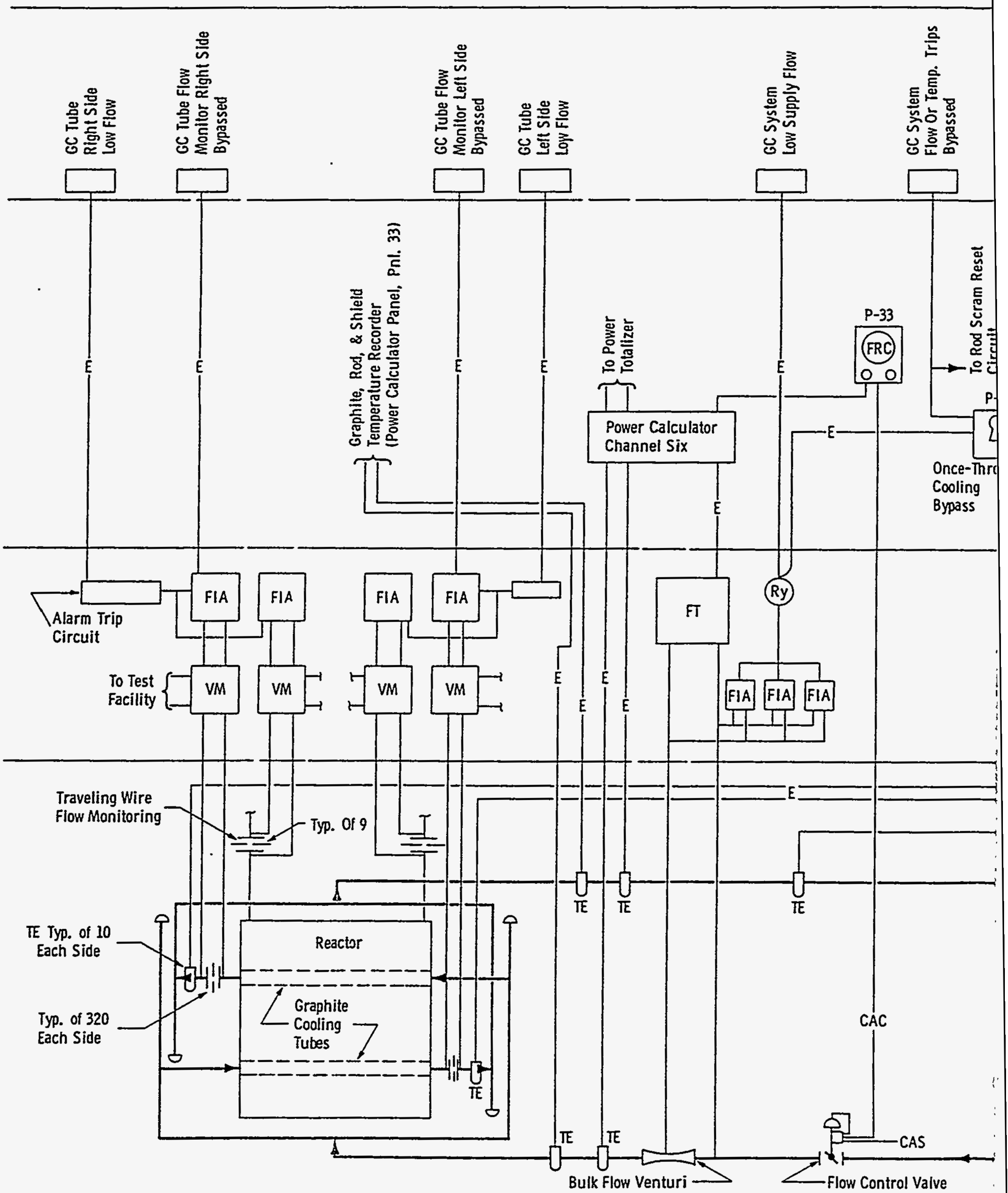
   All of the graphite moderator thermocouples consist of a 3/16 inch diameter, pure nickel sheath, firmly packed with magnesium oxide insulation, and a pair of 20 AWG

GRAPHITE THERMOCOUPLE SYSTEM (CONT'D)

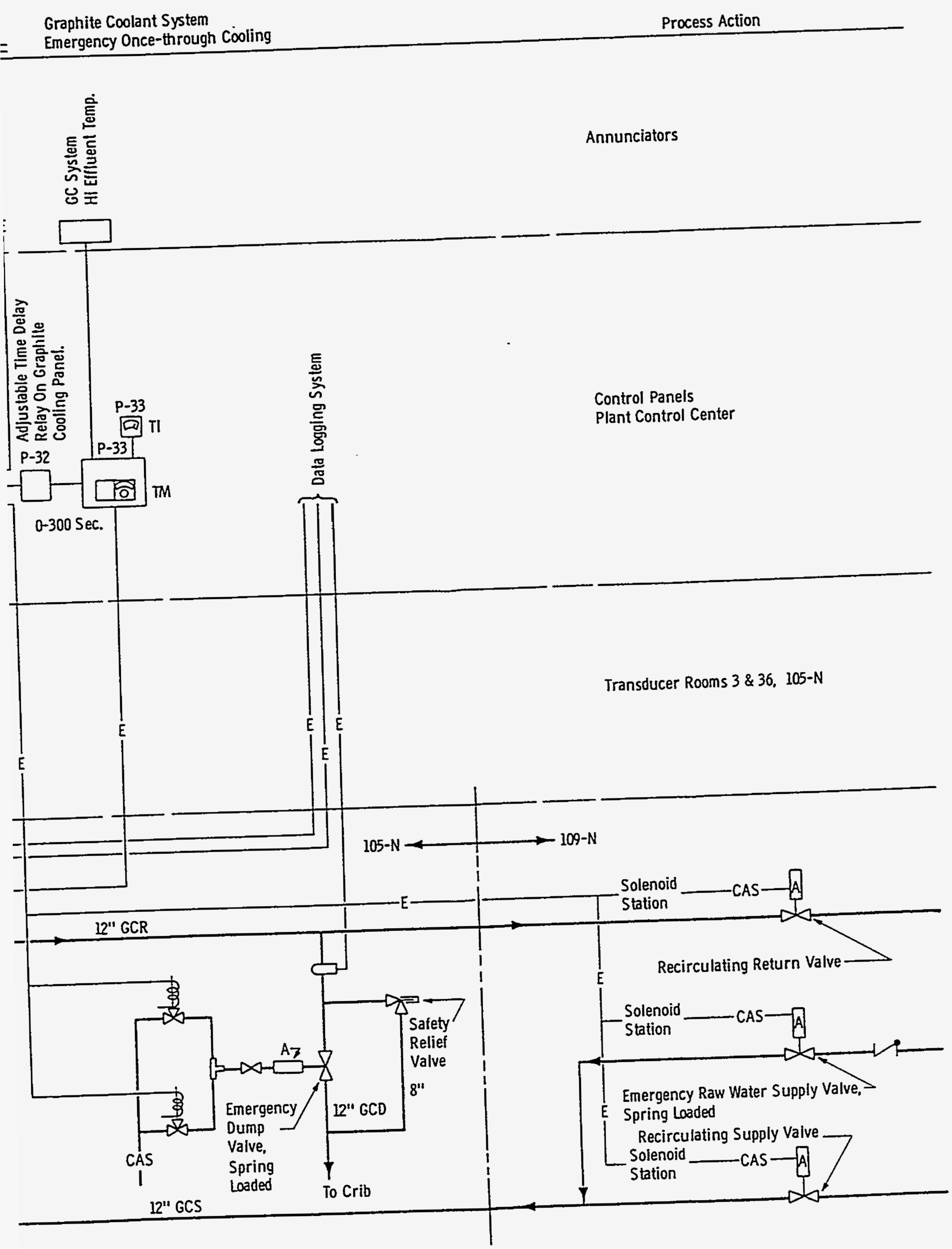
Germinol P & N thermocouple wires which form an ungrounded thermal-junction within the sheath. A 1/2-inch nickel washer is brazed to the sheath 1/2-inch back from the sensing end to provide a method of seating the thermocouple in the graphite with a threaded graphite plug. One hundred and four of these are permanently installed moderator thermocouples which are routed through special channels in the graphite cooling tube blocks, and are terminated in junction boxes in the left inner rod room. The other 35 are run through the center hole of the removable stringers with the sensing end of the thermocouple embedded in the stringer graphite sections in the same manner as above. These 35 thermocouples are also terminated in junction boxes in the left inner rod room.

Thermocouple extension wires are connected at the junction boxes to the metal sheathed ceramic insulated thermocouples. These wires are of 20 AWG PVC insulated conductor pairs with wire characteristics to match the reactor thermocouples. One hundred of these extension wires are routed through conduit and trays to the control room.

In the control room these 100 graphite thermocouples are connected to panel mounted jacks. A single point indicator and two six-point, print-type, single-range recorders are wired to plug-in cords. This permits single point readout of any selected thermocouple and the flexibility of recording any 12 graphite temperatures. In addition, there is a six-point slave recorder at the reactor console. Also, these graphite thermocouples are connected to the central data logging system where it is possible to log all 100 temperatures on demand.



Graphite Bulk Flow and Emergency
and Individual Tube Flow and Tempe



Once-Through Cooling Control,
ature Monitoring Systems - 105N

GRAPHITE BULK FLOW AND EMERGENCY ONCE-THROUGH COOLING CONTROL, AND INDIVIDUAL TUBE FLOW AND TEMPERATURE MONITORING SYSTEMS - 105-N

This system provides graphite bulk coolant flow control by regulation of a control valve in the coolant header supplying the reactor. During periods of low bulk flow or high bulk effluent temperatures, emergency once-through raw water cooling is provided. The system also provides flow monitoring of individual tubes and temperature monitoring of selected tubes.

These control systems are shown schematically on page 21.3.3-1. Various features of these systems are detailed below:

1. The graphite bulk coolant flow is regulated by a diaphram operated butterfly valve located in the coolant header supplying the reactor. This valve will fail open on loss of either control air or power to the control circuit. The valve linkage is set to allow disc travel of only 30 to 90% open with an air signal change of 3 to 15 psig.

   The bulk flow is measured by a venturi located downstream of the flow control valve in the outlet pipe space. The flow signal is sent to a flow transmitter and low flow alarm station, located in Room 175, at the 31'-9"grating. From this station an electrical flow signal is sent through a power calculator to a recorder-controller, located on the power calculator panel No. 33, with automatic-manual controls for positioning and controlling the bulk flow control valve.

2. Once-through emergency raw water cooling is initiated by either a low bulk inlet flow trip or a high bulk effluent temperature trip. A three-position selector switch on the safety circuit control panel can be positioned in the normal position or to bypass either of the above trip sources. Bypassing of either trip actuates an annunciator. Lighted manual trip and reset push buttons are also located on the safety circuit control panel No. 2.

   The above trip function will open the emergency raw water valve, open the emergency dump valve, and close the recirculating return and supply valves. These valves are air cylinder operated and of the butterfly type. The emergency once-through supply and dump valves are fail-safe and will open on loss of control air or de-energization of their control circuit. Three position switches indicating open, automatic, and closed positions for these valves are located on the graphite cooling panel No. 32.

   The high bulk effluent temperature signal originates from a resistance temperature detector which sends its signal through a temperature monitor and indicator on the power calculator panel to the emergency once-through cooling trip circuit and to a plant control center annunciator.

   The low bulk inlet flow trip signal originates from the flow alarm switches in Room 175, with a two out of three coincidence. The signal being sent to the emergency once-through coolant trip circuit and to a plant control center annunciator.

3. During once-through emergency cooling, the bulk effluent temperature is measured by a resistance temperature detector located in the emergency dump

GRAPHITE BULK FLOW AND EMERGENCY ONCE-THROUGH COOLING CONTROL, AND INDIVIDUAL TUBE FLOW AND TEMPERATURE MONITORING SYSTEMS - 105-N (CONT'D)

line. This temperature measurement is fed to the central data logging system where it can be printed on demand.

4. Additional inlet and outlet bulk temperature measurements are sensed with resistance type temperature detectors. A set of inlet and outlet measurements feeds the power calcualtor panel and another set feeds the graphite, rod, and shield temperature recorder on the power calculator panel.

5. The flow through each graphite cooling tube is continuously monitored by an orifice assembly, in the tube exit pigtail, from which sensing lines transfer the differential pressure across the orifice to flow monitor racks in transducer rooms 3 and 36. These racks contain the valving manifolds for the calibration and testing of the flow monitors, the flow monitors, and the electrical alarm circuitry. The individual flow monitors provide visual indication of the flow rate (0 to 12 gpm) and have an adjustable low flow trip contact for actuating a row alarm light and holding relay which in turn actuates an annunciator in the plant control center. Each monitor also has an individual trip identification which remains visible until manually reset. Both the trip points for the electrical contact and for the trip identification signal are adjustable from the front of each monitor unit with a trip adjustment knob. In addition, each monitor unit has a telephone type bypass jack on the front of the unit which will allow the units trip functions to be bypassed. An annunciator in the plant control center will indicate if any monitor units are so bypassed. The above control center low trip and bypass annunciation also indicates whether the condition exists in the right or left transducer rooms.

   The flow from the nine traveling wire flux monitors is also continuously monitored by including them in the above monitoring system. Five tubes have monitoring units in the right transducer room in series with the graphite tube monitoring units; and four tubes have monitoring units in the left transducer room.

6. The outlet temperatures of 20 selected graphite cooling tubes, ten on each side, are measured and fed to the central data logging system where they can be printed on demand. Copper-constantan thermocouples of the quick-disconnect type are used with extra length thermocouple lead wire which is folded and clipped to the tubing, so that any thermocouple may be moved to any other nozzle in the same tube row. The cooling tubes being monitored on the right side are 0491, 0791, 1091, 1391, 1689, 1693, 1991, 2291, 2591 and 2891; and those on the left side are 0390, 0690, 1990, 1290, 1588, 1592, 1890, 2190, 2490 and 2790.

GRAPHITE COOLANT PRESSURE CONTROL SYSTEM

This system is designed to maintain graphite coolant system pressure within predetermined limits at a safe margin above saturation pressure, by the regulation of helium gas pressure in the graphite coolant surge tank.

At the common inlet header to the graphite coolant heat exchanger in the auxiliary cell, a pressure sensing line taps off to supply a signal to two transmitters, (PT-204 & 225) for system pressure control, and to a pressure switch (PS-233) which provides electrical interlocks in the valve motor start circuit of 49 valves associated with the graphite system. This interlock prevents inadvertant opening of these valves whenever system pressure is above a preset valve.

The following valves are interlocked through PS-233:

GCRV-304-1 through 10
GCRV-306-1 " 6
GCSV-310-1,5,6,7 & 8
GCSV-309-2 through 18
DCRV-204-1
DCFV-205-1

(Note: PS-233 is in series with temperature switch TS-274, Ref. 21.3.4 which prevents opening of the above valves with the exception of DCRV-204-1 and DCRV-205-1, when graphite loop temperature is above a preset limit).

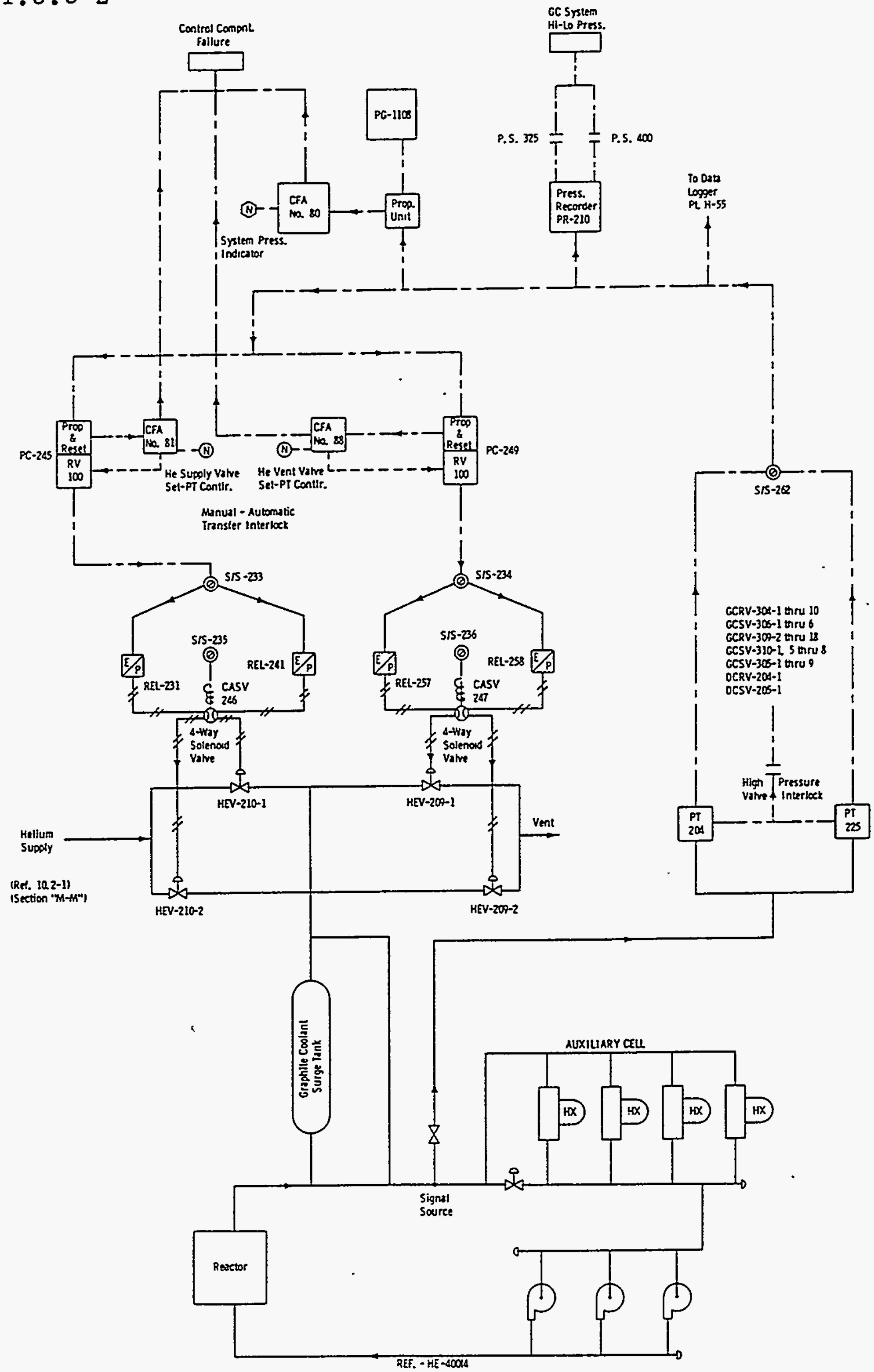
Either of the two pressure transmitter signals can then be selected by (S/S 262) on the graphite coolant panel.

This selected signal is transmitted to the data logger, and to a pressure recorder (PR-210) which contains two pressure switches (PS-325 for low pressure and PS-400 for high pressure), which actuate an annunciator on low or high system pressure. This signal also goes to a proportional unit which provides a signal to a pressure gage (PG-1108). The proportional unit is monitored, and upon failure of the unit, the CFA actuates an annunciator indicating control component failure.

The control signal or input signal goes to two RU-100 type controllers, with proportional and reset action units. PC-245 controls the surge tank helium pressurizing valves and PC-249 controls the surge tank depressurizing valves. The controller action units are monotored, and upon failure, CFA's 81 and 88 actuate an annunciator and transfer the respective controller from automatic to manual, with the same output loading that existed immediately prior to the failure.

The pressurizing control valves, HEV-210-1 and 2, regulate the helium supply to the surge tank whenever the pressure drops below setpoint pressure. The depressurizing control valves, HEV-209-1 and 2, regulate the vent flow from the surge tank whenever the surge tank pressure is above setpoint pressure.

The output loading from each pressure controller is connected to a pair of electropneumatic signal transducers. Each pair of signal transducers is connected to the



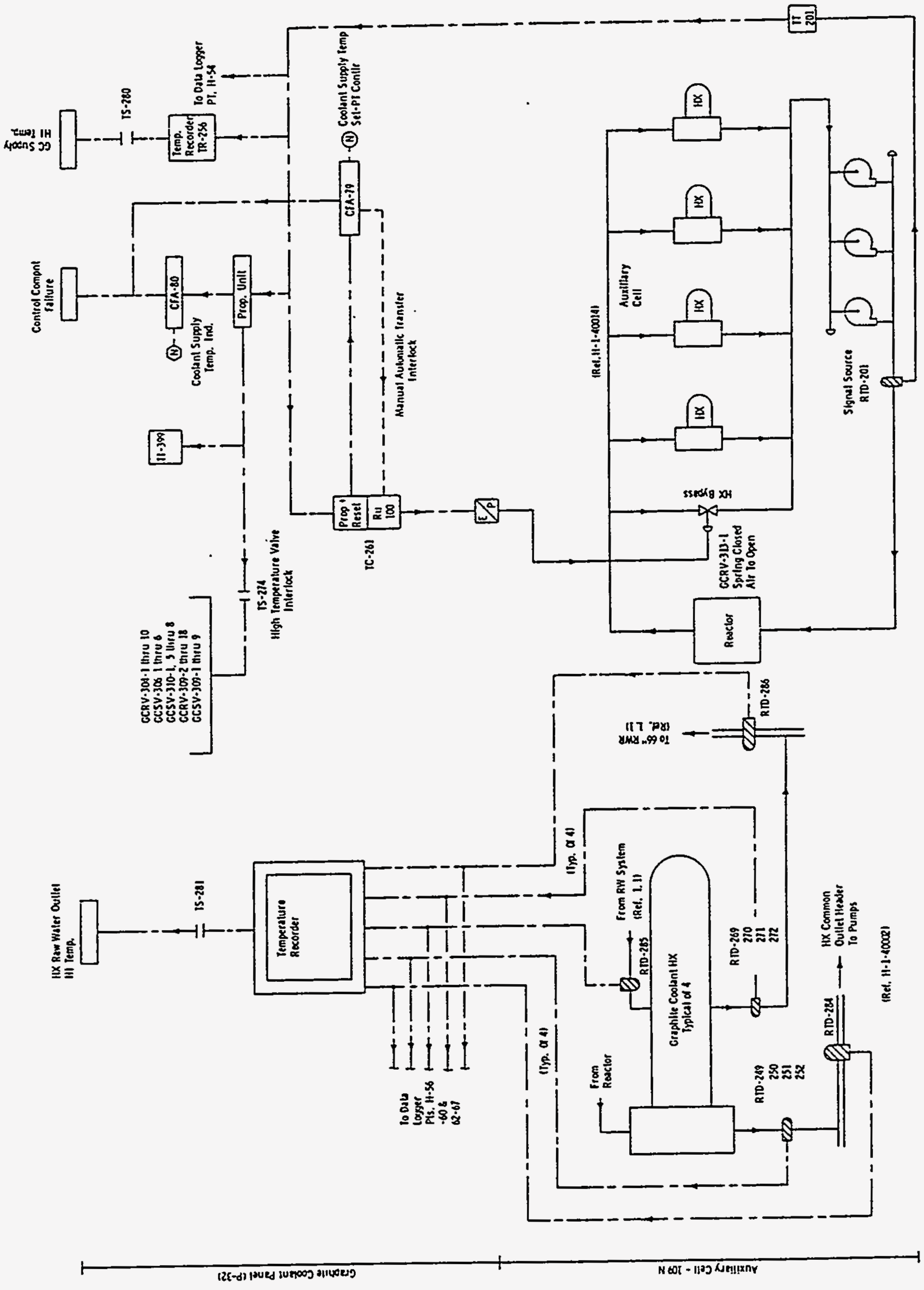
Graphite Coolant Pressure Control System

GRAPHITE COOLANT PRESSURE CONTROL SYSTEM (CONT'D)

associated control valves through a 4-way solenoid air pilot valve. By turning selector switches S/S-233 or 234 one way or the other, either of the two signal transducers can be put into operation. Also, by turning S/S-235 or 236 (which positions the 4-way solenoid pilot valves CASV-246 or 247 one way or the other) either of two control valves can be placed into service. Thus, for control of either the pressurizing or depressurizing valves, either of the transducers can be used for feeding either of the control valves.

The pressurizing and depressurizing valves are 1-inch, normally-closed, air-to-open diaphragm-operated valves.

The controllers, indicators, switches, and recorder of this system are located on the graphite coolant panel, P-32.



Graphite Coolant Bulk Temperature Control System

GRAPHITE COOLANT BULK TEMPERATURE CONTROL SYSTEM

This system provides temperature control of the graphite bulk coolant by positioning of a control valve located in the bypass line around the graphite coolant heat exchangers. The system also provides temperature monotoring of the bulk and individual heat exchanger raw water and graphite coolant streams.

The control signal source is a resistance temperature detector located downstream of the graphite coolant circulating pumps. Temperature transmitter (TT-201) located on a local panel in the auxiliary cell transmits a plus or minus 25 volt d-c signal, proportional to the temperature, for primary control action and to the following:

1. To the data logger, PT. H-54.
2. To a temperature recorder (TR-256), which through a temperature switch (TS-280), actuates an annunciator on high temperature of the graphite coolant supply to the reactor.
3. To a proportional unit which provides signals to a temperature indicator (TI-399) and a temperature switch (TS-274), which acts as a high temperature interlock to 47 graphite coolant system valves. (Note: TS-274 is in series with pressure switch PS-233, Ref. 21.3.3). This proportional unit is monitored, and upon failure of the unit, the CFA actuates an annunciator indicating control component failure.

The control signal goes to a temperature controller (TC-261) on a graphite coolant panel. This controller is a RU-100 type which has a proportional and reset unit. This unit is monitored, and upon failure of the unit, the CFA actuates an annunciator and automatically transfers the controller from automatic to manual control by means of a transfer relay.

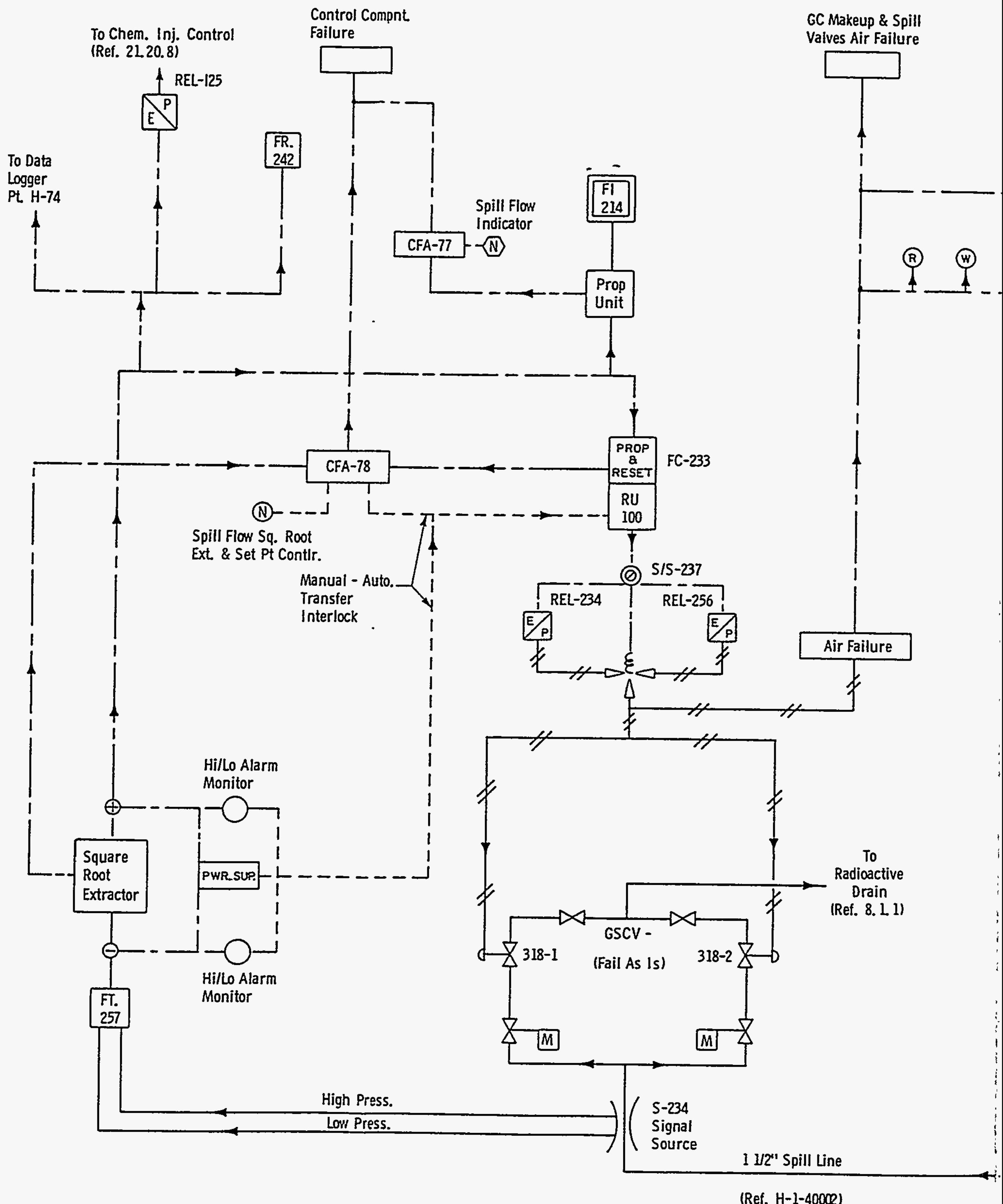
The input signal to the temperature controller is corrected for set point error, and the compensated signal goes to an electric-pneumatic transducer, which converts the electric signal to a proportional air signal.

This signal is used to adjust the graphite coolant heat exchanger bypass valve (GCRV-313). Actuation of this valve adjusts the bulk temperature of the graphite coolant by adjusting the coolant flow through the heat exchanger bypass line.

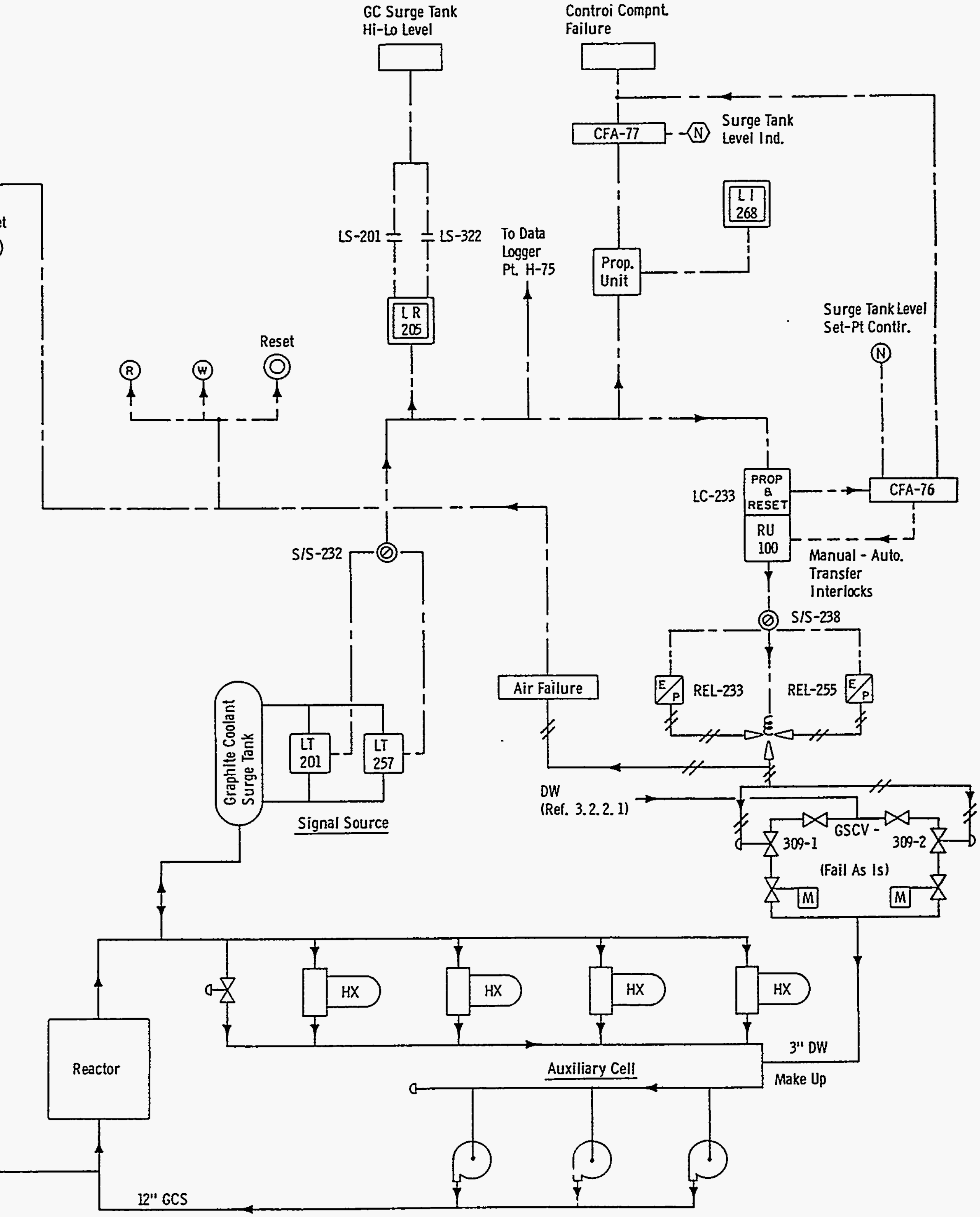
Resistance temperature detectors are provided to monitor the bulk and individual heat exchanger raw water and graphite coolant streams as follows:

1. HX raw water bulk inlet.
2. HX raw water bulk outlet.
3. Individual HX raw water outlet.
4. HX graphite coolant bulk outlet.
5. Individual HX graphite coolant outlet.

All of these points are continuously recorded, and signals are also supplied to the central data logger. A signal is also supplied to a temperature switch (TS-281), which actuates an annunciator when the HX raw water bulk outlet temperature exceeds a pre-set limit.



Graphite Coolant Surge Tank Lev(



and Spill Flow Control Systems

GRAPHITE COOLANT SURGE TANK LEVEL CONTROL SYSTEM

This control system is designed to automatically maintain a set level in the graphite coolant surge tank by automatic control of fill valves GCSV-309-1 and 2.

Two level transmitters (LT-201 and LT-257) transmit d-c signals proportional to the surge tank level. Zero to six feet of water will produce a 0-100% transmitter output. The normal surge tank level will be approximately 3'6" above the lower pressure tap. A transmitter signal selector switch S/S-232, located on the graphite coolant panel selects the signal from either level transmitter for service. This selected signal is transmitted to the following:

1. A surge tank level recorder with high and low level switches (LS-201 and LS-322) which actuate an annunciator.
2. The data logger, point H-75.
3. A proportional unit which supplies a signal to a surge tank level indicator. The proportional unit is monitored, and upon failure, the CFA actuates an annunciator.
4. The control system.

The surge tank level controller (LC-233) is an RU-100 type with proportional and slow reset action. The action unit is monitored, and upon failure the CFA actuates an annunciator and automatically transfers the controller to manual by means of a transfer relay.

Either of two electric pneumatic transducers may be selected by selector switch (S/S-238) on the graphite coolant panel. The two graphite coolant system makeup valves (GCSV-309-1 and 2) receive the same air signal at all times. However, one valve is out of service with its associated motor operated block valve closed.

The supply air to the valve operators is monitored and upon failure of supply air the valves remain in position (fail as is). Actuation of air valves isolates the loading air to the valve operator. Air failure lights, (red for air failure and white for normal) along with an air failure reset push button are on the GCP. The air failure signal also actuates an annunciator.

GRAPHITE COOLANT SPILL FLOW CONTROL SYSTEM

The graphite coolant spill flow control system is designed to automatically control graphite coolant spill at a rate which is manually set to facilitate loop purity.

The control signal source is a flow nozzle installed in the 1-1/2" spill line in the auxiliary cell. The differential pressure across the flow element, which is proportional to the flow, is the loading signal to a flow transmitter.

The transmitter square root extractor transmits a d-c signal linear to the graphite coolant spill flow. A failure of the fixed power supply to the extractor or of the extractor itself, actuates an annunciator, an alarm light, and automatically transfers the flow controller to manual control. The following units are supplied with a signal from the square root extractor:

1. The Data Logger, point H-74.
2. A Flow Recorder, FR-242.
3. A Reference Signal to 184-N for chemical addition.
4. A proportional unit which supplies a signal to a Flow Indicator, FI-214. The proportional unit is monitored, and upon failure the CFA actuates an annunciator.
5. The control system.

The control signal goes to an RU-100 type controller (FC-233) with proportional and slow reset action. This action unit is monitored, and upon failure, the CFA actuates an annunciator and automatically transfers the controller to manual control. S/S-237 on the GCP permits the selection of either one of two electric-pneumatic transducers for spill valve control. Both spill valves respond to the signal changes. However, only one of the valves is actually in use, the other being blocked with a motor operated guard valve.

Upon loss of air supply pressure to the valve operators, valve position remains unchanged by actuation of air valves which isolate the loading air on the operators. Lights, (red for air failure and white for normal) along with an air failure reset push button are on the GCP. Air failure also actuates an annunciator (makeup and spill valve air failure).

GRAPHITE COOLANT SYSTEM CIRCULATING PUMPS AND ASSOCIATED VALVES

This system provides controls, monitoring and interlocks for the operation and protection of graphite cooling system pumps, motors, and valves.

The following are monitored locally and are indicated and annunciated at the graphite coolant panel in the plant control center:

1. Each pump and motor inboard and outboard bearing temperature is monitored. A red alarm indicating light is provided for each monitored point with an annunciator common to all alarms. All 12 bearing temperatures can be indicated individually on a temperature indicator.

2. Each pump is provided with a breaker trip annunciator.

3. Each pump is provided with a pump seal low pressure annunciator.

4. Each pump discharge pressure is monitored. Low pressure actuates an annunciator common to all three pumps.

   (NOTE: For power supplies to the pumps and their associated motor operated guard valves, refer to Section 12 of this manual)

The interlocks for all three pumps and valves are as follows:

1. The pump will not start with the suction valve (GCSV-301) closed. The suction valve will start opening when the pump start switch is turned to close. As soon as the valve is full open, the pump will start automatically. This valve cannot be closed while the pump is running, but will close automatically after the pump has stopped.

2. After the pump is running, the discharge valve (GCSV-304) will open. This valve will also close after the pump has been stopped. The valve cannot be closed while the pump is running.

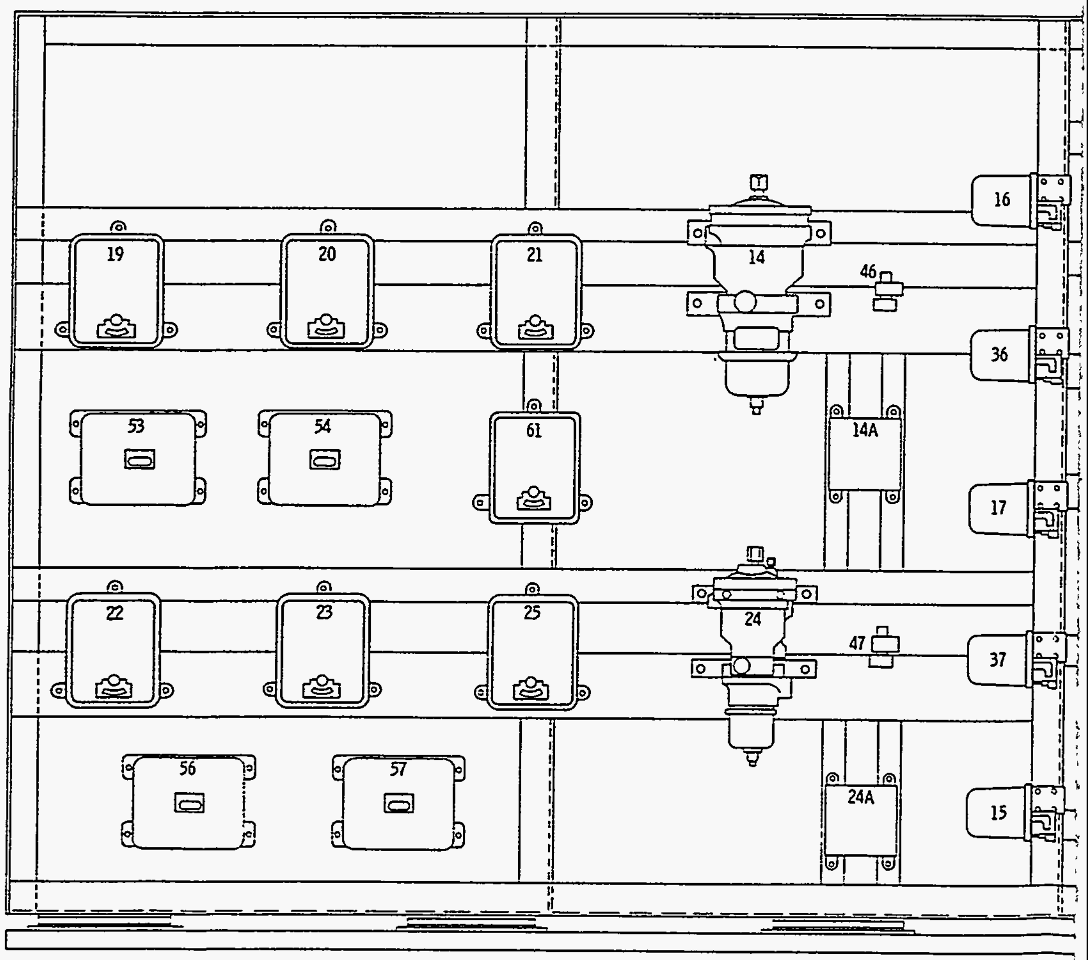
The number three pump has the same interlocks whether power is supplied from A or B bus. The power supply to pump No. 3 suction and discharge valves is always from the same bus which supplies the pump.

All the valves can be manually opened or closed by control switches on the graphite coolant panel, or by test pushbuttons at the motor control centers.

Valve position indicating lights are provided at the GCP and the MCC.

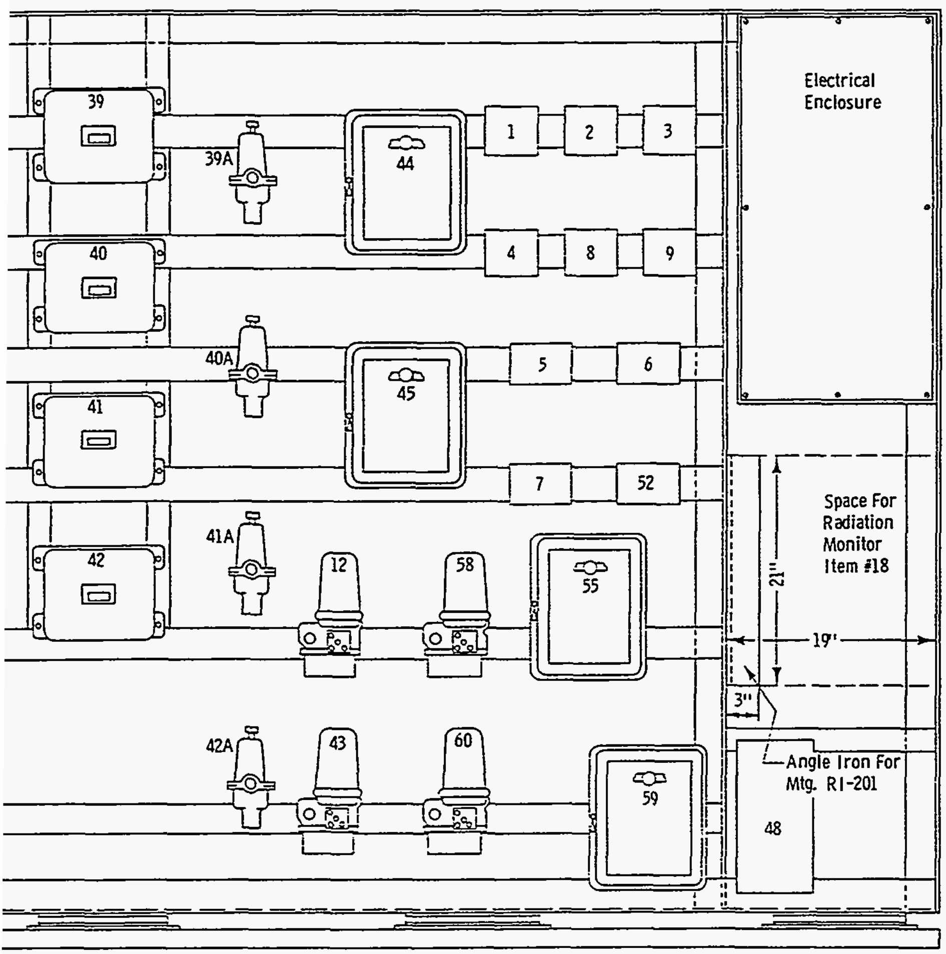
DESIGNATI

ITEM NO.	INST. MARK NO.	DESCRIPTION	ITEM NO.	INST. MARK NO.	DESCI
1	PS-201	Graphite Clg. Recirc. Pump No. 1 Disch. Press. Switch	22	PT-204	Graphite Clg. from Reactor Pr
2	PS-202	Grapnite Clg. Recirc. Pump No. 2 Disch. Press. Switch	23	PT-205	Graphite Clg. Recirc. Pumps !
3	PS-203	Graphite Clg. Recirc. Pump No. 3 Disch. Press. Switch			
4	PS-233	Grapnite Clg. from Reactor Press. Switch	24	FT-263	Inj. Water Return from Prima
5	PS-230	Graphite Clg. Recirc. Pump No. 1 Suction/Seal Diff. Press. Switch	24A	FT-263C	Demodulator for FT-263
6	PS-231	Graphite Clg. Recirc. Pump No. 2 Suction/Seal Diff. Press. Switch	25	PT-281	Helium Feed to Primary Coolar
7	PS-232	Graphite Clg. Recirc. Pump No. 3 Suction/Seal Diff. Press. Switch	36	REL-255	Graph Clg. Surge Tank Level C
8	PS-263	Reactor Prim. Coolant Inlet Header Press. Switch	37	REL-256	Graph Clg. Spill Control Relay
9	PS-264	Reactor Prim. Coolant Inlet Header Press. Switch	39	REL-274	Computing Relay for Obtaining Suction Press. Pneumatic Sig
12	PT-260	Inj. Water HDR/PCP Suction Diff. Press. Transmitter			
14	FT-257	Graphite Clg. to Spill Flow Transmitter	39A	CASV-287	3-Way Pneumatic Trapping Val Relay 274
14A	FT-257C	Demodulator for FT-257			
15	REL-232	Graphite Clg. Temp. Control Relay for GCRV-313-1	40	REL-275	Computing Relay for Obtaining Suction Press. Pneumatic Sig
16	REL-233	Graphite Clg. Surge Tank Level Cont. Relay for GCSV-309-1			
17	REL-234	Graphite Clg. Spill Cont. Relay for GCSV-318-1	40A	CASV-288	3-Way Pneumatic Trapping Val Relay 275
18	RI-201	Radiation Ind. for Cells 1 thru 5 and Aux. Cell			
19	PT-201	Graphite Clg. Recirc. Pump No. 1 Disch. Press. Transmitter	41	REL-276	Computing Relay for Obtaining Suction Press. Pneumatic Sig
20	PT-202	Graphite Clg. Recirc. Pump No. 2 Disch. Press. Transmitter	41A	CASV-289	3-Way Pneumatic Trapping Val Relay 276
21	PT-203	Graphite Clg. Recirc. Pump No. 3 Disch. Press. Transmitter			

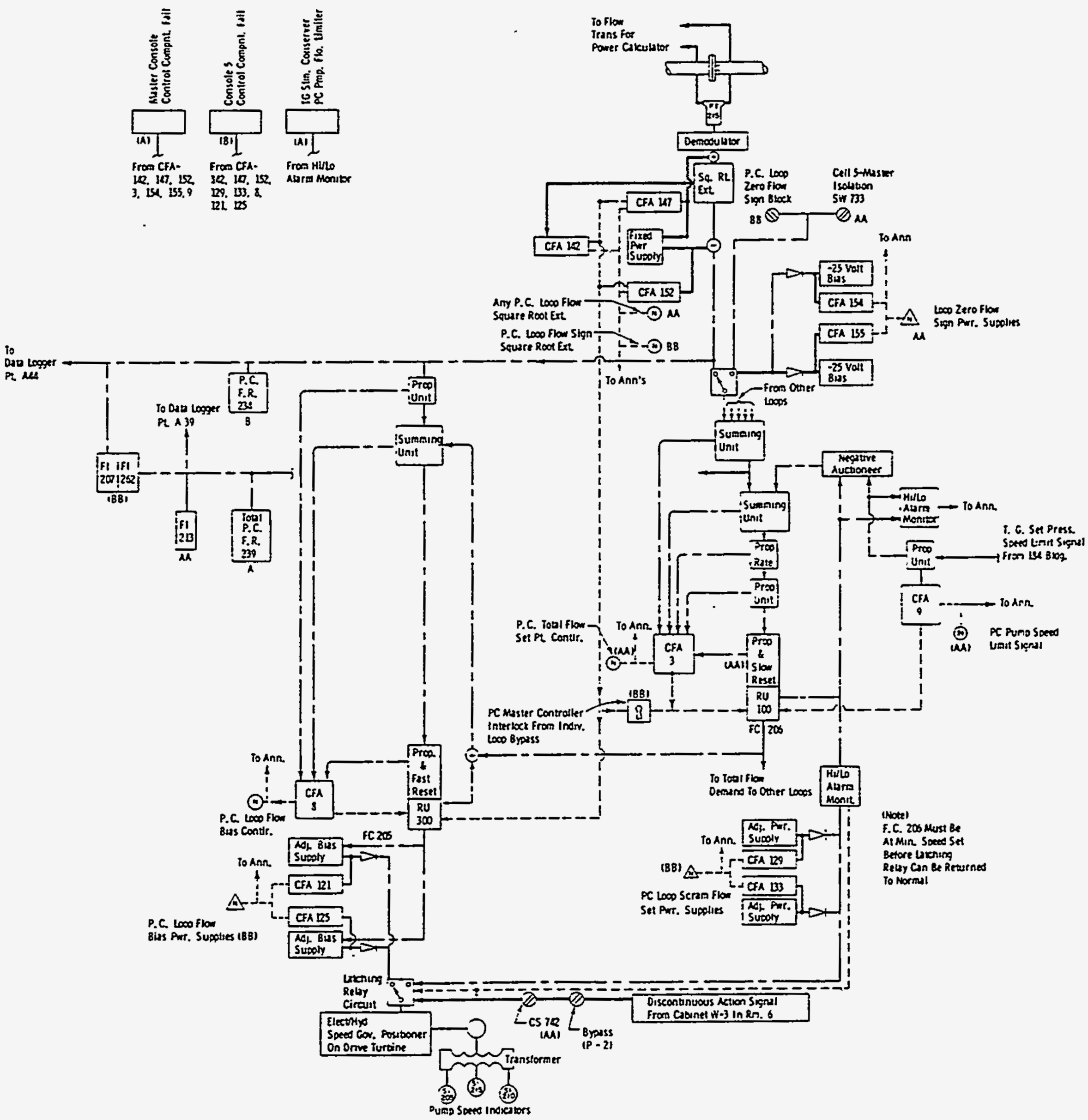


OF ITEMS

ION	ITEM NO.	INST. MARK NO.	DESCRIPTION
Transmitter	42	REL-277	Computing Relay for Obtaining the Highest Prim. Coolant Pump Suction Press. Pneu. Signal
HDR. Press. Transmitter			
oolant Pumps Seals	42A	CASV-290	3-Way Pneumatic Trapping Valve to be Used in Connection with Relay 277
	43	PT-309	Emerg. Seal Water Press. Transmitter
ess. Transmitter	44	REL-278	Pneu./Elect. Trans. for PT-260
ol Relay for GCSV-309-2	45	REL-279	Pneu./Elect. Trans. for PT-309
GCSV-318-2	46	CASV-253	3-Way Solenoid Valve for Selecting REL-233 or Relay 255
Highest Prim. Coolant Pump	47	CASV-254	3-Way Solenoid Valve for Selecting REL-234 or Relay 256
	48		Instrumentation Power Automatic Throwover Switch
be Used in Connection with	52	PS-375	Pressure Switch-Demin. Water Normal Press.
	53	REL-387	Prim. Cool. Pump Suct/Injection Water Disch. HDR. Relay to PT-309
Highest Prim. Coolant Pump	54	REL-388	Prim. Cool. Pump Suct/Injection Water Disch. HDR. Relay to PT-310
	55	REL-390	Pneu/Elect. Transducer for PT-310
be Used in Connection v.th	56	REL-389	Prim. Cool. Pump Suct/Injection Water Disch. HDR. Relay to PT-260
	57	REL-906	Prim. Cool. Pump Suct/Injection Water Disch. HDR. Relay to PT-261
Highest Prim. Coolant ımp	58	PT-261	Inj. Water HDR./P.C.P. Suction Diff. Press. Transmitter
	59	REL-907	Pneu./Elec. Trans. for PT-261
be Used in Connectior ith	60	PT-310	Emerg. Seal Water Press. Transmitter
	61	PT-225	Graphite Coolant from Reactor Press. Transmitter



ocal Panel - 109N



Primary Coolant Flow Control System

PRIMARY COOLANT FLOW CONTROL SYSTEM

The primary coolant flow control system is designed to control bulk and individual loop flows at setpoint by controlling the speed of the turbine driven primary coolant pumps. There is one pump and drive turbine for each primary coolant loop. On scram, the pump speed is reduced quickly to 900 rpm to decrease the rate of primary coolant contraction and to prevent excessive thermal shock to the primary piping.

Failures in the flow control system shown in drawing No. 21.4.1-1 may be corrected by switching to manual control, or will terminate in a scram caused by a process tube flow monitor trip. Scram terminates the effects of flow control failure by switching, via the latching relay, to constant pump speed setpoint and bypassing the normal flow control circuitry. Scram due to control circuitry failure can be eliminated by promptly switching to manual control. Only internal failures of electronic control devices, such as summers and action units, will cause automatic transfer to manual control. Other failures, such as loss of a primary sensing element or grounded electrical connections, will require a quick decision to switch to manual control to prevent a scram.

There are five venturi elements, one of which is located in each 24-inch primary pump outlet pipe (Loop 5 will be used as an example on Page 21.4.1-1 and throughout this narrative). The venturis provide a differential pressure signal to FT-215. The output of the transmitter, an AC signal, is demodulated to a DC signal. Square root extractors then convert this signal to a bulk flow signal.

The system includes one master flow controller (FC-206) and five loop flow controllers. Only one loop flow controller (FC-205) is shown on Page 21.4.1-1.

The master flow control chain consists of a summing unit which obtains total reactor flow by summing the outputs of the five square root extractors operating on the loop venturi signals. The output of the summing unit is fed to the master flow controller consisting of the following components in series:

1. A summing unit, which compares measured total flow against setpoint. The output is the master flow error signal.
2. A proportional plus rate unit.
3. A proportional unit used to reverse polarity of (2) above.
4. A proportional plus slow reset unit.
5. A master selector station (FC-206). Total flow setpoint established in this unit is fed back to summing unit (1) above to be compared with measured total flow. The output of the master selector station may be one of two signals. When on AUTOMATIC, it is the master flow error signal generated in the summing and control action units. When on MANUAL, the signal is manually established in the selector station, via the servo follower which also provides bumpless transfer.

Each loop flow controller consists of the following series of control units:

1. A proportional unit which receives a loop flow signal from its square root extractor.
2. A summing unit which compares measured loop flow against individual biased loop flow setpoint signal. The output of this unit is the loop flow error signal.
3. A proportional plus fast reset unit which generates the pump speed signal.

PRIMARY COOLANT FLOW CONTROL SYSTEM (CONT'D)

4. A bias selector station (FC-205) that provides the ability to manually establish a bias flow adjustment signal which is added algebraically to the master flow demand signal generated in the master flow controller to produce a biased loop flow setpoint signal being fed to (2) above.

System Interlocks and Switches

1. Individual loop square root extractors and fixed power supplies are monitored by CFA's; and when failure is detected, FC-206 and the individual loop bias selector station are transferred from automatic to manual. Selector switches are provided on the cell consoles to bypass these individual loop interlocks of FC-206, so that the master controller may be returned to automatic control.

2. Control action units of master flow controller, FC-206, are monitored by CFA-3. Detected failure transfers the controller from automatic to manual.

3. It is most important that the primary coolant pump turbines do not demand an amount of steam which would reduce the throttle inlet steam pressure at the 184-N TG set below the minimum required for TG operation. To prevent this, a limiting signal representing TG inlet steam pressure is compared with FC-206 setpoint in a negative auctioneer unit. The lower of the two signals is selected and passed to the master flow controller summing unit. The proportional unit monitoring the 184-N limiting signal is monitored by CFA-9; and upon detected failure, FC-206 is transferred from automatic to manual. This limiting signal is in effect only when FC-206 is on automatic control.

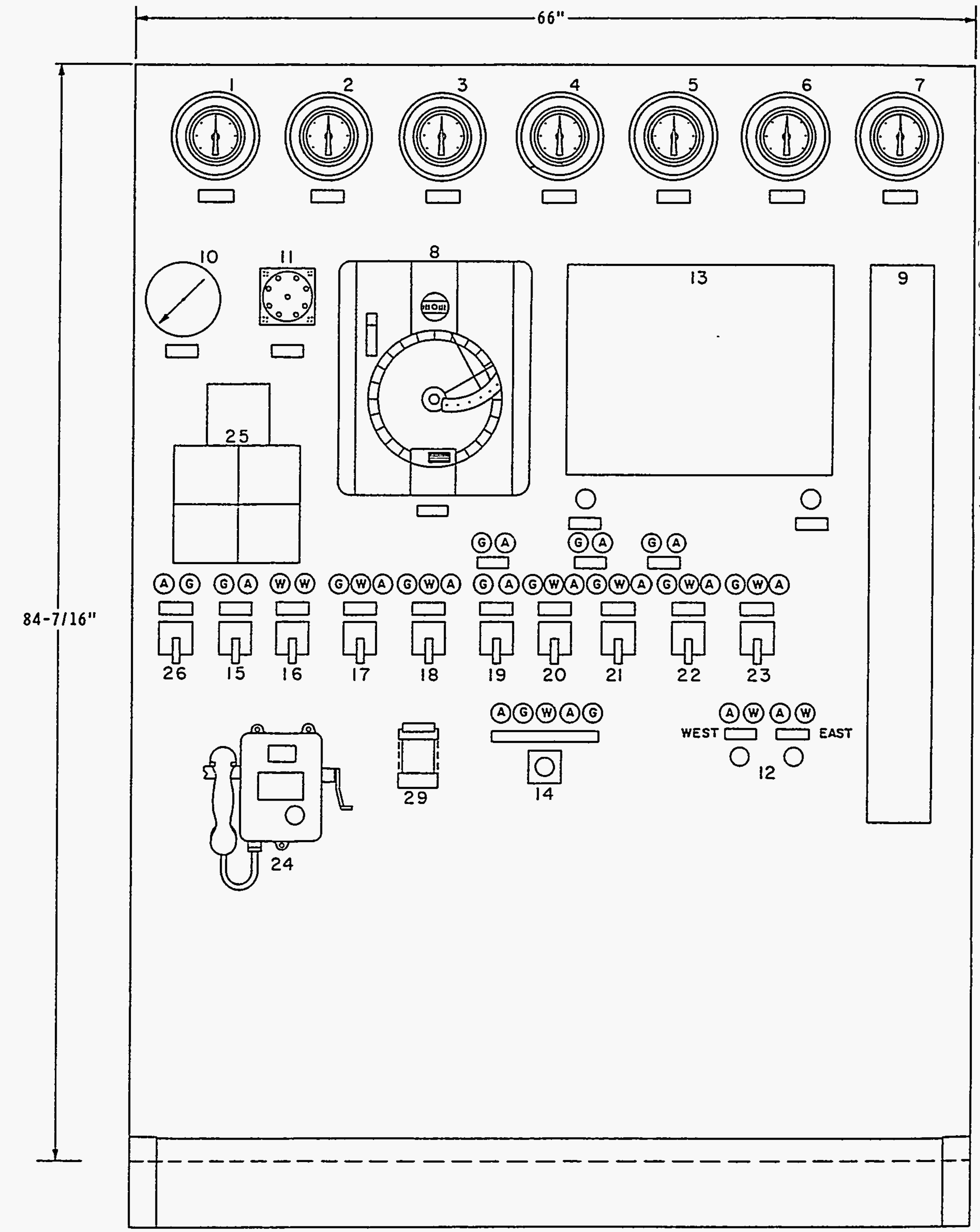
4. Control action units of the individual loop flow controllers are monitored. Upon detected failure, the individual loop bias controller is transferred to manual.

5. Individual loop flow demand signal bias power supplies are monitored by CFA's. Detected failures result in annunciation and CFA light actuation.

6. Individual loop scram setpoint power supplies are monitored by CFA's. Detected failures result in annunciation and CFA light actuation.

7. Following a scram signal after loop flows have been reduced to approximately 25 per cent and before FC-206 can be returned to automatic control, the setpoint of FC-206 must be reduced to the scram set signal. (Ref. 21.6.9 for additional interlocks.) Transfer without setpoint adjustment is prevented by a high-low alarm monitor.

8. There are times when it may be desirable to operate with master flow controller, FC-206, on automatic with only four loops in service. In this case, a zero flow signal for the "removed" loop must be introduced into the summing unit which totals the signals for the five loops. This signal may be introduced with individual cell loop zero flow signal switches or with cell isolation switches (this latter switch also causes other actions, Ref. 21.6.9). Two redundant zero flow (-25V) bias power supplies are provided. These units are monitored by CFA's; and upon detected failure, an annunciator and CFA light are actuated.

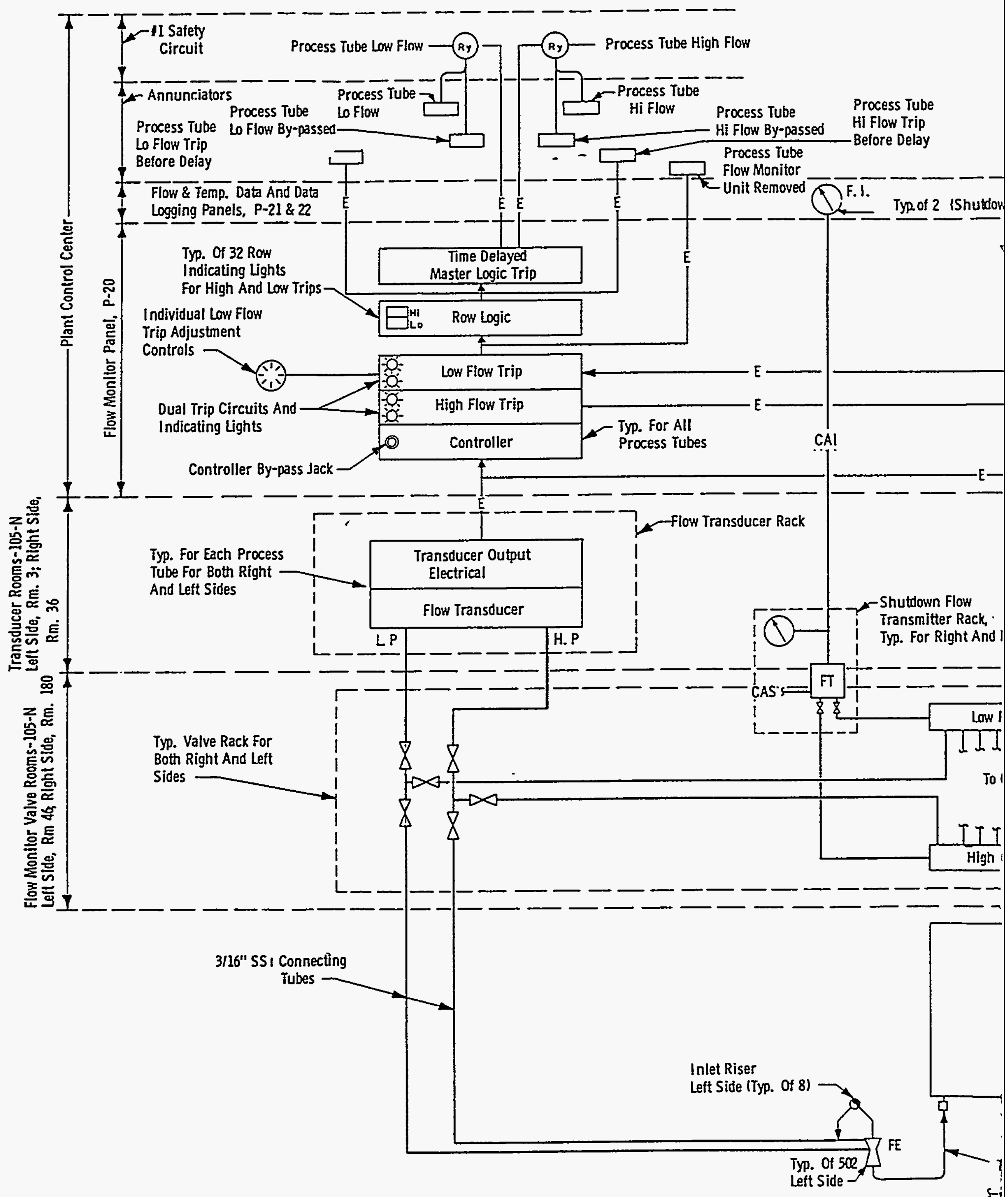


Ref. H-1-40143

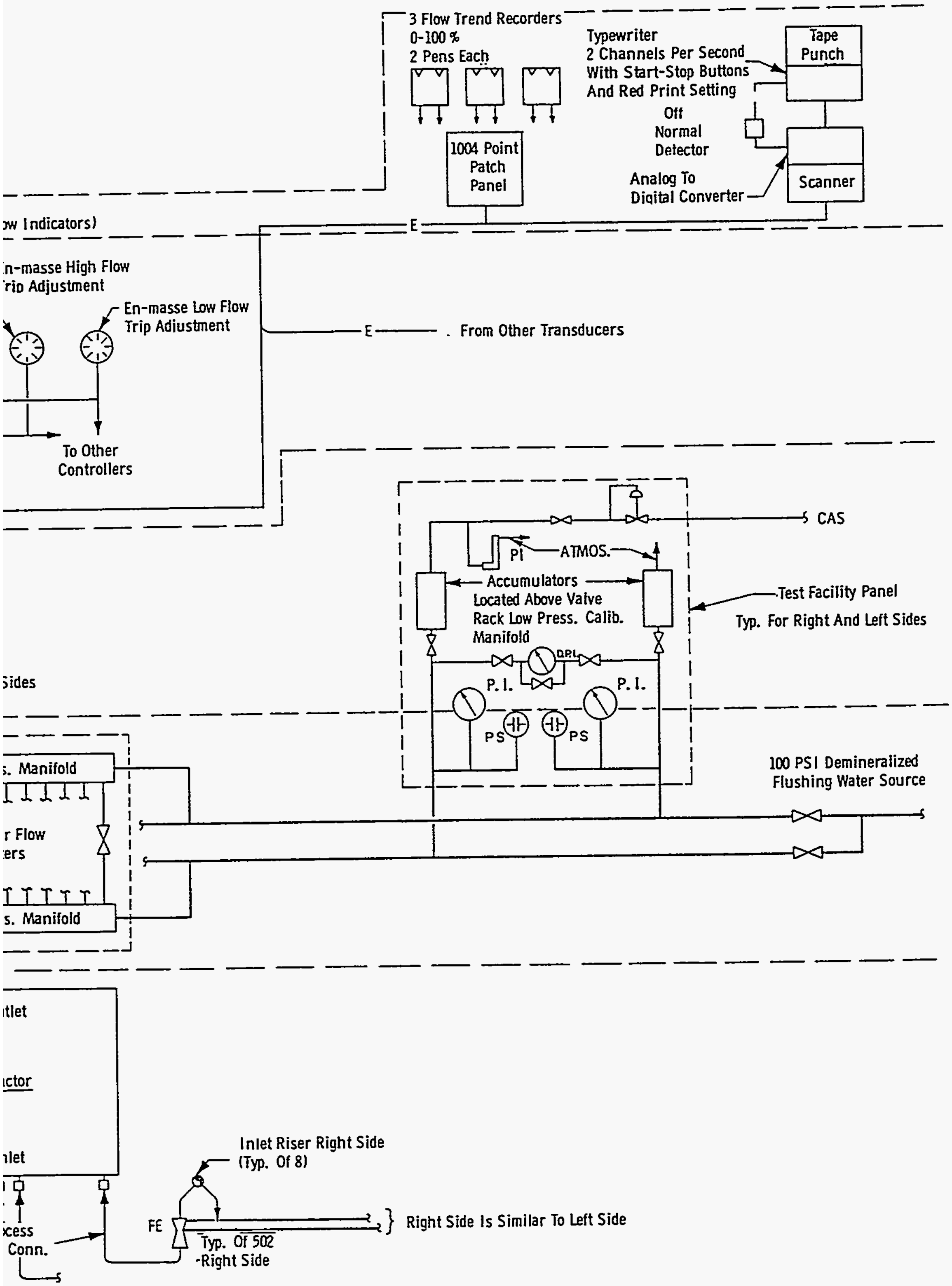
Drive Turbine Control P

DESIGNATION OF ITEMS						
Item No.	Description	Instrument Mark No. Panel No. 1	Panel No. 2	Panel No. 3	Panel No. 4	Panel No. 5
1	Throttle Steam Press. Gage	PG-319	PG-320	PG-321	PG-322	PG-323
2	Turbine First Stage Steam Press.	PG-324	PG-325	PG-326	PG-327	PG-328
3	Turbine Bearing Oil Press. Gage	PG-329	PG-330	PG-331	PG-332	PG-333
4	Turbine Control Oil Press. Gage	PG-334	PG-335	PG-336	PG-337	PG-338
5	Turbine Trip Oil Press. Gage	PG-1059	PG-1060	PG-1061	PG-1062	PG-1063
6	Main Oil Pump A Disch. Press. Gage	PG-1064	PG-1065	PG-1066	PG-1067	PG-1068
7	Main Oil Pump B Disch. Press. Gage	PG-1069	PG-1070	PG-1071	PG-1072	PG-1073
8	Condr. Press, Cond. Temp & Return Flow	FR-201	FR-202	FR-203	FR-204	FR-205
		TR-231	TR-232	TR-233	TR-234	TR-235
		PR-215	PR-216	PR-217	PR-218	PR-219
9	Condenser Pressure	PG-247	PG-248	PG-249	PG-250	PG-251
10	Turbine Speed Indicator	SI-201	SI-202	SI-203	SI-204	SI-205
11	Condenser CRW Outlet Valve Position (RWRV-213)	POI-233	POI-234	POI-235	POI-236	POI-237
12	Turbine Stop Valves Test Pushbuttons and 4 Indicating Lights					
13	30 Pt. Annunciator with Test and Acknowledge PB.					
14	West Stop Valve - Turbine Trip - East Stop Valve					
15	Gland Steam Vapor Extractor Switch (2 Indicating Lights)					
16	Power Bus Selector Switch for Item 15 (2 Indicating Lights)					
17	Condensate Pump A Control Switch (3 Indicating Lights)					
18	Condensate Pump B Control Switch (3 Indicating Lights)					
19	Oil Conditioner Vapor Ext. and By-Pass Pump Sw. (4 Indicating Lights)					
20	Oil Reservoir Vapor Ext. Control Sw. (3 Indicating Lights)					
21	Turning Gear Oil Pump Control Switch (3 Indicating Lights)					
22	Main Oil Pump A Control Switch (3 Indicating Lights)					
23	Main Oil Pump B Control Switch (3 Indicating Lights)					
24	Telephone with Mounting Hook (Magneto and Howler)					
25	Bearing Temp. Monitor and Indicator					
26	Gland Steam Start-Up Supply Control Switch					
27	Turning Gear Engagement Indicating Lights					
28	Turning Gear Motor Indicating Lights					
29	Pony Motor Start-Up Interlock By-Pass Switch					

el (Typical) - 109-N



Process Tube Flow Monitoring



and Data Logging System

UNCLASSIFIED

PROCESS TUBE FLOW MONITORING AND DATA LOGGING SYSTEM

The process tube flow monitoring function provides a reactor safety feature which will scram the reactor whenever out of limit flow conditions occur in any individual process cooling tube. In addition, the flow data logging function provides information on the flow through each process tube for operation and production analysis purposes.

The system monitors coolant flow to each process tube with venturis. Flow transducers receive the differential pressure (DP) signals produced by the venturis, convert these to electrical signals by means of rotary differential transformers, and transmit the electrical signals to controller units which will initiate trip and alarm signals should any individual tube flow vary from selected high or low limits. The same electrical signal is used for tube flow trend recording and is fed through an anolog to digital converter for data logging.

Several of the more important details of this system are:

1. The system monitors 1,004 process tubes. There are provisions at each stage of the system for expansion to 1,072 units.

2. The venturies are designed to put out a pressure differential signal of 25 psi at the Phase II operating design flow. Normal tube flow during Phase I will be approximately 70% of Phase II design flow.

3. The flow monitor valve racks can perform any of the following functions:

   a. Valve the venturi DP to the flow transducers,

   b. Valve the venturi DP to the shutdown flow transmitter,

   c. Valve the DP from the calibration test facility to either the flow transducers or the shutdown flow transmitter, and

   d. Provide a means for back flushing of the sensing lines to the venturi.

4. Since shutdown flows are too small for the flow monitor to accurately detect, shutdown flow transmitters are used specifically for these low flows. There is one transmitter for each transducer room. The transmitter can read only the flow of the tube valved to it by means of the valve rack. Each flow transmitter has an indicator on P-21.

5. The calibration test facility (on each side) is used to apply a precision DP to the flow transducer for checks of accuracy and calibration.

6. Two 100% 420 cycle power supplies (located in Room 301) furnish the excitation voltage to the flow transducers and controllers. Two sets of line terminals and a manual transfer switch permit power to be supplied to these rotating frequency converters from either BPA or Area TG. Although both converters are operated, only one is in use; the standby unit will take over in case a failure occurs in the unit on the line.

7. Each controller consists of two independent trip channels, low flow and high flow; and each trip channel consists of a redundant pair of amplifiers.

PROCESS TUBE FLOW MONITORING AND DATA LOGGING SYSTEM (CONT'D)

Each low flow trip (variable transformer or flux bar) can be adjusted on the front of the controller. The low flow trips of all controllers can also be adjusted en masse by a master low trip adjustment which will modify all low trips by a common percentage of each trip setting. For example: Changing the en masse setting from 100 to 80 will modify all low trips by a multiplication factor of 0.8. All controller high flow trips are determined by fixed value resistors, mounted across the secondary sides of fixed ratio transformers, which give a standard high flow trip at 100%. The high flow trips of all controllers can only be adjusted en masse, by adjusting the primary voltage of the fixed ratio transformers.
The transducer signal enters the controller and is supplied to the redundant low and high trip channels. A diode in the output of each amplifier isolates each amplifier from its redundant mate. The amplifiers are fail-safe, and component failure will cause an individual (low or high) amplifier trip; however, a false trip signal will not be transmitted since both (low or high) amplifiers must trip to actuate row logic. Individual trip indicating lights are provided on each controller for each amplifier.

8. The high and low trip outputs of each controller are diode connected to high and low row trip logic circuits, which in turn are diode connected to a master logic where the high and low trips are combined to form the input to three master trip timers. The outputs of these timers are the inputs to three master relays, which actuate the rod scram safety circuit on a 2 of 3 coincidence. The master trip timers have time delays adjustable between 0.1 and 1.0 seconds.

9. The master logic also actuates annunciators and an inhibit circuit, which prevents any additional controller trip lights from being lighted after a rod scram safety circuit actuation. This provides first to trip identification of the source of the trip signal until the master logic is manually reset. In addition, restoration of normal flow and a reset of row logic before the master logic has timed out will reset the master logic.

10. Each controller unit is provided with a bypass jack. By inserting a bypass plug in one of these jacks, the controller unit may be removed while still maintaining row logic.

11. Monitoring and self-check circuits are provided for the following of the flow monitor system:

    a. The bias voltage of the controller amplifiers is continuously monitored by three sensors. The outputs of these are in a 2 of 3 coincidence, which actuates the three master trip timers.

    b. The flux bars are continuously monitored for loss of excitation, which would mean a low limit trip set of zero. Three sensors are provided. These actuate three time delay relays, which on a 2 of 3 coincidence actuate the three master trip timers. A bypass is provided for this function.

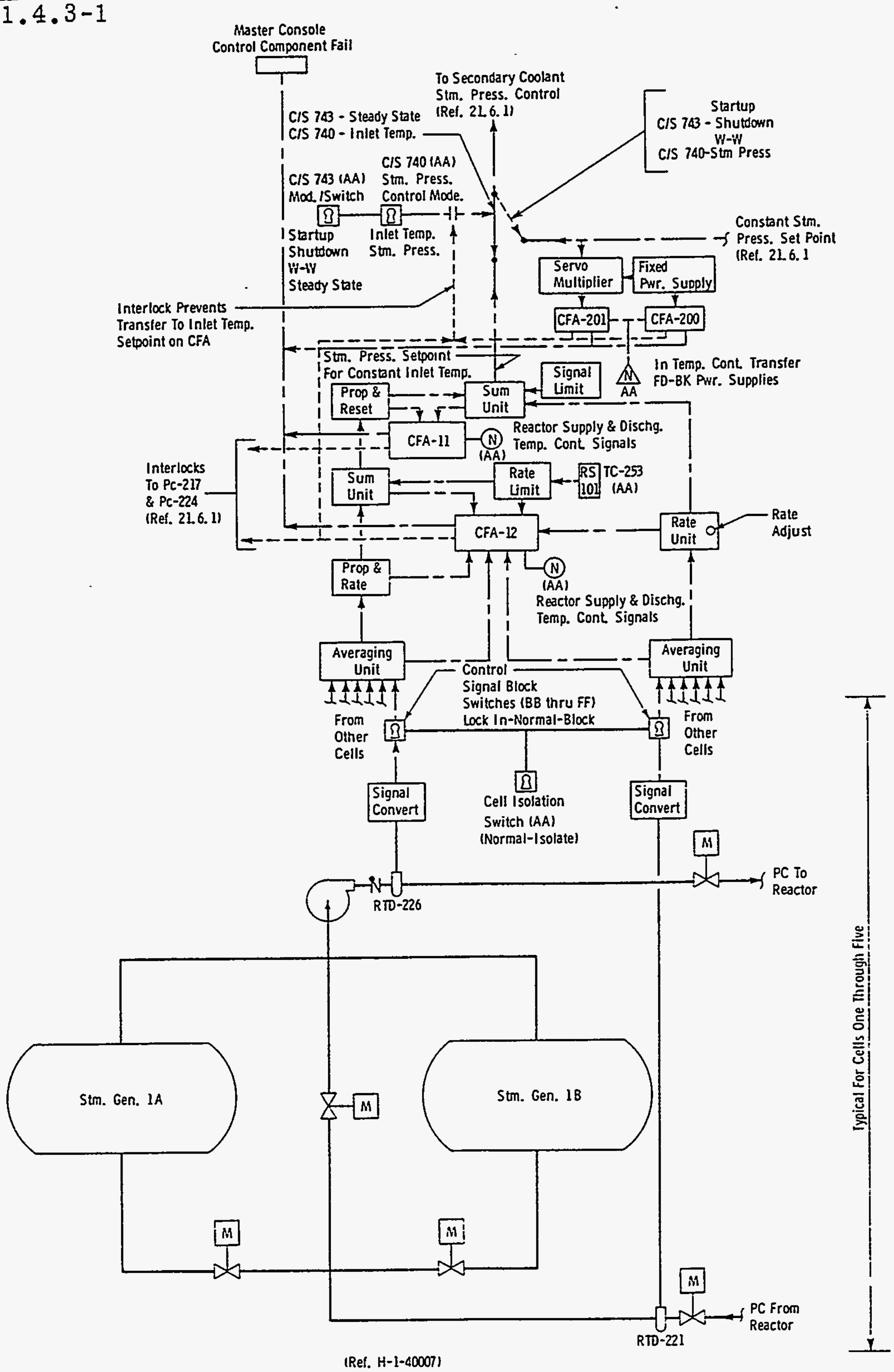
    c. The diode channel logic of each controller is monitored for a shorted condition. A complete short of the high or low diode matrix of a controller

PROCESS TUBE FLOW MONITORING AND DATA LOGGING SYSTEM (CONT'D)

would prevent transmission of a trip signal from any other controller in that row. Test signals are introduced to the high and low diode logics of each channel. The high and low outputs actuate three high and three low detector relays. Either set of relays actuate three time delay relays, which on a 2 of 3 coincidence actuate the three master trip timers. Switches are provided to bypass the high and low shorted detector relays.

d. All diodes, starting with each controller and through the master trip timers, are monitored by a scanner for an open condition. An open diode detector monitors the output of the three master trip timers for test signals inserted before the individual controller low and high logic diode networks. The three open diode detectors actuate three time delay relays, which on a 2 of 3 coincidence actuate the three master trip timers. A bypass is provided for this function. In addition, scanner failure and stopped indicating lights are provided.

12. Electrical anolog DP signals representing the flow are sent to the trend recording and data logging systems, as represented on Page 21.4.3-1. It should be noted again that this data logging is in percent of full scale DP, 25 psig.
The percent DP will be logged in three digit numbers at the rate of two per second by manual initiation of the log cycle. Differential pressures above a single common high DP set point and DP's below a second single common low DP set point will be logged in red. A four-digit time entry, provided by a 24-hour digital clock, is printed at the beginning of each logging cycle. The system also provides for automatically self-checking its accuracy of operation by means of a standard calibration input signal. The system will be checked to three-place accuracy and the value printed on the log sheet. A tape punch is provided for production analysis purposes.



Primary Coolant Temperature Control System

PRIMARY COOLANT TEMPERATURE CONTROL SYSTEM

This system provides the capability, during reactor steady state operation, to maintain the temperature of the primary coolant supply to the reactor at a constant value. In order to accomplish this with constant primary coolant flow, and at the same time accommodate variations in reactor thermal output, the secondary coolant system temperature is adjusted. This adjustment alters the primary to secondary coolant system temperature difference, thereby altering the rate at which heat is transferred to the secondary system. Secondary coolant system temperature adjustment is accomplished by control of secondary steam pressure (Ref. 21.6.1).

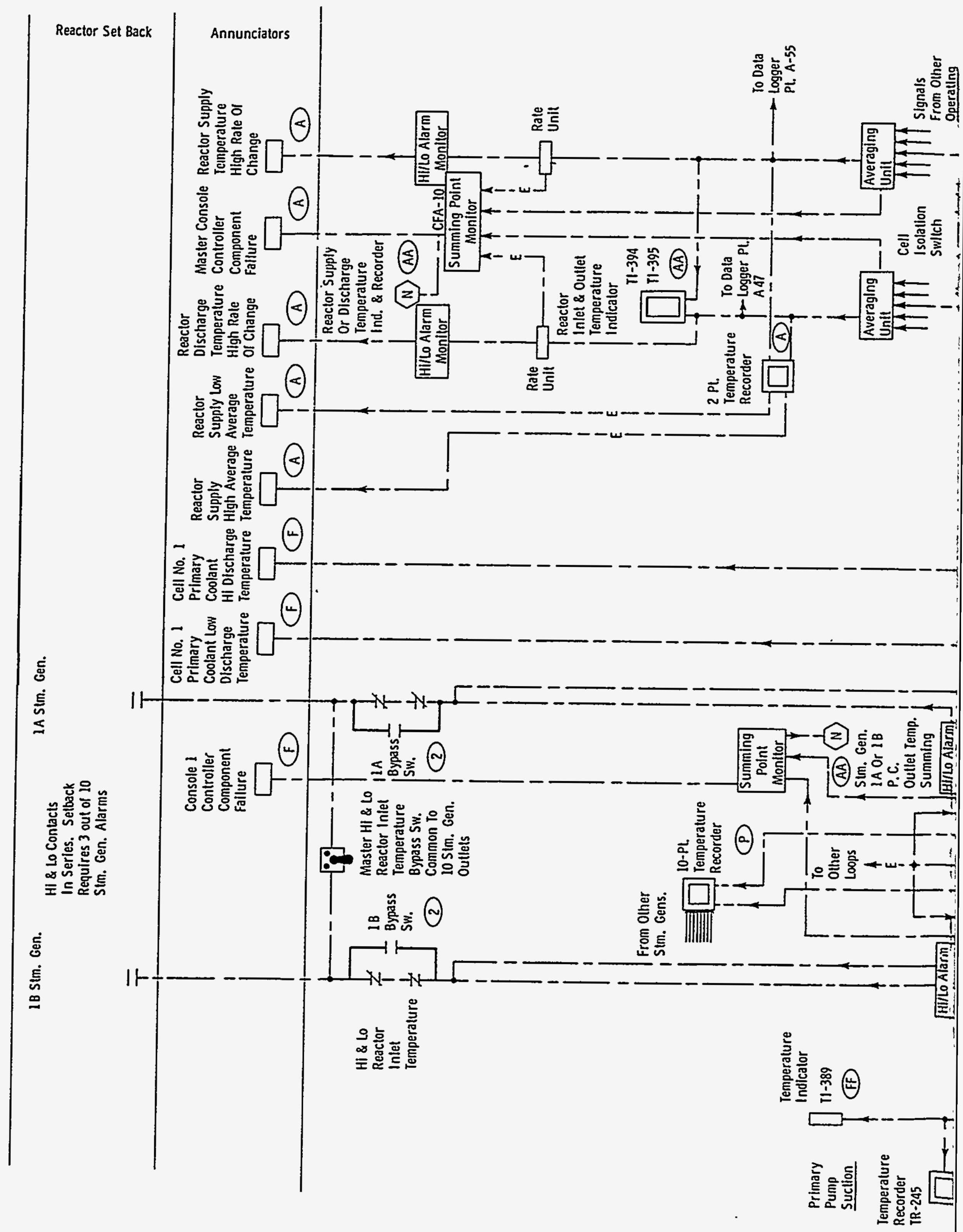
Reactor primary coolant inlet temperatures are measured at the discharge of each primary coolant pump. These temperatures are averaged and compared with the set reactor inlet temperature (TC-253). The resulting error signal becomes the secondary coolant system steam pressure setpoint for constant reactor inlet temperature control.

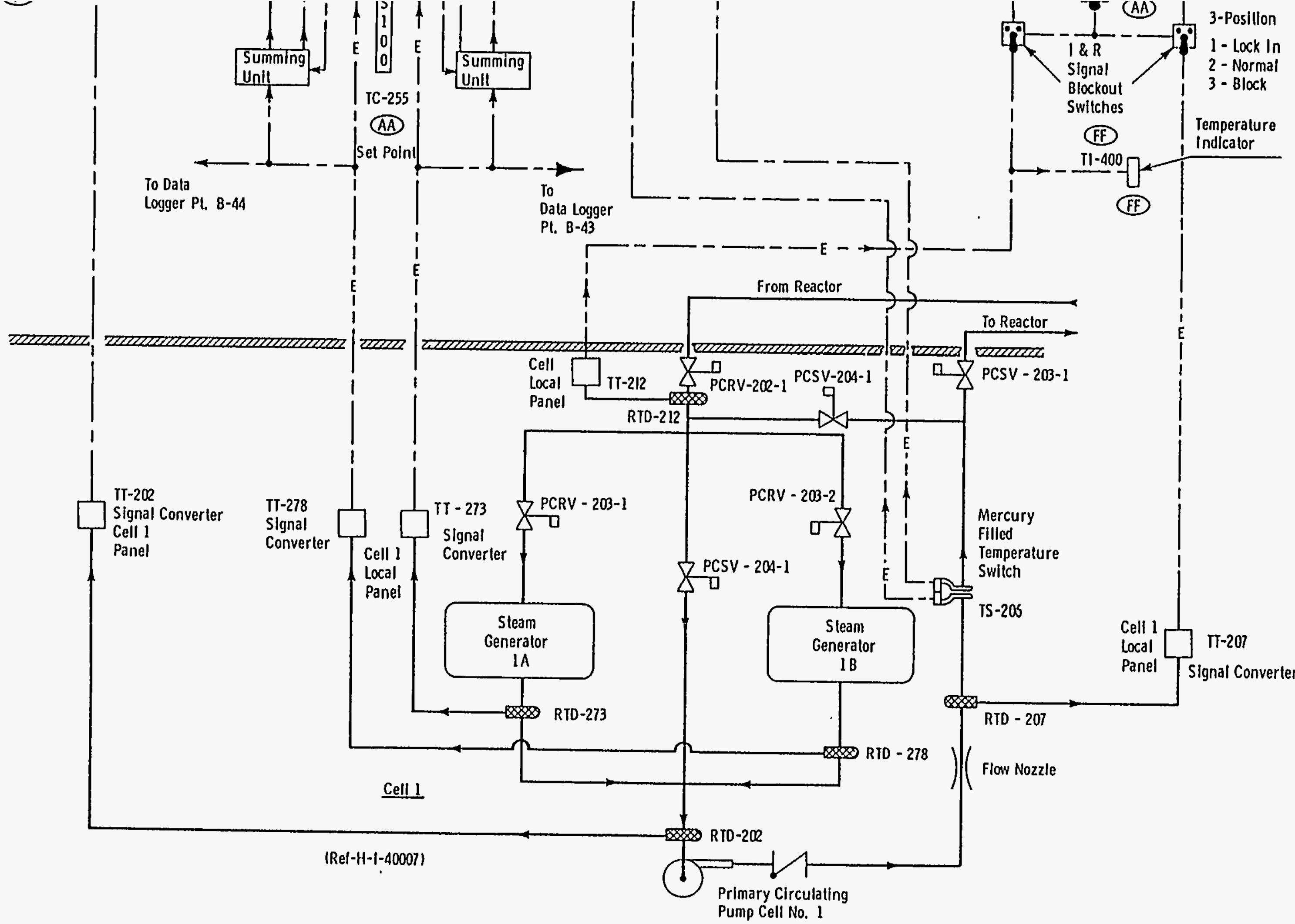
This setpoint signal may be further adjusted, by an anticipatory signal, based on the (adjustable) rate of change of the averaged temperature signals taken in the hot leg of each primary coolant loop. Thus, the secondary system can start to correct before a temperature change is actually sensed at the reactor inlet.

The signal for secondary system steam pressure control is governed by a signal limiter to prevent large step changes which might occur if a reactor inlet or outlet RTD should fail. The unit prevents changing steam pressure setpoint to less than 73 psia or more than 25 psia above normal setpoint.

Other details of this system are:

1. Cell individual temperature control signals may be locked in or blocked out of the system by use of control signal block switches. These switches also have an "isolate" (normal) position which permits removal of both control signals by use of a cell isolation switch.
2. The action units of this system are monitored; and upon failure, an annunciator is actuated. In addition, the following interlocks are effected:
   a. If a failure exists when transfer to inlet temperature control is attempted, CFA's 11, 12, 200, or 201 prevent the transfer.
   b. If CFA's 11 or 12 detect a failure when on inlet temperature control, the in service steam pressure controller (PC-217 or 224, Ref. 21.6.1) is transferred from AUTOMATIC to MANUAL.
3. The rate of change of TC-253 setpoint is controlled by a rate limiter to prevent unwarranted primary coolant system upsets by limiting the rate at which a step change can be introduced.
4. An adjustment (105-N, Rm. 6, Cabinet GGG) is provided to permit a change of the influence of the rate of change of reactor outlet temperature on the steam pressure setpoint.
5. The selection of secondary coolant steam pressure control via TC-253 is normally made by placing the modal switch (c/s-743 in the steady state position (Ref. 21.6.9). Selection may also be made with the modal switch in any of its other three positions, with the use of the steam pressure control selector switch (c/s-740).
6. The servo multiplier (and associated fixed power supply) is provided for bumpless transfer when going from constant steam pressure to constant inlet temperature control. The servo multiplier follows the constant steam pressure setpoint, and provides feedback to modules of this system to accomplish this function.


Reactor Set Back
Annunciators
1B Stm. Gen.
1A Stm. Gen.
Hi & Lo Contacts In Series. Setback Requires 3 out of 10 Stm. Gen. Alarms
Cell No. 1 Primary Coolant Low Discharge Temperature
Cell No. 1 Primary Coolant Hi Discharge Temperature
Reactor Supply High Average Temperature
Reactor Supply Low Average Temperature
Reactor Discharge Temperature High Rate Of Change
Master Console Controller Component Failure
Reactor Supply Temperature High Rate Of Change
Console 1 Controller Component Failure
Master Hi & Lo Reactor Inlet Temperature Bypass Sw. Common To 10 Stm. Gen. Outlets
1A Bypass Sw.
1B Bypass Sw.
Hi & Lo Reactor Inlet Temperature
Reactor Supply Or Discharge Temperature Ind. & Recorder
Hi/Lo Alarm Monitor
CFA-10
Summing Point Monitor
Rate Unit
Reactor Inlet & Outlet Temperature Indicator
TI-394
TI-395
2 Pt. Temperature Recorder
To Data Logger Pt. A47
To Data Logger Pt. A-55
Averaging Unit
Cell Isolation Switch
Signals From Other Operating
Summing Point Monitor
Stm. Gen. 1A Or 1B P.C. Outlet Temp. Summing
Hi/Lo Alarm
10-Pt. Temperature Recorder
From Other Stm. Gens.
To Other Loops
Temperature Indicator TI-389
Primary Pump Suction
Temperature Recorder TR-245



Primary Coolant Temperature Monitoring System

UNCLASSIFIED

PRIMARY COOLANT TEMPERATURE MONITORING SYSTEM

The design intent of this system is to continuously monitor the primary coolant system at specific locations to provide temperature signals to various indicators, recorders, alarms, and the rod setback circuit.

Reactor inlet and outlet temperatures are measured within the cells by duplicate sets of resistance temperature detectors (RTD's). Each of the ten temperature signals is converted to a plus or minus 25 volt DC signal by a signal converter. The five reactor outlet temperatures are indicated on consoles BB through FF. The inlet and outlet signals are averaged separately. The average reactor outlet temperature is recorded on A Panel, and a signal is provided to the data logger (Point A47). The average temperature is also indicated on AA Console.

The rate of temperature change is monitored by a rate unit and a "high-low" alarm monitor, which actuates an annunciator on A Panel if rate is excessive. The average reactor inlet temperature is also recorded on A Panel, indicated on AA Console, and data logged (Point A55). The recorder on A Panel is also provided with temperature switches to actuate annunciators on either high or low inlet temperature. The rate of temperature change is also monitored and annunciated on A Panel.

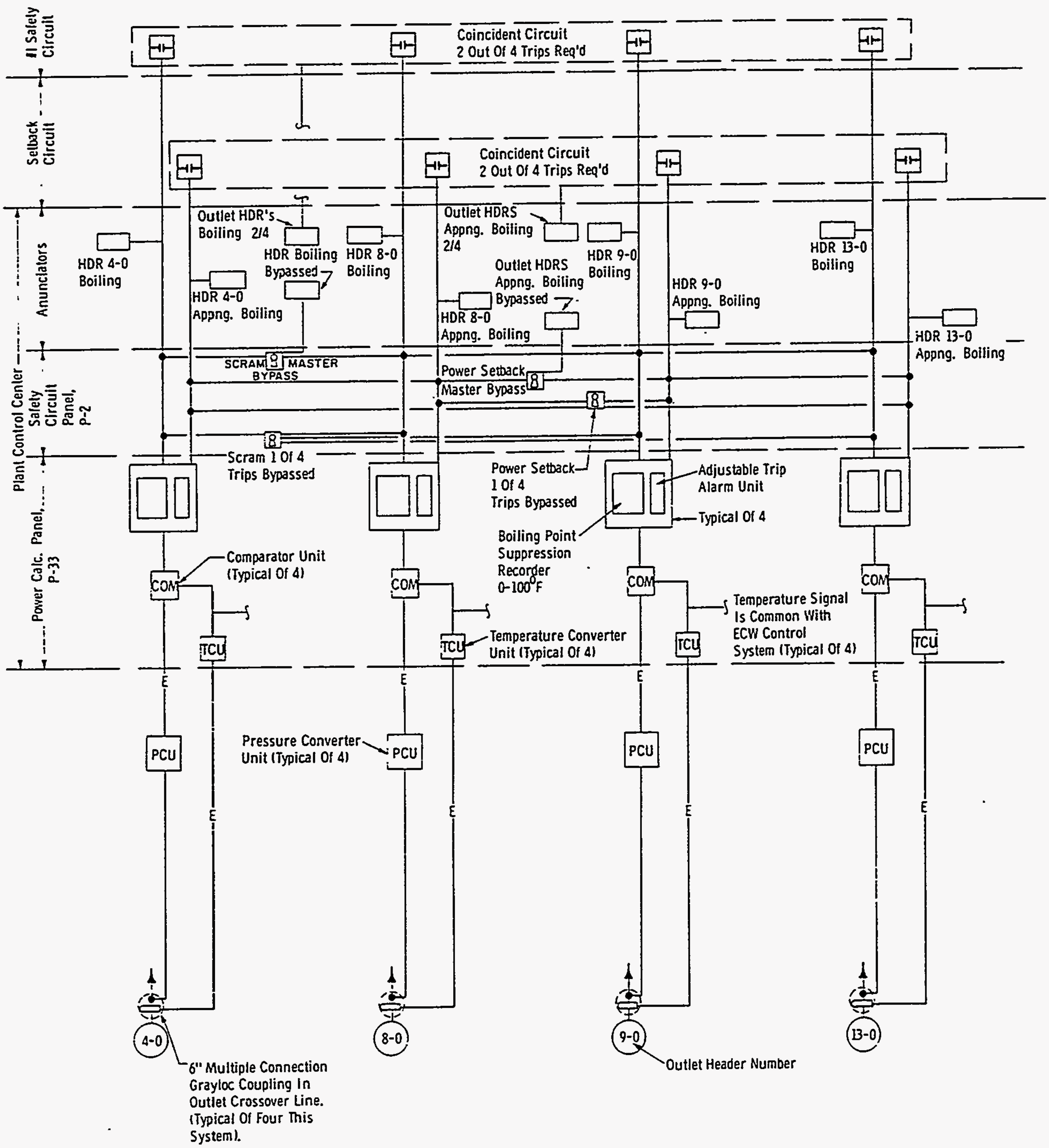
CFA-10 monitors both reactor inlet and outlet temperature averaging units and rate units; and, upon failure, actuates an annunciator on A Panel and a CFA light on AA Console.

Two temperature indicating and recording "cell block-out" switches are provided on each cell console, and a "cell isolation" switch is provided for each cell on AA Console. One "cell block-out" switch is for reactor inlet temperature, and the second is for reactor outlet temperature. Each of the "cell block-out" switches are three-position. The "isolate" position is the normal position with control of the signal from the master cell isolation switch. With the cell isolation switch in "normal", the temperature signal is averaged; and in the "isolate" position, the signal is blocked. With the cell block-out switch in the "lock in" position, the signal is also averaged. With the switch in the "block" position, the temperature signal is taken out of the averaging unit. Note: The master cell isolation switch has no effect on the temperature signals if the cell blocking switch is in either the "lock in" or "block" position.

Each individual steam generator primary coolant outlet temperature is monitored by separate RTD. Each temperature signal is compared to the setpoint signal from TC-255 on AA Console, and the resultant error signal is used to actuate individual high-low alarm monitors. If deviation from setpoint exceeds the settings of the high-low alarms, a reactor setback is initiated (Ref. 21.13.3).

The steam generator outlet temperatures are data logged (points B-43 through B-52), and are recorded on "P" Panel. All ten summing units are monitored, and failure of any unit will actuate an annunciator for the effected cell on panels B through F and a CFA indicating light on AA Console.

Each primary coolant pump suction temperature is monitored, recorded, and indicated on the appropriate cell console and panel. High or low reactor inlet temperatures are also monitored by direct connected temperature switches in each cell, which actuate high or low annunciators on panels B through F. A high reactor outlet temperature interlock to primary coolant system valves is provided by direct connected temperature switches in the five cells.



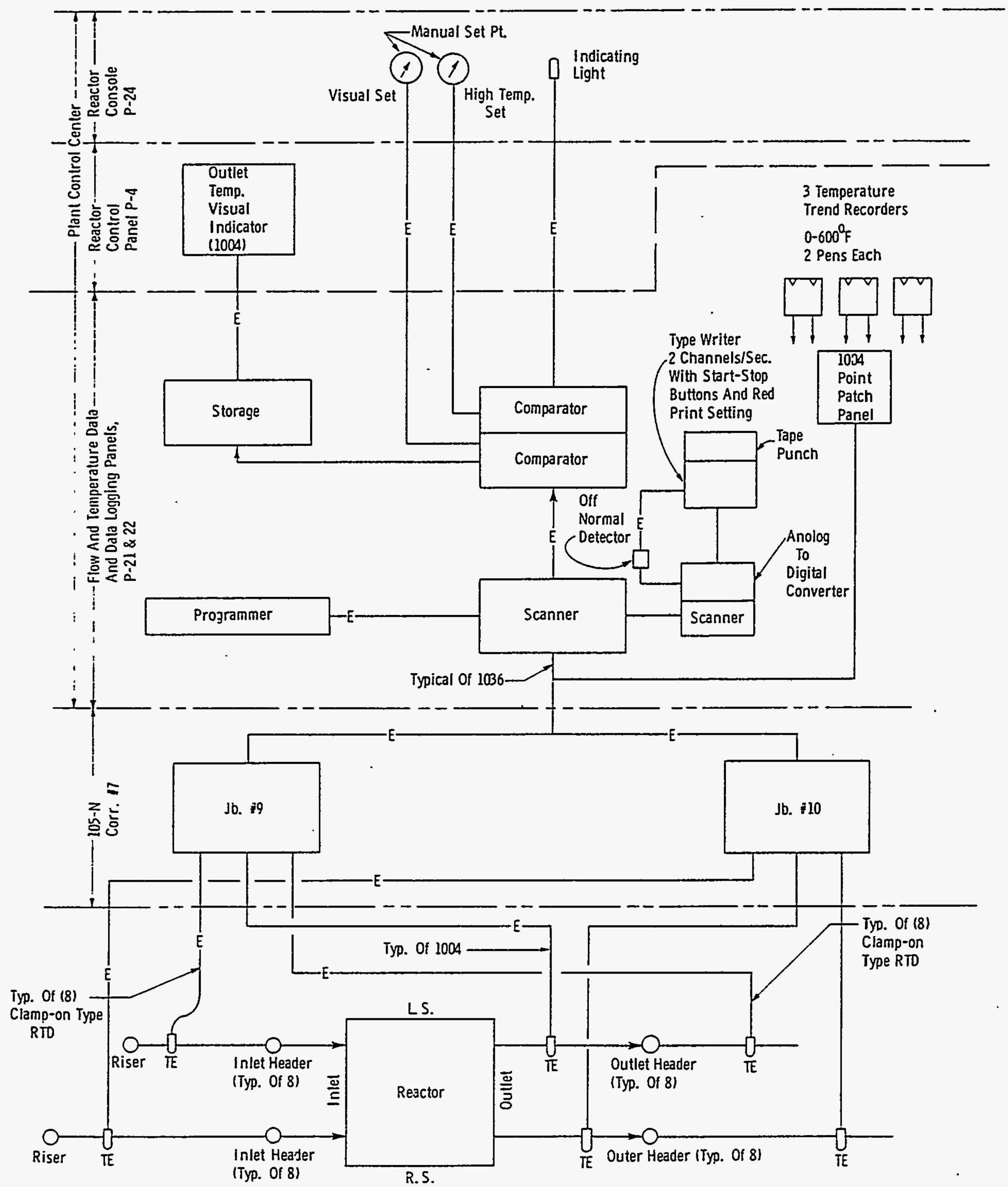
Bulk Boiling Point Monitoring System - 105-N

BULK BOILING POINT MONITORING SYSTEM - 105N

The bulk boiling point measurement system is designed to insure that the bulk primary coolant temperature is at all times sufficiently suppressed below the boiling point temperature. In the event of excessively high bulk coolant temperatures, the system will initiate either setback or scram functions in order to maintain reactor operating conditions within safe limits.

A four-channel system is provided for comparing the bulk temperature with the boiling point temperature in each of four outlet header (4, 8, 9, and 13) cross-over lines. A six-inch multiple-connection Grayloc coupling, located in a tee in each of these cross-over lines, is used for a resistance temperature element well and for a pressure sensing line tap. The temperature signal goes to a temperature converter unit and then to a comparator unit, while the pressure signal goes to a pressure converter unit and then to the same comparator unit. The pressure converter unit transforms the pressure signal to an electrical temperature signal by means of a servo-motor and slide wire which is calibrated according to the pressure-temperature boiling point curve. Thus, the pressure signal is actually being transformed to the boiling point temperature for comparison with the actual temperature. The comparator unit makes this comparison and transmits a boiling point suppression signal which is continuously recorded. The signal is also fed to a trip monitoring unit and then to the rod scram and power setback coincident trip circuits which receive the signals from all four channels.

Any boiling trip will actuate an annunciator. Two of four "approach to bulk boiling" trip signals will cause a power setback, and two of four "bulk boiling temperature" trip signals will cause a scram.



Reactor Process Tube and Inlet and Outlet Header Temperature Monitoring and Data Logging Systems - 105-N

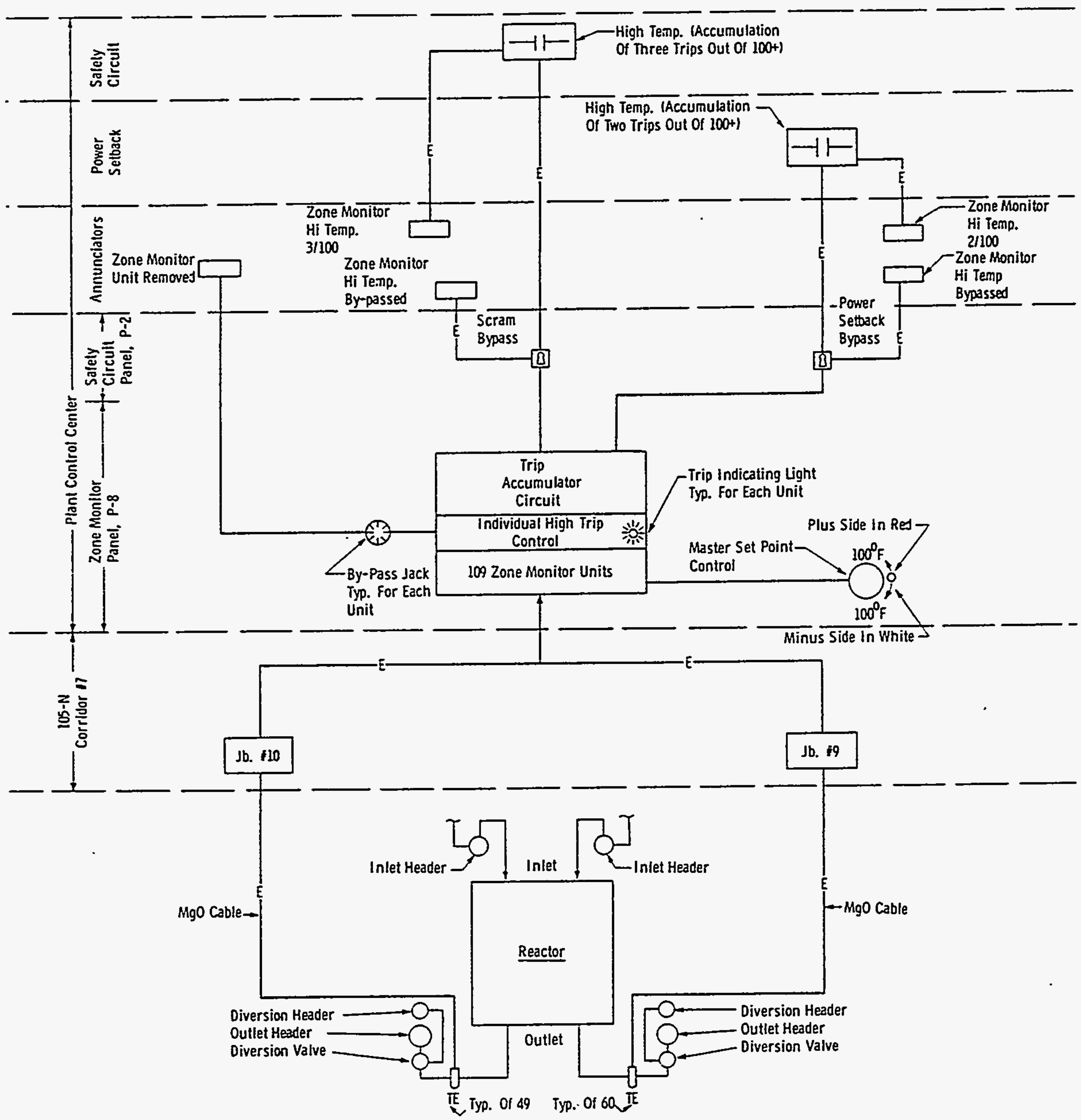
REACTOR PROCESS TUBE & INLET & OUTLET HEADER TEMPERATURE MONITORING & DATA LOGGING SYSTEMS - 105N

The process tube and inlet and outlet header temperature monitoring and data logging systems are designed to provide exit tube temperature information to satisfy both operational and production analysis purposes.

The system is primarily an information system and does not automatically perform any safety functions. It continuously monitors the outlet temperatures from each process tube and from the inlet and outlet headers, providing this information to a trend recorder and a digital data logger. The system also provides information to an indicator which, by a scanning process, provides a visual indication of all outlet temperatures above a common preset limit. In addition, this scanning device provides an alarm function if any tube outlet temperature has increased above a common adjustable high limit.

Several of the more important features of the system are:

1. Resistance-temperature detectors of the surface-measuring strap-on type are installed on all process tube outlet connectors, and on the 18" cross-over lines at the top of the inlet and outlet headers. The resistance material for the detectors is pure platinum.
2. Three conductor, copper-sheathed magnesium-oxide insulated lead wire is used. The use of three leads eliminates considerations of lead wire length in establishing the resistance-temperature correlation.
3. The visual monitoring temperature function is represented by a light bank of non-filament glow type lamps on a format representative of the process tube pattern, of 1004 tubes with provisions for expansion to 1072 tubes. The monitor is located on the panel behind the reactor console. The time response of this monitor is such that the oldest data observable represents a detector temperature, at the point of measurement, that existed no more than 20 seconds previously.
4. A visual set dial is provided at the reactor console which is marked from 75°F to 600°F. All temperatures above the setpoint are lighted on the visual format and remain lighted until the next scanning cycle. Lamps are extinguished one at a time and not in groups.
5. A high-temperature set dial, marked from 75°F to 600°F, is provided at the reactor console for initiating an alarm indicator when any detector temperature is above the dial setpoint.
6. A data logging function is provided by a typewriter for the following inputs: 1004 tube outlet detectors, 16 inlet headers, 16 outlet headers, a digital clock, a self-check function, and 68 spares. Data logging is on demand at the rate of two 3-digit numbers per second. A red-print setpoint dial permits all temperatures above the setpoint to be printed in red. The function also includes a tape punch for production analysis purposes and an automatic calibration feature for self-checking accuracy.
7. Trend recording is provided by means of a jack board and three 2-point recorders. Both data logging and trend recording functions are operable at the same time.



Process Tube Zone Temperature Monitor System

AEC-GE RICHLAND, WASH

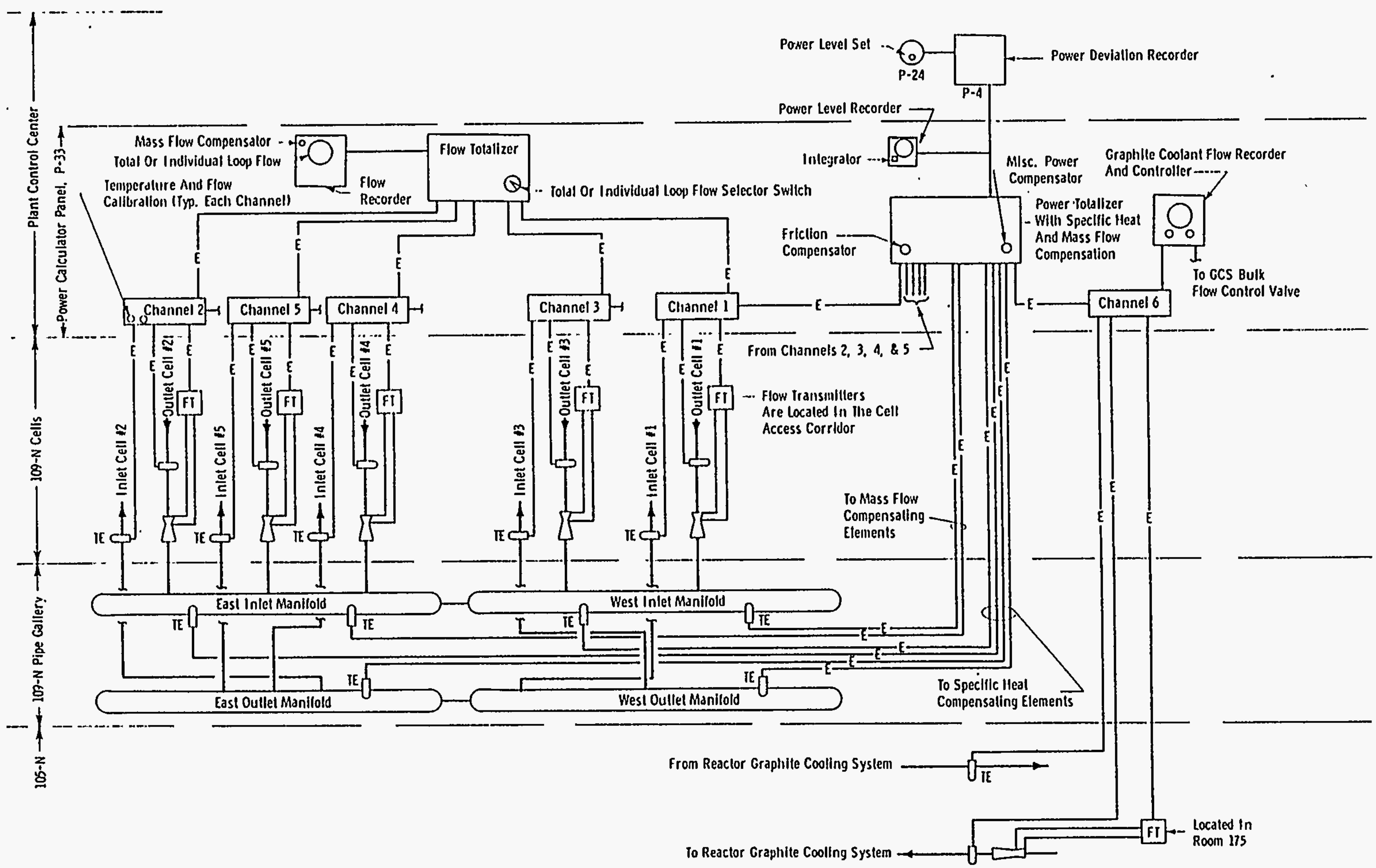
PROCESS TUBE ZONE TEMPERATURE MONITOR SYSTEM

The process tube zone temperature monitor system is designed to monitor exit tube temperatures from approximately ten per cent of the process tubes, and provides automatic rod scram and power setback trip functions in the event of excessive outlet temperatures.

The system consists of 109 immersion type resistance temperature detectors, each having three-conductor, copper-sheathed lead wire which extends to one of two junction boxes in corridor 7. Extension leads from these boxes go to the monitor units in the plant control center. Each monitor unit has an individual measuring circuit, trip point adjustment, external bypass circuit, and trip indicator light. Separate trip logic and accumulator circuits are provided for actuation of the rod scram and power setback functions. The panel housing the monitor units also houses two power supplies.

Other details of this system are as follows:

1. The use of three conductor lead wires to the platinum temperature detectors eliminates lead wire length from being a consideration in the bridge detector circuits. This enables all the monitor unit bridge circuits to be the same.
2. Each of the 109 monitor units has a trip setpoint dial with a locking device which is adjustable from 200 to 600 degrees in two degree increments.
3. A monitor unit trip will actuate an individual indicating light and de-energize a separate normally energized trip circuit. Reset of the trip circuit is automatic, but a manual reset of the monitor indicating light is required.
4. The monitor unit trip accumulator or counter serves the function of counting the number of individual monitor trips, including fail-safe trips, and of actuating contacts in the reactor power setback and rod scram safety circuits. Two monitor trips will cause setback while three monitor trips cause a scram.
5. Upon initiating a signal to the reactor scram circuit, the system will disable all monitor trip indicators not already indicating a trip so that no additional indicators are energized until the indicator disabling circuit is reset.
6. A bypass jack is provided for each monitor unit so that the unit may be removed without impairing the operation of the system.
7. A master setpoint adjustment dial is provided which is capable of changing the setpoint of all units at once by a value of plus or minus 100°F of the individual trip settings in increments of 2 degrees.
8. Two complete power supplies are provided. One unit supplies the entire system, while the other is in a standby condition and will automatically take over, without causing a trip, in case of failure of the operating supply. The supply power is changed to DC power for operation of the systems bridge detector circuits.
9. Where possible, the system has been designed on a fail-safe basis; however, design is such that reactor shutdown due to system failure should not exceed one per year.



Reactor Power Calculator and Bulk Coolant Flow Monitoring System

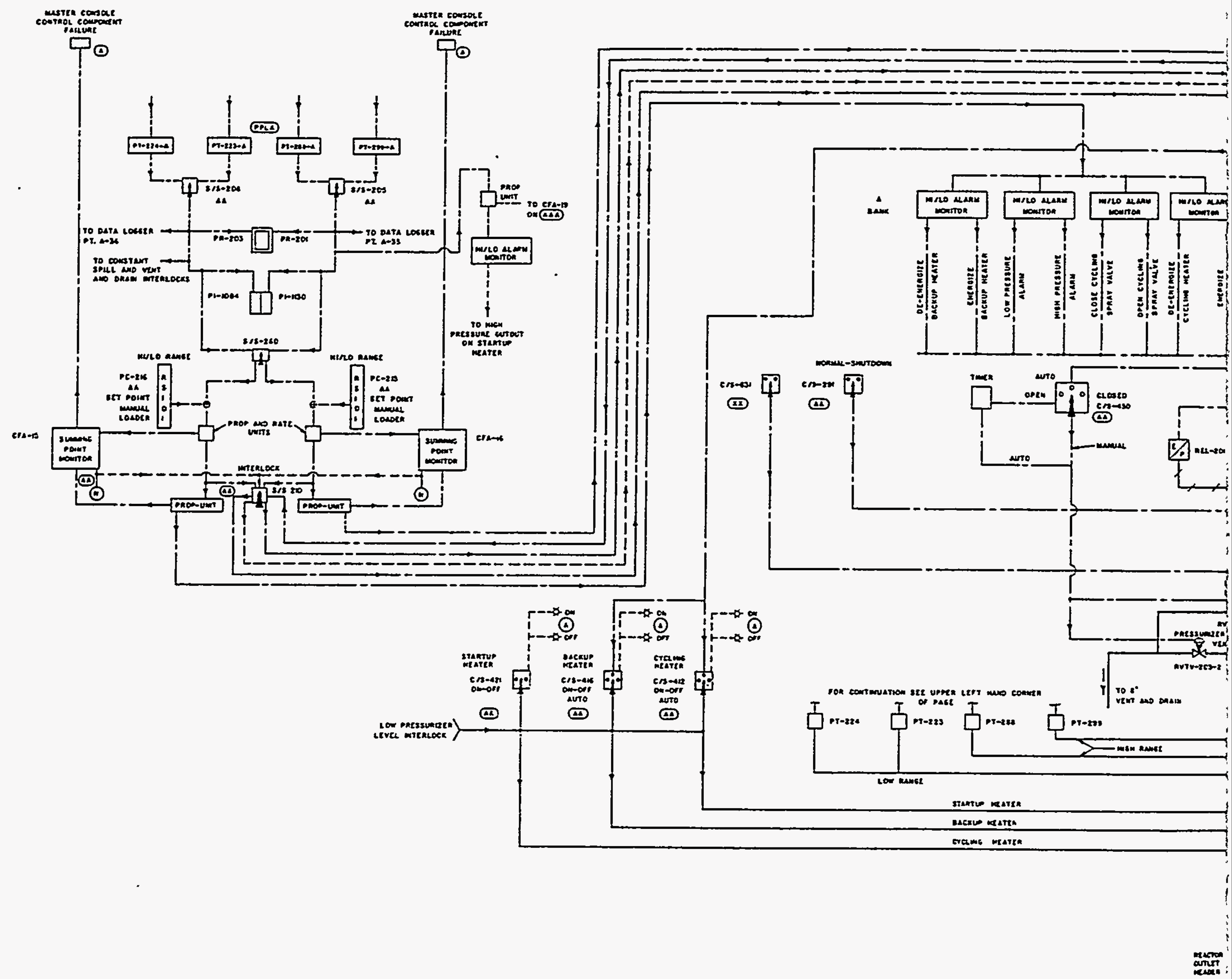
REACTOR POWER CALCULATOR AND BULK COOLANT FLOW MONITORING SYSTEM

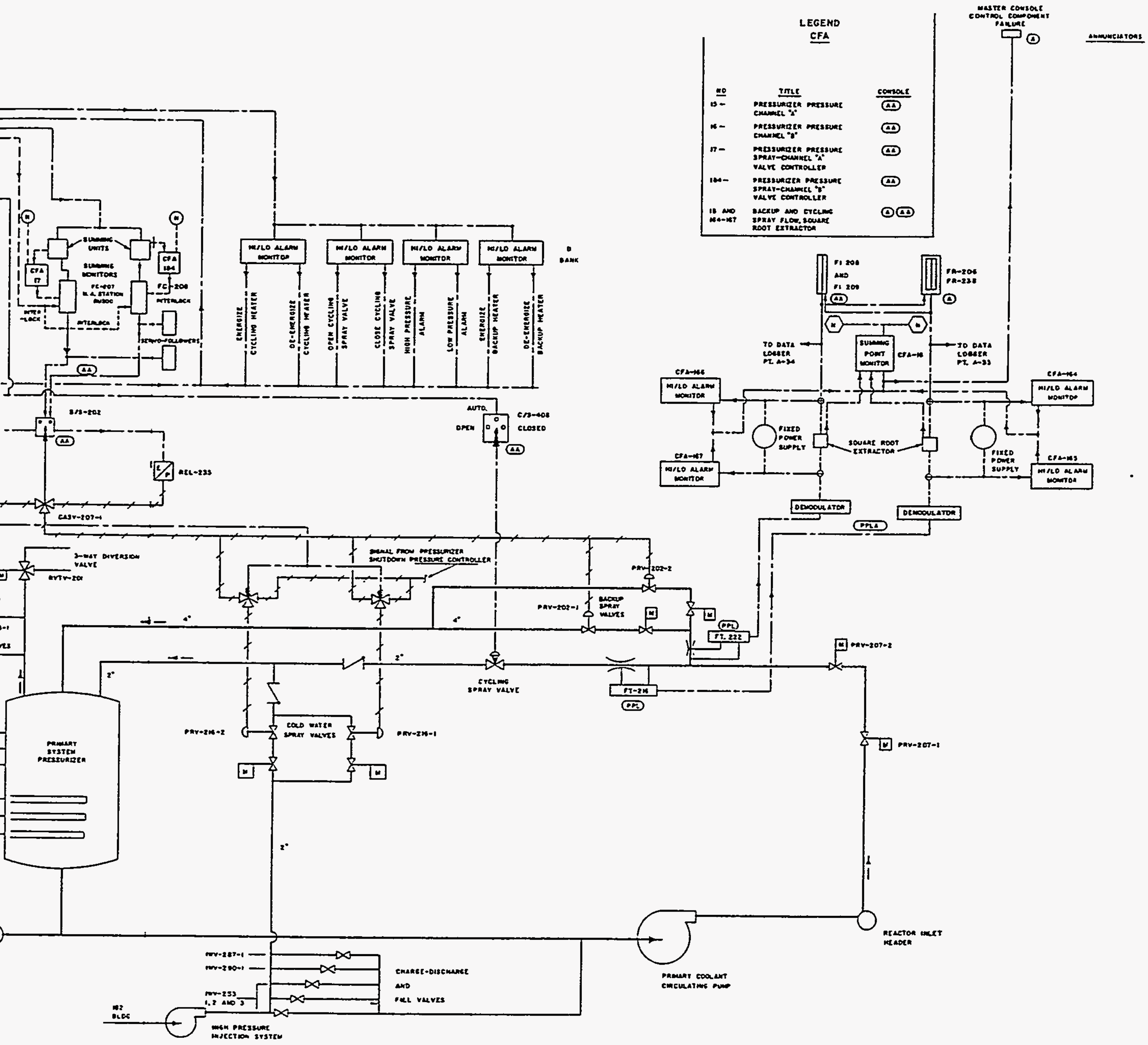
The power calculator and bulk coolant flow monitoring system is intended to be an operating guide and to provide information for production analysis purposes. The system automatically and continuously monitors reactor power level and bulk flow.

Six channels of power calculating equipment are involved; five channels are used to calculate the power generated in each of the five primary loops, and a sixth channel to calculate the power dissipated to the graphite cooling system. Power calculation for each of the channels is based on the flow and differential temperature of the individual coolant loops. The same flow signals that are used for power calculation are also used for bulk flow monitoring.

Other important details of this system are:

1. The over-all accuracy of the power calculating system is within $\pm$ 2% when flow rates are above 50% of maximum operating flow rates.
2. The power dissipated to other cooling systems, such as the thermal shield and horizontal rods, is not automatically calculated; but is manually added through use of a compensator dial on the power totalizer. The power lost to the environs and to the ventilation system is also manually added with this dial.
3. A second compensator dial, located on the power totalizer, is used for subtracting the power generated by friction in the process piping.
4. Specific heat and mass flow corrections are made by means of temperature measurements, taken in the main inlet and outlet manifolds, which are applied into the power totalizer after the calibration circuits. These corrections are made for channels 1 through 5.
5. The total power is continuously recorded on the power calculator panel (P-33). A power level integrator is also provided.
6. The deviation of the total power from a preset level, which is set by a dial on the reactor console, is continuously recorded on the reactor control panel (P-4).
7. The bulk coolant flow measuring system is used for both operating and shutdown flows. A selector switch on the flow totalizer enables the total on any individual loop flow to be recorded continuously. Selecting an individual loop flow automatically changes the recorder range to one-fifth the total range. The recorder is provided with a mass flow compensator.


MASTER CONSOLE CONTROL COMPONENT FAILURE
PPLA
S/S-204 AA
S/S-205 AA
TO DATA LOGGER PT. A-34
PR-203
PR-201
TO DATA LOGGER PT. A-35
TO CONSTANT SPILL AND VENT AND DRAIN INTERLOCKS
PI-1084
PI-1130
S/S-260
PROP UNIT
TO CFA-19
HI/LO ALARM MONITOR
TO HIGH PRESSURE CUTOUT ON STARTUP HEATER
HI/LO RANGE
PC-216 AA SET POINT MANUAL LOADER
PC-215 AA SET POINT MANUAL LOADER
PROP AND RATE UNITS
CFA-15
SUMMING POINT MONITOR
CFA-16
INTERLOCK
S/S 210
PROP-UNIT
A BANK
HI/LO ALARM MONITOR
DE-ENERGIZE BACKUP HEATER
ENERGIZE BACKUP HEATER
LOW PRESSURE ALARM
HIGH PRESSURE ALARM
CLOSE CYCLING SPRAY VALVE
OPEN CYCLING SPRAY VALVE
DE-ENERGIZE CYCLING HEATER
ENERGIZE
NORMAL-SHUTDOWN
C/S-631
C/S-291
TIMER
AUTO
OPEN
CLOSED
C/S-430
MANUAL
STARTUP HEATER C/S-421 ON-OFF
BACKUP HEATER C/S-416 ON-OFF AUTO
CYCLING HEATER C/S-412 ON-OFF AUTO
ON
OFF
LOW PRESSURIZER LEVEL INTERLOCK
FOR CONTINUATION SEE UPPER LEFT HAND CORNER OF PAGE
PT-224
PT-223
PT-288
PT-299
HIGH RANGE
LOW RANGE
STARTUP HEATER
BACKUP HEATER
CYCLING HEATER
PRESSURIZER
TO 8" VENT AND DRAIN
REACTOR OUTLET HEADER



ure Control System

PRIMARY COOLANT PRESSURE CONTROL SYSTEM

The design intent of the Primary Coolant Pressure Control System is to automatically maintain a predetermined system pressure as demanded by a manual setpoint loading signal.

The pressure in the primary system is maintained at a safe margin above primary coolant saturation pressure by the use of electric heaters and water sprays internal to the pressurizer. Pressurizer pressure at or below setpoint automatically actuates the cycling heaters, and a further drop actuates the backup heaters. The startup heaters must be turned on and off manually; however, they have automatic cut-out at 1300 psi. Pressurizer spray action opposes the heater action by condensing steam in the upper void area. Water for the cycling and backup sprays is derived from the reactor inlet header, and directly from the high pressure injection pumps for the cold water sprays.

Pressurizer pressure is measured by four pressure transmitters; two low range, PT-223 and PT-224; and two high range, PT-282 and PT-299. The low range transmitters have a range of from 100 to 1200 psig, and the high range transmitters have a range from 900 to 2000 psig. Both the low and high range signals from the transmitters are demodulated to produce a plus or minus 25 volt DC output signal proportional to pressurizer pressure.

One output signal from both the low and high range transmitters is selected for control by SS-208 and SS-205, respectively, which are mounted on AA Console. The selected control pressures are indicated on AA Console and recorded on A Panel. Also, the control signals are data logged as points A-35 (high range) and A-36 (low range). The low range pressure signal is also supplied to the constant spill control system (Ref. 21.4.7.5).

The low and high range signals are then fed to high range-low range pressure signal routing selector switch SS-260 on AA Console. This selector switch routes the high range signal to PC-215 and the low range signal to PC-216 (normal position); or the low range signal to PC-215 and the high range signal to PC-216 (abnormal position); The output from manual loaders PC-215 and 216 is, then, an error signal between the actual pressurizer pressure and setpoint. The outputs from the proportional plus rate units feed A and B bank selector switch, SS-210 on AA Console, and proportional units which drive A and B bank high-low alarm monitors. The A and B bank alarm settings are identical and serve as on-off contacts for the cycling spray and the cycling and backup heater control circuits. The output signals from the high-low alarm monitors are fed back through SS-210, and the selected bank signals are fed to the cycling spray, heaters, and alarms. With the above flexibility, it is possible to use either alarm bank with either the high or the low range signal.

Failure of either proportional plus rate or either proportional unit automatically transfers controller FC-207 or 208 on AA Console to manual, and actuates an annunciator on A Panel and the appropriate CFA indicating light on AA Console. Selector switch, SS-210, also supplies a signal to redundant backup spray controllers FC-207 and FC-208. Selector switch SS-202 on AA Console selects either FC-207 or 208 for service along with either of two redundant electric pneumatic relays, REL-201 or 235, by the positioning of 3-way solenoid valve CASV-207-1. The controller that has been selected for use can be placed on either automatic or manual control. The normal means of control is such that sufficient backup spray should be obtained through the backup spray valves PRV-202-1 or 2. These valves derive their supply

PRIMARY COOLANT PRESSURE CONTROL SYSTEM (CONT'D)

from the 24" reactor inlet header. During scram, the primary pump speed is reduced to 25 per cent, so very little spray water will be available through these valves. These valves are sequenced with the cold water spray valves, PRV-216 and 217, so that if the backup spray valves are fully open and the pressurizer pressure continues to increase, the cold water spray valves will start to open sequentially. During normal operation, selector switch SS-291, on AA Console, must be in the normal position if the cold water spray valves are to respond to pressurizer pressure control signals via FC-207 or FC-208.

The backup spray valves have valve position indicating lights on the Decontamination Control Panel in 109N. Note: No indication is provided in the control room to indicate air failure or valve position. Valves open on air failure and allow 600 GPM spray flow.

The cold water spray valves fail in position upon air failure. Normal and air failure indicating lights are provided for each valve on AA Console. Pressure switches, PS-234 and 235, are set at 27 psi and 15 psi, respectively, for valves PRV-216-1 and 217-1. The control air to the valves is automatically restored when failure is corrected. Each valve is provided with valve position indicating lights on A Panel.

The following values have been set to actuate the high-low alarm monitor pressure switches:

	On	Off
Cycling Heater	0 psig	+80 psig
Cycling Spray and Vent Valves	+20 psig	-20 psig
Backup Heater	-25 psig	-15 psig
High Alarm	+115 psig	
Low Alarm	-115 psig	

A two-position startup heater control switch, CS-421, is provided on AA Console. The startup heaters are operated manually with an automatic cut-off on high pressure and scram. The heaters cannot be started if the pressurizer level is low; however, once started, the heaters will not cut-off if pressurizer level again becomes low. Heater status indicating lights are provided on AA Console and A Panel.

A three-position backup heater control switch, CS-416, is provided on AA Console. In the "pull-out-off" position, the heaters are locked out. In the "on" position, the heaters remain on. In the "automatic" position, the heaters respond to the high-low alarm monitor pressure switch settings. Low pressurizer level and scram interlocks will shut the heaters off. Heater status indicating lights are provided on AA Console and A Panel.

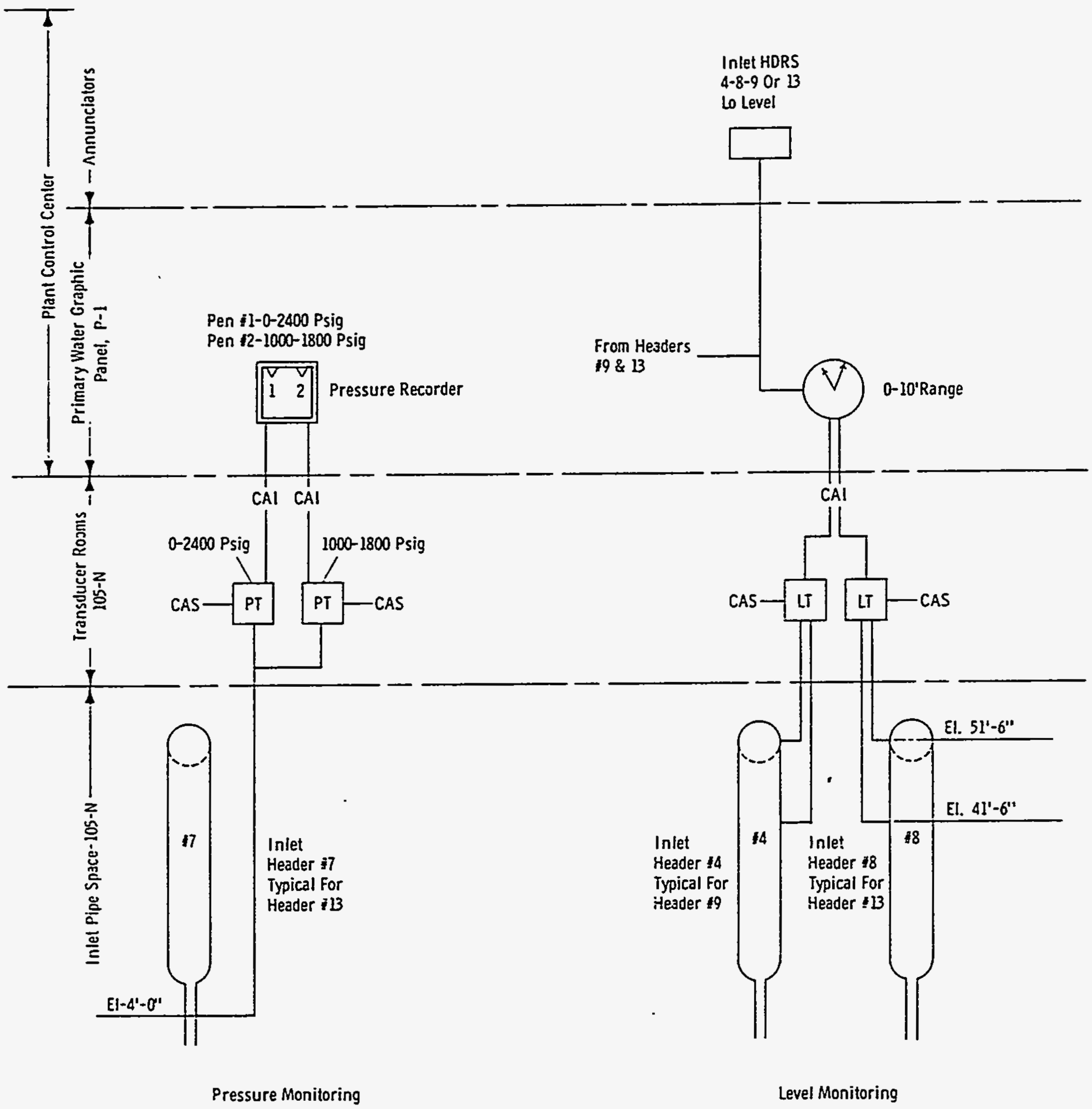
A two-position cycling heater control switch, CS-412, is provided on AA Console. With CS-412 in the "off" position, the cycling heaters are locked out. In the "on" position, the heaters respond to the high-low alarm monitor pressure switches. The heater is also automatically shut off by low pressurizer level and scram interlocks. Heater status indicating lights are provided on AA Console and A Panel. To facilitate shutdown pressure control, a bypass switch, CS-292, is provided to bypass low pressurizer level so the cycling heater can be used.

PRIMARY COOLANT PRESSURE CONTROL SYSTEM (CONT'D)

The same control signal that drives the heaters also controls the cycling spray and the pressurizer vent valves. A three-position cycling spray valve control switch, CS-408, is on AA Console. In the "open" position, the cycling spray valve, PRV-203-1, is locked open. In the "close" position, the valve is locked closed. In the "automatic" position, the valve responds to the high-low alarm monitor pressure switch settings. Valve position indicating lights are provided on AA Console, A Panel, and the Decontamination Panel in 109.

A three-position pressurizer vent valve control switch, CS-450, is on AA Console. In the "open" position, the vent valves are locked open. In the "close" position, the valves are locked closed. In the "automatic" position, the vent valves respond to the high-low alarm monitor pressure switches and to a timer, and open and close at 30 second intervals. Valve position indicating lights are provided on AA Console and the Decontamination Control Panel.

A recorder on A Panel and an indicator on AA Console are provided for the cycling and backup spray flows. The square root extractors and fixed power supplies of these flow systems are continuously monitored; and upon failure, appropriate CFA lights and annunciators are actuated.

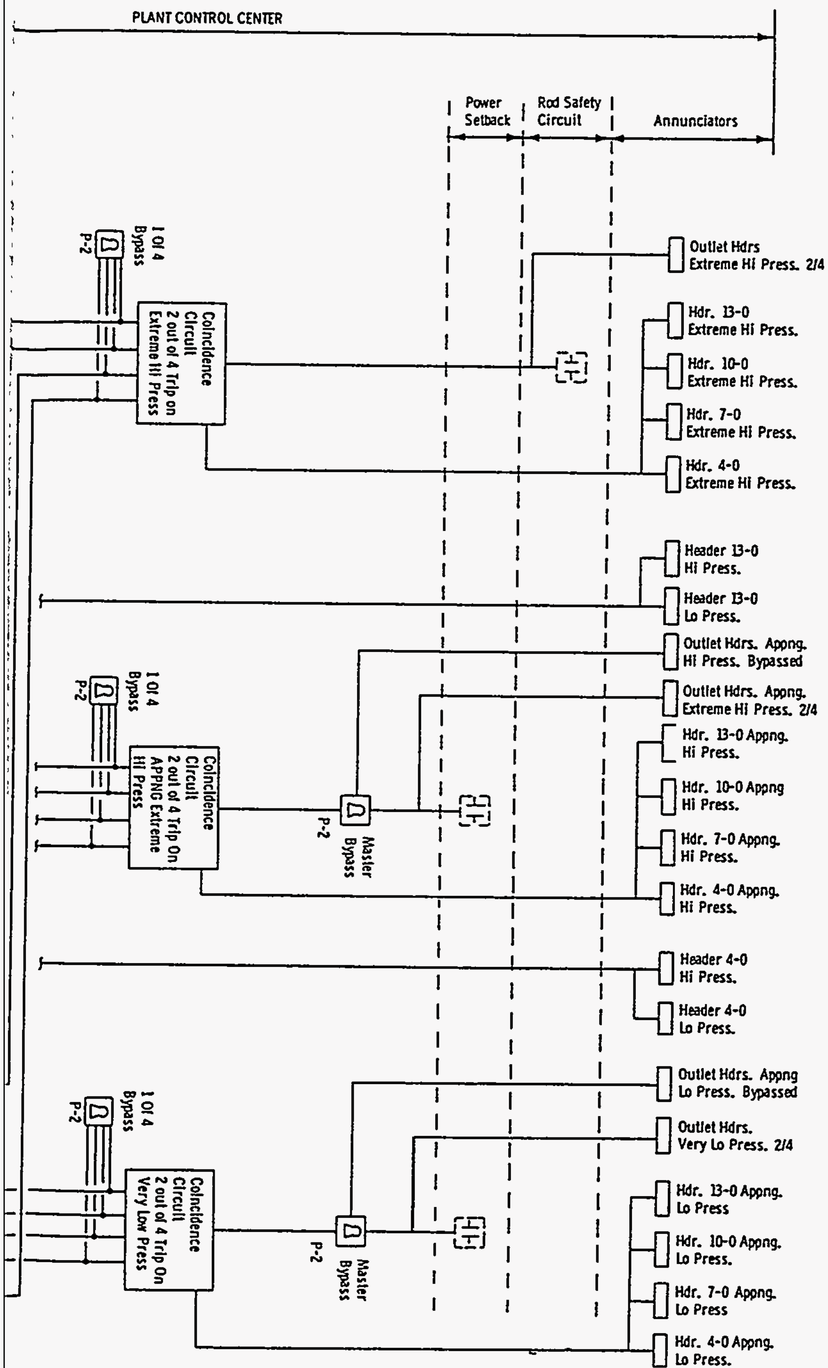


The Inlet Header Pressure Monitoring System Simply Records Inlet Header Pressure For Informational Purposes During The Various Phases Of Operation. There Are No Annunciators Or Automatic Features Connected With This System.

The Purpose Of The Four Liquid Level Monitors Is To Indicate If Lack Of Coolant To The Uppermost Process Tubes Is Occurring During Once Through Shutdown Cooling With Discharge From The Bottoms Of The Outlet Headers. This Type Of Once-through Cooling Would Be In Effect For Maintenance Purposes Or Possibly Some Forms Of Charge-Discharge And Constitutes A Critical Operating Condition With Reactor Safety Considerations Which Require Liquid Level Monitoring In Various Inlet Headers. These Liquid Level Indicators Have Low Level Limit Switches Which Operate An Annunciator In The Plant Control Center.

The Inlet Header Level Indicators Also Provide Information For Proper Venting Of Trapped Gases From The Inlet Headers By Remote Operation Of Vent Valves.

Reactor Inlet Header Level and Pressure Monitoring Systems - 105-N



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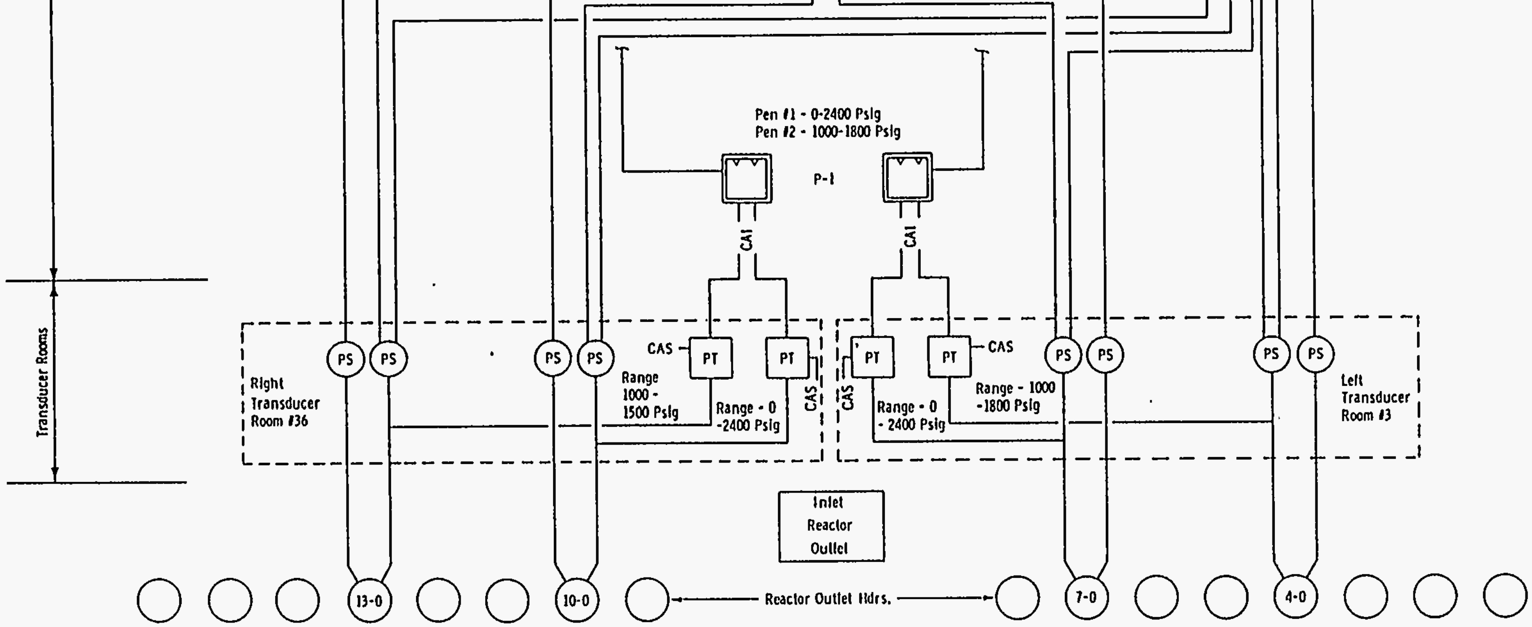
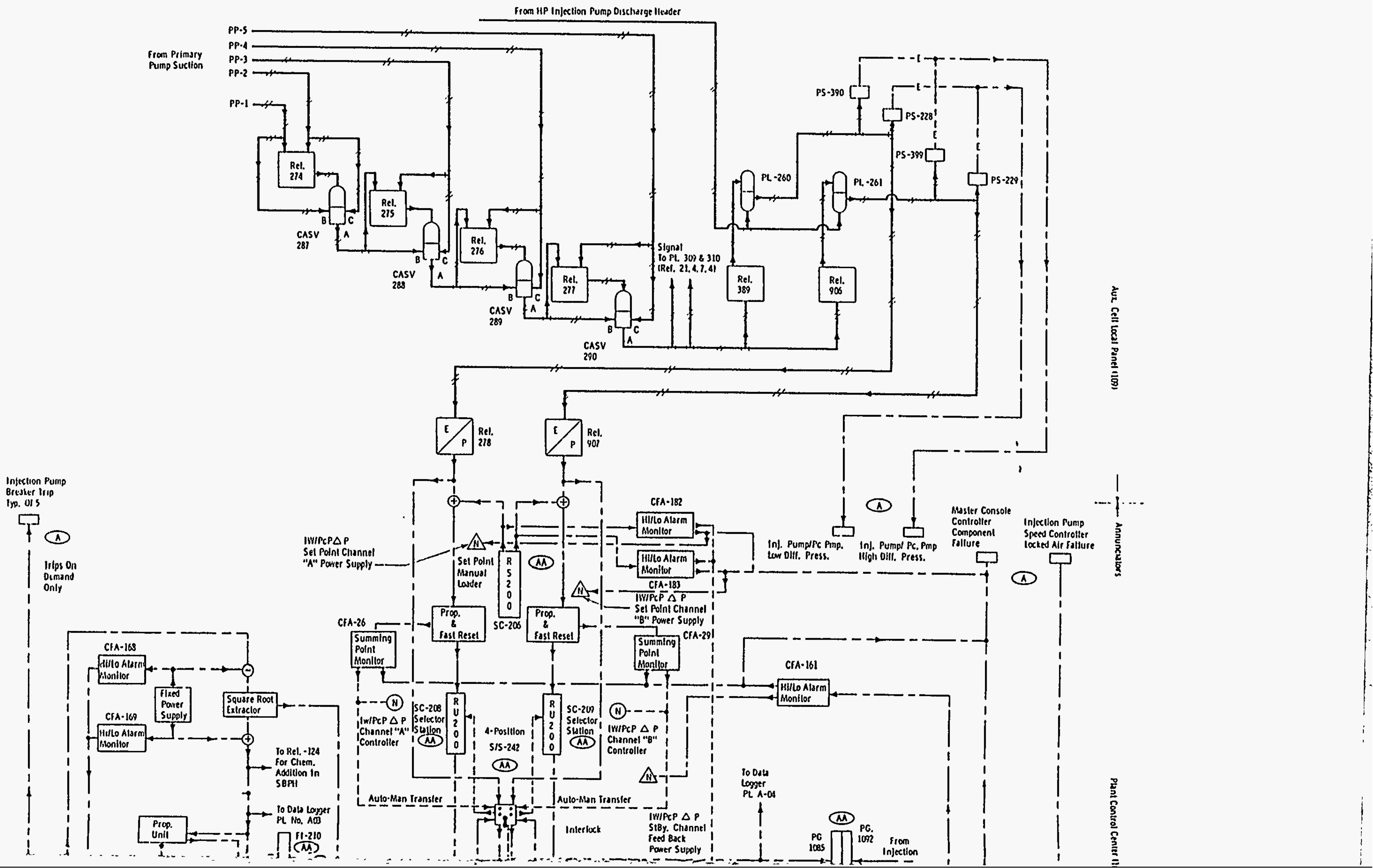
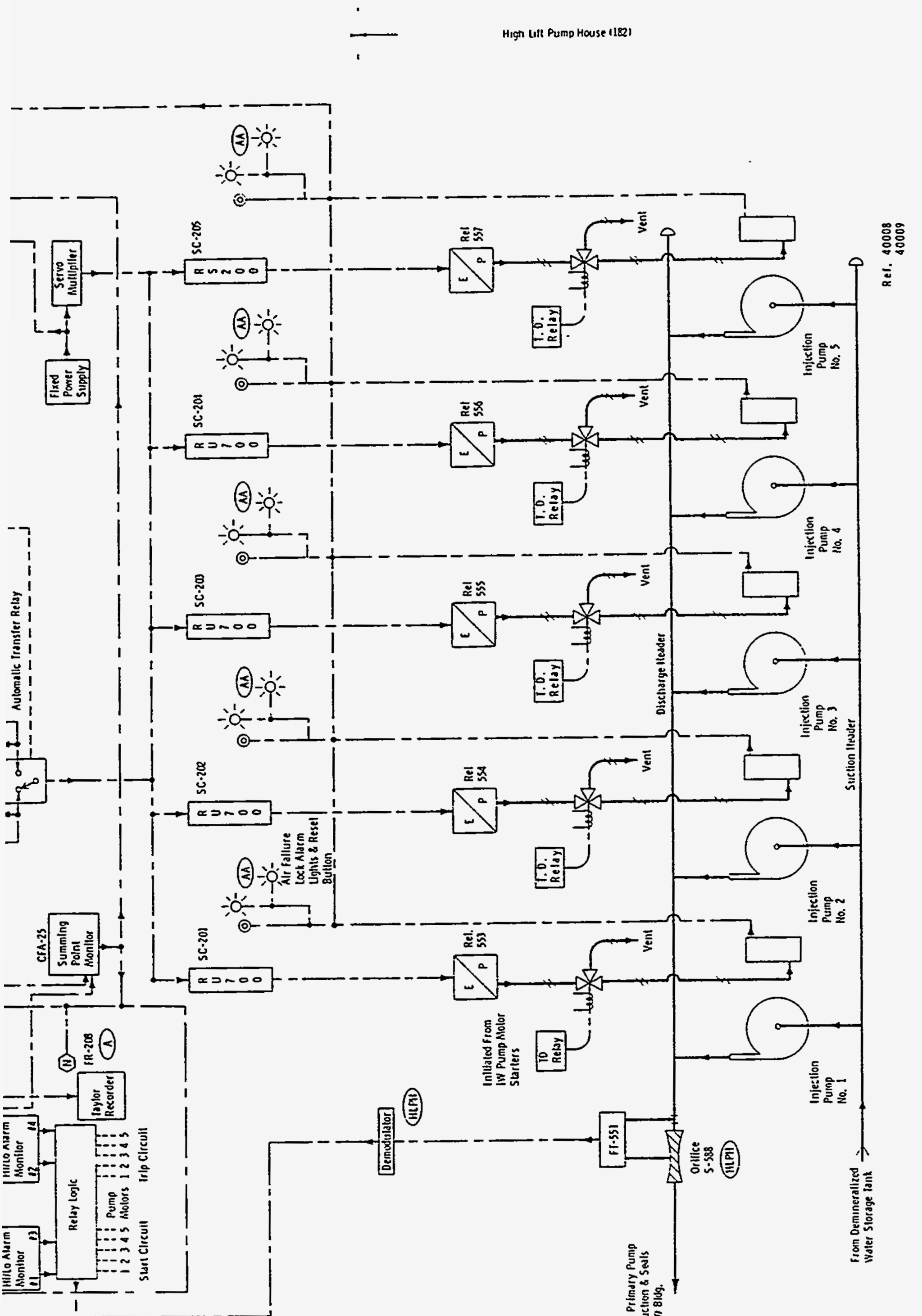


This system monitors the pressure of four reactor outlet headers at the 3'6" Elevation. It provides scram on extreme high pressure, power setback on approaching extreme high pressure, and power set back on very low pressure. Each of these trip functions occur on a two out of four trip coincidence. Two master bypass switches are provided to bypass the setback trip functions. Three other bypass switches are provided to bypass one of four individual trips to each coincident circuit.

The system also records the pressure of each of the four headers, and also provides annunciation of individual and coincident trip functions.

Reactor Outlet Header Pressure Monitoring System - 105-N


From HP Injection Pump Discharge Header
From Primary Pump Suction
PP-5
PP-4
PP-3
PP-2
PP-1
Rel. 274
Rel. 275
Rel. 276
Rel. 277
CASV 287
CASV 288
CASV 289
CASV 290
Signal To PL 309 & 310 (Ref. 21.4.7.4)
PS-390
PS-228
PS-399
PS-229
PL-260
PL-261
Rel. 389
Rel. 906
Rel. 278
Rel. 907
Aux. Cell Local Panel (109)
Injection Pump Breaker Trip Typ. Of 5
Trips On Demand Only
CFA-182
Hi/Lo Alarm Monitor
CFA-183
IW/PcP Δ P Set Point Channel "A" Power Supply
Set Point Manual Loader
RS200
SC-206
IW/PcP Δ P Set Point Channel "B" Power Supply
Prop. & Fast Reset
CFA-26
Summing Point Monitor
CFA-29
CFA-161
CFA-168
CFA-169
Fixed Power Supply
Square Root Extractor
Prop. Unit
FI-210
To Rel. -124 For Chem. Addition In SBPH
To Data Logger PL No. A03
SC-208 Selector Station
IW/PcP Δ P Channel "A" Controller
RU200
4-Position S/S-242
SC-209 Selector Station
IW/PcP Δ P Channel "B" Controller
Auto-Man Transfer
Interlock
IW/PcP Δ P StBy. Channel Feed Back Power Supply
To Data Logger PL A-04
PG 1085
PG 1092
From Injection
Inj. Pump/Pc Pmp. Low Diff. Press.
Inj. Pump/ Pc. Pmp High Diff. Press.
Master Console Controller Component Failure
Injection Pump Speed Controller Locked Air Failure
Annunciators
Plant Control Center



High Pressure Injection Pump Control System

HIGH PRESSURE INJECTION PUMP CONTROL SYSTEM

The design intent of this system is to maintain a constant differential pressure between the highest primary pump suction pressure and a point upstream of the primary loop fill valves. Thus, water at a higher pressure than primary loop pressure is available for pressurizer level makeup, as a supply to the primary coolant pump seals, and as a supply to the pressurizer cold water sprays.

Pump Speed Control - Primary coolant pump suction pressures are measured by transmitters, and the outputs from these pressure transmitters are fed to pneumatic auctioneering circuitry located on the auxiliary cell local panel. This circuitry takes the highest of the primary coolant pump suction pressures and passes this signal along to both the injection water header/primary coolant pump suction differential pressure transmitter, and to the emergency seal water pump/primary coolant pump suction differential pressure transmitter.

The auctioneering circuitry performs as follows (Ref. H-1-40008):

Two of the primary coolant pump suction pressures are compared in pneumatic Standatrol REL-274. Loop No. 1 pressure is fed into the "A" chamber and loop No. 2 pressure is fed into the "B" chamber. The output from the "B" chamber of the Standatrol will then be 27 psi whenever "A" is greater than "B" and 3 psi whenever "A" is less than "B". The output from the "B" chamber is used to actuate a pneumatic 3-way valve which selects whichever of the two pressures is greater, and passes this signal along to REL-275 and CASV-288 where the highest of loop No. 1 and loop No. 2 primary coolant pump suction signals are compared with loop No. 3 signal. This process is continued until all five loops have been compared and the highest pressure selected. The output from this auctioneering circuitry goes through a calibrating relay, and then into two emergency seal water and two injection water header differential pressure transmitters where it serves as a lower pressure reference for the suppressed range differential pressure transmitters.

The injection water pump speed is controlled from injection water header/primary coolant pump suction differential pressure transmitters, PT-260 and PT-261. Transmitters PT-260 and PT-261 have been made redundant for reliability purposes. The output from these two pressure transmitters is transduced to an electrical signal by P/E converters, REL-278 and REL-907. The output from these two P/E converters is fed directly into redundant injection water pump speed control chains. These redundant control chains each consist of a proportional plus fast reset action unit and a selector station. A selector switch and transfer relay have been provided such that either of the two control chains can be selected to be in use. Selector switch, SS-242 is a 4-position selector switch with positions for "A-Auto", "A-Over-ride", "B-Over-ride", and "B-Auto". In the "A-Auto" position of the selector switch, SC-208 will be in use and the injection water pump speed control can be placed in either "manual" or "automatic" control from the selector station. If CFA-182 or 26 is actuated when SC-208 is in service, control will be transferred bumplessly to SC-209. Regardless of whether SC-208 was on automatic or manual at the time the transfer is made to the SC-209, SC-209 will be placed in the same mode of operation that SC-208 was on prior to the transfer. The servo multiplier provides bumpless transfer from one controller to another.

If SC-208 has been selected for control and should fail, control will automatically be transferred to SC-209. If, however, SC-209 then fails, it will then be placed in the manual mode of operation. The "Transfer Over-ride" position of selector switch, SS-242, will lock the selected controller into the control chain. Failure of the selected controller, then, will not transfer control to the standby controller but will interlock the controller to the manual mode.

HIGH PRESSURE INJECTION PUMP CONTROL SYSTEM (CONT'D)

Clear neon lights have been provided on AA Console to indicate which of the two controllers is in use. The output from the controller selection circuitry is fed to five type RU-700 manual biasing type selector stations, then through five E/P converters and on to the five injection water pump speed control drives. Interlocks have been provided in the pneumatic loading lines between the E/P converters and the injection water pump speed control drives to vent the loading signal from the control drive unit whenever a motor is being started. This, then, unloads the drive until the motor has reached operating speed. At this time, the time delay relay circuit will de-energize solenoid valve, CASV-561-1 through 5, and the drive will then be brought up to proper speed.

The supply air to each of the five control drive units is continuously monitored. In the event of control air failure, the control drive unit will fail as is. Air failure on any of the five drive units will also actuate a common annunciator on A Panel and actuate a red (air failure) indicating light on AA Console. When air supply is restored to normal, a white (normal air supply) indicating light on AA Console is activated, and the air failure reset pushbutton can be actuated which returns the control drive unit back to automatic control.

System Component Failures And Alarms - Several of the control components are continuously monitored for failure as follows:

The dual power supplies of setpoint mannual loader SC-206 are monitored by CFA-182 and 183. In the event of power supply failure, the following will occur:
1. An annunciator on A Panel is actuated.
2. Either of two CFA lights is actuated, indicating which setpoint power supply failed.
3. An automatic transfer from the failed control chain to the alternate control chain or to manual on the failed control chain, according to the position of SS-242.

Both redundant proportional and fast reset units are monitored by CFA-26 and 29. Upon failure of either unit, the following occurs:
1. An annunciator on A Panel is actuated.
2. Either of two CFA lights is actuated, indicating which unit failed.
3. An automatic transfer from the failed control chain to the alternate or to manual on the failed control chain, according to the position of SS-242.

The fixed power supply to the servo multiplier is also continuously monitored by CFA-161. Upon failure, only a CFA indicating light on AA Console is activated, indicating to the operator that the alternate controller is not receiving the proper control signal. Consequently, selector switch, SS-242, should be placed in the transfer over-ride position to prevent an automatic transfer to the alternate controller.

The pneumatic output signals from differential pressure transmitters PT-260 and 261 are continuously monitored by four pressure switches, a high and a low on each tranmitter. Actuation of either low or either high initiates respective annunciators on A Panel.

Pump Automatic Start-Stop Control - Normally, only two injection pumps will be operating. However, in the event the injection flow demand approaches the capacity of both pumps, a third and then a fourth are sequentially and automatically started. The fifth pump is always maintained as a maintenance spare. Also, all four pumps are automatically started upon initiation of a reactor scram. The total flow signal

HIGH PRESSURE INJECTION PUMP CONTROL SYSTEM (CONT'D)

source for actuation of the pump motor start-stop circuit is FT-551, which measures the differential pressure created by a flow nozzle, S-288, located in the 12 inch injection water header common to all five pumps.

The AC signal from the flow transmitter is converted to a plus or minus 25 volt DC signal by a demodulator. This signal is then adjusted to a zero to plus 50 volt DC signal by a fixed power supply and then made proportional to the flow rate by a square root extractor. This is then re-adjusted back to a plus or minus 25 volt DC signal and is used to load the pump actuating channel. Failure of the square root extractor or the proportional unit will actuate CFA-25, which in turn actuates a CFA indicating light on AA Console and an annunciator on A Panel. The fixed power supply to the square root extractor is monitored by CFA-168 and 169 which, upon failure, actuates a CFA indicating light and an annunciator on A Panel.

The pump actuating channel consists of a proportional unit and two three-mode switches, FS-209A and 209B (high-low alarm monitors). One switch is used to sequentailly start the spare pumps and one switch to stop them. The actuating channel also provides a signal to data logger point A03, to 184-N for the automatic injection chemicals, and to a flow indicator on AA console and a flow recorder on A Panel.

The following pump selection controls are provided on the AA Console: Each pump has an individual, three position, control switch (on, off, and pull out test). In addition, three pump selection switches are provided, one to select either pump 1 or 3 as main or backup, one to select either pump 2 or 4 as main or backup, and the third, a five position selector switch to select which of the other four pumps the spare is to be substituted for. The following is a development of the pump selection switches and the on-off control points:

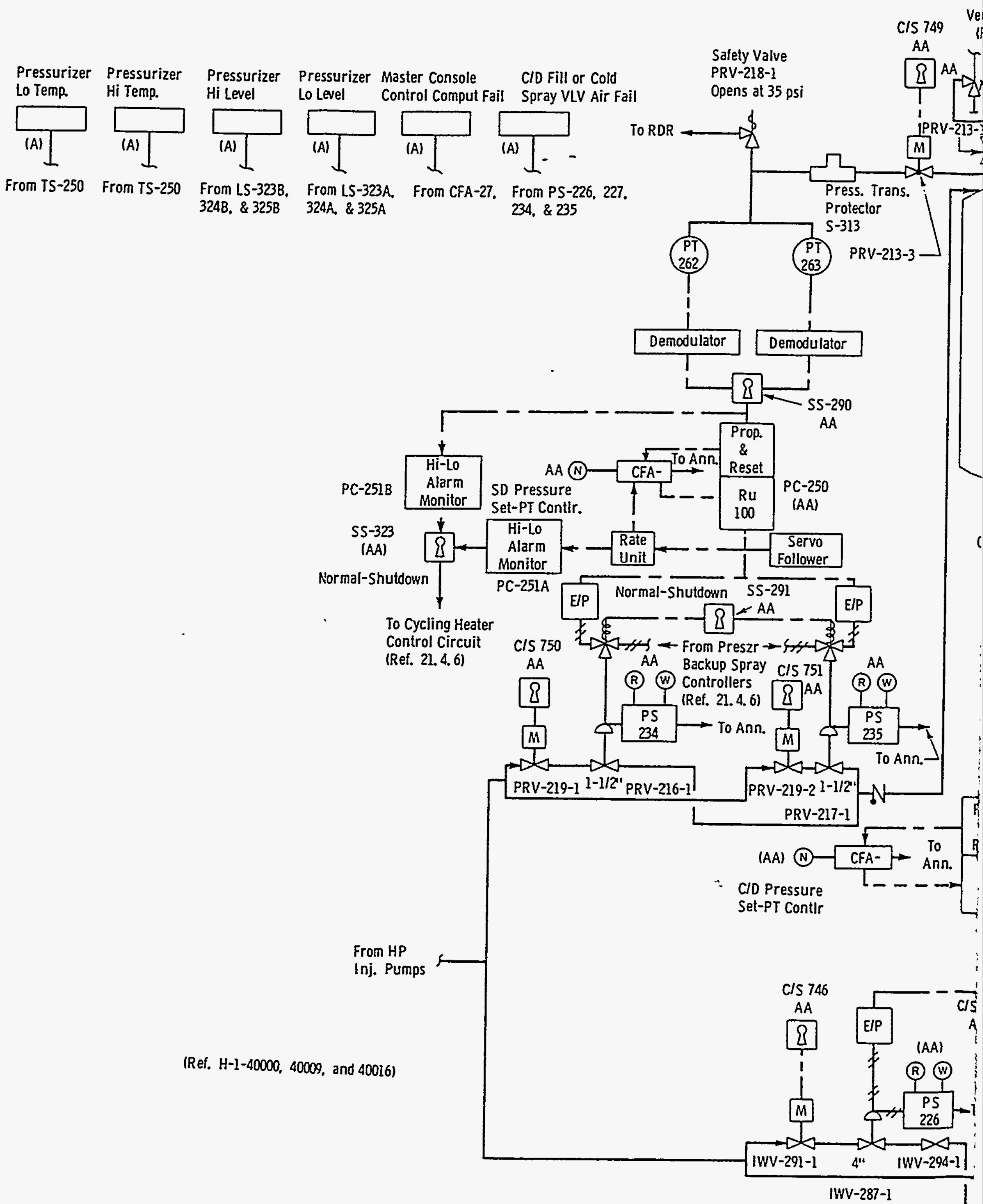
No. 1 & 3 Pump Sel. Switch	No. 2 & 4 Pump Sel. Switch	Backup Pumps Automatically "On"		Backup Pumps Automatically "Off"	
		3rd. Pump 1300 GPM.	4th. Pump 2600 GPM	4th Pump 1300 GPM	3rd. Pump 800 GPM
1	2	3	4	4	3
3	4	1	2	2	1
1	4	3	2	2	3
3	2	1	4	4	1

The pump start circuit for pumps 1, 2, 3, or 4 may be energized in three ways.

1. The pump control switch in the pull out test position and pump not selected by the No. 5 pump selection switch.
2. The pump selected as "main" on either of the two pump selector switches.
3. The pump not selected as "main" and the flow exceeds 1300 GPM to start the third pump, the flow exceeds 2600 GPM to start the fourth pump, or a reactor scram.

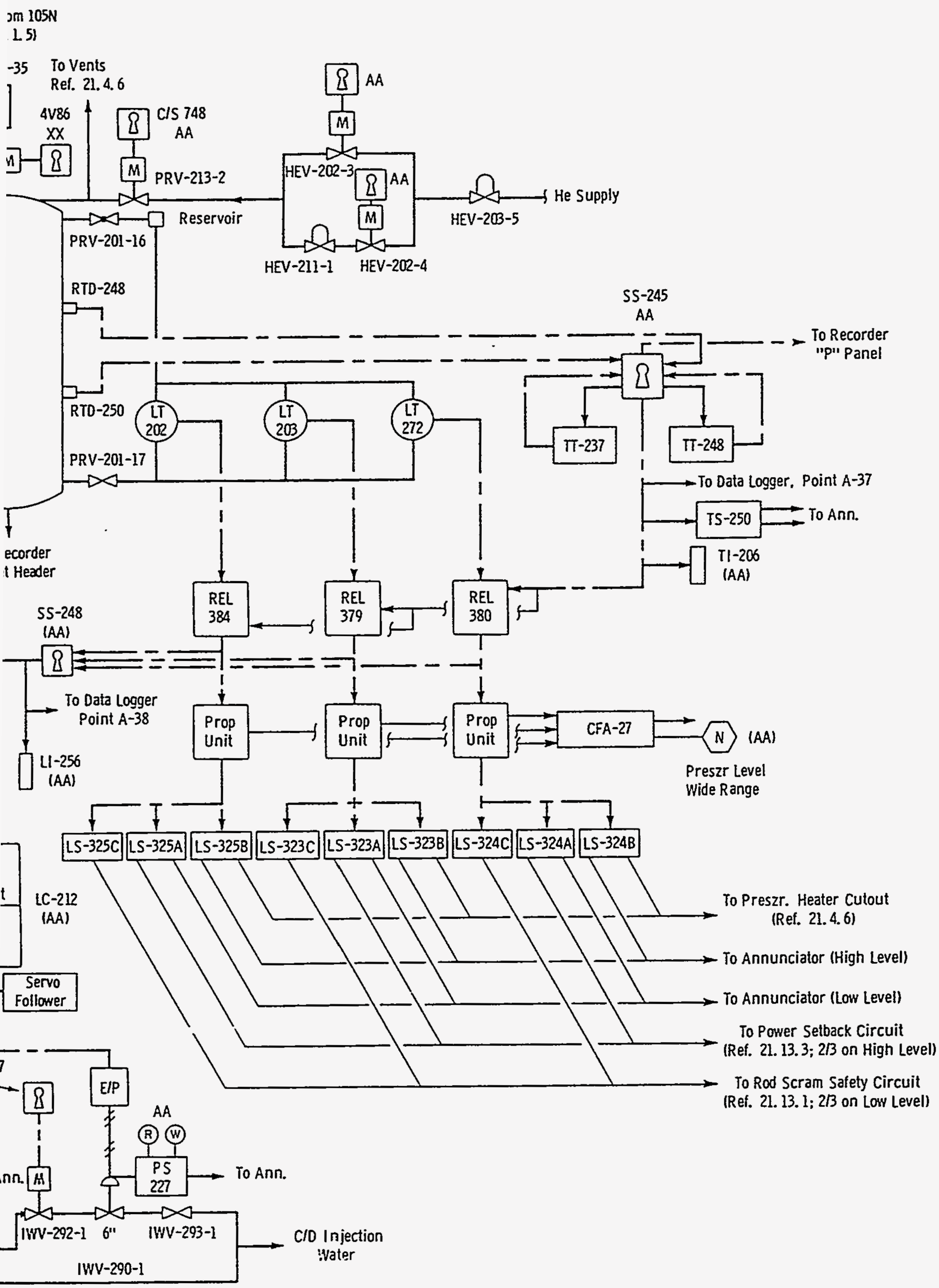
The pump stop circuit for pumps 1, 2, 3, or 4 may be energized in three wyas.

1. Individual control switch in "off" position
2. Pump not selected as "main" and flow below 1300 GPM, shuts off fourth pump and flow below 800 GPM shuts off third pump, and with no scram signal present.
3. If any of the four pumps are selected on the No. 5 pump selector switch. The pump start and stop circuit for pump No. 5 is identical to pumps 1, 2, 3, and 4 position. The pump No. 5 start circuit is energized when the pump selector switch is in the "pull out test position"; and the pump trip circuit is energized when the pump selector switch is in the "off" position.



(Ref. H-1-40000, 40009, and 40016)

Shutdown and Charge/Discharge Pr
Level Trip



ssure Control and Pressurizer
unctions

SHUTDOWN AND CHARGE/DISCHARGE PRESSURE CONTROL AND PRESSURIZER LEVEL TRIP FUNCTIONS

These systems provide controls for primary coolant pressure control in the shutdown and charge-discharge regions. In addition, the system provides pressurizer level trip functions, and a means to blanket the the pressurizer with inert gas.

Shutdown Pressure Control - This system provides controls for primary coolant pressure control from the lower range of the normal control system (Ref. 21.4.6) down to the charge-discharge (C/D) range. Control is by modulation of the pressurizer cold water spray valves and on-off action of the cycling heaters.

Two pressure transmitters, 0-50 psig, are provided. Pressure is sensed in the vent line to the pressurizer from 105N. One of the two pressure signals selected by SS-250 on AA Console is compared to the setpoint of PC-250, and an error signal is generated. This signal is sent to a high-low alarm monitor, which actuates the cycling heaters through the low (pressure) contact only when the pressure is falling at a set rate (see below), and when control of the heaters is vested in this system by selector switch, SS-323, AA Console. The error signal is also acted on by an action unit which supplies signals to a pair of E/P converters and to a rate unit. The pneumatic signals are used to position the cold water spray valves in sequence when control of the valves is vested on PC-250 via SS-291 on AA Console.

The output of the rate unit actuates a high-low alarm monitor, which through the high contact and when system pressure is below setpoint, actuates the cycling heater when pressure is decreasing at a set rate. Again, heater control by this means must be selected by SS-323.

A switch, CS-292, AA Console, is also provided to bypass the low pressurizer water level cut-out of the cycling heaters, as may be required by this system. The action unit of PC-250 is monitored by a CFA, which transfers PC-250 from automatic to manual on failure of the action unit.

Charge-Discharge Pressure Control - This system provides controls for primary coolant pressure control from 0 to 10 psig ± 2.5 psig during charge-discharge (C/D). Control is by modulation of two C/D makeup fill valves acting in response to a pressurizer level signal.

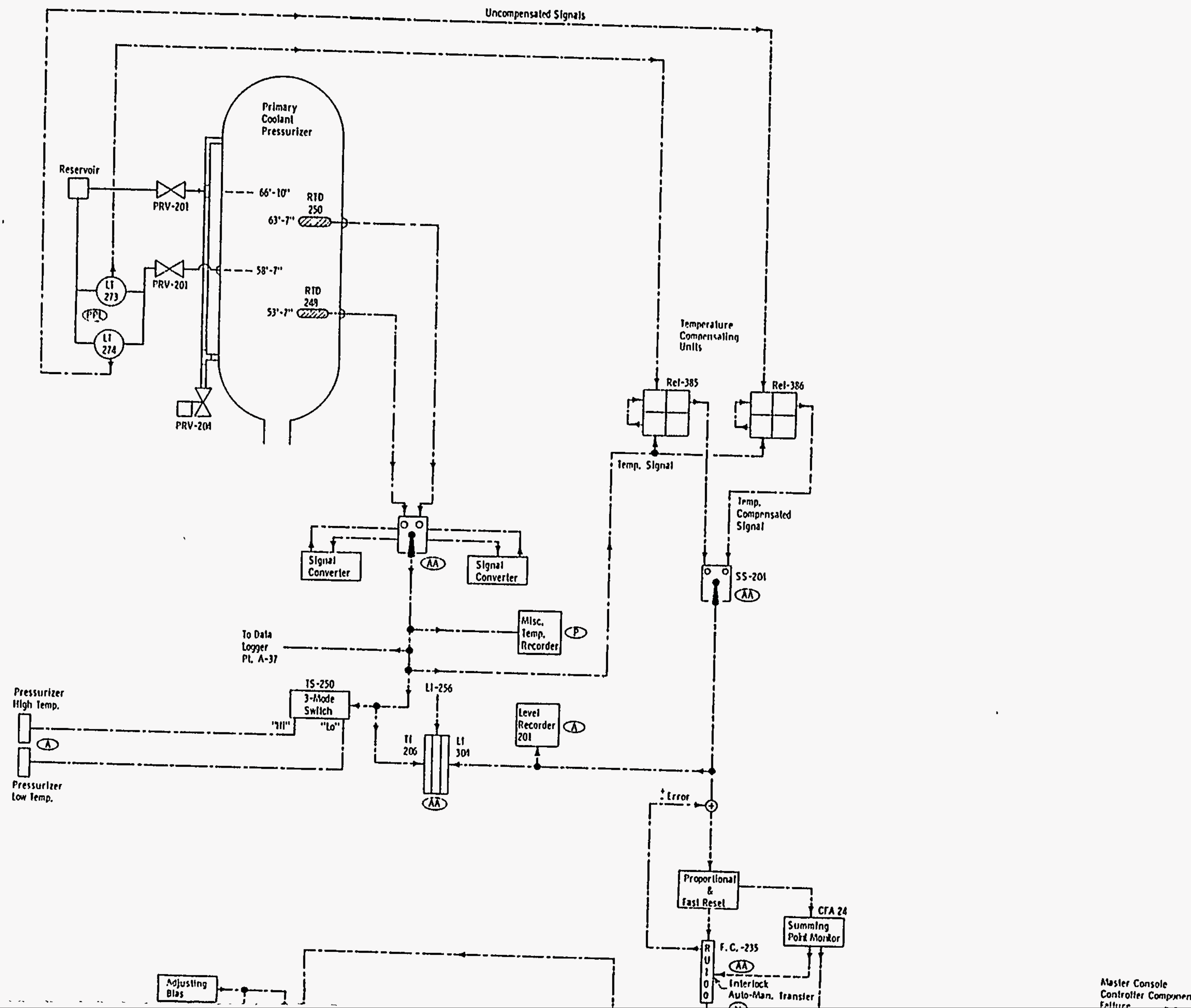
Three wide-range pressurizer level transmitters are provided. The signals from these transmitters are compensated for density by one of two RTD signals selected by a switch, SS-245, on AA Console. The signal not selected is recorded on Panel P. The compensated signals are routed to a selector switch, SS-248, for C/D pressure control system use, and to proportional action units for pressurizer level trip functions (discussed later).

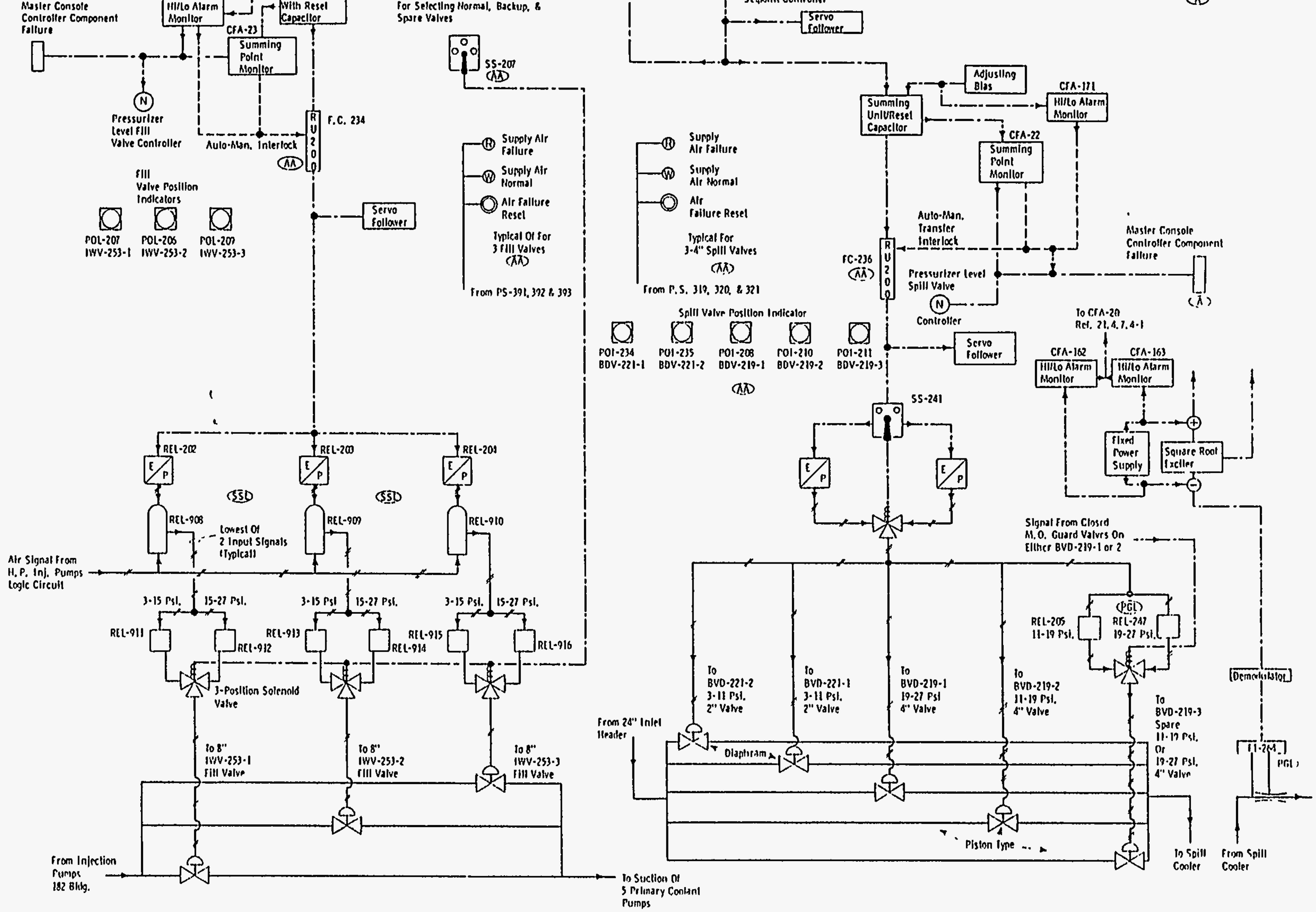
The compensated level signal is compared to the setpoint of LC-212, and the resulting error signal is acted on by a proportional plus fast reset unit. The output of this unit feeds E/P converters, which supply signals to sequentially operate the C/D fill valves. IWV-287-1 opens first and will supply 400 GPM, and IWV-290-1 opens second and will supply 1100 GPM. The C/D fill valves will fail as is on loss of air supply.

SHUTDOWN AND CHARGE/DISCHARGE PRESSURE CONTROL AND PRESSURIZER LEVEL TRIP FUNCTIONS (CONT'D)

Pressurizer Level Trip Functions - This system provides actuating signals based on pressurizer level for annunciation and the rod scram and setback circuits, and interlocks for the pressurizer heaters. Each of three compensated pressurizer level signals (see above) is supplied to an action unit and to three high-low alarm monitors. These monitors provide signals on a two out of three coincidence to the rod scram safety circuit on low pressurizer water level and to the setback circuit on high pressurizer water level. Signals are also provided to high and low pressurizer water level annunciators and to circuits which prevent pressurizer heater operation at a set low level.

Helium Supply to Pressurizer - This system provides controls to blanket the pressurizer steam space, with helium at 4" of water or 5 psig, by opening the appropriate block valves. Switches for these valves are on AA Console.


Uncompensated Signals
Primary Coolant Pressurizer
Reservoir
PRV-201
PRV-201
PRV-204
66'-10"
58'-7"
RTD 250
63'-7"
RTD 249
53'-7"
LI 273
LI 274
Temperature Compensating Units
Rel-385
Rel-386
Temp. Signal
Temp. Compensated Signal
Signal Converter
Signal Converter
SS-201
To Data Logger Pt. A-37
Misc. Temp. Recorder
TS-250 3-Mode Switch
"Hi"
"Lo"
Pressurizer High Temp.
Pressurizer Low Temp.
LI-256
TI 206
LI 304
Level Recorder 201
± Error
Proportional & Fast Reset
CFA 24
Summing Point Monitor
F. C. -235
Interlock
Auto-Man. Transfer
Adjusting Bias
Master Console
Controller Component
Failure



Pressurizer Level Control System

PRESSURIZER LEVEL CONTROL SYSTEM

The design intent of this system is to maintain pressurizer level at a constant predetermined setpoint. This is accomplished by the sequential operation of either the fill or spill control valves in the primary loop. Primary coolant spill is from the 24" reactor inlet header, and fill is at the five primary coolant pumps suction headers via common fill valves.

Two pressurizer level transmitters (LT-273 & LT-274) are narrow range level transmitters and are used for control. The output from these level transmitters are fed to compensator circuits located on Panel PPLA. Pressurizer level is compensated for pressurizer pressure (as measured by pressurizer temperature because the water in the pressurizer vessel is at saturation temperature before the signal is used for either alarm or control purposes).

Pressurizer temperature is measured by RTD-TT-248 and RTD-TT-250. Either of these two RTD signals can be switched into the compensation circuit for the correction of pressurizer level. The output from the RTD that is not used in the compensation circuit is recorded on the miscellaneous temperature recorder located on Vertical Panel P. Selection of which of the two RTD elements that is to be used for compensation is made through selector switch SS-245 located on AA Console. This selected signal is also used for alarm and is indicated on AA Console.

The two control range compensated pressurizer level signals are fed to selector switch SS-204 located on AA Console. This switch selects one of the two available signals for control purposes. The output from the selector switch is indicated on AA Console and also is fed to the master pressurizer level setpoint controller. This signal is compared against a setpoint from selector station FC-235 and the resultant error signal is applied to the proportional plus fast reset action unit, FC-235A. The output from this unit is, then, a master level demand signal to both the spill and the fill level controllers.

Spill Valve Control - The master level demand signal goes to a summing unit with reset capacitor, FC-236A, where the signal is rescaled. The output from the master level controller is +25 volt DC signal. The spill controller must work over only the negative half of this control range (0 to -25 volts DC) and the fill controller must work over only the positive half (0 to +25 volts DC) of this control range. Therefore, the signal is rescaled in summing unit, FC-236A, so that for a 0 to -25 volt DC input into the summer the output will be ∓25 volts DC. The signal then passes through manual/automatic selector station, FC-236, and then to selector switch, SS-241, where either E/P REL-244 or REL-248 can be selected for control. The output from the E/P converters is selected by CASV-248 (also operated from SS-241) and the selected pneumatic signal is supplied to the five spill control valves.

These control valves are arranged to operate sequentially. Valves BDV-221-1 and 2 operate in parallel over a pneumatic input range of from 3 to 11 psi. Both valves are operated in parallel; however, only one valve is in use at a time. Flow through the spare valve is shut off by means of block valves. Spill valve BDV-219-1 opens on a pneumatic input loading of from 11 to 19 psi. BDV-219-2 opens on a pneumatic input loading of from 19 to 27 psi. Valve BDV-219-3 is a spare valve but can be switched in (through the use of motor operated block valves) as a substitute for either BDV-219-1 or BDV-219-2. This valve is calibrated to open

PRESSURIZER LEVEL CONTROL SYSTEM (CONT'D)

from a pneumatic loading input of either 11 to 19 psi or 19 to 27 psi through calibrating relays REL-205 and REL-247. Selection of which of the two relays to be used with the spare valve is by means of limit switches on the block valves of BDV-219-1 and 2.

Fill Valve Control - The master pressurizer level demand signal is also fed to summing unit with reset capacitor FC-234A. This summing unit has an output that goes from ∓ 25 volts DC for a 0 to +25 volt DC input. The output from this summing unit goes through manual/automatic fill flow controller, FC-234, and then to three E/P converters, REL-202, 203, and 239. The output from these E/P converters goes through a custom-line relay, either of two Mini-Line relays, and on to control valves IWV-253-1, 2, and 3.

The purpose of the custom-line relay is to limit the maximum opening of the injection water fill valves in proportion to the number of injection pumps that are running. This is accomplished through a logic circuit and a series of pressure reducing and solenoid valves. The logic circuit determines the number of injection pumps that are running and energizes the appropriate redundant set of solenoid valves, CASV-308-1 and 2, 309-1 and 2, 310-1 and 2, or 311-1 and 2. These solenoid valves then admit a pneumatic supply pressure that has been set in proportion to the correct number of injection pumps running. This supply pressure is admitted to the supply connection on the custom-line relay. This, then, limits the output (from Chamber D3) of the custom-line relay to a value no greater than the supply pressure. The custom-line relay output is fed to the input of two Mini-Line relays. One of these relays is calibrated to give a 3 to 27 psi output for a 3 to 15 psi input. The second relay is calibrated to give a 3 to 27 psi output for a 15 to 27 psi input. One output from the Mini-Line relays is selected by a 4-way solenoid valve for loading the injection fill valve positioner (Ref. H-1-40009 for details). Thus, with this redundant valve and calibrating relay arrangement, it is possible to sequentially operate two of the injection water fill valves and retain the third valve as a spare.

It is also possible to select which of the three injection water fill valves is the first valve to operate, which is the second, and which valve will be used as a spare. The selection of the sequencing of the control valves is made through selector switch, SS-207, located on AA Console.

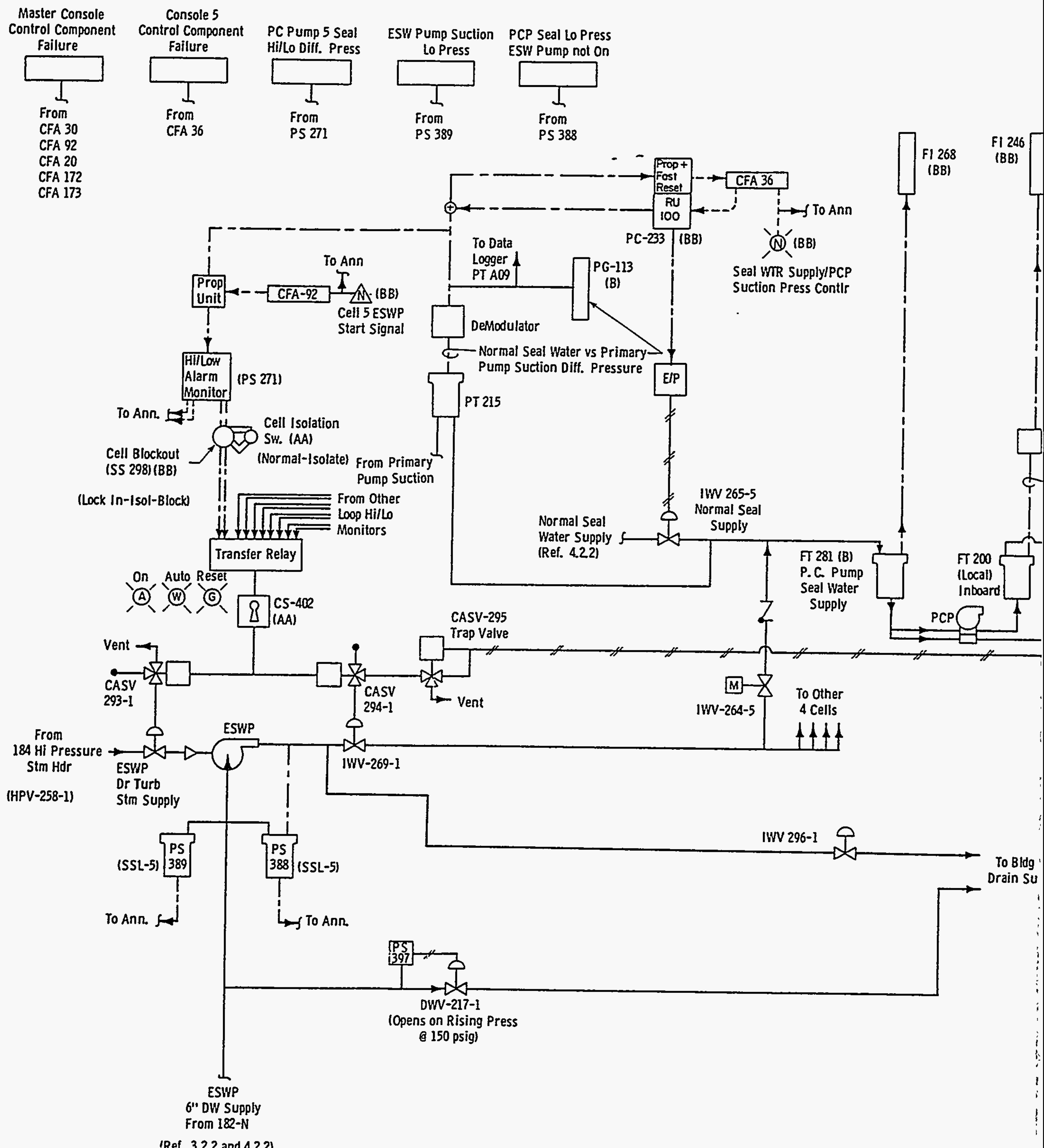
This three-position selector switch has the following switch development:

Position	Valve No.	Relay	Air Signal - Psi
A	IWV-253-1	912	15-27
"	IWV-253-2	Spare	---
"	IWV-253-3	915	3-15
B	IWV-253-1	Spare	---
"	IWV-253-2	913	3-15
"	IWV-253-3	916	15-27
C	IWV-253-1	911	3-15
"	IWV-253-2	914	15-27
"	IWV-253-3	Spare	---

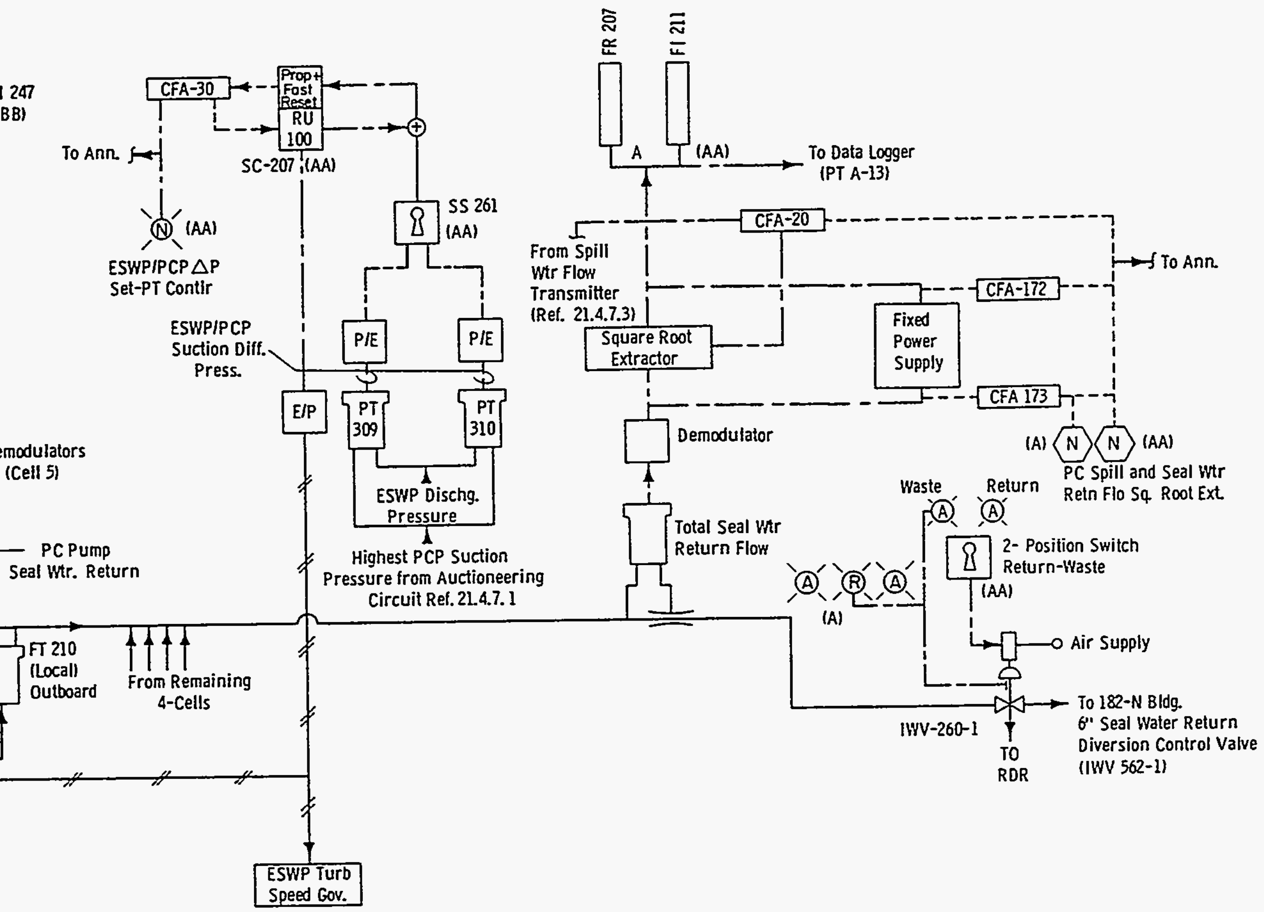
PRESSURIZER LEVEL CONTROL SYSTEM (CONT'D)

Interlocks - The pressurizer level master fill controller and both the individual spill and fill controllers have all critical components and power supplies monitored by summing point monitors and high-low alarm monitors. If any of these controllers or power supplies should fail, the respective controller will be transferred to "manual" control. This failure will be annunciated on A Panel, and the appropriate neon light on AA Console will come on indicating which controller has failed.

Also, all the valves have position indicators on AA Console, and all the valves except BDV-221 valves fail in position upon air failure and have air failure indicating lights on AA Console. The white light indicates normal air supply. The red light indicates air supply failure, and a reset pushbutton provides a means of resetting the control air system to normal after the supply air is normal.



Primary Coolant Pump Normal and E
Systems



nergency Seal Water Control

PRIMARY COOLANT PUMP NORMAL AND EMERGENCY SEAL WATER CONTROL SYSTEMS

These systems provide normal and emergency seal water to the primary coolant pumps. This narrative is for Cell No. 5, and is representative of the other four cells by substituting the appropriate valve and controller numbers.

The normal seal water supply to each primary coolant pump is from the high pressure injection water system. Differential pressure transmitter, PT-215, measures the differential pressure across the inboard seals of the primary coolant pumps (from seal inlet to pump suction); and signals differential pressure controller, PC-223, which compares the actual signal with the setpoint value. Approximately 50 psi differential pressure is maintained by positioning seal water control valve, IWV-265-5. The control action unit of PC-223 is monitored by a CFA, and upon detected failure, the controller is transferred from automatic to manual. If the differential pressure drops to 40 psi or lower or increases to 60 psi or higher, HI/LO alarm monitor PS-271 causes annunciation at the respective graphic panel for the affected pump and simultaneously initiates operation of the ESW system. The proportional action unit supplying the signal to PS-271 is monitored, and upon failure, the CFA actuates an annunciator and a CFA indicating light on BB Console.

The function of the emergency seal water system is to supply seal water to the primary coolant pumps within 10 seconds should normal seal water fail. When differential pressure transmitter PT-215 signals its HI/LO alarm monitor, PS-271, that abnormal differential pressure exists across the inboard seals of Number 5 coolant pump, the HI/LO monitor simultaneously starts the ESW pump through a transfer relay and actuates an annunciator on B Panel.

The ESW pump starts by opening of steam supply valve, HPV-258-1, by de-energizing three-way solenoid pilot valve, CASV-293-1. Once the ESW pump is started, it continues operating until manually stopped by CS-402 on AA Console. This is a three-position switch: ON manually starts the pump, AUTO places the pump in the automatic control system, and RESET stops the pump.

Blockout of the ESW actuating signal is provided to permit greater operating flexibility and to allow the removal of faulty actuating signals by operating cell isolation or cell blockout switches.

The "cell blockout" switch on BB Console is a three-position switch: "LOCK IN", "ISOL", and "BLOCK." In the "LOCK IN" position, the trip signal will actuate the ESW pump regardless of the position of the "cell isolation" switch. In the "BLOCK" position, a trip signal will not start the ESW pump. Only in "ISOL" will the cell isolation switch on AA Console be in control to permit or prevent pump starting.

Simultaneous with starting of the ESW pump, supply valve IWV-269-1 is opened wide by de-energizing CASV-294-1 which vents the control valve through trap valve CASV-295. This valve is controlled later by SC-207 as the ESWP discharge pressure increases.

The ESWP discharge/highest primary coolant pump suction (Ref. 21.4.7.1) differential pressure is measured by two transmitters. One of the converted (P to E) signals is selected by SS-261 on AA Console, and is compared to the setpoint of SC-207. The resulting error becomes the loading signal for the ESWP turbine speed governor and

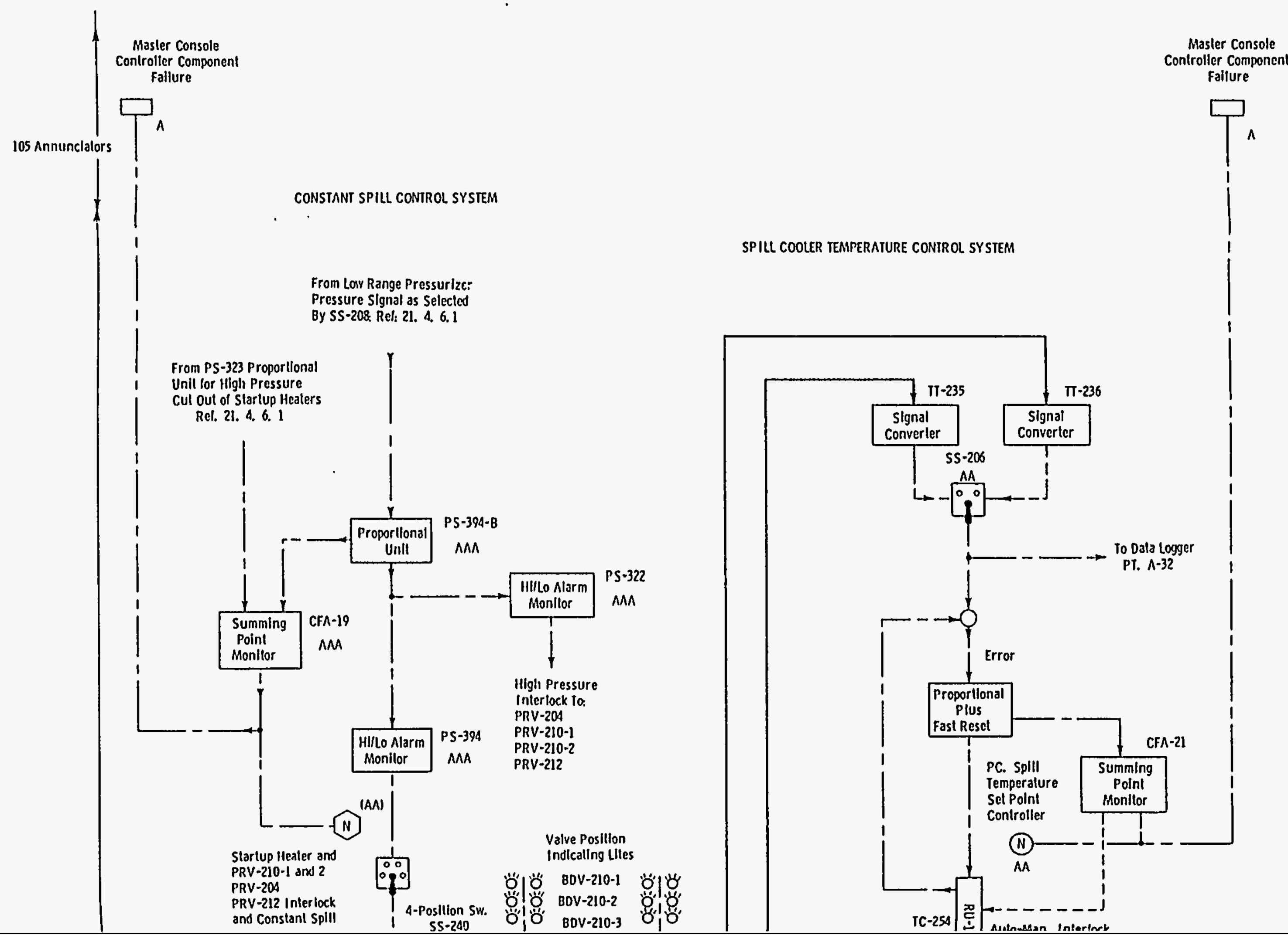
PRIMARY COOLANT PUMP NORMAL AND EMERGENCY SEAL WATER CONTROL SYSTEMS

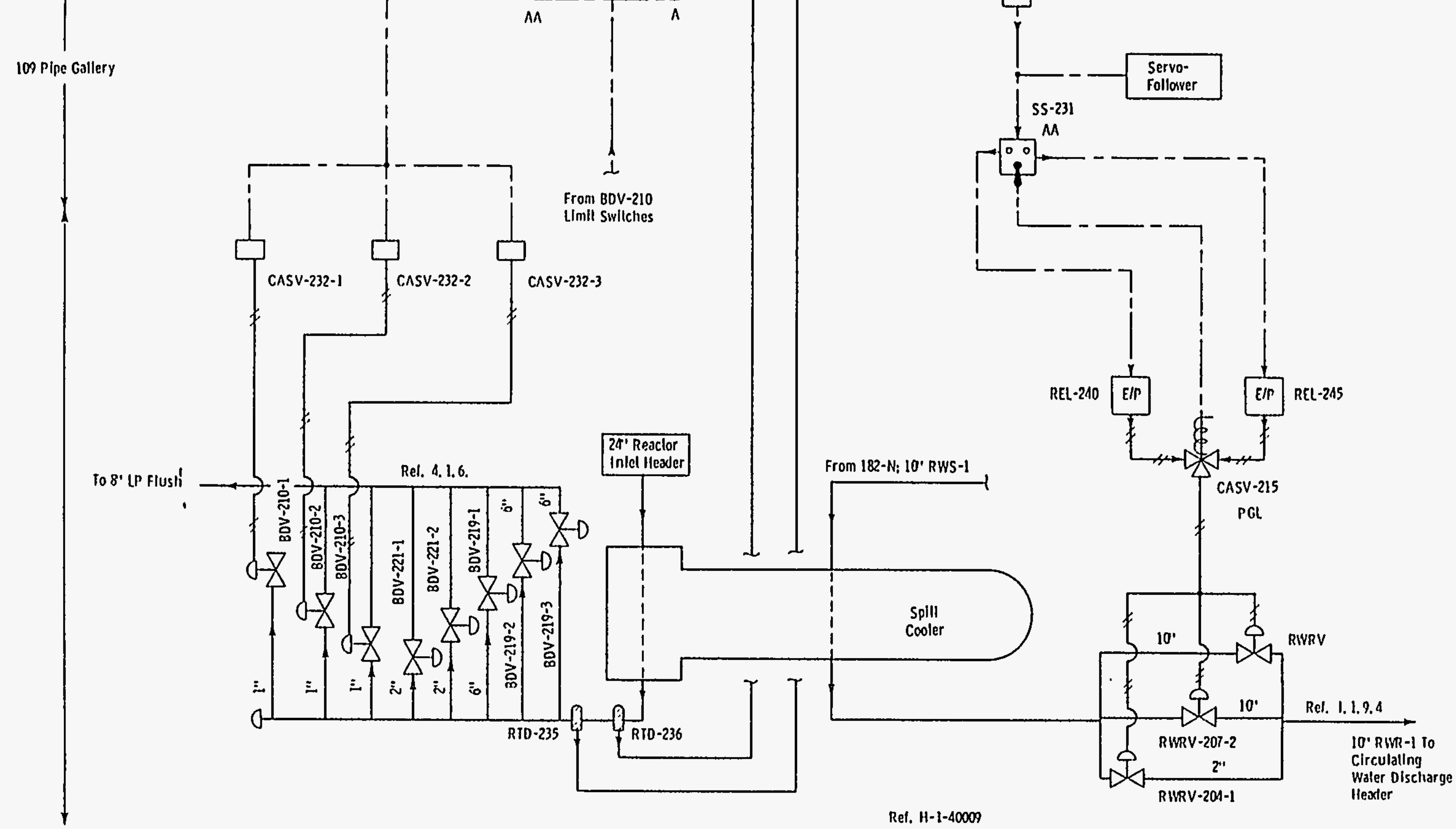
for IWV-269-1. Low differential pressure calls for a higher speed setting of the governor, while IWV-269-1 remains wide open. As the measured differential pressure increases, turbine speed is reduced; and at some low turbine speed, trap valve CASV-295 is actuated which puts IWV-269-1 under modulating control of SC-207.

The action unit of SC-207 is monitored by CFA-30. Upon detected failure, SC-207 is transferred to manual control and an annunciator and an indicating light are actuated.

Two ESP pressure relieving systems are provided.

The first protects the pump from excessive pressure should steam valve HPV-258-1 open when the pump start circuit is not actuated. Under these conditions, IWV-296-1 will open. The second protects the low pressure DW supply system, and opens DWV-217-1 when pump suction pressure exceeds 150 psi and when HPV-258-1 is closed.


Master Console Controller Component Failure
A
105 Annunciators
CONSTANT SPILL CONTROL SYSTEM
From Low Range Pressurizer Pressure Signal as Selected By SS-208 Ref: 21. 4. 6. 1
From PS-323 Proportional Unit for High Pressure Cut Out of Startup Heaters Ref. 21. 4. 6. 1
Proportional Unit
PS-394-B
AAA
Hi/Lo Alarm Monitor
PS-322
AAA
Summing Point Monitor
CFA-19
AAA
High Pressure Interlock To: PRV-204 PRV-210-1 PRV-210-2 PRV-212
Hi/Lo Alarm Monitor
PS-394
AAA
(AA)
N
Startup Heater and PRV-210-1 and 2 PRV-204 PRV-212 Interlock and Constant Spill
4-Position Sw. SS-240
Valve Position Indicating Lites
BDV-210-1
BDV-210-2
BDV-210-3
SPILL COOLER TEMPERATURE CONTROL SYSTEM
Master Console Controller Component Failure
A
TT-235
TT-236
Signal Converter
Signal Converter
SS-206
AA
To Data Logger PT. A-32
Error
Proportional Plus Fast Reset
CFA-21
Summing Point Monitor
PC. Spill Temperature Set Point Controller
N
AA
TC-254
RU-1
Auto-Man. Interlock



Primary Coolant Constant Spill and Spill Cooler Temperature Control Systems

PRIMARY COOLANT CONSTANT SPILL AND
SPILL COOLER TEMPERATURE CONTROL SYSTEMS

Primary Coolant Constant Spill Control System - The design intent of this system is to automatically provide spill flow of 30 to 60 GPM through the spill cooler regardless of primary coolant pressure. A constant bleed of primary loop water through the cooler keeps it pre-heated and prevents excessive thermal shock to the cooler in the event of a large spill of high temperature water.

The constant spill flow from the primary system is maintained by three sequentially operated 1" blowdown valves, BDV-210-1, 2 and 3. These valves are in parallel with the BDV-219 and BDV-221 valves at the discharge of the spill cooler.

The signal source to operate these valves is from the low range pressurizer pressure signal as selected by selector switch, SS-208, on AA Console. This signal is fed to proportional unit, PS-394-B, and then to a high-low alarm monitor, PS-394, for automatic control, and to a high-low alarm unit, PS-322, to provide a high pressure interlock of valves PRV-204, 210-1 and 212

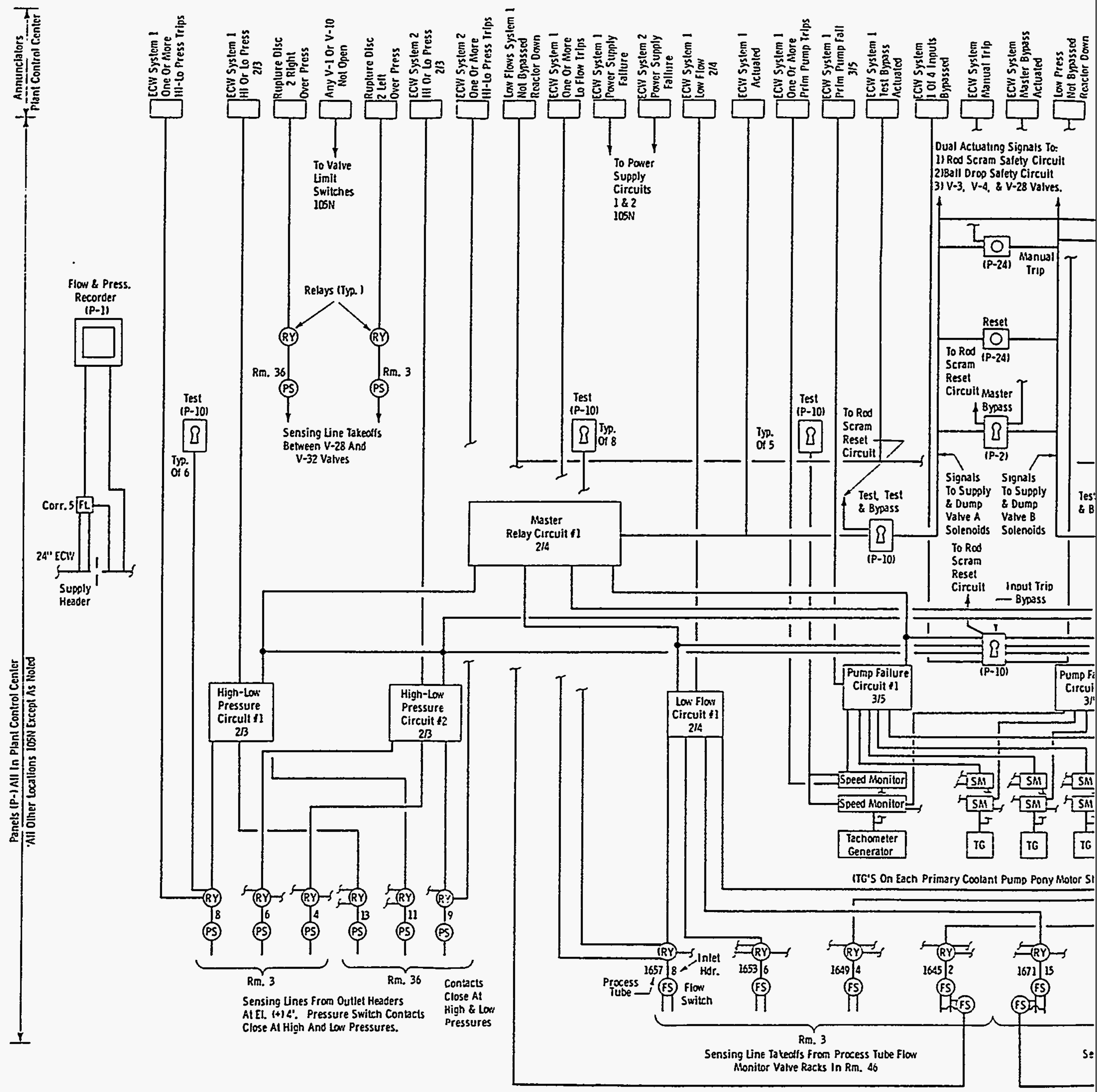
The control signal output from high-low alarm monitor PS-394, sequentially operates the blowdown valves. If the primary system pressure is at normal operating range, only the valve which is selected by SS-240 on AA Console will be open. As primary system pressure is reduced, the pressure drop across the pressure breakdown orifices will decrease and, therefore, the flow decreases. When the flow is reduced to 30 GPM, a contact on the high-low alarm monitor, PS-394, will open the second valve in sequence and increase the flow to 60 GPM. As the pressure continues to decrease and the spill flow again is reduced to 30 GPM, the high-low alarm monitor will open the third blowdown valve and flow is restored to 60 GPM. Consequently, a spill can be maintained between 30 and 60 GPM over the fall range of primary system operating pressures.

Note: SS-240 on AA Console is provided with a fourth position which permits the manual closing of all three blowdown valves.

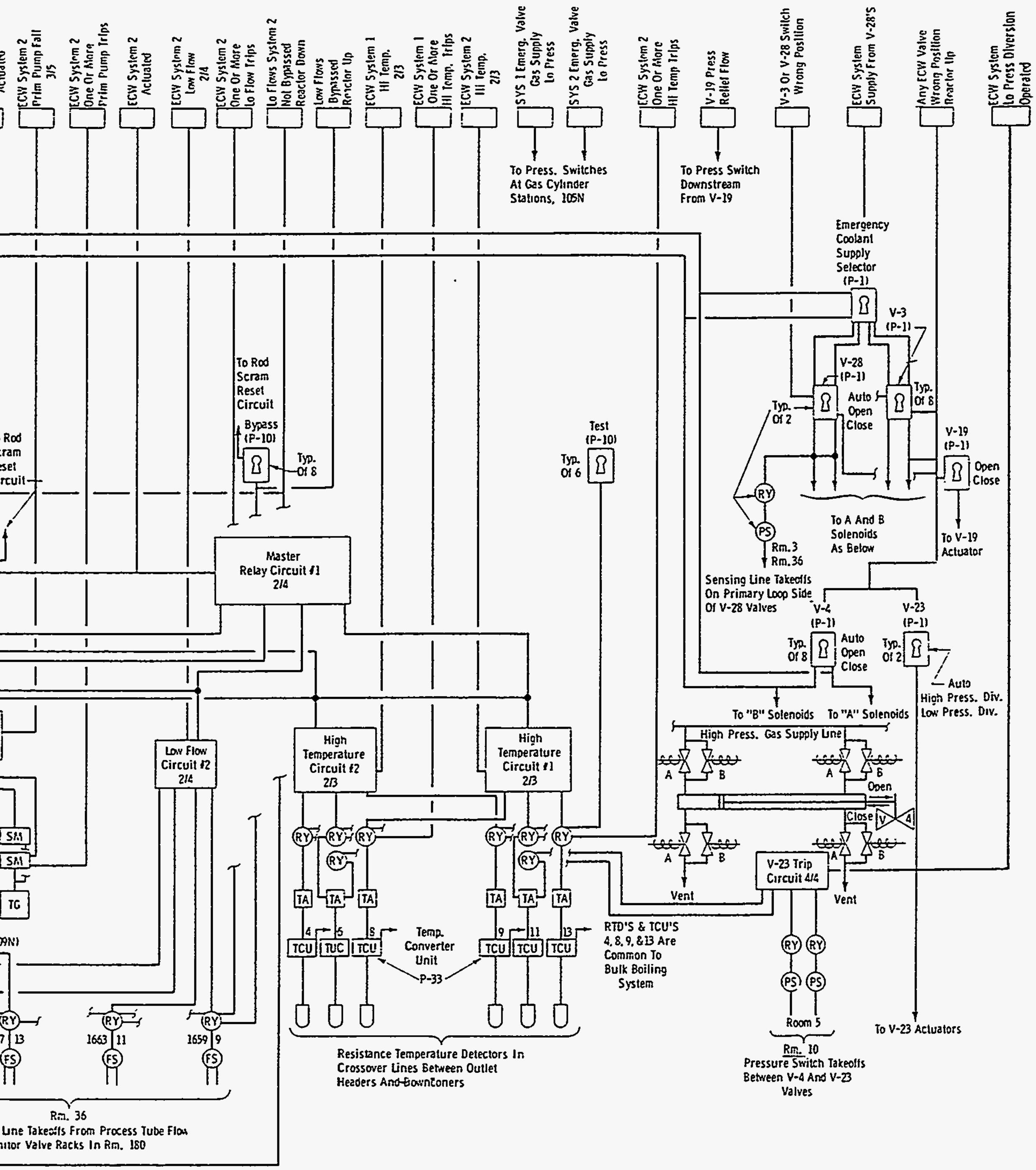
Spill Cooler Temperature Control System - The design intent of this system is to maintain the outlet temperature of the spill cooler below 180°F by automatic sequential operation of two of the three raw water coolant control valves downstream of the spill cooler. The cooler outlet temperature is measured by two RTDs, TT-235 and 236. The output from these two temperature detectors goes to individual signal converters which converts the input signal to the standard plus or minus DC electric control signal.

One of the two signals is selected for control by SS-206 on AA Console. This output signal is then data logged on point A-32 and compared to controller TC-254 setpoint output signal. The resultant temperature error signal is fed through a proportional plus fast reset action unit, through selector station TC-254, which is an RU100, and to a selector switch, SS-231, on AA Console. This selector switch provides the control signal to either electric-pneumatic converter, REL-240 or 245. The output from these two E/P converters is then fed to the three cooling water flow control valves, RWRV-204-1, and RWRV-207-1 and 2. RWRV-204 is operated sequentially with either RWRV 207, and the other RWRV-207 is used as a maintenance spare.

The proportional plus fast reset unit is monitored, and upon failure will initiate an automatic to manual transfer of the selector station along with appropriate CFA alarm and annunciation.



Reactor Emergency Cooling Wa



r Control System - 105N

REACTOR EMERGENCY COOLING WATER CONTROL SYSTEM-105N

This system is designed to activate the valves which initiate once-through cooling of the reactor (Ref. 4.3.4), and to supply actuating signals to the reactor rod scram and ball drop safety circuits.

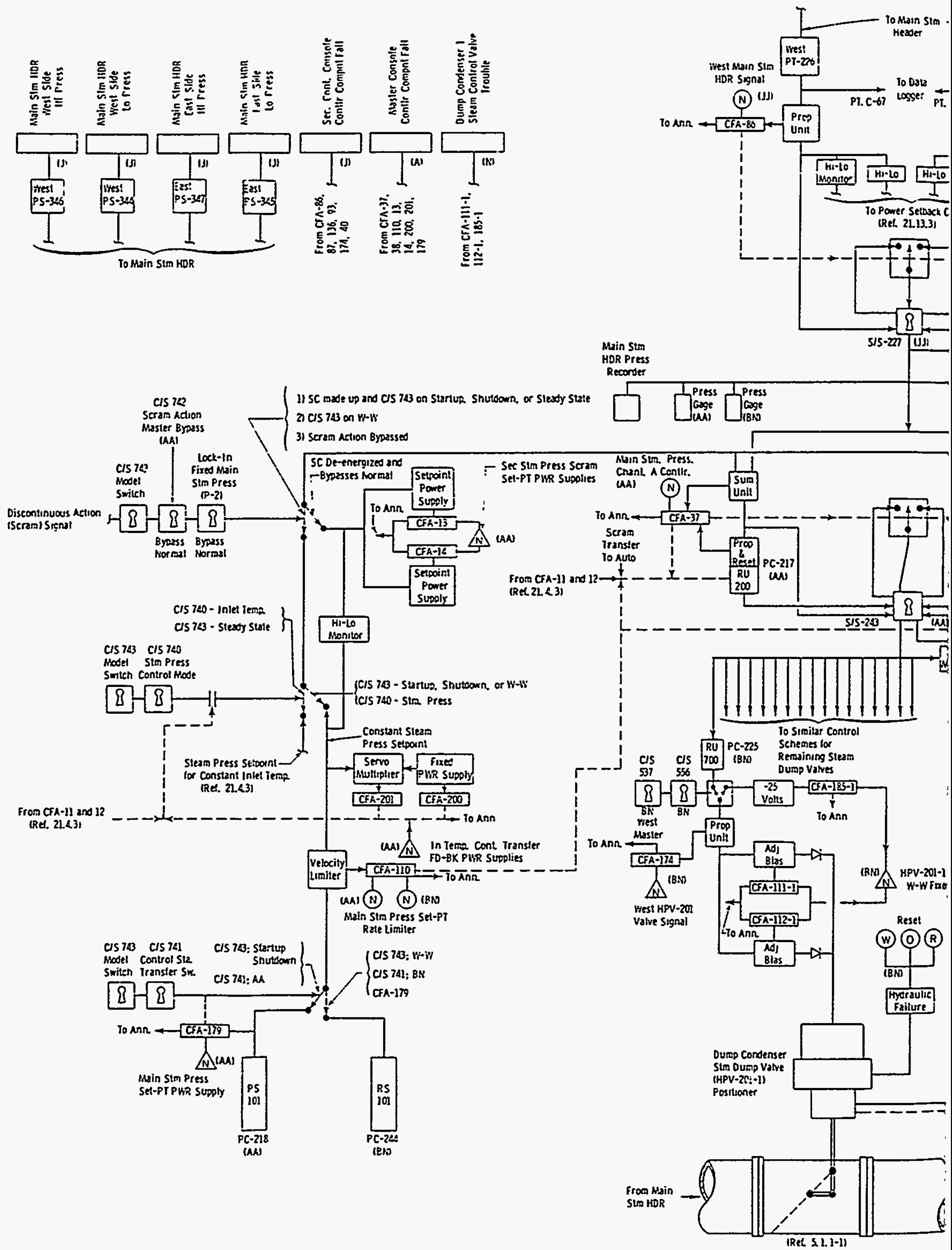
Because of severe thermal and depressurization shock resulting from operation of the emergency cooling water system, a control system of very high reliability has been provided. Protection against spurious operation of the system is obtained by using a fail negative design, and by requiring a coincidence of signals to cause actuation. To provide protection against failure of the system to operate when required, dual control systems are used. The control systems are parallel and completely separate, including power supplies, cables, etc. A positive signal from either control system will cause actuation of the reactor emergency cooling water valves, and the reactor rod scram and ball drop safety circuits.

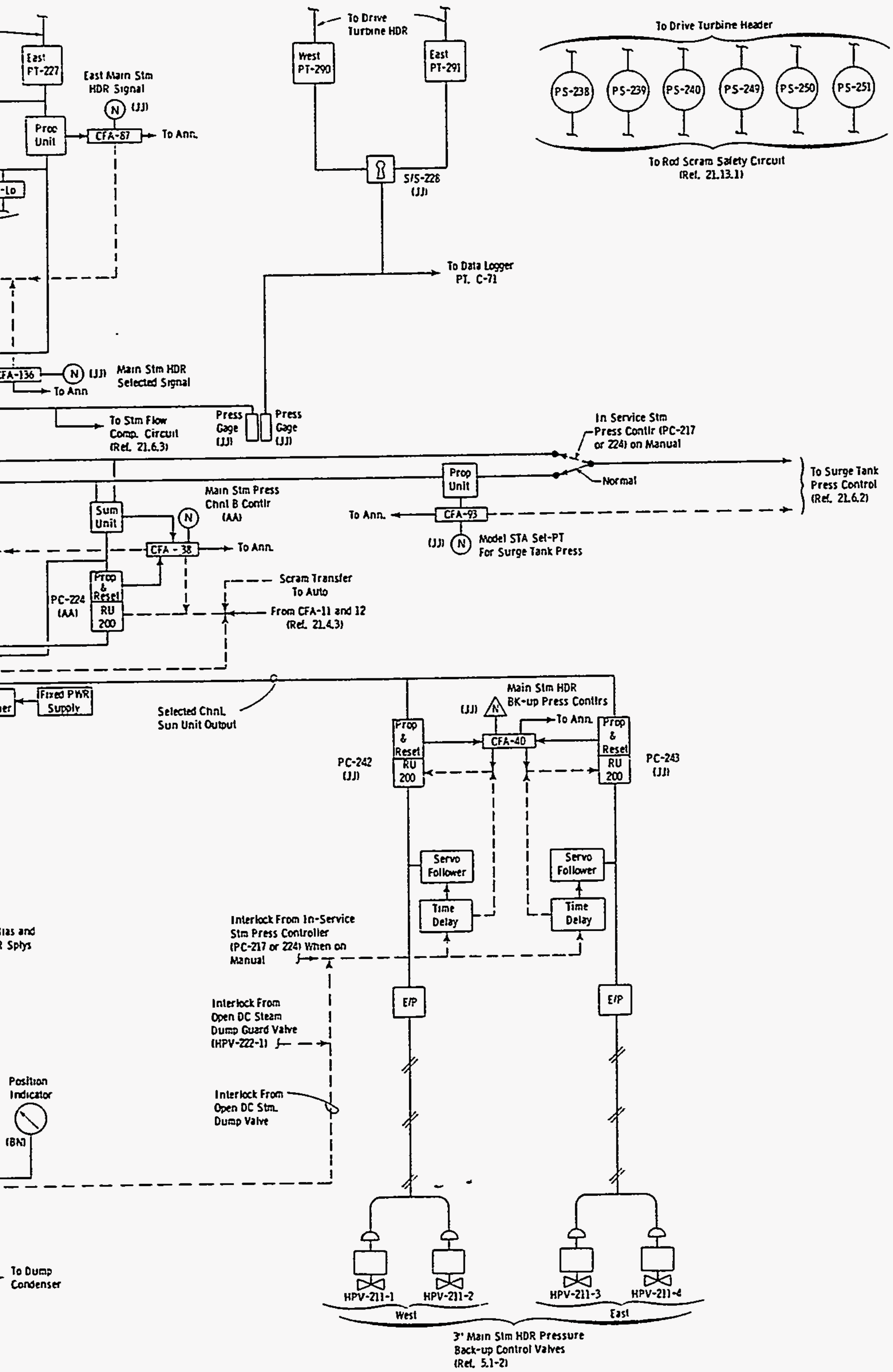
Each control system consists of a master relay control actuated by 2 of 4 input signals. The input signals to each master relay result from coincident trips of monitored points as follows:

Monitor Circuit	Number of Points	Number of trips to Activate Monitor Circuit
High-Low Pressure	3	2
Low Flow	4	2
Pump Failure	5	3
High Temperature	3	2

Other features of this system are as follows:

1. A master manual trip button and master bypass switch are provided.
2. A five-position input trip bypass switch is provided to allow bypassing signals of one of the four monitor circuit functions to both master relay circuits.
3. A test switch is provided for each master relay circuit. This switch, in conjunction with individual monitoring point test switches, provides a means to electrically check the input trip circuits of the system.
4. Individual switches are provided to bypass the monitoring point signals of the low flow monitor circuits.
5. An emergency coolant supply selector switch is provided to permit selection of the V-3 or V-28 valves as the source of emergency coolant water.
6. The V-28 valves are electrically interlocked with pressure switch contacts to prevent opening of the V-28 valves if the primary loop pressure is above 250 lbs.
7. The V-19 and V-18 (Ref. 8.1.9) valves will close automatically, if open, when either master relay circuit is actuated.
8. Power to the emergency cooling water system control circuits 1 and 2 are from 125-V D.C. power panels CD and CN respectively (Ref. 12.18.4.2).
9. The actuation of valves V-23, from high-pressure to low-pressure diversion (Ref. 4.3.4), is electrically interlocked with two temperature and two pressure sensing devices to prevent low-pressure diversion until primary loop temperature and pressure are below 250° and 200 lbs. respectively.
10. The following switches have contacts in the rod scram reset circuit and must be in the "Normal" position to be able to reset the reactor rod scram safety circuit:
    a. Master Bypass Switch.
    b. Test switches (two) of each master relay circuit.
    c. Input trip bypass switch.
    d. Individual low flow bypass switches (eight).


Main Stm HDR West Side Hi Press
Main Stm HDR West Side Lo Press
Main Stm HDR East Side Hi Press
Main Stm HDR East Side Lo Press
Sec. Cont. Console Contr Compnt Fail
Master Console Contr Compnt Fail
Dump Condenser 1 Steam Control Valve Trouble
West PS-346
West PS-344
East PS-347
East PS-345
To Main Stm HDR
From CFA-86, 87, 136, 93, 174, 40
From CFA-37, 38, 110, 13, 14, 200, 201, 179
From CFA-111-1, 112-1, 185-1
To Main Stm Header
West PT-276
West Main Stm HDR Signal
To Data Logger
PT. C-67
Prop Unit
To Ann.
CFA-86
Hi-Lo Monitor
Hi-Lo
To Power Setback C
(Ref. 21.13.3)
SJS-227
Main Stm HDR Press Recorder
Press Gage (AA)
Press Gage (BN)
C/S 742 Scram Action Master Bypass (AA)
1) SC made up and C/S 743 on Startup, Shutdown, or Steady State
2) C/S 743 on W-W
3) Scram Action Bypassed
C/S 743 Model Switch
Lock-In Fixed Main Stm Press (P-2)
Discontinuous Action (Scram) Signal
Bypass Normal
SC De-energized and Bypasses Normal
Setpoint Power Supply
CFA-13
CFA-14
Sec Stm Press Scram Set-PT PWR Supplies
Main Stm. Press. Chanl. A Contlr. (AA)
Sum Unit
CFA-37
Scram Transfer To Auto
Prop & Reset
RU 200
PC-217 (AA)
From CFA-11 and 12 (Ref. 21.4.3)
SJS-243
C/S 740 - Inlet Temp.
C/S 743 - Steady State
Hi-Lo Monitor
C/S 743 Model Switch
C/S 740 Stm Press Control Mode
C/S 743 - Startup, Shutdown, or W-W
C/S 740 - Stm. Press
Constant Steam Press Setpoint
Servo Multiplier
Fixed PWR Supply
CFA-201
CFA-200
Steam Press Setpoint for Constant Inlet Temp. (Ref. 21.4.3)
To Similar Control Schemes for Remaining Steam Dump Valves
RU 700
PC-225 (BN)
C/S 537
C/S 556
West Master
-25 Volts
CFA-185-1
In Temp. Cont. Transfer FD-BK PWR Supplies
Velocity Limiter
CFA-110
Main Stm Press Set-PT Rate Limiter
CFA-174
West HPV-201 Valve Signal
Adj Bias
CFA-111-1
CFA-112-1
HPV-201-1 W-W Fixe
Reset
Hydraulic Failure
C/S 743 Model Switch
C/S 741 Control Sta. Transfer Sw.
C/S 743; Startup Shutdown
C/S 741; AA
C/S 743; W-W
C/S 741; BN
CFA-179
Main Stm Press Set-PT PWR Supply
PS 101
PC-218 (AA)
RS 101
PC-244 (BN)
Dump Condenser Stm Dump Valve (HPV-201-1) Positioner
From Main Stm HDR
(Ref. 5.1.1-1)



ressure Control System

SECONDARY COOLANT STEAM PRESSURE CONTROL SYSTEM

This system provides the capability to control the secondary coolant system steam pressure at a fixed setpoint. Steam pressure control may also be via reactor constant inlet temperature control (Ref. 21.4.3). Steam pressure control is accomplished by regulation of the dump condenser steam valves, HPV-201-1 through 16.

The setpoint for constant main steam header pressure originates from one of two manual loaders which are located on AA and BN consoles. The selection of the in-service loader is made with the modal switch, c/s 743, or the console control station transfer switch, c/s 741, (Ref. 21.6.9). The power supply in loader PC-218 on AA Console is monitored by CFA-179, which causes automatic transfer to PC-244 on BN on detected failure of PC-218.

The output from the selected manual loader goes through a velocity limiter, so that large changes in setpoint will not feed rapidly into the control system and cause large disturbances. The velocity limiter is monitored by CFA-110, and upon detected failure, the in-service manual-automatic selector station (PC-217 or PC-224, see below) is transferred from automatic to manual control. This transfer takes place only when steam pressure setpoint originates with PC-218 or PC-244.

The selection of steam pressure control via reactor constant inlet temperature setpoint loader TC-253 or PC-217/244 is made with c/s 743 or steam pressure control selector switch, c/s 740. The servo multiplier and fixed power supply, provided for bumpless transfer only when going from constant steam pressure to constant inlet temperature control, are monitored by CFA-200 and 201. Detected failure prevents transfer to constant inlet temperature control.

The selected steam pressure control signal is routed to redundant summing units which also receive a measured main steam header pressure signal. Main steam header pressure is monitored by PT-226 and 227. The outputs of these transmitters goes through action units which are monitored by CFA-86 and 87. The selection of the main steam header pressure signal routed to the redundant summing units is with SS-227. This switch has 4-positions: A and B automatic, and A and B manual. When SS-227 is in A (B) automatic and on actuation of CFA-86 (87), the transfer relay automatically transfers the output of SS-227 from PT-226 (227) to PT-227 (226). In the manual positions of SS-227, there is no transfer on actuation of CFA-86 or 87.

CFA-136 monitors the output of SS-227; and if the header pressure becomes greater or less than preset limits, the transfer circuitry associated with SS-227 is actuated as noted above.

The outputs from the redundant summing units is an error signal representing variation in actual (measured) steam pressure with the desired setpoint. These error signals are routed to redundant action units and to manual-automatic selector stations PC-217 and PC-224. The in-service selector station is determined by switch SS-243 which has 4-positions: A and B automatic and A and B transfer override. If SS-243 is in A (B) automatic, then on actuation of CFA 37 (38) which monitors the summing and action unit supplying a signal to PC-217 (224), the transfer relay automatically transfers the output of SS-243 from PC-217 (224) to PC-244 (217). If PC-244 (217) then fails, the selector station will be transferred

SECONDARY COOLANT STEAM PRESSURE CONTROL SYSTEM (CONT'D)

from automatic to manual control. In the A (B) transfer over-ride positions, PC-217 (224) is transferred from automatic to manual control on actuation of CFA-37 (38). The in-service selector station is also transferred from automatic to manual on actuation of CFA-11 or 12 (Ref. 21.4.3) and CFA-110 (see above).

A scram-transfer to automatic interlock is also provided for PC-217 and PC-224. One of the discontinuous scram actions (Ref. 21.6.9) is the establishment of a predetermined main steam header pressure setpoint. This is accomplished by introducing the signal from one of two setpoint power supplies, which are monitored by CFA-13 and 14. This signal cannot become effective, however, if the in-service selector station (PC-217 or 224) is on manual control. Therefore, on scram, the in-service controller is transferred to automatic if on manual; or if a failure exists in the control chain of the in-service controller when on manual, a transfer to the other controller will take place.

SS-243 provides an output from the in-service selector station which goes to 16 bias selector stations (RU-700). The output of the bias selector stations goes through a transfer relay, which provides a water-to-water interlock. When in service, a +25 volt signal replaces the normal control signal and holds the dump condenser steam valves closed. The transfer relay output then goes through an action unit, and is adjusted in value by one of two bias power supplies to provide a signal compatible with the steam valve positioner.

Each dump condenser steam valve positioner is an electro-hydraulic mechanism that is monitored for hydraulic failure. Normal and failure indicating lights, together with a reset pushbutton are provided on BN Console. The positioner includes a hydraulic reservoir which has the capacity for two complete valve cycles if electric power is lost. In case of loss of hydraulic or positioner power, the steam valve will fail closed.

This system also provides the means for main steam header backup pressure control. The input to the action units of PC-242 and 243 is the in-service summing unit output, as established by SS-243 and transfer relay. The outputs of PC-242 and 243 when on automatic and with no interlocks in effect, will open valves HPV-211-1 through 4 when the measured main steam header pressure drops below setpoint.

Selector stations PC-242 and 243 have several interlocks. The action units are monitored by CFA-40, which causes transfer from automatic to manual control on detected failure. Two other interlocks, when actuated, energize the servo followers of PC-242 and 243 to initially close (if open) the backup control valves. Once closed, the valves can then be opened by the manual toggle switches on the selector stations. If the in-service steam pressure selector station (PC-217 or 224) is on manual, the backup control valves will close. The backup control valves will also close if any dump condenser steam valve and guard valve are open simultaneously.

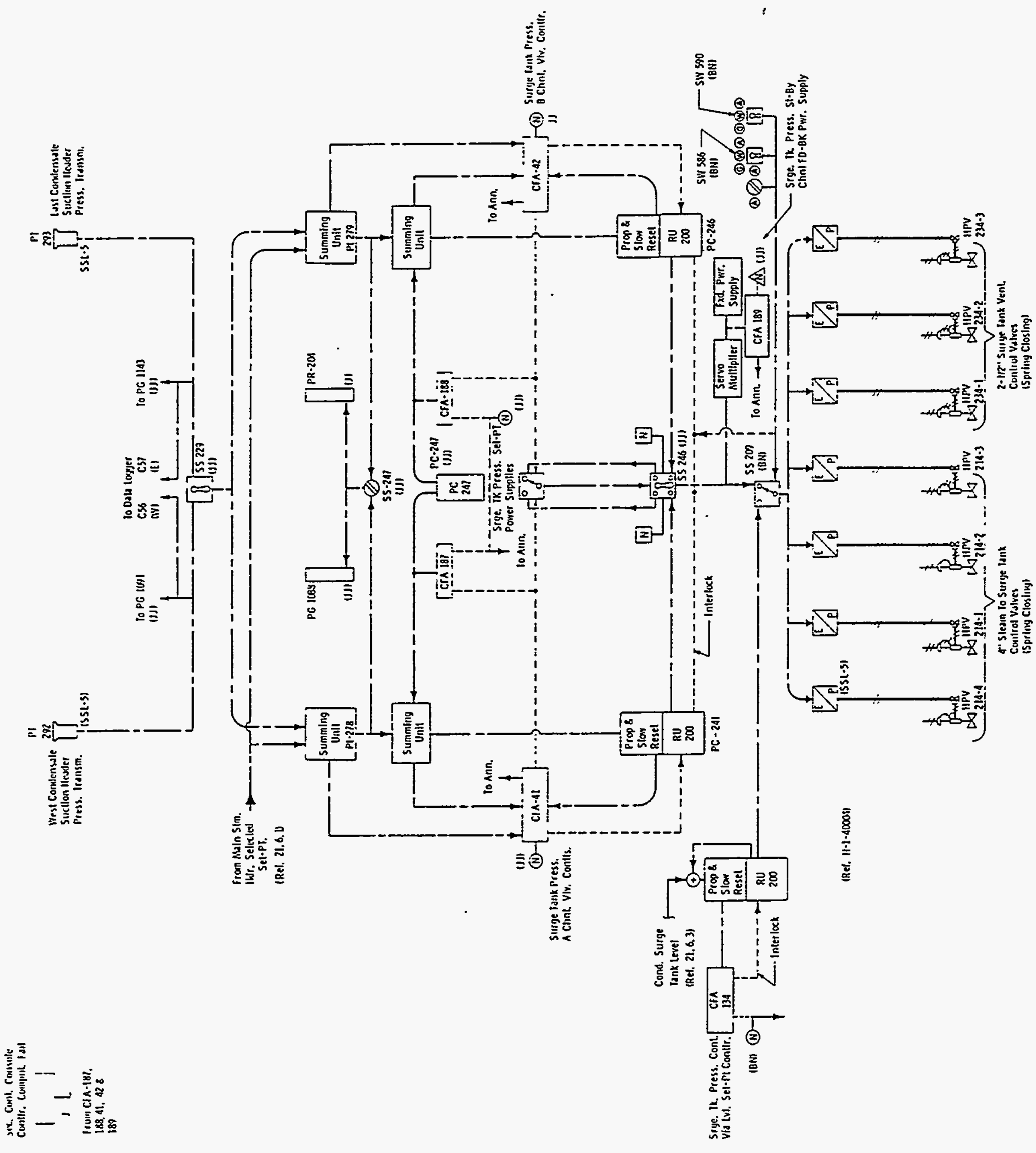
This system also provides a control signal to the surge tank pressure control system (Ref. 21.6.2). This signal is the measured main steam header pressure when the in-service selector station PC-217 or 224 is on manual or on actuation of CFA-93. At all other times, this signal is the modal station selected steam pressure setpoint.

SECONDARY COOLANT STEAM PRESSURE CONTROL SYSTEM (CONT'D)

The action units receiving signals from PT-226 and 227 provide signals to high-low alarm monitors in addition to the control system. These monitors cause a reactor power setback on a 2 of 4 coincidence.

Drive turbine header pressure is monitored by six pressure switches. These switches cause a rod scram safety circuit actuation on a 2 of 6 coincidence.

The locations of switches, loaders, controllers, etc. are shown on Page 21.6.1-1. Annunciators and CFA indicating lights are also shown.



Secondary Coolant Surge Tank Pressure Control System

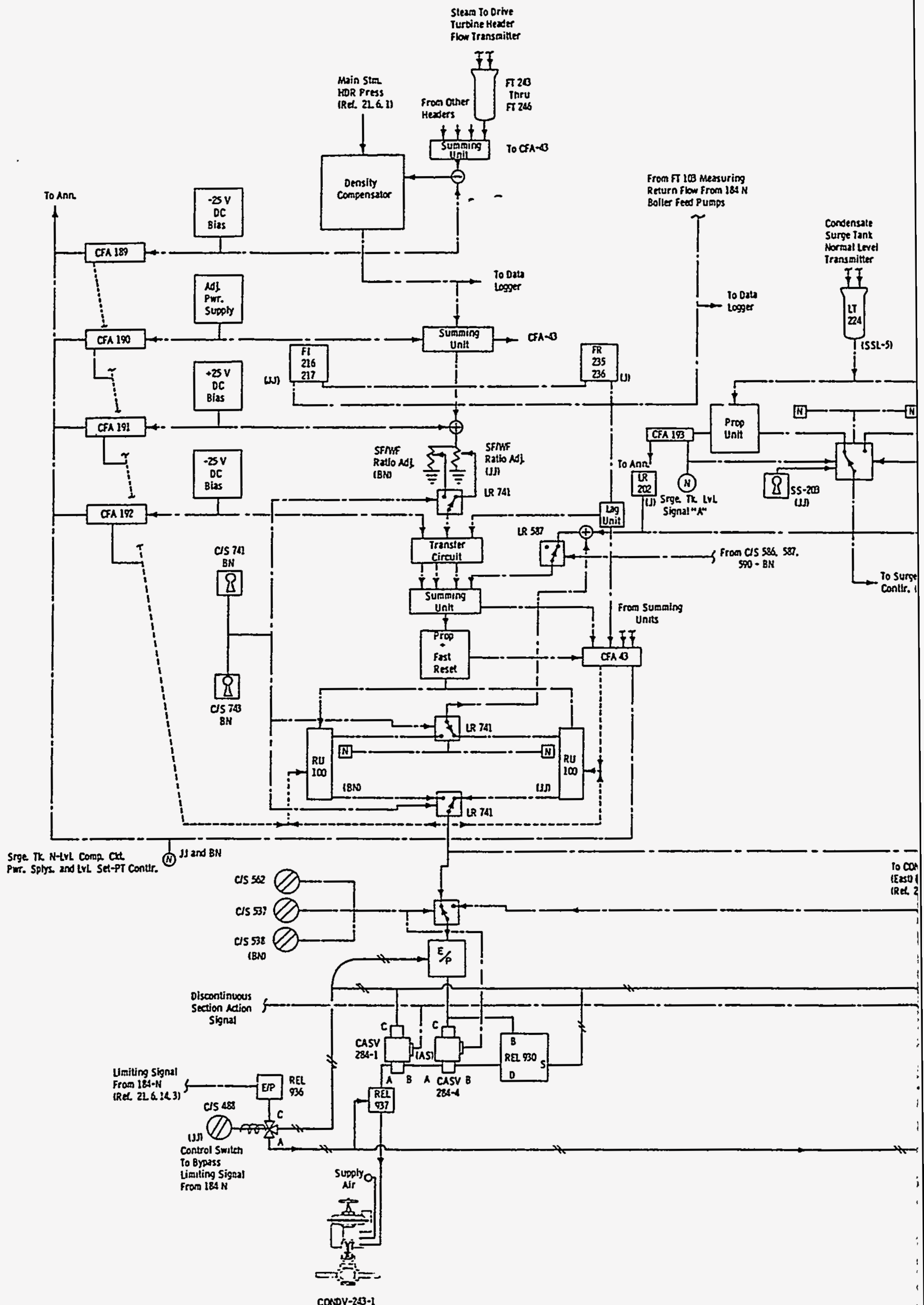
SECONDARY COOLANT SURGE TANK PRESSURE CONTROL SYSTEM

This system is designed to control surge tank pressure at a setpoint that is a fixed differential between the main steam and condensate pump suction headers, so that the condensate return pumping head may be held to a minimum. Control is via valves which admit steam to, or permit venting from the space above the water level of the surge tank.

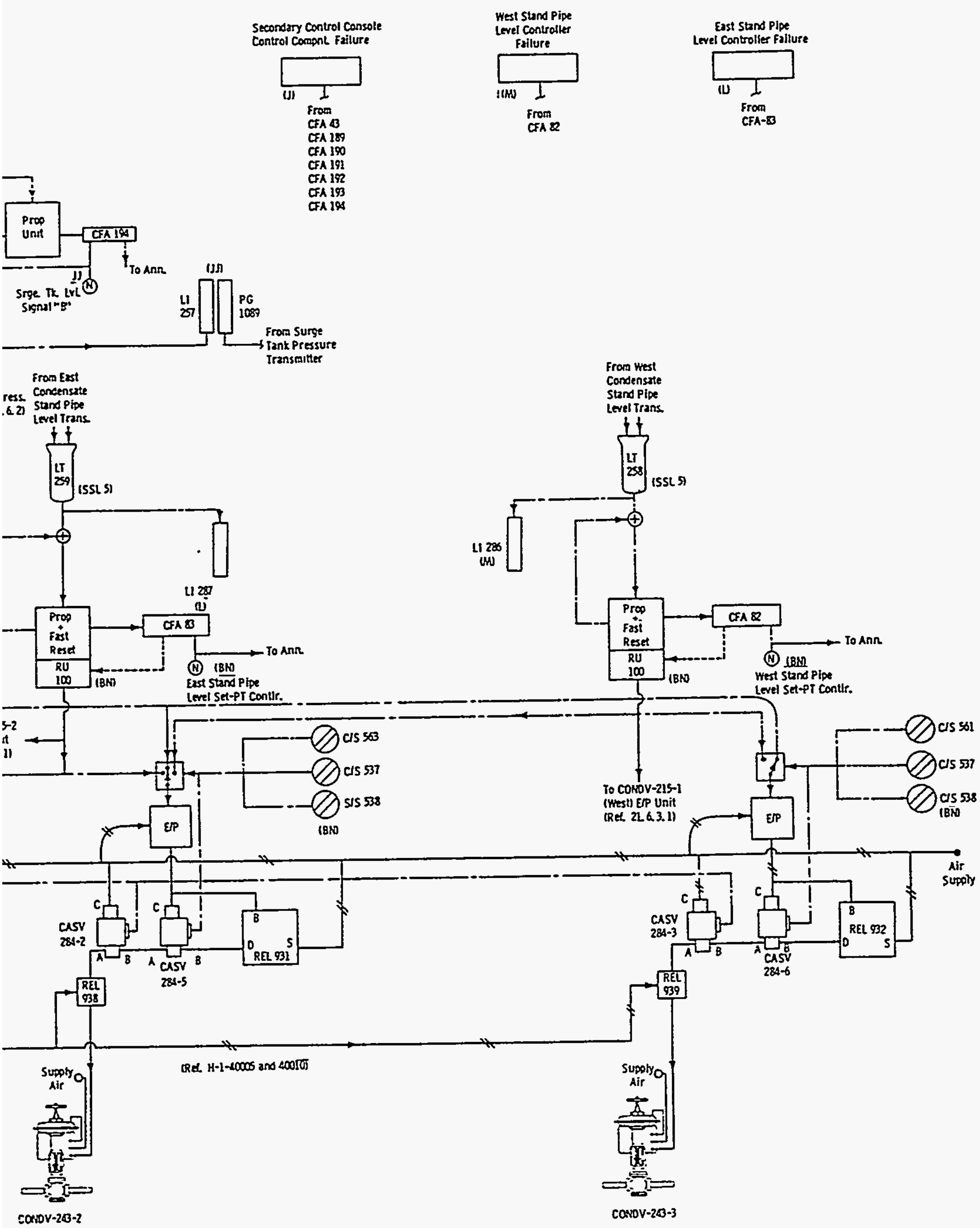
The East and West condensate pump suction header pressures are monitored, and the selected signal is sent to summing units of redundant control chains. A signal representing main steam header selected setpoint signal (Ref. 21.6.1) is also routed to the same summing units. The output of these units is the differential pressure between the main steam and condensate pump suction headers, which is compared to the setpoint of PC-247. The resulting error signal is then acted on by proportional plus reset units, and routed through manual-automatic selector stations (PC-241 and 246).

Control chain selection is via 4-position selector switch, SS-246 (JJ): A or B automatic and A or B transfer over-ride. If on A automatic, actuation of CFA-41 or 187 will cause a transfer from PC-241 to PC-246 in the same mode of control (whether manual or automatic). The transfer over-ride position prevents transfer on CFA actuation, and transfers the mode of control from automatic to manual. The common control signal is routed to seven E/P converters, four of which supply steam admittance valves and three which supply vent valves. HPV-214-1 and 4 operate simultaneously and in sequence with HPV-214-2 and 3. Only one valve in each group is in service at any one time. Flow through the spare valve is shut off by block valves. For surge tank venting, HPV-234-1 operates in sequence with HPV-234-2 and 3. Only one valve in this last group is in service at any one time.

Control of the valves of this system may also be from LC-206 during certain phases of water-to-water operation (Ref. 21.6.9.1), by actuation of CS-586, 587, or 590. The signal compared to the setpoint of LC-206 is a surge tank level signal (Ref. 21.6.3). The error signal is routed to a proportional and reset unit which then becomes the control signal to the steam admittance and vent valves. The action unit of LC-206 is monitored by CFA-134, which transfers LC-206 from automatic to manual control on detected failure.



Secondary Coolant Surge Tank N



rmal Level Control System

SECONDARY COOLANT SURGE TANK NORMAL LEVEL CONTROL SYSTEM

This system is designed to maintain the surge tank water level at setpoint to maintain the secondary loop inventory, and to actuate high and low level alarms. Level is controlled by regulating the flow of condensate return from the 184N boiler feed pumps. Emergency fill and spill valves are actuated in the event of extreme low or high surge tank levels (Ref. 21.6.3.1). This system is a three element control system which compares total steam flow to the drive turbine header to condensate return flow with measured surge tank level as a readjustment signal.

Four steam flow transmitters (FT-243 through FT-246) send a DC signal proportional to the steam flow to a summing unit. The resulting total steam flow signal is then biased by a -25 volt DC bias to a 0 to -50 volt DC signal, which is then density compensated in REL-308 with the main steam header pressure signal (Ref. 21.6.1). The compensated steam flow is then summed with an adjustable power supply. The 0 to +50 volt DC signal is then fed to steam flow to water flow ratio adjusters through latch relay 741 and to a transfer circuit. Also fed into this transfer circuit via a lag unit is the uncompensated condensate flow. At this point, a biasing signal from -25 volt DC bias is used to convert the signal back to ±25 volts DC. These three signals are then fed to a summing unit and summed with the error signal between measured surge tank level (from LT-224) and the selected setpoint controller, LC-208 or LC-209. The sum of these four signals is then fed to a proportional plus fast reset action unit, and then through manual automatic setpoint selector stations, LC-208 and LC-209. The selected control signal is sent to three E/P units and then through certain relays, depending on the mode of operation, (see following paragraph on Relay Operation) to the three secondary coolant makeup flow control valves. All of these valves operate from this one signal, but only two valves normally will have flow through them; the third valve is shut off by block valves.

Relay Operation - During normal operation, the air signal from the E/P units is from C to A through CASV-284-4,5 and 6; then through B to A on CASV-284-1, 2, and 3 to REL's-937, 938, and 939 to the makeup valves.

On a scram signal, air comes directly through C to A on CASV-284-1, 2, and 3 to REL's-937, 938, and 939 to the makeup valves, causing the valves to open wide.

During standpipe (water to water) operation, (see below) the air signal from the E/P unit follows the path from B to D on REL's-930, 931, and 932; then from B to A on CASV-284-1, 2, 3, 4, 5, and 6 to REL's-937, 938, and 939 to the makeup valves. Relays 937, 938, and 939 are provided to restrict the opening of the makeup valves (CONDV-243-1, 2, and 3) when either the boiler water level or the feed water pump discharge pressure in the standby power plant becomes too low. When either of these conditions occurs, the final restrictive signal from REL-936 will start to adjust the normal control signals of the valves at REL's 937, 938, and 939 so as to progressively close down these valves. However, if it should be so desired to cut out this protective arrangement, CS/488 can be used to change the position of the three-way pilot, CASV-324-1, so that the loading entering Port "B" of the stack REL's-937, 938, and 939 will be such that it will make them repeating the normal control signals to the valves from CASV-284-1, 2, and 3.

SECONDARY COOLANT SURGE TANK NORMAL LEVEL CONTROL SYSTEM (CONT'D)

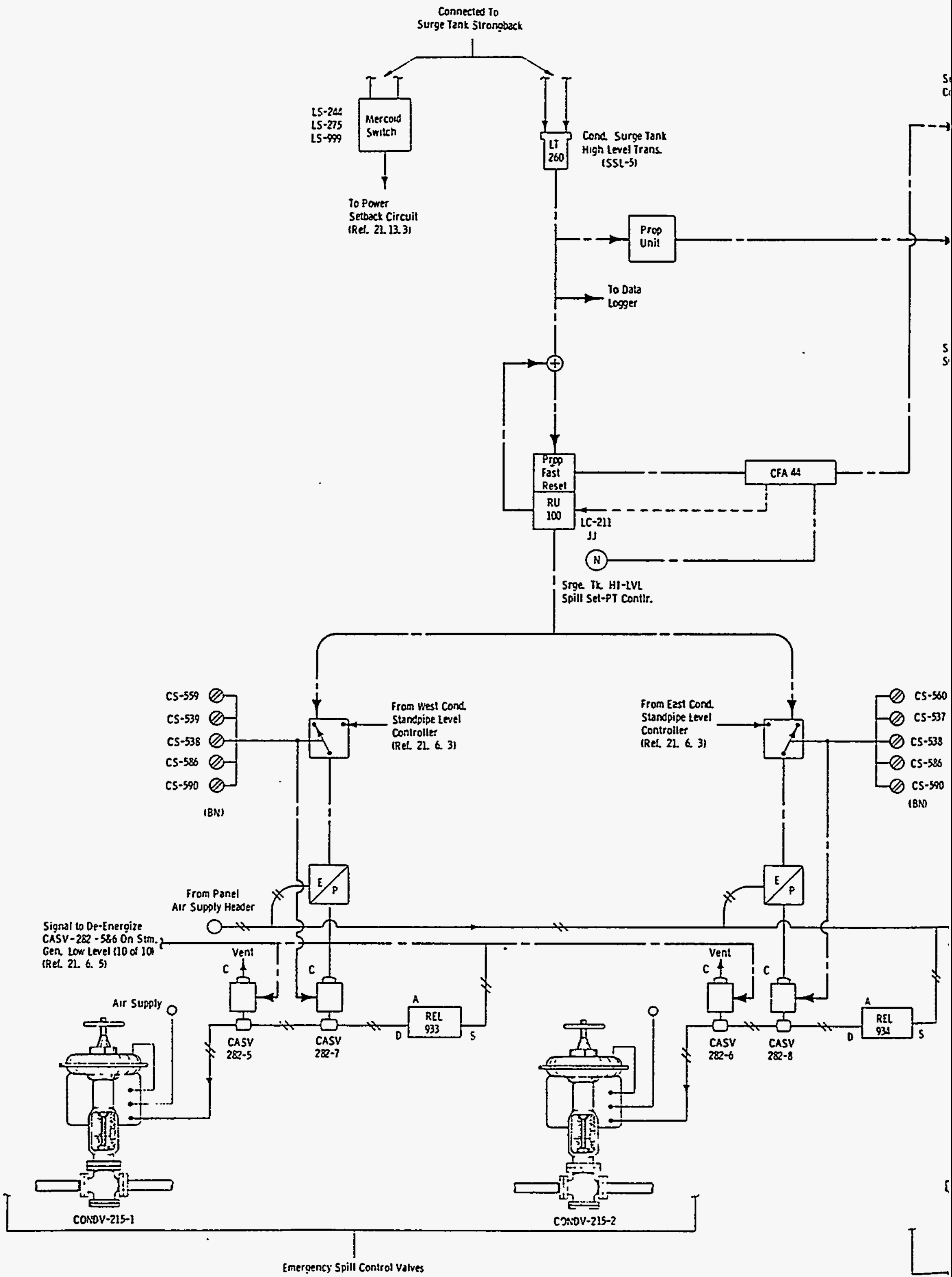
Water To Water Operation - During certain phases of water to water operation (Ref. 21.6.9.1), the East and West normal makeup valves, and the emergency spill valves (Ref. 21.6.3.1) are placed under control of the respective condensate standpipe level controllers.

These controllers are usual manual-automatic selector stations with setpoint. The measured standpipe level is compared to setpoint, and the error signal goes through an action unit. The resulting control signals are used to position the normal make-up valves as follows:

A. Control signal from West standpipe level controller (LC-224) to CONDV-243-3, or CONDV-243-2, if assigned to replace CONDV-243-3.
B. Control signal from East standpipe level controller (LC-225) to CONDV-243-1, or CONDV-242-2, if assigned to replace CONDV-243-1

Interlocks and Switches -

1. The assignment of the in-service proportional unit acting on the surge tank normal level transmitter signal is via SS-203 on JJ Console. This switch has four positions: A and B automatic, and A and B manual. The automatic positions cause automatic transfer to the opposite action unit when a failure of the selected unit is detected by CFA-193 or 194. In the manual position, there is no transfer on detected failure.
2. All action units and power supplies of the normal control chain are monitored by CFAs. Detected failures will cause a transfer from automatic to manual of the controller (LC-208 or LC-209) in service.
3. The action units of the standpipe level controllers are monitored; and upon detected failure, the CFA causes a transfer of the controller (LC-224 and LC-225) from automatic to manual.
4. The selection of LC-208 (BN) or LC-209 (JJ) and SF/WF adjusters (BN or JJ), is by the modal switch or control station transfer switch (Ref. 21.6.9). Setpoints of the two controllers should be the same before transfer is made to avoid a system bump.
5. The transfer from a three to two element control system is made during the water to water draining operation by CS-586, 587, or 590.



Secondary Coolant Surge Tank E
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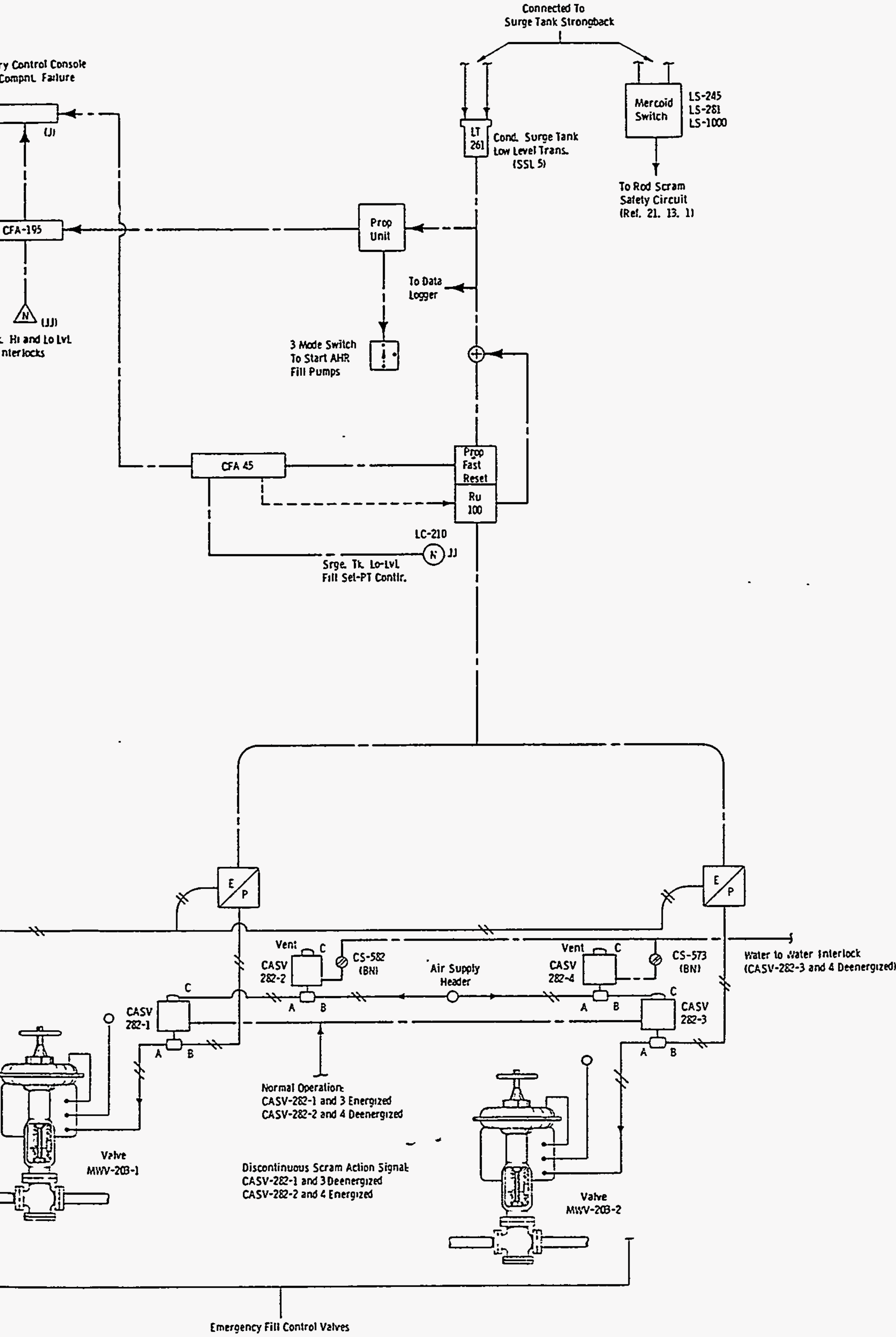


ergency Spill and Fill Control
s

SECONDARY COOLANT SURGE TANK EMERGENCY SPILL AND FILL CONTROL SYSTEMS

These systems are supplementary to the surge tank normal level control system (Ref. 21.6.3). If surge tank level exceeds or falls below the control range of the normal level control system, these systems provide emergency spill or fill controls.

Emergency Spill System - This system senses surge tank level with LT-260. The measured level is compared to the setpoint of LC-211, and an error signal is generated that is acted on by an action unit. The output of this unit is converted to two pneumatic signals which position the East (CONDV-215-1) and West (CONDV-215-2) emergency spill valves. During normal operation, the control signal goes from the E/P converter through CASV-282-7 and 8 (A-C) and through CASV-282-5 and 6 (A-B) to the valve positioner. The emergency spill valves will close on a 10 out of 10 coincidence of steam generator low liquid level signals (Ref. 21.6.5). In this case, CASV's-282-5 and 6 are de-energized (A-C), venting the valve positions, and causing the spill valves to close.

Control of the East and West spill valves may also be vested in the respective condensate standpipe level controllers (Ref. 21.6.3) during certain phases of water to water operation (Ref. 21.6.9.1). During these times, the control signals from the E/P units are routed through REL's-933 and 934 (A-D), through CASV's-282-5 through 8 (A-B), to the valve positioners.

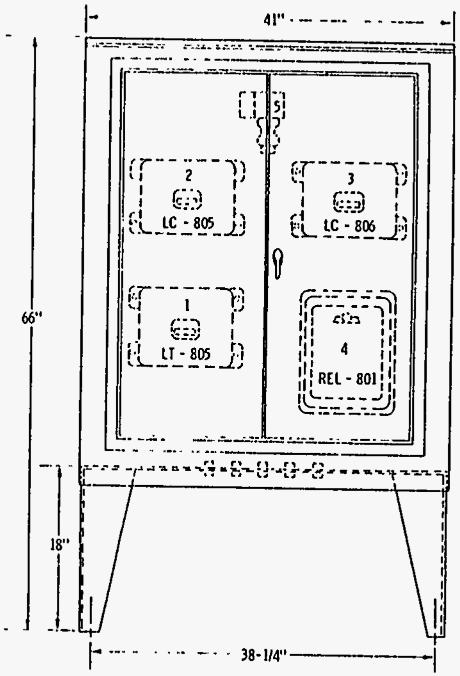
The control action unit of this system is monitored by CFA-44. Detected failure causes transfer from automatic to manual of LC-211.

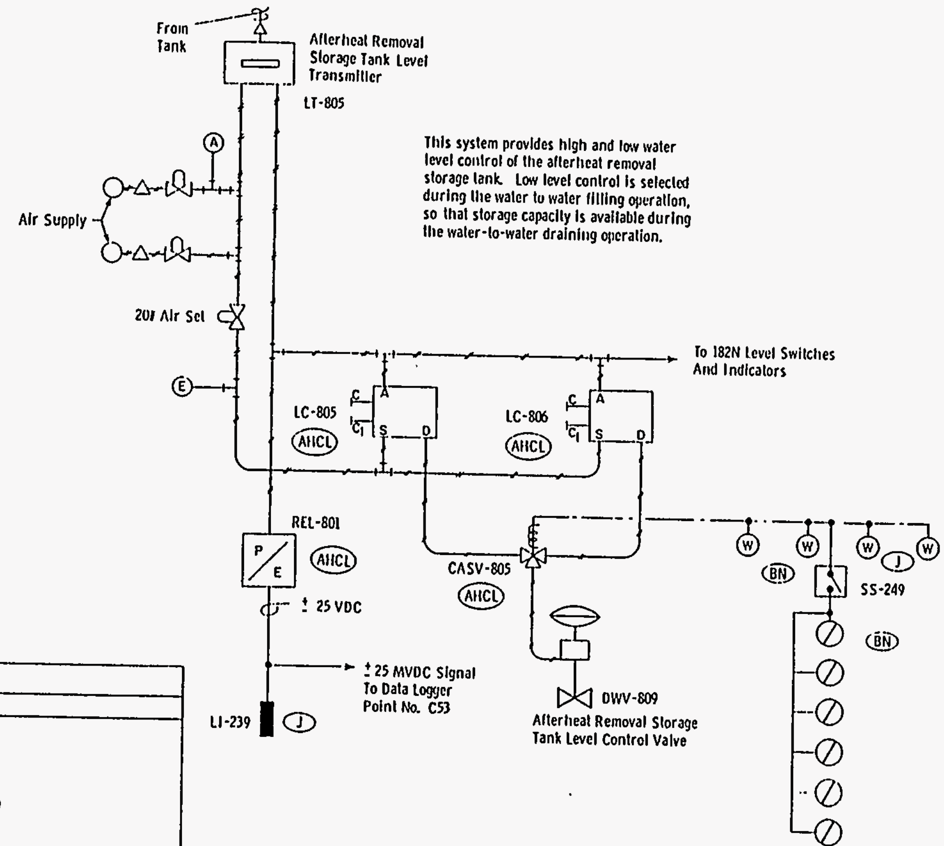
Emergency Fill System - This system is very similar to the spill system. Surge tank level is measured by LT-261, and the measured level is compared to the setpoint of LC-210. The resulting error signal is acted on by an action unit and sent to two E/P converters. The pneumatic signals are used to position the East (MWV-203-1) and West (MWV-203-2) emergency fill valves. During normal operation, the signals from the E/P units are routed through CASV-282-1 and 3 (A-B) to the valve positioners.

The emergency fill valves open wide on a scram signal (Ref. 21.6.9). In this case, CASV-282-2 and 4 are energized (A-B), admitting air through CASV-282-1 and 3 (A-C) to the valve positioners, and causing the fill valves to open.

During certain portions of water to water operation, the emergency fill valves are held closed. This is accomplished by venting the valve positioners through de-energized CASV's-1 through 4 (A-C), which causes the valves to close.

The control action unit of this system is monitored by CFA-45. Detected failure causes transfer from automatic to manual of LC-210.

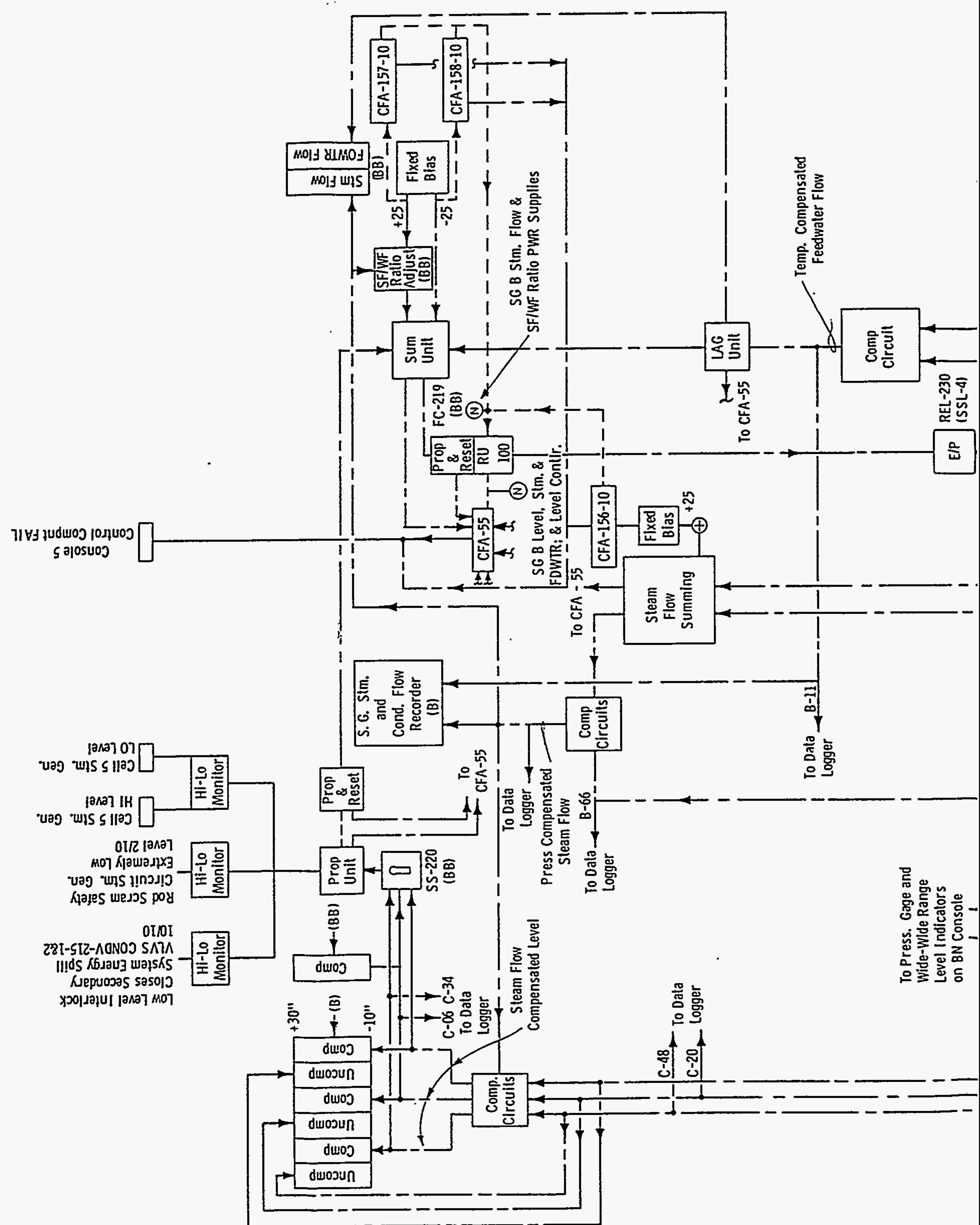




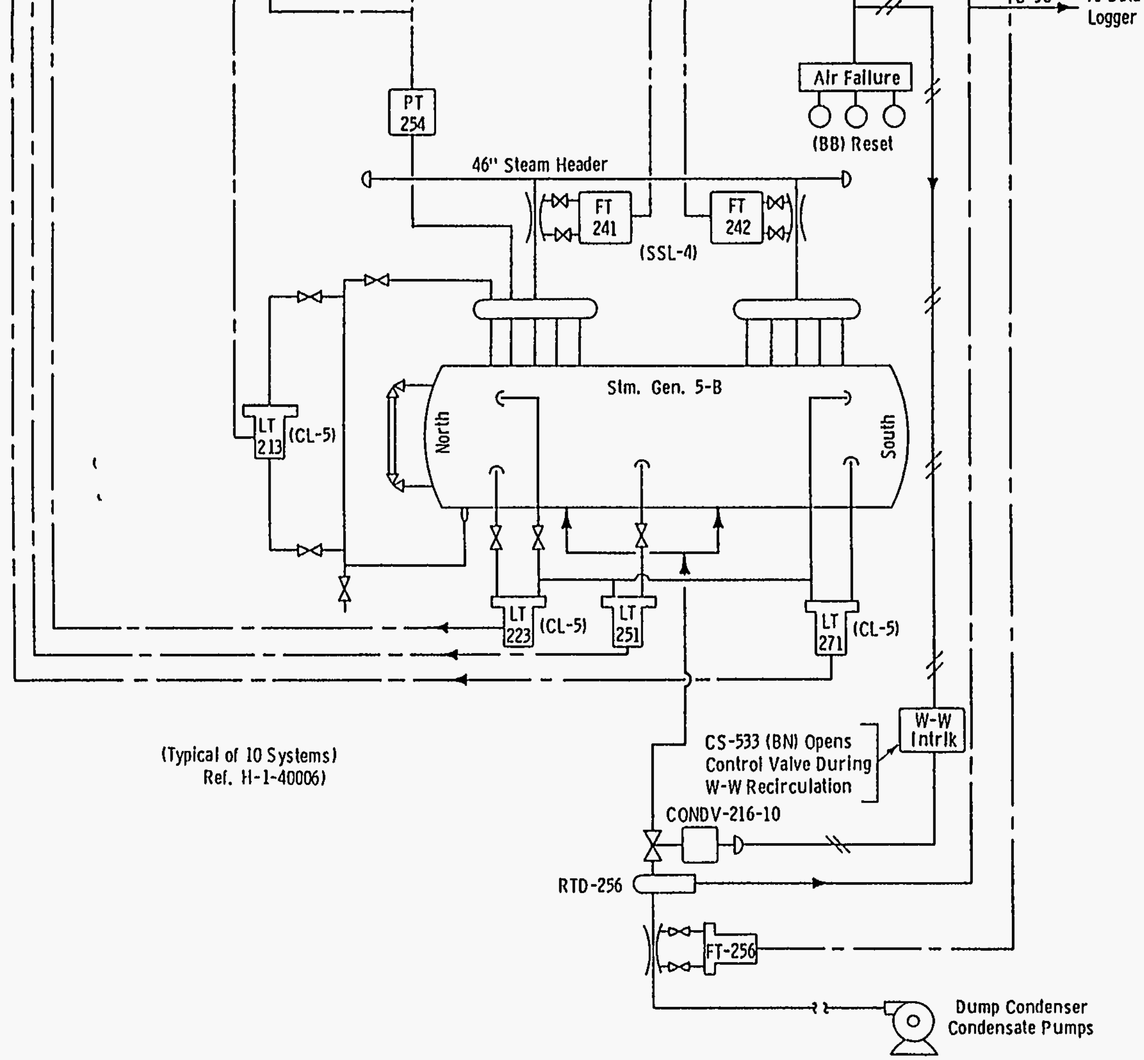
This system provides high and low water level control of the afterheat removal storage tank. Low level control is selected during the water to water filling operation, so that storage capacity is available during the water-to-water draining operation.

Designation of Items		
Item No.	Instrument No.	Description
1	LT - 805	Afterheat Removal Storage Tank Level
2	LC - 805	To Maintain Tank Water Level At "High Setting"
3	LC - 806	To Maintain Tank Water Level At "Low Setting"
4	REL - 801	Afterheat Removal Storage Tank Level
5	CASV - 805 - 1	Transfers "Low or Hi" Setting Relay Output to DWV - 809
6		Panel Air Supply (30 P. S. I.)
6A		Panel Air Supply (30 P. S. I.)
7		Panel Air Supply (20 P. S. I.)
7A		Panel Air Supply (20 P. S. I.)

Afterheat Removal Storage Tank Level Control Cabinet and Level Control System



AEC-GE RICHLAND, WASH.



(Typical of 10 Systems)
Ref. H-1-40006)

Main Steam Generator Secondary Side Level Control System

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MAIN STEAM GENERATOR SECONDARY SIDE LEVEL CONTROL

This system is designed to maintain the secondary or shell side level of each steam generator within predetermined limits by the automatic regulation of the feedwater supply valve in each steam generator supply line. Each of these valves is automatically controlled from an individual 3 element control system, which matches feedwater flow to steam output flow, while correcting valve position for steam generator shell side water level.

Secondary coolant steam generated at the ten main steam generators is replaced by condensate collected at the dump condenser condensate pump suction header, pumped by dump condenser condensate pumps into a common discharge header, and distributed in parallel through individual feedwater supply lines to the shell side of each steam generator unit.

In terms of operating demands and steam generation characteristics, level must be controlled within close tolerances. For this reason, the level control system is designed so that steam generator level influence normally takes precedence over input-output flow balance control.

Steam output flow from each steam generator is metered by flow nozzles installed in each of the two outlet leads connecting a steam generator with the main (46") steam header. Output flows from each steam generator are totaled and density compensated, and are routed through console mounted steam flow/water flow ratio adjusters to compensate for steam generator blowdown. Feedwater flow to the steam generator is similarly metered and density compensated.

Individual steam generator level control loadings originate at three level transmitters. These signals are compensated with a density compensated steam flow signal. Assignment of in-service operating status to one of the three signals is by means of a console mounted selector switch.

The compensated and adjusted steam flow signal, and the compensated feedwater and level signals are then summed and routed to the proportional and reset action unit of a console-mounted RU-100 type controller. The output of this controller goes to an electro-pneumatic transducer, which converts the electric signal to a proportional pneumatic signal. This signal adjusts the steam generator feedwater valve, CONDV-216.

The bias power supplies (three) and action units (six) of this system are monitored for failure. Upon CFA actuation, an annunciator is actuated, and the system controller is transferred from automatic to manual with the same output that existed immediately prior to the failure.

The diagram on 21.6.5-1 is typical for each of ten steam generators. Instrument numbers and locations shown are those for steam generator 5B. Annunciators for the system are located on the appropriate cell graphic panels. Other details of this system are:

1. Steam generator (compensated and uncompensated) levels are indicated on the cell graphic panels. The levels are also data logged.

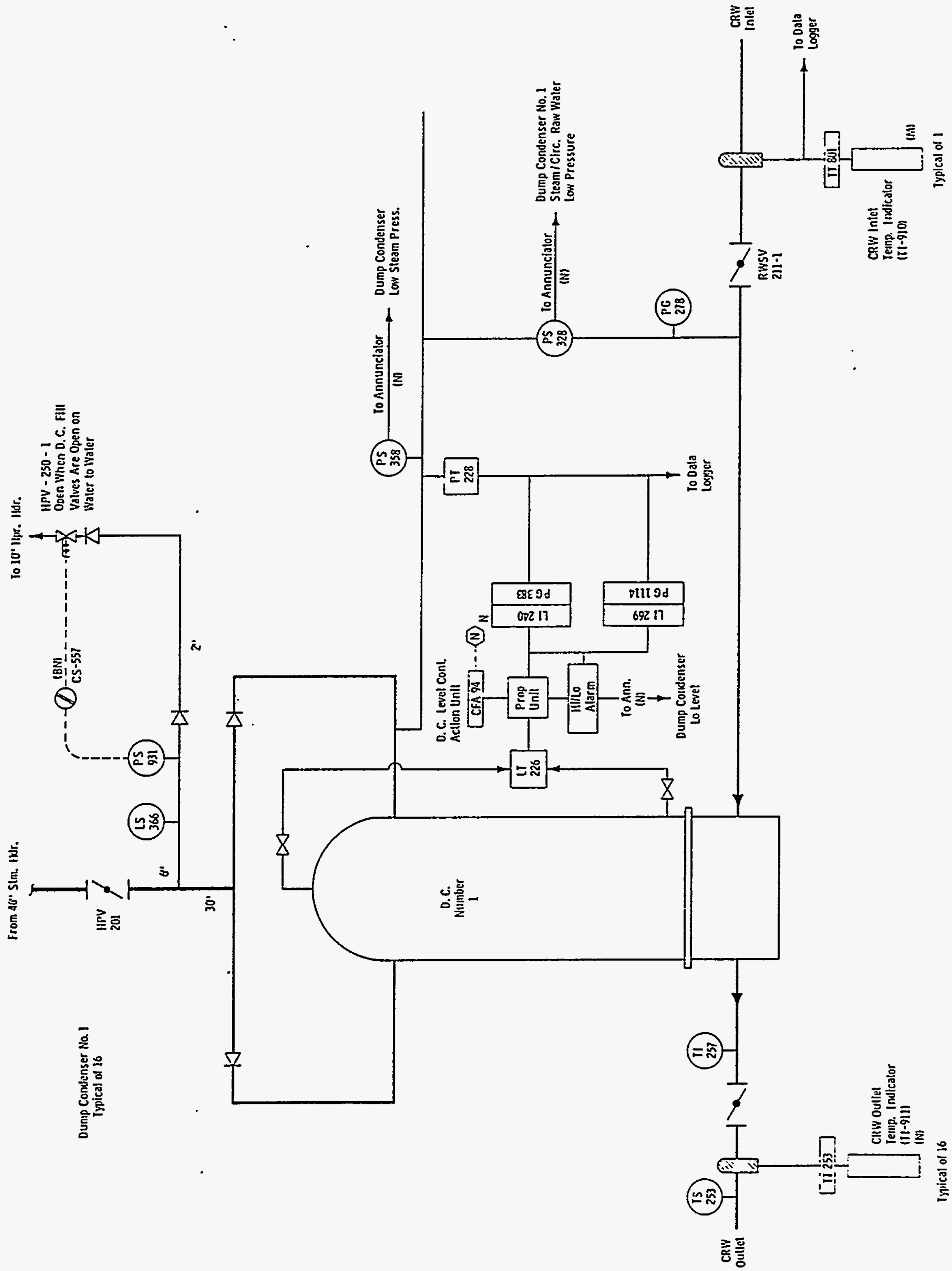
MAIN STEAM GENERATOR SECONDARY SIDE LEVEL CONTROL (CONT'D)

2. Steam generator compensated steam and feedwater flows are recorded on the cell graphic panels. These flows are also data logged.

3. Steam generator compensated level, steam, and feedwater flows are indicated on the cell control consoles.

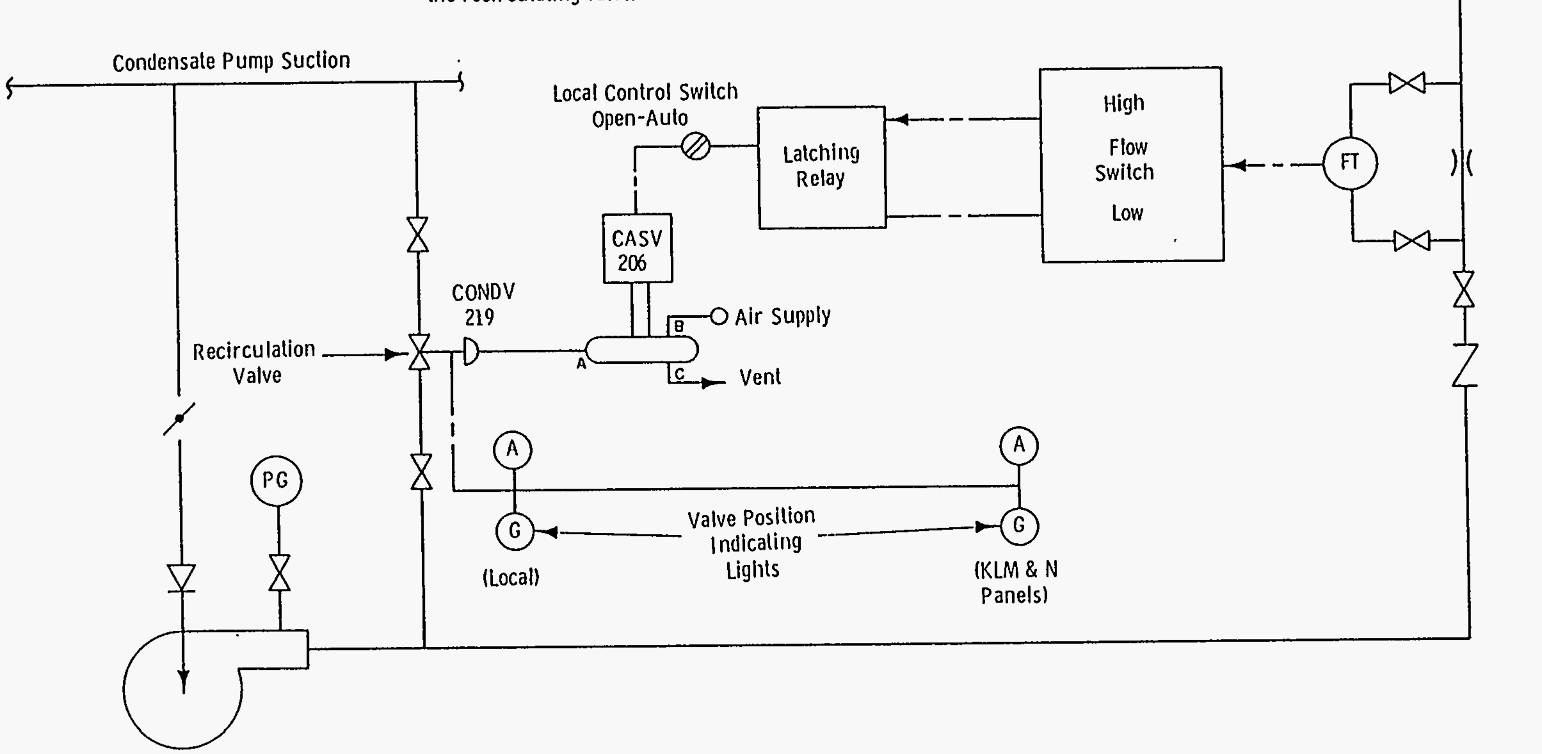
4. The level signal selected for the control system also provides signals to steam generator high and low level annunciators, to the rod scram safety circuit, and to interlocks of the secondary system emergency spill valves.

5. Upon loss of supply air pressure to valves CONDV-216, valve position remains unchanged by actuation of air valves which isolate loading air to the valve operators. Lights (red for air failure and white for normal) and an air failure reset pushbutton are located on the cell control consoles. An annunciator is also actuated on air failure.

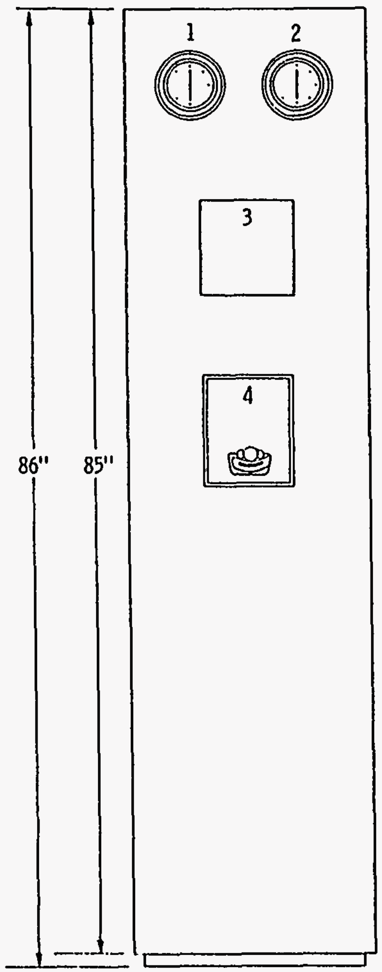


Dump Condenser Miscellaneous Controls

This system is designed to prevent overheating of the dump condenser condensate pump. When the dump condenser condensate pump flow increases to 400 gpm the high flow switch closes the recirculating valve - as flow is being reduced the low flow switch opens the recirculating valve at 200 gpm. A local control switch permits opening of the recirculating valve.



Dump Condenser Condensate Pump Recirculation Control System



Front View

H-1-40153

		DESIGNATION OF ITEMS
Item No.	Instr. No.	Description
1	PG-339	Steam to Auxiliaries Pressure Gage
2	PG-340	Steam to Auxiliaries Pressure Gage
3	PC-201	Steam to Auxiliaries Pressure Controller
4	PT-284	Steam to Auxiliaries Pressure Transmitter
* 5A		Air Set
* 5B		Air Set
* 6	REL-218	Cond. Surge Tank Level Control Relay for CONDV-243-1 E/P Converter
* 6A		Cond. Surge Tank Level Control Relay for CONDV-243-1 Vol. Chamber
* 6B	CASV-284-1	Cond. Surge Tank Level Control Relay for CONDV-243-1 Solenoid Valve
* 7	REL-251	Cond. Surge Tank Level Control Relay for CONDV-243-2 E/P Converter
* 7A		Cond. Surge Tank Level Control Relay for CONDV-243-2 Vol. Chamber
* 7B	CASV-284-2	Cond. Surge Tank Level Control Relay for CONDV-243-2 Solenoid Valve
* 8	REL-252	Cond. Surge Tank Level Control Relay for CONDV-243-3 E/P Converter
* 8A		Cond. Surge Tank Level Control Relay for CONDV-243-3 Vol. Chamber
* 8B	CASV-284-3	Cond. Surge Tank Level Control Relay for CONDV-243-3 Solenoid Valve
* 9	REL-259	Dearator High Level Control Relay for CONDV-228-1
* 10	PS-376	Med. Press. Htg. Stm. Hdr. Low Press. Alarm Press. Switch
* 11	PS-377	Med. Press. Htg. Stm. Hdr. High Press. Alarm Press. Switch
* 12	PS-378	Cont. Air Supply Hdr. Low Press. Alarm Press. Switch
* 13	CASV-284-4	Water to Water Standpipe Level Control of Valves CONDV-243-1 Solenoid Valve
* 14	REL-930	Water to Water Standpipe Level Control of Valves CONDV-243-1 Pneu. Relay
* 15	CASV-284-5	Water to Water Standpipe Level Control of Valves CONDV-243-2 Solenoid Valve
* 17	REL-931	Water to Water Standpipe Level Control of Valves CONDV-243-2 Pneu. Relay
* 18	CASV-284-6	Water to Water Standpipe Level Control of Valves CONDV-243-3 Solenoid Valve
* 19	REL-932	Water to Water Standpipe Level Control of Valves CONDV-243-3 Pneu. Relay

* Equipment Mtd. Inside Panel

Auxiliary Steam and Miscellaneous Local Panel - 109-N

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REACTOR OPERATING MODE SELECTOR STATION

This station, located on AA Console, consists of a number of switches and is designed to assign specific conditions which affect the operation of the heat dissipation control systems.

The following switches and pushbuttons are provided:

1. c/s 743 - Modal switch
2. PB 744 - Reset for modal switch
3. c/s 740 - Steam pressure control selector switch
4. c/s 741 - Console control station transfer switch
5. c/s 742 - Discontinuous action bypass switch
6. c/s 733 through 737 - Cells 1 through 5 isolation switches
7. PB 745 - Discontinuous action timer bypass

These switches and pushbuttons are discussed in detail later.

The following conditions are affected by the switches provided:

A. Secondary steam pressure control is via reactor inlet temperature setpoint control, TC-253 on AA Console (Ref. 21.4.3).
B. Secondary steam pressure control is via steam pressure setpoint control, either PC-218 on AA or PC-244 on BN (Ref. 21.6.1).
C. For condition B, PC-218 on AA is in service.
D. For condition B, PC-244 on BN is in service.
E. Surge tank normal level control is via LC-209 on JJ (Ref. 21.6.3).
F. Surge tank normal level control is via LC-208 on BN.
G. Master water to water switches on BN are operative (Ref. 21.6.9.1).
H. Master water to water switches on BN are inoperative.
J. Annunciators indicating reactor shutdown are actuated in 182, 163-183, and 184N.
K. Annunciators indicating reactor startup are actuated in 182, 163-183, and 184N.
L. Interlocks are positioned to prevent the following discontinuous actions for the heat dissipation system from taking place when a scram signal is initiated:
    1. Establish a predetermined main steam header pressure control setpoint (Ref. 21.4.3 and 21.6.1).
    2. Reset primary loop flow to 25% (Ref. 21.4.1).
    3. Open steam generator primary coolant bypass valves.
    4. Start 184N boiler and open steam outlet valves.
    5. Close steam generator blowdown valves.
    6. Close dump condenser vent valves.
    7. Start afterheat removal fill pumps.
    8. Open fully secondary loop normal makeup valves (Ref. 21.6.3).
    9. Open fully surge tank emergency fill valves (Ref. 21.6.3.1).
    10. Start standby high pressure injection pumps (Ref. 21.4.7.1).
    11. Cut off all pressurizer heaters (Ref. 21.4.6).
    12. Start all boiler feed pumps.

    NOTE: These actions provide necessary backup, serve to limit coolant cool-down and contraction, and minimize thermal shock when a reactor scram is initiated.

M. Interlocks are positioned to permit the discontinuous actions listed above to occur when a scram signal is initiated.

REACTOR OPERATING MODE SELECTOR STATION (CONT'D)

Modal Switch - c/s 743 - The modal switch is a four-position switch. The following lists the positions of the modal switch and the conditions established for each position:

Condition Established	Switch Position			
	No. 1 Startup	No. 2 Steady State	No. 3 Shutdown	No. 4 Water to Water
A		x		
B	x		x	x
C	x		x	
D				x
E	x	x	x	
F				x
G				x
H	x	x	x	
J			x	
K	x			
L				x
M	x	x	x	

The conditions established for each modal switch position may be amended by the use of c/s's 740, 741, or 742. However, the conditions as shown in the above table will be established each time the modal switch is repositioned, regardless of actions taken by c/s's 740, 741, 742.

Pairs of indicating lights (green and red) are mounted adjacent to c/s 743, one pair for each position. For any position of c/s 743, either a green or red light will be on. The green light for a particular position will be on when all the conditions normal for that position (see above table) are in effect. The red light for a particular position will be on when the conditions normal for that position have been amended by other switches (see c/s 740, 741, and 742).

Position 4 of the modal switch establishes condition L, while positions 1, 2, or 3 establish condition M. Condition L will not be established by position 4, unless the reactor is subcritical at that time and a timer has timed out. In addition, if condition L has been established by position 4 and the reactor becomes super-critical, the discontinuous actions will occur.

Reset for Modal Switch - PB 744 - A pushbutton is provided to establish the conditions after the modal switch has been turned to a new position. When the modal switch is re-positioned, the conditions normal for the new position will not be established until PB-744 is actuated.

Steam Pressure Control Selector Switch - c/s 740 - This is a three-position switch with spring return to neutral. The right position (TEMP) establishes condition A, and the left position establishes condition B (PRESS).

Console Control Station Transfer Switch - c/s 741 - This is a three-position switch with spring-return to neutral. The right position (BN) establishes conditions D, F, and G, and the left position (AA) establishes conditions C, E, and H.

REACTOR OPERATING MODE SELECTOR STATION (CONT'D)

Discontinuous Action Bypass Switch - c/s 742 - This is a three-position switch with spring-return to neutral. The right position (subcritical) establishes condition L, and the left position (critical) establishes condition M. This switch is interlocked to prevent establishing condition L unless the reactor is subcritical at that time.

Cell Isolation Switches, c/s's 733 through 737 - These are two-position switches with "block" and "normal" positions. For a particular cell, with the isolation switch in the block (right) position:

1. Removes reactor outlet and inlet temperature signals from averaging units for monitoring purposes (Ref. 21.4.3.1).
2. Removes reactor outlet and inlet temperature signals from averaging units of inlet temperature control system (Ref. 21.4.3).
3. Removes primary coolant loop flow signal and substitutes a zero flow signal in the primary coolant flow control system (Ref. 21.4.1).
4. Prevent starting of emergency seal water turbine (Ref. 21.4.7.4).
5. Prevents the following discontinuous actions from taking place:
   a. Reset primary loop flow to 25%.
   b. Open steam generator primary coolant bypass valve.
   c. Close steam generator blowdown valves.

For the cell isolation switches to become effective, the individual signal block switches must be in the "isolate" position (see above references).

Discontinuous Action Timer Bypass - PB-745 - Simultaneous with the demand for discontinuous scram actions, a timer is started to prevent reset of the actions until scram induced system upsets have stabilized. PB-745 is provided to bypass this timer.

Reset of Discontinuous Scram Actions - Circuitry to cause or permit the reset of discontinuous scram actions can be actuated in three ways:

1. Reset the rod scram safety circuit.
2. When the reactor is subcritical, actuate the discontinuous action timer bypass, PB-745.
3. When the reactor is subcritical and the discontinuous scram action timer has timed out, turn the modal switch to position 4 and actuate PB-744; or when the reactor is subcritical, turn the discontinuous scram action bypass switch to the right (condition L).

When one of these items has been accomplished, the following will return to automatic control:

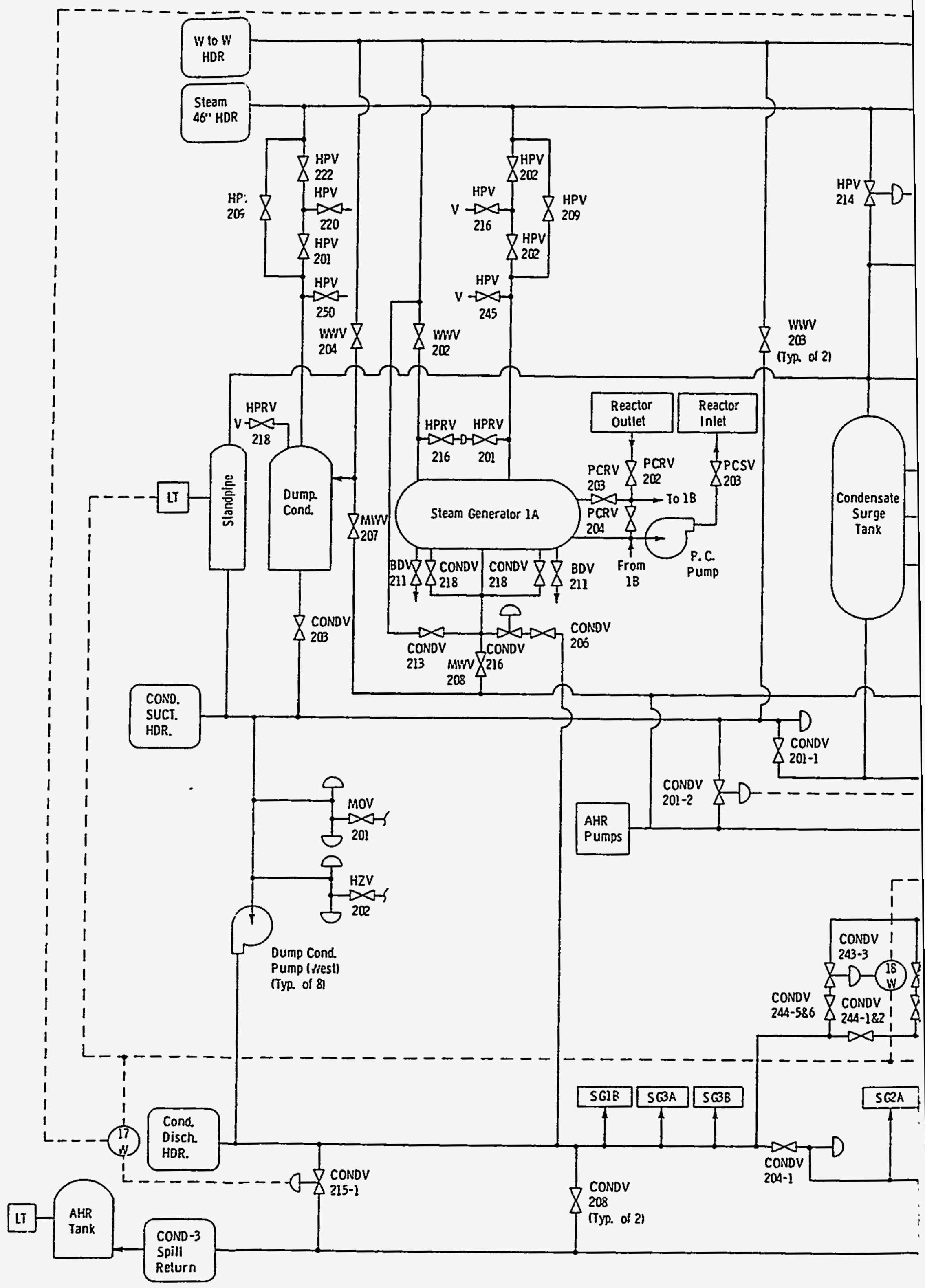
1. Dump condenser vent valves.
2. Secondary loop normal makeup valves.
3. Secondary loop emergency fill valves.
4. The two standby high pressure injection pumps.
5. Pressurizer heaters.

When one of the previous reset items has been accomplished, the following return to remote manual control:

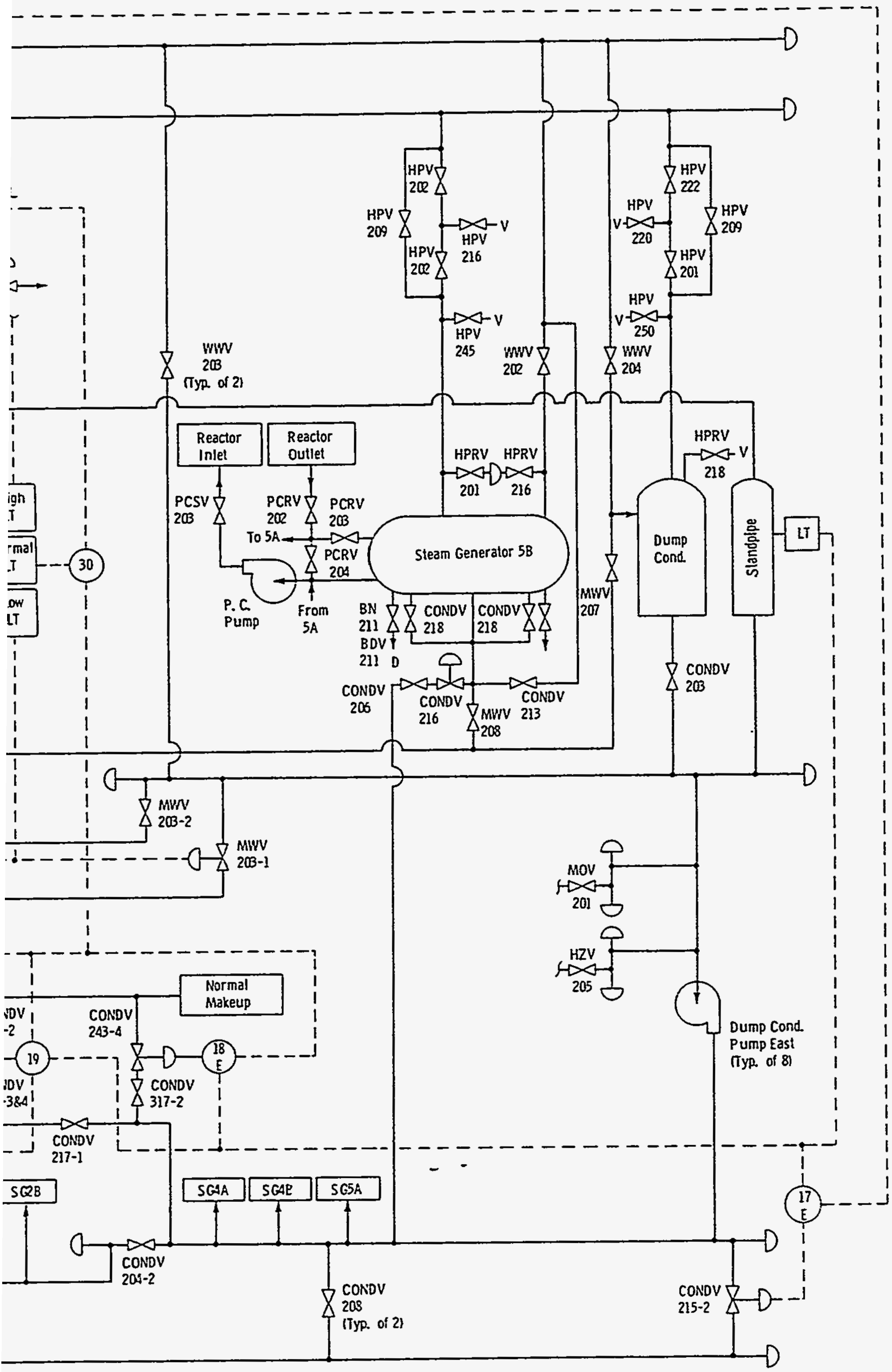
1. Steam generator primary coolant bypass valves.
2. 184N boiler and block valves.
3. Steam generator blowdown valves.
4. Afterheat removal fill pumps.
5. Boiler feedpumps.

When one of the previous reset items has been accomplished, the following can be returned to normal control after setpoints have been reduced to values set at time of scram:

1. Main steam header pressure control.
2. Primary coolant flow control.



Water-to-Water Operati



Schematic Diagram

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WATER-TO-WATER OPERATION

This mode of operation is designed to provide the means for sub-cooling reactor primary coolant.

Heat removal from the primary coolant is normally accomplished by transfer to the steaming secondary coolant system. This steam is then condensed in the dump condensers, with the heat being transferred to the circulating raw water system. Hence, secondary system pressure determines primary coolant temperature. If this pressure should be as low as atmospheric and with the shell side of the steam generators filled only to normal levels, primary system temperatures below boiling could not be attained. Therefore, flooding of the secondary coolant system steam generators and dump condensers is required to lower primary coolant system temperatures below boiling. The secondary coolant is then recirculated from the steam generators to the dump condensers, via the water-to-water header, and back to the steam generators by the dump condenser condensate pumps. In the dump condensers heat is again transferred to the circulating raw water system. The primary coolant will now be cooled to below the boiling point.

Water-to-water (WW) system controls are located primarily on BN console (Ref. 21.1.2.6). Since this operation involves a large number of valves and some changes in locations of control, master switches have been provided which perform sequenced series of operations. Individual switches are also provided. The following is not intended to be a complete resume of going to and from WW operation, but is intended to outline the general sequence of events.

1. When the WW mode of operation is required, the modal switch (c/s-743, AA console) is turned to position 4 and reset PB-744 is actuated (Ref. 21.6.9). This causes or permits reset of and also bypasses heat dissipation system discontinuous scram actions, if the reactor is and remains subcritical and the scram action timer has timed out. In addition, secondary steam pressure setpoint and surge tank level control are transferred to BN console, and BN console master WW switches are rendered operative.
2. Actuate c/s 537 or 538, west or east master switches. Assume that 538 is actuated first, then for cells 4 and 5 and dump condensers 9 through 16: Primary coolant flow through cell 4 and 5 steam generators (SG's) is shut off, and flow is diverted through the SG bypass valves. The steam generators and dump condensers (DC's) are isolated from the main steam header, flow of secondary coolant system condensate is stopped, the east sections of the condensate pump suction and discharge headers are isolated, and "flooding" of SG's 4 and 5 and DC's 9 through 16 is begun from the afterheat removal pumps. The surge tank is now isolated from the east or flooding side, and remains in control of makeup to and spill from the west or "steaming" side. The east normal makeup and emergency spill valves are placed under control of the east standpipe level controller, and the east emergency fill valve is closed. Actuation of c/s 538 also changes the range of the afterheat storage tank level control system from a high to a low level control point. This is done so that during the "draining" portion of WW operation, space will be available in the afterheat storage tank to receive water required to flood the secondary system.
3. When cells 4 and 5 SG's and DC's 9 through 16 are flooded, circulation through these units is begun via the WW header by means of the east DC condensate pumps. Primary coolant flow through SG's 4 and 5 is also restarted.
4. The cell 3 master switch (511) is then actuated, which terminates PC flow through cell 3 SG's, isolates the SG's from the main steam header, and begins

WATER-TO-WATER OPERATION (CONT'D)

flooding these units. When filled, the west and east DC condensate pump discharge header isolation valves are closed and opened respectively, and primary and secondary coolant flow through cell 3 is again started similar to step 3.

5. The west master (c/s 537) switch is then actuated. This performs primary and secondary system isolation and begins secondary system flooding operations for cells 1 and 2, and DC's 1 through 8. The east condensate pump suction and west condensate pump discharge valves are opened, and the east normal makeup and emergency fill and spill valves are returned to surge tank control.
6. When cells 1 and 2 SG's and DC's 1 through 8 are flooded, primary and secondary coolant system recirculation is again begun similar to step 3. Reactor afterheat removal via WW operation is now being accomplished. The return to a steaming or non-flooded secondary coolant system in general is a reverse of the foregoing operation.
7. Actuate west master drain (c/s 586). Then for cells 1 and 2 and DC's 1 through 8: Secondary system recirculation is terminated, and the SG and DC recirculation valves to the WW header are closed. The east condensate pump suction header isolation valve is closed placing the surge tank on the "draining" side. The west condensate pump discharge header isolation valve is closed, and the east emergency spill valve control is transferred to the east standpipe. Surge tank normal level control is changed from a 3 to a two element control system (level signal is removed), and surge tank pressure control is changed from the normal differential pressure signal to a surge tank level signal. This is done to avoid a simultaneous regulation of both surge tank makeup and pressure valves for control of surge tank level; and to prevent the surge tank, which is at a higher elevation than the DC's, from draining too low before normal DC levels are reached. The DC's are drained until the water level is just above the top of the DC tubes. The SG's are drained through the WW header, until normal steaming water levels are reached, and water from this header is drained by two valves to the west half of the DC condensate pump suction header. Water from the DC's is drained to the DC condensate pump suction header, pumped to to the discharge header, and returned to the afterheat removal tank through two valves. Actuation of c/s 586 also returns afterheat tank level control from the low to the high level control point.
8. When DC and SG normal levels are reached, as noted above, draining is stopped, and the east master drain switch (c/s 590) is actuated. This stops secondary system recirculation through cells 3, 4, and 5, and DC's 9 through 16. The west and east DC condensate pump suction header isolation valves are closed and opened respectively, placing the surge tank on the side to be drained. (Note: The west DC condensate pump discharge header isolation valve is still closed.) Control of the west emergency spill valve is transferred from the surge tank to the west standpipe, and control of the east emergency spill valve is transferred from the east standpipe to the surge tank. Draining of cell 3, 4, and 5 SG's and DC's 9 through 16 is accomplished as before, using the east drain valves from the east condensate pump discharge header to the afterheat tank.
9. When cell 3, 4, and 5 SG's and DC's 9 through 16 drain to normal levels, draining is stopped. Control of the west emergency spill valve is returned to the surge tank, the west DC condensate pump suction and discharge header isolation valves are opened. Surge tank level and pressure control are returned to normal control systems. After satisfying other requirements, other reactor operating modes can be selected with the modal switch together with a return to a steaming secondary coolant system.

BOILER BURNER LIGHT-OFF AND FLAME DETECTION SYSTEM - 184-N

GENERAL DESCRIPTION

In general, the system consists of three standard system cabinets (vertically mounted and bolted together) located in the control room, various burner hardware and operators, feedback signals from the forced draft fans and oil pumps, interlocks with combustion control equipment and certain control and indications on the mechanical control board.

The cabinet assembly consists of three 2 Ft. square digital systems cabinets. The front of the cabinet is the side into which the modules are plugged, and where the annunciators and control stations are located. All field wiring connections are made from the front side of the cabinet and factory wiring connections were made at the back side.

The various operators for air registers, oil shutoff valves, steam shutoff valves, and solenoids for interlocking the combustion control are operated by means of mercury-wetted relay contacts contained within the system cabinet.

The system operates from 115 volt, 60 cycle power supplied from the constant voltage flame failure equipment MG set. This power supply is connected to the terminals located in the bottom of "B" cabinet and to terminal boxes located at the bottom of the boiler front. The 115 volt power is used at the main burner solenoid actuated switch contacts for air operated valves, blowout steam, atomizing steam and No. 6 oil; and auxiliary burner set minimum firing rate, auxiliary to maximum rate and close recirculating oil valve solenoid actuated switch contacts. The terminal boxes at the bottom of the boiler front distribute 115 volt power to each ignitor. A step-up transformer, mounted on each ignitor supplies the igniting potential (10,000 volts) for the No. 2 fuel oil.

Power used in the light-off systems cabinets is converted by the systems power supply unit to +5, -10, -15, and -24 volt d-c power. The power supply unit is located in cabinet "B". The three cabinets are connected to a solid grounding bus within the cabinets. The fuel oil system annunciator, Item 107-b is supplied by 125 volt d-c power from the 184 Building power panel A-2 which is energized from the 153 switchgear building power panel A-1 (Ref. Page 12.18.2-1).

NOTE: Transistors used in the module circuitry are designed to operate within a specified temperature range not to exceed 100°F ambient. When this temperature range is exceeded, transistor operating characteristics will change and shorten the life of the transistors. In order to prevent the ambient temperature from exceeding 100°F within the module enclosures, ambient temperature within the control room must not exceed 77°F. Cabinets "A" and "B" both have filter equipped ventilation air inlet registers with a thermostatically controlled air supply fan located in the roof of each cabinet, and exhaust air registers located on the front and back sides near the bottom.

The location of any module identified on a logic diagram is defined by a matrix containing the cabinet location, row and module position. Cabinet A, B and C, each contain 10 rows numbered top to bottom, 1 through 10. Each row contains 15 module locations numbered from left to right, 1 through 15. As an example, a memory module, designated on the logic diagram as N5-5, would be located in Cabinet A the fifth row from the top, in the fifth position from the left. This

BOILER BURNER LIGHT-OFF AND FLAME DETECTION SYSTEM - 184-N (CONT'D)

co-ordinate system is used throughout the logic diagrams and wiring schemes. For additional information on burner cycle logic, sequence and interlock logic diagrams, refer to Bailey Meter B 760 System Instruction Manual listed under BPF-13016.

Cabinet "A" - The left hand cabinet, designated cabinet A, contains the solid state logic equipment for each burner and for sequencing mechanisms. The modules located in Row 1 are for the control of burner 1, modules in Row 2 are for burner 2, modules in Row 3 are for burner 3 and modules in Row 4 are for burner 4. All modules located in Row 5 pertain to the sequencing and interlocking mechanisms of this system. The modules in rows 7 through 10 are associated with burners 5 through 8 respectively.

Cabinet "B" - The center cabinet, designated cabinet B contains the power supplies relays and terminal panels for the entire system. The top row (1) contains the power supply for +5, -10, and -15 volts (with meters for current and voltage) which may be switched by a three-position switch, to any of the three voltage outputs. The -24 volt power supply, which is adjustable from 5 to 35 volts, is located in the second row. This supply is capable of supplying 7 amps and is set for 24 volts. The third row contains a power input relay assembly. The fourth and fifth rows contain gated switches (GS) and relays, arranged in vertical rows, for burners 1 through 4. Rows 6 and 7 contain the same equipment for burners 5 through 8. Rows 8, 9 and 10 contain field wiring terminals (arranged in pairs) for burners 1 through 8.

Placing Power on the Systems Cabinet - Of the two power supplies mounted in Cabinet B, only the -24 volt d-c supply has a power on-off switch. The +5, -10, and -15 volt d-c is a non-adjustable composite supply which is wired directly to an a-c power plug and has a selector switch mounted at the front which controls the readout of the respective supply as indicated by the voltage and current meters. Before placing a-c power on the system, turn off the -24 d-c supply.

After power has been placed on the system, check the composite supply for correct voltage output and current drain. In no case should the current drain of the composite supply exceed the following ratings:

+5	2 amps
-10	4 amps
-15	4 amps

At this point, all lights in systems cabinet B and on the control cabinet C should be completely off.

The -24 volt power supply may then be turned on. Adjust the indicating meter to read correct voltage output. Any lights that come on as a result of turning on the -24 volt power should be of constant and equal brilliancy. The current drain of this supply will vary with load in the range of 4 amps to 8 amps.

Cabinet "C" - The operator's controls for this system are located in the right hand cabinet, adjacent to the main mechanical control board. The equipment located on this panel is identified on the drawing. It consists of the fuel-oil annunciator, Item 107b, the burner annunciator, Item 107c, the fuel oil annunciator acknowledge push button, Item 6k, the auxiliary burner trip push button, Item 2ss and the light-off system controls (which consists of the master control station, Item 6n and eight

BOILER BURNER LIGHT-OFF AND FLAME DETECTION SYSTEM - 184-N (CONT'D)

burner control stations, Items 6-0.

The Master Control Station, Item 6n, consists of three master sequence switches and an indicating light. These switches are, a three position rotary switch for turning the system to "On", "Auto" and "Off", a push button for starting the ignitors only sequence, with an indicating light showing when the sequence is in progress, and a three-position rotary switch for determining the number of burners to be established at one time. While sequencing burners into operation, the possible combinations are 1, 2 or 4 burners at a time.

NOTE: Ignitor light-off and shutdown can be done locally by positioning a "Local" switch at the ignitor and by the operation of local start and stop switches. Remote operation requires the positioning of a "Remote" switch, also located at the ignitor. The failure of any solenoid valve located in the air supply line to air operated valves for ignitor atomizing air and No. 2 fuel oil, and main burner atomizing steam No. 6 fuel oil and blowout steam prevents light-off and/or continued operation of the effected burner.

The burner control stations consist of four lights labeled "Ready","Off","In Process" and "On". These lights trace the sequencing of the individual burner. Also located on this station is a lockout switch, and a two position rotary switch indicating "Secured" or Sequence". There are also four indicating lights showing the closed and open positions of the register and fuel-oil valve, and two push buttons for start and stop of this burner. These control stations are interchangeable. The housing for the control station is identified by burner number, indicating the burner controlled by that station.

Any malfunction of a burner in operation (main or auxiliary) will cause flashing red and green lights on the burner annunciator 107c. An alarm on this annunciator causes an alarm on the mechanical control board annunciator of burner trouble. In addition to the burner trouble alarm on the mechanical control board annunciator, there are alarms for burner shutdown - Unsuccessful, Burner Cleanout - Incomplete, Burner Lighter Automatic Sequence - Off, Boiler Purge Required, Fan Failure and Auxiliary Blower Trip. A Boiler Purge Completed push button, Item 160, located on the mechanical control board, is provided to signal the system when a purge is complete (Ref. Page 21.6.11-2).

Flame Detectors - Two flame detectors are provided for each burner assembly. One is located on the downstream side of the ignitor as close as possible to the origin of the ignitor flame but in such a position that both the ignitor flame and the main burner flame are monitored simultaneously. The other detector is located on the side opposite the ignitor flame detector and monitors only the main burner flame. The flame sensing devices are sensitive to the far ultraviolet spectra only. In particular, they are sensative to that portion of the spectrum which is unique to the flame and respond only to flame under surveillance, not to adjacent flames or infrared radiation from glowing refractories.

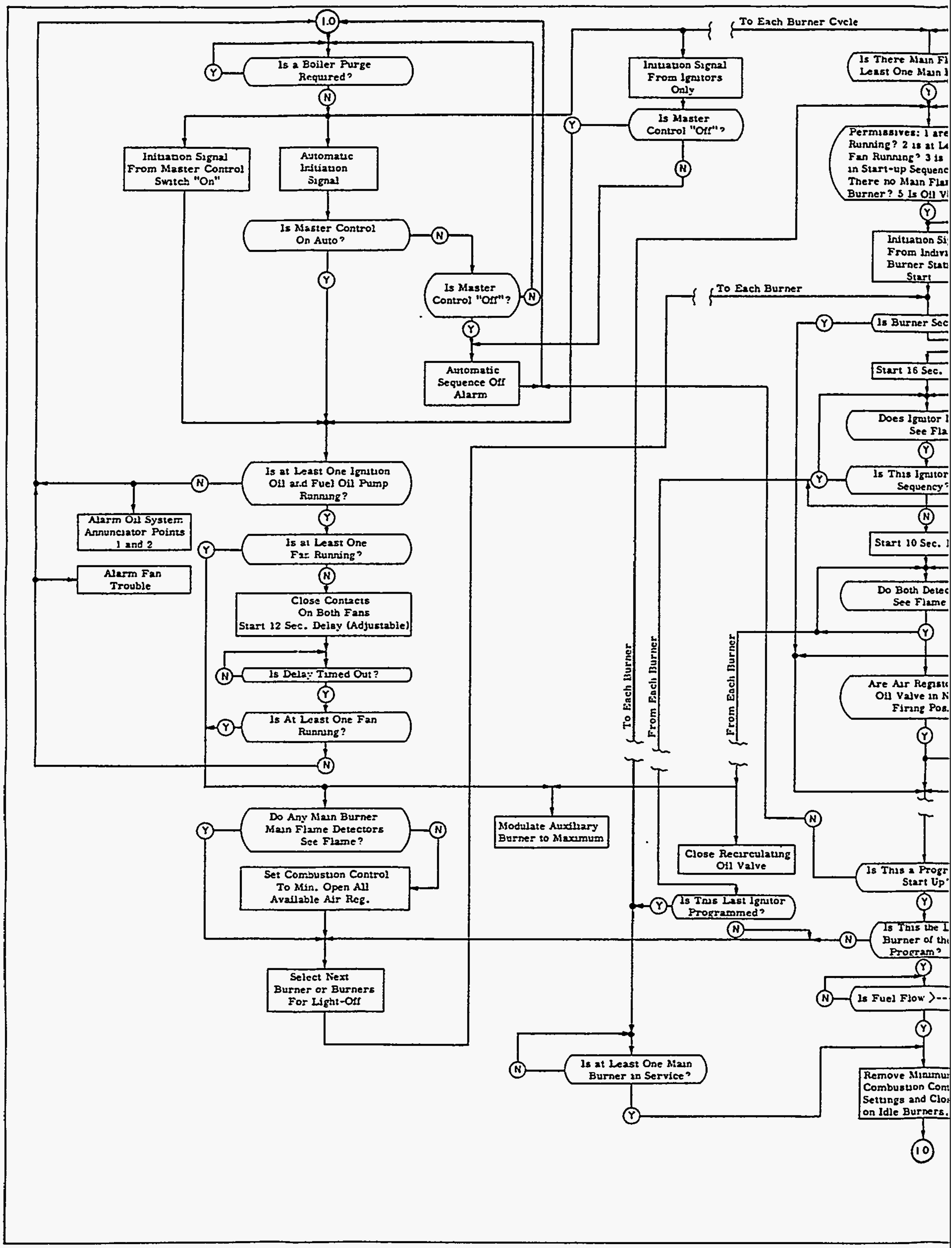
BOILER BURNER LIGHT-OFF AND FLAME DETECTION SYSTEM - 184-N (CONT'D)

Each detector tube is enclosed in a windowed heat shielded head. (Refer to Bailey Meter Bulletins E66-2 and 760-1.) The flame detectors transmit a pulsed d-c signal to the Burners Light-Off System flame detector receiver modules. The flame detector receiver converts the output of a flame detector signal into a logic signal. A logic ZERO (-10 volts, ± 1 volt) indicates a no-flame condition and a logic ONE (0 volt, ± 1 volt) indicates a flame-on condition. Upon receipt of a no-flame condition from either an operating ignitor or main burner, shutdown is initiated and associated alarm or burner annunciator, Item 107c, is actuated. The detector tubes are designed to operate in areas with temperatures up to 400°F. A purge adaptor is provided in each assembly to aid in cooling the detector head and to keep the sight glass clean.

Purging and cooling air for the flame detectors and soot blowers is supplied by one of two full sized high pressure fans each rated 300 cfm at 23.7" H_2O. These units are located on the ground floor at the left front side of the boiler. Each blower is driven by a 3 hp, 480 volt, 3495 rpm motor. Electric power is supplied to the No. 1 blower motor from MCC #3, and to the No. 2 blower motor from Emergency Power Panel "E". A main line disconnect switch is located in the power supply to the No. 2 blower motor above the local start-stop pushbutton stations. Service air supply is also provided for individual detector sight glass cleaning.

Air Register Drives - Each burner assembly is equipped with a vaned motor-driven air register. The vanes for each air register are positioned automatically by independent gear motor operators. Each drive assembly is comprised of a 1/6 hp, 480 volt, 1725 rpm motor, directly connected to a gear box having an output shaft speed of 1.9 rpm. The motors are controlled in the sequencing by the burner light-off system. Three micro-limit switches are provided for each register to indicate positions of the vanes. They are "Closed, Light-off, Open". During a burner blowout sequence, the vanes are positioned to "Light-off" and then "Close" in readiness for another light-off. Handwheel operators are provided for each assembly in the event of remote control malfunctions.

Electric power for the gear motors is provided from the 480 volt Emergency Power Panel "E", switch No. 17. Each motor has its own power panel containing a disconnect switch, magnetic starter and 120 volt control transformer. These cabinets are vertically mounted and located adjacent to MCC #3.



Light-Off Sequence Flow

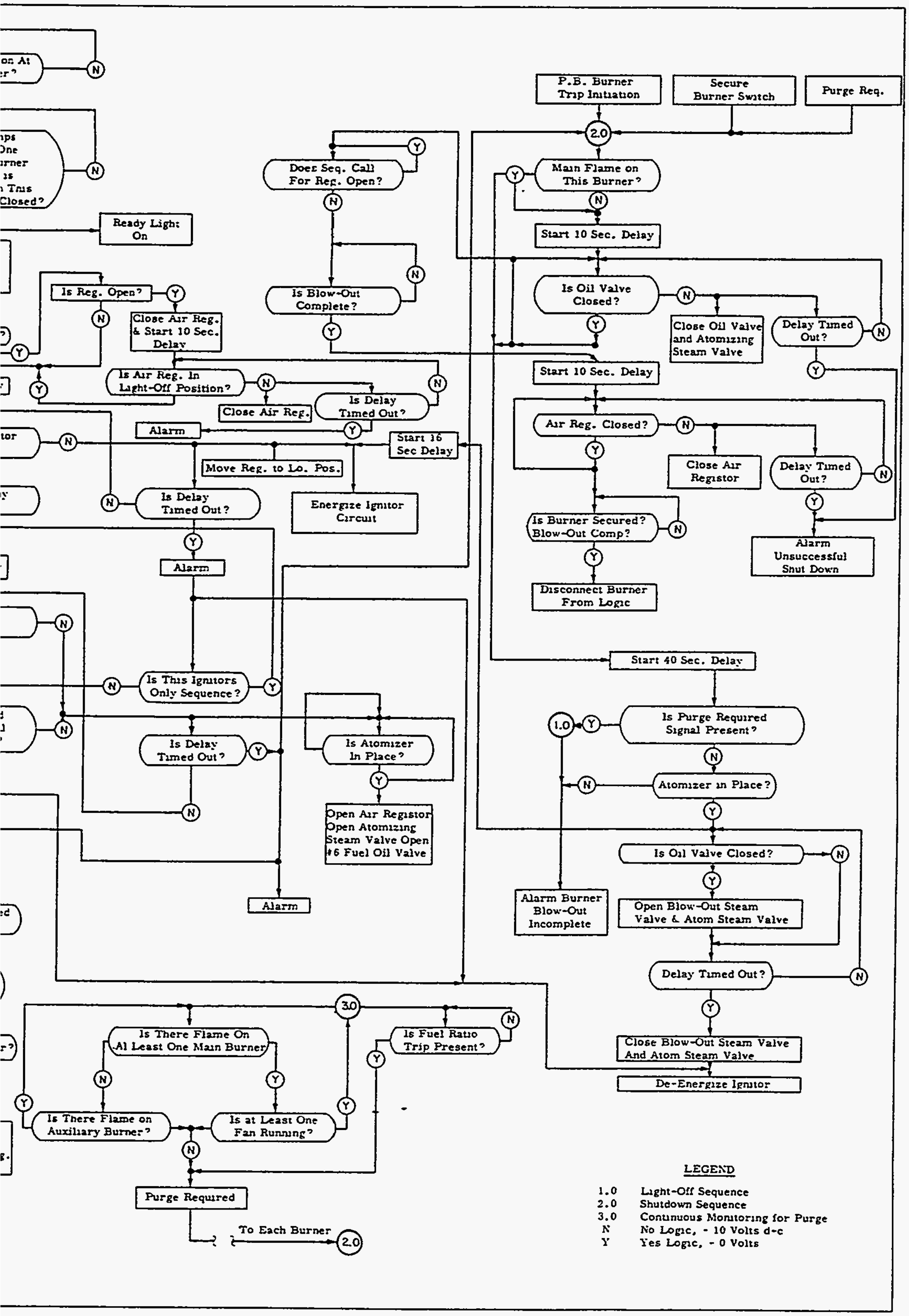


Diagram - 184-N

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N

This system provides for several different sequences of operation, each of which can be programmed from the controls on the front of the cabinet. The system logic is shown on the Sequence Diagram. To determine the sequence of operation in any of the several shutdown sequences, start at 2.0 in the upper right hand corner of the drawing. To follow any logic sequence you must first determine what sequence you are interested in. This will define the point of initiation. Then follow the line diagram in the direction of the arrows, assuming that the answer to each interrogation is such that you proceed along the normal path. For instance, having initiated the sequence from ignitors only push button, the interrogation that asks "is this an ignitors only sequence" will be answered in the affirmative. Initiating the sequence from any other point will answer this interrogation in the negative. Having followed the normal sequence, you may then go back to the sequence and determine what would happen in the event of a failure at any of the indicated interrogations. The following descriptions describe the modes of operation. Refer to Page 21.6.10.1-1 for pictorial representation of the control stations. (For description of system logic detailed drawings and narratives refer to Bailey 760 Burner Light-off System Manual listed under BPF 13016.)

Cold Startup - Cold startup is basically a manual operation. However, the automatic programing and flame failure control can be used to perform the functions which are automated in normal operation. The boiler will be filled with water to the normal startup level. One ignition oil pump and one fuel oil pump will be started. At this point it is customary to perform a boiler purge, in which case one forced draft fan will be started manually and a purge accomplished by securing all burners at the control panel and manually opening the air registers. When the purge time is complete, the air registers are manually closed.

All ignitors are to be established, in sequence, to bring the boiler up to atomizing steam pressure, so all burner secure switches should be switched to the sequence position. Following the purge, as accomplished above, the purge complete push button on the control panel should be initiated. This allows the automatic programing equipment to sequence the lighters upon initiation of the ignitors only push button. The ignitor's only sequence is initiated from the push button and proceeds to prove that the pumps have been started and to investigate whether a fan is running or not. If no fan is running, the normal automatic sequence for starting a fan is initiated. When a fan is proven running, the combustion control signals, which are the output of the selector stations for air and fuel, are transferred from the auxiliary burner to the main burner control devices. The auxiliary burner devices are modulated to maximum.

At this point in the sequence there is still no fire in the boiler. Therefore, modulating the auxiliary burner control devices to maximum does nothing (it will distribute air into the furnace through the auxiliary burner throat if the auxiliary blower is running). This modulation is accomplished by operating the solenoids marked Key 3 shown on the boiler automatic combustion control drawing on Page 21.6.12-1.

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

The sequence continues, setting the Automatic Combustion Control Signals at the normal lightoff minimums. This is accomplished by operating solenoids marked Key 1 on the above diagram. At this point, all available air registers are opened and the sequence proceeds to program the lightoff of ignitors only. Lighters should be programmed one at a time by selecting Sequence 1 on the Master Control Station. As the sequence proceeds it will sequentially close the register on each burner to the lightoff position, light its ignitor and proceed to the next burner. Ignitors only will be established on all eight burners and the sequence will be completed with registers in the lightoff position.

Prior to this point in the sequence, the position (MAN or AUTO) of the selector stations for fuel and air has been immaterial, inasmuch as no fuel has been admitted to the furnace through these control devices and the system has automatically established a minimum position of these output devices (the air dampers and the control valves for No. 6 oil).

As mentioned above, the full ignitor operation shall continue until steam drum pressure is high enough for steam atomization of No. 6 fuel oil and the oil is heated to the burning temperature. When this is accomplished the control room operator is ready to selectively fire No. 6 oil burners to bring the boiler up to the operating pressure of 450 psig.

When the first No. 6 oil burner is fired the automatic programming and flame failure control system will automatically remove the minimum bias conditions established by the solenoids operated according to Key 1 on the above drawing. Therefore, prior to establishing the first burner, the operator must first be sure that the fuel and air selector stations, Items 60b and 60c (or SV102 and SV104) are set to manual operation. When putting the stations on manual the operator can adjust the manual signal to the automatic loading signals appearing at the selector valve. This is possible because these signals are still in minimum setting established by solenoids of Key 1. With the selector stations on manual the operator will have full manual control of any burners he selects to be fired, even after the minimum combustion control settings are removed by the automatic programming and flame failure control system. These settings will be removed by de-energizing the solenoids of Key 1 as soon as the first burner is established. With the selector stations on manual, this will not affect the loading pressures established by the operator.

The operator will continue to control the fuel and air to the burners being fired and initiate additional burners, when required, until such time as the boiler drum pressure reaches 450 psig and the operator decides to go on automatic control. He then performs normal selector station transfers from manual to automatic. This control system is such that the selector stations can then remain on automatic until such time as a cold start is again required.

With the main burners on automatic the operator is now free to go the auxiliary burner front and establish the auxiliary burner by the manual procedure outlined under auxiliary burner operation.

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

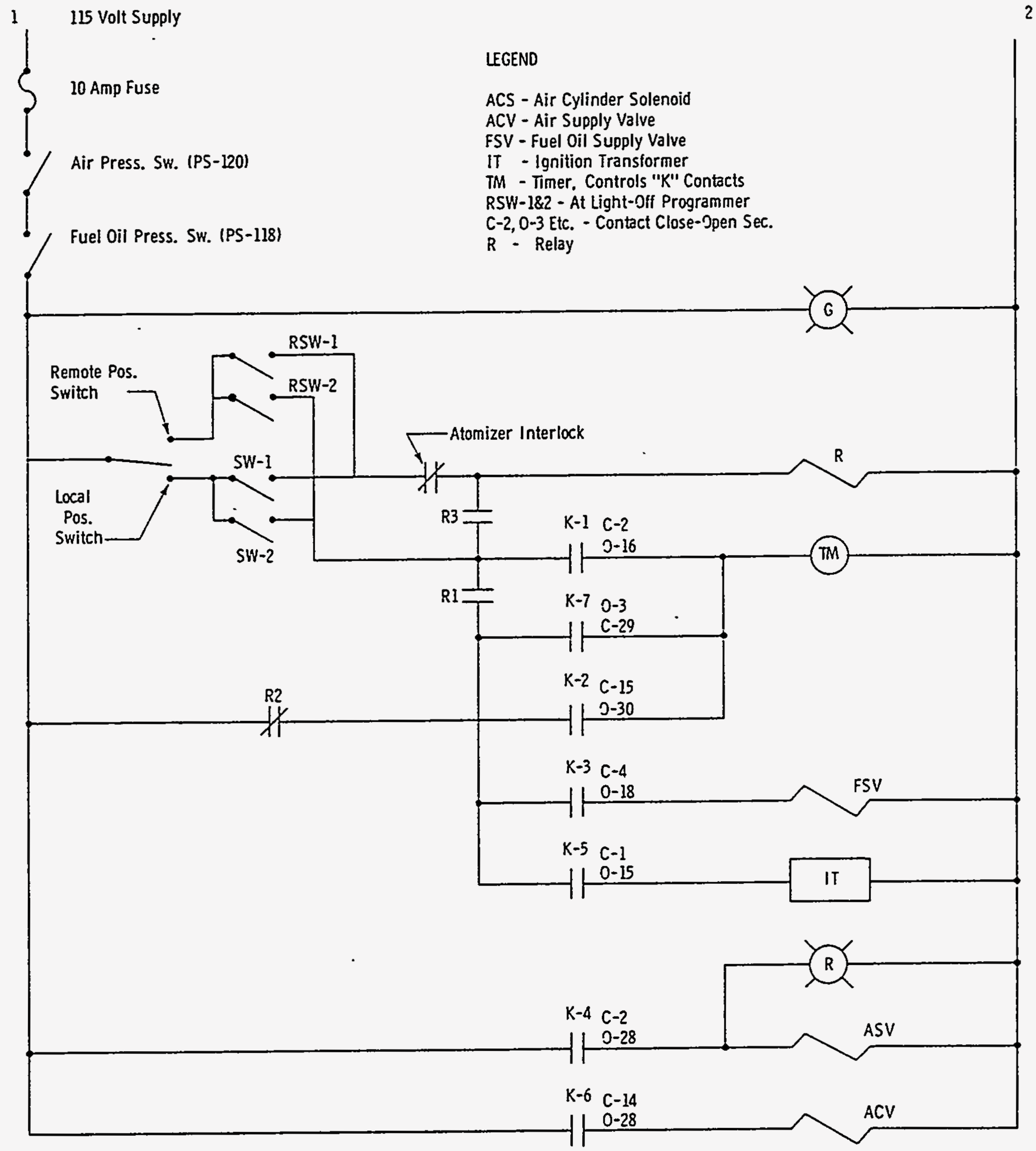
Ignitors Only Sequence - This description is an addendum to "Cold Startup" and is intended to convey a clear understanding of the "Ignitors Only" mode of operation, thereby augmenting the decision as to when it is proper to operate in this mode and when it is improper. The "Ignitors Only" mode of operation is included in this system to facilitate the cold startup of the boiler. This mode of operation is intended for limited use only, because of its effect on the other modes of operation (referred to as the side effects of the ignitors only mode of operation). A separate description of the ignitors only sequence is deemed necessary because, although the sequence is intended as a cold startup operation, the system is not physically limited to operation when the boiler requires a cold startup.

The initiation of the ignitors only sequence is electrically dependent upon two permissive conditions. One, that the operator has previously indicated that a purge is complete; and two, that the three position master selector switch for "On-Automatic-Off" is in the "Off" position. In the event that a purge is required, depressing the ignitors only start switch results in no action. In the event that the three position selector switch is not in the "Off" position, depressing the ignitors only start switch will initiate an alarm "Automatic Sequence Off". One side effect of this mode of operation is that when the three position selector switch is in the "Off" position the control system prohibits the initiation of the burner light off sequence from a scram signal.

Upon the proper initiation of the ignitors only sequence an "Ignitors Only" indicating lamp is turned on at the Master Control Station indicating that the sequence is in progress. This sequence is automatically locked in and controls the sequence until its completion. After the initiation of this sequence it is permissible to rotate the three position selector switch to the "On" or the "Automatic" position. This action will not initiate a new action since a sequence is already in progress, and it will not initiate a new sequence upon the completion of the ignitors only sequence. If turned and left in the "Automatic" position, it will then be ready for automatic standby operation in the event that a scram signal should occur following the completion of the "Ignitors Only Sequence". Although the rotation of this switch is permissible after the "Ignitors Only" sequence has been executed, it is suggested that the switch be left in the "Off" position until the sequence has come to its completion so that the initiation of a scram signal during the sequence will cause the "Automatic Sequence Off" alarm, indicating that a scram signal has occurred.

The "Ignitors Only Sequence" should proceed on the basis of igniting one ignitor at a time. This is determined by the position of a three position selector switch on the Master Control Station. The fact that this selector switch is not in "One at a Time" will not inhibit the procedure of the ignitors only sequence. It will merely proceed by igniting two or four ignitors at a time, rather than one at a time as the position of the switch indicates. After this sequence is initiated it proceeds as other normal modes of operation to check the oil pumps running and one fan running, starting a fan if necessary.

The "Atomizer Interlock" consists of a miniature snap action switch mounted between each main oil burner coupling and its atomizer. (Similarly, one is mounted between each ignitor coupling and its ignitor gun.) These switch contacts are normally open; when contact is closed, flame failure is indicated on main burner control panel which closes oil and atomizing steam valves. Ignitor switches actuate only ignitor solenoids.



Ignitor Sequence

In 1 Sec. - Ignitor Eelctrodes are energized
In 2 Sec. - Air Supply Valve Opens
In 4 Sec. - Fuel Oil Supply Valve Opens
In 14 Sec. - Air Cylinder Solenoid Drives Burner In
In 16 Sec. - Timer Stops and De-energizes Ignitor Electrode
In 18 Sec. - Fuel Oil Supply Valve Closes
In 28 Sec. - Air Supply Valve Closes, Burner Retracts

Timing Diagram - Main Burner Ignitor Light-Off Sequence - 184-N

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

The sequence continues by modulating the auxiliary burner controls to maximum in anticipation of main burner activity and setting the control signals for minimum firing in anticipation of igniting main burners. At this point in the sequence, all available air registers are opened wide to establish a stable air flow to the furnace. These conditions thus established, will remain until ignitors only sequence has come to its completion.

The completion of this sequence involves the lighting of all available ignitors, and the firing of at least one main burner, by depressing the start switch on the burner control station. The time at which a main burner can be thus established is indicated by the ready light. The "Ignitors Only" light will remain on until the "Ignitors Only Sequence" is completed by lighting the first main burner. Any length of time may be allowed to lapse between the time that the ready light comes on and the start button is pushed to establish the first burner. During the cold startup, for instance, sufficient time can be allowed, with full ignitor operation, to establish atomizing steam pressure before the first burner is initiated from the manual station.

As mentioned above, the three position selector switch for "On-Automatic-Off" can be rotated to any position after the initiation of the ignitors only sequence and not cause a sequence initiation. When the first burner is lit and the ignitors only sequence is complete, this switch can be rotated to either the "On" or the "Automatic" position and normal operation will occur. That is, in the "On" position the sequence will begin and sequentially light off the main burners. In the automatic position, it will await the initiation of a scram signal and then sequence the automatic light off of the main burners.

At the completion of the "Ignitors Only Sequence", one main burner will be lit, its ignitor extinguished and the rest of the ignitors, if they are not secured, will be fired. In accordance with normal procedure in lighting off the main burner, the ignitor is extinguished when the burner is established. Therefore, to extinguish the pilots that are left in operation at the completion of the ignitors only sequence establish the main burners desired and then extinguish the remaining ignitors by one of two means: either depress the burner stop button or switch that burner to the secured position. Burners and ignitors can be shut down by either of two means: the burner stop button or the "Sequence-Secure" switch in the "secured" position. However, they can only be secured from subsequent operations by using the secure switch.

It is possible to prevent the completion of a normal light off sequence for any one burner by a number of means, all of which would represent faults in the system. The automatic ignitor package could be switched to local operation, in which case the remote control system could not operate the ignitor and it would not establish an ignitor flame. This would result in a burner failure and alarm, thus preventing the burner from lighting off. It would not be a true secured situation because the air register would be caused to operate during this attempt at light off.

Main Burner Light Off - After the last ignitor has been programmed for a cold start-up, or whenever there is one other main burner on, the logic for each burner

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

interrogates permissives for lighting that burner: Are the pumps running; is at least one fan running; is no other burner in the startup sequence; is there no main flame on this burner and is the oil valve on this burner closed? When these conditions are satisfied, the ready light will turn on, signaling the operator that he may initiate this burner from the start push button on the burner station.

From this point in the sequence the light off of the burner proceeds in the same manner whether it is initiated by the start push button or by the burner sequencing logic. If the burner is secured by the rotary lockout switch, the sequence will then bypass this burner light off and proceed to the next burner. If the burner is not secured, the sequence interrogates the register position. If the register is open, it closes the register to the light off position. If the register is not open, it starts the ignitor time delay and then, because the ignitor detector will not yet see flame, opens the register to the light off position and energizes the ignitor circuit. While the ignitor time delay is timing, it continually checks for ignitor flame until such time as it sees the flame or the delay times out. If the delay times out while there is no flame, an alarm and ignitor shutdown occurs.

When the ignitor detector does see flame, it proceeds to the next interrogation. If this sequence had been initiated by the ignitors only sequence push button, it would continue to monitor the ignition flame and recycle through the sequencing circuit to the next burner. Having initiated this sequence from the start push button, it proceeds on to start a 10-second time delay and interrogates for flame on both detectors. The main flame detector will not see flame at this time. Therefore, the "No" answer will proceed to interrogate to see if the atomizer is in place. If the atomizer is not in place, it will circle on this question and not energize the operators; (Atomizer Interlock).

If the atomizer is in place, it will also continue to ask this question but it will open the air register, the atomizing steam valve and the No. 6 oil valve. This process should then establish flame on the main detector so that both detectors do see flame. The interrogation for both main flames will continue to be checked for normal operation of the burner. If flame is not seen within this 10-second time period, an alarm shutdown will occur. Having sighted both flames, the system proceeds to check the air register and fuel valve for normal firing position. This should also be accomplished within the 10-second time delay period.

When both flames have been sighted and the register and the valve are in firing position, the system proceeds to de-energize the ignitor. The pilot detector maintains a flame signal by sighting the main flame. The light off sequence is now complete and a junction is reached between the signal from the burner being secured on the initiation, this sequence complete signal, and an alarm shutdown signal, all of which go into an interrogation "is this a program startup". If this is not a program startup, return to the beginning from which point another sequence can be initiated. If this is a program startup but is not the last burner on the program, return to the sequencing logic which will select the next burner. When the last burner in the sequence has been programmed, the system interrogates the fuel flow signal to see that it is above some preset minimum value. When this minimum fuel flow is reached, the minimum combustion control settings are removed and the air registers on idle burners are released so that they will close. Once

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

this is accomplished, the operator controls load with the control stations or puts the stations on automatic and the sequence returns to 1.0 from which point another sequence can be initiated.

Automatic Programmed Startup - The automatic programing of burners into service can be initiated from either of two sources, but only after the operator has signaled the system that a purge has been completed. The initiation of the sequence is controlled by 3-position switch on the Master Control Station. On a reactor scram signal, the motorized valves HPV-109-1 and 2 are opened in anticipation of a steam demand in the turbine generator and deaerating heater steam supply headers. The three positions of the master control switch are as follows:

1. OFF - The "Off" position is provided so that the boiler can be secured from an automatic start. In the event of a reactor scram, while in the "Off" position, an alarm is initiated from an annunciator on the Mechanical Control Board with window engraving "Automatic Sequence Off". If the boiler is cold (not on standby), the switch will be in the "Off" position and cannot respond to a reactor scram. While in this position, a cold startup can be initiated.

2. AUTOMATIC - In this position, the light-off sequence will proceed as the result of a reactor scram signal, providing a boiler purge is not required and individual burner control station rotary switches are positioned to "Sequence".

3. ON - This position shall be used to provide testing of the ability of the burners to respond to the sequence light off. Actuation of the control switch to the "On" position will initiate the sequence in the same manner as a reactor scram providing individual burner control station rotary switches are positioned to "Sequence". Once this initiation has been accomplished, the sequence proceeds in the same manner as the ignitor's only sequence, as described before. Sequencing in this manner has the capability of starting a fan if no fan is running or proceeding on one fan if the fan has been started previously. Each burner in turn is pulsed with a start signal and proceeds according to the light off of a burner as described under main burner light off. The order in which burners are selected is determined by the system patchboard (modules 9 and 10, row 5, Cabinet A).

Although each burner is pulsed with a start signal, any burner can be secured from sequencing with its individual lockout rotary switch. When a secured burner is pulsed, it immediately sends back a signal to the sequencing logic telling the logic to select the next burner. When a burner light off is complete, it sends back a signal to the same sequencing logic to select the next burner. Using the three position sequence number selector switch the operator can elect to operate 1, 2 or 4 burners at a time, whenever a burner is selected. The position of this selector switch should be set before the sequence is initiated. At the end of the burner light off sequence the interrogation for program startup will be "yes" and the system will continue to select burners until all the burners have been programed, and will then look for a predetermined fuel flow. When this fuel flow has been reached it will remove the minimum combustion control settings, allow the idle registers to close and return to 1.0 (logic sequence diagram), from which point a new sequence can be initiated.

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

The progress of the various steps through a boiler light off can be followed by observing the indicating lights on the burner control stations. Let's assume a light-off sequence is initiated under the following conditions:

1. Auxiliary burner is in service.

2. At the burner control station all rotary switches are positioned to "Sequence", all "Ready" lights are "On", the "In Process" off light "Off", the "Air Register" and "Fuel Oil" closed positioned lights are on, the burner sequence switch is positioned to one (1), and the Master Control Switch is positioned on "Auto".

3. Transfer the Master Control Switch from "Auto" to "On".

4. First burner "In Process" light comes on, the "Ready" and "Burner" off lights go out.

5. Relay switches RSW-1 and RSW-2 are energized for ignitor "On" 28 second sequence as shown on drawing on Page 21.6.10.2-5.

6. Air register "Closed" and fuel oil "Closed" lights go out. Air register "Open" light comes on, atomizing steam valve opens, and fuel oil valve "Open" light comes on. If ignitor is still lit and main burner lights off, the burner "On" light comes on and the "In Sequence" light goes out. If these do not take place within 10 seconds, burner trouble light comes on and burner sequence will return to a shutdown condition.

7. When main burner flame detector detects flame, the red light on the flame annunciator panel will stay lit.

8. Fuel oil return valve FORV-103-1 closes.

9. Modulate auxiliary burner to maximum, light stays "On".

10. Relay switches RSW-1 and RSW-2 are de-energized for the No. 1 burner. This places the ignitor into a shutdown sequence.

11. Light off continues for as many burners having rotary switches positioned to "Sequence". After the last or eighth burner has been lit, the minimum fire light should go out and burner control is transferred from windbox pressure differential to boiler steam drum pressure set point. (Ref. Page 21.6.12 for boiler automatic combustion control.)

Burner Shutdown - The normal shutdown can be initiated by either of two manual means provided on the individual burner control stations. One is the push button burner trip and the other is the burner secure switch. These switches initiate sequence 2.0 (sequence flow diagram). This sequence can be operated either while the burner is in operation or after the burner is shut down. It may be desirable to operate this sequence after the burner has been shut down to perform an additional blowout of the oil gun. It can also be initiated automatically by the system when Boiler Purge is required.

DESCRIPTION OF BOILER BURNER LIGHT OFF SYSTEM OPERATION - 184-N (CONT'D)

The sequence begins by interrogating whether or not there is a main flame on this burner. If such a flame exists, a signal is sent directly to initiate the blowout timer. Whether the flame exists or not, the signal is transmitted to initiate the shutdown of the oil valve. A ten-second delay is started and the oil valve and the atomizing steam valve are closed. If this function is not accomplished in the 10 seconds allowed, an "Unsuccessful Shutdown" alarm occurs. If the shutdown of these valves is accomplished, a 10-second delay is started for closing the air register, and the air register drive is initiated in the closed direction. The signal resulting from the closing of the oil valve and the atomizing steam valve goes to initiate the blowout timer. The closing of the air register and the timing of the blowout timer then proceed in parallel. If the air register is not closed in the 10 seconds allowed, an "Unsuccessful Shutdown" also occurs from this malfunction. When the register is fully closed, and, if this burner is switched to the secured position, the system interrogates to see whether a blowout is in progress. If the blowout is also completed, the burner is disconnected from the logic circuitry.

The blowout timer is set at 40 seconds. This includes the 30 seconds for blowout and the 10 seconds allowed for closing the oil valve. As soon as this delay is initiated the sequence asks the following questions:

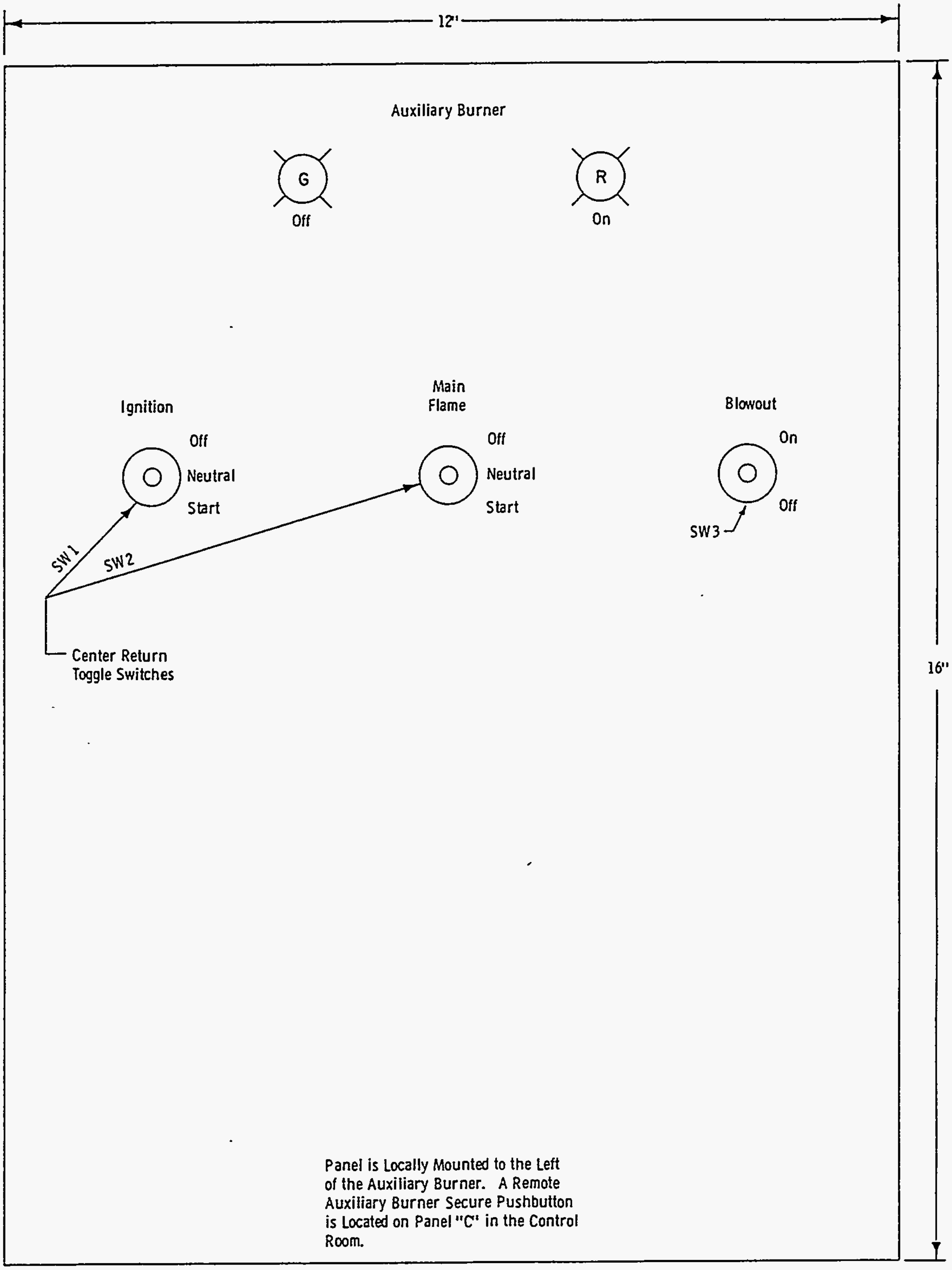
1. Is a purge required signal present?
2. Is the atomizer of this burner in place?

If the answer to one is no and question two is yes, the system initiates the ignitors and asks the question again "Is the oil valve closed"? Under normal conditions then, the ignitor will be energized prior to the closing of the oil valve and will have the time of the oil valve trav 1 for establishing ignition. If the above two questions are not satisfied, an alarm "Blowout Incomplete" is initiated and the ignitor is not energized. Following the establishment of the ignitor and the closing of the oil valve, the blowout steam valve and the atomizing steam valve are opened for the remainder of the blowout timer period. When this time delay is timed out, these valves are closed and the ignitor is de-energized.

This completes the normal shutdown sequence and is the point at which, when the burner is secured, it is disconnected from the burner logic circuitry.

The initial interrogation for main flame on this burner allows the ignitor to be established as soon as it is safe to do so, not waiting for the oil valve to be fully closed. The second interrogation for oil valve closed prevents the opening of the blowout steam valve prior to the closing of the oil valve. Removing the initial interrogation for main flame would merely mean that the ignitor would not be established until the main oil valve was closed.

The purge required signal is developed by a continuous monitoring circuit, 3.0. A purge is always required if fuel to air ratio becomes excessive, whenever there is no flame in the boiler including the auxiliary burner, and when a loss of fan occurs while a main burner is in operation whether the fuel to air ratio is high or not.



Auxiliary Burner Control Panel - 184-N

AUXILIARY BURNER CONTROL SYSTEM - 184-N

General - The control system for the auxiliary burner is designed for local manual startup whether or not main fuel oil burners are in service, and remote manual-automatic combustion control when operating singly. During other modes of operation, the controls for auxiliary burner fuel oil flow and air flow are automatically set at a preset rate. If boiler load conditions are such that it is desirable to shut down the auxiliary burner, low load operation can continue with one or more main burners in service. Whenever the auxiliary burner is removed from service it is essential that air supply, preferably, from the auxiliary blower or from main burner windbox auxiliary duct be directed through the unit to protect equipment against overheating.

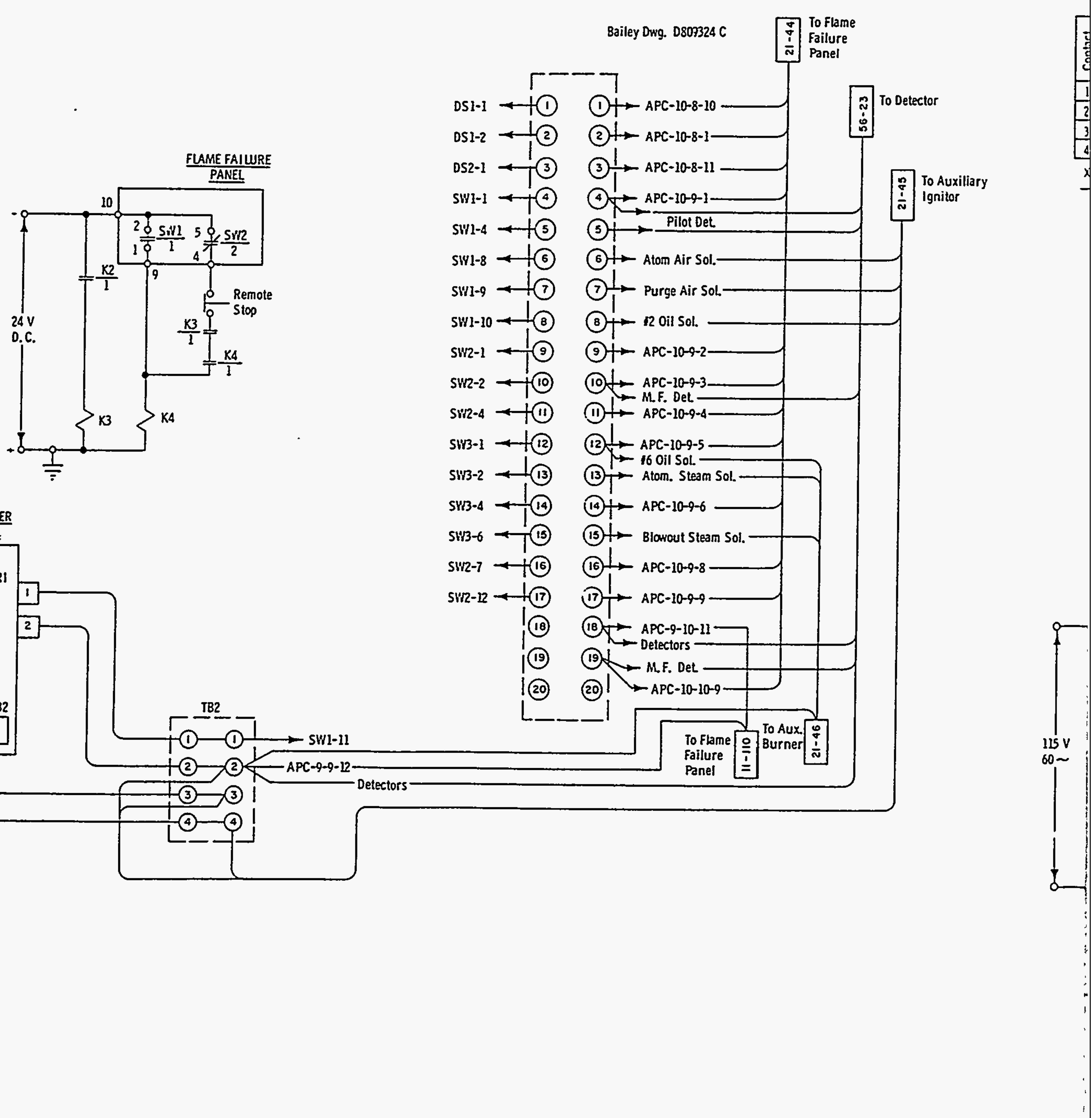
The startup operation of the auxiliary burner is controlled from a locally mounted control cabinet. The switches and indicating lights are flush mounted on the hinged door and the relays, terminal boards and wiring are mounted inside of the cabinet. The ignitor step-up transformer, similar to the ones used for the main burners, is mounted near the burner itself. The ignitor for the auxiliary burner is a mechanical atomizing type unit, whereas the ignitors for the main burners are of the air atomizing type. The ignition oil pump discharge header pressure as maintained by valve IOV-108-1 is set sufficiently high to insure satisfactory operation of the auxiliary burner ignitor. The lower pressure required by the main burner ignitors is obtained by pressure reducing valve IOV-112-1. During standby or low load operations using the auxiliary burner only, the No. 6 fuel oil for the main burners is recirculated at a pressure of approximately 40 psi.

Auxiliary Burner Control Station - The auxiliary burner control station located to the left of the burner assembly consists of the following:

1. Two (2) three-position, Neutral-Start-Off, toggle switches. One for "Burner Ignition", other for "Burner Main Flame".
2. One (1) two-position "On-Off" toggle switch for "Burner Gun Blow Out".
3. Lights to indicate "Burner On", "Burner Off".

Operation of the Auxiliary Burner - Startup sequence of the auxiliary burner will be as follows:

1. Start auxiliary blower from local control panel.
2. Open 2-inch butterfly valve supplying air to ignitor (or atomizing air will be supplied to ignitor when future modifications are made when step 3 is performed).
3. Turn and hold the 3-way burner ignitor switch in "Start" position until flame is observed (flame scanner is bypassed, ignition oil solenoid is opened and ignitor coils are energized). When the switch is released, the ignitor coils are de-energized and the ignition oil solenoid remains open if ignition is proven by flame detector.
4. Position burner main flame switch to the "Start" position (flame scanner is bypassed and the No. 6 fuel oil valve opens). When "Burner On" light illuminates, burner flame is established and the switch can be released. The fuel oil valve remains open as long as flame is proven by the burner flame detector.
5. Secure the ignitor by positioning the ignitor switch to the "OFF" position.
6. The auxiliary burner is now in operation under remote combustion control.

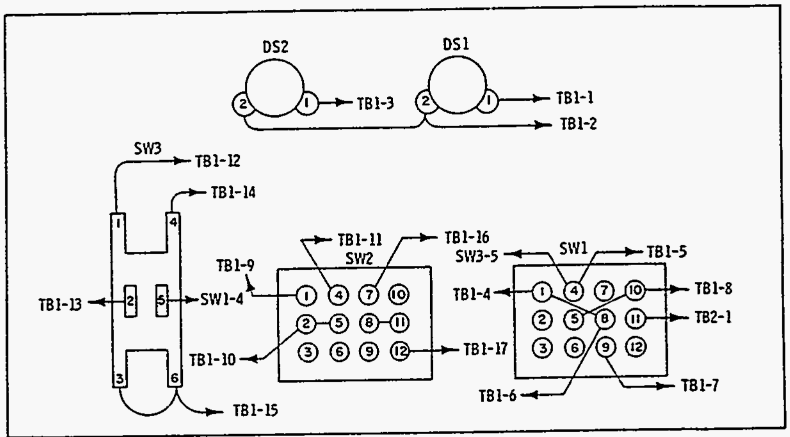


Schematic Auxiliary Burner (

Contact Development

SW1			SW2			SW3	
t ...L	Neut	Off	Start Mint.	Neut	Off	On	Off
	—	—	X	—	—	—	X
	—	—	X	X	—	X	—
	X	—	X	X	—	X	—
	—	X		X	X	—	X

...tes Closed
...tes Open

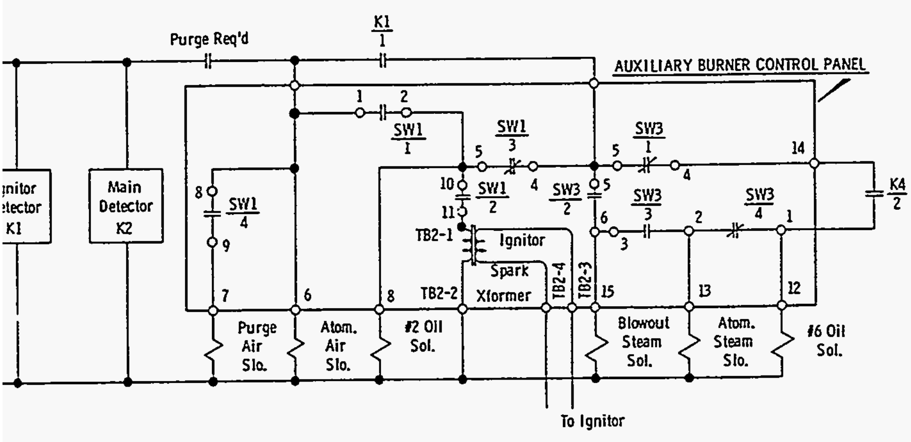


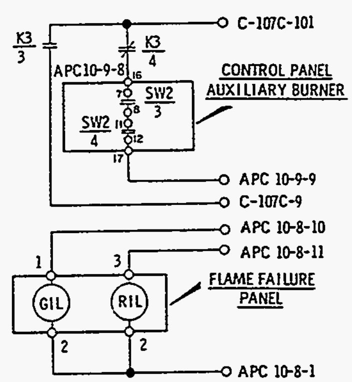
AUXILIARY BURNER CONTROL PANEL

LEGEND

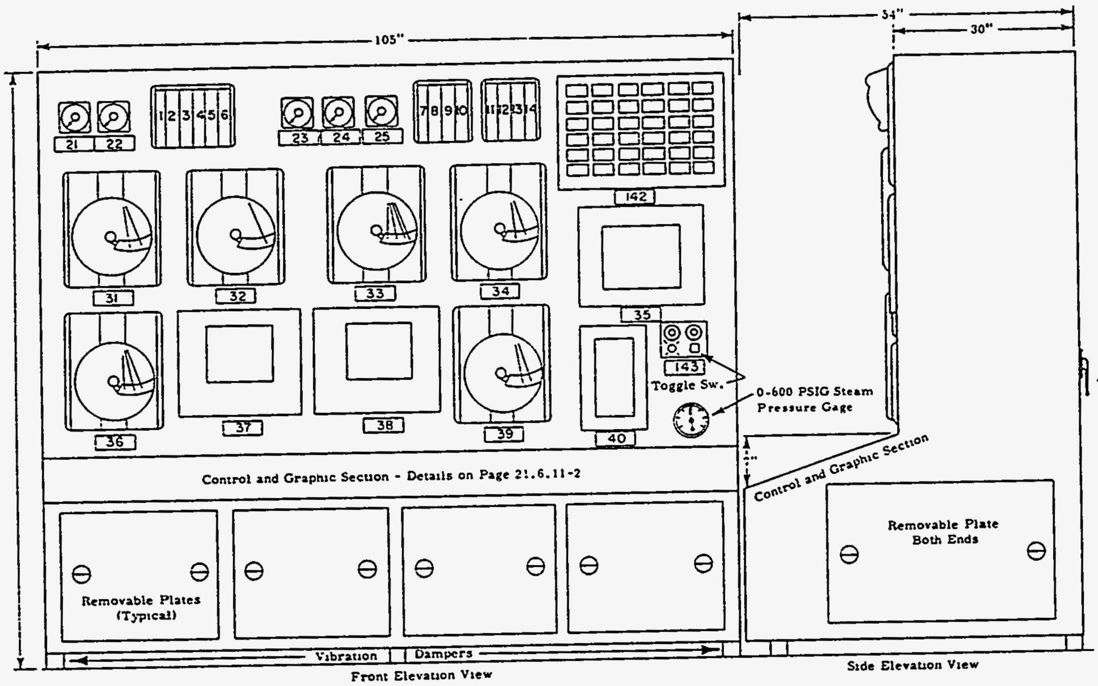
SW1 Ignitor Switch - 4 Pole 3 Pos.
SW2 Main Flame Switch - 4 Pole 3Pos.
SW3 Blowout Switch - DPDT
DS1 Green Indicating Lamp
DS2 Red Indicating Lamp
APC Designates Wire Runs To Main Burner Control Panel "C"

NOTE:
Heavy Lines Denote Equipment Enclosed In Cabinet Assembly





...ntrol Circuitry - 184-N

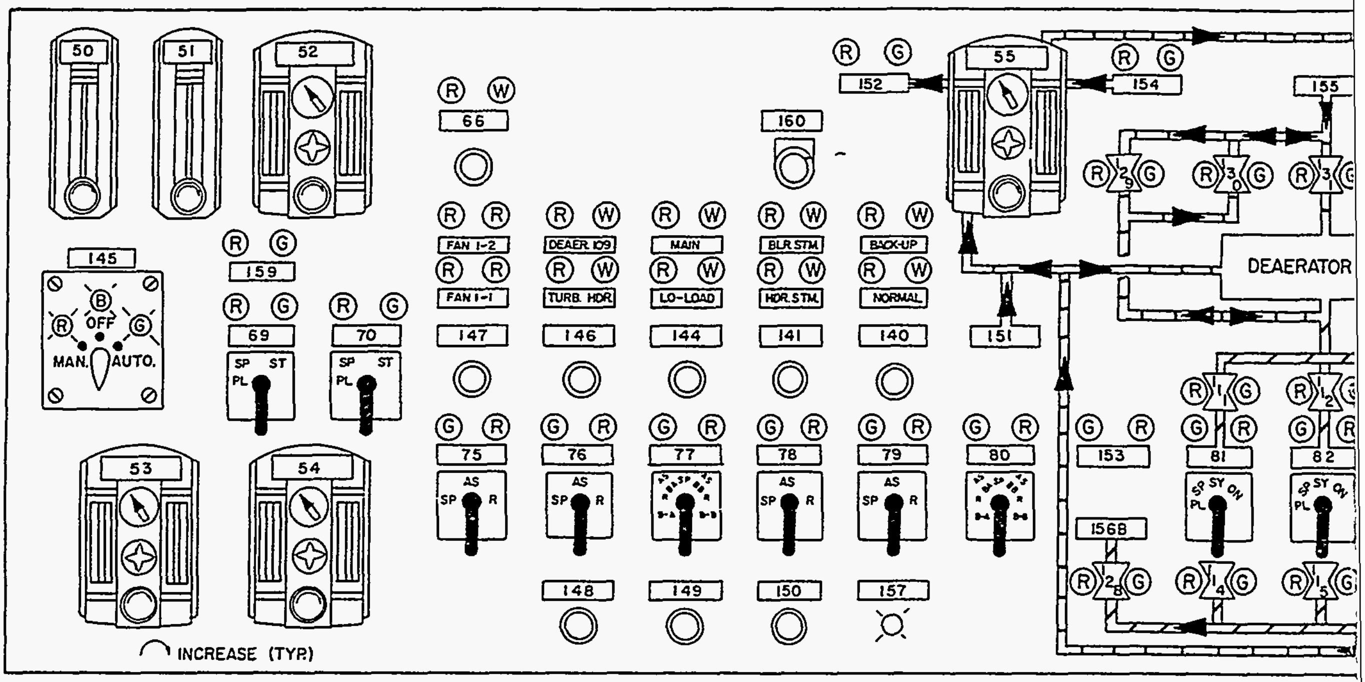


This control board is designed to provide control switching, indication and recording of mechanical equipment in 184N. The control board is located in the control room on the 22'-0" operating floor level. It consists of vertical indicators - recording panel, annunciators and a control bench. The control bench contains the graphic flow diagram, selective controllers, motor control switches and indicating lights necessary for central control.

LEGEND

1. Fuel Oil Pressure (PG-148)
2. Atomizing Steam Pressure (PG-149)
3. Ignition Oil Pressure (PG-150)
4. No.1 Fuel Oil Day Tank Level (LI-104)
5. No.2 Fuel Oil Day Tank Level (LI-105)
6. Ignition Oil Day Tank Level (LI-106)
7. Forced Draft Fan Outlet Pressure (DG-101)
8. Burner Windbox Pressure (DG-102)
9. Furnace Pressure (DG-103)
10. Boiler Gas Outlet Pressure (DG-104)
11. Feedwater Pressure (PG-146)
12. Boiler Outlet Steam Pressure (PG-147)
13. Boiler Steam Drum Level (LI-103)
14. Instrument Air Pressure (PG-151)
21. F.D. Fan Motor #1-1 Ammeter
22. F.D. Fan Motor #1-2 Ammeter
23. Feedwater Pump Motor #1-1 Ammeter
24. Feedwater Pump Motor #1-2 Ammeter
25. Feedwater Pump Motor #1-3 Ammeter
31. Recorder, Fuel Oil Flow (FR-106) and Relative Air Flow (PR-105)
32. Recorder, Gas Outlet-Oxygen (OR-101)
33. Recorder, Deaerator Level (LR-102), Deaerator Pressure (PR-102) Hotwell Level (LR-103) and Condenser Pressure (PR-104)
34. Recorder, Boiler Outlet Steam Flow (FR-101), Boiler Feedwater Flow (FR-102)
35. Turbine Vibration Recorder
36. Recorder, Boiler Outlet Steam Pressure (PR-101), Turbine Inlet Pressure (PR-103) and Boiler Steam Drum Level (LR-101)
37. Multi-Point Temperature Recorder (TR-101 Through 109) (Air, Gas, Steam and Water)
38. Multi-Point Temperature Recorder (Turbine Brg. Oil Temp., "A" and "B" Cabinets and Room Temperature
39. Recorder, Condensate Flow to Deaerator (FR-104) and Feedwater Flow to 109 Heat Exchange Building (FR-103)
40. Turbine Speed Indicator
142. 36 Point Statalarm Annunciator
143. Power Unit for Turbine Vibration Recorder

Mechanical Control Board - 184-N



SBM SWITCH POSITION LEGEND					
A	Automatic	C	Close	R	Run
AS	Automatic Start	N	Neutral	SP	Stop
BA	Bus "A"	O	Open	ST	Start
BB	Bus "B"	PL	Pull Lockout	SY	Standby

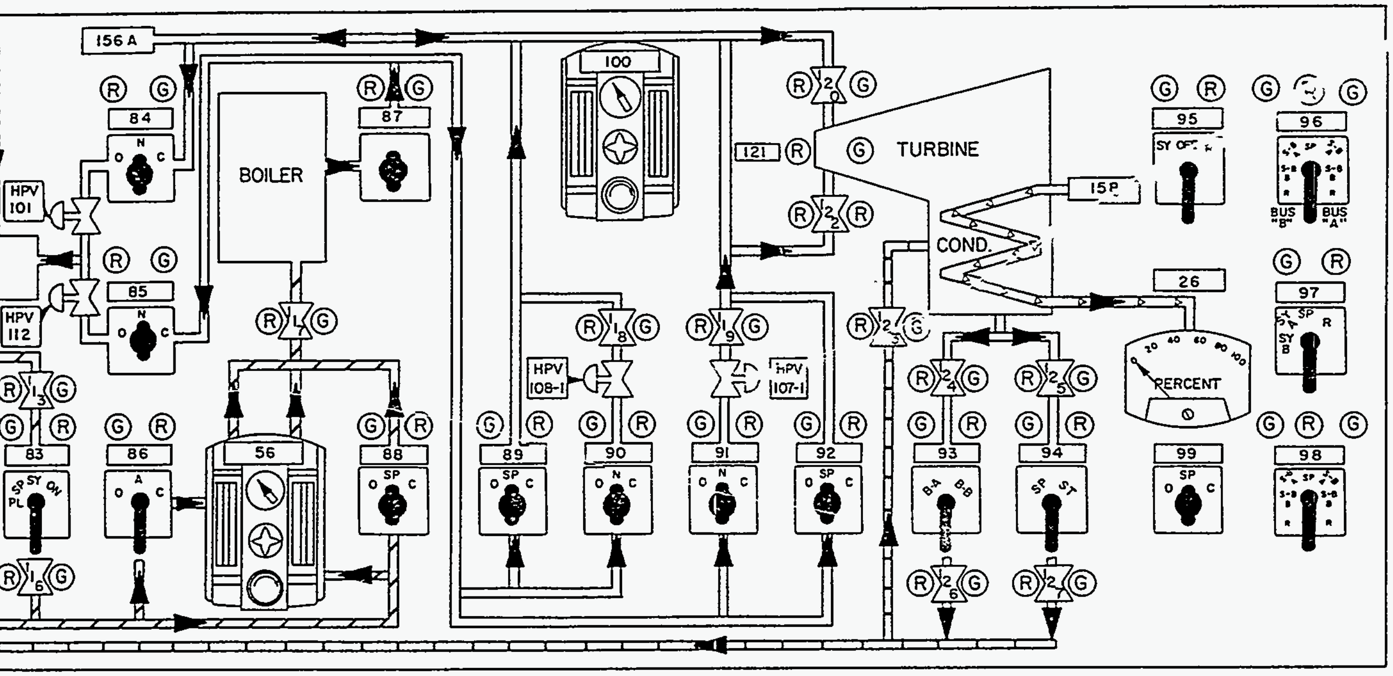
50 Oil-Air Ratio Adjuster SV-101
51 Oil-Air Bias Adjuster SV-107
52 Combustion Air - Flow SV-102
53 Steam Pressure Master SV-103
54 Fuel Oil-Flow SV-104
55 Deaerator Level SV-105
66 Pushbutton and Ind. Lights - Fuel Oil Supply Valve - Air Fail Release - Valve FOSV - 108
69 SBM Switch and Ind. Lights for F.D. Fan Motor #1-1
70 SBM Switch and Ind. Lights for F.D. Fan Motor #1-2
75 SBM Switch and Ind. Lights for Fuel Oil Pump Motor #1-1
76 SBM Switch and Ind. Lights for Fuel Oil Pump Motor #1-2
77 SBM Switch and Ind. Lights for Fuel Oil Pump Motor #1-3
78 SBM Switch and Ind. Lights for Ignition Oil Pump Motor #1-1
79 SBM Switch and Ind. Lights for Ignition Oil Pump Motor #1-2
80 SBM Switch and Ind. Lights for Ignition Oil Pump Motor #1-3
140 Pushbutton and Ind. Lights - Deaerator Make-up - Air Fail Release - Valves MWV-114-1 and MWV-106-1
141 Pushbutton and Ind. Lights - Deaerator Steam Supply - Air Fail Release - Valves HPV - 101 and HPV-112
144 Pushbutton and Ind. Lights - Feedwater Supply - Air Fail Release - Valves FPDV-105 and FPDV-114
145 Boiler Power Control - Relief Valve HPV-141-1
146 Pushbutton and Ind. Lights - Boiler Outlet Steam - Air Fail Release - Valves HPV-108 and HPV-107
147 Pushbutton and Ind. Lights - Forced Draft Fan Dampers - Air Fail Release - (Left Lights Inlet, Right Outlet)
148 Annunciator Acknowledge Pushbutton
149 Annunciator Reset Pushbutton
150 Annunciator Test Pushbutton
151 Nameplate - Drive Turbine Condensate Returns
152 Ind. Lights for Valve Condv. 228 in 109-N Bldg. - Condensate Diversion to Afterheat Removal Tank
157 Red Indicating Light - Annunciator Power Supply Unit
159 Ind. Lights - For Bus Power Supply (BPA Left, TG Right) for Forced Draft Fan Motor #1-1
160 Purge Complete Pushbutton

56 Drum Level SV-105
81 SBM Switch and Ind. Lights fo
82 SBM Switch and Ind. Lights fo
83 SBM Switch and Ind. Lights fo
84 SBM Switch and Ind. Lights fo
85 SBM Switch and Ind. Lights fo
86 SBM Switch and Ind. Lights fo
87 SBM Switch and Ind. Lights fo
88 SBM Switch and Ind. Lights fo
111 Ind. Lights for Feedwater Pu
112 Ind. Lights for Feedwater Pu
113 Ind. Lights for Feedwater Pu
114 Ind. Lights for Feedwater Pu
115 Ind. Lights for Feedwater Pu
116 Ind. Lights for Feedwater Pu
128 Ind. Lights for Feedwater to 1
129 Ind. Lights for Emerg. Make-
130 Ind. Lights for 109-N Second
131 Ind. Lights for Emerg. Make-
153 Ind. Lights for Bus Power Sup
154 Ind. Lights for Normal Make-
155 Nameplate - Emergency Make
156 Nameplate - "A" Steam to 109

MIMIC

Code	
	Pin
	Lig
	Pin
	Lig

Mechanical Contr



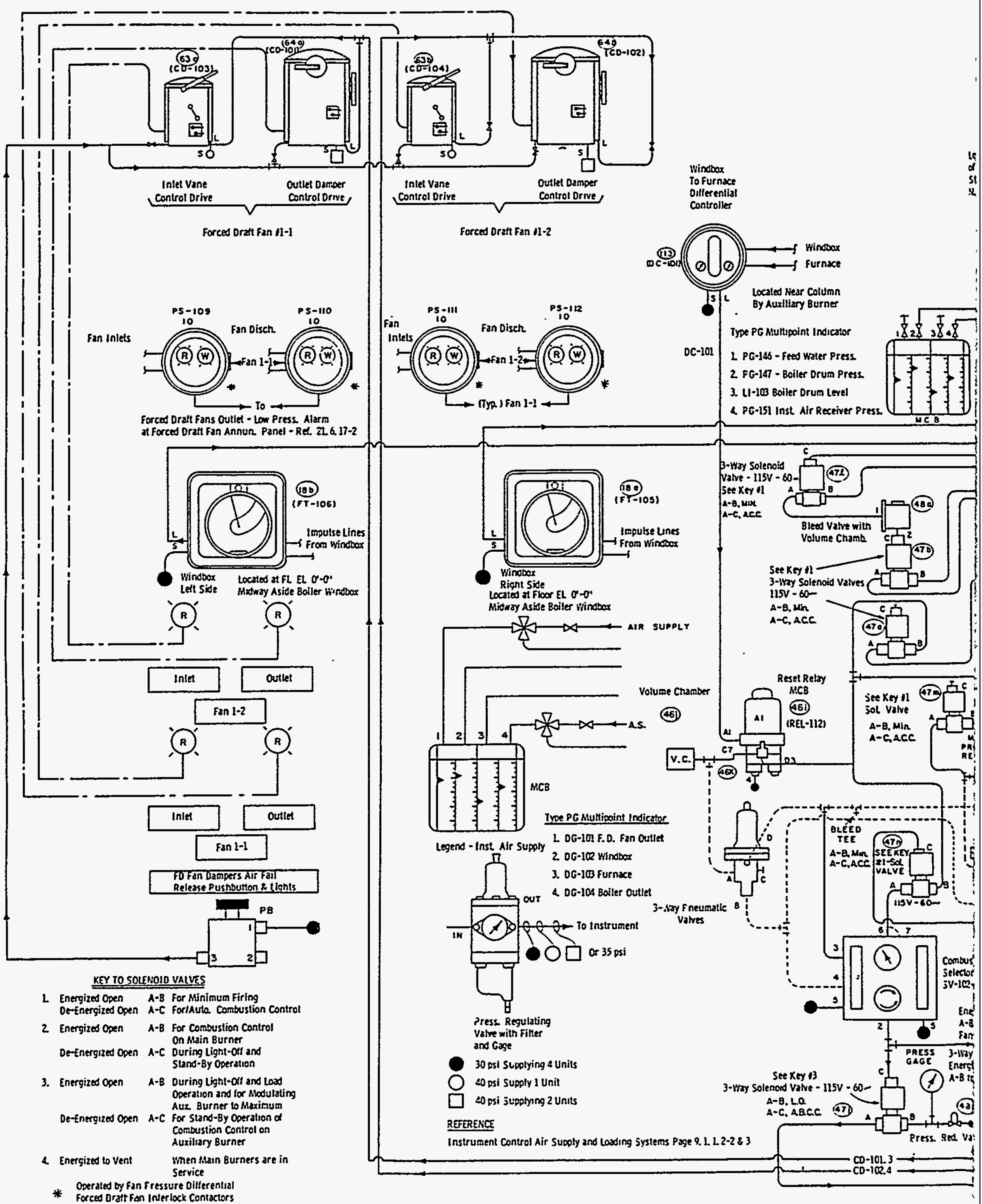
eedwater Pump Motor #1-1
eedwater Pump Motor #1-2
eedwater Pump Motor #1-3
eaerator Steam (Turb. HDR) Supply Shutoff - HPV-102
eaerator Steam (Blr. Supply) Shutoff - HPV-121
ain Control Valve Feedwater Shutoff - FPDV-106
oiler Outlet (Non-Return) Steam Valve - HPV-105
eedwater Control Bypass Valve - FPDV-107
1-1 Suction Valve Pos. FPSV-101-3
1-2 Suction Valve Pos. FPSV-101-2
1-3 Suction Valve Pos. FPSV-101-1
1-1 Discharge Valve Pos. FPDV-103-3
1-2 Discharge Valve Pos. FPDV-103-2
1-3 Discharge Valve Pos. FPDV-103-1
-N Bldg. Valve Pos. FPDV-113-1
to Feedwater Pump Suction MWV-101-1
Loop Flooding Valve Pos. MWV-105-1
to Deaerator Valve Pos. MWV-114-1
(BPA Left, TG Right) To Feedwater Pump Motor #1-3
Supply to Deaerator - Valve MWV-106-1
Supply
"B" Feedwater Return to 109-N

R COLOR CODE

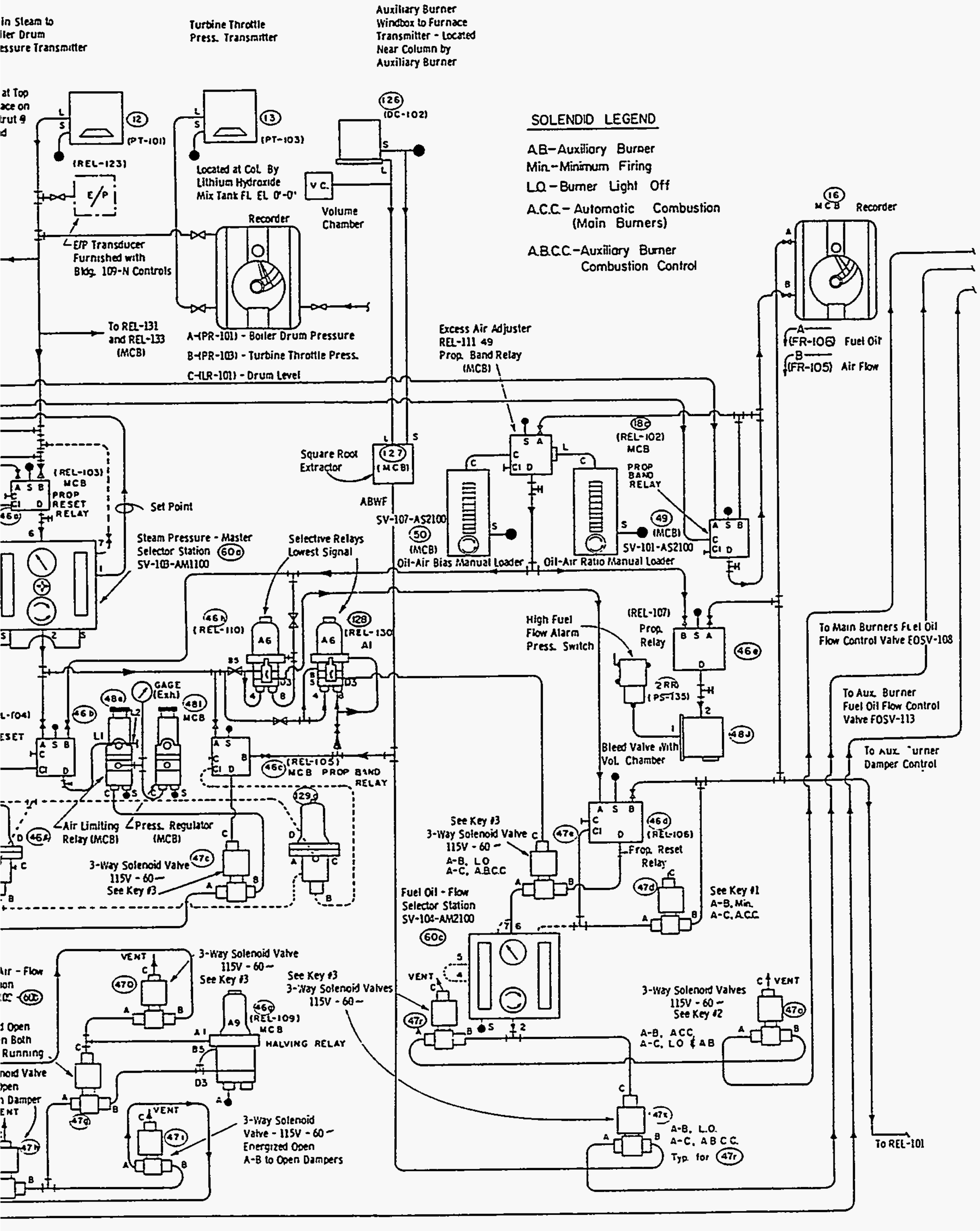
Color	Service
	Steam
Blue With	Condensate and Make-up Water
iagonal Stripes	Feedwater
Brown	Circulating Raw Water

26 Circulating Water Valve Position (RWRV-102) % Open
89 SBM Switch and Ind. Lights for Turbine Header Steam Supply Bypass Valve HPV-110-1
90 SBM Switch and Ind. Lights for Turbine Header Steam Supply Shutoff Valve HPV-109-1
91 SBM Switch and Ind. Lights for Turbine Header Steam Supply Shutoff Valve HPV-109-2
92 SBM Switch and Ind. Lights for Turbine Header Steam Supply Bypass Valve HPV-110-2
93 SBM Switch and Ind. Lights for Condensate Pump Motor #1-1
94 SBM Switch and Ind. Lights for Condensate Pump Motor #1-2
95 SBM Switch and Ind. Lights for Service Air Compressor Motor
96 SBM Switch and Ind. Lights for Instrument Air Compressor Motor #1-1
97 SBM Switch and Ind. Lights for Instrument Air Compressor Motor #1-2
98 SBM Switch and Ind. Lights for Instrument Air Compressor Motor #1-3
99 SBM Switch for Positioning Circulating Raw Water Outlet Valve RWRV-102
100 Turbine Header Pressure Controller SV-108
118 Ind. Lights for Main Steam Control Valve Outlet HPV-106-2
119 Ind. Lights for Main Steam Control Valve Outlet HPV-106-1
120 Ind. Lights for Main Steam to Turbine Valve Position HPV-104-1
121 Ind. Lights for Turbine Steam Chest
122 Ind. Lights for Main Steam to Turbine Valve Position HPV-104-2
123 Ind. Lights for Condensate Recirculation to Condenser Valve Position Condv. 108-1
124 Ind. Lights for Condensate Pump 1-1 Suction Valve Position Condv. 101-1
125 Ind. Lights for Condensate Pump 1-2 Suction Valve Position Condv. 101-2
126 Ind. Lights for Condensate Pump 1-1 Discharge Valve Position Condv. 104-1
127 Ind. Lights for Condensate Pump 1-2 Discharge Valve Position Condv. 104-2
158 Nameplate - Circulating Water Inlet

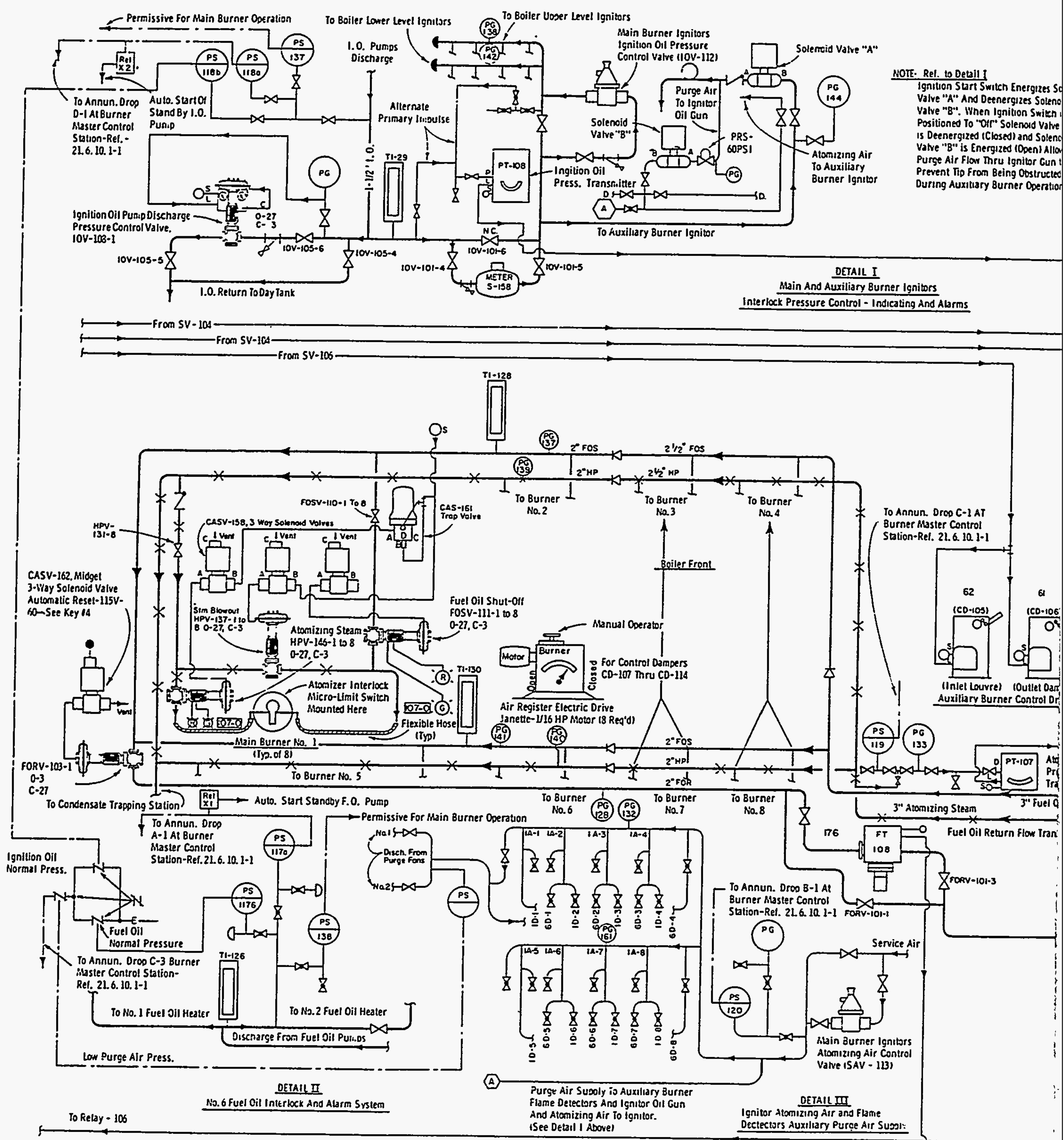
l Board - 184-N



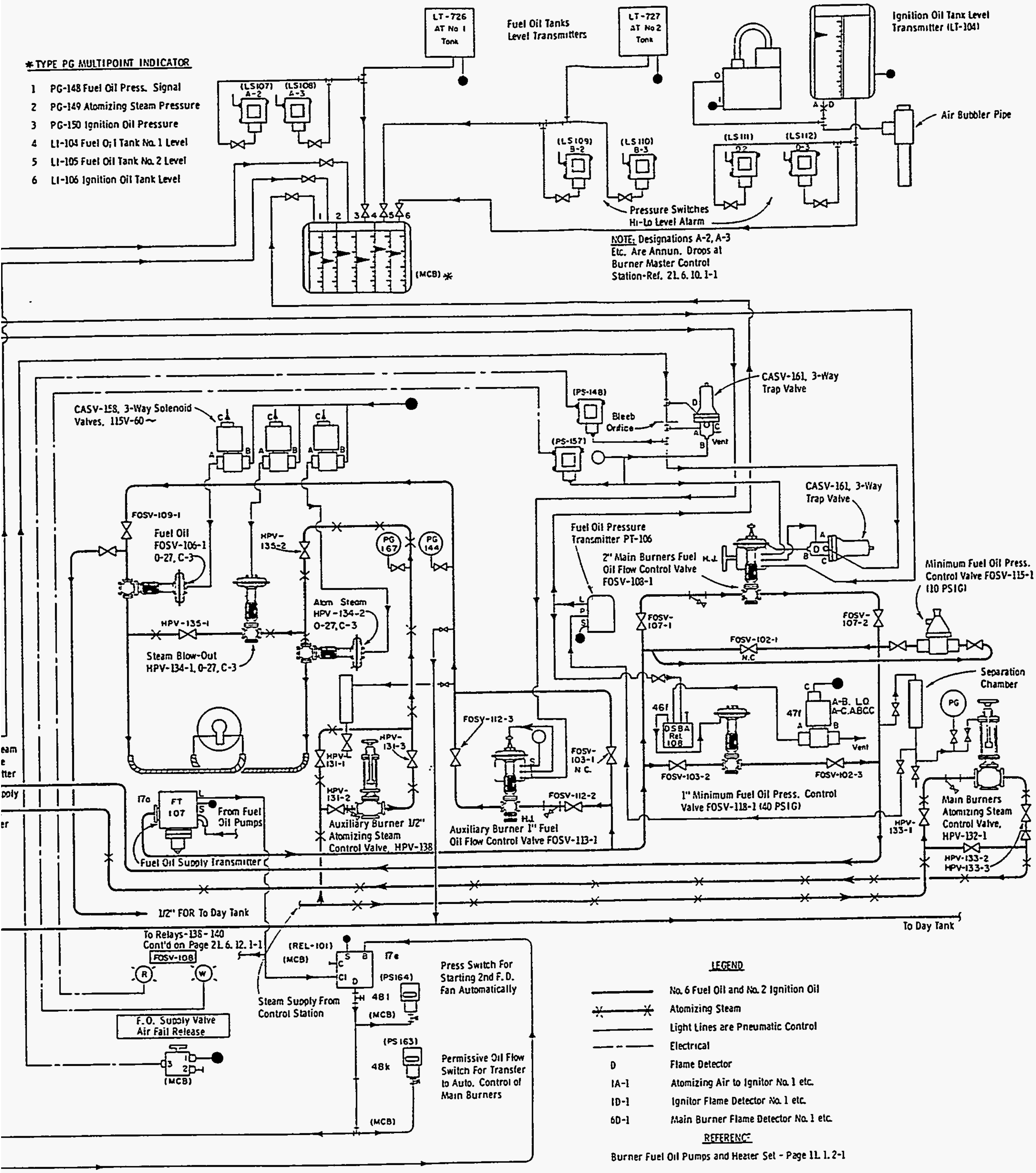
Boiler Automatic Combustio



Control System - 184-N



Boiler Automatic Combustio



UNCLASSIFIED

BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N

General - The automatic combustion control system is designed to maintain constant steam pressure and safe combustion with the auxiliary burner or any number of main burners in operation. Upon an automatic or manual initiation, the controls will program a complete automatic startup and light-off each of the eight (8) main burners and maintain safe and efficient combustion at all operating loads.

Whenever the steam demand during standby operation exceeds the capacity of the auxiliary burner, one or more main oil burners will be in operation and controls for fuel oil-air flow to the auxiliary burner shall automatically set at maximum. In this case, the master steam pressure controller signal will transfer automatically to main burner fuel oil flow and forced draft fan control. Upon receipt of an automatic scram signal from the reactor control room, or by manual initiation, the control system will program a complete automatic light-off of all main oil burners.

Boiler Light-Off Programmer - In general, this system provides for the automatic programming of forced draft fan startup and burner ignition in sequence. It also provides continuous flame scanning of burners during their operation.

Upon receipt of a scram signal, the boiler will go through a pre-set light-off sequence and respond to steam flow demands as required by the operating mode succeeding a reactor scram. The master control station mounted on the burner light-off cabinet provides for the required operation. Individual burner control stations provide the means for selecting the sequence of desired light-off of burner, and for the removal of burners from service (Ref. Section 21.6.10.1 and 21.6.10.2).

Automatic Combustion Control System - During normal operating conditions the rate of combustion will be controlled in accordance with steam demand to maintain pressure at the boiler outlet within plus or minus 1% of the master steam pressure controller setpoint range. This pressure tolerance will be maintained during all load change demands which can be satisfied by boiler design capacity.

The master steam pressure controller (PT-101) establishes the loading pressure proportional to steam pressure changes. The resulting signal will then establish the demand index for fuel oil flow and combustion air flow rates. Necessary proportioning and computing relays are provided, including those supplying reset and rate actions to achieve stable control action with maximum combustion efficiency. As a minimum the master controller has adjustable proportioning and reset actions. The following selector control stations are mounted on the MCB:

1. Master manual-automatic steam pressure control station for regulation of oil and air flow, SV-103.
2. Manual-automatic station for fuel oil valve control, SV-104.
3. Manual-automatic control station for forced draft fan louvre and damper position control, SV-102.
4. Fuel oil-air flow ratio loader, SV-107 and fuel oil-air flow bias loader, SV-101.

NOTE: Refer to "Key to Solenoid Valves" on drawing to determine position of solenoid valve ports to follow pneumatic signal travel. Gated Switch Modules in the "Burner Light-Off Programmer" (Cabinet "B") are used to switch d.c. current on or off to solenoid valves. Ref. Bailey 760 Burner Light-Off System Manual - DWG No. D809206C.

BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N (CONT'D)

Control of Air Flow - Combustion air for the eight (8) main burners is supplied from two (2) 100% capacity forced draft fans. Each fan is rated at 156,000 cfm (687,000 lb/hr) of 80°F air at a discharge pressure of 11.65 inches of water. The flue gasses leave the boiler through a 11'-6" diameter stack mounted on top of the boiler extending 70'-8" above its supporting structure which is a height above grade of 125 feet. The stack is expected to handle a maximum rate of 628,000 lb/hr of flue gas.

Air flow through the boiler is controlled by varying the position of the Forced Draft Fan inlet vanes and outlet dampers. The initial control signal is made from the master steam pressure controller in parallel with fuel oil to burners. Predetermined fuel-air ratios are maintained throughout the boiler load range by positioner relay cams which provide desirable relationship of position to pneumatic signal for valve operators or fan damper control drives. These ratios are maintained throughout the boiler load range in accordance with metered fuel oil flow to the burners and metered relative boiler air flow as measured across two orifices in the split forced draft air duct.

At full load, two (2) 100% capacity F.D. fans will be operated. At part loads which are in excess of standby burner capability, but are below loads permitting stable operation with two (2) F.D. fans, a single fan will be operated.

At any time when only one F.D. fan is in operation, the inlet and outlet louvres and dampers on the shut down fan are held closed by an interlock circuit which de-energizes either of the solenoid valves designated 47h or 47i.

Halving Relay-109 is provided for automatic control loading of F.D. fan vanes and damper positioners when two (2) fans are in operation. This relay is actuated by the interlock circuit which positions solenoid valve designated 47g from A-C ports to A-B ports as shown on the drawing. The closed position of the F.D. fan inlet louvres and outlet dampers are set to permit sufficient combustion air flow for eight (8) main burner light-off with one operating fan (air limiting relay 48h and pressure regulator 48i). A time delay incorporated with each fan motor starting control circuit delays the opening of louvres and dampers until the fans have reached operating speed. Pressure switches PS-109 and PS-110 for Fan 1-1 and PS-112 serve as a permissive for the fan dampers, and when preset air flow is measured, progression of main burner light-off continues until the eight (8) main burners are lit and automatic combustion control takes over provided all master selector stations are positioned to "Automatic".

The air flow control circuit also contains a "fuel cutback" control. Its function is to maintain a minimum preset fuel-air ratio by cutting back on fuel oil flow if air flow cannot be maintained. Fuel cutback may be required below a minimum preset fuel oil flow. Two oil flow-air flow ratio selective relays are provided to actuate the oil trip circuit should air-fuel ratio fall below a safe minimum. They are: Rel-110 for main burner fuel cutback and Rel-130 for auxiliary burner fuel cutback.

Boiler protection on F.D. fan failure is actuated by the following interlocks:

1. Two Fans Operating
   a. One F.D. fan fails: Action - secure vane and damper on failed fan and remove halving Rel-109 from circuit.

BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N (CONT'D)

b. Two F.D. fans fail: Action - same as on previous page and shut off all main fuel oil burners.

2. One Fan Operating
   a. Operating fans fails: Action - same as 1.b.

Control of Fuel Oil Flow and Atomizing Steam Pressure Fuel Oil Flow - During main burner operation, all of the oil is delivered to the burners by positioning relay operated control valve FOSV-108-1. This valve is a 2-inch 316 SS single port, tapered plug type equipped with a side-mounted handjack for manual operation. Action upon air failure is to close, however, this valve operator is equipped with 3-way trapping valves (CASV-161) which maintains the valve operator in its operating position upon loss of control air supply (Ref. Page 21.6.14.1-5). Design conditions are: Inlet pressure psig shutoff-225, maximum flow rate #/hr-45000 at 25 psi pressure drop.

During periods when no oil is being fired by the main oil burners, No. 6 oil is automatically recirculated through the main oil burner supply header. Recirculation is automatically effected by:

1. Opening of solenoid actuated oil recirculating valve FORV-103-1.
2. Closing of main fuel oil combustion control valve FORV-108-1.
3. Actuation of an adjustable setpoint and adjustable proportional band Relay-108 mounted on valve FOSV-118-1. This relay is provided for pressure control from fuel oil pressure transmitter PT-106. Valve FOSV-118-1 is arranged for burner header pressure control during recirculation operation. Relay-108 is set for approximately 40 psig downstream pressure which is sufficient to keep recirculating oil hot. This valve is a 1-inch 316 SS single port, tapered plug type. Action upon air failure is to close. Design conditions are: Inlet pressure psig shutoff-225, maximum flow rate #/hr-4000 at 160 psi pressure drop.

During periods of oil firing control Relay-108 holds valve FOSV-118 in the closed position, and a minimum downstream pressure of 20 psig is maintained by self-operated, adjustable setpoint, reducing valve FOSV-115-1. This self-operated regulator serves as a minimum set and startup valve for main burner light-off. The regulator is sized to pass from 1000 to 10,000 lbs. per hour of 180°F No. 6 fuel oil at a pressure differential of 140 psig.

Atomizing Steam Pressure Control - Atomizing steam is supplied to a constant differential pressure regulator HPV-132-1 directly from the boiler steam drum through a pressure reducing station designated HPV-124-1 preset to maintain downstream side steam pressure at 150 psig. Regulator HPV-132-1 is a 2-inch 316 SS type, designed for a maximum flow rate of 4500 lbs. per hour. The regulator maintains main burners atomizing steam pressure at 20 pounds higher than No. 6 fuel oil control pressure throughout the entire operating range.

Control of No. 2 Ignition Oil and Atomizing Air Ignition Oil - The ignition oil system is designed for fixed firing rate ignitors. Header pressure is automatically kept constant with variation of number of ignitors in service by action of a 3/4-inch 316 SS single port type recirculating control valve designated IOV-108-1. This control valve maintains a constant pump discharge pressure to a 1 1/2-inch self-operated, adjustable setpoint main burner ignition oil header pressure regulating valve designated IOV-112. Design conditions for valve IOV-108-1 are:

BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N (CONT'D)

Inlet pressure-psig shutoff-130, flow rate gpm- 26 with valve 85% open with pressure drops of 75 psi @ 26 gpm/92@ 18 gpm. For valve IOV-112-1 they are: Inlet pressure-psig shutoff-130, flow rate gpm- 8 with a pressure drop of 25 psi @ 8 gpm.

Atomizing Air - Ignitor atomizing air is supplied from the plant service air system. Regulation of the atomizing air pressure at the ignitors is by action of a 1-inch self-operated, adjustable setpoint pressure reducing valve SAV-113-1. Design conditions are: Inlet pressure-psig shutoff-125, maximum flow rate #/hr-270 cfm at 25 psi pressure drop.

Pressure Switches - The following pressure switches are provided to actuate annunciator alarm system and used as the part of the program light-off interlocking equipment:

1. No. 2 Ignition Oil Pumps
   a. Pressure switches PS-118a, PS-118b and PS-137.
   b. Range 0 to 100 psig.
   c. Switch contacts close when pressure falls below 50 psig for PS-118a, actuating low pressure alarm and starts standby pump. Contacts open for PS-137, permissive, stopping main burner light-off.
   d. Pressure switch PS-118b contacts open when pressure falls below 50 psig. In parallel with PS-117b; both in series with flame detector purge air header pressure switch for flame detection air-low pressure alarm.

2. No. 6 Fuel Oil Pumps
   a. Pressure switches PS-117a, PS-117b and PS-138.
   b. Range 0 to 300 psig.
   c. Switch contacts close when pressure falls below 200 psig for PS-118, actuating low pressure alarm and starts standby pump. Contacts open for PS-138, permissive, stopping main burner light-off.
   d. Pressure switch PS-117b contacts open when pressure falls below 200 psig. In parallel with PS-118b; both in series with flame detector purge air header pressure switch for flame detection air-low pressure alarm.

3. Forced Draft Fans
   a. Pressure switches PS-109, 110, 111 and 112.
   b. Range 0 to 15" H_2O (Differential Pressure).
   c. Switch contacts close when differential pressure drops below 1" H_2O; actuates fan outlet differential pressure alarm and permissive for stopping main burner light-off.

Refer to relay and instrument function schedule on Page 21.6.12-8 for additional information.

Valve Positioner Supply and Bypass Valves - Positioning relays associated with control drives for the F.D. fans and auxiliary blower inlet vanes and outlet dampers, valves FOSV-108-1 and FOSV-113-1 are equipped with "Supply" and "Bypass" valves which provide local and/or remote manual operation in the event of positioner outage (Ref. Pages 21.6.14.1-4 and 5).

BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N (CONT'D)

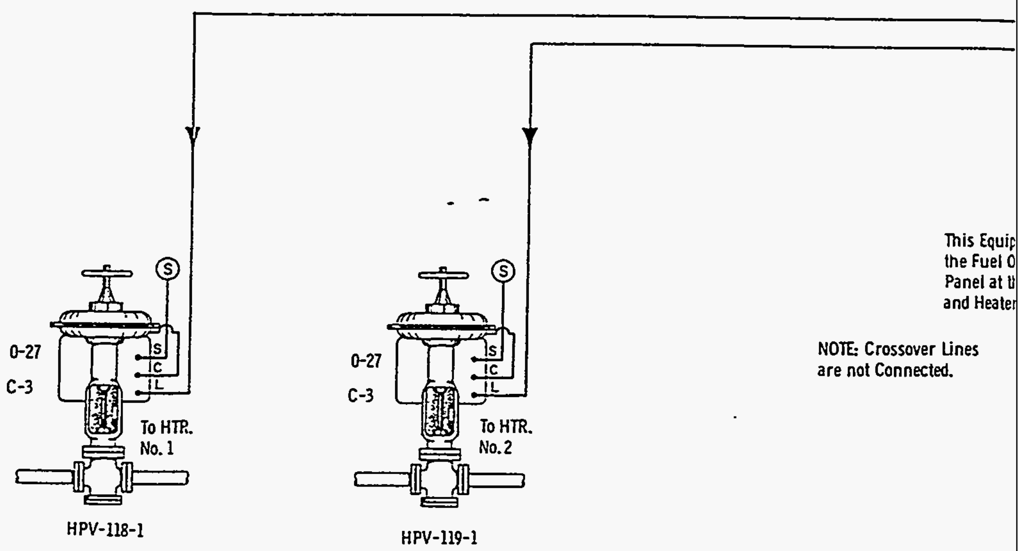
RELAY AND INSTRUMENT FUNCTION SCHEDULE

Item	Location		Function	Primary
Rel-101	*MCB	R	Fuel Oil Flow to FR-106, Rel-107 & 106	FT-107, FT-108
Rel-102	*MCB		Boiler Total Air Flow to FR-105 & Rel-111	FT-105, FT-106
Rel-106	*MCB		Fuel Oil Flow and Air Flow to SV-104	Rel-101 & 110
Rel-107	*MCB		Fuel Oil Flow and Air Flow to PS-135	Rel-101 & 111
Rel-108	FOSV-118-1		Fuel Oil Press. Control Signal to FOSV-118-1	PT-106
Rel-109	*MCB		Halving Relay for F.D. Damper Control (2 fans)	SV-102
Rel-110	*MCB		Air or Steam Flow Loading Signal to Rel-106	Rel-111 & SV-103
Rel-111	*MCB		Air Flow Loading Signal to Rel-104, 107 & 110	Rel-102, SV-101 & 107
Rel-112	*MCB		Windbox, Furnance Diff. Press. Loading to SV-102	DC-101
Rel-123	Local		Main Steam Press. to PG-376 & PG-1131	PT-101
Rel-130	*MCB		Air or Steam Flow Loading Signal to SV-104	SV-103 & DC-102
Rel-131	*MCB		Steam Press. Loading Signal to Rel-132	PT-101
Rel-132	HPV-112-1		Deaerator Steam Pressure Control Loading Signal to HPV-112-1	PT-101
Rel-133	*MCB		Steam Press. Loading Signal to Rel-134	PT-101
Rel-134	HPV-107-1		Steam to Turbine Header Pressure Control Signal to HPV-107 & 108	SV-108 & Rel-133
PS-109 PS-110	Local Local	A	Forced Draft Fan 1-1 Outlet Differential Pressure Alarm and Permissive for Main Burner Light-off	F.D. Fan 1-1 Outlet
PS-111 PS-112	Local Local		Forced Draft Fan 1-2 Outlet Diff. Press. Alarm and Permissive for Main Burner Light-off	F.D. Fan 1-2 Outlet
PS-117a	Local		No. 6 Fuel Oil Supply Low Press. Alarm	Supply to Heaters
PS-117b	Local		Flame Detection Low Air Pressure Alarm	
PS-118a	Local		No. 2 Ignition Oil Supply Low Press. Alarm	Pump Disch.
PS-118b	Local		Flame Detection Low Air Pressure Alarm	
PS-119	Local		Atomizing Steam Low Pressure Alarm	Stm. to Burners
PS-135	*MCB		Boiler High Fuel Oil Flow Alarm	Rel-107
PS-137	Local		Ignition Oil Permissive for Burner Light-off	Pump Disch.
PS-138	Local		No. 6 Fuel Oil Permissive for Burner Light-off	Supply to Heaters
PS-148	FOSV-108-1		Air Fail Brake Release Indicating Light at the MCB	"CAS" to CASV-161
PS-157	FOSV-108-1		Indicating Light at the MCB when Control Air Supply is Normal	"CAS" to Positioner
PS-170	Local		Flame Detection Low Air Pressure Alarm	Purge Air Header

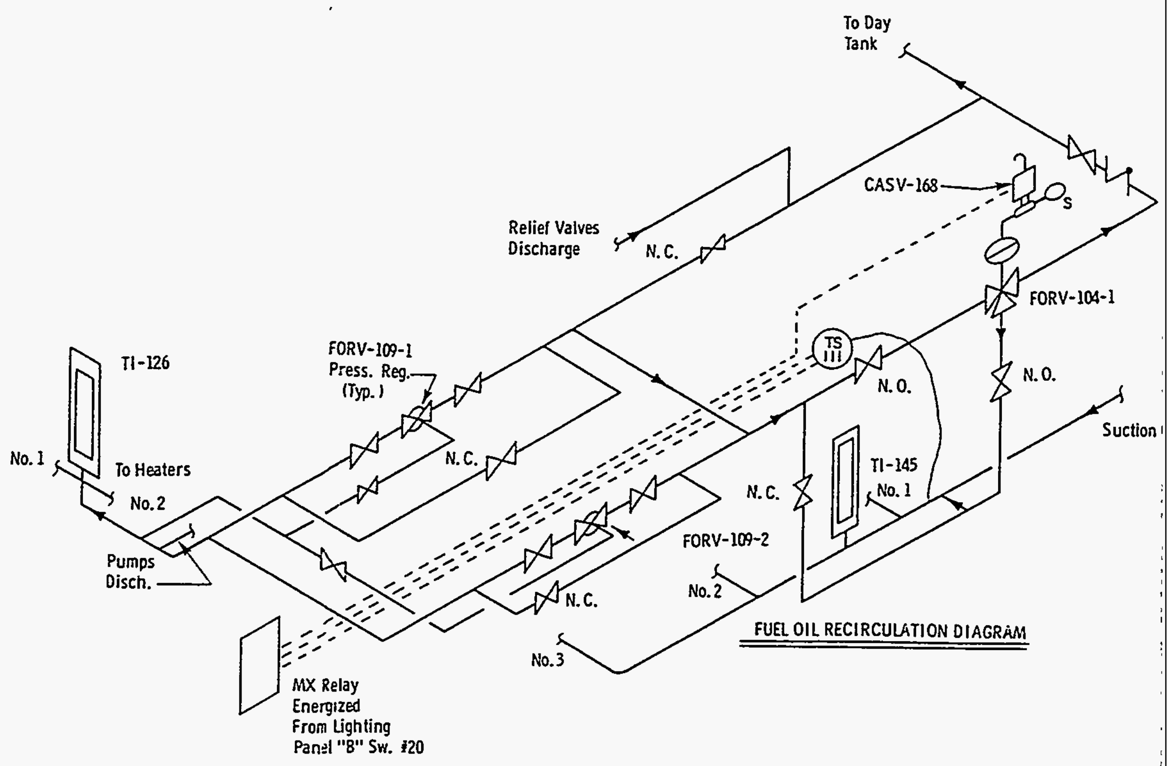
BOILER AUTOMATIC COMBUSTION CONTROL SYSTEM - 184-N (CONT'D)

Item	Location	Function	Primary
PT-101	Local	T Blr. Steam Pressure to PR-101, PG-147, Rel-123, 103, 131, 133 and SV-103	Main Stm.-Boiler
PT-106	Local	Fuel Oil Press. to PG-148 and Rel-108	Fuel Oil Supply
PT-107	Local	Fuel Oil Atomizing Stm. Press. to PG-149	Atom. Stm Supply
PT-108	Local	Ignition Oil Pressure to PG-150	Pump Disch.
FT-103	Local	T No. 6 Fuel Oil Return Flow to Rel-101	F.O. Return Hdr.
FT-107	Local	No. 6 Fuel Oil Supply Flow to Rel-101	From Oil Heaters
FR-105	MCB	r Boiler Air Flow	Rel-102
FR-106	MCB	Boiler Fuel Oil Flow	Rel-101
TR-108	MCB	r Forced Draft Air Supply to Boiler Temp.	Main Supply Duct
TR-109	MCB	Flue Gas Temp. Leaving Boiler	Blr. Breeching
TS-101	*TR-107	T No. 6 Fuel Oil to Blr. Low Temp. Alarm	TR-107
SV-101	MCB	C Boiler Fuel-Air Ratio	Man. Positioning
SV-102	MCB	F.D. Fans Inlet Louvres & Oulet Dampers	Rel-104, 105, 106 & 112
SV-103	MCB	Main Steam Pressure	PT-101 & Rel-103
SV-104	MCB	No. 6 Fuel Oil Flow	Rel-101 & Rel-106
SV-107	MCB	Boiler Fuel-Air Bias	Man. Positioning
CD-101	Fan 1-1	Control Drive - F.D. Fan 1-1 Outlet Damper	Rel-109
CD-102	Fan 1-2	Control Drive - F.D. Fan 1-2 Outlet Damper	Rel-109
CD-103	Fan 1-1	Control Drive - F.D. Fan 1-1 Inlet Vane	Rel-109
CD-104	Fan 1-2	Control Drive - F.D. Fan 1-2 Inlet Vane	Rel-109
CD-105	Aux. Fan	Control Drive - Aux. Blower Inlet Vane	SV-102
CD-106	Aux. Fan	Control Drive - Aux. Blower Oulet Damper	SV-102
DC-101	Local	C Boiler Furnance/Windbox Diff. Pressure	
DG-101	MCB	I Forced Draft Fan Outlet Pressure	Fans Outlet
DG-102	MCB	Boiler Burners Windbox Pressure	Windbox
DG-103	MCB	Furnance Pressure	Furnance
CG-104	MCB	Boiler Flue Gas Outlet Pressure	Blr. Breeching
OAT-101	O_2 Panel	T Boiler Flue Gas O_2 Analysis to OR-101	Blr. Breeching
OR-101	MCB	r Boiler Flue Gas O_2 Analysis	OAT-101

Legend - *Inside, A - Actuates, C - Controls, I - Indicates, R - Relays,
r - Records, T - Transmits

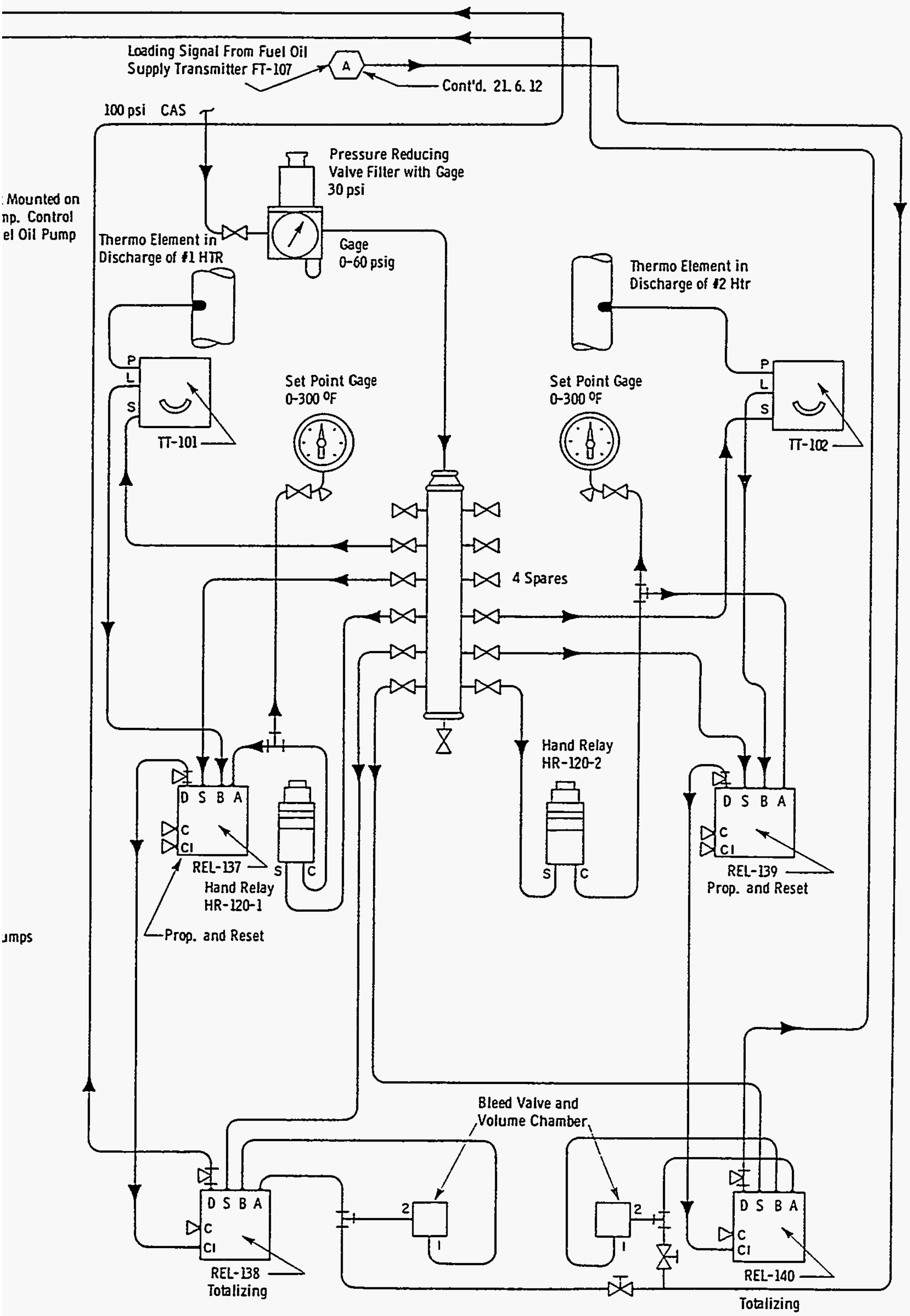


Steam Supply Control Valves to
Fuel Oil Heaters - Ref. Page 11. 1.2. -1



FUEL OIL RECIRCULATION DIAGRAM

Fuel Oil Temperature Co


Loading Signal From Fuel Oil
Supply Transmitter FT-107
A
Cont'd. 21.6.12
100 psi CAS
Pressure Reducing
Valve Filter with Gage
30 psi
Mounted on
np. Control
el Oil Pump
Thermo Element in
Discharge of #1 HTR
Gage
0-60 psig
Thermo Element in
Discharge of #2 Htr
P
L
S
TT-101
Set Point Gage
0-300 °F
Set Point Gage
0-300 °F
TT-102
4 Spares
Hand Relay
HR-120-2
D S B A
C
CI
REL-137
S C
Hand Relay
HR-120-1
Prop. and Reset
REL-139
Prop. and Reset
umps
Bleed Valve and
Volume Chamber
2
1
REL-138
Totalizing
REL-140
Totalizing

FUEL OIL TEMPERATURE CONTROL SYSTEM - 184-N

General - The fuel oil temperature control system is designed to control the temperature of the No. 6 fuel oil being delivered to the boiler auxiliary burner and main burner oil atomizers. Two fuel oil heaters, each 100% capacity units, are provided to operate with the fuel oil pumps. Each heater is horizontal, multi-pass, straight tube type unit designed to heat 100 GPM of No. 6 fuel oil from 100°F to 235°F when supplied with 450 psig saturated steam.

Normally, two fuel oil pumps will be in operation, with fuel oil being supplied from one of two 35,000 gallon vertical fuel oil day tanks to the suction of the pumps through a duplex strainer. The oil from the pumps is passed through one of the two fuel oil heaters then through another duplex strainer to the fuel oil burner supply header. Header pressure is maintained upstream of the fuel oil heaters by two back pressure control valves connected in parallel which bypass excess oil back to either the suction of the pumps or to both the pump suction and fuel oil day tank in service.

During low load operation of the boiler, the fuel oil in the day tanks is maintained at a temperature corresponding to viscosity of 1500 SSU (120°F). With two pumps in operation and the auxiliary burner maintaining the steam demands, the major portion of the oil is being recirculated. When the fuel oil temperature entering the pump suction increases to 125°F by the mixing of supply oil with the heated oil being recirculated, temperature control valve FORV-104-1 will open to return a small quantity of oil back to the day tank. This quantity of oil recirculated back to the tank has been established to a value to limit the minimum viscosity of the fuel oil to the pumps at approximately 1000 SSU (130°F).

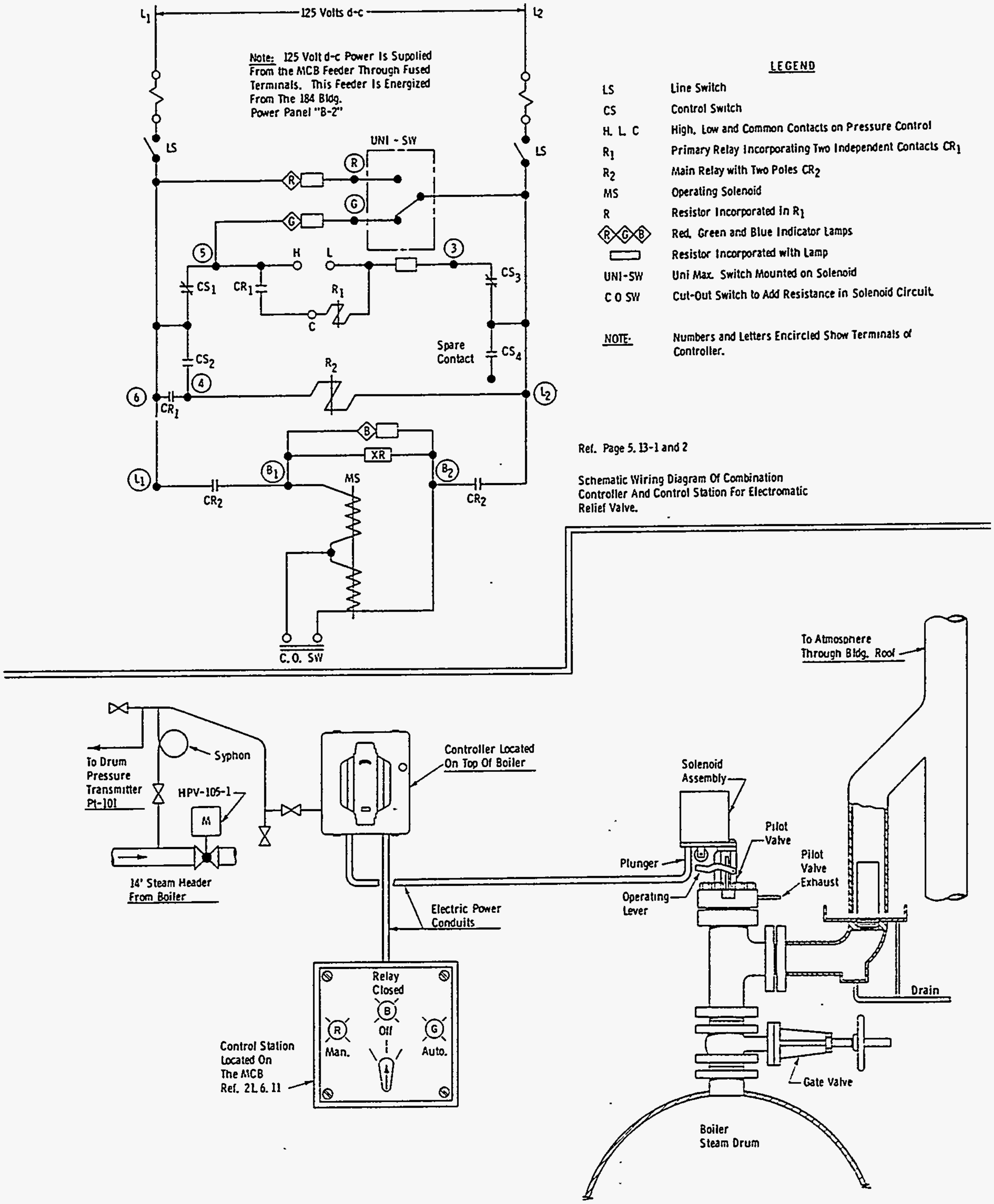
During full load operation of the boiler, the temperature control valve returning oil to the day tank will be closed, and the fuel oil being recirculated through the back pressure control valves will be returned and mixed with the supply oil to the burner pumps suction. The viscosity of the oil being pumped will then be at approximately 1250 SSU (125°F).

Fuel Oil Temperature Control - The temperature of the fuel oil leaving the fuel oil heaters is maintained at 180°F by setpoint adjustment from hand relays designated HR-120-1 and HR-120-2 as read from associated setpoint temperature gages. Temperature transmitters TT-101 and TT-102 receive the temperature of the fuel oil leaving the fuel oil heaters through independent capillary tubing arrangement. These transmitters transmit a loading signal representative of the temperature of the fuel oil leaving each heater to either Relay 137 or Relay 139.

Relay 137 transmits fuel oil heater No. 1 temperature control signal to Relay 138 from where the control signal is relayed to the positioner at steam control valve HPV-118-1. Relays 138 and 140 perform the same function for No. 2 fuel oil heater to steam control valve HPV-119-1.

The pneumatic signal from the fuel oil supply flow transmitter FT-107 to Relays 138 and 140 modifies the loading signal from the temperature transmitters during fuel oil flow changes, thus maintaining constant temperature of the fuel oil during an increase or decrease in demands. Temperature switch TS-111 opens at 130°F and closes at low oil temperature, energizing the solenoid at valve CASV-168.

Viscosity and Temperature - For most economical results the temperature of the fuel oil should be such that the viscosity is between 230 and 203 SSU (175 to 180°F). Minimum viscosity at 300 SSU, approximately 165°F. The temperature required to obtain these viscosities varies with the character of the fuel.



Boiler Electromatic Relief Valve Control System - 184-N

ELECTROMATIC RELIEF VALVE CONTROL SYSTEM - 184-N

General Description - The Electromatic Relief Valve is an electrically actuated pressure relief device. The valve is used to purge the boiler steam drum, thereby decreasing the possibility of damaging safety valve seats. The pressure element is set to open the relief valve automatically at a pressure slightly below the lowest set spring loaded safety valve, and will effectively prevent the safety valves from lifting except on major over-pressures. The valve may be operated at will by positioning a switch at the control station located on the Mechanical Control Board, or through the pressure sensitive element to relieve pressure automatically and accurately within very close limits. The application of this valve places at the command of the plant operator a means of instantaneously opening and closing a relief valve on the boiler steam drum from a central control point.

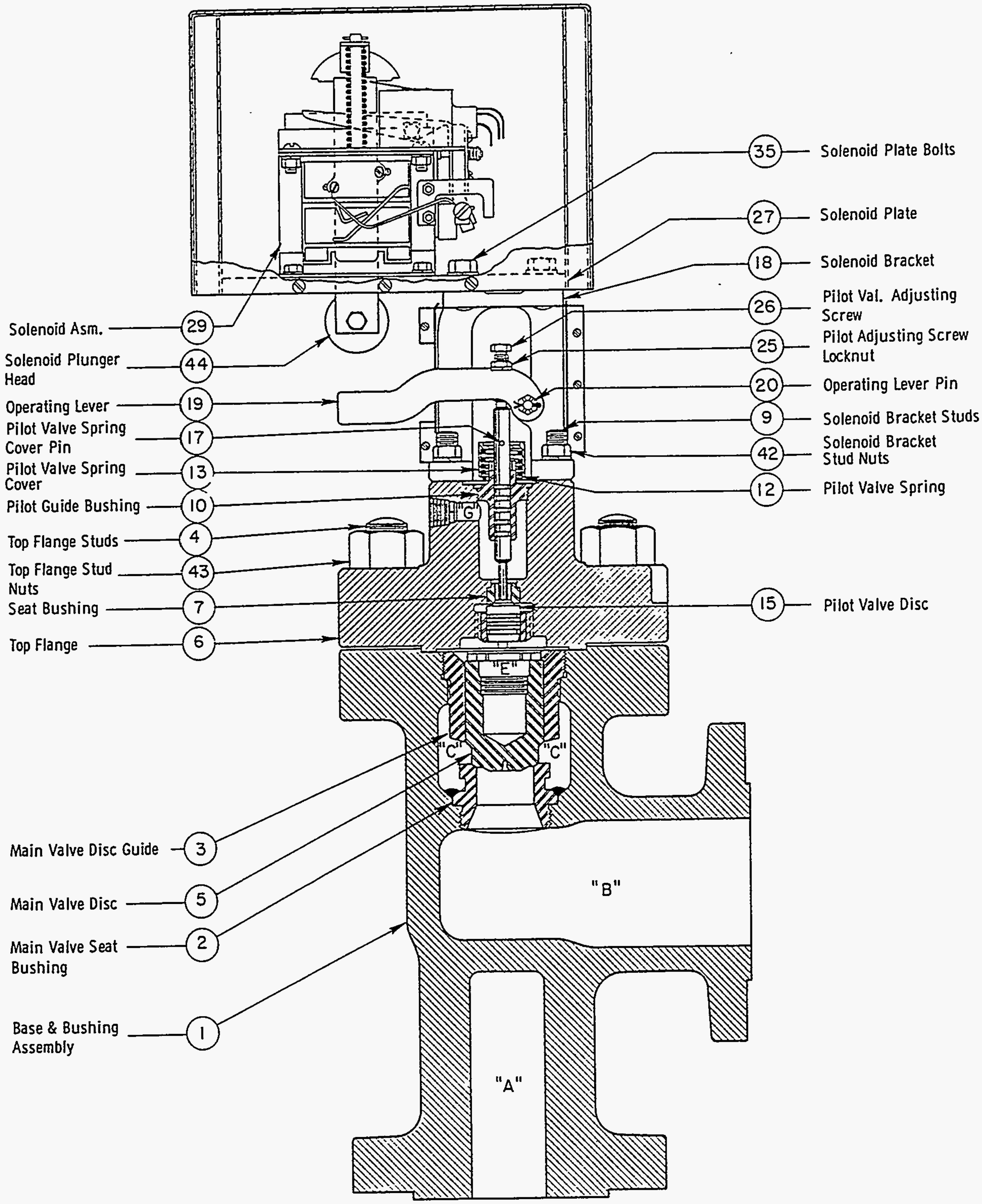
The drawing on opposite page illustrates diagramatically the relationship of the various elements of the control system. The controller consists of a pressure sensative element composed of two large spring loaded Bourdon tubes which actuate electrical contacts, a primary relay controlled by the Bourdon tube system contacts a heavy duty relay to switch the solenoid load. The control station is equipped with a 3-position (Manual, Off and Automatic) switch and with three indicating pilot lights (red, blue and green). The pressure element and the relays working in conjunction with the control station supply electrical power to the solenoid assembly which operates a pilot valve. The pilot valve in turn control the opening and closing of the main valve.

The electrical components are wired to provide positive latch-in and out in order to eliminate chattering. Electric power is supplied from the 125 volt d-c feeder at the Mechanical Control Board through fused terminals. A resistor is built into the solenoid assembly for the purpose of reducing the current when the solenoid is in its holding position.

How the Electrical System Functions - The schematic wiring diagram is also shown on page opposite. Additional data and diagrams may be found in the Consolidated Electromatic Relief Valve Service Department Manual No. 9 under BPF No. 13104 Through the use of resistors and relays only a small amount of current passes through the electrical contacts of the Bourdon tube element. The two relay system has high sensitivity and is very reliable.

The relief valve can be opened manually regardless of the pressure in the Bourdon tube system, or the valve is set to open automatically when pressure increases to a pre-determined point (which is 460 psig). To open the valve manually, the control switch is turned to the position marked "MANUAL", thus energizing the solenoid through main relay R_2. The main valve will open and continue to blow until the control switch is turned the the "AUTOMATIC" or the "OFF" position.

When the control switch is turned to "AUTOMATIC" the valve will open automatically on pressure increase when the contact on the upper contact arm of the Bourdon tube system touches the high pressure contact and because of the electrical latch-in feature of this arrangement will remain open until the upper contact arm makes contact with the low pressure contact.



Sectional View - Electromatic Relief Valve and Pilot Valve - 184-N

ELECTROMATIC RELIEF VALVE CONTROL SYSTEM - 184-N (CONT'D)

The indicating lamps at the control station are connected so that the green lamp burns, showing that the electrical circuit is energized and the valve is closed. The green lamp goes out and the blue light and the red light burns, which indicates that the main relay is closed and the solenoid plunger has moved to the bottom of its stroke closing the unimax switch and opening the valve. The blue light is mainly a trouble shooting light. It is used to locate equipment failures immediately.

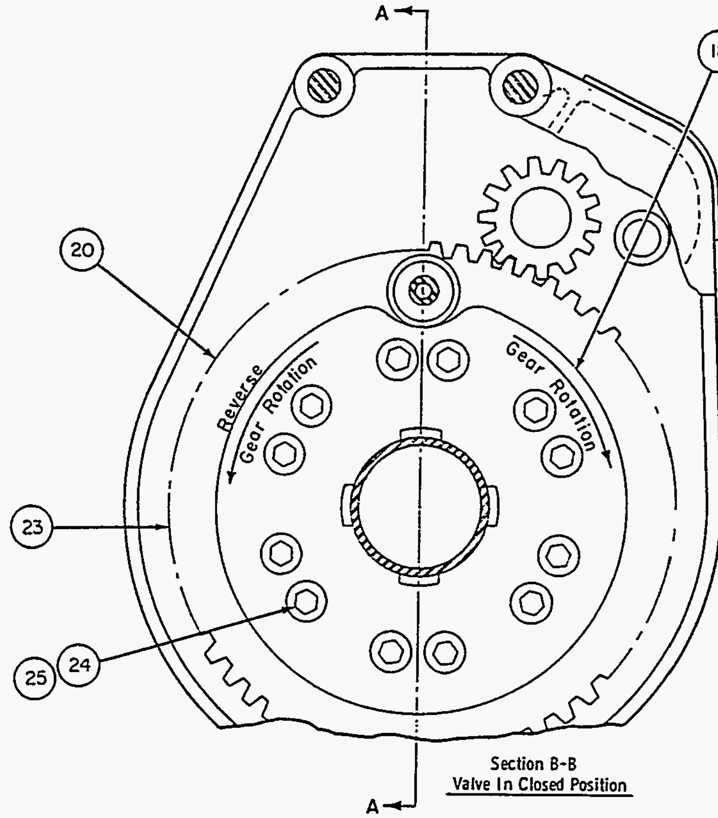
How the Valve Operates - Steam under pressure from the boiler enters the main valve through the inlet chamber (A)-Sectional View of Main Valve and Pilot Valve, and passes upward around both sides of exhaust chamber (B) into section (C). Steam enters chamber (E) through the clearance space between the main valve disc (5) and its guide (3). The main valve disc (5) is held in the closed position by steam pressure in chamber (E). The pressure in chamber (E) is the same as in the chamber (C) when escape through port (G) is prevented by the closure of the pilot valve disc (15).

The pilot valve disc (15) is held in the closed position by pilot valve spring (12) and by the steam pressure in chamber (E). It is opened by the operating lever (19) under the action of the solenoid plunger head (44).

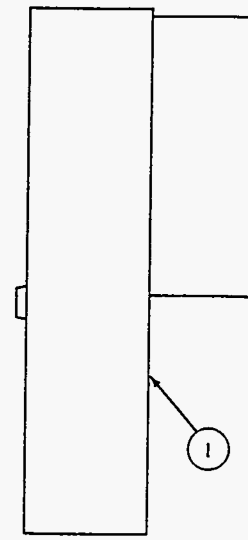
When the pilot valve is opened, steam is released from chamber (E) through port (G) at a faster rate than supplied through the clearance space between the main valve disc and the main valve disc guide. The resultant unbalance of pressures in chambers (E) and (C) produces a lifting force which lifts the main valve disc from its seat permitting steam to escape from chamber (C) to the outlet (B).

When the pilot valve closes as a result of the solenoid being de-energized, steam is trapped in chamber (E) where it builds up pressure and forces the main valve disc (5) back down on its seat, thereby closing the main valve.

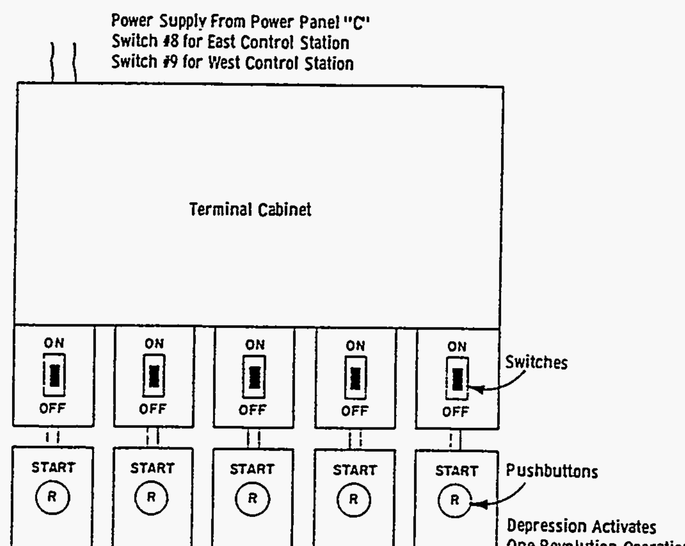
UNCLASSIFIED



Section B-B
Valve In Closed Position



MODEL D-4 HEAD ASSEMBLY - ELE



Soot Blower Control Station - Right Side
(Left Side Typical)

STEAM SUPPLY PRE

Soot Blowers

No. 1

No. 2

No. 4

No. 5

No. 6

NOTE

1. Blowing S
Element 4

2. Control St
Boiler. No
Grating Pl

3. Element R

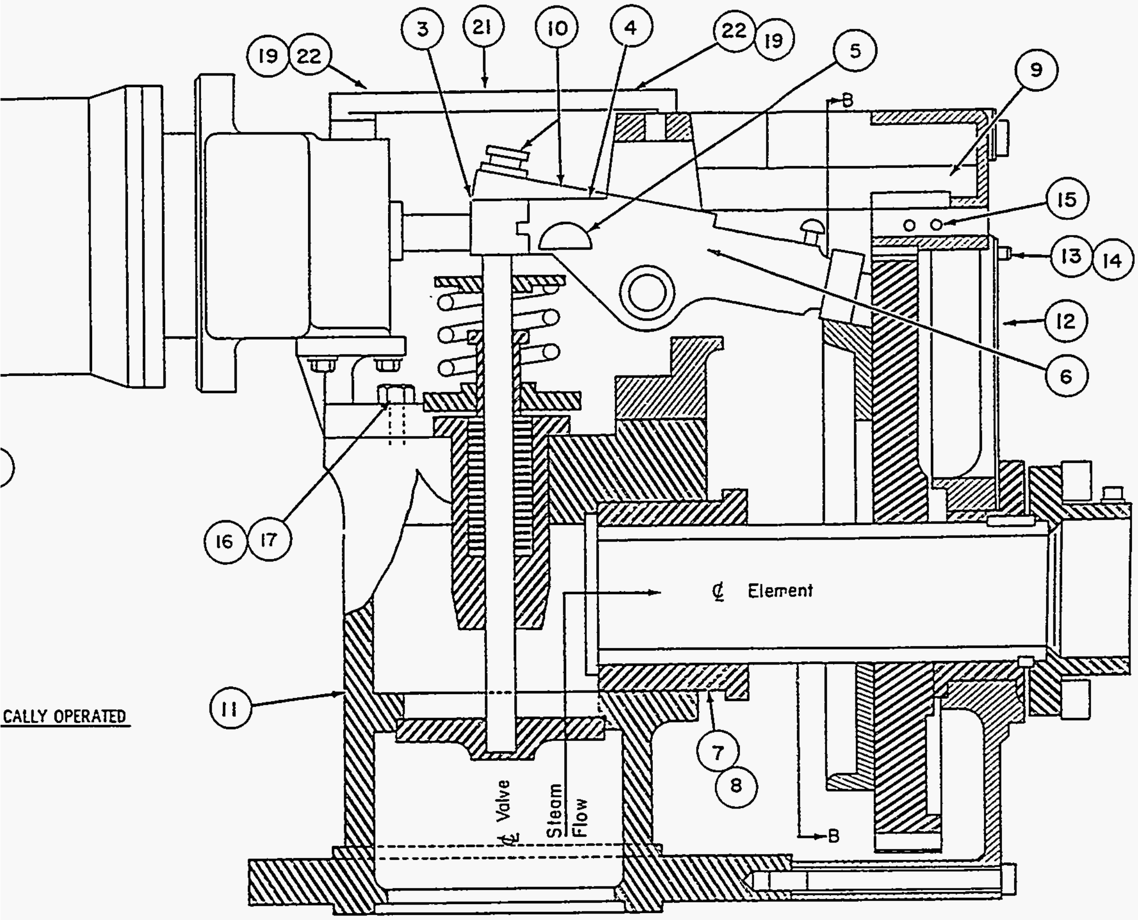
REFERENCE

1. Standby B

2. Purge Air
Page 21. 6.

AEC-GE RICHLAND, WASH.

Boiler Soot Blowers C



CALLY OPERATED

Section A-A

RE SETTINGS AND BLOW CYCLE

etting	Sweep Setting	Soot Blower Arrangement	
150#	180°	⑥	
150#	180°		①
125#	360°		②
125#	180°	⑤	
100#	180°	④	

Left Side
Right Side (Typ)

Item No.	Description
1	Terminal Box
2	Power Pack Ass'y. Electric
3	Coupling
4	Coupling
5	Woodruff Key #G07
6	Operating Shaft
7	Packing Rings (Steam Blowing)
8	Packing Rings (Air Blowing)
9	Pinion
10	1/4" x 3/8" Set Screws
11	Basic Assembly
12	Cover Plate
13	1/4" Socket HD. Cap Screw
14	1/4" Lockwasher
15	Spring Pin 1/8" x 13/16" Long
16	3/8" Lockwasher (Spring)
17	3/8" x 1" Hex. HD. Cap Screw
18	Closing Can
19	1/2" Lockwasher (Spring)
20	Opening Cam
21	Support Bar
22	1/2"-13NC x 1" Lg. Cap Scr.
23	60° Spacer Cam
24	3/8"-16 x 3/4" Lg. Flat HD. Soc. Screw
25	3/8" Countersunk Washer

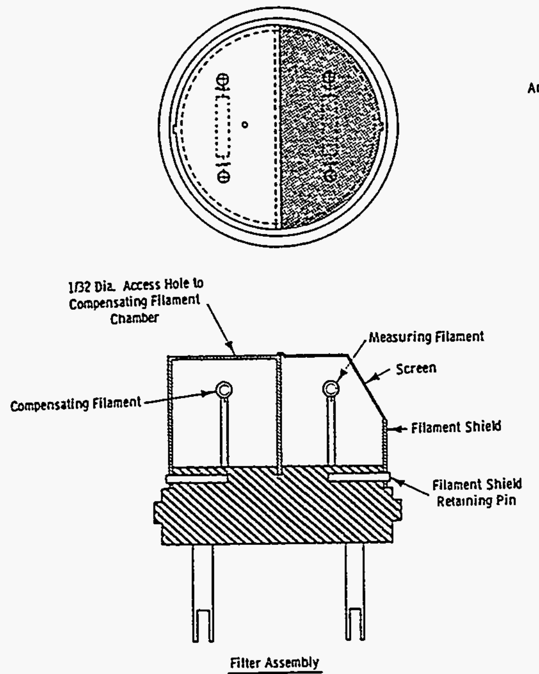
ence is 1, 2, 4, 5 and 6.
ation in 29 seconds all others - 16 seconds each.

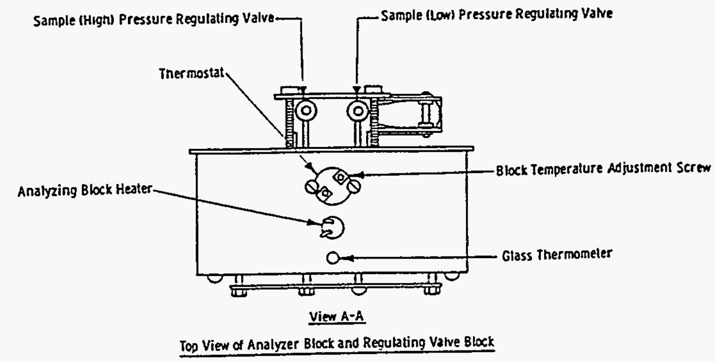
ns are Located at the East and West Side of the
End and Accessible from EL 10'-0" Metal
rms.

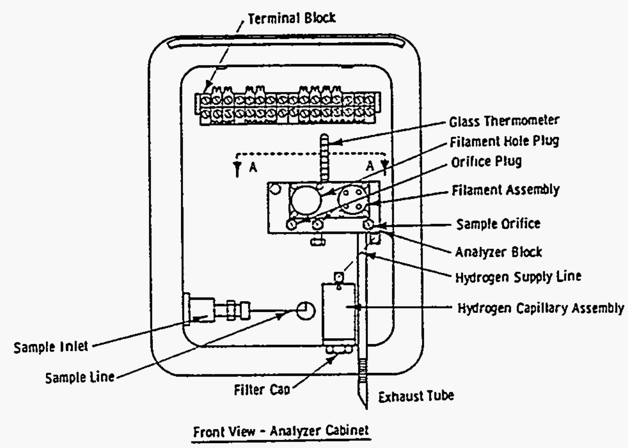
ion is Clockwise.

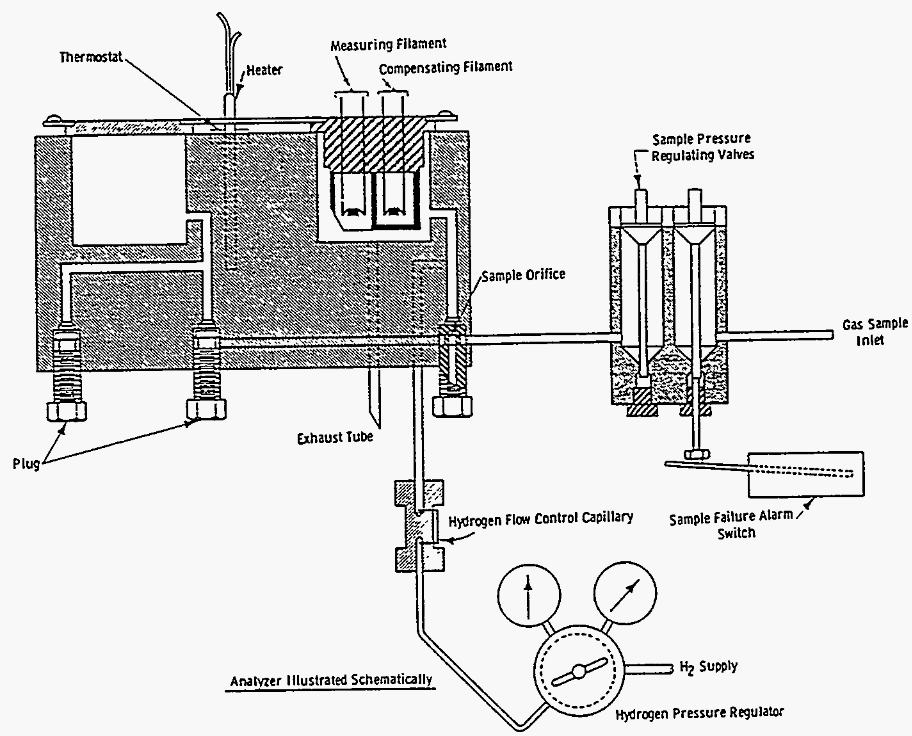
r and Auxiliaries - Page 5.2.1-3 and 5.2.1-6

pply to Flame Detectors and Soot Blowers -
1-1









Oxygen Analyzer and Panel - 184-N

OXYGEN ANALYZER AND PANEL - 184-N

General

The oxygen analysis is made by combining a continuous sample of the measured gas with hydrogen and then burning the gas mixture in the presence of a noble-metal catalyst filament. The heat of combustion and the resulting temperature of the filament are proportional to the amount of oxygen present in the gas sample. The filament is one leg of a bridge circuit, and its resistanee varies directly with its temperature. Unbalance of the bridge circuit caused by a change in the resistance of the filament produces a signal voltage which controls the operation of a balancing motor in the Receiver. The motor rotates in the direction required to rebalance the circuit and operate a transmitting device which drives linkage to position a pen on the boiler gas outlet-oxygen recorder located on the MCB. Electric power for the Analyzer bridge circuit is supplied through an "On-Off" switch located at the rear of the panel. This switch is energized from switch #13 from the 120 Volt Power Panel "EE".

DESCRIPTION OF OPERATION

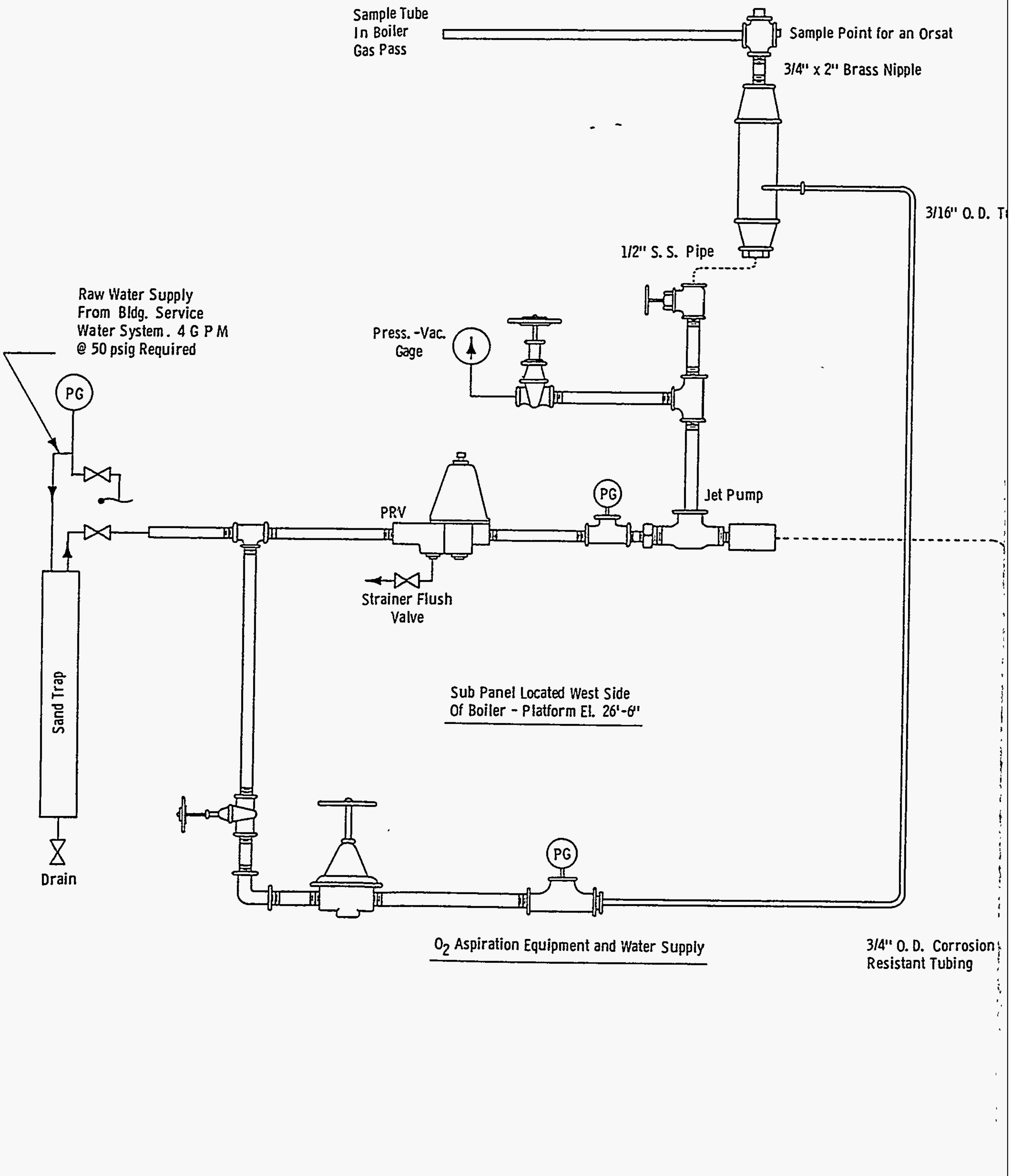
Gas Sample

A continuous sample of the measured gas is delivered to the Analyzer by the sampling system. The pressure of the measured gas entering the Analyzer block is controlled by two gas pressure regulating valves located at the rear of the Analyzer case. The valves are arranged in series and form loosely fitting pistons for the cylinders in which they are housed. At the top of each cylinder a rectangular slot forms an exhaust port to atmosphere.

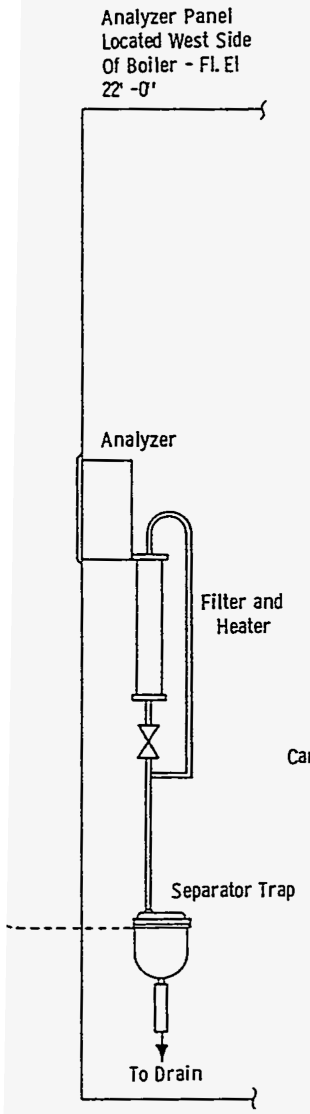
In operation, the valves float on the gas stream, rising and falling to vary the column of gas exhausted to atmosphere so that a constant pressure is maintained in the Analyzer block. The pressure in each valve chamber is determined by the weight of the valve.

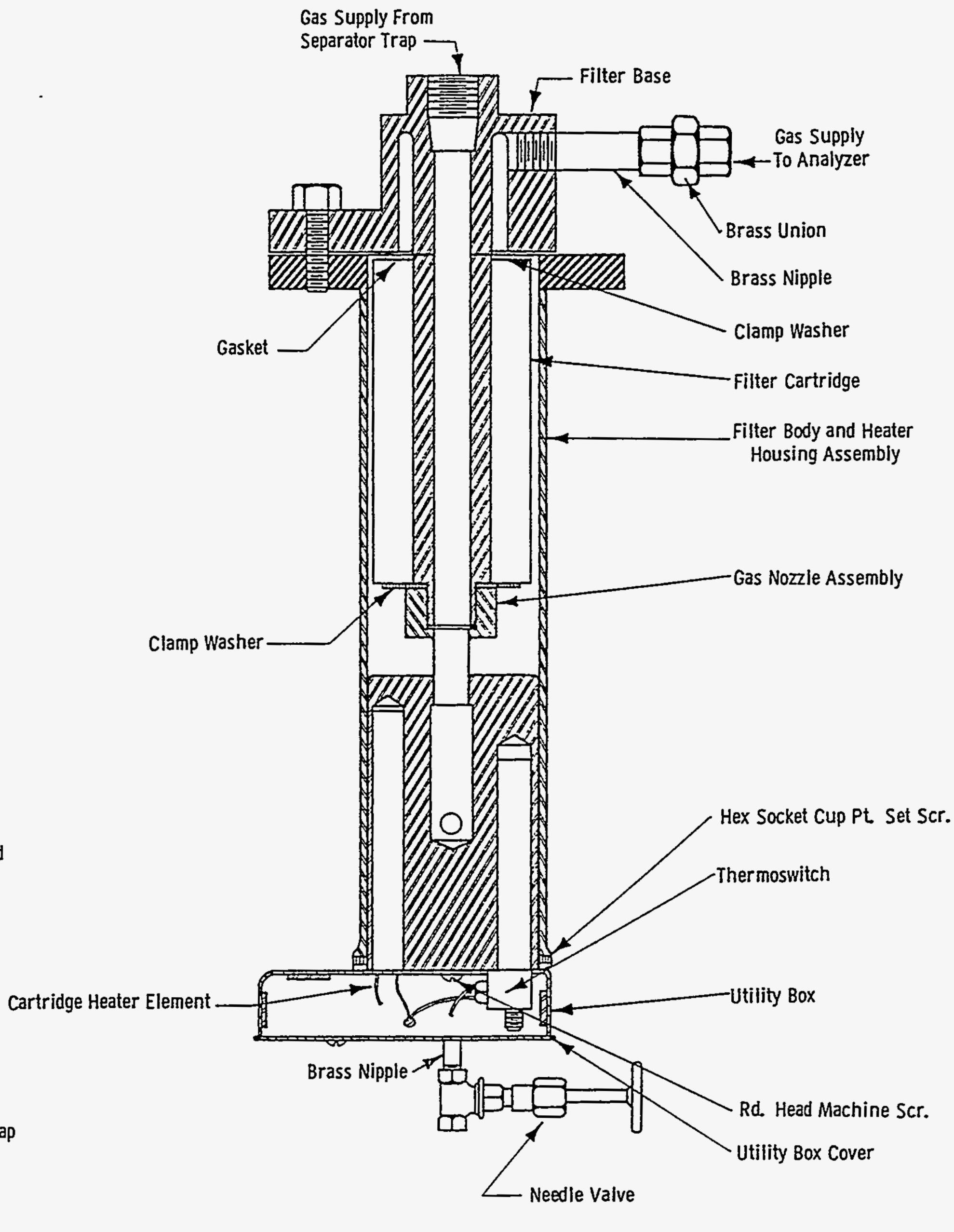
Only about 1% of the gas which is delivered to the Analyzer from the sampling system actually undergoes analysis; the rest is exhausted to atmosphere. This relatively high rate of flow from the sampling system is maintained to keep the response lag of the instrument at a minimum.

From the regulating valves, the gas sample enters the Analyzer block, and passes through the sample arifice. The sample arifice maintains a constant rate of flow to the analyzing cell. At the discharge side of the arifice, the measured gas is combined with hydrogen and the mixture of the measured gas and hydrogen enters the analyzing cell at a constant temperature of approximately 160° F, maintained by the heater provided in the Analyzer block.



Oxygen Analyzer and Pa





Filter and Heater Assembly

OXYGEN ANALYZER AND PANEL - 184-N (CONT'D)

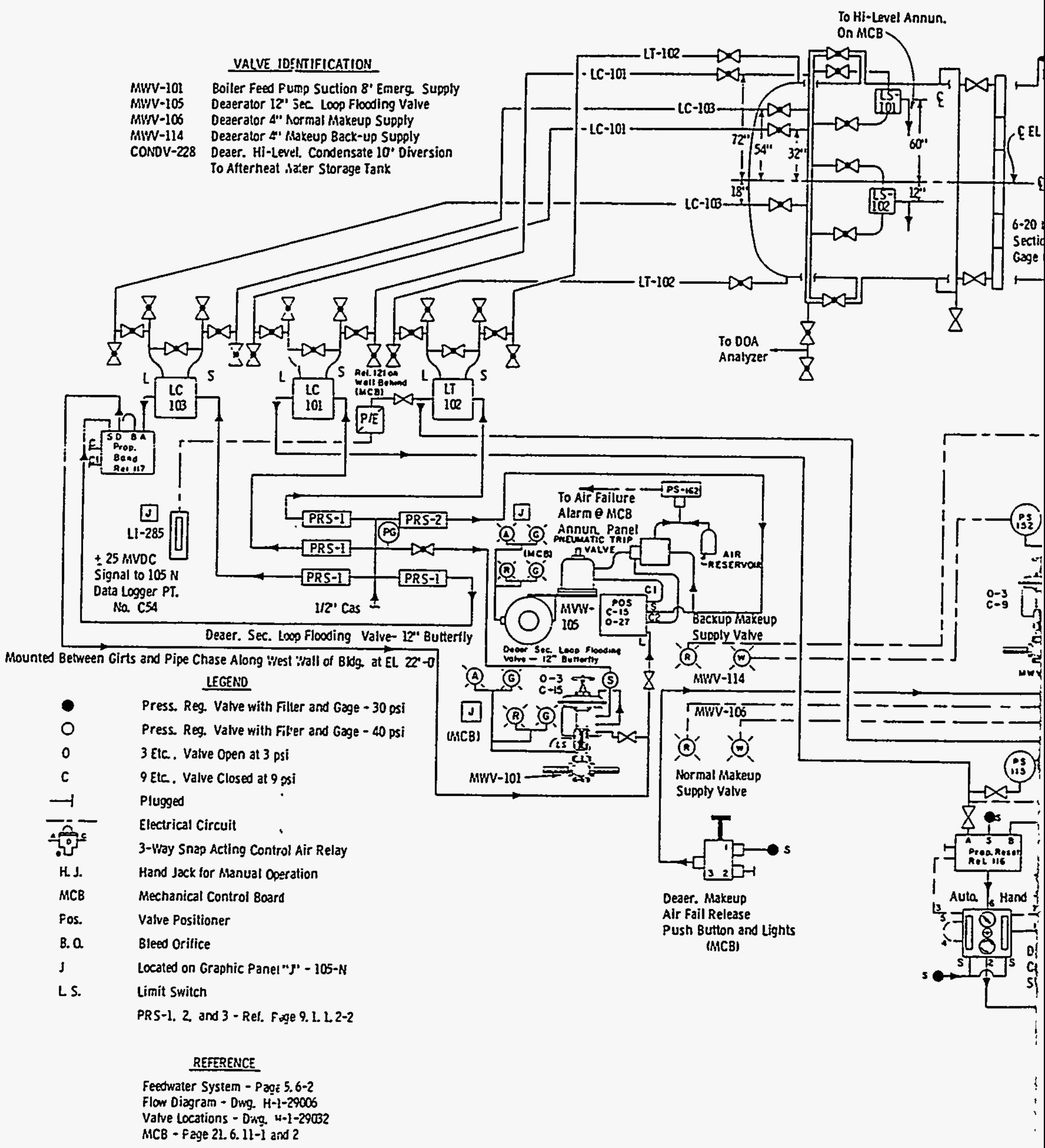
Hydrogen Supply

The hydrogen is obtained from the hydrogen system HY-2 which supplies 109-N Building. A two-stage pressure regulator mounted at the rear of the panel reduces the hydrogen pressure to 25 psig. At 25 psig on the gage the flow rate will be 6 cu. in./min. to the inlet of the flow control capillary. The capillary provides for a constant flow of hydrogen to the Analyzer block.

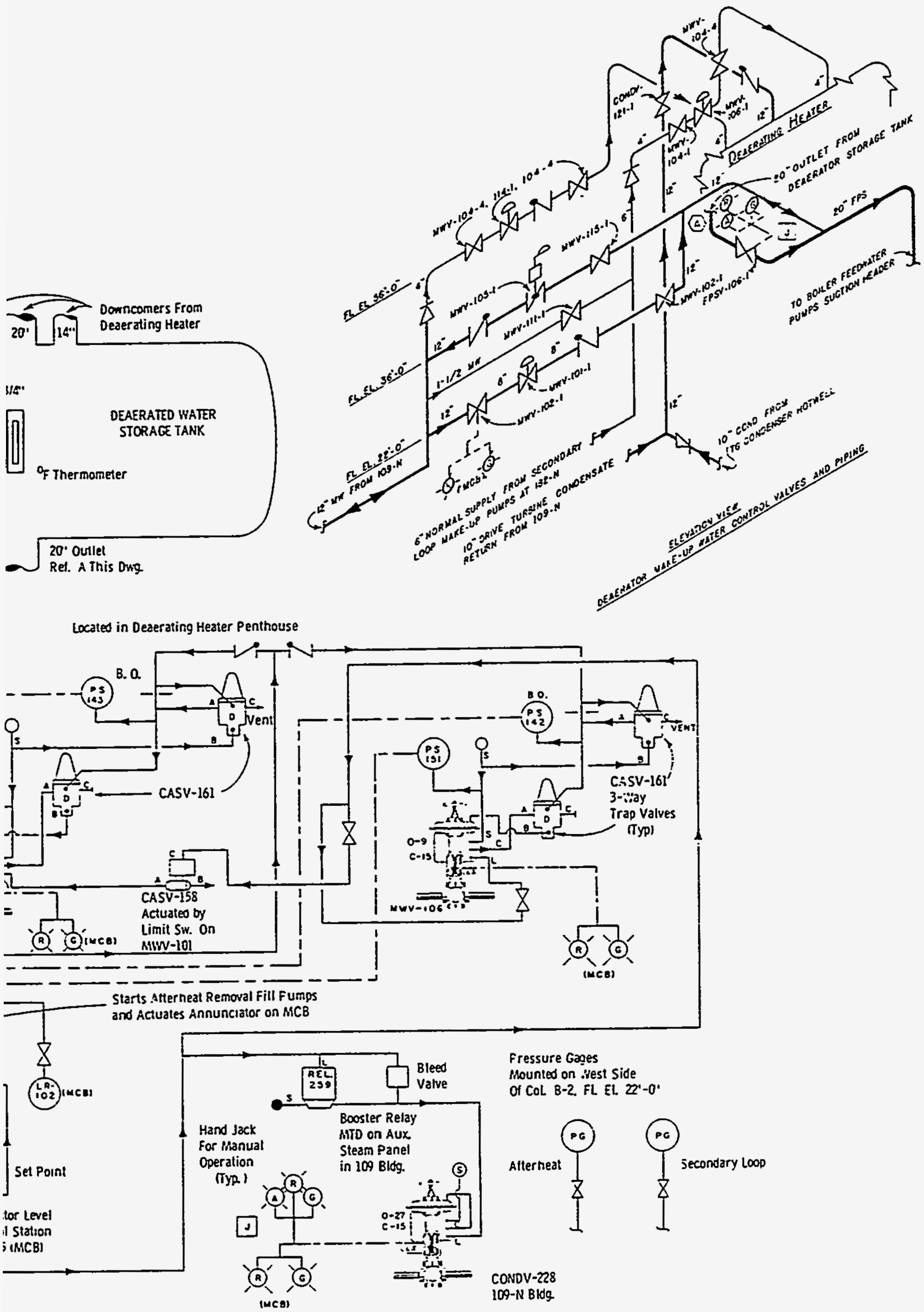
Filament Assembly

The filament assembly contained in the analyzing cell consists of two identical noble-metal catalyst filaments mounted on a common base. The filaments are surrounded by a shield and are separated from each other by a metallic wall. One filament chamber is covered at one end only by a screen so that the filament is completely exposed to the gas mixture entering the analyzing cell. This filament is the measuring filament. The other filament chamber is closed on all sides except for an access hole, which has only a small percentage of the area of the screened section of the measuring filament chamber. The access hole allows a small amount of the gas mixture to enter the chamber. This filament is the compensating filament.

The gas mixture enters the analyzing cell and passes through the screen into the measuring filament chamber. A relatively small amount of the mixture enters the compensating filament chamber through the access hole. In each chamber, the initial temperature of the filament causes combustion of the mixture. The temperature rise and the resulting increase in resistance of the measuring filament are proportional to the amount of oxygen present in the measured gas. The small amount of gas mixture surrounding the compensating filament is identical in composition to the mixture surrounding the measuring filament. There, physical properties of the gas mixture, such as thermal conductivity, specific heat, etc., have the same effect on both filaments and any such effect is balanced out, since the two filaments are located on the same side of the bridge circuit but in the opposite legs. After combustion of the mixture has taken place, the gases are exhausted from the analyzing cell through a stainless steel tube.



Deaerator Storage Tank Level
Flooding Control Sy



nd 109-N Secondary Loop
tems - 184-N

DEAERATOR STORAGE TANK LEVEL & 109-N SECONDARY LOOP FLOODING CONTROL SYSTEMS - 184-N

These control systems are designed to maintain set point level in the deaerator storage tank by controlling the flow of normal and emergency make-up water, and/or make-up water directly into the boiler feedwater pumps suction header in the event of low level in the deaerated storage tank or deaerator outage. The major portion of water supplied to the deaerator is condensate from the turbine-generator set and the 109 Building primary pump drive turbine surface condenser hotwells. A system is also provided to use the deaerator storage tank as an emergency make-up supply to supplement the 109 Building secondary coolant surge tank and standpipes storage capacity, used for the flooding of the dump condenser tube bundles during drastic reductions in reactor power levels.

Deaerator Normal Level Make-Up System - The normal make-up water to the deaerator is supplied from the afterheat water storage tank by two 100% capacity secondary loop make-up pumps, located in Building 182-N. This system also supplies make-up water to the steam jet air ejector inter-condenser loop seal, fill for the TG set surface condenser hotwell, pre-lubrication for the hotwell condensate pump seals, and make-up for the chemical mixing station.

The discharge from these pumps supplies water through the deaerator normal level control valve MWV-106-1. The position of this valve is maintained automatically by a control system which is a single element with primary loading from the deaerator storage tank. Pneumatic signals from level transmitter LC-101 are transmitted to Relay 116. The output signal from this relay is transmitted to the selector station SV-105 at the MCB. Signals from the selector station are transmitted to a positioner mounted on valve MWV-106-1. The positioner supplies or bleeds off control air from the diaphragm of the valve for signalled positioning. The storage tank level is maintained within plus or minus 6-inches of control point level, preset by set point adjuster of SV-105. Independent control air supply pressure regulators are provided at each transmitting element. Valve position indicating lamps at the MCB are energized through valve mounted limit switches. Pneumatic control air range for valve operation is 9 to 15 psig. Valve operation - spring opening (air to close action).

Valve MWV-106-1 operation is as follows:

1. On decreasing deaerated water storage tank level, the valve opens to establish setpoint level.

2. On increasing level above setpoint the reverse action takes place and the deaerator condensate supply diversion valve CONDV-228 in the 109 Building opens in sequence. This operation returns excess condensate to the afterheat water storage tank at Building 182-N.

3. Should the level in the deaerated water storage tank fall below the range of valve MWV-106-1, deaerator normal make-up back-up control valve MWV-114-1 opens.

Deaerator Normal Make-Up Back-Up System - The back-up water to the deaerator is supplied from the afterheat water storage tank by three (normally not running) afterheat removal make-up pumps located in building 182-N. These three pumps are automatically started from pressure switch PS-115, located in the common loading air

DEAERATOR STORAGE TANK LEVEL & 109-N SECONDARY LOOP FLOODING CONTROL SYSTEMS - 184-N

Deaerator Normal Make-Up Back-Up System (Cont'd)

signal from LC-101 to control valve MWV-106-1, when this signal falls into the control range of valve MWV-114-1. Once started, these pumps continue to run until shut off manually from Control Console "BN" located in the 105 Control Room.

The discharge from these pumps supplies emergency make-up sequence with the normal make-up valve MWV-106-1 from a split band control signal from the normal level controller LC-101. Control valve MWV-114-1 will start to open when the normal make-up valve MWV-106-1 cannot maintain normal operating level. An independent control air supply station is provided at the positioner for valve MWV-114-1. Pneumatic control air range for valve operation is 3 to 9 psig. Valve operation - spring opening (air to close action). Valve position indicating lamps at the 184-N MCB are energized by valve mounted limit switches.

Deaerator Emergency Low Level Supply - Should the level in deaerated water storage tank fall below the range of the normal make-up and the normal make-up back-up control the deaerator low level transmitter LC-103 transmits a pneumatic loading signal to relay 117. This relay sends a pneumatic signal to a positioner mounted on valve MWV-101-1. An independent control air supply pressure regulator is provided for the positioner. The positioner supplies or bleeds off control air from the diaphragm of valve MWV-101-1 for signaled positioning. The opening of this valve supplies water directly into the pump suction header for the boiler feedwater pumps.

Valve position indicating lamps at the 184-N MCB and at the 109-N Graphic Panel "J" located in the 105 control room are energized by valve mounted limit switches. Pneumatic control air range for valve operation is 3 to 15 psig. Valve operation - spring opening (air to close action).

Deaerator Bypass System - An emergency supply to the boiler feed pump suction is provided to permit boiler operation without the deaerating heater. During this type of planned emergency operation, all condensate returns to the deaerator must be diverted to the afterheat water storage tank through the 109 Building condensate diversion valve CONDV-228. The deaerated water storage tank outlet valve FPSV-106-1 must be closed and the required afterheat removal pumps started. Water will be supplied directly into the boiler feedwater pumps suction header through control valve MWV-101-1.

109-N Secondary Loop Flooding System - Water from the deaerator storage tank may also be used as an emergency make-up supply to supplement the secondary coolant surge tank and standpipe storage capacity used for the flooding of the dump condenser tube bundles in the event of drastic reductions in reactor power levels. A reduction of the 109-N dump condenser condensate pumps suction header pressure is an indication of insufficient water for the flooding of dump condenser tubes and in the event that this drastic reduction in pressure does take place. Water from the deaerator storage tank can be supplied to the condensate pumps suction header through control valve MWV-105-1 located at the condensate outlet connection of the deaerator storage tank

DEAERATOR STORAGE TANK LEVEL & 109-N SECONDARY LOOP FLOODING CONTROL SYSTEMS - 184-N

109-N Secondary Loop Flooding System (Cont'd)

and through the 109-N secondary loop low level make-up stations.

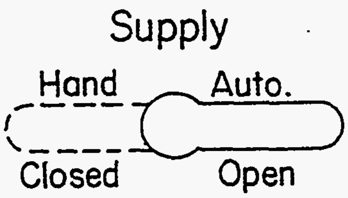
Control valve MWV-105-1 is normally in the open position. Reverse flow takes place whenever the pressure in the 12" MW line and the 109-N condensate pumps suction header drops below that pressure required to keep the check valve, located downstream of valve MWV-105-1 closed.

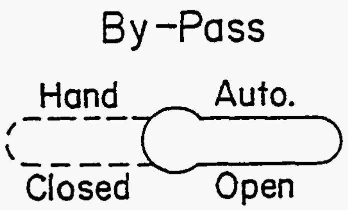
Control valve MWV-105-1 is controlled from the deaerator low level transmitter LC-103. This transmitter sends loading signal to a positioner mounted on the valve. When the water in the deaerator water storage tank reaches an abnormally low level, control valve MWV-105-1 will automatically close to prevent flashing at the suction side of the boiler feedwater pumps.

Valve position indicating lamps at the 184-N MCB and at the 109-N Graphic Panel "J" located in the 105 Control Room are energized by valve mounted limit switches. An independent control air supply pressure regulator is provided for the valve positioner. Pneumatic control air range for valve operation is 15 to 27 psig. This valve is piston operated.

Selector Valve - The set point selector station SV-105 is a small, compact, self-contained selector station providing all indications and controls necessary for hand operation of a pneumatic control system, and for transferring from hand to automatic control operation or vice versa, quickly and easily without bumping the control system. This station is an integral unit with a hand-automatic transfer switch, a hand loader, a set point switch, and two indicating gages, each having two pointers one black, the other red. The gage scale legend, scale ranges and indications are listed on data sheet on Page 21.6.14.1-

Valve Positioner Supply and Bypass Valves - Valve positioners equipped with "Supply" and "Bypass" valves (cabinet mounted) provide local and/or remote manual operation of the controlled valve in the event positioner outage is required. This feature applies to direct loading transmitters, common in the 184-N Building, with control air supplied either to the top or bottom of the valve diaphragm operators.





Valve Operators Without Handjacks

1. To change from automatic to manual operation:
   a. Release locking mechanism
   b. Turn the bypass valve to "Open-Hand"
   c. Turn the supply valve to "Hand-Closed"

   The control valve may be positioned either by the loading pressure from the control system or, preferably, by manual operation of the Selector Station.

DEAERATOR STORAGE TANK LEVEL & 109-N SECONDARY LOOP FLOODING CONTROL SYSTEMS - 184-N

Valve Positioner Supply and Bypass Valves (Cont'd)

2. To Change From Manual to Automatic Operation
   a. Turn the Supply valve to "Auto-Open".
   b. Turn the Bypass valve to "Closed-Auto"
   c. Be sure locking mechanism is latched

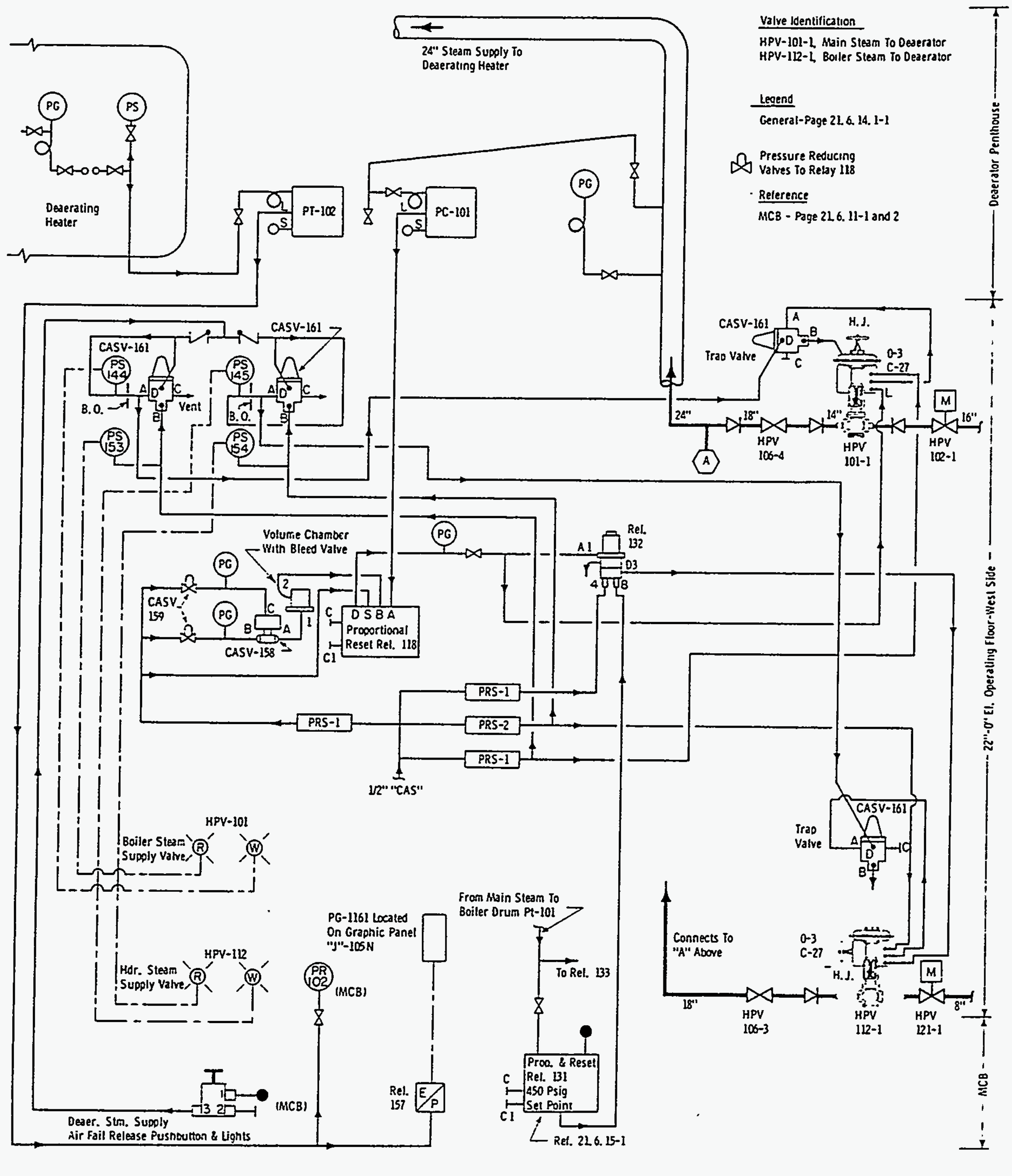
Valve Operators with Handjacks

1. To Operate Valve Manually by Means of its Handjack
   a. Pick up the Control valve position with the handjack.
   b. Turn the Supply valve to "Hand-Closed".
   c. Leave the Bypass valve in "Closed-Auto" position.

2. To Return Valve to Automatic Operation
   a. Turn the Supply valve to "Auto-Open".
   b. Release handjack from Control valve.
   c. Be sure locking mechanism is latched.

3-Way Air Trap Valves and Air Failure Release Push Button - Air trap valves, designated CASV-161, maintain the operating position of a control valve upon loss of control air supply to a valve positioner. Let's assume that control air supply from station "O" (40 psi) to valve MWV-106-1 positioner is interrupted. Pressure switch PS-151 de-energizes white indicating lamp at the MCB air fail release push-button station, and pressure switch PS-143 energizes the red indicating lamp. Snap action of the trap valves upon loss of control air supply to ports "D", repositions a pilot valve, blocking air flow "A" to "B" of the lower trap valve, and "B" to "A" of the upper trap valve. Port "C" of the lower trap valve is plugged, therefore, the control air is trapped to the diaphragm operator and control valve position is maintained. Port "B" chamber is vented through port "C" of the upper trap valves.

When control air supply station "O" (40 psi) is restored, pressure switch PS-151 energizes white indicating lamp. At this time, both the red and the white indicating lamps are illuminated. Depression of the air fail release push button supplies control air supply from the "O" (30 psi) station through the check valve to Port "D" of the vented trap valve, and through bleed orifice to port "D" of the lower trap valve. This repositions the pilot of the upper trap valve, allowing control air supply from the "O" (40 psi) station to flow through ports "B" to "A", closing the check valve and to port "D" of both trap valves. The red light goes out and control air from the valve positioner flows through ports "A" to "B" to the control valve diaphragm operator.



Deaerating Heater Pressure Control System - 184-N

DEAERATING HEATER PRESSURE CONTROL SYSTEM - 184-N

The deaerating heater is designed to deaerate 1,550,000 lb/hr of condensate to an oxygen content of 0.005 cc/liter, and heating the condensates to 250°F when supplied with steam at 30 PSIA (15 psig). Ref. Page 5.2.2 and 5.6.1. Normal steam supply will be from the 109-N steam generators through the deaerator 14-inch main steam supply PRV station HPV-101-1. PRV station HPV-101-1 is alternately supplied by boiler generated steam through the No. 2 main steam PRV station HPV-108-1. Auxiliary steam is supplied from the boiler directly through the deaerator 8-inch auxiliary steam supply PRV station HPV-112-1. The upstream block valves for control valves HPV-101-1 and HPV-112-1, designed HPV-102-1 and HPV-121-1 are motor operated, controlled remotely from the Mechanical Control Board (MCB) and equipped with limit switches to indicate valve positions locally, at the MCB and at Graphic Panel "J" in the 105-N Control Room.

Deaerator pressure is normally controlled automatically by pressure transmitter PC-101, set to maintain pressure at 15 psig. The control range is 0 to 70 psig. A proportional band and reset relay, designated Relay 118, and located near valve HPV 101-1, provides adjustable proportional and reset actions. Pressure within the deaerating heater is sensed by pressure transmitter PT-102, and transmitted pneumatically to a pressure recorder on the MCB, and to a pressure indicator PG-1161 at Graphic Panle "J" in the 105-N Control Room through Relay 157, which is a pneumatic/electric transducer.

Steam pressure in the 24-inch supply line to the deaerator is sensed by PC-101 which transmitts a pneumatic loading signal to Relay 118. This relay transmitts the deaerator pressure control loading signal to the valve positioner on valve HPV-101-1 and to Relay 132, which relays the pressure control loading signal to valve HPV-112-1.

Both valve positioners receive the same control loading signal, normally only HPV-101-1 will supply steam to the deaerator. Valve HPV-112-1 serves as an alternate steam supply should HPV-101-1 require service, or if reactor steam is not available. The position of the motorized block valves upstream of the control valves and operated from the MCB will determine which valve will supply steam to the deaerator. Provisions are made to permit automatic set point switching from the normal deaerator operating pressure of 15 psig to any pressure within the control range on a scram signal.

In addition, control of valve HPV-112-1 includes pressure limiting features to override normal deaerator pressure control should main steam from the boiler drop below 430 psig. This action is accomplished by Relay 131 which receives the boiler steam pressure loading signal from PT-101 and relays this signal to Relay 132. From Relay 132, this signal is transmitted to the positioner at valve HPV-112-1.

Two trap valves, designated CASV-161, are provided at each control valve to maintain operating position upon loss of valve positioner control air supply. The operation of the trap valves, pressure switches, MCB indicating lights and air

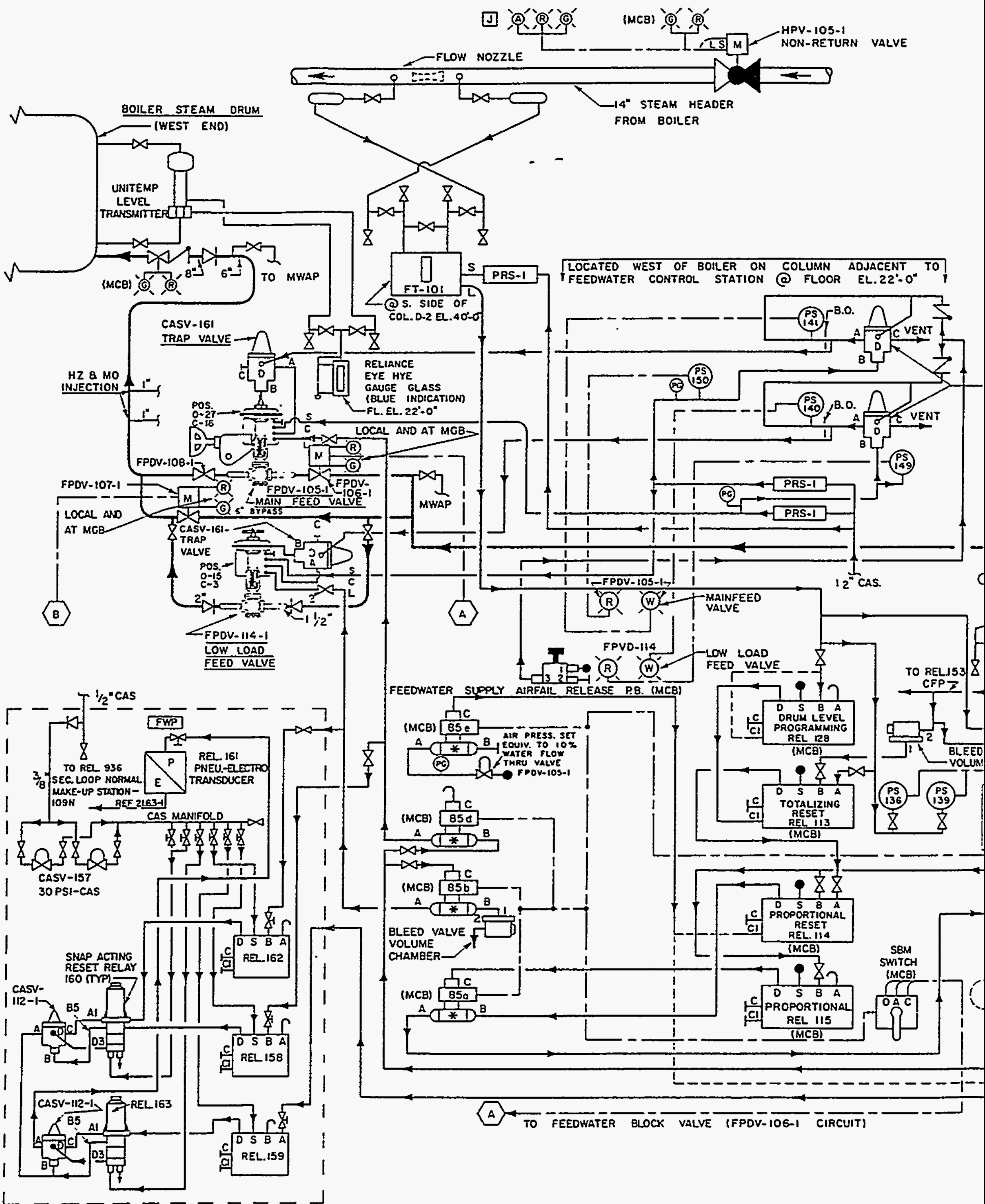
DEAERATING HEATER PRESSURE CONTROL SYSTEM - 184-N (CONT'D)

failure release push button are described on Page 21.6.14.1-4.

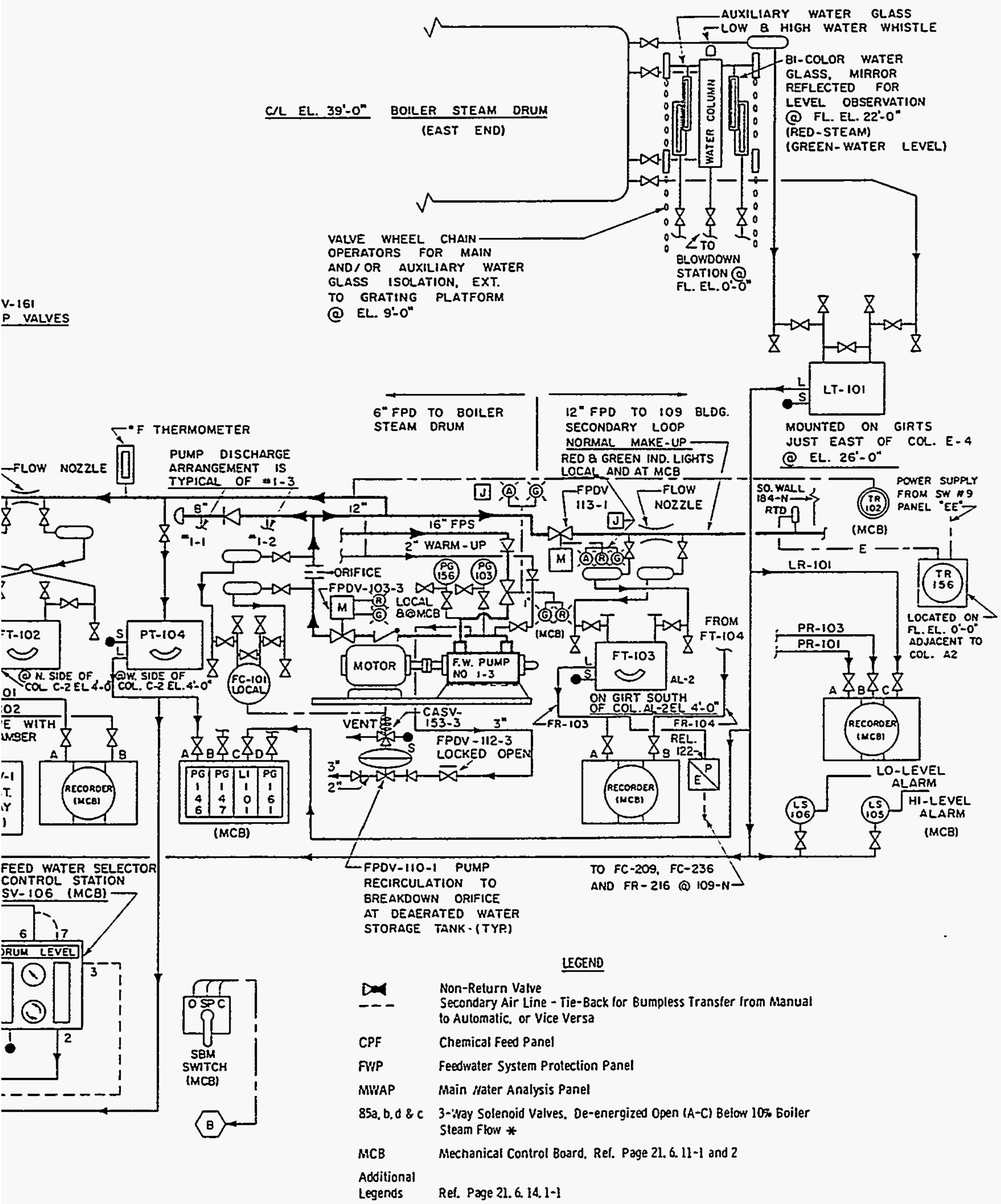
Pressure switch PS-101, located at the deaerator actuates an annunciator on the MCB whenever a low pressure condition exists. Pressure gages PG-102 also located on the deaerator, and PG-164 located on the sensing line to PC-101 are provided for local observation within the deaerator penthouse.

Micro limit switches mounted on valves HPV-101-1 and HPV-112-1, and geared limit switches at downstream block valves HPV-106-4 and HPV-106-3 are provided to indicate valves position at a remote location not designated at this time.

Deaerator overpressure protection is provided for by three safety relief valves located on the vessel and set at 100 psig each. In addition, three safety relief valves designated LPV-112-1, 2 and 3; located on the 24-inch steam header prior to deaerator entry are set at 90, 95 and 100 psig respectively.



Boiler Drum Level Control, Level
Auxiliary Control S



dicating and Feedwater Supply
tems - 184-N

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BOILER DRUM LEVEL CONTROL, LEVEL INDICATING AND FEEDWATER SUPPLY AUXILIARY CONTROL SYSTEMS - 184-N

General

The feedwater control system is of the three element type, operating on method flow of steam, feedwater and measured level of the boiler steam drum. Automatic compensation for boiler blowdown is provided in the form of preselected steam to water flow ratio adjustment so that any water loss from the boiler, not accounted for by the steam flow meter, will not produce offset. A panel mounted manual-automatic feedwater selector station SV-106 is located on the Mechanical Control Board (MCB). The feedwater system is also provided with (2) protective over-riding control signals to prevent run out of the feedwater pumps and/or insufficient feedwater supply to the boiler drum.

Feedwater from the deaerator storage tank is supplied to three boiler feedwater pumps from where it is discharged to the boiler steam drum and to the 109-N dump condenser condensate pump discharge headers. Normally two (2) boiler feed pumps (each of 100% capacity) are in operation, motors energized from separate power sources with the third pump, No. 3 which can be energized from either power source, in standby condition.

The feedwater pump motors are started from independent 4-position (Pull-Lockout, Stop, Standby and On) SB-1 switches, located on the MCB. When a switch is positioned to "ON", the auxiliary lube oil pump starts, and when oil pressure is up to normal, pressure switch PS-A at the pump oil reservoir closes electrical contact to start the pump motor. When the pump motor is up to speed, oil pressure from the main gear driven pump opens a contact on pressure switch PS-B which stops the auxiliary lube oil pump. Pressure switch PS-C actuates a low lube oil pressure alarm at the feedwater pumps local annunciator panel and a feedwater pump trouble alarm at the MCB annunciator panel. The oil pressure at which pressure switch PS-A closes electrical contact in closing circuit to start a feedwater pump motor can be checked by depressing a local "Test" pushbutton which starts the auxiliary lube oil pump motor.

The feedwater pumps motor-operated discharge valves FPDV-103-1, 2 and 3 open and close automatically with associated pump start and stop operation. These valves can also be operated locally from an independent pushbutton station at each pump. The main control switch for valve FPDV-113-1 (feedwater supply to 109-N) is located on Graphic Panel "J" in the 105-N Control Room. Local operation is provided for from a pushbutton station located on the north side of Col. B-2 at floor elevation 0'-0" in the 184-N Building.

A low pressure switch PS-114 sensing the feedwater system pressure at a point downstream of the discharge valve of feedwater pump No. 1-1, is actuated whenever the system pressure decreases to 550 psig ± 10 psi. The operation of this switch will automatically start the auxiliary lube oil pump for the feedwater pump motor having its control switch positioned to "STANDBY" at the MCB, and sequentially start the feedwater pump motor when the lube oil header pressure is built up to normal as monitored by pressure switch PS-A. In addition, the automatic starting of a boiler feedwater pump motor having its control switch positioned to "STANDBY" is also initiated from a reactor scram signal by closure of contacts for relay CRA or CRB located in the scram relay panel on the wall at the rear of the MCB.

BOILER DRUM LEVEL CONTROL, LEVEL INDICATING AND FEEDWATER SUPPLY AUXILIARY CONTROL SYSTEMS - 184-N (CONT'D)

Boiler Drum Level Control System

The feedwater supply header to the boiler is equipped with two different sized control valves. A 1 1/2-inch size control valve designated FPDV-114, is in make-up control when the boiler is in the low load or "banked" condition (steam output at 65,000 lbs/hr. or under). Feedwater flow through this control valve is operated only as a function of boiler drum level. During low steam flow conditions, the loading signal from LT-101 is transmitted to Relay-115, through solenoid valve 85a, feedwater selector station SV-106, and through solenoid valve 85b to the positioner at the low flow feedwater control valve. This valve has a maximum capacity of 65,000 lbs/hr., and at operating steam flows of approximately 10% of capacity, the boiler drum level will be maintained 2 inches below the steam drum centerline.

The second feedwater control valve, sized 6 inches and designated FPDV-105 is provided with a motor-operated block valve, which automatically opens from the same signal that actuates the control valve on increasing steam load (occurs only when the main feedwater control block valve SB switch at the MCB is positioned to "AUTOMATIC").

The feedwater flow through control valve FPDV-105 is dependent upon boiler steam flow, feedwater flow to the boiler steam drum and steam drum water level. The loading signal from the steam flow transmitter FT-101 is transmitted to a totalizing relay designated REL-113 which also receives a loading signal from feedwater flow transmitter FT-102. Relay-113 transmits a modified loading signal to Relay-114 which also receives a loading signal from the boiler drum level transmitter LT-101. At the same time upon increasing steam flows, pressure switches PS-136 and PS-139 switches feedwater flow control from FPDV-114 to FPDV-105 by actuation of solenoid valve 85a position from A-C to B-A, venting solenoid valve 85b A-B and and positioning solenoid valve 85d from A-C to B-A. In addition, pressure switches PS-136 and PS-139 actuate an electric relay, designated FWBV-1 which in turn energizes the circuit to open the main feedwater control block valve FPDV-106-1 and at the same time repositions solenoid valve designated 85e to A-C, setting air pressure equivalent to 10% water flow through valve FPDV-105. This operation permits the loading signal from the feedwater selector station SV-106 to be relayed to the positioner at control valve FPDV-105. On decreasing steam load, control switch-over and block valve closure occurs simultaneously. The automatic starting of a feedwater pump is indicated by the actuation of a "Feedwater Pump Automatic Start" alarm at the MCB annunciator panel.

The main feedwater control block valve motor operator and the feedwater control station bypass valves designated FPDV-106-1 and FPDV-107-1 are both energized from the 480 volt emergency power panel "E". The operation of the bypass valve FPDV-107-1 is controlled with a SBM switch from the MCB. Valve positioner supply and bypass valves, and 3-way air trap valves with air failure release pushbuttons at the MCB are provided. The function of these features are described on Pages 21.6.14.1-4 and 5 respectively.

Boiler Feedwater Pumps Low Flow Recirculation Control

Recirculation control consists of one (1) square root extracting differential

BOILER DRUM LEVEL CONTROL, LEVEL INDICATING AND FEEDWATER SUPPLY AUXILIARY CONTROL SYSTEMS - 184-N (CONT'D)

pressure meter of the mercury filled type, one for each of the boiler feedwater pumps. These controllers are designated FC-101, 102 and 103. Each feedwater pump discharge header is equipped with an orifice plate to measure flow and a recirculation valvw associated with the control. The recirculation valves are designated FPDV-110-1, 2 and 3.

Each meter is designed for 250°F, 900 psig feedwater with a differential head of 212 inches of water at maximum flow of 2200 gpm. Each control is provided with a local self-contained flow indicator and three individually adjustable contacts. These contacts, 125 volt d.c. operation initiate the following action:

Contact No.	Contact Position	Pump Flow GPM - LBS/HR	Operating Action	Control Range
1	Closes	240 - 113,000	Low Flow Alarm	± 1700 #/hr
2	Opens	250 - 118,000	FPDV-110 Opens	± 1800 #/hr
3	Opens	275 - 127,500	FPDV-110 Closes	± 2000 #/hr

Electric power for the solenoid valve at each recirculation control valve and circuitry from the flow controllers FC-101, 102 and 103 is supplied from the 125 volt d.c. Power Panel "B2".

Feedwater System Protection

The feedwater system is provided with two (2) protective over-riding control signals to prevent run out of the feedwater pumps and/or insufficient feedwater supply to the boiler steam drum.

For feedwater pump protection, a predetermined minimum safe pump differential pressure is established to prevent cavitation of the pumps. Since the pump suction pressure remains at a relative constant value, the pump discharge pressure is used to determine the pump safe differential pressure. This pressure signal originates from PT-104 and is used to over-ride the control signal to the 109-N secondary loop normal makeup valves (CONDV-243) by throttling the valves (to the full close position if necessary).

To prevent insufficient feedwater supply to the boiler steam drum, the control signals to both feedwater valves (FPDV-105 or FPDV-114) is used to over-ride the signal to the 109-N secondary loop normal makeup valves when either of the boiler feedwater valve control signal approaches the maximum feedwater rate requirements (feed valve almost full open).

Relays, as shown on the drawing, are provided to select the lower of either signal to over-ride the control signal to the 109-N makeup valves. The final signal to the 109-N valves is transmitted electrically through Relay 161 to Relay 936 at the 109-N control station.

BOILER DRUM LEVEL CONTROL, LEVEL INDICATING AND FEEDWATER SUPPLY AUXILIARY CONTROL SYSTEMS - 184-N (CONT'D)

Auxiliary Control Panels

Local mounted panel boxes with disconnect switches are located on the east side of each pump assembly:

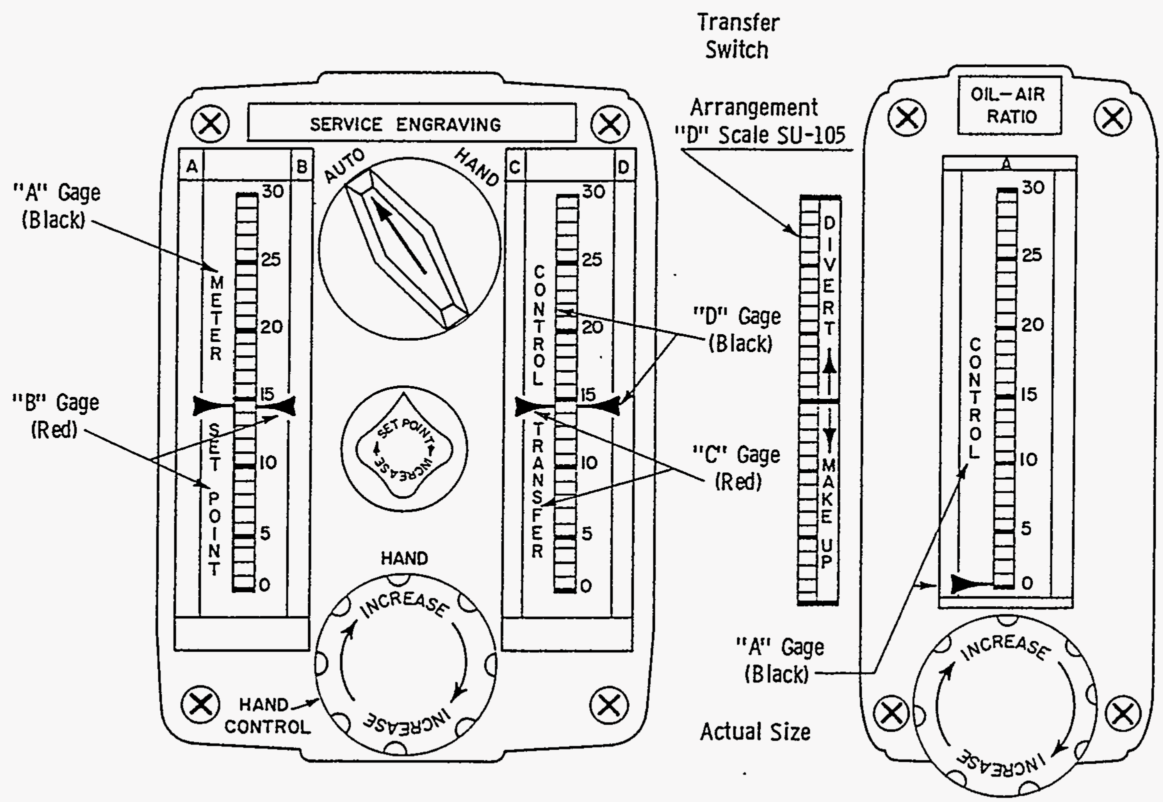
1. For feedwater pump discharge valves FPDV-1, 2 and 3 motor operators. The motor operator for No. 1 pump discharge valve is energized from the 480 volt Power Panel "D" and motor operators for No. 2 and No. 3 pump discharge valves are energized from the 480 volt Emergency Power Panel "E".

2. For each motor 1000 watt space heater. The switch must be opened when a motor is in operation, and closed when a motor is shut down and/or in standby status. The heater for No. 1 motor space heater is energized from the 480 volt Power Panel "D" and heaters for No. 2 and No. 3 motors are energized from the 480 volt Emergency Power Panel "E".

3. For auxiliary lube oil pump motors. Each panel is also equipped with a "Reset" pushbutton. The panel for #1 auxiliary lube oil pump motor is energized from the 480 volt Power Panel "D" and for #2 and 3 oil pump motors from the 480 volt Emergency Power Panel "E".

4. Feedwater pumps and motors bearing temperature Edison Omniguard type monitoring panel located along west wall by #3 feedwater pump. This panel is energized from the 120 volt a.c. Power Panel "EE".

5. Feedwater pumps local annunciator panel also located along west wall by the #3 feedwater pump. This panel is energized from the 125 volt d.c. Power Panel "B2". Annunciator details are shown on Page 21.6.17.



1. Typical for SV-103, SV-105 and SV-108.
2. Set Point Adjuster and "B" Gage are Omitted for SV-102, SV-104, and SV-106 and "A" Gage Legend is "Control".

Typical for SV-101. Oil-Air Ratio and SV-107. Oil-AIR Bias

Scale Legends and Gage Indications - Control Selector Valves - 184-N

CONTROL SELECTOR STATIONS DATA SHEET - 184-N

No. and Type	Operating Function	Left Gage Assembly "A" Gage (B.P.)	Left Gage Assembly "B" Gage (R.P.)	Right Gage Assembly (Transfer) "C" Gage (R.P.) Automatic	Right Gage Assembly (Transfer) "C" Gage (R.P.) Hand	Right Gage Assembly (Control) "D" Gage (B.P.) Automatic	Right Gage Assembly (Control) "D" Gage (B.P.) Hand	Scale Ranges And Control Signal Range	Scale Ranges And Control Signal PSI
SV-101 Basic AS-2100	Oil-Air Ratio	(Control)	--	--	--	--	--	0-30	3-27
SV-102 Basic AM-2100	Combustion Air Flow	(Loading) Control Signal From Relay	--	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27
SV-103 Setpoint AM-1100	Steam Pressure Master	(Meter) Signal From Pneu. Transmitter	(Setpoint) Signal	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27
SV-104 Basic AM-2100	Fuel Oil Flow	(Loading) Control Signal From Relay	--	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27
SV-105 Setpoint AM-1100	Deaerator Level	(Meter) Signal From Pneu. Transmitter	(Setpoint) Signal	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27
SV-106 Basic AM-2100	Boiler Drum Level	(Loading) Control Signal From Relay	--	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27
SV-107 Basic AS-2100	Oil-Air Bias	(Control)	--	--	--	--	--	0-30	3-27
SV-108 Setpoint AM-1100	Turbine Header Pressure	(Meter) Signal From Pneu. Transmitter	(Setpoint) Signal	Hand Loader Pressure	Automatic Loading Pressure	Automatic Control Signal	Hand Loader Control Signal	0-30	3-27

<u>Legend</u> - Words in ( ) are scale legends; B. P. designates black pointer, R. P. - red pointer.

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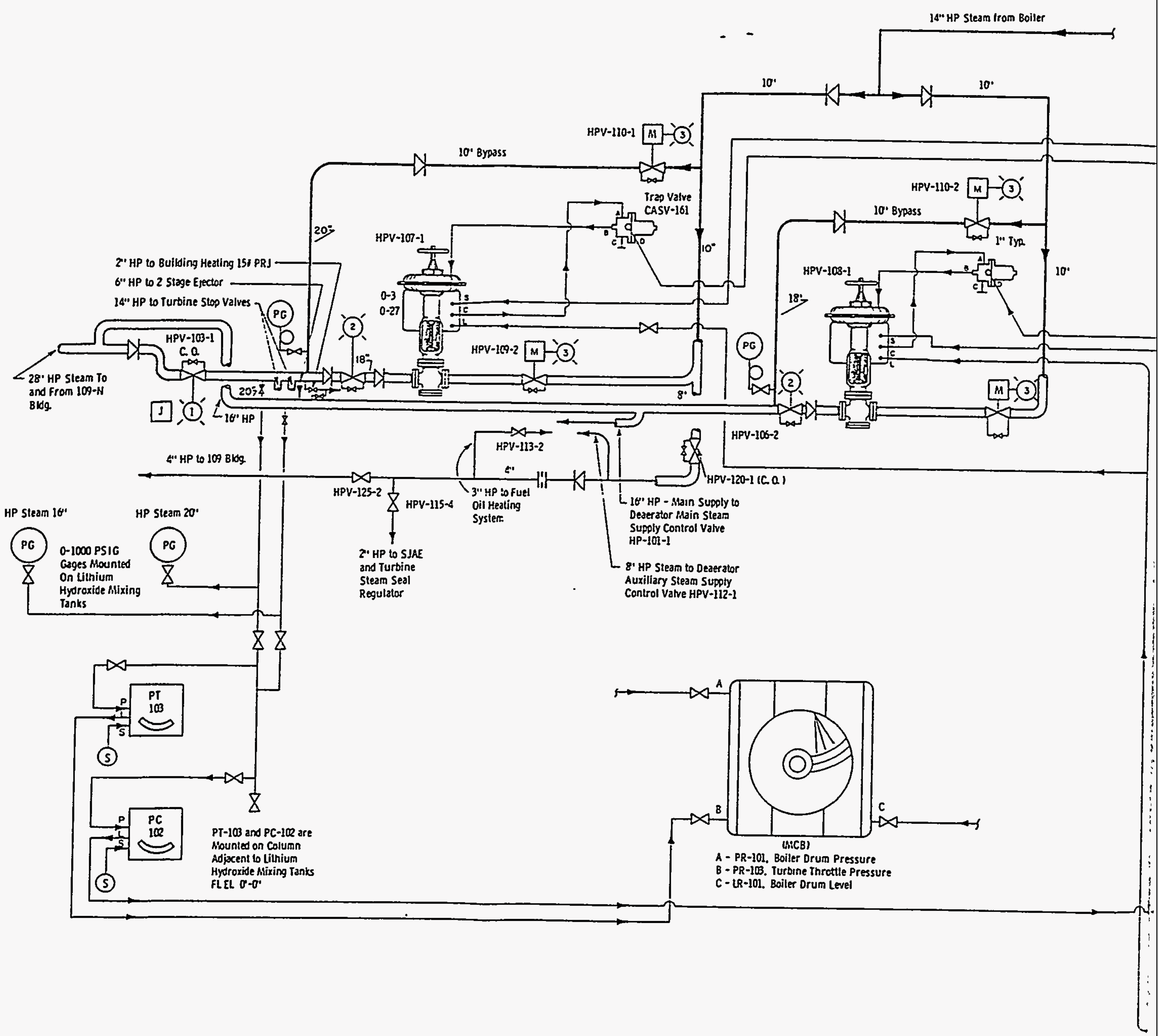
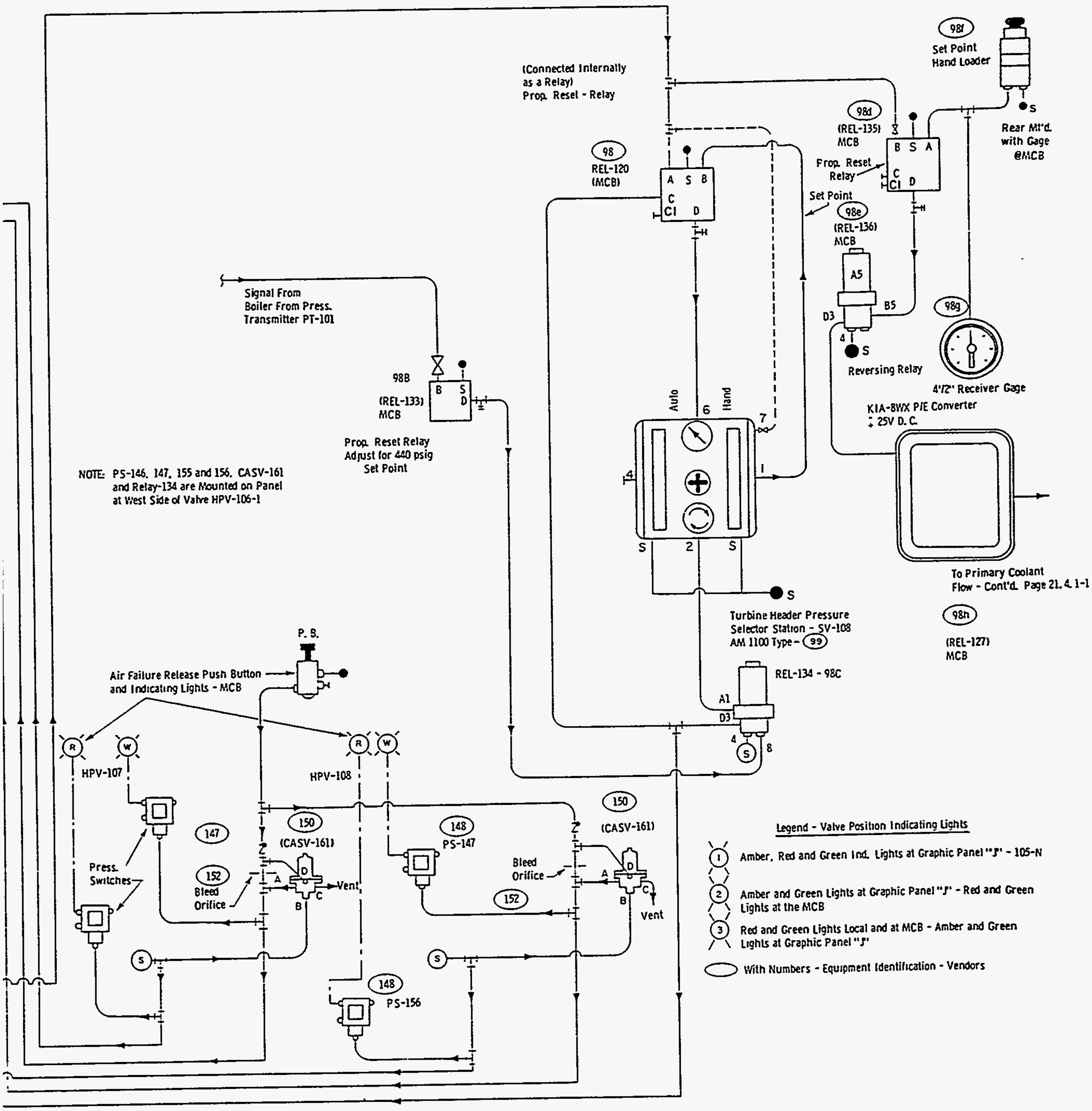


Main Steam Pressure Co



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MAIN STEAM PRESSURE CONTROL SYSTEM - 184-N

General - The normal supply to the main steam system is from the 109-N main steam generators. During this operating mode (reactor critical) the main steam system pressure is automatically maintained at 55 psig at the turbine generator 20-inch steam header by the secondary coolant pressure control system in the 109-N Building. Ref. - Page 21.6.1-1 through 4. This control system maintains the desired main steam pressure by adjusting the rate which steam is delivered from the 109-N steam generators to the 109-N dump condensers.

The main steam system supplies the 184-N deaerator, the turbine generator and hogging ejector, the 184-N low pressure heating steam system, as well as the 109-N drive turbines and hogging ejectors, the secondary coolant system surge tank and the area heating steam main pressure control station (valves HPV-227-1 and 2) also located in the 109-N Building. The main steam system has been designed for future operating pressures ranging up to 600 psig.

Main Steam Pressure Reducing Controller - 184-N - The main steam pressure control system located in the 184-N Building is comprised of two (2) pressure reducing valves (HPV-107-1 and HPV-108-1), parallel operated with the combined capability of reducing the steam pressure from the boiler drum pressure (450 psig) to the operating pressure of the main steam system at a rate equal to or greater than the maximum expected boiler generation rate. Two motor-operated guard valves (HPV-109-1 and 2), one located upstream of each pressure reducing valve and normally in the closed position; prevent steam flow from the boiler drum through the pressure reducing valves into the main steam system during reactor normal operation.

The main steam pressure controller (PC-102), impulsed normally from the 20-inch turbine generator steam header (or alternately from the 16-inch steam header), and set at a higher pressure than the expected normal main steam pressure, controls the position of the two pressure reducing valves (HPV-107-1 and HPV-108-1) in parallel. The pressure reducing valves will, therefore, remain in the opened position without passing steam because of the closed position of the motor-operated block valves (HPV-109-1 and 2).

Pressure controller PC-102 is a single element type with proportional band and reset action. Remote setpoint adjustment and selection for manual-automatic operation are provided from a selector station SV-108 mounted on the Mechanical Control Board.

Two trap valves, designated CASV-161, are provided at each pressure reducing valve to maintain operating position upon loss of valve positioner control air supply. The operation of the trap valves, pressure switches, MCB indicating lights and air failure release pushbutton are described on Page 21.6.14.1-5.

Auxiliary Burner Operation and Main Burner Light-Off - The auxiliary burner which is normally in operation when main steam is supplied from the 109-N steam generators, maintains boiler drum pressure at 450 psig as required by steam demands from the auxiliary high pressure (450 psig) steam system which also supplies the intermediate pressure (150 psig) steam system. This burner, operating under combustion control, remains in operation during a programmed startup of the boiler main burners upon receipt of an emergency shutdown of the reactor (scram signal). Upon receipt of a scram signal, the motor-operated block valves (HPV-109-1 and 2) are automatically placed in the open position, and the boiler main burner

MAIN STEAM PRESSURE CONTROL SYSTEM - 184-N (CONT'D)

light-off programmer is initiated. Approximately eight (8) minutes after the receipt of the scram signal, the boiler will attain full firing rate and maximum steam generation without reducing boiler drum pressure.

The boiler will continue to operate and supply all steam demands until the reactor is again operating at some steady state power level. At this time the boiler can be operated at minimum load with all eight (8) main burners until sufficient reactor heat has been built up to supply the main steam system demands from the 109-N steam generators. When this time occurs, the main burners will be shut down and the auxiliary burner will again supply all connected boiler loads.

During normal reactor shutdowns, reactor heat is available for a sufficient period of time to allow manual light-off of the eight (8) main burners. This manual light-off is accomplished from the main burner control panel located in the 184-N Control Room where the operator can manually initiate the programmer circuit for all eight (8) main burners, or light-off any number of individual burners. Ref. - Section 21.6.10.1 and 21.6.10.2.

Boiler Depressurization Protection - During periods of a major demand for steam, as during a reactor emergency shutdown (scram signal), control of the pressure reducing valves (HPV-107-1 and HPV-108-1) include pressure limiting feature below boiler steam pressures of approximately 440 psig to prevent depressurization of the boiler steam drum. The loading signal from the boiler drum pressure transmitter PT-101 to Relay 133 and 134 limits the output from Rel-134 to adjust the position of pressure reducing valves HPV-107-1 and HPV-108-1 to maintain the predetermined minimum boiler steam drum pressure. By means of the over-riding feature of this operation, the main pressure reducing valves are precluded from passing more steam into the main steam system than the boiler is capable of delivering without unstable pressure transients.

In addition, control of deaerator pressure control valve HPV-112 also includes pressure limiting feature to over-ride normal deaerator pressure control should main steam from the boiler drop to approximately 430 psig (Ref. Page 21.6.14.2-2).

Turbine Generator Set Pressure Speed Limit Signal - In order to assure adequate steam supply to the turbine generator, Relay-127 is provided. This relay being a pneumatic-electro converter transmits an electric signal to the Primary Coolant Pump Flow Restriction Controller FC-206 at the 105-N Building. This controller is installed in the 109-N master flow controller common output control signal lead to all five (5) loop flow controllers. It acts to limit primary loop flows to minimize drive turbine steam consumption and thus assure adequate steam supply to the turbine generator.

The effect of the input signal from pressure controller PC-102 to Relay-133 output to reversing Relay-136 is manually adjustable from the setpoint hand loader designated 98f and can be read from the receiver gage designated 98g.

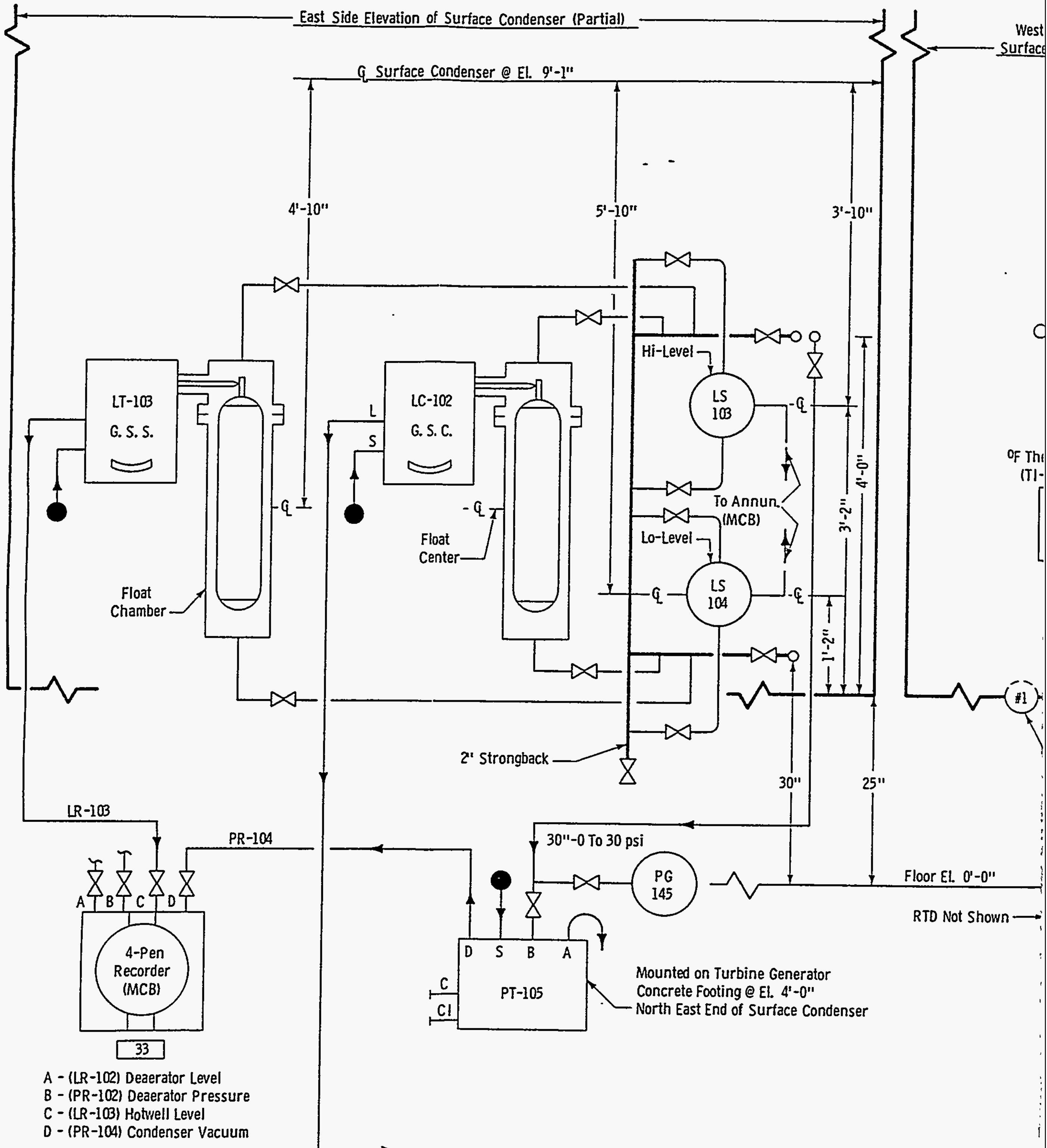
Valve Position Indicating Lights - Geared limit switches associated with the pressure reducing valves upstream side motor-operated block valves and bypass line valves, actuate valve position indicating lights at both the MCB and Graphic Panel "J" in the 105-N Control Room. The pressure reducing valves downstream side manual-operated block valves, also equipped with geared limit switches, actuate valve position indicating lights on the MCB only.

MAIN STEAM PRESSURE CONTROL SYSTEM - 184-N (CONT'D)

Steam Pressure Gages - Boiler steam drum pressure is read locally from a master steam pressure gage at the boiler front, one at the auxiliary burner, from PG-147 and pressure recorder PR-101 at the MCB. The 16-inch and 20-inch steam header pressures can be read locally from individual pressure gages located on the pressure reducing valves bypass lines, which can be valved independently to a pressure gage mounted on the MCB; also from pressure gages associated with independent impulse lines to pressure controller PC-102 as shown on the drawing and at the turbine panel.

RELAY AND PRESSURE SWITCH FUNCTIONS

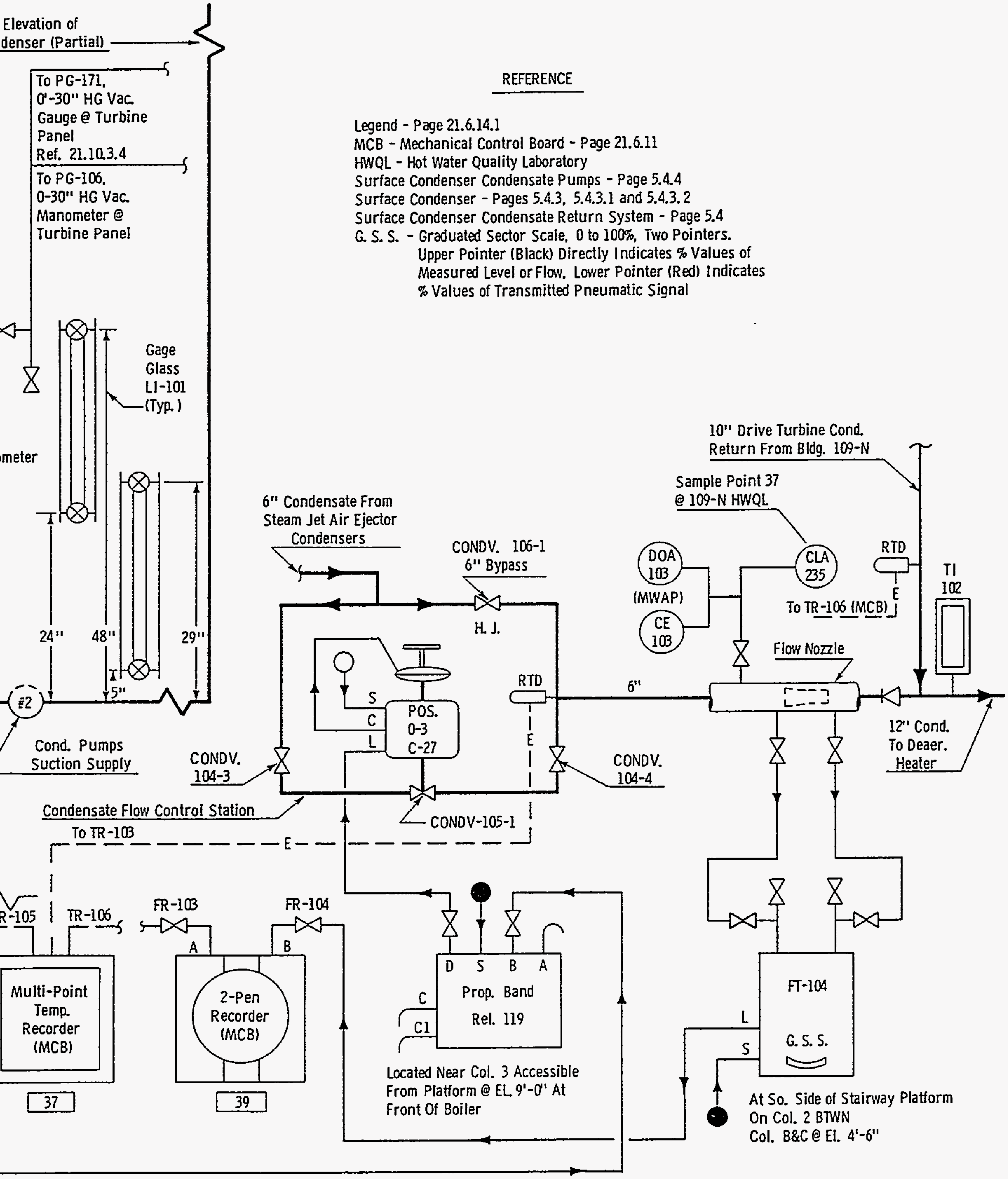
Item	Location	Function	Primary
Rel-120	*MCB	Relays Turbine Steam Header Pressure Control Loading Signal to SV-108	PC-102
Rel-127	*MCB	Relay Turbine Steam Header Pressure Loading Signal to FC-206 (in 109-N Building)	Rel-136
Rel-133	*MCB	Relays Steam Pressure Loading Signal to Rel-134	PT-101
Rel-134	HPV-107-1	Relays Steam to Turbine Pressure Control Loading Signal to Valve Positioners - HPV-107 and 108	SV-108, Rel-133
Rel-135	*MCB	Relays Steam to Turbine Pressure Loading Signal to Rel-127	PC-102
Rel-136	*MCB	Relays Steam to Turbine Pressure Loading Signal to Rel-127	Rel-135
PS-146	HPV-107-1	Actuates Air Fail Brake Release Indicating Light at the MCB	"CAS" to Trap Valves CASV-161
PS-147	HPV-108-1	Actuates Air Fail Brake Release Indicating Light at the MCB	"CAS" to Trap Valves CASV-161
PS-155	HPV-107-1	Actuates Indicating Light at the MCB when Control Air Supply is Normal	"CAS" to Valve Positioner
PS-156	HPV-108-1	Actuates Indicating Light at the MCB when Control Air Supply is Normal	"CAS" to Valve Positioner



Condensate Hotwell Level Control,
and Flow Recording and In

REFERENCE

Legend - Page 21.6.14.1
MCB - Mechanical Control Board - Page 21.6.11
HWQL - Hot Water Quality Laboratory
Surface Condenser Condensate Pumps - Page 5.4.4
Surface Condenser - Pages 5.4.3, 5.4.3.1 and 5.4.3.2
Surface Condenser Condensate Return System - Page 5.4
G. S. S. - Graduated Sector Scale, 0 to 100%, Two Pointers. Upper Pointer (Black) Directly Indicates % Values of Measured Level or Flow, Lower Pointer (Red) Indicates % Values of Transmitted Pneumatic Signal



Condensate Level, Temperature
cating Systems - 184-N

CONDENSER HOTWELL LEVEL CONTROL, CONDENSATE LEVEL, TEMPERATURE AND FLOW RECORDING AND INDICATING SYSTEMS - 184-N

Steam consumed by the turbine for the turbine-generator set is condensed by the surface condenser and collected in the hotwell. The condensate from the hotwell is delivered to the deaerating heater by either of two vertical 3-stage condensate pumps, Ref. Page 5.4.4-2. Each pump is capable of handling full condenser load. The systems described below are designed to maintain the hotwell level within acceptable limits, record and indicate condensate level, record and indicate condensate flow and temperatrue, record and indicate condenser pressure, and actuate high and low level alarms when condensate level in the condenser hotwell is abnormal from a set point.

The condensate from both pumps is discharged into a common header and passes through a steam jet air ejector inner-condenser and after-condenser, then through the flow control station to the deaerating heater. To insure a minimum acceptable flow rate (250 gpm) to the steam jet air ejector, condensate is continuously being bled off to the condenser hotwell through recirculating line valve CONDV-108-2 located directly downstream of the after-condenser. During turbine low load periods, it is important that this valve is open to maintain hotwell level within acceptable limits and protect the condensate pumps against overheating. Low level switch (LS-104), will actuate an annunciator when an unacceptable low level condition exists.

Hotwell Level Control - Is by action of level transmitter LC-102, comprised of a float actuating device connected to the mechanism of an indicating level transmitter. This transmitter sends a pneumatic loading signal to Relay 119, which in turn transmits a loading signal to a pneumatic positioner located on valve CONDV-105-1. This valve maintains the hotwell level within specified limits ±12" by controlling the rate of flow from the condensate pumps. Control air supply is through independent pressure regulating stations as shown on the drawing. Pneumatic signal range is 3-27 psig. Valve operation - spring opening (air to close action.)

Hotwell Level Recording and Indicating - Is by action of level transmitter LT-103, (same characteristics ad LC-102 above). The indicating level transmitter sends a pneumatic loading signal to a 4-pen recorder located on the MCB Pneumatic signal range is 3-27 psig. The hotwell level may also be observed from dual gage glasses located on the west side of the hotwell.

Condensate Flow - Is measured by the differential pressure transmitter FT-104 sensing the high and low side pressures of a flow nozzle located in the condensate piping downstream of the flow control station. This transmitter sends a pneumatic signal to a 2-pen recorder located on the MCB. Pneumatic signal range is 3-27 psig.

Hi-Low Level Alarms - Electrical contacts on the low level switch LS-104 close when condensate level is lowered to 1'-2" as measured from the bottom of the hotwell or (3'-3" ± 1" above floor el.) Contacts on the high level switch LS-103 close when condensate level is increased to 3'-2" as measured from the bottom of the hotwell or (6'-3" ± 1" above floor el.) The level switches are float actuated type. The closing of the level switch contacts actuate an annunciator located on the MCB.

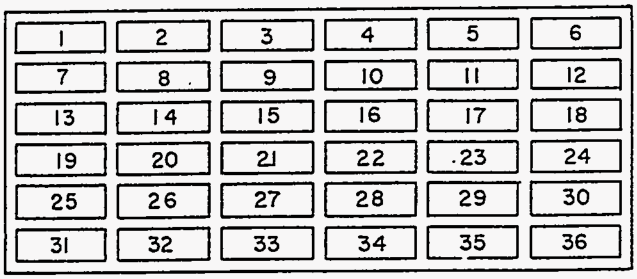
CONDENSER HOTWELL LEVEL CONTROL, CONDENSATE LEVEL, TEMPERATURE AND FLOW RECORDING AND INDICATING SYSTEMS - 184-N (CONT'D)

Temperature - Condensate temperature is measured at six locations:

Number	Location	Type	Reading
TI-102	Total Cond. Flow From TG & DT Condensers	Hg-Direct Reading	Local
TI-103	Cond. From Steam Jet Air Ejector Condensers	" " "	"
TI-104	Condensate Discharge From Condensate Pumps	" " "	"
TI-134	Condensate in Condenser Hotwell	" " "	"
TR-103	Condensate Discharge at Flow Control Station	RTD-Pyrotron Sealed	Remote
TR-105	Condensate Discharge from Condensate Pumps	" " "	"
TR-106	Condensate Returns for 109-N Drive Turbines	" " "	"

TR-103,TR-105 and TR-106 Transmit Electric Signals to a Multi-Point Recorder Located Located on the 184Bldg. MCB.

Condenser Pressure - Condenser pressure is observed from the dual type presssure gage PG-145, and pressure gages PG-171 and PG-106, both located on the turbine panel. Condneser pressure is pneumatically transmitted from pressure transmitter PT-105 to a 4-pen recorder located on the MCB.



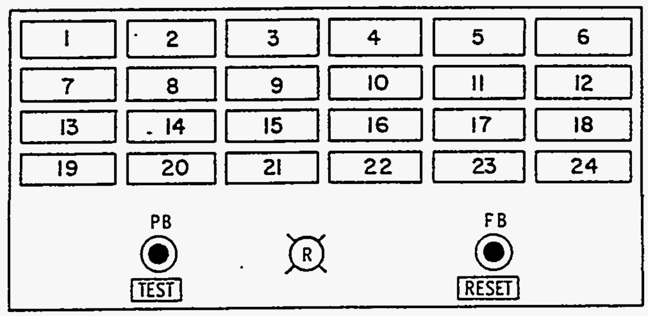
36 DROP ANNUNCIATOR AT MCB

(125 Volt D. C. Power Supply from Panel "B-2" Sw. #7)

1. F. D. Fan Trouble
2. Deaerator Low Pr. Alarm PS-101
3. Feedwater Pumps Trouble
4. Feedwater Pump Auto Start
5. Condensate Pump Trip
6. Air System Trouble
7. Steam lo Pressure
8. Hi-Lo Level Deaerator
9. Steam Drum Lo Level
10. Spare
11. Hotwell Hi-Low Level
12. Spare
13. Turbine Trouble
14. Turbo-Gen. Bearing Hi Temp.
15. Auxiliary Blower Trip
16. Burner Shutdown Unsuccessful
17. Burner Lighter Auto Sequence-Off
18. AH Removal Pumps 184-N Auto Start
19. Stop Valves Closed
20. Air Failure-Loop Flooding Valve
21. Burner Control Panel Trouble
22. Burner Cleanout Incomplete
23. Boiler Purge Required
24. Service Water Lo Pressure
25. Hydrogen Trouble
26. MWV-102-1 Closed
27. Power Setback
28. Scram
29. Turbine Low Vacuum
30. Water Monitoring Trouble
31. Thrust Bearing Failure
32. Turbine Exhaust Hi Temperature
33. Reactor Program Start Up
34. Reactor Program Shutdown
35. Spare
36. Chemical System Trouble

ALARM SEQUENCE FOR MCB ANNUNCIATOR

a. Normal Condition - Lamps "Off" - Horn "Off"
b. Alarm Condition - Lamps Flash White - Horn "On"
c. Acknowledgement - Lamps Steady White - Horn "Off"
d. Malfunction Corrected - Lamps Steady Green - Bell "On"
e. Reset - Lamps "Off" - Bell "Off"
f. Test - P. B. Depressed - Flashing White Lights - Horn "On"
P. B. Released - Steady Green Lights - Horn "On"



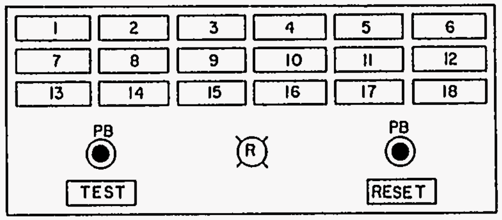
REMOTE SUBSTATION ANNUNCIATOR

24 Drop Panel Located on Wall by MCB
(125 Volt D. C. Power Supply from Panel "A-2" Sw. #7)

1. Bldg. #109-N XFMR A1 Trouble
2. Bldg. #109-N Substa. A1 Undervoltage
3. Bldg. #109-N XFMR B1 Trouble
4. Bldg. #109-N Substa. B1 Undervoltage
5. Bldg. #109-N XFMR A2 Trouble
6. Bldg. #109-N Substa. A2 Undervoltage
7. Bldg. #109-N XFMR B2 Trouble
8. Bldg. #109-N Substa. B2 Undervoltage
9. Bldg. #163-N XFMR A Trouble
10. Bldg. #163-N Substa. A Undervoltage
11. Bldg. #163-N XFMR B Trouble
12. Bldg. 163-N Substa. B Undervoltage
13. Bldg. #182-N XFMR A Trouble
14. Bldg. #182-N Substa. A Undervoltage
15. Bldg. #182-N XFMR B Trouble
16. Bldg. #182-N Substa. B Undervoltage
17. Bldg. #109-N Substa. A1-A2 Blown Fuse
18. Bldg. #109-N Substa. B1-B2 Blown Fuse
19. Northeast XFMR Trouble
20. Northeast Substa. Undervoltage
21. Spare
22. Spare
23. Spare
24. Spare

Annunciator System Panels - 184-N

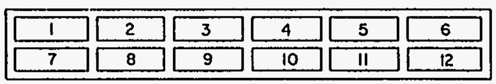
AEC-GE RICHLAND, WASH.



AIR SYSTEM ANNUNCIATOR PANEL

(125 Volt D. C. Power Supply from Panel "A-2" Sw. #5)
Annun. Panel Located Along Wall by
the Service Air Receiver.
This Panel Actuates Drop #6 at the MCB.

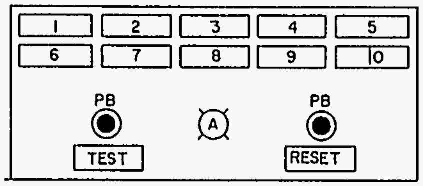
1. Service Air - Low Pressure
2. Serv. A/C #1 - Discharge - High Temp.
3. Serv. A/C #1 - Lube Oil - Low Pressure
4. Serv. A/C #1 - Breaker Trip
5. Inst. A/C #1 - Discharge - High Temp.
6. Inst. A/C #1 - Lube Oil - Low Pressure
7. Inst. A/C #1 - Breaker Trip
8. Instrument Air - Low Pressure
9. Inst. A/C #2 - Discharge - High Temperature
10. Inst. A/C #2 - Lube Oil - Low Pressure
11. Inst. A/C #2 - Breaker Trip
12. Spare
13. Inst. A/C #3 - Discharge - High Temp.
14. Inst. A/C #3 - Lube Oil - Low Pressure
15. Inst. A/C #3 - Breaker Trip
16. Air Dryer - Trouble
17. Spare
18. Spare



TURBINE PANEL ANNUN. REF. 21.10.3.4

(125 Volt D. C. Power Supply from Panel "B-2" Sw. #5)
This Panel Actuates Drop #13 at the MCB

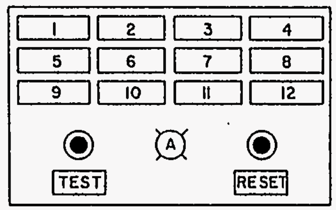
1. Steam Flow Minimum
2. Emerg. Brg. and Seal Oil Pump-Auto Start
3. Auxiliary Oil Pump-Auto Start
4. Bearing and Seal Oil Pump-Trip
5. Oil Reservoir - Vapor Extractor Trip
6. Spare
7. Seal Oil Trouble
8. Emerg. Brg. and Seal Oil Pump-Trip
9. Auxiliary Oil Pump Trip
10. Gen. Brg Oil H_2 Extractor Trip
11. Turbine Gland Vacuum Pump Trip
12. Oil Reservoir - Hi-Lo Level



FORCED DRAFT ANNUNCIATOR PANEL

(125 Volt D. C. Power Supply from Panel "A-2" Sw. #11)
Annun. Panel Located West Wall by
the No. 1 Boiler Feedwater Pump.
This Panel Actuates Drop #1 at the MCB.

1. F. D. Fans Outlet - Low Pressure
2. F. D. Fan #1 Breaker - Trip
3. F. D Fan #1 Bearing - High Temp.
4. F. D. Fan #1 Overload
5. Spare
6. F. D. Fan #2 Breaker - Trip
7. F. D. Fan #2 Bearing - High Temp.
8. F. D. Fan #2 Overload
9. Spare
10. Spare



FEEDWATER PUMP ANNUN. PANEL

(125 Volt D. C. Supply from Panel "B-2" Sw. #8)
Annun. Panel Located Along West Wall by
the No. 3 Boiler Feedwater Pump.
This Panel Actuates Drop #3 at the MCB.

1. Feedwater Pump #1 - Breaker Trip
2. Feedwater Pump #2 - Breaker Trip
3. Feedwater Pump #3 - Breaker Trip
4. Feedwater Pump - Low Flow
5. Feedwater Pump #1 - Lube Oil - Low Pressure
6. Feedwater Pump #2 - Lube Oil - Low Pressure
7. Feedwater Pump #3 - Lube Oil - Low Pressure
8. Spare
9. Feedwater Pump #1 - Overload
10. Feedwater Pump #2 Overload
11. Feedwater Pump #3 - Overload
12. Spare

ANNUNCIATOR PANELS ALARM SEQUENCE

1. REMOTE SUBSTATION ANNUNCIATOR
   a. Normal Condition - Lamps "Off - Horn "Off"
   b. Alarm Condition - Lamps Flash White - Horn "On"
   c. Reset - Lamps Steady White - Horn "Off"
   d. Malfunction Corrected - Lights "Off" - Horn "Off"
   e. Test - Lamps Steady White

2. AIR SYSTEM ANNUNCIATOR
   a. Normal Condition - Lamps "Off" - Horn "Off"
   b. Alarm Condition - Lamps Flash White - Horn "On" - Actuated #6 @ MCB
   c. Reset - Lamps Steady White - Horn Off - #6 @ MCB Lamp Steady White
   d. Malfunction Corrected - Lights "Off"
   e. Test - Lamps Steady White

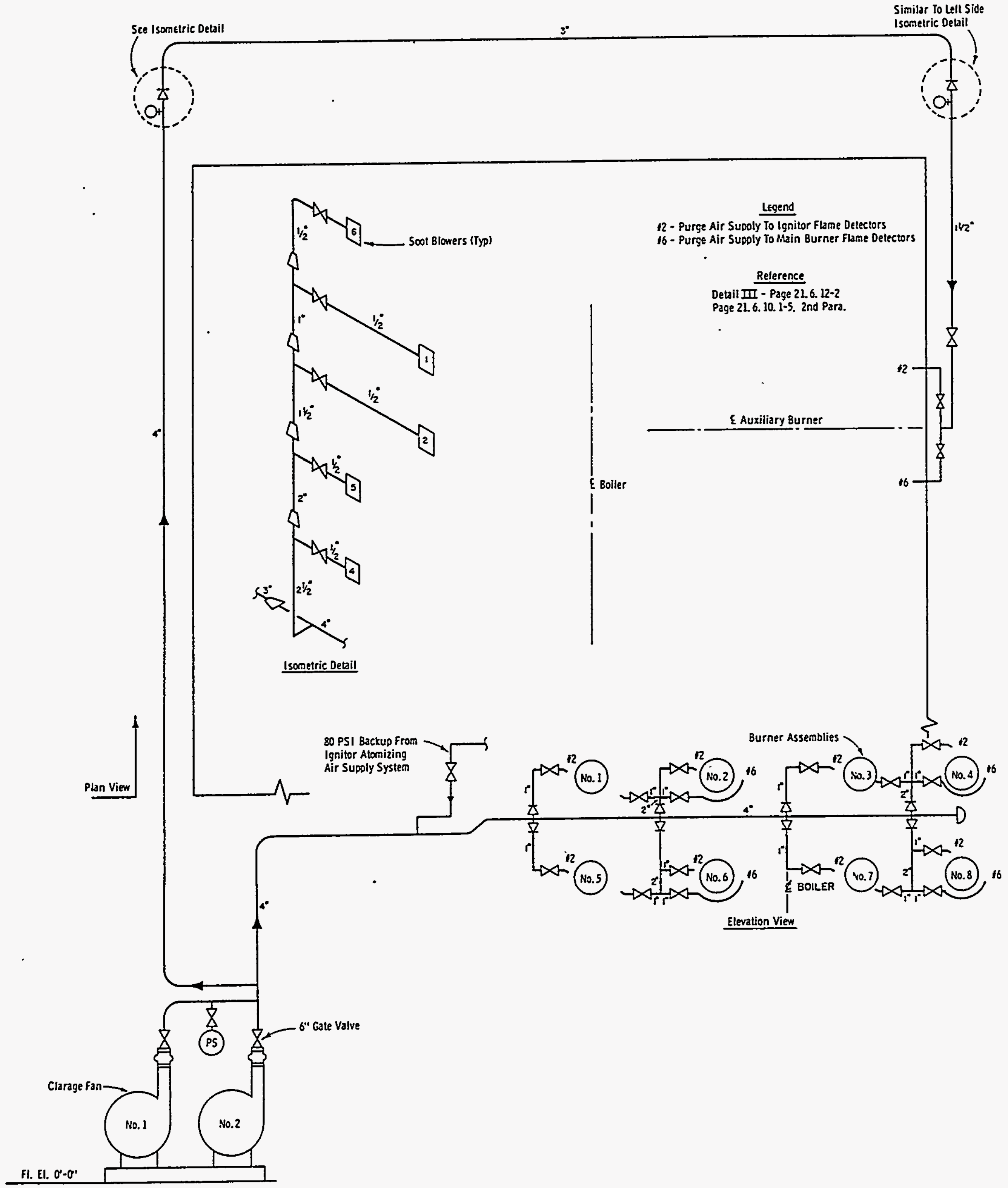
3. TURBINE PANEL ANNUNCIATOR
   a. Normal Condition - Lamps "Off" - Horn "Off"
   b. Alarm Condition - Lamps Flash White - Horn "On" Actuates #13 @ MCB
   c. Reset - Lamps Steady White - Horn Off - #13 MCB Lamp Steady White
   d. Malfunction Corrected - Lights "Off" - Horn "Off" #13 @ MCB Green Lamp and Bell
   e. Test - Lamps Flash White Horn "Off" Actuate #13 @ MCB

4. FORCED DRAFT FAN ANNUNCIATOR
   a. Normal Condition - Lamps "Off" - Horn "Off"
   b. Alarm Condition - Lamps Flash White - Horn "On" - Actuates #1 @ MCB
   c. Reset - Lamps Steady White - Horn Off - #1 @ MCB Lamp Steady White
   d. Malfunction Corrected - Lights "Off" - Horn "Off"
   e. Test - Lamps Steady White

5. FEEDWATER PUMP ANNUNCIATOR
   a. Normal Condition - Lamp "Off" - Horn "Off"
   b. Alarm Condition - Lamps Flash White - Horn "On" - Actuates #3 @ MCB
   c. Reset - Lamps Steady White - Horn Off #3 @ MCB Lamp Steady White
   d. Malfunction Corrected - Lights "Off" - Horn "Off"
   e. Test - Lamps Steady White

NOTE: Fuel Oil System Annunciator Is Described on Page 21.6.10.1-1
Hydrogen System Annunciator Is Described on Page 21.9.4.2-1

Annunciator System Panels - 184-N



Purge Air Supply to Flame Detectors and Soot Blowers - 184-N

AEC-GE RICHLAND, WASH.

DRY CHEMICAL TRANSFER, STORAGE AND PROPORTIONING CONTROL SYSTEMS FOR SOLUTION PREPARATION - 109-N

This system is designed to receive, store and feed dry chemicals to the decontamination mix tank (Ref. 7.1.1-2). The controls are interlocked for sequential starting to prevent material pile up which would result in spills or plugging of conveyor units. All controls for this system are located on Decontamination Control Panel "A" (DCA) (Ref. 21.7.6).

Transfer of Incoming Dry Chemicals to Storage Bins

Incoming dry chemicals are transferred to the storage bins from the receiving hopper by a vibrator feeder, bucket elevator, swing chute and screw conveyor. The swing chute feeds directly to the 900 cubic foot bin or to the 2500 cubic foot bin via the screw conveyor.

Controls for the individual components are on-off pistol grip or key lock switches with associated indicating lights. The control interlocks require the equipment to be operated in the following sequence:

1. Swing chute positioned to the 900 cubic foot bin directly or to the 2500 cubic foot bin via the screw conveyor. If the swing chute is positioned to the screw conveyor, the screw conveyor must be started before the bucket elevator can be started. The screw conveyor can be started at any time; however, if swing chute is positioned to the conveyor and the bucket elevator is running, stopping of the screw conveyor will automatically stop the elevator.

2. Start bucket elevator.

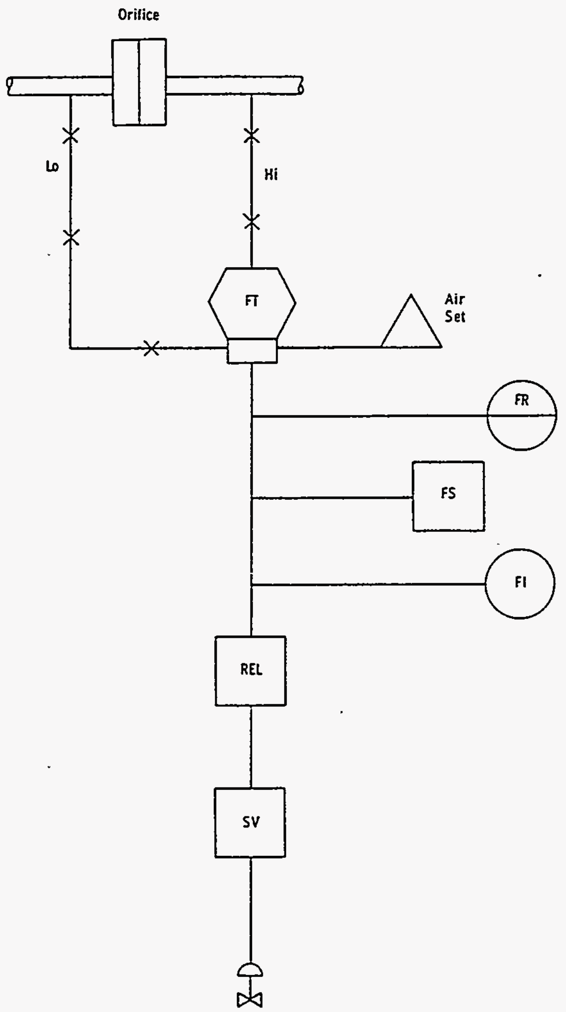
3. Start vibrator feeder. Vibrator feeder cannot be started unless bucket elevator is running. If the elevator is stopped the vibrator feeder will stop.

4. Start bin agitator. The agitators are not interlocked. They may be started or stopped at any time.

Bin level control is accomplished through high and low level switches and a weight indication on each bin. The weight indicator and high and low level annunciators are located on DCA Panel.

Dry Chemical Proportioning Control System

Dry chemical proportioning (make-up to mix tank) is controlled by variable speed screw feeders. Each storage bin has an individual screw feeder controlled by an "on-off" key lock switch and a pistol grip speed control switch. The switches are located on DCA Panel. The screw feeder for the 900 ft^3 bin has an adjustable feed rate from 55,400 #/hr to 83,000 #/hr. The screw feeder for the 2500 ft^3 bin has an adjustable feed rate from 81,000 #/hr to 135,000 #/hr. In addition to control of feed rate by varying the speed of the screw feeder, further control is obtained by observing the change in the bin weight indicator.



	Sodium Hydroxide	Phosphoric Acid	Hydrogen Peroxide	Filtered Water	Demin. Water
Orifice Size	6"	4"	2"	6"	4"
Flow Trans.	FT-275	FT-274	FT-276	FT-271	FT-270
Flow Recorder	FR-246	FR-247	FR-248	FR-249	FR-250
Flow Switch	FS-206	FS-207	FS-208	------	------
Flow Indicator	FI-248	FI-249	FI-250	FI-254	FI-253
Control Relay	REL-261	REL-263	REL-206	REL-238	REL-264
Selector Station	SV-201	SV-202	SV-203	SV-208	SV-207
Flow Control Valve	SOHV-203	CPAV-203	CHPV-203	FWV-225-1	DWV-216-1

Liquid Chemical Transfer, Storage and Proportioning Control Systems
for Solutions Preparation - 109-N

LIQUID TRANSFER, STORAGE AND PROPORTIONING CONTROL SYSTEMS FOR SOLUTION PREPARATION - 109-N

The four liquid chemical storage tanks (Ref. 7.1.1-3) have similar control systems for loading, storage (temperature control) and proportioning control for batch mixing. A typical control system is described below.

Transfer and Storage

An individual truck unloading connection for each tank is connected to the suction of the corresponding transfer pump. The pumps are controlled by on-off switches from the DCA Panel.

Each tank is equipped with a locally mounted level transmitter and temperature transmitter. The level transmitter receives a signal from a bubbler installed in the tank. The transmitter retransmits a proportional signal in the 3# to 27# range, to the remote level indicator and to the high and low level alarm switches on the DCA Panel.

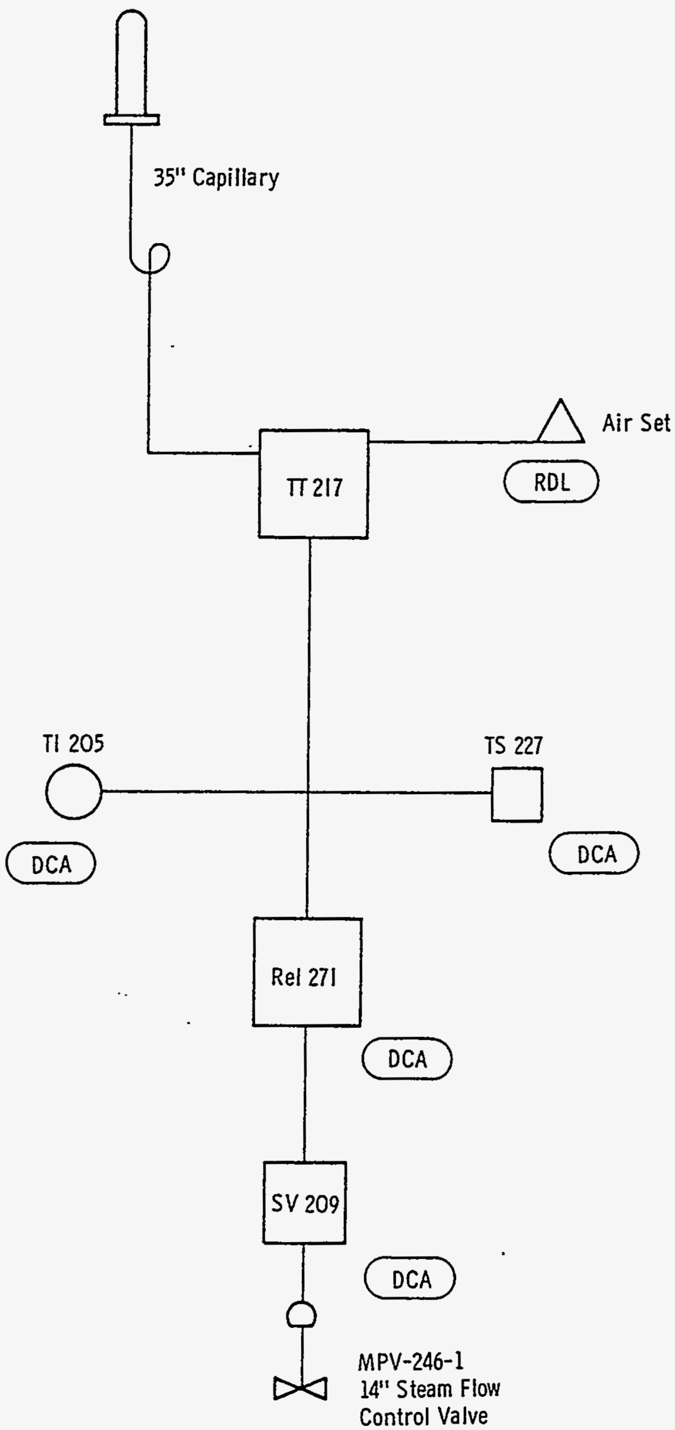
The temperature transmitter receives a signal from and retransmits a proportional signal to a temperature indicator, high and low temperature switches and to a temperature controller. The temperature indicator and high and low temperature annunciators are on DCA Panel. The output of the locally mounted temperature controller is used as an input signal to position the MPV-814 valve which controls the flow of steam to the heating coils in the tank.

Proportioning Control

Proportioning control of a sodium hydroxide, Acid, H_2O_2, demineralized and filtered water make-up to the chemical mix tank is accomplished through control action on the respective transfer pump discharge flow control valve for liquid chemicals and through control action on the flow control valves on the incoming lines for filtered and demineralized water. The control chain described below is identical for all five liquid feeds except the flow switch has been omitted from the filtered and demineralized water feeds.

An orifice installed in the transfer pump discharge line (incoming filtered and demineralized water lines) creates a differential pressure which is used as an index of total flow for loading the associated flow transmitter. The transmitter retransmits a pneumatic signal, linear to total flow, through a flow controller to position the flow control valve. The transmitted signal is also used for remote flow indication and actuation of the low flow alarm. The flow controllers, mounted on DCA Panel, include a hand-automatic transfer switch, incorporating a hand loader, setpoint selector and signal indicators for transmitter output, setpoint, hand loading pressure and automatic loading pressure.

The controllers have the necessary controls for manual positioning of the associated control valve, transferring from hand to automatic, adjustable proportional band plus reset control, and adjustment of the setpoint.



Decontamination Solutions Temperature Control System - 109-N

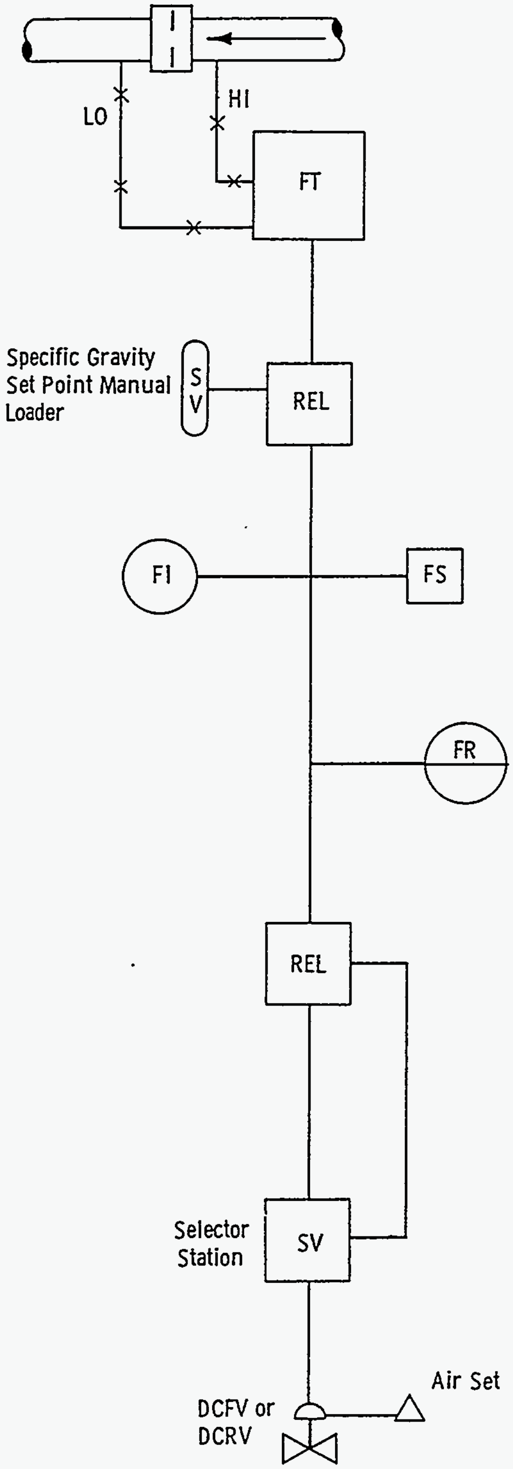
DECONTAMINATION SOLUTION TEMPERATURE CONTROL SYSTEM - 109-N

The decontamination solution is heated to 200°F and maintained at this temperature by passing the make-up solutions and/or circulating the decontamination solution through the heat exchanger (Ref. 7.1.2.1-2). Heat input to the solution is controlled by regulation of steam flow to the shell side of the heat exchanger.

Decontamination solution temperature is controlled by sensing the decontaminant temperature at the outlet of the heat exchanger with a liquid filled thermal sensing element (capillary). Temperature transmitter (TT-217) receives a loading signal from the capillary and retransmits a proportional pneumatic signal in the 3-27 psig range through temperature controller (REL-271 and SV-204) to position steam flow control valve MPV-246-1.

The temperature controller consists of the following equipment mounted on DCA Panel: Hand-automatic transfer switch, incorporating hand loader, setpoint selector and signal indication for transmitter output, setpoint, hand loading pressure and automatic loading pressure.

The output signal from the temperature transmitter (TT-217) is also used for remote temperature indication (TI-205) and for actuation of the high temperature alarm (TS-227).



COMPONENT	INJECTION PUMP FLOW	SPILL FLOW	MIX TANK RETURN	DRAIN FLOW
(FT) Flow Transmitter	273	265	269	272
(REL) Computing Relay	214	299	266	269
(SV) S.G. Et Pt. Man. Loader	231	232	229	230
(FI) Flow Indicator	255	263	251	252
(FS) Flow Switch	210	---	---	---
(FR) Flow Recorder	243	---	244	245
(REL) Control Relay	215	300	267	270
(SV) Selector Station	209	226	205	206
(DCFV) Flow Control Valve	216	225	---	---
(DCRV) Flow Control Valve	---	---	207-1	218

Decontamination Injection Pump Fill, Return and Spill Control Systems
109-N

AEC-GE RICHLAND, WASH.

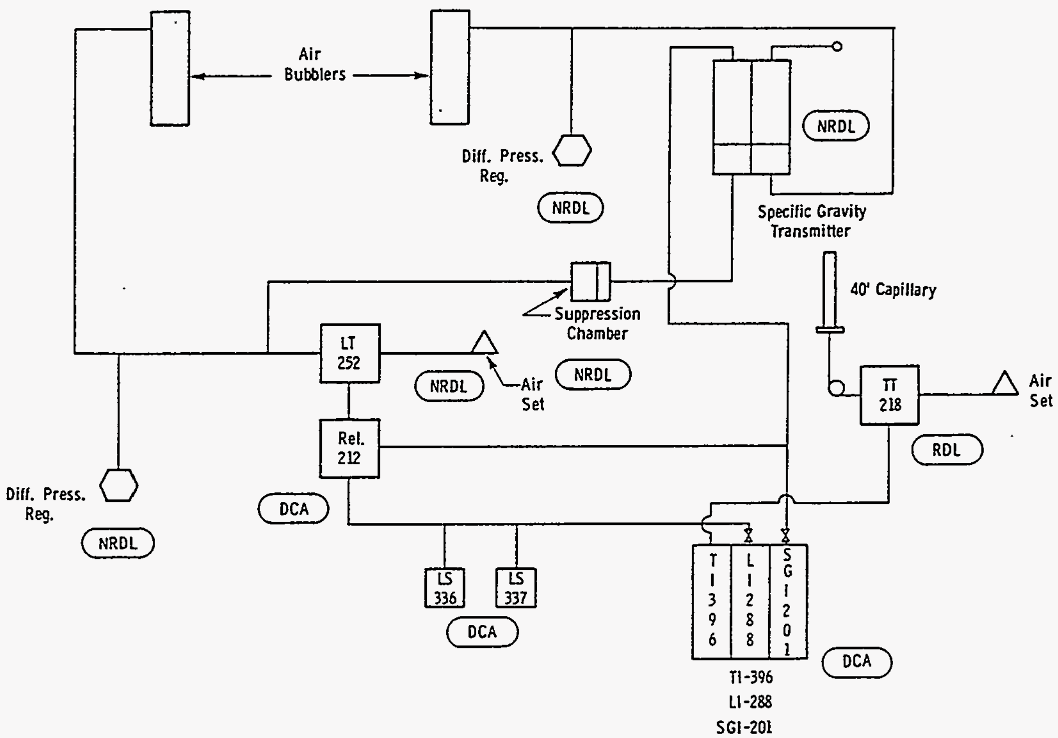
DECONTAMINATION INJECTION PUMP FILL, RETURN AND SPILL FLOW CONTROL SYSTEMS - 109-N

The control chains for Injection Pump Flow, spill flow, return to mix tank flow and return to radioactive drain flow are identical except the injection pump system has a low flow switch while the other three flow control systems do not.

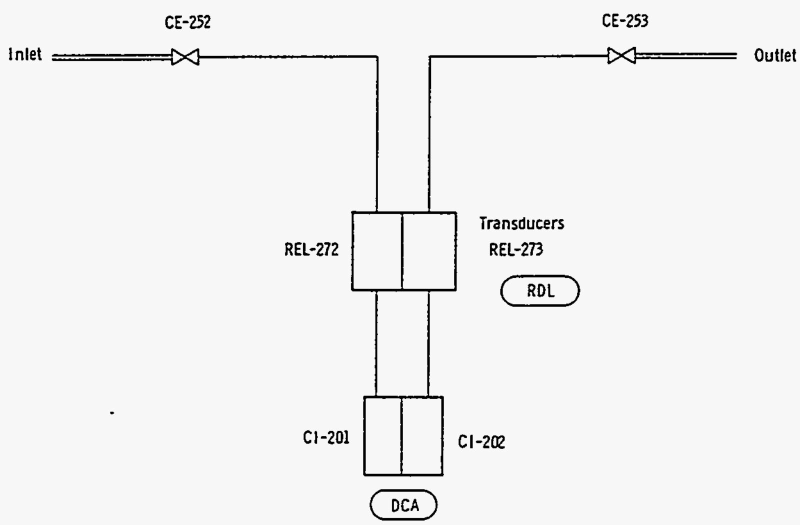
The control chains consist of a 6" flow nozzle (1½" orifice for spill flow) to create a differential pressure as an index of flow for loading the associated transmitter. The transmitter retransmits a signal linear to total flow to a computing relay. A signal from a specific gravity setpoint manual loader is also fed into the computing relay to compensate the total flow signal for specific gravity of the decontamination solution. The compensated signal is used for actuation of a low flow switch (Injection Pump Flow only), a flow indicator, flow recorder and for input to the control relay. For automatic operation the input signal to the control relay is compared to the setpoint signal from the selector station and the resulting error transmitted to position the diaphragm of the flow control valve. In manual operation, the compensated flow signal indicates on the "C" scale of the selector station. The valve is controlled by manual loading from the selector station.

The manual automatic selector station has a face mounted hand-automatic transfer switch, hand loader, setpoint selector and signal indications for transmitter output, setpoint, automatic loading pressure and hand loading pressure.

Mix Tank Level, Specific Gravity and Temperature Indication



Ion Exchanger Conductivity Cells



Miscellaneous Decontamination System Instrumentation - 109-N

MISCELLANEOUS DECONTAMINATION SYSTEM INSTRUMENTATION - 109-N

Mix Tank Level, Specific Gravity and Temperature Indication

Specific Gravity

Two bubblers are installed in the decontamination mix tank to index liquid level and specific gravity. The level indexing bubbler is located at the bottom of the mix tank while the specific gravity indexing bubbler is located twelve inches above the bottom of the tank. An air signal proportional to the height of liquid above the base of each bubbler is used for loading the specific gravity transmitter. One signal is subtracted from the other signal and the difference retransmitted to the to the specific gravity indicator SGI-201. The specific gravity signal is also used for compensation of the tank level signal through Computing Relay (REL-212).

Tank Level

The pneumatic signal from the lower bubbler is used for loading mix tank level transmitter (LT-252). The signal is also used for loading the A port of the specific gravity transmitter. From transmitter LT-252 the signal is retransmitted to Computing Relay REL-212 where it is compensated for specific gravity. The compensated signal is used for actuation of high and low level switches LS-336 and LS-337 and for level indication on LI-288.

Mix Tank Temperature

Mix tank temperature is sensed by a 40 foot capillary connected to temperature transmitter TT-218. The signal is retransmitted to temperature indicator TI-396.

Ion Exchanger Conductivity Cells

The ion exchange unit is provided for polishing the final flush water following the decontamination process. Quality of both the infulent and effluent water through the ion exchanger is constantly monitored by conductivity cells (Ref. 7.1.2.4-2). Monitoring inlet and outlet serves a twofold purpose; first, indication of total dissolved solids in the system and second, the effectiveness of the ion exchange resin.

Two conductivity elements, inlet 0-1000 mmho. and outlet 0-100 mmho. measure the conductivity of the solution in which they are immersed. The electrical output from the conductivity elements is used for loading two transducers (REL-272 inlet and REL-273 outlet), output of the transducers is used for loading two conductivity indicators on DCA Panel (inlet CI-201, outlet CI-202).

VALVES LOCATED IN CELLS 1 THRU 5

NOTE: Items Nos. Shown on Listing are for Cell No. 1 Valves. Cells 2, 3, 4 and 5 will have Identical Last 2 Digits but will have Different First Digit.

EXAMPLE:	CELL 1	CELL 2	CELL 3	CELL 4	CELL 5
	101	201	301	401	501

ITEM NO.	VALVE MARK NO.	VALVE MARK SUFFIX NO. FOR CELLS NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	DESCRIPTION
102	PCSV-205	-10	-6	-7	-8	-11	Primary Coolant from Cell Drain
103	FLV-202	-1	-2	-3	-4	-5	Cell Primary Coolant Flush-Drain
104	PCRV-214	-1	-2	-3	-4	-5	Cell Primary Coolant Flush-Shutoff
107	PCSV-203/ 211	-1/1	-2/2	-3/3	-4/4	-5/5	Primary Coolant from Cell-Shutoff and By-Pass
108	PCRV-202/ 201	-1/11	-2/12	-3/13	-4/14	-5/15	Primary Coolant to Cell-Shutoff and By-Pass
109	DCRV-202	-1	-2	-3	-4	-5	Decontaminant Return-Drain
110	PCSV-210	-1	-2	-3	-4	-5	Decontaminant Return-Shutoff
111	PCSV-205	-12	-13	-14	-15	-16	Primary Coolant from Cell Drain
112	PCSV-207	-18	-19	-20	-21	-22	Prim. Clt. Pump Bypass Helium Feed
113	PCSV-207	-2	-4	-6	-6	-10	Primary Clt. Pump Bypass-Vent
114	PCRV-209	-25	-26	-27	-28	-29	Primary Coolant to Cell-Drain
115	DCFV-202	-1	-2	-3	-4	-5	Decontaminant Supply-Drain
116	PCRV-206	-1	-2	-3	-4	-5	Decontaminant Supply-Shutoff
117	PCSV-204	-1	-2	-3	-4	-5	Primary Coolant Pump Bypass
118	PCSV-211	-6	-7	-8	-9	-10	Primary Coolant Pump Disch. Vent
119	PCSV-209	-1	-4	-6	-8	-10	Primary Coolant Flow Nozzle Inlet Drain
120	PCSV-209	-2	-3	-5	-7	-9	Primary Coolant Flow Nozzle Outlet Drain
121	PCSV-205	-1	-2	-3	-4	-5	Primary Coolant Pump Bypass Drain
122	PCRV-201	-49	-52	-55	-58	-61	Primary Coolant to Stm. Gens. - Helium Feed
123	PCRV-201	-16	-17	-18	-19	-20	Primary Coolant to Stm. Gens. - Vent
124	PCRV-203	-1	-3	-5	-7	-9	Primary Coolant to Stm. Gen. A-Shutoff
125	PCRV-201	-38	-40	-42	-44	-46	Primary Coolant to Stm. Gen. A-Vent
126	PCRV-204	-1	-2	-3	-4	-5	Primary Coolant Bypass at Stm. Gens. Shutoff
127	PCRV-201	-39	-41	-43	-45	-47	Primary Coolant to Stm. Gen. B Vent
128	PCRV-203	-2	-4	-6	-8	-10	Primary Coolant to Stm. Gen. B Shutoff
129	PCRV-201	-21	-23	-25	-27	-29	Primary Coolant from Stm. Gen. A - Vent
130	PCRV-201	-50	-53	-56	-59	-62	Primary Coolant from Stm. Gen. A - Helium Feed
131	PCRV-209	-3	-6	-9	-12	-15	Primary Coolant Bypass at Stm. Gens. - Drain
132	IWV-252	-1	-2	-3	-4	-5	Primary Coolant Bypass at Stm. Gens. - Inj. Wtr. Feed
133	PCRV-201	-51	-54	-57	-60	-63	Primary Coolant from Stm. Gen. B - Helium Feed
134	PCRV-201	-22	-24	-26	-28	-30	Primary Coolant from Stm. Gen. B - Vent
135	PCRV-209	-1	-4	-7	-10	-13	Stm. Gen. a Prim. Coolant - Drain
136	IWV-265	-1	-2	-3	-4	-5	Seal Water to Prim. Clt. Pump Shutoff
137	IWV-268	-1	-2	-3	-4	-5	Seal Water Normal Return from Pri. Clt. Pmp. Shutoff
138	PCRV-209	-2	-5	-8	-11	-14	Stm. Gen. B. Prim. Coolant - Drain
139	IWV-270	-21	-22	-23	-24	-25	Demin. Wtr. to Pri. Clt. Pump Seals-Shutoff
140	IWV-267	-1	-2	-3	-4	-5	Seal Water Norm. Supply to Pri. Clt. Pump Shutoff
141	RDRV-201	-2	-4	-6	-8	-10	Drain to Cell Sump from Points Inside Cell Shutoff
142	RDRV-202	-6	-7	RDRV 210-1	*	RDRV 206-2	Drain to Cell Sump from Points Outside Cell Shutoff
143	IWV-266	-1	-2	-3	-4	-5	Seal Water Return from Pri. Clt. Pumps-Drain
144	PCRV-201	-1	-3	-5	-7	-9	Primary Coolant Pump Disch. - Drain

* Cell #4 Sump does not have any Drains Entering from Outside Cell.

All Indicating Lights are General Electric ET5

All Selector Switches are Cutler Hammer 10250T

ITEM NO.	VALVE MARK NUMBER	DESCRIPTION
601	HEV-210-1 & HEV-210-2	Graphite Cooling Surge Tank Helium Pressurizing-Control
602	HEV-209-1 & HEV-209-2	Graphite Cooling Surge Tank Helium Depressurizing Control
603	GCRV-309-1	Graphite Cooling Surge Tank Vent
604	GCRV-309-19	Graphite Cooling Surge Tank Helium Fill - Shutoff
605	GCRV-302-1	Graphite Cooling Surge Tank Bypass - Shutoff
606	GCRV-313-1	Graphite Cooling Heat Exchers. Bypass - Control
607	GCSV-302-1	Graphite Coolant from Heat Exch. No. 1 Shutoff
608	GCSV-302-2	Graphite Coolant from Heat Exch. No. 2 Shutoff
609	GCSV-302-3	Graphite Coolant from Heat Exch. No. 3 Shutoff
610	GCSV-302-4	Graphite Coolant from Heat Exch. No. 4 Shutoff
611	GCSV-301-1	Graphite Coolant Recirc. Pump No. 1 Suction - Shutoff
612	GCSV-301-2	Graphite Coolant Recirc. Pump No. 2 Suction - Shutoff
613	GCSV-301-3	Graphite Coolant Recirc. Pump No. 3 Suction - Shutoff
614	GCRV-303-5	Graphite Cooling Heat Exchers Bypass - Shutoff
615	GCRV-303-1	Graphite Coolant to Heat Exch. No. 1 Shutoff
616	GCRV-303-2	Graphite Coolant to Heat Exch. No. 2 Shutoff
617	GCRV-303-3	Graphite Coolant to Heat Exch. No. 3 Shutoff
618	GCRV-303-4	Graphite Coolant to Heat Exch. No. 4 Shutoff
619	GCSV-304-1	Graphite Coolant Recirc. Pump No. 1 Discharge-Shutoff
620	GCSV-304-2	Graphite Coolant Recirc. Pump No. 2 Discharge-Shutoff
621	GCSV-304-3	Graphite Coolant Recirc. Pump No. 3 Discharge-Shutoff
622	PRV-213-1	Vent to Pressurizer from 105-N - Shutoff
623	PRV-210-1	Vent from Pressurizer - Shutoff
624	PRV-210-2	Pressurizer - Drain
625	PRV-211-1	Prim. Coolant from Pressurizer Drain to Radioactive Valve Pit -
626	PRV-205-1	Prim. Coolant from Pressurizer Shutoff
627	PRV-205-2	Prim. Coolant from Pressurizer Shutoff
628	PRV-207-3	Decontaminant Return from Pressurizer Shutoff
629	PRV-203-1	Spray Water to Pressurizer Control
630	PRV-202-1	Spray Water to Pressurizer Control
631	PRV-202-2	Spray Water to Pressurizer Control
632	PRV-207-5	Spray Water to Pressurizer Shutoff
633	PRV-207-4	Spray Water to Pressurizer Shutoff
634	PRV-215-1	Decontaminant Feed to Pressurizer Spray Water - Shutoff
635	PRV-207-2	Spray Water to Pressurizer Shutoff
636	PRV-212-1	Spray Water to Pressurizer Drain
637	PRV-207-1	Spray Water to Pressurizer Shutoff
638	PRV-204-2	Spray Water to Pressurizer Drain
639	DCFV-205-1	Decontaminant Feed to Graphite Cooling - Drain
640	DCFV-201-1	Decontaminant Feed to Graphite Cooling - Shutoff
641	GCRV-301-1	Graphite Coolant from Reactor Shutoff
642	GCSV-307-1	Graphite Coolant Recirculation Shutoff
643	GCSV-308-1	Graphite Coolant to Reactor Shutoff
644	DCRV-201-1	Decontaminant Return from Graphite Cooling - Shutoff
645	DCRV-204-1	Decontaminant Return from Graphite Cooling - Drain
646	PCSV-207-16	Reactor Inlet Headers Cross Connection - Vent
647	PCSV-201-2	Reactor Inlet Headers Cross Connection Filtered Water Supp. Sh
648	PCSV-201-1	Reactor Inlet Headers Cross Connection Filtered Water Supp. Sh
649	PCSV-206-1	Reactor Inlet Headers Cross Connection Shutoff
650	PCSV-201-3	Reactor Inlet Headers Cross Connection Filtered Water Supp. Sh
651	PCSV-207-17	Reactor Inlet Headers Cross Connection Vent
652	PCSV-205-9	Reactor Inlet Headers Cross Connection Drain
653	PCRV-201-36	Reactor Outlet Headers Cross Connection - Vent
654	PCRV-209-19	Reactor Outlet Headers Cross Connection - Drain
655	PCRV-205-1	Reactor Outlet Headers Cross Connection - Shutoff

Designation and Valve Locations
Panel - "D

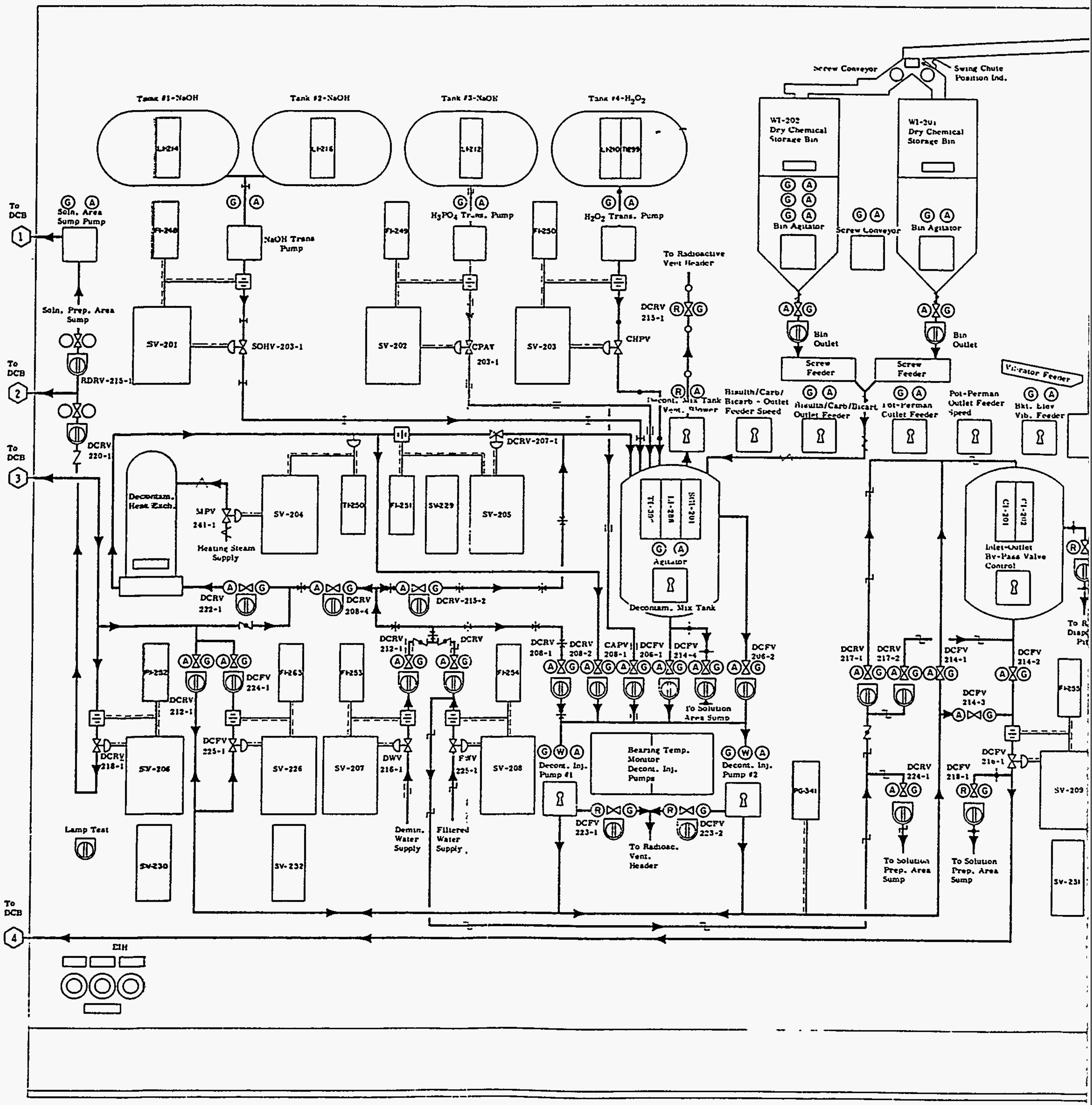
VALVES LOCATED OUTSIDE STEAM GENERATOR CELLS

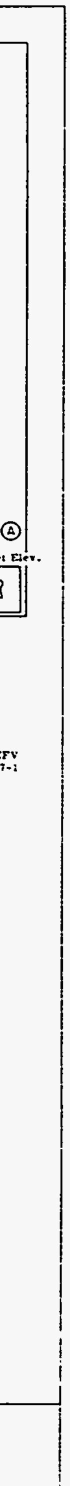
ITEM NO.	VALVE MARK NUMBER	DESCRIPTION
656	PCRV-201-48	Reactor Outlet Headers Cross Connection - Vent
657	FLV-201-1	Decontaminant Flush to Waste Check
658	FLV-203-1	Spill Cooler Flush to Waste Check
659	FLV-202-7	Spill Cooler Flush to Waste Vent
660	FLV-202-6	Spill Cooler Flush to Waste Drain
661	BDV-208-2	Spill Cooler Outlet Drain
662	BDV-218-1	Spill Cooler Outlet Flush - Shutoff
663	PCRV-213-2	Primary Coolant from Spill Cooler to Reactor Outlet HDR. Shutoff
664	IWV-251-1	Primary Coolant from Reactor Inlet Header to Spill Cooler - Shutoff
665	BDV-201-1	Diversion and Purity Blowdown to Recup. Heat Exchs Shutoff
666	BDV-203-1	Reactor Inlet Header to Recup. Heat Exchs. Shutoff
667	BDV-207-1	Recuperative Heat Exchs. Inlet - Helium Feed
668	BDV-207-1	Recuperative Heat Exchs. Inlet - Drain
669	BDV-205-1	Decontaminant Feed to Recuperative Heat Exchangers Shutoff
670	DSV-801-1	Waste to Chemical Waste Facility - Shutoff
671	BDV-207-2	Recuperative Heat Exch. No. 1 Outlet - Vent
672	BDV-207-3	Recuperative Heat Exch. No. 1 Outlet - Drain
673	DSV-802-1	Waste to Crib - Shutoff
674	V-6 Valves by G.E.	Recuperative Heat Exch. No. 2 Outlet to Waste Through Radioactive Valve Pit Shutoff
675	BDRV-802-1	Waste From Radioactive Valve Pit to Waste Disposal Valve Pit Shutoff
676	BDV-208-1	Recuperative Heat Exch. No. 2 Outlet - Drain
677	RDRV-802-2	Waste to River - Shutoff
678	PCRV-213-1	Prim. Coolant Diversion from Recuperative Heat Exch. to Reactor Outlet Header Shutoff
679	BDV-206-1	Decontaminant Return from Recuperative Heat Exch. Shutoff
680	RDRV-213-1	Solution Prep. Area Sump Pump Disch. Shutoff
681	PCSV-205-17	Reactor Inlet Header Drain
682	PCRV-209-36	Reactor Outlet Header Drain
683	PCSV-205-18	Reactor Inlet Header Drain
684	DCRV-201-2	Decontaminant Return to Preparation Area Shutoff
685	DCRV-205-1	Decontaminant Return to Preparation Area Check
686	DCFV-201-2	Decontaminant Supply from Preparation Area Shutoff
687	DCRV-223-1	Decontaminant Return to Preparation Area Drain
688	DCFV-203-1	Decontaminant Supply to 105-N - Shutoff
689	DWV-205-1	Demin. Water to Prim. Clt. Pump Seals - Control
690	GCRV-304-10	Graphite Cooling Surge Tank Bypass Drain
691	GCRV-309-18	Graphite Cooling Heat Exchs. Bypass Vent
692	GCRV-309-2	Graphite Cooling Heat Exch. No. 1 Vent
693	GCRV-309-3	Graphite Cooling Heat Exch. No. 1 Vent
694	GCSV-305-1	Graphite Cooling Heat Exch. No. 1 Outlet - Vent
695	GCRV-304-1	Graphite Cooling Heat Exch. No. 1 Inlet
696	GCRV-309-4	Graphite Cooling Heat Exch. No. 2 Vent
697	GCRV-309-5	Graphite Cooling Heat Exch. No. 2 Vent
698	GCSV-305-2	Graphite Cooling Heat Exch. No. 2 Outlet - Vent
699	GCRV-304-2	Graphite Cooling Heat Exch. No. 2 Inlet - Vent
700	GCRV-309-6	Graphite Cooling Heat Exch. No. 3 Vent
701	GCRV-309-7	Graphite Cooling Heat Exch. No. 3 Vent
702	GCSV-305-3	Graphite Cooling Heat Exch. No. 3 Outlet - Vent
703	GCRV-304-3	Graphite Cooling Heat Exch. No. 3 Inlet
704	GCRV-309-8	Graphite Cooling Heat Exch. No. 4 Vent
705	GCRV-309-9	Graphite Cooling Heat Exch. No. 4 Vent
706	GCSV-305-4	Graphite Cooling Heat Exch. No. 4 Outlet - Vent
707	GCRV-304-4	Graphite Cooling Heat Exch. No. 4 Inlet Vent
708	GCSV-317-1	Demin. Makeup Water to Graphite Cool. Sys. Shutoff
709	GCSV-317-2	Demin. Makeup Water to Graphite Cool. Sys. Shutoff
710	GCSV-310-1	Graphite Coolant Recirc. Pump No. 1 Suction - Drain

ITEM NO.	VALVE MARK NUMBER	DESCRIPTION
711	GCSV-305-6	Graphite Coolant Recirc. Pump No. 1 Disch. - Vent
712	GCSV-310-5	Graphite Coolant Recirc. Pump No. 2 Suction - Drain
713	GCSV-305-7	Graphite Coolant Recirc. Pump No. 2 Disch. - Vent
714	GCSV-310-6	Graphite Coolant Recirc. Pump No. 3 Suction - Drain
715	GCSV-305-8	Graphite Coolant Recirc. Pump No. 3 Disch. - Vent
716	GCRV-309-10	Graphite Cooling Heat Exch. No. 1 Drain
717	GCRV-309-11	Graphite Cooling Heat Exch. No. 1 Drain
718	GCRV-304-6	Graphite Cooling Heat Exch. No. 1 Inlet - Drain
719	GCRV-309-12	Graphite Cooling Heat Exch. No. 2 Drain
720	GCRV-309-13	Graphite Cooling Heat Exch. No. 2 Drain
721	GCRV-304-7	Graphite Cooling Heat Exch. No. 2 Inlet Drain
722	GCRV-309-14	Graphite Cooling Heat Exch. No. 3 Drain
723	GCRV-309-15	Graphite Cooling Heat Exch. No. 3 Drain
724	GCRV-304-8	Graphite Cooling Heat Exch. No. 3 Inlet Drain
725	GCRV-309-16	Graphite Cooling Heat Exch. No. 4 Drain
726	GCRV-309-17	Graphite Cooling Heat Exch. No. 4 Drain
727	GCRV-304-9	Graphite Cooling Heat Exch. No. 4 Inlet Drain
728	GCSV-306-4	Graphite Coolant Recirc. Pump No. 1 Drain
729	GCSV-306-5	Graphite Coolant Recirc. Pump No. 2 Drain
730	GCSV-306-6	Graphite Coolant Recirc. Pump No. 3 Drain
731	GCSV-304-5	Graphite Coolant from Reactor - Drain
732	GCSV-310-7	Graphite Coolant to Reactor - Drain
733	GCSV-305-5	Graphite Coolant Recirc. Pump Discharge Header - Vent
734	GCSV-305-9	Graphite Coolant Recirculation - Vent
735	GCSV-316-1	Emergency Raw Water Graphite Coolant to Reactor
736	RVTV-203-1	Pressurizer Vent
737	RVTV-203-2	Pressurizer Vent
738	GCSV-310-8	Graphite Coolant Recirc. Pump Discharge Header - Drain
739	PRV-204-1	Pressurizer Strongback - Drain
740-A		Low Pressure Helium
		Valves Located Outside Stm. Gen. Cells
740-B	GCSV-315-2	Graphite Coolant Recirc. Pump Disch. Header - Drain
741	GCSV-315-1	Graphite Coolant Recirc. Pump Disch. Header - Drain
742	GCSV-306-1	Graphite Coolant Recirc. Pump No. 1 Casing - Vent
743	GCSV-306-2	Graphite Coolant Recirc. Pump No. 2 Casing - Vent
744	GCSV-306-3	Graphite Coolant Recirc. Pump No. 3 Casing - Vent

off

own on Decontamination Control
B" - 109-N


Tank #1-NaOH
Tank #2-NaOH
Tank #3-NaOH
Tank #4-H_2O_2
Screw Conveyor
Swing Chute Position Ind.
WI-202 Dry Chemical Storage Bin
Dry Chemical Storage Bin
Bin Agitator
Screw Conveyor
Bin Outlet
Screw Feeder
Vibrator Feeder
To DCB
Soln. Area Sump Pump
NaOH Trans Pump
H_3PO_4 Trans. Pump
H_2O_2 Trans. Pump
To Radioactive Vent Header
DCRV 215-1
Soln. Prep. Area Sump
RDRV-215-1
SV-201
SOHV-203-1
SV-202
CPAT 203-1
SV-203
CHPV
DCRV 220-1
Decont. Mix Tank Vent. Blower
Bisulfite/Carb/Bicarb - Outlet Feeder Speed
Pot-Perman Outlet Feeder
Pot-Perman Outlet Feeder Speed
Bkt. Elev Vib. Feeder
DCRV-207-1
Decontam. Heat Exch.
MPV 241-1
SV-204
TI-250
FI-251
SV-229
SV-205
Heating Steam Supply
Agitator
Decontam. Mix Tank
Inlet-Outlet By-Pass Valve Control
DCRV 222-1
DCRV 208-4
DCRV-215-2
DCRV 212-1
DCRV
DCRV 208-1
DCRV 208-2
CAPV 208-1
DCFV 206-1
DCFV 214-4
DCFV 206-2
DCRV 217-1
DCRV 217-2
DCFV 214-1
DCFV 214-2
DCFV 214-3
FI-252
FI-263
FI-253
FI-254
FI-255
DCFV 224-1
To Solution Area Sump
Bearing Temp. Monitor Decont. Inj. Pumps
DCRV 212-1
DCFV 225-1
DWV 216-1
FWV 225-1
DCRV 218-1
SV-206
SV-226
SV-207
SV-208
SV-209
Decont. Inj. Pump #1
Decont. Inj. Pump #2
PG-341
DCRV 224-1
DCRV 218-1
DCFV 216-1
Lamp Test
Demin. Water Supply
Filtered Water Supply
DCFV 223-1
DCFV 223-2
To Radioac. Vent. Header
To Solution Prep. Area Sump
SV-230
SV-232
SV-231
EIH



LEGEND

- Equipment Control Switch
- Flow Measuring Orifice (Color Same as Piping)
- Pushbutton Switch
- Valve Operating Switch
- Green Indicating Light (Off or Closed Position)
- Amber Indicating Light (On or Open Position)
- Shut Off Valve
- Control Valve
- Check Valve
- Red Indicating Light (Abnormal Condition)
- White Indicating Light
- Temperature Measurement Mimic (Color Same as Piping)

MIMIC BARS COLOR CODE

- Filtered or Demin. Water
- Chem. Decontaminant
- Pot. Permanganate Sod. Bisulphate or Carbonate Bicarbonate
- Hydrogen Peroxide
- Phosphoric Acid
- Sodium Hydroxide
- Steam
- Filtered Water
- Demineralized Water
- Instrument Sensing
- Instrument Loading
- Vents
- Drains

DESIGNATION OF INDICATORS AND CONTROLLERS

INSTR. MARK NO.	DESCRIPTION
LI-214	Sodium Hydroxide Tank No. 1 Level Ind.
LI-216	Sodium Hydroxide Tank No. 2 Level Ind.
LI-212	Phosphoric Acid Tank No. 3 Level Ind.
LI-210	Hydrogen Peroxide Tank No. 4 Level Ind.
TI-299	Hydrogen Peroxide Tank No. 4 Temp. Ind.
WI-201	Potassium Permanganate Bin Weight Ind.
WI-202	Sodium Bisulphate or Carbonate Bicarbonate Bin Weight Ind.
FI-248	Sodium Hydroxide Transfer Pump Disch. Flow Ind.
FI-249	Phosphoric Acid Transfer Pump Disch. Flow Ind.
FI-250	Hydrogen Peroxide Transfer Pump Disch. Flow Ind.
SV-201	Sodium Hydroxide Transfer Pump Disch. Flow Contr. Selector
SV-202	Phosphoric Acid Transfer Pump Disch. Flow Contr. Selector
SV-203	Hydrogen Peroxide Transfer Pump Disch. Flow Contr. Selector
SV-204	Decontaminant to Mix Tank Temp. Contr. Selector
TI-205	Decontaminant to Mix Tank Temp. Ind.
FI-251	Decontaminant to Mix Tank Flow Ind.
SV-205	Decontaminant to Mix Tank Flow Contr. Selector
LI-288	Decontaminant Mix Tank Level Ind.
TI-396	Decontaminant Mix Tank Temp. Ind.
CI-201	Ion Exch. Inlet Conductivity Ind.
CI-202	Ion Exch. Outlet Conductivity Ind.
FI-252	Decontaminant Return Drain Flow Ind.
FI-253	Demineralized Water Supply Flow Ind.
FI-254	Filtered Water Supply Flow Ind.
PG-341	Decontamination Injection Pumps Disch. Pressure Gage
FI-255	Decontaminant Supply Flow Ind.
SV-206	Decontaminant Return Drain Flow Contr. Selector
SV-207	Demineralized Water Supply Flow Contr. Selector
SV-208	Filtered Water Supply Flow Contr. Selector
SV-209	Decontaminant Supply Flow Contr. Selector
SV-226	Decont. Spill Flow Contr. Selector
FI-263	Decont. Spill Flow Indicator
SGI-201	Decont. Mix Tank Specific Gravity Indicator
SV-231	Decont. Injection -------Specific Grav. Set Pt. Manual Loader
SV-229	Decon. Return to Mix Tank -----------------Specific Grav. Set. Pt. Manual Loader
SV-230	Decon. Return to Radioactive Drain ------- Specific Grav. Set Ft. Manual Loader
SV-232	Decont. Spill ------ Specific Grav. Set Ft. Manual Loader
	Lamp Test Control Switch

DESIGNATION OF VALVE MIMICS

VALVE MARK NO.	SERVICE
SOHV-203-1	Sodium Hydroxide to Decontamination Mix Tank
CPAV-203-1	Phosphoric Acid to Decontamination Mix Tank
CHPV-203-1	Hydrogen Peroxide
DCRV-215-1	Decontamination Mix Tank Vent
DCRV-207-1	Decontaminant Return to Decontamination Mix Tank
MPV-246-1	Steam to Decontamination Heat Exch.
DCFV-212-1	Decontaminant Supply and Return Cross Conn.
DCFV-224-1	Decontaminant Spill Flow
DCRV-218-1	Decontaminant Return Radioactive Drain
DCRV-220-1	Decontaminant Return Radioactive Drain
DCRV-212-1	Demineralized Water to Preparation Area
DCRV-208-3	Filtered Water to Preparation Area
DWV-216-1	Demineralized Water to Preparation Area
FWV-225-1	Filtered Water to Preparation Area
DCRV-208-1	Water to Decontamination Inj. Pumps Suction
DCRV-208-2	Decontaminant Bypass at Decontamination Mix Tank
CPAV-208-1	Phosphoric Acid to Decontamination Inj. Pumps Suct.
DCFV-206-1	Decontamination Mix Tank Bottom Outlet
DCFV-214-4	Decontamination Mix Tank Bottom Outlet Drain
DCFV-206-2	Decontamination Mix Tank Upper Outlet
DCFV-214-1	Decontaminant Feed to Ion Exchanger
DCRV-217-1	Filtered Water to Ion Exchanger Inlet
DCRV-217-2	Filtered Water to Ion Exchanger Outlet
DCFV-214-2	Decontaminant Feed From Ion Exch.
DCFV-214-3	Decontaminant Feed Bypass at Ion Exch.
DCFV-216-1	Decontaminant Feed From Preparation Area
DCRV-222-1	Decontaminant To Decontamination Heat Exch.
DCRV-208-4	Water to Decontaminant Return
DCRV-215-2	Water to Decontamination Mix Tank
DCFV-225-1	Decontaminant Spill Flow
DCFV-217-1	Resin Disposal From Ion Exchanger
DCFV-218-1	Decontaminant Feed to Sump
DCRV-224-1	Filtered Water to Sump
DCFV-223-1	Decontamination Injection Pump No. 1 Vent
DCFV-223-2	Decontamination Injection Pump No. 2 Vent
RDRV-215-1	Decontaminant Return to Sump

DECONTAMINATION CONTROL PANELS "DCA", "DCB" AND "DR" - 109-N

General

The master control center for the Decontamination System is located on the 0'-0" level, area 6, in the 109-N Bldg., east of the turbine bay area. This center consists of three panels: Panel "DCA", "DCB", and "DR". Panels "DCA" and "DCB" are of the graphic type and "DR" is a small instrument panel housing three recorders. The three panels are mounted as one unit, with the panel-graphic layouts joining as a single system. These panels contain the master control switches for operating the unloading, mixing and transferring equipment used in the decontamination system.

Panel "DCA" contains the control switches, indicating lights, and associated instruments used in conjunction with the chemical preparation operation. The lines connecting the various pieces of equipment are color coded for easier identification. A legend is mounted on the panel for reference to color code. All valves, orifices, check valves, tanks, pumps, and other pieces of equipment are symbolized on the panels. Indicating lights are mounted next to the switch or valve with which they are associated.

Green light indicates "off" or "closed" position
Amber lights indicate "on" or "open" position
Red light indicates an abnormal condition

All drive motors are energized from the 480 Volt system through MCC #35, with the exception of the two Injection Pumps which are 4160 Volts.

Panel "DCB"

Mounted on this panel are the control switches, indicating lights and graphic layout for routing and control of the decontamination solutions to the primary and graphite cooling systems, annunciator panel and communication facilities (HCC Master and WPC Remote).

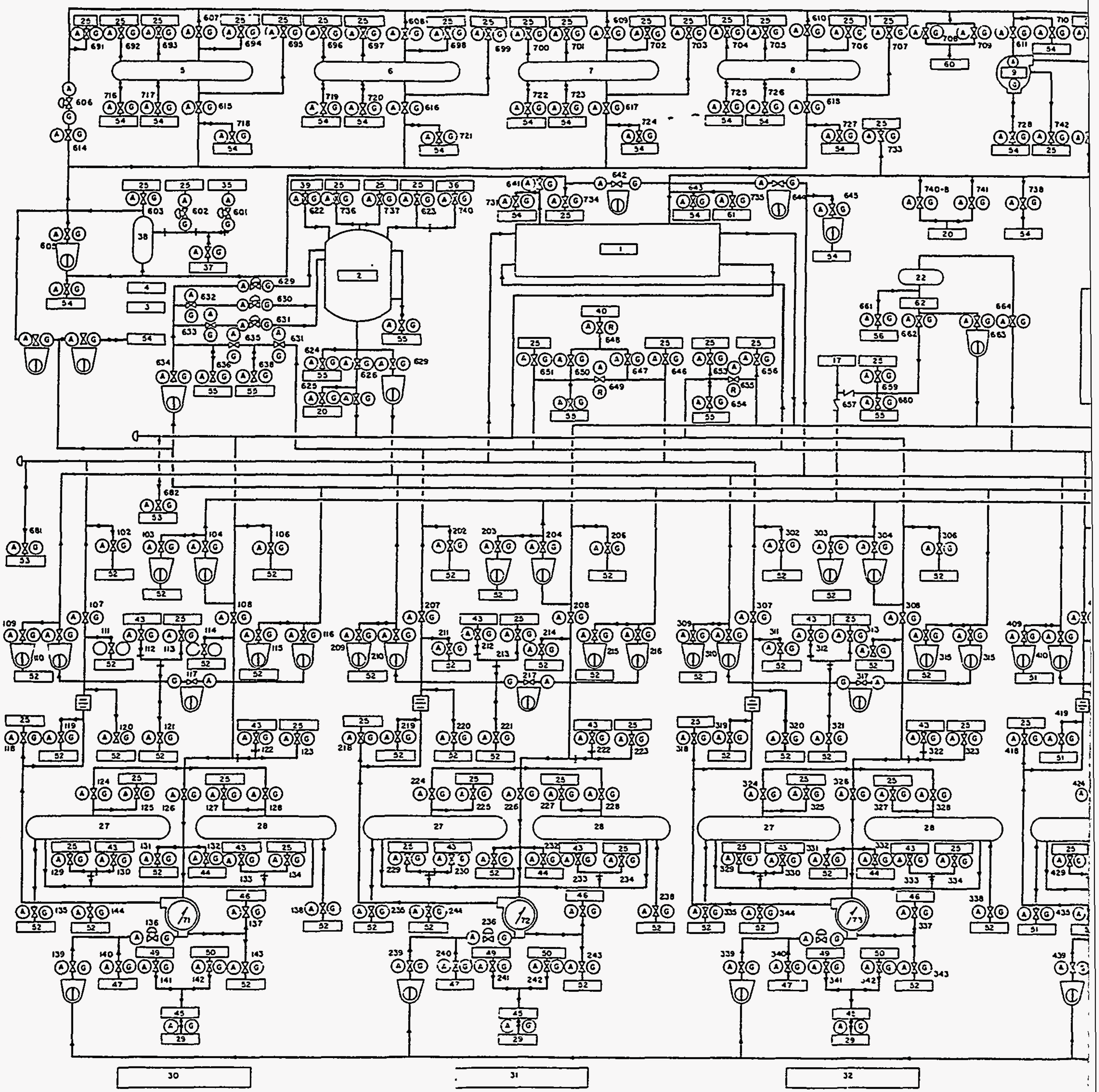
Should the secondary system become contaminated, temporary piping will be installed and the decontamination process controlled from the "DCA" and "DCB" panels.

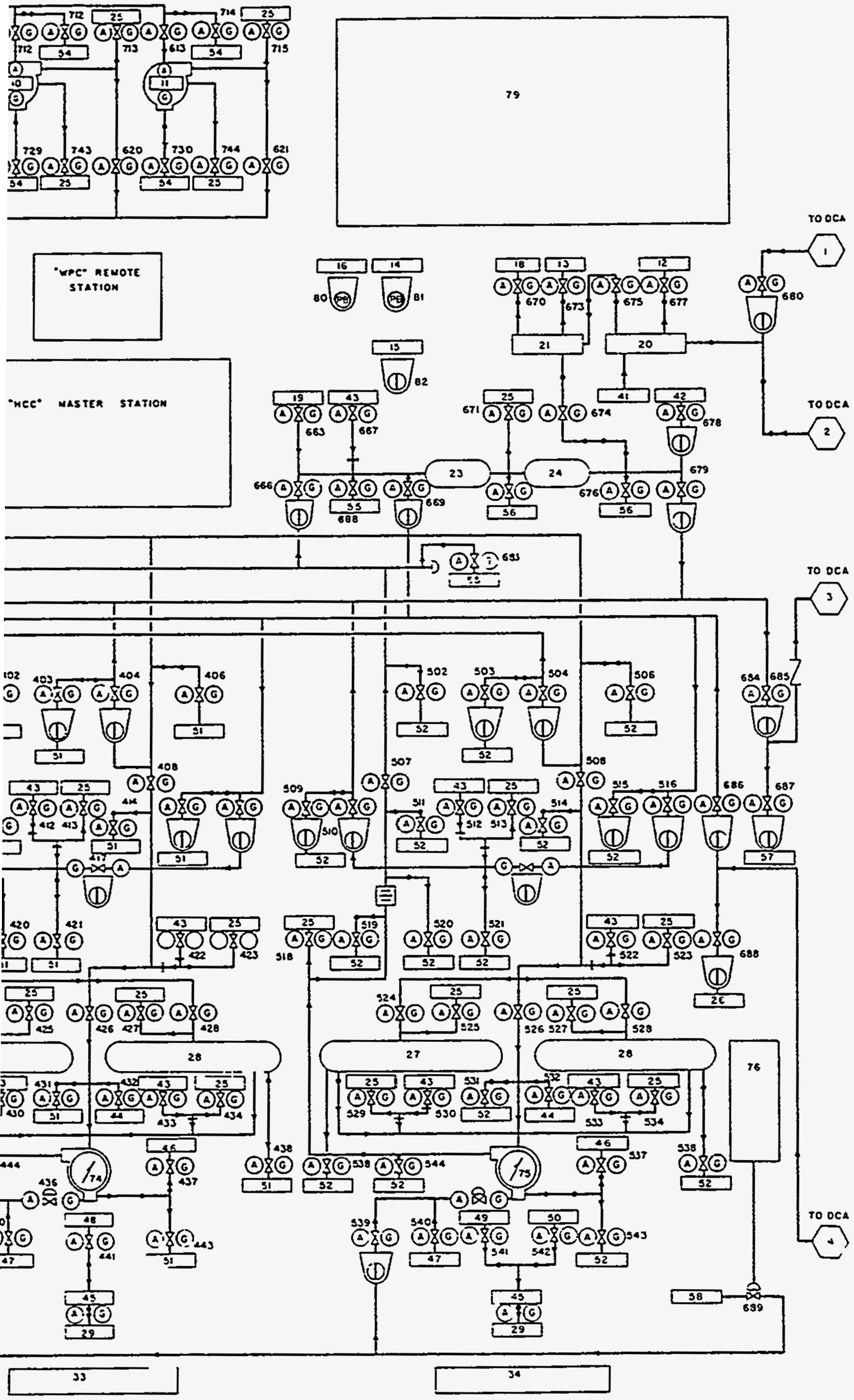
DR - Decontamination Recorder Panel

The "DR" panel serves as a mounting for three flow recorders:

Recorder #1 (3 pen)	FR-243 - Injection Pump discharged flow FR-244 - Return flow to mix tank flow FR-245 - Return flow to Radioactive Drain flow
Recorder #2 (2 pen)	*FR-246 - Sodium Hydroxide Transfer Pump discharge flow *FR-247 - Phosphoric Acid Transfer Pump discharge flow
Recorder #3 (3 pen)	*FR-248 - Hydrogen Peroxide Transfer Pump flow FR-249 - Filtered Water to decontamination system flow FR-250 - Demineralized Water to decontamination system flow

*With integrator





EQUIPMENT MIMICS AND NAMEPLATES

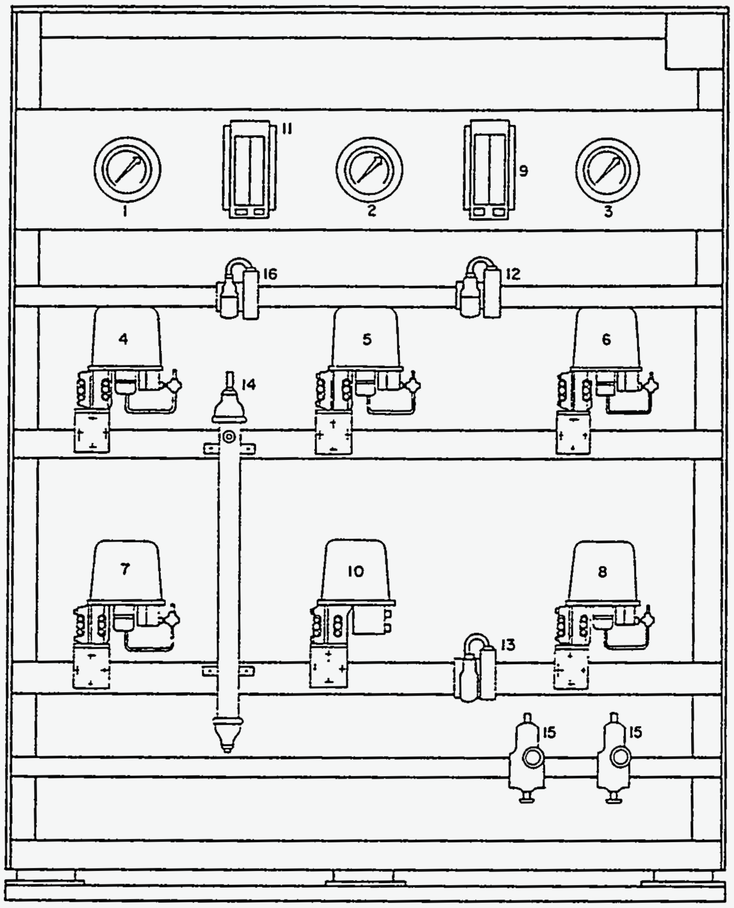
ITEM NO	ENGRAVING
1	Reactor
2	Pressurizer
3	Backup Spray
4	Cycling Spray
5	Graphite Cooling Heat Exchanger No. 1
6	Graphite Cooling Heat Exchanger No. 2
7	Graphite Cooling Heat Exchanger No. 3
8	Graphite Cooling Heat Exchanger No. 4
9	Graphite Coolant Recirc. Pump No. 1
10	Graphite Coolant Recirc. Pump No. 2
11	Graphite Coolant Recirc. Pump No. 3
12	Waste to River
13	Waste to Crib
14	Annunciator Test
15	Lamp Test
16	Annunciator Acknowledge
17	Flush to Waste Thru 105N
18	Waste to Chemical Waste Facility
19	From Diversion and Purity Blowdown
20	To Radioactive Valve Pit via 10" RDR
21	To Waste Disposal Valve Pit via 12" RDR
22	Spill Cooler
23	Recuperative Heat Exchanger No. 1
24	Recuperative Heat Exchanger No. 2
25	To Radioactive Vent Header
26	Decontaminant Supply to 105N Bldg.
27	Steam Generator A
28	Steam Generator B
29	Cell Sump Pump
30	Cell No. 1
31	Cell No. 2
32	Cell No. 3
33	Cell No. 4
34	Cell No. 5
35	H.P. Helium Pressurizing
36	Lo Press. Helium
37	L.P. Helium Fill
38	Graphite Cooling Surge Tank
39	Vents from 105N Reactor Outlet Header
40	Once thru Filtered Water Supply
41	From Pressurizer - Reactor Outlet Header Connector Drain
42	To Reactor Outlet Header
43	Helium Supply
44	Injection Water to Pump Makeup
45	Cell Sump Tank
46	To Waste via Radioactive Drain Valve Pit or to High Lift Pump House
47	Normal Seal Water Supply From H.P. Injection System
48	Cell Drain Inlet
49	Cell Drain Inlet
50	Pipe Gallery Drain Inlet
51	Drain to Cell Drain Inlet
52	Drain to Cell Drain Inlet
53	Drain to Cell No. 1 Pipe Gallery Drain Inlet
54	Drain to Cell No. 2 Pipe Gallery Drain Inlet
55	Drain to Cell No. 3 Pipe Gallery Drain Inlet
56	Drain to Cell No. 5 Pipe Gallery Drain Inlet
57	To Solution Preparation Area Sump
58	L.P. Demin. Water Supply to Primary Coolant Pump Seals
59	
60	Demineralized Makeup Water Supply
61	Emergency Raw Water Supply From Fog Spray Pumps
62	Spill Control Station

MISCELLANEOUS ITEMS

NO.	INSTR. MARK NO.	DESCRIPTION
71	SI-211	Primary Coolant Pump No. 1 Speed Indicator
72	SI-212	Primary Coolant Pump No. 2 Speed Indicator
73	SI-213	Primary Coolant Pump No. 3 Speed Indicator
74	SI-214	Primary Coolant Pump No. 4 Speed Indicator
75	SI-215	Primary Coolant Pump No. 5 Speed Indicator
76	SV-210	Demin. Water to Primary Coolant Pumps Seals Control Selector
77	POI-238	Graphite Cooling Surge Tank Bypass Valve (GCRV-302-1) Position Indicator
79	-------	Annunciator (Furn. By Buyer)
80	-------	Annunciator Acknowledge Pushbutton
81	-------	Annunciator Test Pushbutton
82	-------	Lamp Test Switch - Control Switch
WPC	-------	"WPC" Remote Station
HCC	-------	"HCC" Master Station
HS	-------	Hand Set

nel "DCB" - 109-N

The NRDL panel, located at the -16' level along the south wall adjacent to the hydrogen peroxide transfer pump, was designed for local mounting of pressure gauges, flow transmitters, level transmitters, votometers and air regulators associated with the decontamination system.



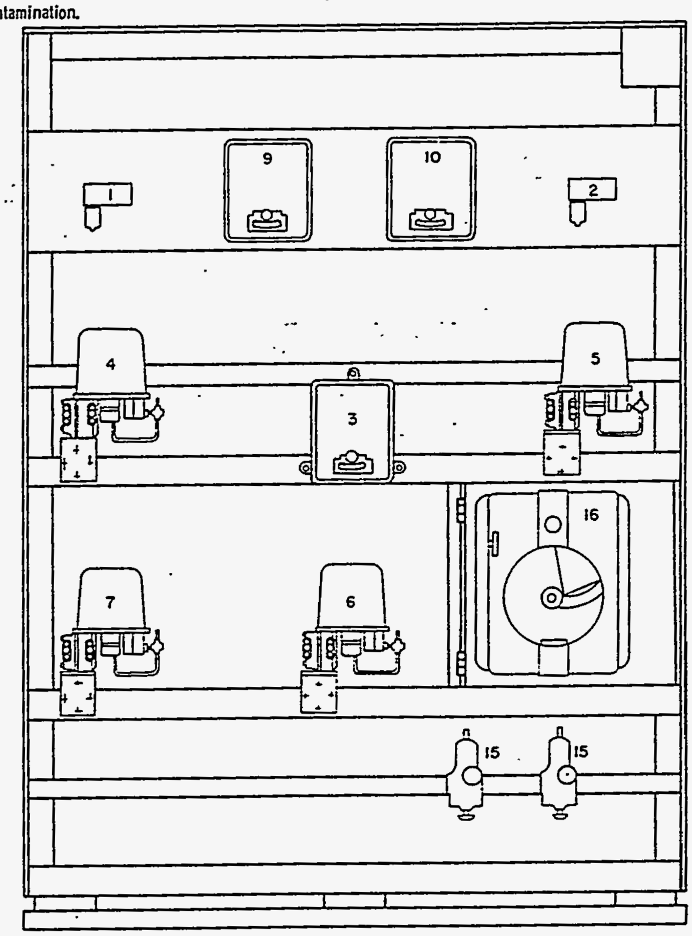
DESIGNATION OF ITEMS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
1	PG-373	50% Hydrogen Peroxide Transfer Pump Discharge Pressure Gauge
2	PG-374	Phosphoric Acid Transfer Pump Discharge Pressure Gauge
3	PG-375	Sodium Hydroxide Transfer Pump Discharge Pressure Gauge
4	FT-276	50% Hydrogen Peroxide Transfer Pump Discharge Flow Transmitter
5	FT-274	Phosphoric Acid Transfer Pump Discharge Flow Transmitter
6	FT-275	Sodium Hydroxide Transfer Pump Discharge Flow Transmitter
7	FT-270	Demineralixed Water to Decontamination System Flow Trans.
8	FT-271	Filtered Water to Decontamination System Flow Transmitter
9	LT-253	Hydrogen Peroxide Tank Level Transmitter
10	LT-252	Decontamination Mix Tank Level Transmitter
11	SGT-201	Specific Gravity Transmitter
12		Diff. Pressure Regulator with Rotometer
13		Diff. Pressure Regulator with Rotometer
14		Suppression Chamber
15		Supply Air Reducing Station
16		Diff. Pressure Regulator with Rotometer

NRLD-Non-Radioactive Decontamination Local Panel - 109-N

The RDL panel, located at the -22' level in the solutions preparations area cell was designed for local mounting of pressure switches, pressure transmitters, flow transmitters and ion exchanger conductivity transducers associated with the decontamination system.

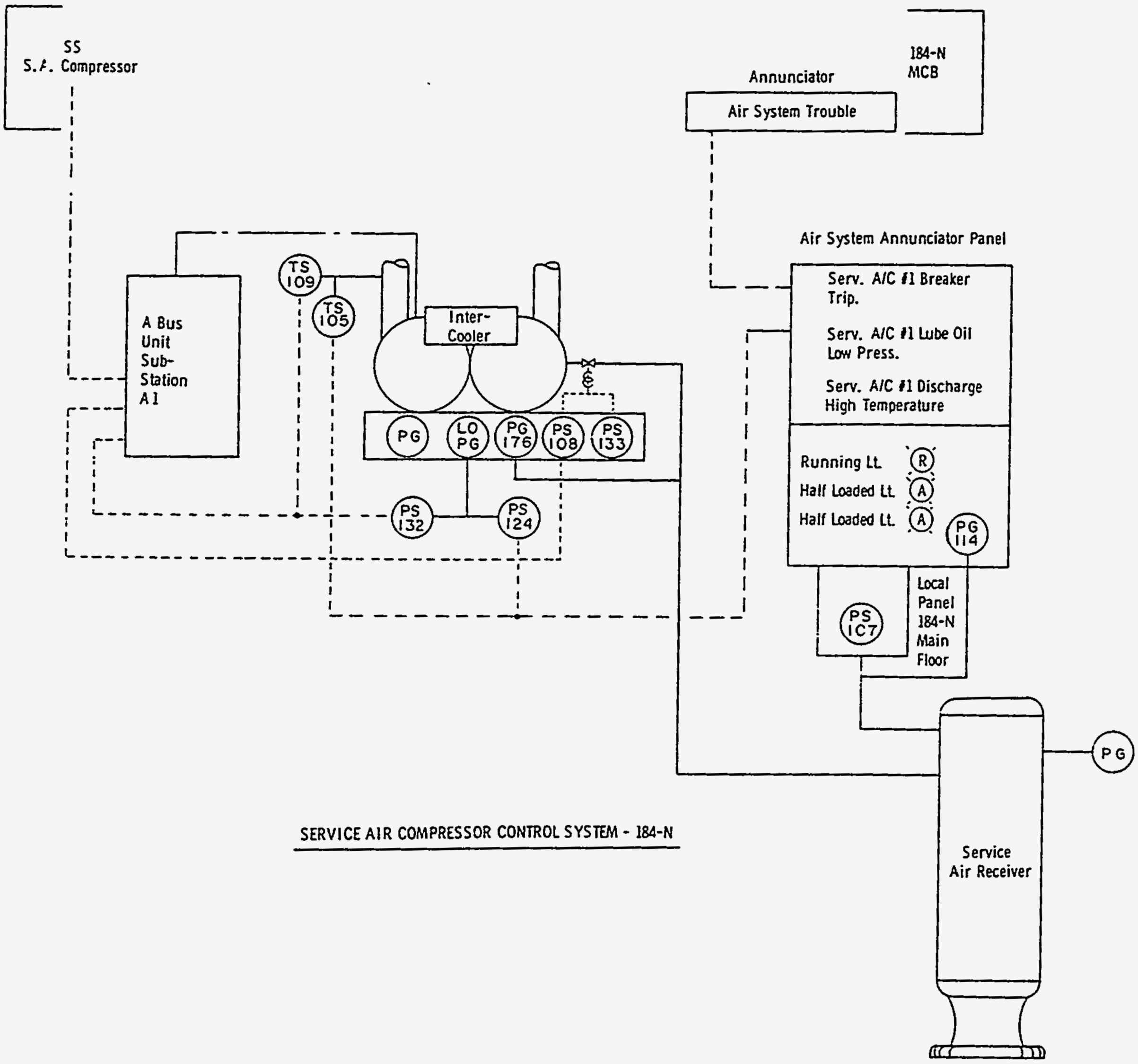
The panel is located in a radiation zone and normally will not be accessible during system decontamination.



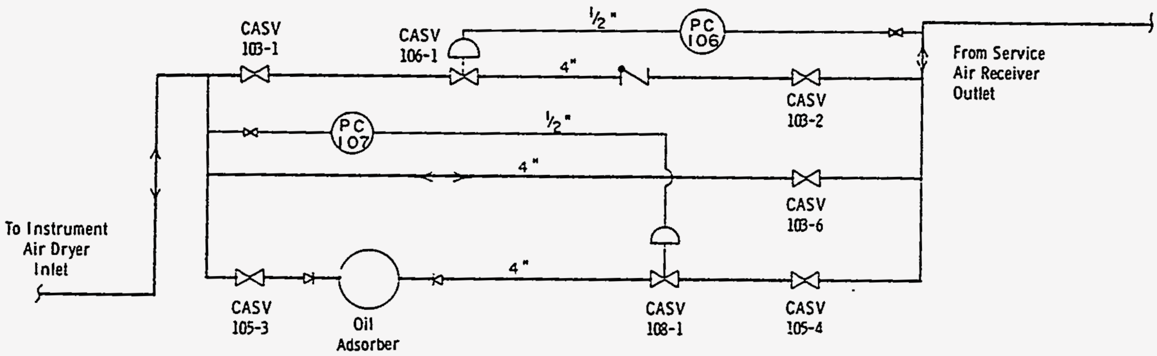
DESIGNATION OF ITEMS

ITEM NO.	INSTR. MARK NO.	DESCRIPTION
1	PS-305	Decontamination Injection Pump No. 2 Seal Water Diff. Pressure Switch
2	PS-304	Decontamination Injection Pump No. 1 Seal Water Diff. Pressure Switch
3	PT-283	Decontamination Injection Pumps Discharge Pressure Transmitter
4	FT-273	Decontaminant Feed to Primary Systems Flow Transmitter
5	FT-269	Decontaminant Return to Decont. Mix Tank Flow Transmitter
6	FT-265	Decontaminant Spill Flow Transmitter
7	FT-272	Decontaminant Return to Radioactive Drain Flow Transmitter
9	TT-218	Mix Tank Temperature Transmitter
10	TT-217	Decontaminant Return Temperature Transmitter
15		Supply Air Reducing Station
16	REL-272, 273	Ion Exchanger Conductivity Transducer

NRLD-Non-Radioactive Decontamination Local Panel - 109-N



SERVICE AIR COMPRESSOR CONTROL SYSTEM - 184-N



SERVICE AIR-INSTRUMENT AIR BACKUP CONTROL

Service Air Control Systems - 184-N

SERVICE AIR CONTROL SYSTEMS - 184-N

The service air compressor controls act to regulate compressor output within set pressure limits thus maintaining a constant service air pressure range. The service air compressor (Ref. 9.1-2) is provided with "Step Control" to increase or decrease the output of the compressor in steps. The compressor can operate in the following steps:

1. No load on either the high pressure or low pressure cylinder heads.

2. Half of the high pressure cylinder and half of the low pressure cylinder loaded (compressing).

3. Both halves of each cylinder loaded.

Air is admitted to each half of the HP and LP compression cylinders through inlet valves which close for the compression stroke when loaded. When a desired pressure is attained in the air receiver, a pressure switch on the compressor is actuated. Pressure switch actuation opens the unloader solenoid which allows unloading air pressure to build up against the diaphragm of the inlet valve. Thus, the inlet valve is held open and the inlet air, which would normally be compressed on the compression stroke, is pushed back out of the open inlet valve.

A selector switch for the service air compressor is located on the Mechanical Control Board in 184-N and has positions for "Run", "Off" and "Standby".

The compressor will load and unload from pressure switches 108 and 133 located on the compressor. With the selector switch on "Standby", the compressor motor will start from PS-108 when the receiver pressure drops to 95 psig. The compressor will start in the unloaded condition and a cooling water solenoid valve will open admitting cooling water to the compressor and intercooler. After a time delay to allow the motor to come up to speed, half of each compressor cylinder will load. If the receiver pressure increases to 115 psig, PS-108 will unload the cylinders; if the receiver pressure decreases to 90 psig, PS-133 will load the remaining half of each cylinder. When the pressure increases to 110 psig, PS-133 will unload half of each cylinder and at 115 psig, PS-108 will unload the other half.

The compressor motor will start when the selector switch is turned to "Run" and the compressor will load-unload according to PS-108 and PS-133 as outlined above. The half of the compressor which is controlled by the pressure switch with the higher setpoints will carry the base load.

The compressor motor will trip from the following causes:

1. High discharge air temperature from TS-109 on the compressor discharge header.

2. Low lube oil pressure from PS-132 on the compressor.

3. Thermal overload at unit substation switchgear.

These trips will initiate a lockout relay in the unit substation "A" to prevent the compressor from being restarted. The lockout switch must be reset by turning the Service Air Compressor Reset Knob above the unit substation main breaker before restarting the compressor.

SERVICE AIR CONTROL SYSTEMS - 184-N (CONT'D)

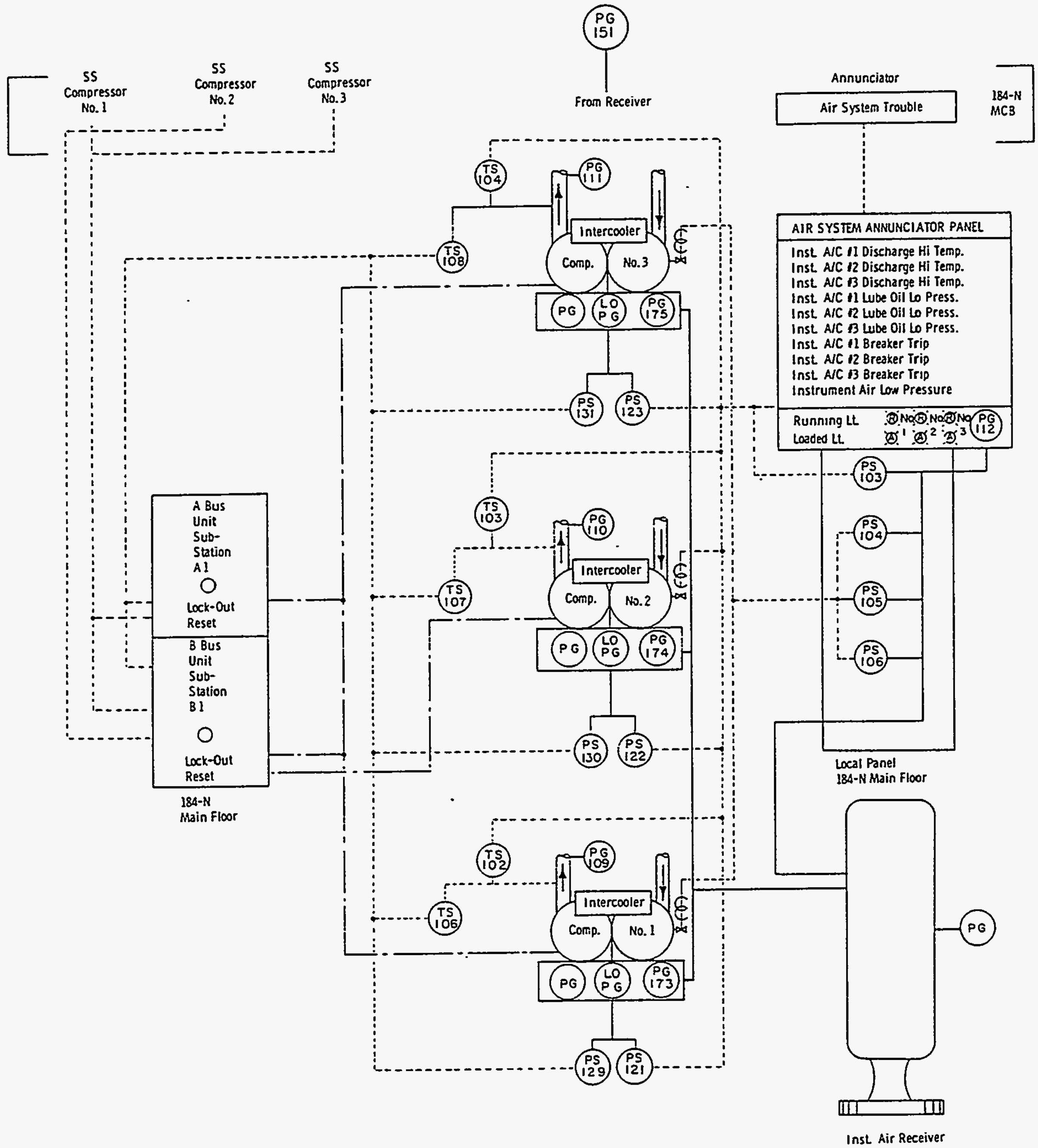
A local annunciator panel and indication panel are located on the east wall of 184-N. Service air low pressure is annunciated by PS-107 on the receiver, service air compressor high discharge air temperature is annunciated by TS-105 on the compressor discharge, and low lube oil pressure is annunciated by PS-124 on the compressor (See 9.1-2). Service air compressor breaker trip is annunciated from substation "A". Any local annunciation initiates an "Air System Trouble" annunciator in the 184-N control room.

Two separate indicating lights, each labeled "Half Loaded" are located on the indication panel. Both lights will be on when the compressor is fully loaded.

Service air receiver pressure is indicated at the compressor and at the local panel. Lube oil pressure intercooler pressure, and discharge air temperature are indicated at the compressor.

A contact on PS-107 will close SAV 103-1 by means of solenoid valve CASV 153-1 when service air receiver pressure drops. This has the effect of removing all 184-N services, except the boiler atomizing air, from the service air system.

A service air-instrument air backup station is provided in 184-N for cross-feeding the two systems. Low service air pressure will open CASV 106-1 admitting instrument air, which has bypassed the dryer, into the service air system. CASV 108-1 will allow service air to flow through an oil absorber to the dessicant dryer inlet on low instrument air pressure. Service air cannot, however, enter the breathing air system.



Breathing and Instrument Air Control Systems - 184-N

BREATHING AND INSTRUMENT AIR CONTROL SYSTEMS 184-N

The instrument air compressor controls act to regulate compressor output within specified limits and thus, maintain a constant pressure range to the instrument and breathing air systems. Instrument and breathing air systems are supplied from three instrument air compressors (Ref. 9.1-2). These compressors are loaded and unloaded by inlet valve regulation as is the service air compressor (See 21.8.1). Thus, when the desired pressure is attained in the receiver, a pressure switch will cause the inlet valve to the compressor cylinders to be held open and no air will be compressed.

These compressors are not capable of half-load operation, but achieve load flexibility by varying the number of compressors in the loaded condition.

Selector switches for the instrument air compressors are located on the Mechanical Control Board in 184-N with positions for "RUN", "STANDBY A", "STANDBY B", and "STOP" (the first three of these positions are provided on Bus "A" and Bus "B" for compressors No. 1 and No. 3). The compressors will load and unload from pressure switches 104, 105, and 106 located in the compressed air panel on the east wall of 184.

When the selector switch is turned to "RUN" the compressor motor will start. The solenoid cooling water valve will open, admitting cooling water to the compressor and intercooler, and the interstage calrod heaters will be energized. The compressor will begin to load after a time delay if the receiver pressure is below 95 psig as set on PS-104. When receiver pressure reaches 115 psig the compressor will run in the unloaded condition.

With the selector switch on "STANDBY A", PS-105 will start the compressor when receiver pressure drops to the setpoint of 90 psig. The compressor will load after a time delay and will unload at 110 psig while the motor continues to run. Operation of a compressor from the selector switch position of "STANDBY B" is similar to "STANDBY A" except the control setpoints are 85 psig to 110 psig as set on PS-106.

Thus, an operating sequence can be provided by placing one compressor on "RUN", one on "STANDBY A" and one on "STANDBY B". The "lead" compressor, or the one with the selector switch on "RUN", will carry most of the load.

Instrument air compressor motors trip off from the following causes:

1. Low lube oil pressure initiated from PS-129 (Comp. #1), PS-130 (#2), or PS-131 (#3) on the compressor.

2. High discharge air temperature initiated from TS-106 (#1), TS-107 (#2), or TS-108 (#3) on the discharge header from the compressor.

3. Thermal overload in unit substation switchgear.

These trips actuate a lock-out relay in the unit substation. This lock-out relay must be reset by the reset knob above the main breaker at each substation before the compressor can be restarted.

BREATHING AND INSTRUMENT AIR CONTROL SYSTEMS 184-N (CONT'D)

Instrument air system annunciation is outlined below:

1. Instrument air compressor discharge high temperature from TS-102 (#1), TS-103 (#2), or TS-104 (#3) on the compressor discharge header.

2. Instrument air compressor lube oil low pressure from PS-121 (#1), PS-122 (#2), or PS-123 (#3) at the compressor.

3. Instrument air compressor breaker trip from the lock-out relay at unit sub-station "A1" (#1 and #3) or "B1" (#1, #2, and #3).

4. Air dryer trouble from the cycling failure limit switch between the dryer towers.

5. Instrument air low pressure from PS-103 in the local panel. Setpoint is 70 psig.

6. Any of the local annunciators outlined above will initiate an air system trouble annunciator in the 184 control room.

Instrument air receiver pressure is indicated at the receiver, at the local panel, and at the compressor. Lube oil pressure, intercooler pressure, discharge pressure and discharge temperature are indicated at the compressor. Indicating lights are provided at the local panel for "RUNNING" and "LOADED".

The Dehyditrol Unit (Ref. 9.1.1.3-2) for drying instrument air consists of two towers which alternate service and regenerate every four hours. Air flow is switched from one tower to the other by four-way valves which are operated by an air cylinder. A timer actuates solenoid valves to supply driving air to the cylinder.

Heating and purging is maintained in the regenerating tower for about 2.2 hours at which time the timer de-energizes the heating element. The tower is then cooled for 1.8 hours before assuming the drying load.

DIESEL STARTING AIR
SERVICE AIR
INSTRUMENT AIR CONTROL SYSTEMS
182-N AND 181-N

Diesel Starting Air Control System

Diesel starting air control systems act to regulate the compressed air output of two high pressure air compressors in 182-N (Ref. 9.1.6.1) by dual control, permitting constant speed load-unload, or automatic start-stop operation. Controls consist of a solenoid operated three-way valve, magnetic motor starter, suction unloading valves, selector switch and one pressure switch for each of the two modes of operation.

Unloading of the first and second stage compressor cylinders is accomplished when the suction valves are held open by means of unloading air pressure, thus, allowing air to pass freely in and out of the cylinders without being compressed. Unloading of the first and second stages results in reduced suction pressure to the third stage, automatically causing the third stage suction valve to be held open. The unloading air pressure is admitted to the first and second stages through a solenoid operated, three-way valve from an auxiliary air receiver at each compressor.

A HAND-OFF-AUTOMATIC selector switch for each compressor is located on the mechanical control board at 182-N. When the selector switch is placed to the "HAND" position, the compressor will start in the unloaded condition and a solenoid valve will be energized, admitting cooling water to the compressor. After a time delay, the compressor will load if pressure is below the setpoint of a pressure switch located on the main receiver manifold (PS 600 for compressor No. 1 and PS 607 for compressor No. 2). The compressor will unload but continue running when the pressure reaches the high setpoint on the same pressure switch.

With the selector switch on "AUTO" the compressor will start when pressure falls below the setting of a pressure switch on the receiver manifold (PS 599 for compressor No. 1 and PS 606 for compressor No. 2). When pressure reaches the upper setpoint of this pressure switch, the contacts snap open interrupting the circuit to the motor as well as the unloading solenoid. Thus, the motor is stopped and the compressor is simultaneously unloaded.

The following situations will initiate a trip of an operating compressor motor and annunciation on the 182-N control room panel No. 101:

1. High discharge air temperature from adjustable temperature switches on the compressor discharge line (TS 551 for compressor No. 1 and TS 552 for compressor No. 2).

2. Low lube oil pressure from Bowser pressure switches on each compressor.

These motor trips actuate a latching relay for each compressor which prevents the motor from being restarted. To restart the compressor, the latching relay must be reset at the south side of the compressors.

DIESEL STARTING AIR
SERVICE AIR
INSTRUMENT AIR CONTROL SYSTEMS
182-N AND 181-N (CONT'D)

Additional annunciation for the diesel starting air system sonsists of the following signals:

1. "Hi Press. Air Comp. Discharge Header Lo Press." in 182 control room from PS 566 on the receiver outlet.

2. "High Lift Diesel No. 1 Lo Air Pressure", "High Lift Diesel No. 2 Lo Air Pressure", and "High Lift Diesel No. 3 Lo Air Pressure" on 182-N annunciator panel No. 100 from PS 577, 578 and 579, respectively, at the local diesel panels.

3. "Fog Spray Diesel No. 1 Lo Air Pressure" and "Fog Spray Diesel No. 2 Lo Air Pressure on 182-N annunciator panel No. 100 from PS 580 and 581, respectively, at the local diesel panels.

4. "Low Lift Diesel No. 1 Low Starting Air Pressure" and "Low Lift Diesel No. 2 Low Starting Air Pressure" annunciators are actuated at 181-N from PS 510 and PS 511, respectively. This, in turn, annunciates "Low Lift Diesel No. 1 Trouble" and "Low Lift Diesel No. 2 Trouble" at 182-N on panel No. 101.

Indication for the diesel starting system is outlined below:

1. First stage pressure, second stage pressure and third stage pressure indication by pressure gauges mounted on each compressor.

2. Auxiliary air receiver pressure indication by a pressure gauge on the auxiliary receivers.

3. Air compressor discharge pressure indication at pressure gauges on the discharge lines.

4. Cooling water inlet temperature (TI 590 for compressor No. 1, TI 591 for compressor No. 2) and coolign water outlet temperature (TI 588 for No. 1, TI 589 for No. 2) at the compressors.

5. Cooling water inlet pressure indication on compressor No. 1.

6. Air receiver pressure at each of the three receivers and in the 182 control room.

7. Lube oil flow indication and crankcase level indication at each compressor.

8. Starting air pressure indication at pressure gauges on local panels for each fog spray diesel, each high lift diesel, and each low lift diesel.

DIESEL STARTING AIR
SERVICE AIR
INSTRUMENT AIR CONTROL SYSTEMS
182-N AND 181-N (CONT'D)

Service air controls act to reduce high pressure compressed air to constant pressures for use in 182-N and 181-N services (see 9.1.6.1).

In 182-N, a pressure reducing valve, SAV-554-1, reduces air pressure to 151 psig for the SA-1 system which supplies the fog spray accumulator. Another pressure reducing valve, SAV-562-1, reduces high pressure air to 100 psig for system SA-2 which supplies service air outlets. Pressure is indicated on PG 684 north of the starting air receivers.

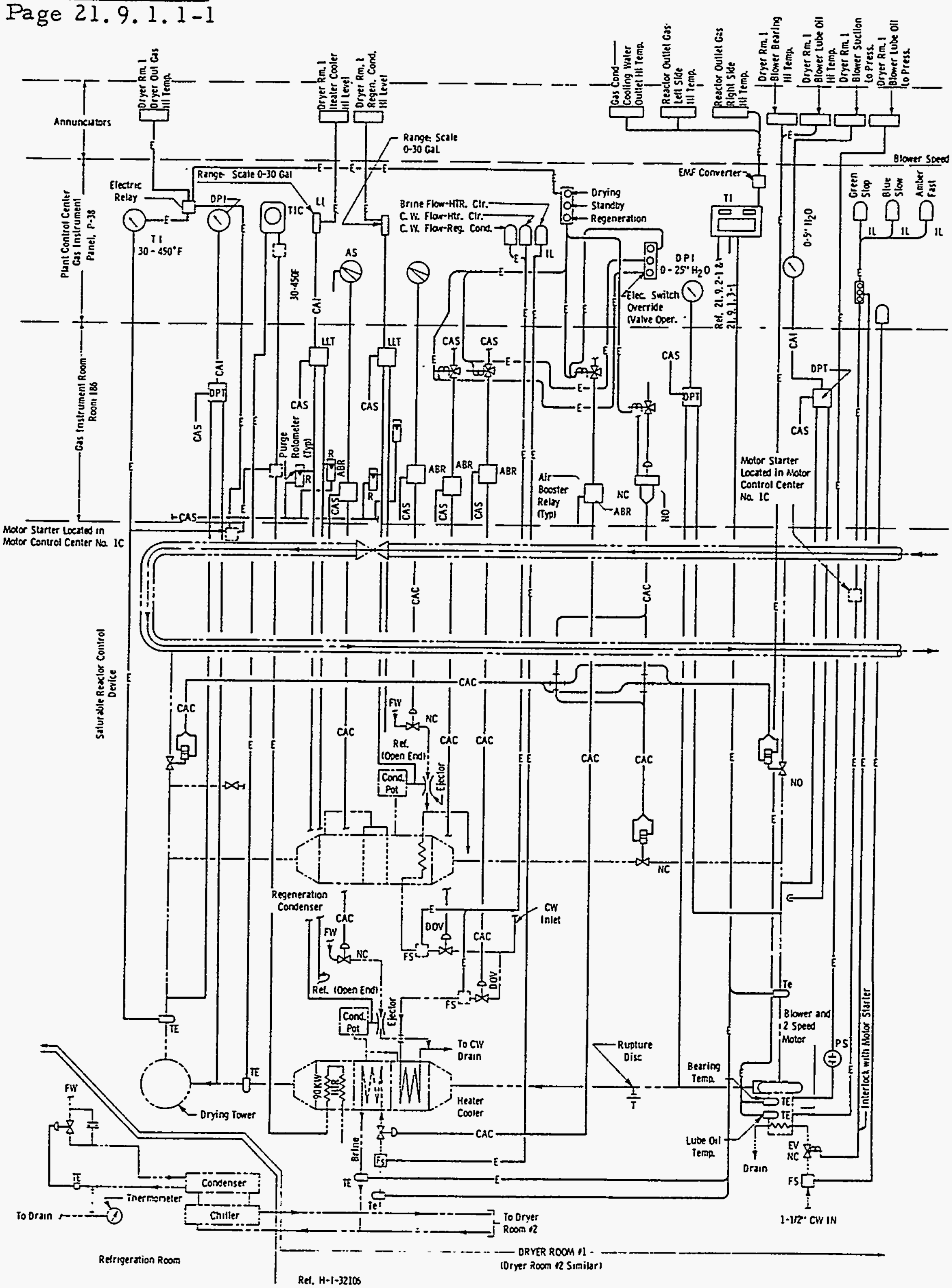
Pressure reducing valve SAV-560-1 is set at 70 psig for system SA-3 supplying the potable water tank and pressure controller PC-557 acts to vent excess air pressure from the tank to atmosphere.

A pressure reducing valve in 181-N, SAV-503-1, reduces high pressure starting air to 100 psig for supply to the building service air outlets (Ref. 9.1.7.1). Pressure is indicated on PG-512 at a small air surge tank in the south-east corner of the building.

Instrument Air Control

The instrument air control system regulates control air supply pressure for valve operators, flow transmitters, flow controllers, pressure controllers, and heating-ventilation control equipment (Ref. 9.1.6.2). A pressure reducing valve, CASV-551-2, reduces control air pressure to 68 psig for potable water tank pressurization as a backup to the SA-3 supply. A pressure switch, PS-593, is located on the CAS supply header from 184-N in the northeast norner of the 182-N basement. This pressure switch actuates an "Instrument Air Supply Header Low Pressure" alarm on panel 100 in the 182-N control room.

The CAS pressure to 181-N instrumentation is indicated at pressure gauges on the back of the screen wash control panel.



Dryer Room Control System - 105N

DRYER ROOM CONTROL SYSTEM - 105N

Two identical control and dryer room systems are provided so that drying of the reactor gas atmosphere can be continuous. Semi-automatic control of all fluid flow or heating operations is maintained by two sets of selector switches located on the gas instrument panels in the plant control center. These switches provide three operating modes. They are: Drying, standby, and regeneration.

The electrical control to accomplish the above operations includes magnetically-held pushbuttons, relays and solenoid pilot valves. The following describes the normal operating sequence:

1. Position selector switch No. 1 to "drying" and selector switch No. 2 to "regeneration".
2. At high moisture alarm, position selector switch No. 1 to "regeneration" and No. 2 to "drying".
3. Alternate "drying" and "regeneration" for each subsequent high moisture alarm or on a time schedule as desired.

The functions that occur during each of the three modes of operation are outlined in the table below:

Selector Switch Position	Helium Gas Flow For Each Switch Position	Automatic Utility Flow For Each Switch Position (Amber Light Indicates Flow)	Automatic Gas Heater Operation For Each Switch Position	Manually Position Blower Sw. to -
"DRYING" (Manually set)	From loop thru heater cooler & dryer then back to loop. No flow thru R. cond.	* F.W. to htr. clr. - Open Brine " " " - Open F.W. to reg. cond.- Closed	Heater is OFF, "DRYING" pushbutton lighted	SLOW/FAST (ill. P.B. lighted)
"STANDBY" (Manual or auto. set after reg.)	Circulates thru regen. cond. & heater cooler loop only. Main gas circ. loop is isolated.	* F.W. to htr. clr. - Closed Brine " " " - Closed F.W. to reg. cond.- Closed	Heater is OFF, "STANDBY" pushbutton is lighted.	STOP
"REGEN." (manually set)	Recirculates thru regen. cond. heater cooler & drying tower only. Main gas circ. loop is isolated.	* F.W. to htr. clr. - Closed Brine " " " - Closed F.W. to reg. cond.- Open *Refers to supply valve position.	Heater is ON indicated by lighted regen. pushbutton. Auto. return to standby and off when dryer becomes reactivated.	SLOW/FAST

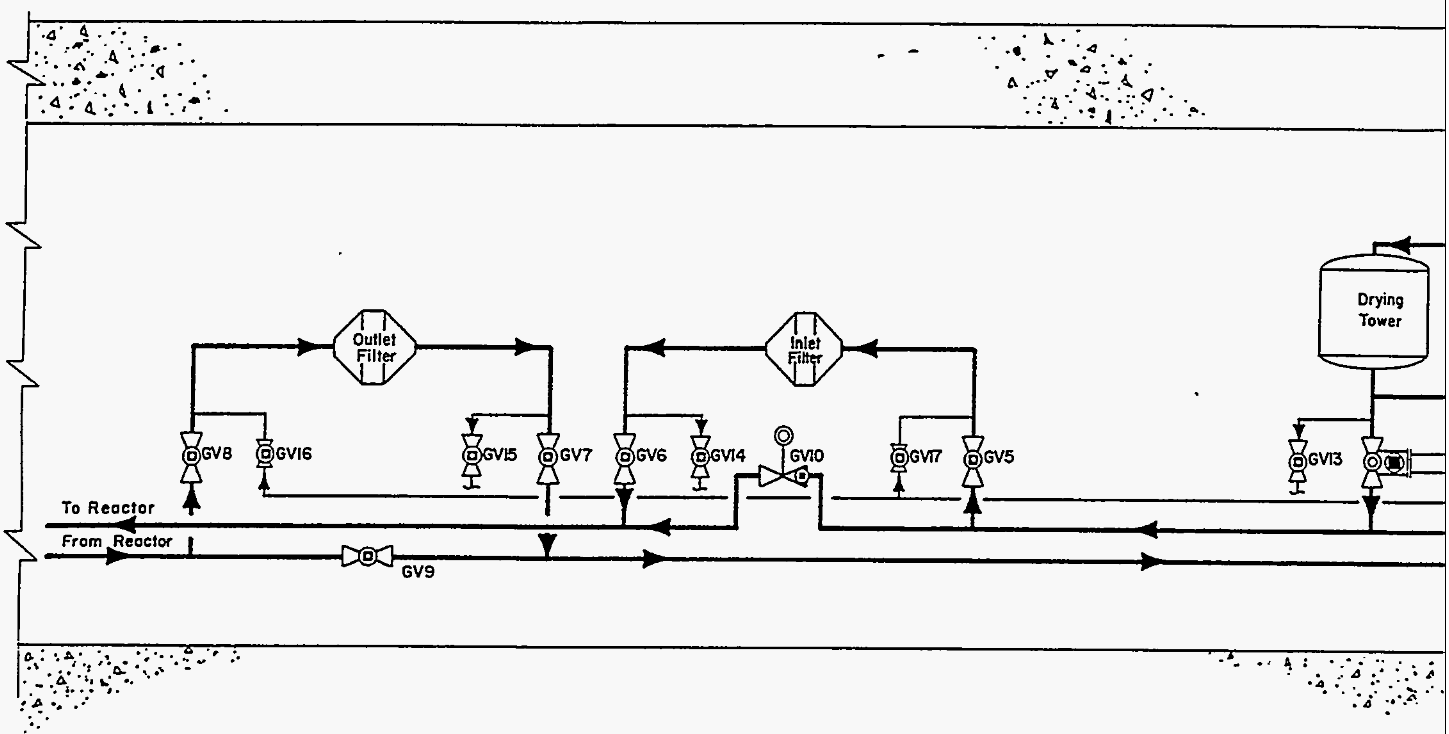
DRYER ROOM CONTROL SYSTEM - 105N (CONT'D)

Other instrumentation and controls are detailed below with their relationship to the above three operating modes (See Section 10 for mechanical description).

1. The selector switch automatically positions supply valves for the utility services. The open-closed notation in the table refers to these valves. Normally, brine will not be indicated as flowing, as brine flow should only be needed during drying-out periods. When brine is needed, the refrigeration compressor must be started locally (Ref. 10.1.2.1). Flow for all utilities is indicated by amber lights actuated by flow switches.
2. An over-ride switch permits opening the brine and filtered water supply valves at any time. This would be useful to remove sensible heat from the dryer after the heating cycle, if regeneration and cooling time is critical.
3. The blower speed (slow-fast) and stop controls are manual. The blower suction static pressure indicates and annunciates, the blower bearing oil temperature and pressure annunciate; blower lube oil temperature, blower differential temperature and gas suction temperature indicate; and blower oil cooling water flow is shown by an indicating light and is controlled by a solenoid valve actuated when the blower is started.
4. A temperature indicator controller is used to control drying tower inlet gas temperature during regeneration by modulating the electrical input to the heater. When the drying towers outlet gas temperature rises, a temperature indicator with relay interlock acts to shut off the heater. This signals that the dryer is regenerated. The relay is also connected to the drying room selector switch, causing it to return to the "standby" position. High outlet dryer temperature is annunciated.
5. The drying tower differential pressure is indicated.
6. A miscellaneous temperature indicating system consisting of an 18-point temperature indicator receives 11 T/C signals (7 spares). Each of the 11 inputs can be indicated by actuation of a switch on the instrument. Three of the 11 points annunciate as shown in the schematic. The following lists the inputs:

    Left side outlet gas (indicate & alarm)
    Right side outlet gas (indicate & alarm)
    Cooling water outlet main condenser (indicate & alarm)
    Reactor outlet gas
    Heater cooler No. 1 brine inlet
    Heater cooler No. 2 brine inlet
    Heater cooler No. 1 brine outlet
    Heater cooler No. 2 brine outlet
    Reactor inlet gas
    Suction gas blower No. 1
    Suction gas blower No. 2

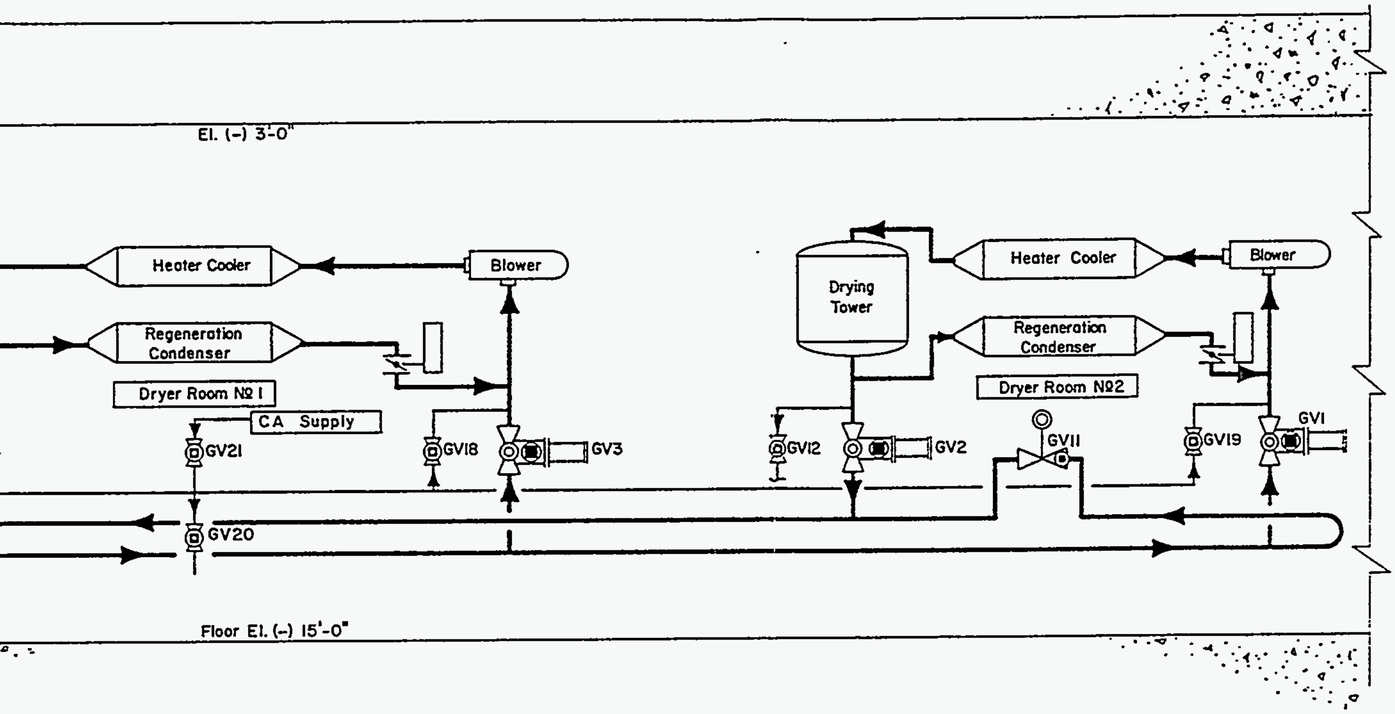
7. The liquid level in the condensate tanks for the heater cooler and the regenerator is indicated and annunciated on high level. Air switches are used to eject tank contents to drain.



VALVE IDENTIFICATI

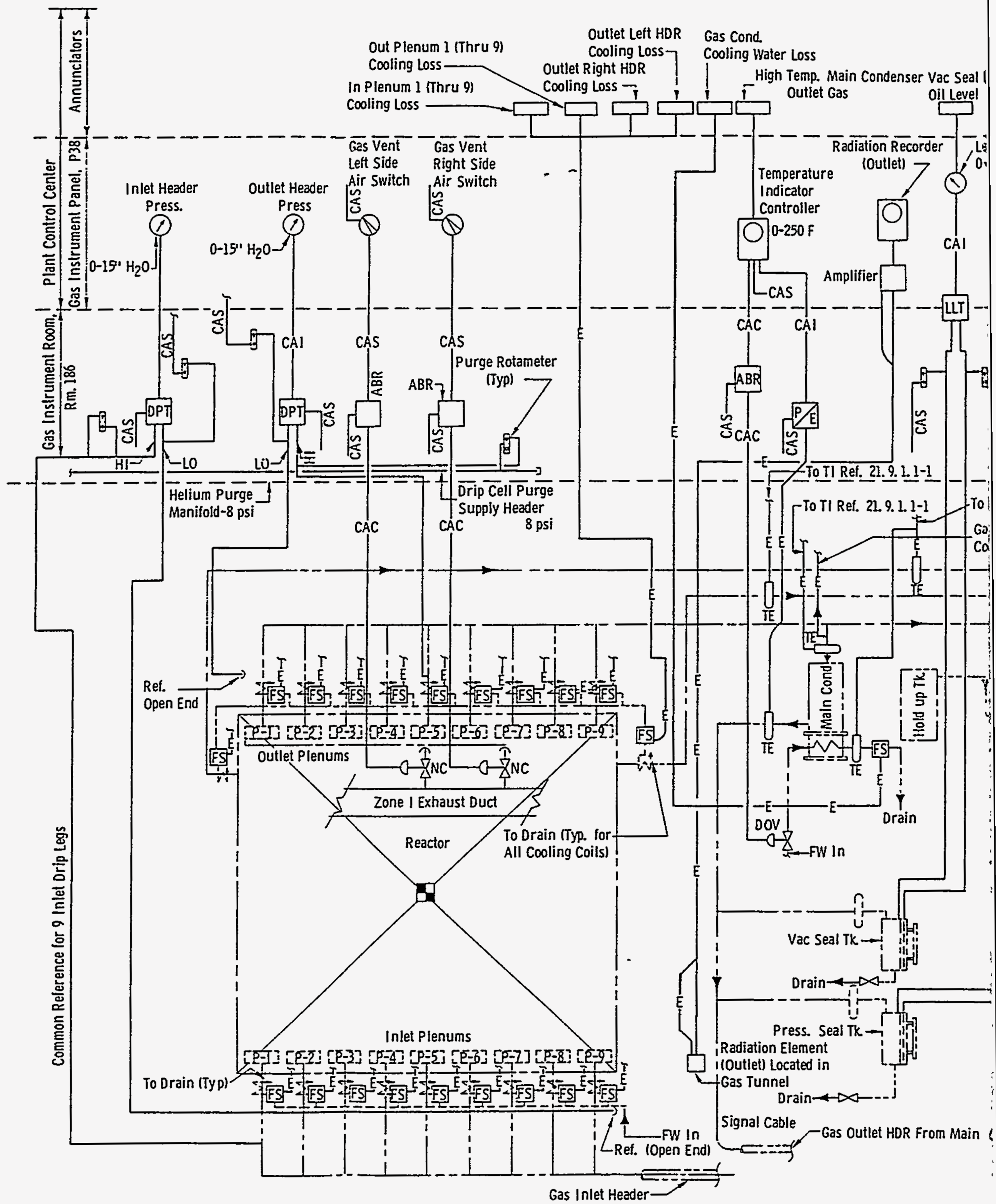
Valve No.	Description
GV1	To Blower
GV2	From Tower
GV3	To Blower
GV4	From Tower
GV5	To Filter
GV6	From Filter
GV7	From Filter
GV8	To Filter
GV9	Filter Bypass
GV10	Filter Bypass
GV11	Isolation Valve

Gas Operating Gallery Fl

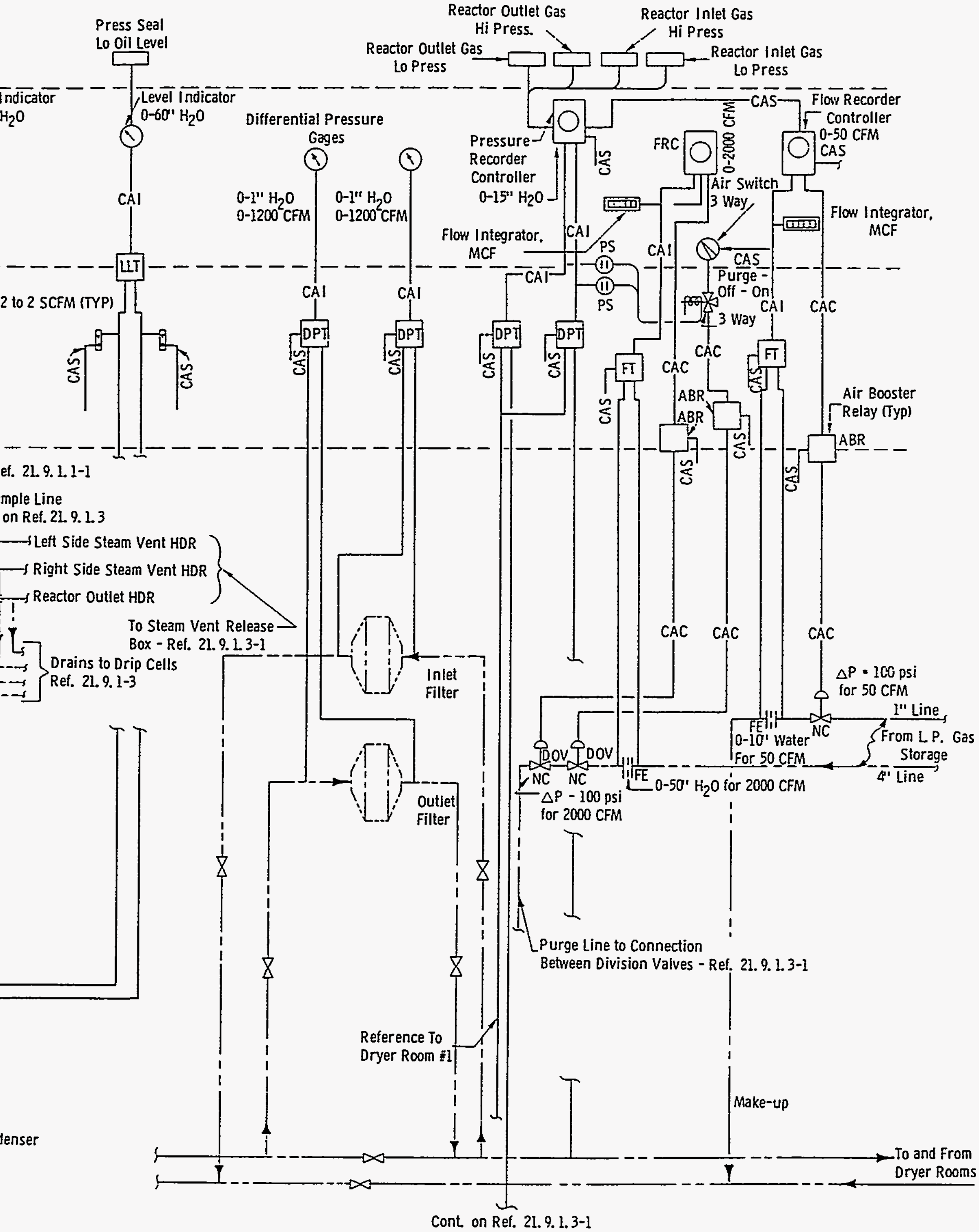


TABLE

Valve No.	Description
GV12	Vent
GV13	Vent
GV14	Vent
GV15	Vent
GV16	"CA" Purge & Press. Equalizing
GV17	"CA" Purge & Press. Equalizing
GV18	"CA" Purge & Press. Equalizing
GV19	"CA" Purge & Press. Equalizing
GV20	"CA" Purge Vent Valve
GV21	"CA" Purge Supply Valve (Blanked)



Pile Gas Contro



Press Seal
Lo Oil Level
Reactor Outlet Gas
Hi Press.
Reactor Inlet Gas
Hi Press
Reactor Outlet Gas
Lo Press
Reactor Inlet Gas
Lo Press
Indicator
H_2O
Level Indicator
0-60" H_2O
Differential Pressure
Gages
Pressure Recorder Controller
0-15" H_2O
CAS
FRC
0-2000 CFM
Flow Recorder
Controller
0-50 CFM
CAS
Air Switch
3 Way
Flow Integrator,
MCF
CAI
0-1" H_2O
0-1200 CFM
0-1" H_2O
0-1200 CFM
Flow Integrator,
MCF
PS
CAI
LLT
2 to 2 SCFM (TYP)
Purge - Off - On
3 Way
CAC
DPT
FT
ABR
Air Booster
Relay (Typ)
ef. 21.9.1.1-1
mple Line
on Ref. 21.9.1.3
Left Side Steam Vent HDR
Right Side Steam Vent HDR
Reactor Outlet HDR
To Steam Vent Release
Box - Ref. 21.9.1.3-1
Drains to Drip Cells
Ref. 21.9.1-3
Inlet
Filter
Outlet
Filter
ΔP = 100 psi
for 50 CFM
1" Line
FE
0-10" Water
For 50 CFM
NC
From L.P. Gas
Storage
4" Line
DOV
NC
ΔP - 100 psi
for 2000 CFM
0-50" H_2O for 2000 CFM
Purge Line to Connection
Between Division Valves - Ref. 21.9.1.3-1
Reference To
Dryer Room #1
Make-up
denser
To and From
Dryer Rooms
Cont. on Ref. 21.9.1.3-1

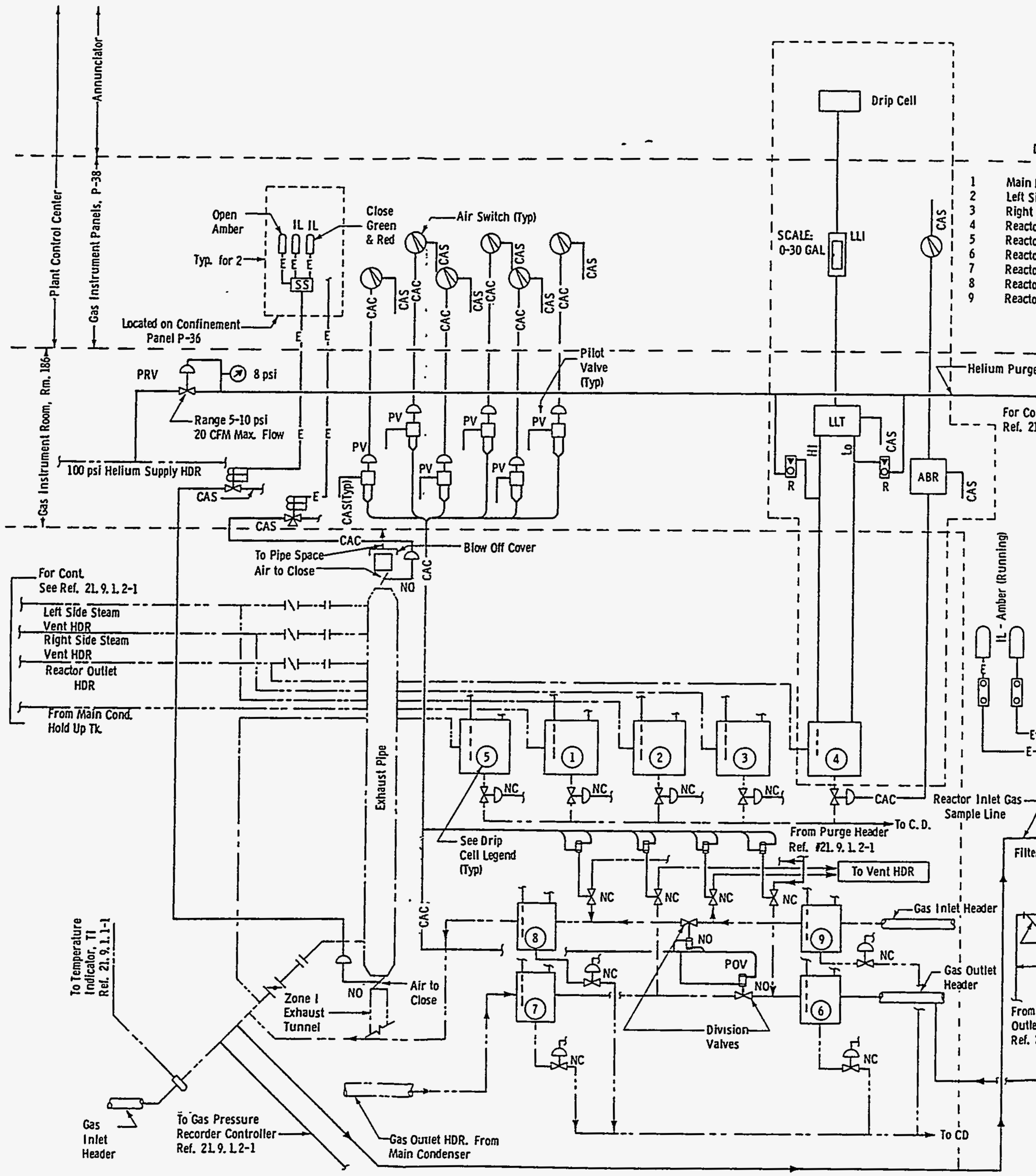
PILE GAS CONTROL SYSTEM - 105N

The pile gas control system is designed to maintain system pressure through normal makeup, to permit purging the system with helium in the case of contaminants, to control gas temperature with the main condenser, and to monitor various pressures, temperatures, and levels.

The control functions shown in the schematic on Page 21.9.1.2-1 are itemized below:

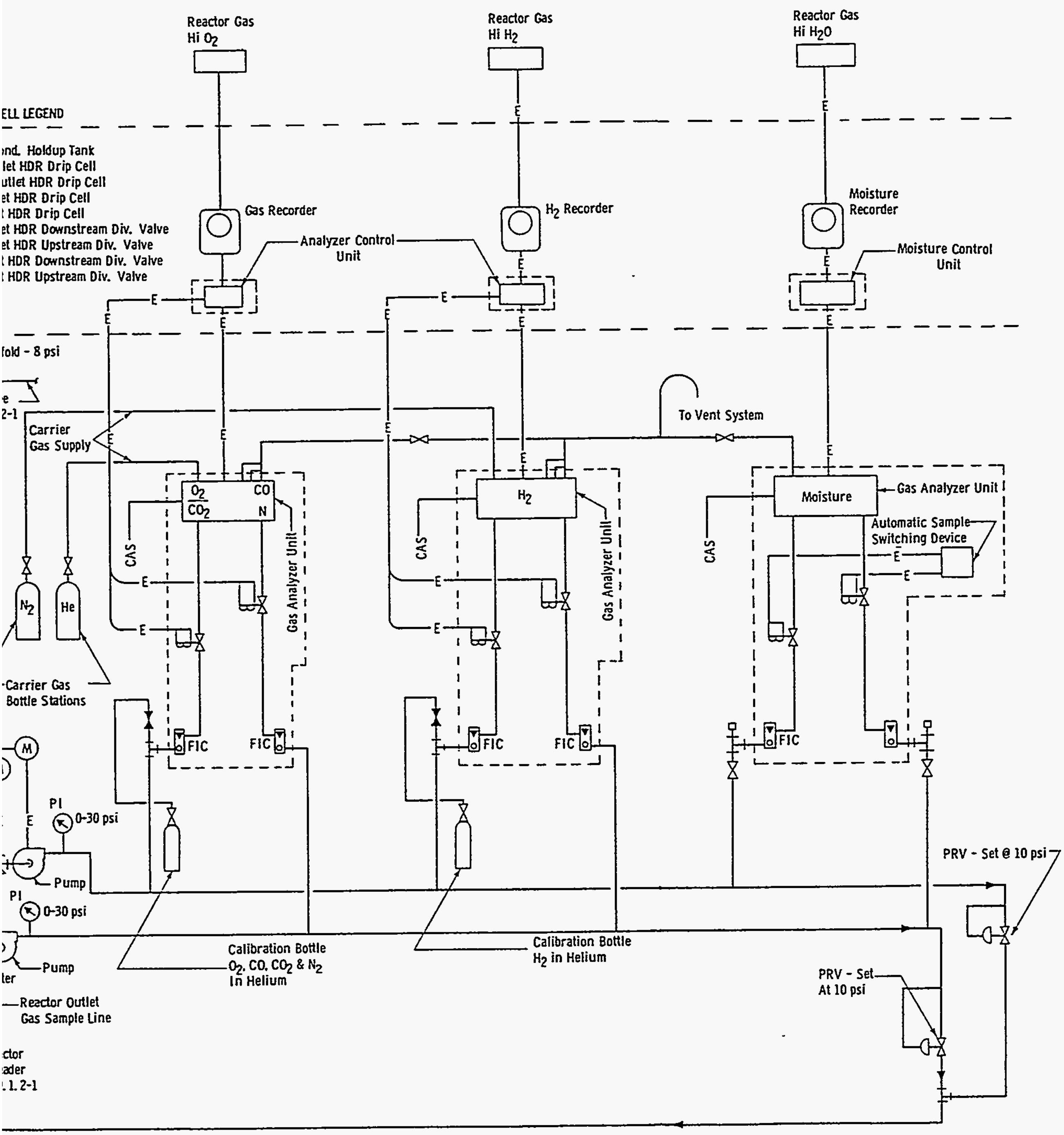
1. Reactor Outlet Gas Temperature Control - A thermocouple (0-250°F) in the gas outlet from the main condenser sends a signal to an indicator-controller which positions a diaphragm-actuated valve controlling cooling water (FW) flow to the main condenser. High outlet gas temperature is annunciated.
2. Normal Makeup Flow Control - A pneumatic, two pen, pressure recording controller with high and low alarm trips for each pen receives input signals representing the reactor inlet (0-15") and the outlet (0-6") gas pressures as referenced to dryer Room No. 1. One pen of this controller records only, while the other pen records and indexes the control section of the instrument which sends a signal to a one-pen flow recorder-controller. This second recorder-controller positions a diaphragm operated control valve to regulate normal makeup flow (0-50 cfm) and records the normal makeup flow signal as received from an orifice assembly and transmitter. In addition, an integrator tabulates this flow signal for inventory purposes.
3. Purge Flow Control - This control consists of two flow control diaphragm operated valves in series. One valve is controlled by a purge On-Off switch and is a blocking valve rather than a control valve. This valve will close automatically if either of two pressure switches (adjustable from 0-14' and sensing inlet and outlet pressure) close to energize a three-way solenoid bleed valve in the control air line to the blocking valve. The second valve is actually a flow control valve and is controlled by a flow recorder controller which compares a flow signal from an inline orifice with the manual setpoint (0-2000 cfm). In addition, the flow signal is tabulated by an integrator for inventory purposes.

   When purging, it is also normal to vent. This is accomplished by using the top of unit gas vents (right and left outlet plenums) or the division valve gas vents (inlet or outlet, Ref. 21.9.1.3). These vents are operated by air switches, and in both cases vent to the Zone I exhaust duct.
4. Radiation Detection Element - A radiation detection element is located on the reactor gas outlet piping in the gas tunnel. This element sends a signal through a micro-micrometer to a radiation recorder.
5. Cooling Coil and Main Condenser Flow Switches - There are 21 flow switches which monitor flow to the 18 gas loop water-cooled penetrations, to the two steam release water cooled penetrations, and from the main condenser. Each of these flow switches annunciate on low flow.
6. Vacuum and Pressure Seal Tank Oil Levels - The oil liquid level for each of the seal tanks is measured with an air dip tube device. The levels are indicated on separate gages, and an annunciator is provided for each tank to signal low oil level.
7. Inlet and Outlet Plenum Pressure - Inlet and outlet plenum pressures with reference to Room 22 are each indicated.
8. Differential Pressure Across Inlet and Outlet Filters - The differential pressure across each of the inlet and outlet filters is indicated.



AEC-GE RICHLAND, WASH.

Gas Analysis and Drip Cell



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GAS ANALYSIS AND DRIP CELL MONITOR SYSTEMS - 105N

The gas analysis system is provided to continuously analyze the helium being recirculated to the reactor to determine the percentage H_2, CO_2, N_2, O_2, CO and moisture; the drip cell monitor system is provided to measure condensate collected in various portions of the gas piping.

The equipment locations, control functions and annunciation are shown schematically on Page 21.9.1.3-1 and are detailed below:

1. Moisture Analyzer - This analyzer unit analyzes two helium gas streams respectively and in sequence for percentage moisture in the helium inlet and outlet headers. The unit is located in the same cabinet as the other gas analyzers. This analyzer sends a millivolt electrical signal to a remote recorder (in the plant control center) which will actuate an annunciator on high moisture.

2. Gas Analysis - One unit analyzes for CO, CO_2, O_2, and N_2 contaminants in a helium gas stream. Both a sample stream and a helium carrier gas stream are introduced into the analyzer and then sent to the vent system after passage through the instrument. The analyzer sends a signal to a control unit (in the plant control center) on which all control operations are grouped. The analyzer signal is relayed to a recorder which will actuate an annunciator on high O_2.

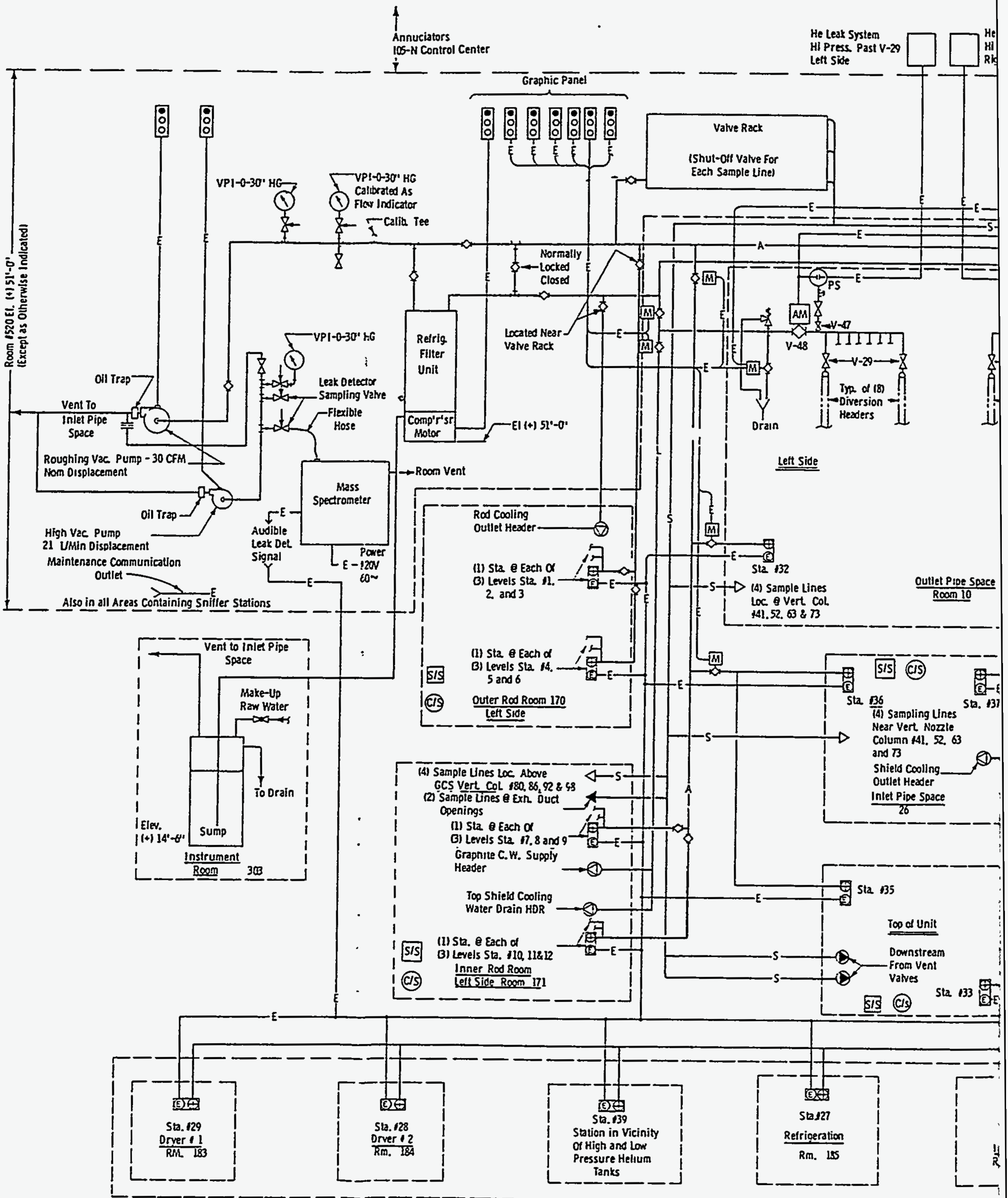
   A second similar analyzer is used to detect H_2. This unit is the same except that a N_2 carrier is used. The control unit and recorder in the plant control center are again the same, with the recorder actuating an annunciator on high H_2.

   Both analyzers can be controlled to sample either inlet or outlet gas header. As part of this analyzing system, two pumps operating in conjunction with back pressure regulators maintain two circulating sample streams at 10 psig pressure prior to entry into the analyzers.

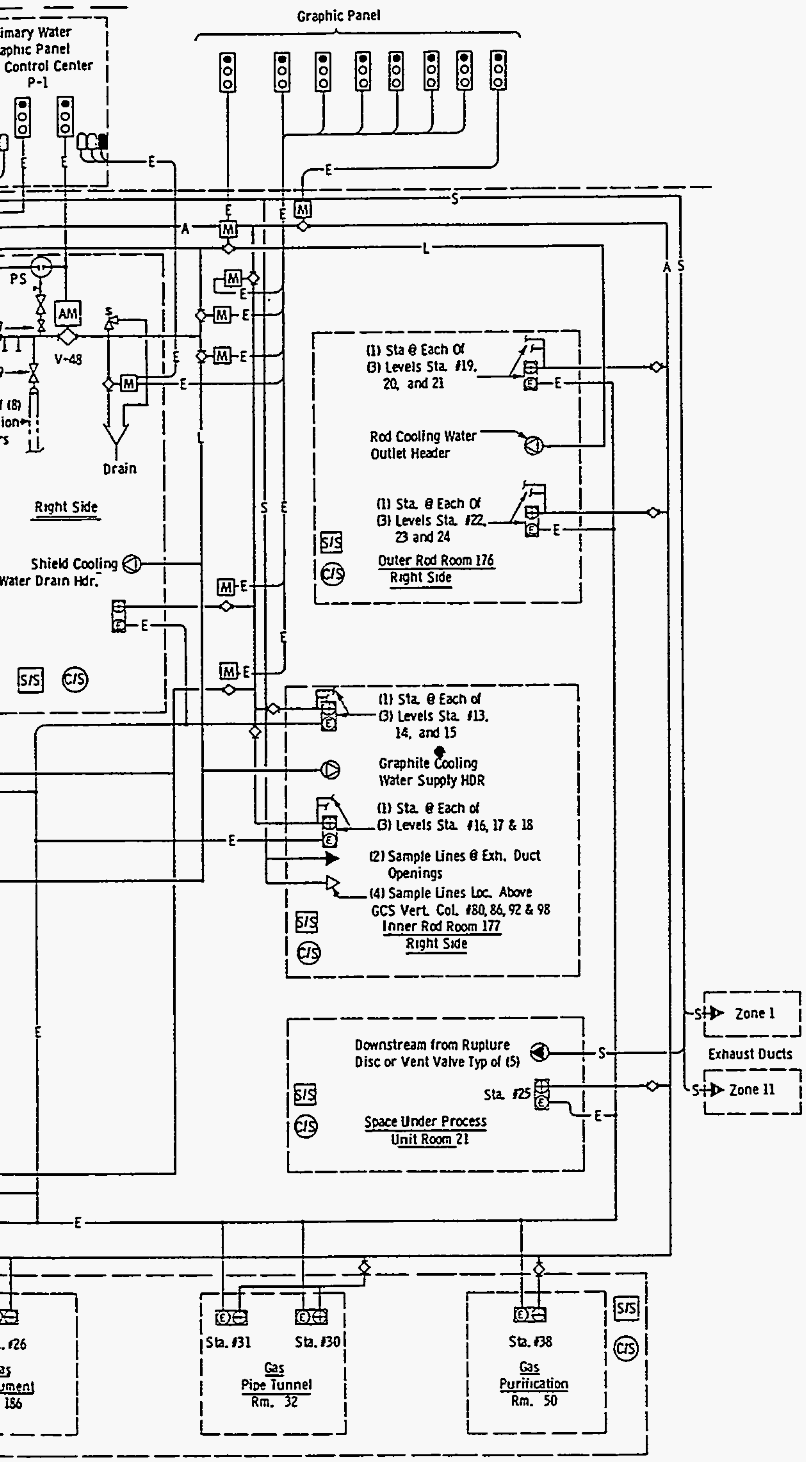
3. Drip Cell Liquid Level and Drain Valve Operation - There are nine drip cell collection points, as listed on the schematic. These drip cells are each equipped with a helium dip tube liquid level sensing device which is supplied helium from the helium purge manifold at 8 psig. A liquid level transmitter sends the level signal to a 0-30 gal. indicator which actuates an annunciator on high liquid level. Each of the drip cells can be drained by opening a normally closed air-operated diaphragm valve with an air switch in the plant control center. The drip cells are vented to the outlet gas header.

4. Division, Purge and Vent Valves - These valves are all operated by air switches in the plant control center. The valve layout is shown in the schematic.

5. Steam Release Butterfly Valves - The butterfly valves which act as isolating valves for the steam release box are also operated by air switches in the plant control center.



Helium Leak Detec



	Valve - Plug Type
	Valve - Needle Type
	Motor Operated Valve (Cone or Ball Type)
	On-Off Switch with Indicating Lights
	VPI Gage - Vacuum Pressure Indicator
	Sniffer Station
S/S	Portable Sniffer Probe (Typical of 9)
C/S	Portable Probe Calibration Station (Typical of 9)
	Valved Connection to Water Header (Sample)
	Valve Connection to "Gas Pipe" Header (Sample)
	Fixed Port, Open End
	Fixed Port, Open End, in Exh. Duct
—A—	Sample Line, Air or Room Atmosphere
—L—	Sample Line, Liquid or Process Pipe HDR.
—S—	Sample Line from Fixed Port or Valved Conn.
—E—	Electrical Lead
	Pressure Switch
	Indicating Lights, Valve Position

Ref. H-1-28519

HELIUM LEAK DETECTION SYSTEM - 105N

The helium leak detection system provides a means for locating leakage points of process gas from the reactor and its associated gas piping, for measuring process gas concentration in the Zone I and II ventilation exhaust ducts and in other selected space areas and exhaust ducts surrounding the reactor, and for locating leaks in the various reactor cooling water tubes.

System equipment is schematically located on Page 21.9.2-1 and consists of the following:

1. Mass Spectrometer - A GE type M-60 mass spectrometer is used for determining leakage with helium as the tracer gas. The machine has a local audible alarm and two audible alarm boxes for remote locations. Also, a calibrated leak is incorporated in the machine.
2. High Vacuum and Roughing Vacuum Pumps - A dual vacuum pump system is used for sample collection with the leak detection probe for the mass spectrometer being placed between the pumps at the optimum point for fast leak determination. The exhaust from both pumps is vented to Zone I.

   The roughing vacuum pump is air-cooled and of the rotary piston type with double pistons 180° apart on the same shaft. The pump is driven by a 440 volt, 1-1/2 hp. motor. Power is supplied from MCC-3A2. The free air displacement of the pump is 30 ft^3/min. with a nominal speed of 525 rpm. The pump uses a gas ballasting feature which serves to remove condensibles from the compression chamber.

   The high vacuum pump is air-cooled and of the two-stage, dual-seal type. It is driven at 450 rpm by a 115 volt, 1/3 hp. motor with power source from lighting panel NN which receives its power from MCC-3A2.
3. Vacuum Pressure Indicators - A vacuum gage is located on the suction side of the vacuum pumps immediately upstream from the detector probe sampling port. The gage is calibrated in terms of flow at a given vacuum (against the characteristic pump curves). Two other vacuum pressure indicators are also installed in the suction piping. The sensing range for these pressure indicators is 0-30" Hg.
4. Refrigeration - Filter Unit and Sump - For the purpose of filtration and water removal from the samples going to the mass spectrometer, a unit provided with filter cartridges and refrigeration condenser coils is located just downstream of the calibrated flow indicator gage. This unit has an open drain to a sump tank, as shown in the schematic. The refrigeration compressor is driven by a 1/2 hp. motor with power source from lighting panel NN.
5. Valve Rack - This rack permits valving any one of 29 individual sample sources (and one spare) into the suction line to the mass spectrometer. These sample sources are divided into the following groups and locations:
   a. Reactor Gas Pipe Sampling - There are seven valved sample lines to the reactor gas piping; a sample line is located just downstream of each of the four rupture discs in the gas piping to the steam release vent box; a sample line is downstream of each of the two top of the unit purge-vent valves; and a sample line is downstream of the purge-vent valve from the diversion valve purge and vent piping.
   b. Exhaust Duct Sampling - There are six fixed-port, open-end sample lines with one sample line to each of the Zone I, Zone II, and the four inner rod room exhaust ducts.
   c. Air Space Sampling - There are 16 fixed port, open-end air space sample lines; four sample lines are located equidistantly across and 15 inches above the top row of process tubes in each of the inlet and outlet thermo-barrier

HELIUM LEAK DETECTION SYSTEM - 105N (CONT'D)

enclosures; and four sample lines are located equidistantly across and 15 inches below the top thermal shield cooling tubes in each of the right and left inner rod rooms.

6. Helium Leak Detection Graphic Panel - (See Page 21.9.2.1) This panel permits remote operation of the 14 electric motor operated blocking valves in the sample line matrix to 39 sniffing stations and to 8 valved connections to various water headers. The panel also contains the controls for the vacuum pumps and the refrigeration-filter unit. The only remote valves in the system not controlled from this panel are the two V-48 valves which are air-motor operated and controlled from the primary water graphic panel in the plant control center. The above two groups of sampling sources are detailed below:

   a. Sniffer Sampling Stations - Each of the 39 stations contains a manually operated blocking valve, a connection to attach a flexible vacuum hose, a receptacle to attach an audible leak detection signal receiver, and a name plate with the sniffer station number. These sniffer stations are all located in the nine general areas located in the schematic. Each of these sampling areas is provided with a probe calibration station and a special probe.

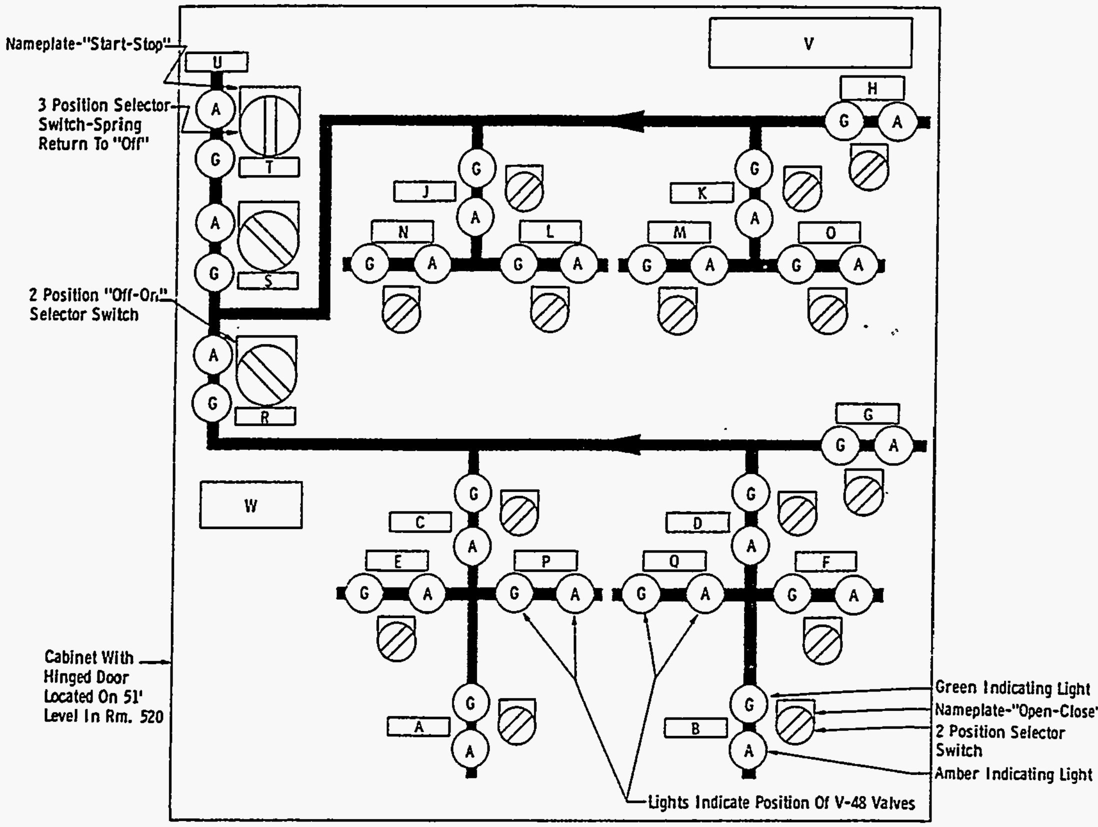
   b. Valved Connections to Water Headers - These sample lines are all valved closed at the header connections during reactor operation. Manual valves are used with the exception of the V-48 valves. The headers with a helium sample line connection are:

      1. Inlet shield cooling water outlet.
      2. Side and outlet shield cooling water outlet.
      3. Graphite cooling water supply headers, right and left sides.
      4. Rod cooling water outlet headers, right and left sides.
      5. Process water diversion vent manifolds, right and left sides.

These two sample sources are normally routed through the refrigeration-filter unit while the other sample sources normally bypass the unit.

General system operation requires adequate valving procedures to obtain a system that can be evacuated. During reactor operation, leak testing is limited to those sample sources routed through the valve rack and to those sniffer stations in accessible areas.

Control instrumentation is limited to an interlock with the No. 1 safety circuit, which prevents opening the V-48 valves whenever the No. 1 safety circuit is made up, and pressure switches which annunciate in the control room on high pressure in the diversion system vent manifolds downstream of the V-29 valves. Indicating lights for the header drain valves on the downstream, low pressure side of the V-48's are on the primary water graphic. These drain valves must be left open during reactor operation to protect the low pressure piping.



Nameplate Letter	Nameplate Legend		
A	Left Side Liquid Header Drain	T	Rough Pump
B	Right Side Liquid Header Drain	U	Mass Spectrometer
C	Left Side Liquid Header Isolation	V	Helium Leak Detection Remote Valves
D	Right Side Liquid Header Isolation	W	Helium Leak Detection Vacuum System
E	Left Side Graphite & Shield CW Header Sample		
F	Right Side Graphite & Shield CW Header Sample		
G	Right Side Rod CW Sample		
H	Right Side Outer Rod Room & Gas Facility Isolation		
J	Left Side Sub Header Isolation		
K	Right Side Sub Header Isolation		
L	Left Side Outlet Pipe Space Sample		
M	Right Side Outlet Pipe Space Sample		
N	Left Side Inlet & Top Space Sample		
O	Right Side Inlet & Top Space Sample		
P	Left Side Diversion Water Header Sample		
Q	Right Side Diversion Water Header Sample		
R	Refrigerator		
S	Hi Vac Pump		

Helium Leak Detection Graphic Panel - 105N

VACUUM SYSTEM CONTROL - 105N

The controls for the vacuum system provide for remote operation of the vacuum equipment and for selection of either the building or ball vacuum service.

Duplicate sets of remote controls are located in the plant control center on the rod and ball panel, and in the ball control room on the ball control panel. Local equipment controls are provided in the sub-pile room for the vacuum producer and the bag shaker. The controls at each location are detailed below (See Ref. 10.4-1 for the vacuum system flow diagram).

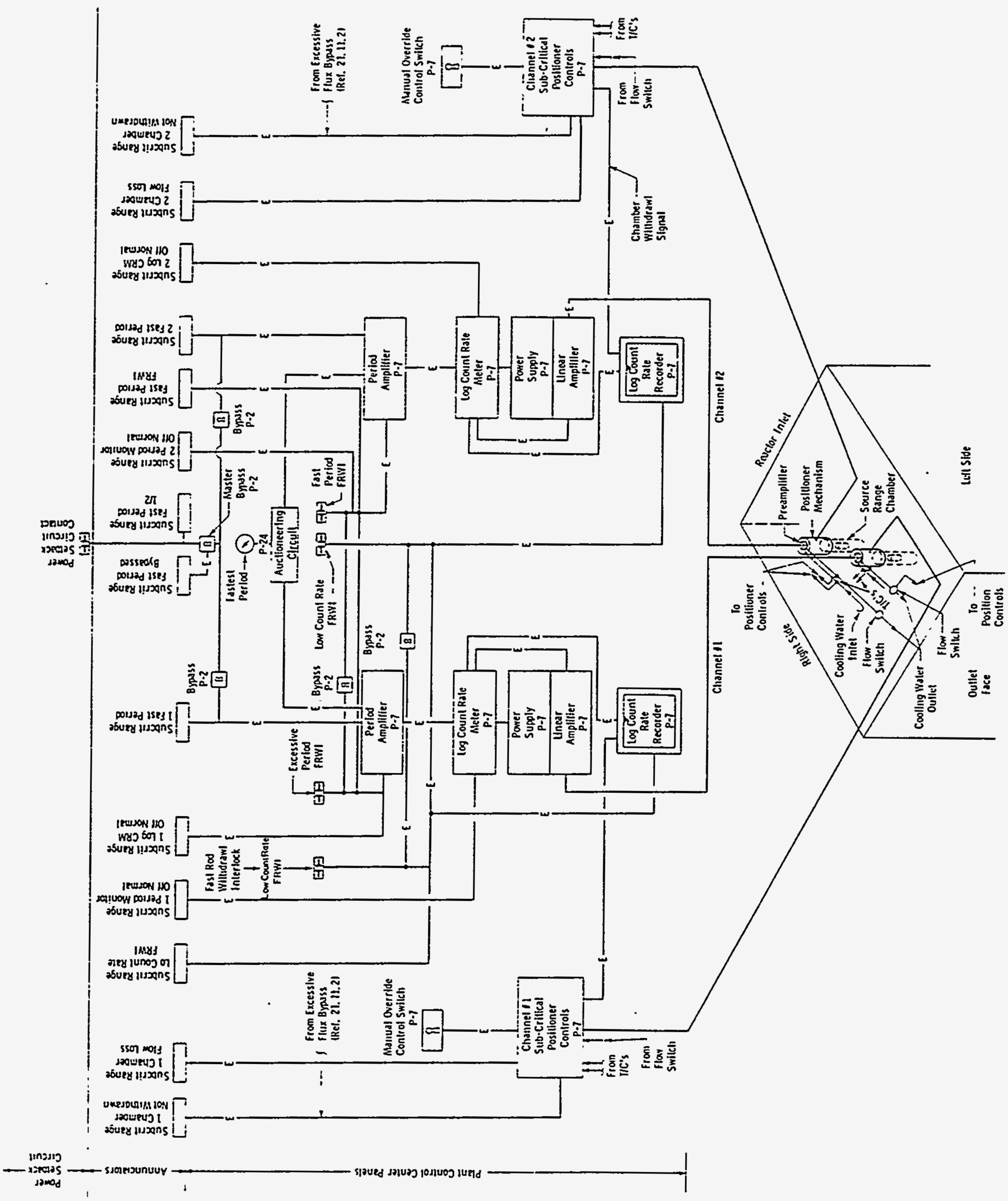
1. "Power On" is indicated by a backlighted amber pushbutton.

2. The ball collector hopper exit valve is opened by an amber, backlighted pushbutton and closed by a green, backlighted pushbutton. Magnets on the valve shaft actuate proximity switches to indicate valve position.

3. A full ball collector hopper is indicated by an amber indicating light which is actuated by a capacitance probe in the hopper.

4. Manual pushbuttons are provided to select either the building or the ball vacuum systems. An amber backlighted pushbutton for selecting the ball vacuum system will open the valve to the ball system on top of the reactor, close the valves to the C and D elevators and to the rod rooms, and position the sorting valve to the ball collector hopper. The amber light is activated by a magnetic proximity switch when the valve to the rod rooms closes. A green backlighted pushbutton for selecting the building vacuum system will close the valve to the ball system, open the valves to the C and D elevators and to the rod rooms, and position the sorting valve to the vacuum system dust bag. The green light is actuated in the same manner by the open position of the valve to the rod rooms.

5. Illuminated start and stop buttons are provided for the vacuum pump motor, and a second set of illuminated start and stop buttons are provided for the bag shaker motor.



Subcritical Nuclear Level Monitoring System - 105N

SUBCRITICAL NUCLEAR LEVEL MONITORING SYSTEM - 105N

This system is designed to monitor the neutron flux level of the reactor from the fully shutdown condition to the flux region just above supercritical, and to determine the reactor period in the later region. The system consists of two identical monitoring channels.

Each subcritical monitor channel derives a signal from a movable fission pulse counter tube. This tube is inserted into the top of the reactor through a water cooled thimble (Ref. 2.3.3), which extends approximately two feet through the reactor top thermal shield. To obtain the required sensitivity, the tube is positioned vertically within the thimble by a motor-driven positioner. Withdrawal of the tube from the lowest to the highest position extends the range of the system to overlap the intermediate nuclear level monitoring system (Ref. 21.11.2), and protects the counter tube against radiation damage at reactor high power levels.

Counter tube positioning is normally accomplished automatically be controls which receive signals from subcritical count rate recorders. As the recorder reaches an upscale trip point, the tube is withdrawn to a predetermined position. The initial positions of the two tubes are offset slightly, so that only one recorder signals tube withdrawal at any one time. A manual positioning switch is also provided to insert or withdraw the counter tube. This switch over-rides the automatic positioning controls.

Each subcritical nuclear level monitoring channel includes log count rate and period instrumentation. The signal to this instrumentation is the output of the counter tube linear pulse preamplifier. The log count rate is indicated and recorded. The period instrumentation extracts the derivative of the log count rate instrument output, and indicates the reactor period.

Other details of this system are:

1. The AC power supply to each channel is from separate circuits, so that malfunction or removal of instruments from one channel will not cause trip action in the other channel.

2. The counter tube positioner controls include the following: a meter to indicate the position of the tube; indicating lights to show the direction of movement of the tube and both ends of tube travel; a temperature indicator and selector switch to read inlet and outlet thimble cooling water temperatures; and a flow switch to indicate low flow from the thimble cooling tubes.

3. The log count rate meters and recorders have a range of five decades, from 1 to 1 x 10^5 counts per second.

4. Each log count rate recorder provides contacts which permit use of a fast rod withdrawal rate when the count rate is above ten counts per second, and other contacts to initiate fission counter tube withdrawal at a range of approximately 90 per cent of full scale. The low count rate fast rod withdrawal interlocks are provided with a bypass switch.

5. Upon loss of signal input, the log count rate recorders drive upscale.

SUBCRITICAL NUCLEAR LEVEL MONITORING SYSTEM - 105N (CONT'D)

6. The log count rate meters incorporate an internal calibration means such that the count rate accuracy can be checked at approximately 100, 1000, and 40,000 to 90,000 counts per second. The calibration signal is inserted at the pulse amplifier input.

7. The range of the period instrumentation is from minus 100 seconds to infinity to plus ten seconds.

8. Each period amplifier incorporates two independent trip functions; one adjustable from 10 to 60 seconds and the other from 20 to 60 seconds. The former function prevents use of a fast rod withdrawal rate due to an excessive period. A switch is provided to bypass this interlock. The latter function initiates a reactor power setback (Ref. 21.13.3) due to an excessive fast period. Switches are provided to bypass the individual and overall power setback trip functions.

9. The period amplifiers provide signals to an auctioneering circuit, which indicates the faster of the two periods on a meter at the reactor control console.

10. A calibration test signal can be applied to the period amplifiers such that a 10 second period is indicated by application of the signal.

11. If the subcritical monitoring chambers are not withdrawn when the intermediate nuclear level (Ref. 21.11.2) excessive flux rod scram trip is bypassed, an annunciator will be actuated.

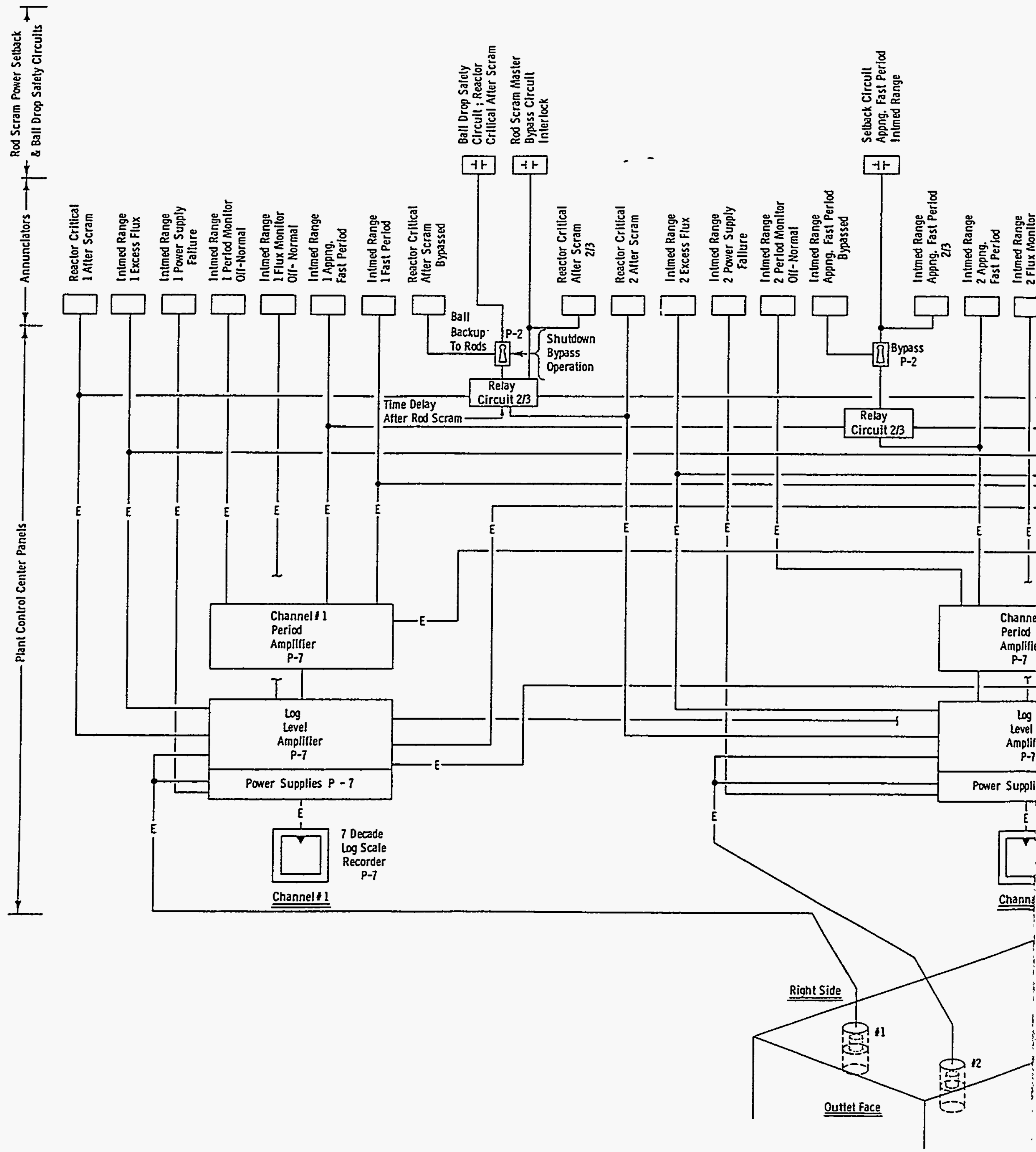
INTERMEDIATE NUCLEAR LEVEL MONITORING SYSTEM - 105N

This system is designed to monitor the neutron flux of the reactor throughout the intermediate flux range, from just above criticality to about ten per cent of the design level, and to determine the reactor period throughout this range. The system consists of three identical monitoring channels and overlaps the upper range of the subcritical monitoring system and the lower range of the high nuclear level monitoring system (Ref. 21.11.3).

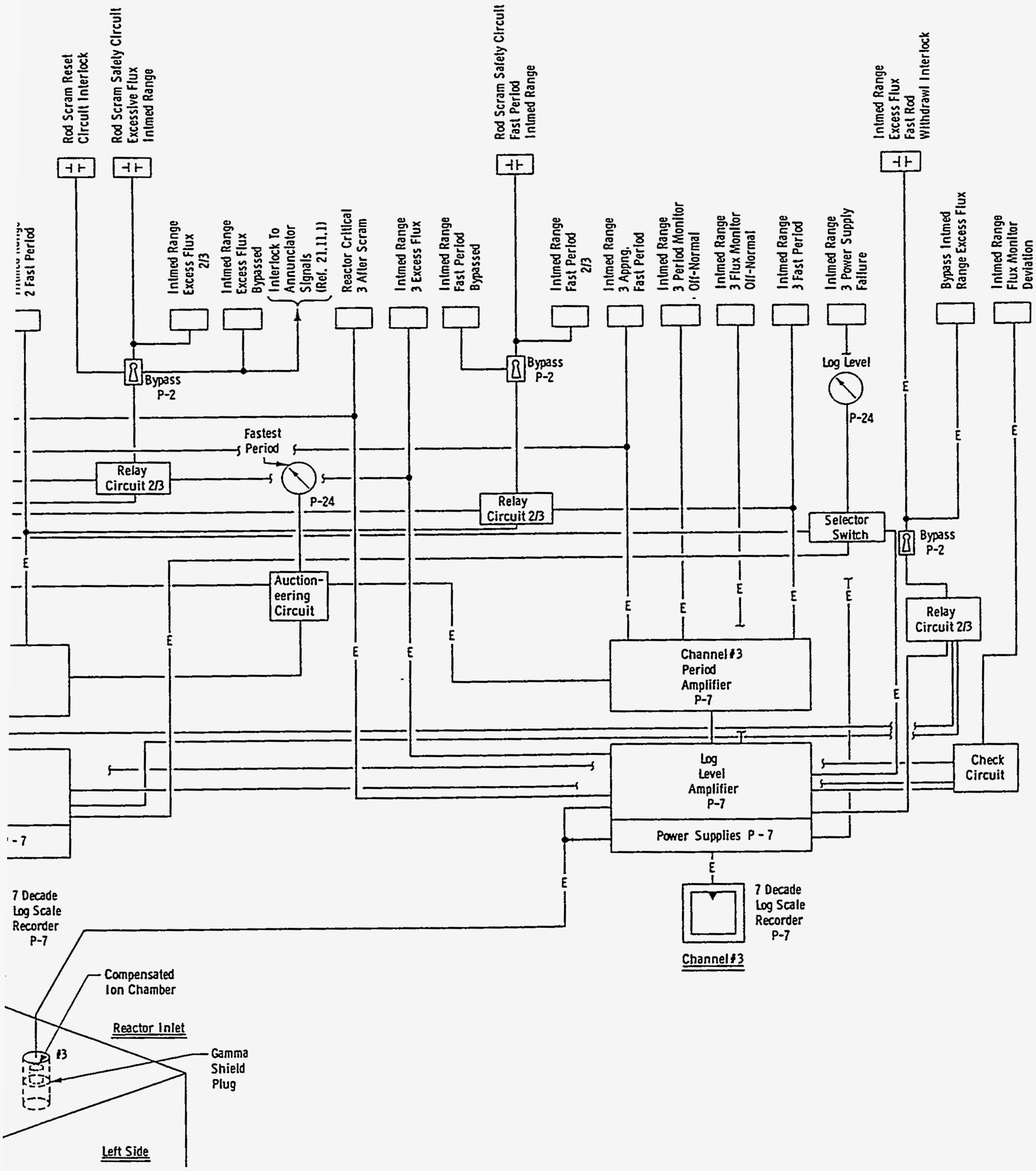
Each intermediate level channel derives a signal from a fixed position, gamma radiation compensated, thermal neutron sensitive ion chamber. The chambers are located below removable shield plugs in the reactor top primary shield, and are electrically compensated for gamma radiation

Each intermediate nuclear level channel includes log level and period monitoring instrumentation. Other details of this system are:

1. The AC power supply to each channel is from separate circuits, so that malfunction or removal of instruments from one channel will not cause trip action in any of the other two channels.
2. Each channel includes two voltage supplies, one a spare unit, for polarizing the gamma compensated ion chambers.
3. The input to each log level amplifier is the output from one neutron sensitive ion chamber.
4. The log level amplifiers have ranges of seven evenly spaced decades from approximately 1×10^{-11} to 1×10^{-4} amperes. Since the intermediate range channels remain in service during full reactor output, the amplifiers are capable of withstanding a continuous input of 3×10^{-3} amperes without damage.
5. Each log level amplifier provides three independent trip functions adjustable over the upper six decades. If the reactor neutron flux becomes excessive in the intermediate range, these functions provide signals to relay circuits, which require two of three input signals to actuate, and provide a fast rod withdrawal interlock and a rod scram safety circuit actuation. The third function provides signals to a similar relay circuit and causes a ball drop safety circuit actuation if the reactor power has not decayed properly after a time delay following a rod scram, or if the reactor becomes supercritical during shutdown (Ref. 21.12.2). Switches are provided to bypass the fast rod withdrawal interlock, the rod scram, and ball drop actuating signals.
6. The rod scram safety circuit bypass switch is interlocked with the rod scram reset circuit, so that the switch must be on normal before the safety circuit can be made up.
7. A log level meter is located at the reactor control console with a selector switch to select the signal from any channel.
8. The log level recorders have a range of seven decades and fail downscale on loss of input signal.
9. The log level amplifier incorporates circuits and controls for checking the calibration at three current values. These values are at the top of decades one, three, and six.
10. The current outputs of the log level amplifiers are compared by a circuit which annunciates when one of the outputs deviates from the other two channels. The deviation alarm span is adjustable.
11. The trip functions of the log level and period instrumentation are automatically checked every 1½ seconds to assure that these functions will actuate when required.



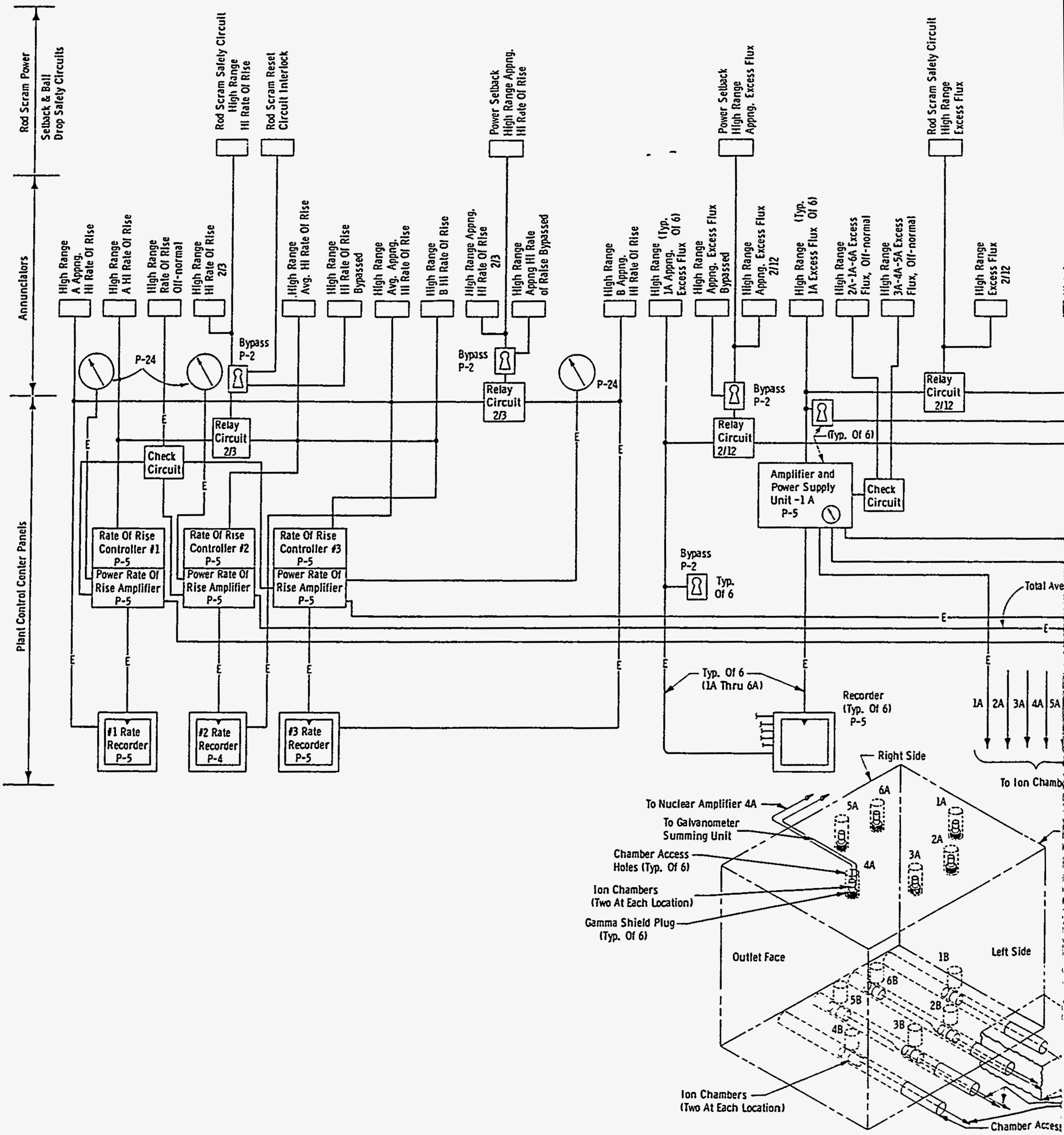
Intermediate Nuclear Level M



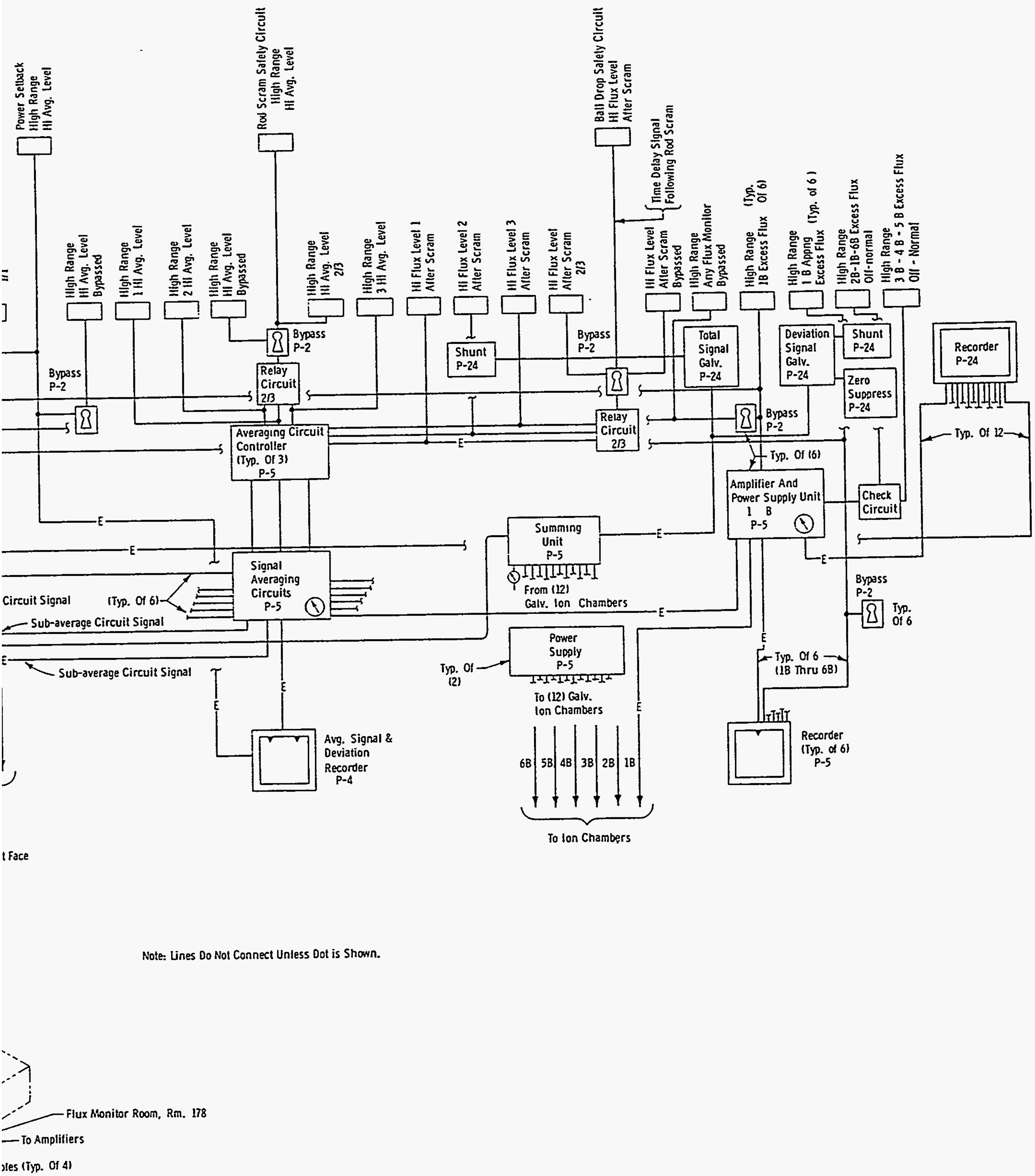
onitoring System - 105N

INTERMEDIATE NUCLEAR LEVEL MONITORING SYSTEM - 105N (CONT'D)

12. The range of the period instrumentation is from minus 100 seconds to infinity to plus ten seconds.
13. The period amplifier provides two independent trip functions adjustable over the range of ten to forty seconds. If the reactor period becomes excessive in the intermediate range, these functions provide signals to relay circuits which require two of three input signals to actuate and cause a reactor power setback actuation followed by a rod scram safety circuit actuation at a slightly faster period. Switches are provided to bypass the power setback and rod scram actuating signals.
14. The period amplifiers provide signals to an auctioneering circuit, which indicates the fastest of the three periods at the reactor control console.
15. Means are provided for testing the span of the period amplifier and meters, and for checking the correspondence of the actual period trip points and the period indicating meters.



High Nuclear Level Moni



oring System - 105N

HIGH NUCLEAR LEVEL MONITORING SYSTEM - 105N

This system is designed to monitor the neutron flux level of the reactor throughout the power range, and to determine the rate of rise of reactor power throughout this range. This system overlaps the upper range of the intermediate nuclear level monitoring system and consists of the following: 1. twelve power range channels; 2. power range averaging instrumentation; 3. total and deviation galvanometer instrumentation; and 4. power rate instrumentation.

The high nuclear level monitoring system derives signals from fixed position, thermal neutron sensitive ion chambers. These chambers are uncompensated for gamma radiation. To satisfy the signal requirements of the system, 24 ion chambers are provided. Twelve of the chambers are located below removable shield plugs in the reactor top primary shield; two chambers below each of six plugs. Twelve chambers are located in four horizontal channels through the reactor foundation at the 0' elevation, and are accessible from the left side. These chambers are positioned below risers through the reactor insulation layer, two below each of six risers.

Other system details are:

A. Power range channels
   1. The twelve power range channels are functionally identical but completely independent. All instruments in each channel are supplied with AC power from separate circuits. Loss of AC power or malfunction of one or more instruments in a given channel will result in trip function action only in the channel involved and no more than one power rate channel.
   2. The ion chamber polarizing voltage source and amplifier are incorporated in the same unit. The input to each of the 12 amplifiers is the current from one ion chamber, and corresponds to approximately 0.4×10^{-3} amperes for 100 per cent amplifier output.
   3. Means are provided for routine amplifier calibration.
   4. Each amplifier provides signals to individual indicating meters and recorders, each with a scale of 120 divisions. All amplifiers send a signal to a 12 point recorder with a scale of 100 divisions.
   5. Each of the 12 amplifiers provides a trip function with trips adjustable over a range of 2 to 100 per cent of amplifier output. The trip functions provide signals to a relay circuit, which requires two of twelve input signals to actuate, and causes a rod scram safety circuit actuation due to excessive flux in the high power level range. Bypass switches are provided for the trip function of each amplifier. Bypassing is limited to four amplifiers, of which no more than one can be in any quadrant (top inlet - 1A, 2A, and 6A; top outlet - 3A, 4A, and 5A; bottom inlet - 1B, 2B, and 6B; bottom outlet - 3B, 4B, and 5B); and no more than two on each side (left side - 2A, 3A, 2B, and 3B; right side - 5A, 6A, 5B, and 6B). If these limits are exceeded, the reactor will be automatically scrammed following an adjustable time delay. An alarm sounds when more than the maximum number of amplifiers has been bypassed, warning of an impending reactor scram, unless the error is corrected.
   6. Each of the twelve power range recorders provides a trip function with trips adjustable over the full scale of the instrument. The trip functions provide signals to a relay circuit which requires two of twelve input signals to actuate, and causes a reactor power setback due to an approaching very high average power level. The trip function of each recorder can be bypassed. The reactor setback actuating signal can also be bypassed.

HIGH NUCLEAR LEVEL MONITORING SYSTEM - 105N (CONT'D)

7. Each power range recorder drives downscale on loss of signal.
8. Each of the twelve amplifiers also provides four output signals to the power range averaging instrumentation.
9. The current outputs of the power range amplifiers are compared by a circuit which annunciates when one of the outputs deviates from the average signal of the other amplifiers. The deviation alarm span is adjustable.

B. Power range averaging instrumentation
1. The power range averaging instrumentation includes signal averaging circuits to receive the outputs from the twelve power range amplifiers.
2. The signal averaging circuits provide two outputs known as subaveraging circuit outputs, each of which is an average of six different power range amplifier outputs. The subaveraging circuits provide outputs to the power rate instrumentation.
3. Four outputs of the signal averaging circuits are known as total averaging circuit outputs, and are an average of all twelve power range amplifier outputs. The total averaging circuits provide outputs to three averaging circuit controllers, and to an average signal and deviation recorder and a precision indicator.
4. The average signal and deviation recorder is a two-indicator and two-pen recorder. This recorder fails on signal loss. The average signal range is 120 divisions, and the deviation range is 60 divisions on either side of a zero center. The average signal drive mechanism provides an adjustable trip function, which actuates the reactor power setback circuit due to an approaching high average power level. A switch is provided to bypass this trip function.
5. The three averaging controllers each provide two adjustable trip functions. Each group of three has a common trip adjustment which is independent of the other group. The first trip function provides signals to a relay circuit, which requires two of three input signals to actuate and causes a rod scram safety circuit actuation due to a very high average power level. The second trip function is similar, except that it actuates the ball drop safety circuit if the reactor flux has not decayed properly within 1-10 seconds after a rod scram safety circuit actuation. Switches are provided to bypass the rod scram and ball drop actuating signals.

C. Total and deviation galvanometer instrumentation
1. Two independent power supplies are provided for polarizing the twelve ion chambers supplying the galvanometer instrumentation. Each power supply is capable of supplying all twelve chambers.
2. A summing unit receives the signals from the twelve ion chambers. These signals first pass through indicating meters. The summed signal is cabled to the galvanometer housing.
3. Two light beam galvanometers are provided with a common 500 millimeter scale. The beam spots of the galvanometers are different in shape.
4. Total signal galvanometer shunts provide for increasing galvanometer sensitivity by factors of 10, 100, 1000, and 10,000.
5. The deviation galvanometer shunt, in conjunction with a zero depress circuit, permits sensitivities which are 1, 10, and 100 times the deflection sensitivity of the total signal galvanometer.

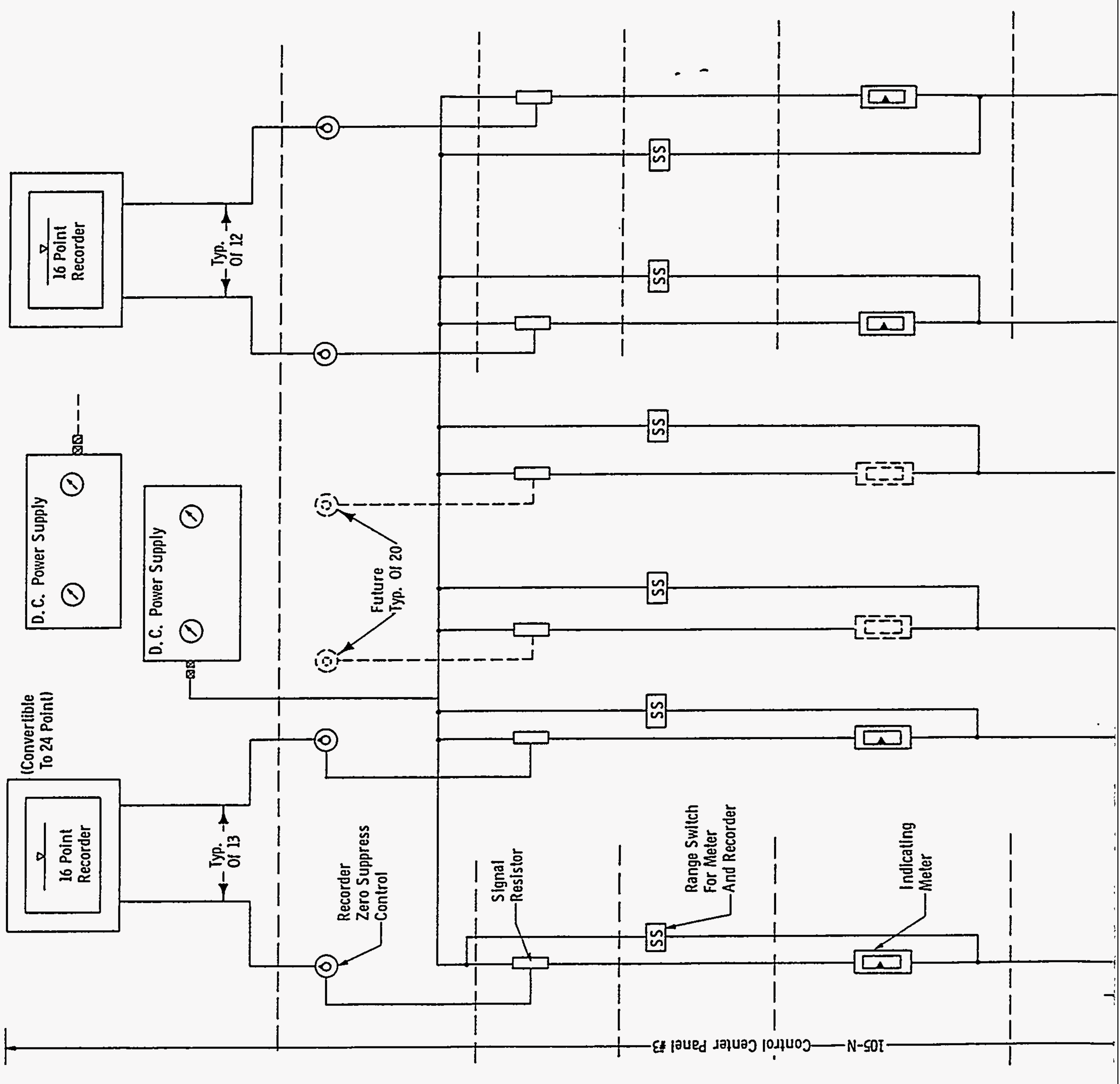
HIGH NUCLEAR LEVEL MONITORING SYSTEM - 105N (CONT'D)

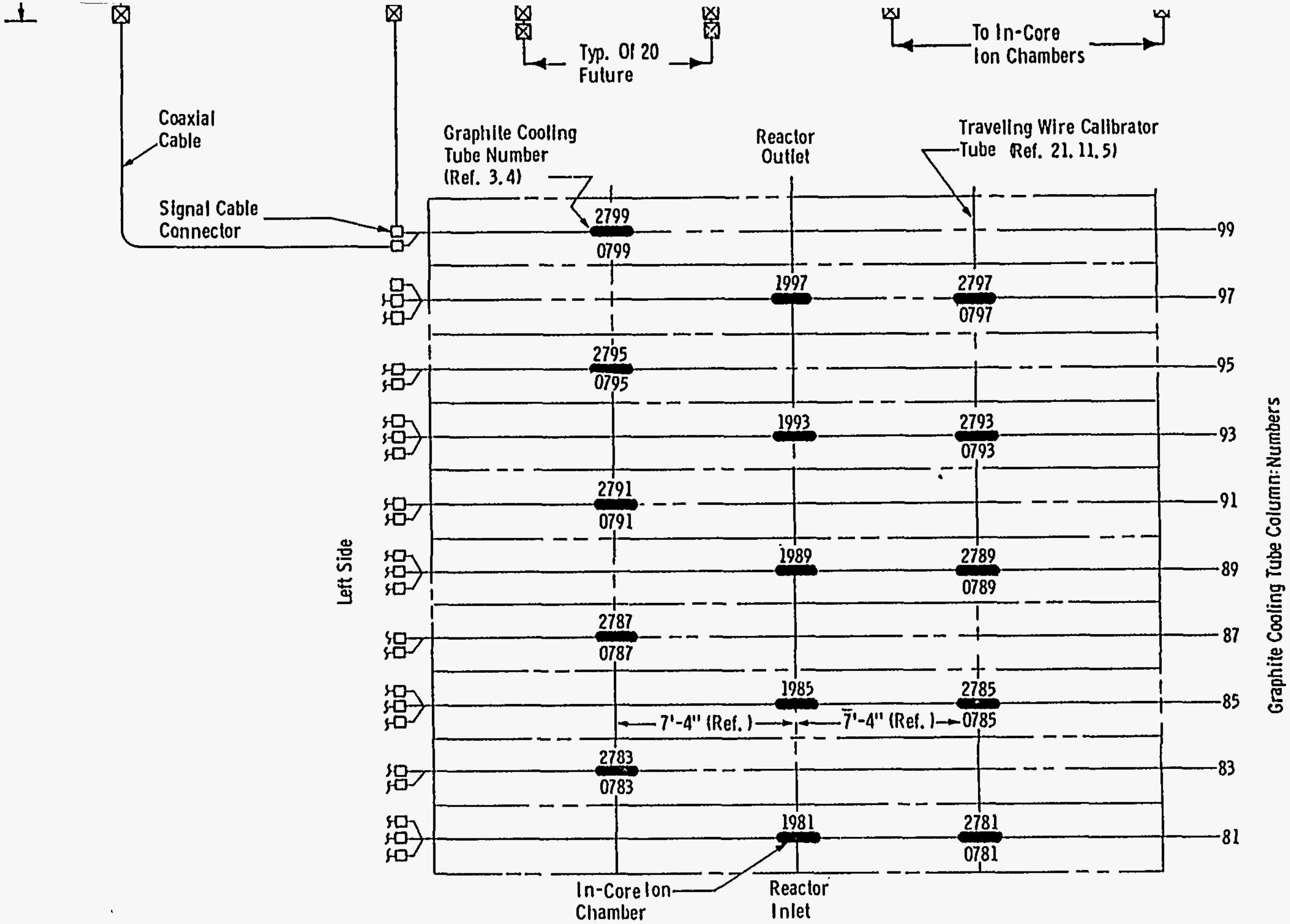
6. The signal from the galvanometers and shunts returned to the summing unit is developed for driving one channel of power rate instrumentation.

D. Power rate instrumentation

1. The three power rate circuits are identical except for signal inputs. Two inputs are from the power range subaveraging circuits and the third is from the galvanometer summing unit.
2. The power rate amplifiers provide signals to recorders and meters. These instruments have scales with a zero point at the center. Deflection to the right or left of center represents a positive or negative power rate of change.
3. The power rate recorders fail downscale on a loss of signal, and each provides a trip function with adjustable trips. The trip functions provide signals to a relay circuit, which requires two of three input signals to actuate, and causes a reactor power setback due to an approaching excessive power rate of rise. A switch is provided to bypass the setback signal.
4. Each power rate controller provides a trip function with adjustable trips. The trip functions provide signals to a relay circuit, which requires two of three input signals to actuate, and causes a rod scram safety circuit actuation due to an excessive power rate of rise. A switch is provided to bypass the rod scram actuating signal.
5. The rod scram power rate of rise bypass switch is interlocked with the rod scram reset circuit, so that the switch must be on normal before the safety circuit can be reset

All trip functions of the high nuclear level instrumentation are automatically checked every 1½ seconds to assure that these functions will actuate when required.


16 Point Recorder
Typ. Of 12
D.C. Power Supply
D.C. Power Supply
Future Typ. Of 20
(Convertible To 24 Point)
16 Point Recorder
Typ. Of 13
Recorder Zero Suppress Control
Signal Resistor
Range Switch For Meter And Recorder
Indicating Meter
SS
105-N—Control Center Panel #3

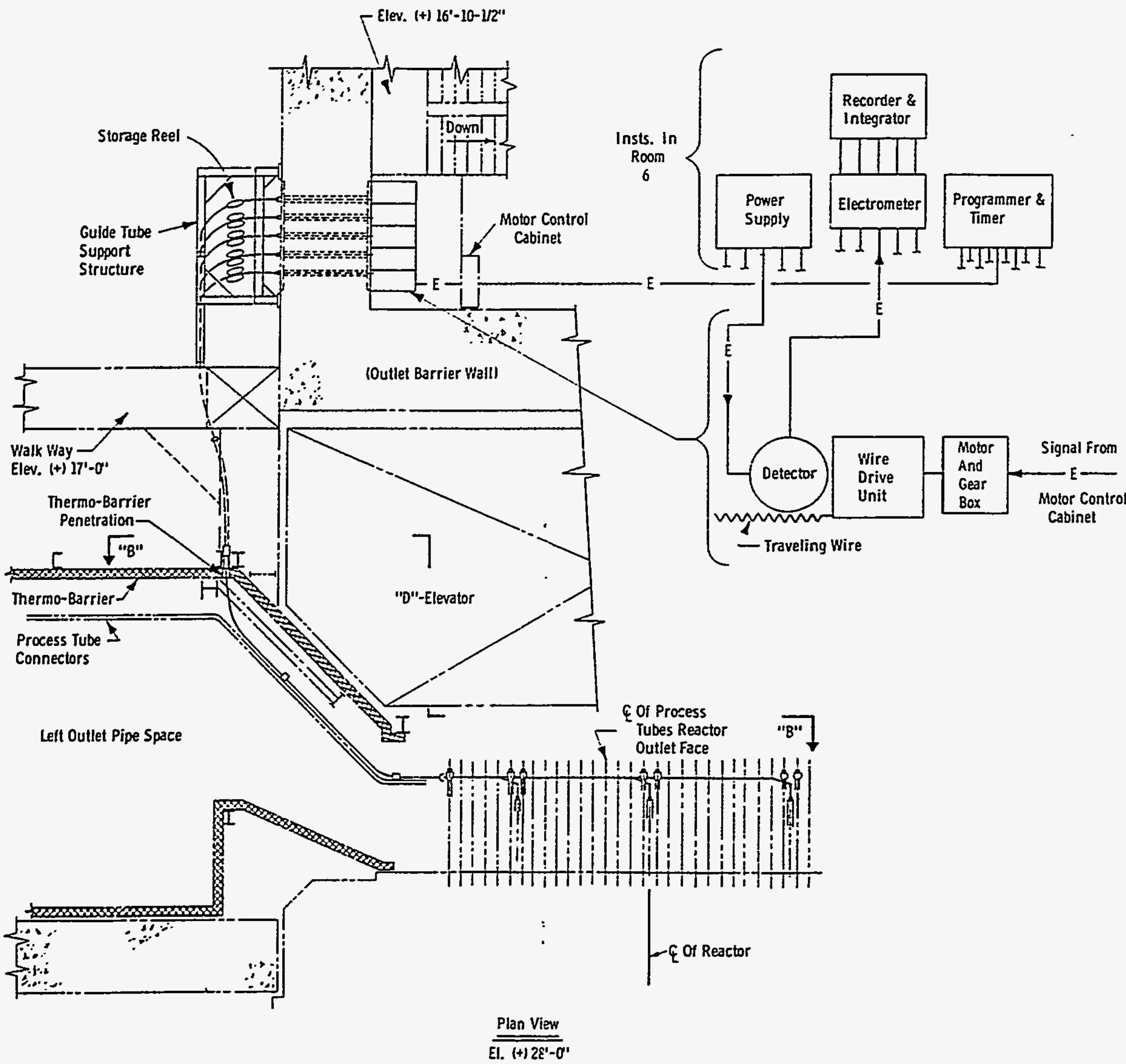


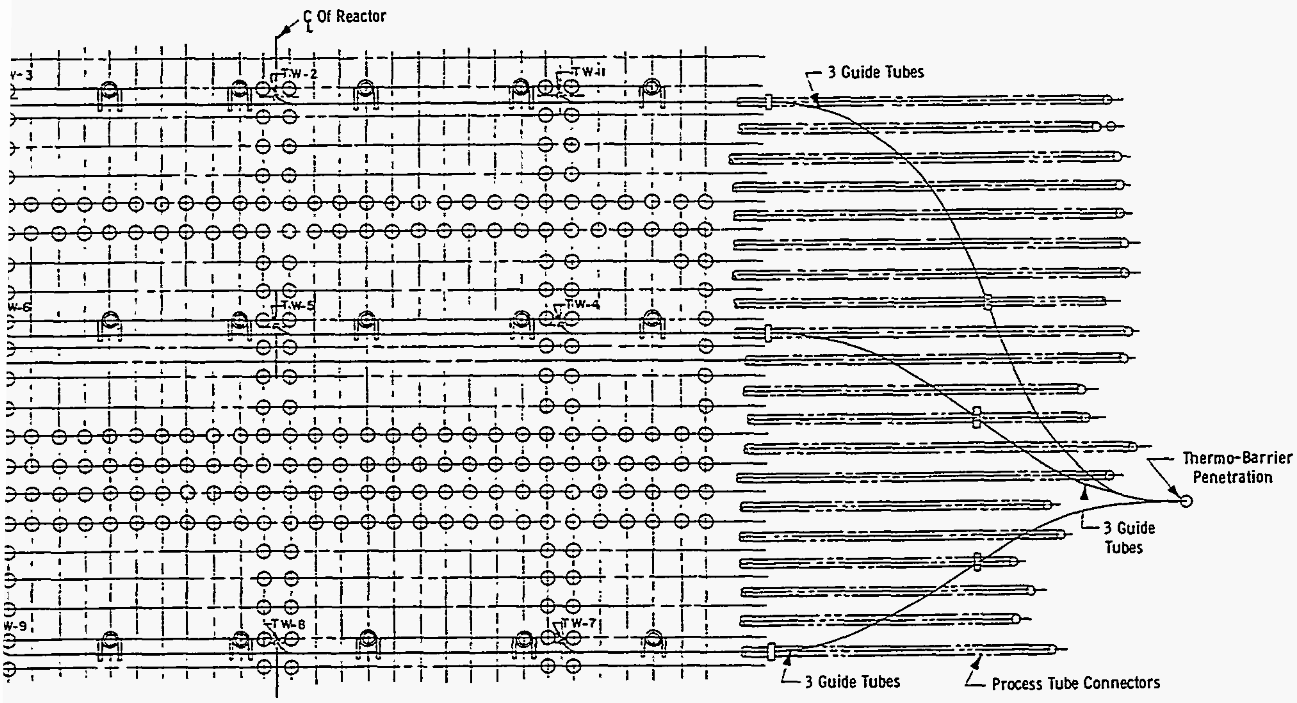
This system is designed to provide a longitudinal neutron flux profile of reactor inlet to outlet power distribution to permit optimum operational control. The system consists of fixed continuous monitoring ion chambers inserted in selected reactor moderator cooling tubes.

Twenty five miniature ion chambers are provided. Only one chamber is installed in any one moderator cooling tube, and all are located in tubes which are supplied with cooling water from the left side of the reactor. The chambers are arranged in groups of five, from reactor inlet to outlet, to provide a profile of neutron flux in the upper right, upper left, central, lower right, and lower left zones of the reactor. A single coaxial cable connected to each chamber supplies the polarizing voltage and returns the signal.

In the Plant Control Center, the entire system is mounted on P-3 (Ref. 21.1). Two power supplies are provided for polarizing the ion chambers. Signals from the ion chambers are indicated on meters, which are arranged in groups of five, one for each of the above zones. The signals are also supplied to one of two recorders.

Panel space, layout, and recording equipment of this system are designed for expansion to forty-five ion chamber inputs.


Elev. (+) 16'-10-1/2"
Down
Storage Reel
Guide Tube Support Structure
Motor Control Cabinet
Insts. In Room 6
Recorder & Integrator
Power Supply
Electrometer
Programmer & Timer
E
(Outlet Barrier Wall)
Walk Way Elev. (+) 17'-0"
Thermo-Barrier Penetration
"B"
Thermo-Barrier
Process Tube Connectors
"D"-Elevator
Detector
Wire Drive Unit
Motor And Gear Box
Signal From
Motor Control Cabinet
Traveling Wire
℄ Of Reactor
Left Outlet Pipe Space
℄ Of Process Tubes Reactor Outlet Face
℄ Of Reactor
Plan View
El. (+) 28'-0"


C Of Reactor
T.W-2
T.W-1
3 Guide Tubes
T.W-5
T.W-4
Thermo-Barrier
Penetration
3 Guide
Tubes
T.W-8
T.W-7
3 Guide Tubes
Process Tube Connectors

Elev. "B-B"

TRAVELING WIRE FLUX MONITOR SYSTEM - 105N

This system is designed to provide a reactor inlet to outlet flux profile at nine different locations to permit optimun operation control, and to calibrate the ion chambers of the in-core system.

This system performs by insertion and withdrawal of flexible wires through the reactor active zone. The wires are driven from shielded storage containers by separate drive assemblies into guide tubes, which extend through water cooled tubes through the reactor active zone, for exposure to neutron flux in the reactor. After a soaking period, the wires are withdrawn past radiation detectors and into the storage reels for storage and re-use. Correlation of wire incremental activation versus position within the reactor active region yields the desired neutron flux profile.

Nine flexible wire drive assemblies are provided and are located at the 16' 10" level behind the reactor outlet barrier wall, room 175. Each drive assembly is an individually electrically powered, reversing type, gear driven, wire drive which forms a unit. Each drive unit operates in forward or reverse direction with an adjustable speed control. Maximum speed is 80 FPM; slow speed is 5 FPM. The storage reels are located in the left outlet pipe space.

Nine flexible wires, 3/16" in diameter and 150' long, of pure titanium are provided. The wires are driven by the drive assemblies through guide tubes into the reactor active zone for neutron activation. Approximately forty feet of each wire enters the reactor.

Nine guide tubes for the flexible wires extend from the drive assemblies to the reactor outlet face approximately 110 feet away. These tubes are 304 stainless steel with an OD of 0.27 inches. At the reactor outlet face, the guide tubes enter water-cooled channels, both of which extend through the reactor. The water-cooled channels are zirconium tubes, and are supplied with coolant from the reactor shield cooling water system (Ref. 2.3.3). (See Ref. 21.3.2 for tube flow monitoring system.)

The radiation detection equipment consists of five assemblies. In all cases except one, a single detector monitors two traveling wires. The detector is a scintillation crystal and photomultiplier tube. The activated wire is drawn past a collimator, consisting of a stepped lead plug, with a beam hole directed at the wire. The collimator provides the geometry to produce the proper count rate at the photomultiplier tube.

System instrumentation and controls are located on a panel in Room 6 of the 105N Building. Included is a detector high voltage supply unit, an electrometer receiving the detector outputs, a recorder, and a programmer-timer. The electrometer has a range of 10^{-9} to 10^{-4} amperes in eleven ranges, and the recorder has a scale of 120 divisions. The recorder includes an integrator which automatically records the chart area under the recorder variable.

Power to the traveling wire motor control cabinet is from the 2A2 bus of MCC-2A.

BALL HOPPER AND TRIP MECHANISM CONTROL SYSTEM - 105N

This system is designed to provide controls for locking and unlocking of ball drop gates, and cocking of trip mechanisms, and instrumentation to indicate the unlocked and closed conditions of the ball drop gates, and a low level of balls in the ball containing hoppers. The ball hopper and trip mechanisms are discussed in detail in Ref. 15.2.1.

System details are as follows:

1. Locking or unlocking of the ball hopper gates can be performed with a "Master Hopper Locking Switch", three position with spring return to a neutral center; or by individual "hopper locking" switches, three-position---lock, off, and unlock, located on panels in the ball control room, Room 4.
2. Hopper gate locking and unlocking energizes the air cylinder solenoid pilot valve locking or unlocking coils respectively.
3. If the hopper gates are locked with the master switch or with the individual switches, they must be unlocked with the same switch.
4. Lights are provided in Room 4 and on P-16 to indicate an unlocked condition of each hopper, when all hoppers have been locked, and when five or more hoppers are individually locked. Annunciators are actuated when all ball hoppers, or five or more hoppers are individually locked.
5. The individual unlocked lights are actuated by the proximity switch adjacent to the magnet on the air cylinder piston rod when the piston rod is up or unlocked.
6. If all ball hoppers are locked with the master switch, or five or more hoppers are individually locked, annunciators are actuated and interlocks prevent the rod scram reset circuit from being made up.
7. To prevent burn-out of the air cylinder solenoid pilot valve locking and unlocking coils, the coils are automatically de-energized one second after the master hopper locking switch is actuated. If the individual hopper locking or unlocking switches are not returned to off after actuation, an annunciator is actuated, an alarm sounds in Room 4, and lights in the control center on P-16 and in Room 4 indicate "any hopper locking switch not returned to off".
8. The ball trip mechanism cocking sequence can be initiated by pushbuttons for each ball row or for each ball hopper from Room 4. Cocking is limited to one row of trip mechanisms at a time because of the high current requirements of the lifting coils, and the limited current capacity of the circuitry.
9. The cocking pushbuttons initiate the following actions:
   a. The air cylinder locking coil energizes and de-energizes after 1 second.
   b. The solenoid assembly lifting coils energize and de-energize after 1 second.
   c. The solenoid assembly holding coils energize.
   d. The air cylinder unlocking coil energizes and de-energizes after 1 second.
10. Individual hopper closed indicating lights are provided on P-16 and in Room 4. These lights are actuated by the proximity switch adjacent to the magnet on top of the gate rod when the gate rod is down (closed).
11. Hopper low ball level indicating lights are provided on P-16 and in Room 4. These lights are actuated by contacts of a relay which is de-energized when the ball level in the hopper is below the level detecting probe.
12. Contacts from the hopper closed circuits are used to energize a time delay relay, which in turn energizes the solenoid assembly lifting coils during the cocking sequence. A successful cocking sequence can, therefore, be initiated only when the ball drop gates have been opened. A switch is provided in Room 4 to de-energize and energize the hopper closed circuits, permitting a successful cocking sequence if power should be removed from both solenoid assembly holding coils while the hoppers are locked. This switch is actuated (open) before row or individual cocking PB's are actuated, and returned to normal after the cocking PB's are actuated.

BALL SAFETY CONTROL SYSTEM - 105N

The ball safety control system is designed to de-energize all ball hopper trip assembly holding solenoid coils resulting in a complete ball drop when any of the five monitored functions de-energize the control circuits.

The ball safety control system is composed of two identical but separate series circuits, each containing contacts which must remain closed to keep the circuits energized. The trip functions, which will open contacts in both circuits, are listed below together with the signal source and trip coincidence required.

1. Earthquake - Three seismoscopes, Ref. 21.18.4 (Coincidence: 2 of 3).
2. Emergency Cooling System - Either emergency cooling water system master relay circuit, Ref. 21.5 (Coincidence: 1 of 2).
3. High flux level after rod scram - Three safety circuit controllers, Ref. 21.11.3 (Coincidence: 2 of 3). This function causes a ball drop when the reactor flux has not decayed properly within 1-10 seconds after a rod scram safety circuit actuation.
4. Reactor super-critical after a rod scram or during shutdown - three channels intermediate nuclear level instrumentation, Ref. 21.11.2 (Coincidence: 2 of 3).
5. Manual - Push-button at reactor console, P-24.

For trip function No. 4 above, a three-position switch is provided on P-2 to select ball drop protection during reactor operation or shutdown, and to bypass this trip function. In the reactor operation position, a rod scram safety circuit trip actuates two timers (P-16), adjustable between 3 and 1200 seconds. If the reactor remains super-critical, as sensed by the intermediate level instruments after the timers have timed out, a ball drop will occur. The timers are AC powered, and backed up with a DC to AC inverter in case of an AC power loss. A light on P-2 indicates when the inverter is operating.

In the shutdown position, the timer bypass contacts are not used, and a ball drop will occur instantaneously when the intermediate level instruments senses the reactor being super-critical.

Other details of this system are as follows:

1. Each ball drop safety circuit trip function actuates an annunciator.
2. Bypass switches are provided on P-2 for the first four trip functions. These switches also actuate annunciators.
3. In addition to a ball drop, de-energization of either ball safety control circuit causes actuation of the rod scram safety circuit.
4. The two ball safety control circuits are supplied with power from separate sources, buses A and B of the 105-N, 125V-DC power supply system (Ref. 12.18.4.2).
5. The ball control circuits are normally energized, and supply power to the ball hopper solenoid assembly dual holding coils (Ref. 15.2.1), one coil of each hopper being supplied from each control circuit.
6. In addition to the above listed trip functions, a ball drop will occur if both sources of 125V-DC power fail.
7. For maintenance purposes, ammeters and voltmeters are provided in Room 4 and on a panel on the 51-foot level to read the line current of, and voltage to, each of the two ball hopper holding coil circuits. Also on the 51-foot level panel, switches and meters are provided to take current readings of the holding coils of each circuit.
8. After a ball drop, before the hopper trip mechanism cocking sequence can be successfully initiated, the cause of the ball trip must be corrected. The ball control circuits can then be reset (energized), with push-buttons on P-24, followed by initiation of the cocking sequence.

BALL BACKUP TO RODS CONTROL SYSTEM - 105N

This system provides a backup to rods, following a rod scram safety circuit actuation by dropping rows of balls on both sides of rod columns which contain "failed rods" when:

a. Four or more of all rods, or
b. Three rods in one column fail to scram properly.

A failed or improperly scrammed rod is defined as one which does not reach the 75% in limit switch, starting 0.3 to 3 seconds after a rod scram safety circuit actuation; and ending 10 to 30 seconds later when the system is automatically bypassed, to prevent unwarranted ball drops during reactor shutdown.

This system provides circuits to count:

1. Four or more of all rods which fail.
2. Columns which contain failed rods, and
3. Three failed rods in each rod column.

Rods assigned to withdrawal or off are detected and counted as failed rods. When the necessary number of failed rods and columns have been counted, the solenoid holding coils of rows of ball hoppers on both sides of the proper rod columns are de-energized, resulting in a ball drop in the appropriate areas.

Switches and lights are provided on P-16 to bypass the ball backup to each rod column and to indicate one or more slow rods in each of the eleven rod columns. Another light is provided to indicate four or more slow rods in the reactor. Push-buttons are provided on P-16 to reset (turn-out) the lights. These buttons must be activated each time the rod scram safety circuit is broken, or the lights will indicate a false condition the next time rods are withdrawn for reactor startup.

Annunciators are actuated when one or more slow rods are detected in each rod column, when the ball backup to any rod column is bypassed, and when a ball drop occurs due to four or more slow rods following a rod scram safety circuit actuation.

BALL RECOVERY CONTROL SYSTEM - 105N

This system provides controls for the ball collection and cleaning system (Ref. 15.2.2), and for the return and distribution system (Ref. 15.2.3). The majority of the controls for ball recovery are located on a graphic panel and on control panels in Room 4. Other controls for this operation are located at the equipment in Room 22, on P-16 and P-2 in the plant control center, on top of the unit at the 43' level, and at the ball distribution equipment, located above the 60' level. Details of the system are as follows:

1. Power for the control system is turned on with a switch in Room 4. This switch also turns "power on" indicating lights in Room 4, and on P-16. An "emergency stop" push-button is located adjacent to the "power on" switch.
2. A three-position switch (partial bypass, normal, and bypass) is provided in Room 4. This switch permits partial or complete bypassing of certain control system interlocks, as noted below.
3. Steam to the ball washer-dryer supply fan air heater coils and to the water heater is turned on and off with push-buttons in Room 4.
4. The washer-dryer exhaust fan can be started and stopped with push-buttons in Room 4 or at the fan. Steam to the air and water heaters must be turned on (Item 3) before the exhaust fan can be started. This interlock can be bypassed (Item 2, Bypass Position).
5. The washer-dryer supply fan can be started and stopped with push-buttons in Room 4 or at the fan. The exhaust fan must be running (Item 4) before the supply fan can be started. This interlock can be bypassed (Item 2, Bypass Position).
6. The washer-dryer feed valve can be opened and closed with push-buttons in Room 4. The supply fan must be running (Item 5) before this valve can be opened. This interlock can be bypassed (Item 2, Partial Bypass and Bypass Positions).
7. Hot water to the washer-dryer can be turned on and off with push-buttons in Room 4.
8. Hot water to the gravity ducts can be turned on and off with push-buttons in Room 4. The washer-dryer feed valve must be open (Item 6) before these valves can be opened.
9. The washer-dryer water temperature and air temperature are monitored by a thermoswitch and thermocouple respectively, which provide interlock functions and activate lights. When the water and air temperatures reach 180°F and 160°F respectively, indicating lights are actuated in Room 4. The dryer air temperature is also indicated in Room 4.
10. Ball recovery may now proceed on a manual or automatic basis. Selection is made by push-buttons in Room 4. Use of the bypass switch (Item 2, Bypass Position) prevents automatic operation of the ball recovery control system.
11. Level in the lower surge hoppers is detected by a probe which actuates a light in Room 4 when the hopper is full and provides interlock functions.
12. The washer-dryer motor starts automatically when the supply fan is on (Item 5), the water and air temperatures are satisfactory (Item 9), and the lower surge hopper is not full (Item 11). The supply fan and temperature interlocks can be bypassed (Item 2, Partial Bypass Position). The washer-dryer motor can be started manually from Room 4, or at the washer. The interlocks listed above apply. The supply fan and temperature interlocks can be bypassed (Item 2, Partial Bypass and Bypass Positions).
13. When the skip-hoist is completely down, it rests on a load cell. The load in the hoist is indicated on a meter in Room 4, and provides interlock functions.

BALL RECOVERY CONTROL SYSTEM - 105N (CONT'D)

14. Limit switches are provided to limit skip-hoist travel and speed. The extreme and normal up and down limits of hoist travel are protected by geared over-travel and directly actuated limit switches respectively. Hoist-down travel is also limited by a slack cable limit switch. Fast lift rates of the hoist are permitted only between other directly actuated switches, located approximately 3' from the normal ends of travel of the hoist. A switch is provided in Room 4 to permit bypassing of the geared over-travel limit switches.
15. The skip-hoist supply valve opens automatically when the hoist is not full (Item 13) and completely down (Item 14), and closes automatically when the hoist is full. This supply valve can be opened with a push-button in Room 4. The same interlocks apply and can be bypassed (Item 2, Bypass Position). The valve can be closed anytime with another push-button.
16. Power to the ball channel down valves is turned on with a switch on P-2. This switch is interlocked with the rod scram safety circuit, so that power can be turned on only when the rod scram safety circuit is not made up.
17. The individual ball channel drain valves can be opened with push-buttons on P-16, and opened or closed with push-buttons in Room 4. Lights on P-16 indicate open drain valves; and in Room 4, lights indicate both positions of the valves. These lights are actuated by proximity switches adjacent to a magnet mounted on the valve diaphragm compressor.
18. The Room 4 ball channel open drain valve push-buttons also actuate a timer which is adjustable between 0-20 minutes. If the washer-dryer feed valve (Item 6) is open and the washer-dryer motor is running (Item 12) when the timer times out, a light is actuated in Room 4. This light indicates "ball tube drained".
19. The level in the upper surge hopper is detected by a probe, which actuates a light in Room 4 when the hopper is full, and provides interlock functions.
20. The skip-hoist automatically starts up at slow speed when the hoist is full (Item 13), the over-travel limit switches are not engaged (Item 14), the hoist supply valve is closed (Item 15), the up over-travel limit switch has not been bypassed (Item 14), the upper surge hopper is not full (Item 19), and the up limit switch is not engaged (Item 14). The skip-hoist can be manually started up with a push-button in Room 4. The same interlocks apply, except the hoist need not be full and the hoist supply valve can be open.
21. The hoist up speed changes from slow to fast, on both automatic and manual control, after the hoist has risen above the lower slowdown limit switch (Item 14); and continues up at fast speed until the upper slowdown limit switch is engaged, after which the hoist speed is reduced to slow. The hoist continues up at slow speed until the upper limit switch is engaged stopping up travel.
22. The hoist up limit switch actuates a timer, adjustable between 0 and 20 minutes, which actuates a light when timed out, and starts the skip-hoist down at slow speed; if the over-travel limit switches are not engaged (Item 14), the down over-travel limit switch has not been bypassed, the down limit switch is not engaged, and the slack cable limit switch is not actuated. The skip-hoist can be manually started down with a push-button in Room 4. The same interlocks apply, except the timer need not be timed out.
23. Hoist down speed changing and stopping is similar to Item 21.
24. When ball recovery is complete, a final wash of the washer-dryer can be initiated and turned off by push button in Room 4. This engages a solenoid valve which sprays hot water into the washer-dryer.

BALL RECOVERY CONTROL SYSTEM - 105N (CONT'D)

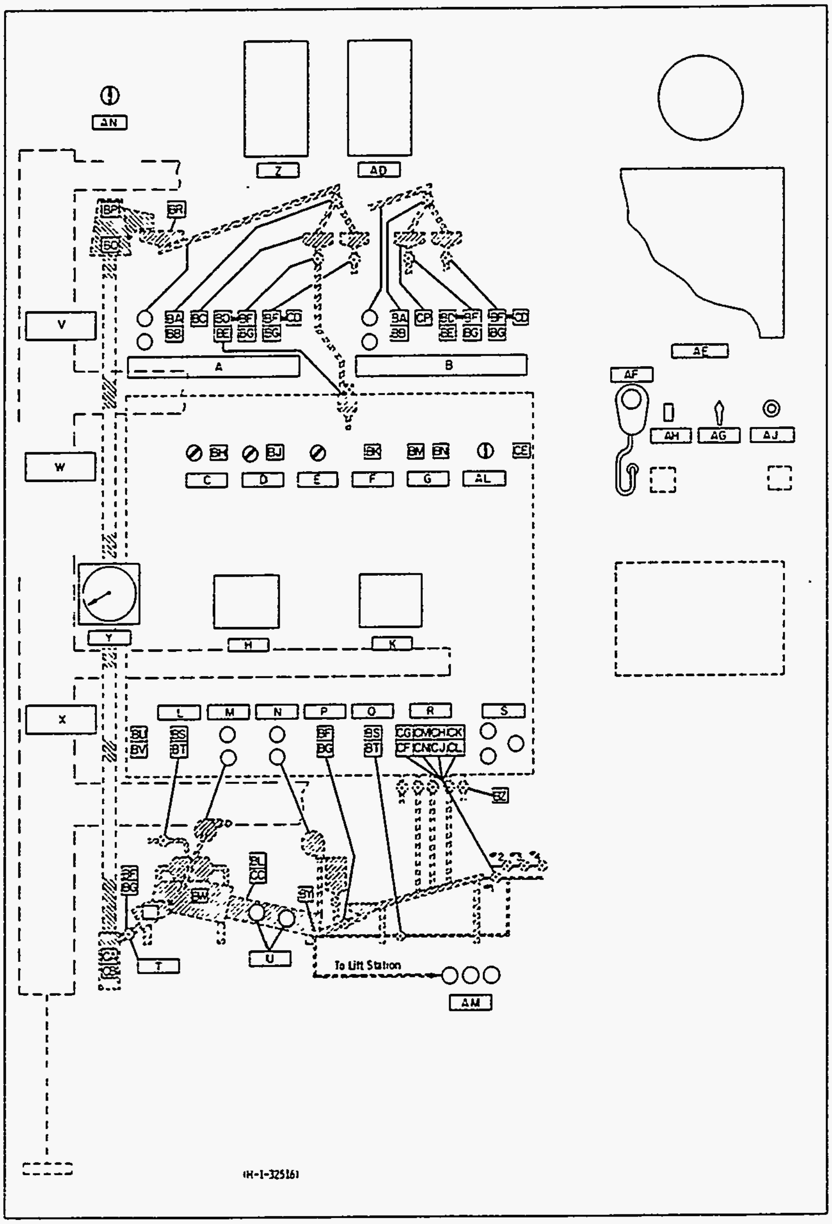
25. At the 60' level, the metering hoppers are provided with probes to detect a full condition, to actuate indicating lights in Room 4, and to provide interlock functions.
26. The front (rear) screw conveyor automatically starts when the front (rear) metering hopper is not full (Item 25), and the front (rear) metering hopper drain valve is closed (Item 30). The conveyor automatically stops when the metering hopper is full. The conveyors can be started and stopped with push-buttons in Room 4 or at the 60' level. The same interlocks apply but may be bypassed (Item 2, Bypass Position).
27. The front (rear) screw conveyor sorting valve can be diverted to the front (rear) metering hopper or front (rear) compartment of the storage bin by push-buttons in Room 4.
28. The front (rear) distribution hose limit switch is actuated when the hose is connected to a hopper full pipe. This switch actuates a light in Room 4, and provides interlock functions.
29. A panel on the 43' level includes four switches, one for each of the metering hopper drain valves and the storage bin drain valves. These switches provide interlock functions which prevent opening of the drain valves unless the switches are actuated.
30. The metering hopper and storage bin drain valves are equipped with limit switches that indicate the position of the valves and provide interlock functions.
31. The front (rear) metering hopper drain valve can be opened from Room 4 when the front (rear) distribution hose is connected (Item 28), and the front (rear) metering hopper release switch is actuated (Item 29). The distribution hose interlock can be bypassed (Item 2, Bypass Position). The valves can be closed from Room 4 or on the 43' level.
32. The storage bin front (rear) compartment drain valve can be opened from Room 4 when the front (rear) distribution hose is connected (Item 28), and the storage bin front (rear) compartment release switch is actuated (Item 29). The distribution hose interlock can be bypassed (Item 2, Bypass Position). The valves can be closed from Room 4 or on the 43' level.

Nameplate #NP-A

NP-B Same as NP-A Except Insert "Rear" in Place of "Front"

Screw Conveyor	Two-Way Valve	Metering Hopper	Upper Switch & Hose	Metering Hopper Valve	Storage Bin Valve	Storage Bin Switch

FRONT DISTRIBUTION



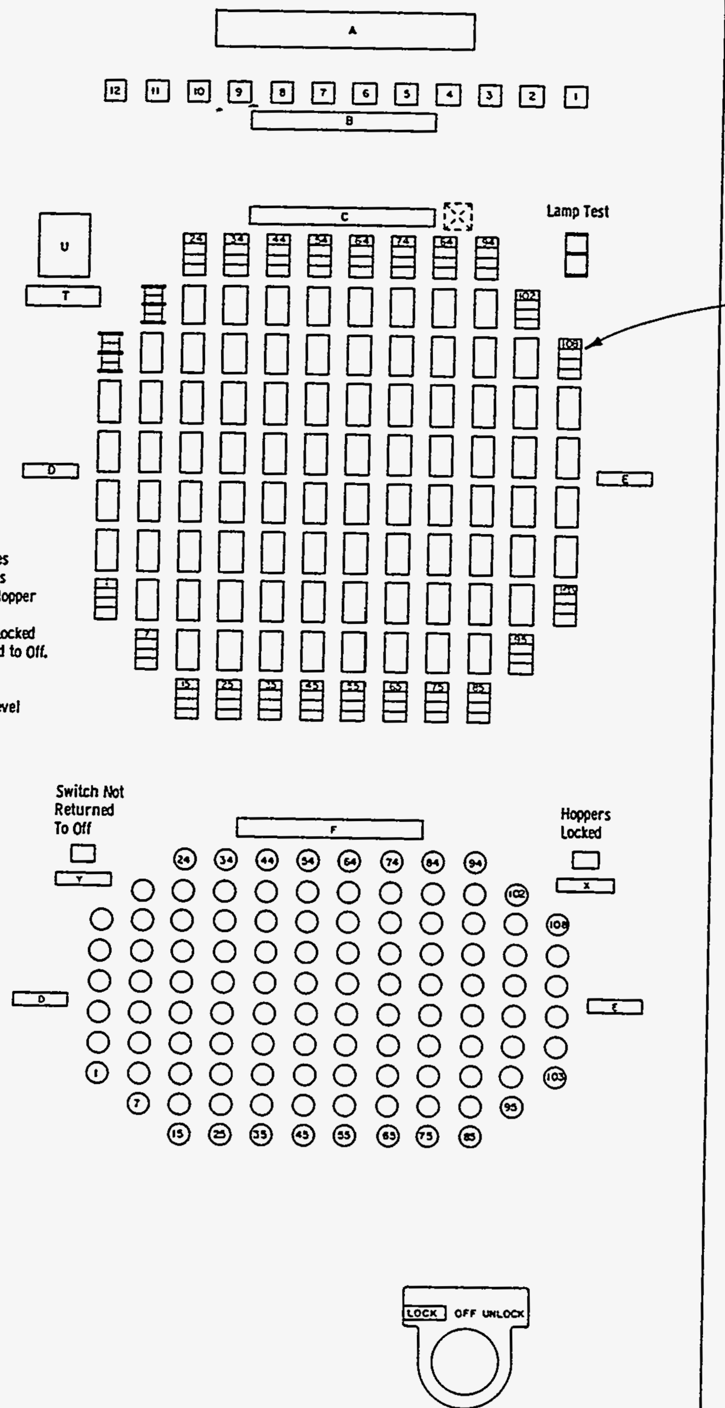
C	Master Hopper Locking Switch
D	Bypass Ball Return System Interlocks
E	Control Power
F	Push Button for Emergency Stop
G	Type of Operation
H	Skip Fill Weight
K	Dryer Air Temperature
L	Steam to Washer, Dryer and Water Heater
M	Exhaust Fan
N	Supply Fan
P	Washer-Dryer Feed Valve
Q	Hot Water to Washer-Dryer
R	Hot Water to Gravity Ducts
S	Skip Hoist Manual Control
T	Skip Hoist Supply Valve
U	Washer Dryer Conveyor
V	Top of Reactor Controls
W	Master Controls
X	Bottom of Reactor Controls
Y	Skip Hoist Position
Z	Skip Hoist Dump Timer
AD	Ball Drain Timer
AE	Radiation Time-Keeping Intercom
AF	Ball Return Communications
AG	Ball Return Communications Speaker Volume
AH	Microphone On-Off Switch
AJ	Instrument Maintenance Communications
AL	Skip Hoist Over-Travel Limit Switch Bypassed
AM	Ball Washer Drain Valve to Lift Station
AN	Prevent Ball Drop with Hoppers Locked after D. C. Failure
CG	#1 On
CF	#1 Off
CE	Push for Lamp Test
CD	Storage Bin Valve Released
BA	To Metering Hopper
BB	To Storage Bin
BC	Front Metering Hopper Full
BD	Metering Hopper Released
BE	Hose Connected
BF	Open
BG	Close
BH	Hoppers Locked
BJ	Interlocks BP Partial Bypass
BK	Control Power
BL	Final Ball Machine Wash
BM	Automatic
BN	Manual
BP	Skip Timed Out
BQ	Skip Hoist Up
BR	Upper Surge Hopper Full
BS	On
BT	Off
BU	Any Hopper Gate Open
BV	All Top Hoppers Closed
BW	Dryer Air Temperature Okay
BX	Lower Surge Hopper Full
BY	Water Temperature Okay
BZ	Ball Tube Drained
CA	Skip Full
CB	Skip Down
CC	Final Machine Wash Off
CH	#3 On
CJ	#3 Off
CK	#4 On
CL	#4 Off
CM	#2 On
CN	#2 Off
CP	Rear Metering Hopper Full

Ball Recovery Graphic Panel - 105N

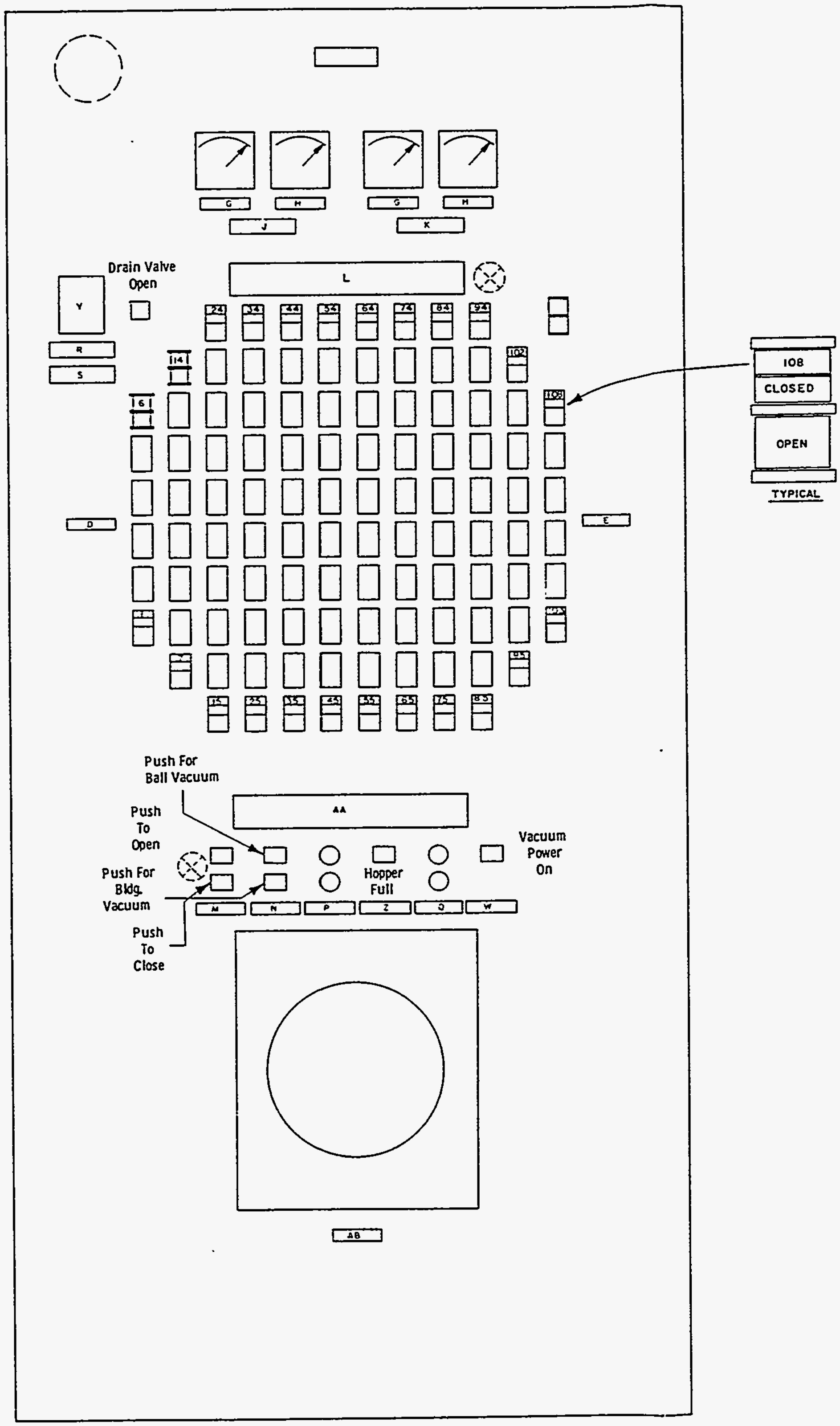
UNCLASSIFIED

NAMEPLATE LEGEND

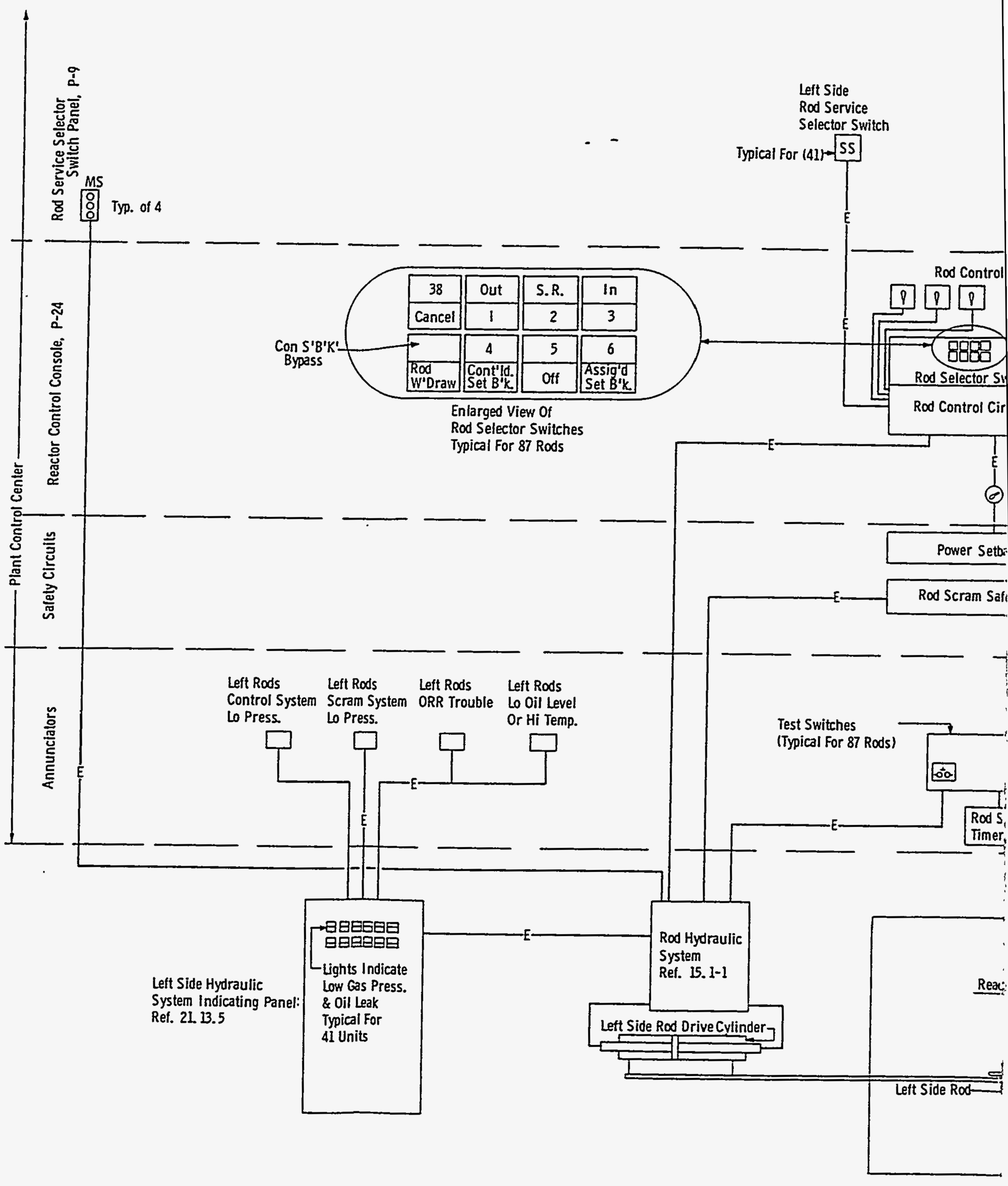
- A Top of Reactor Controls
- B Row Cocking
- C Hopper Cocking
- D Outlet
- E Inlet
- F Hopper Locking
- G Ball System Volts
- H Ball System Amps
- J Battery "A"
- K Battery "B"
- L Bottom of Reactor Drain Valves
- M Vacuum Collector Hopper Valve
- N Building or Ball Vacuum System
- P Vacuum Pump Motor
- Q Bag Shaker Motor
- R Push Upper Button to Close Drain Valves
- S Push Lower Button to Open Drain Valves
- T Push Lower Button to Cock Individual Hopper
- W Power to Vacuum System
- X Five or More Ball Hoppers Individually Locked
- Y Any Hopper Locking Switch not Returned to Off.
- Z Ball Collector Hopper Level
- AA Vacuum System Controls
- AB Vacuum System Collector Hopper Ball Level



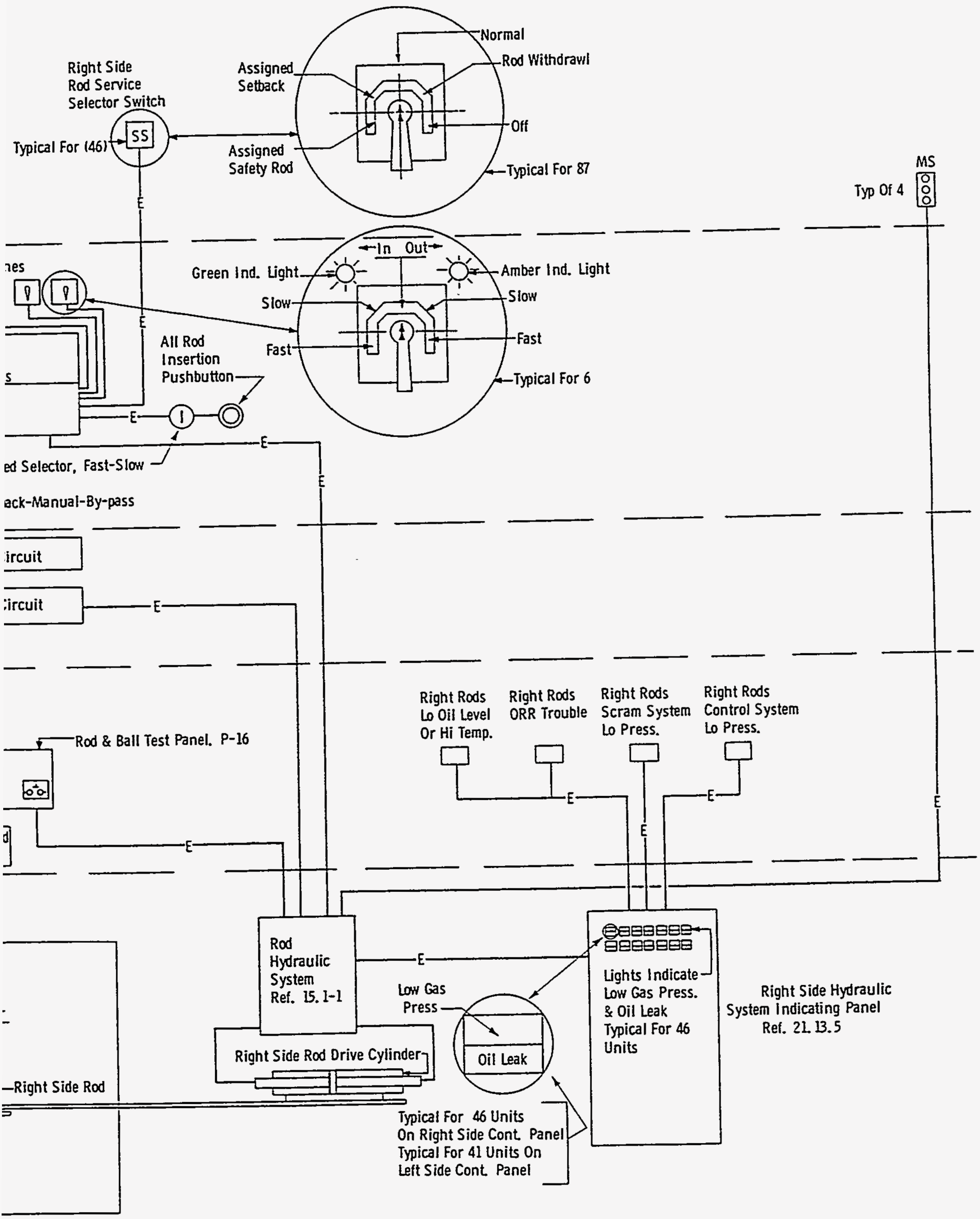
Ball Control Room C



ntrol Panel - 105N



Horizontal Rod Cont



ol System - 105N

HORIZONTAL ROD CONTROL SYSTEM - 105N

The horizontal rod control system is designed to provide means of controlling rod movement during all phases of reactor operation.

The schematic on Page 21.13-1 shows the relationship of the various rod control system components. These are all described in more detail in other sections of the manual but are shown here together for clarification.

For normal rod operation, each rod is assigned a particular operating function by the rod service selector switches. Rod movement is then controlled from the reactor control console within the limitations of certain restricting electrical interlocks.

At the reactor console, rods are assigned for controlled movement to the six control switches by sets of selector push buttons which are provided for all 87 rods. The rod control circuit (as directed by the rod service selector switches, the rod selector push buttons, and the rod control switches) operates the solenoid valves in the low pressure oil system for controlled rod movement.

The power setback feature also functions through the normal rod control circuit and the low pressure oil system. Upon a setback circuit trip, all rods in the setback circuit are inserted stepwise at the slow rod control speed.

The high pressure oil system is used only on a rod scram resulting from a safety circuit trip or for rod scram testing and timing during reactor shutdown.

ROD SCRAM SAFETY CIRCUIT - 105N

The rod scram circuit with its auxiliary equipment is designed to automatically drive all servicable rods in at scram speed to reduce the reactor power level to zero, if any of the operating parameters specified in the circuit should indicate the existence of an unsafe operating condition.

A fail-safe philosophy is used throughout the design of the safety circuit. Failure of a power supply or of a component always causes a trip action to take place. Where-ever feasible, redundant-coincident features are used to reduce the number of false scrams caused by the fail-safe philosophy. Furthermore, where the option exists, a reliable direct current power source with battery backup is used in preference to alternating current.

The rod scram circuit is energized when made up. De-energizing the scram circuit opens the main rod scram circuit breakers (1K1 and 1K2) which in turn de-energizes the rod scram solenoids, permitting the hydraulic scram accumulators to force the rods in at scram speed. The rod scram circuit is de-energized by any of the following trip functions which are listed together with the signal source and the trip coincidence required.

1. Manual Push Button - Located at the reactor console with no time delays or by-passes.

2. Fast Period Intermediate Power Level - Three channels of intermediate level nuclear instrumentation located in the top of the reactor, Ref. 21.11.2 (coincidence: 2 of 3).

   The over-all trip function can be bypassed, but the individual trips cannot.

3. Excessive Neutron Flux, Intermediate Power Level - Same signal source as Item 2 (coincidence: 2 of 3).

   The over-all trip function can be bypassed, but the individual trips cannot.

4. Excessive Neutron Flux High Power Level - Twelve channels of high level nuclear instrumentation with six flux chambers located in the top of the reactor and six in the bottom, Ref. 21.11.3 (coincidence: 2 of 12, if any chambers are bypassed, then 2 of those in service).

   Individual instruments can be bypassed up to a total of four with no more than one in a quadrant (top inlet, top outlet, bottom inlet, bottom outlet). In addition, a maximum of two of the four side instruments can be bypassed. On improper bypassing of an instrument, an adjustable time delay provides time to correct the mistake before a scram occurs.

5. Excessive Power Rise Rate - Three controllers receiving individual signals from three averaging circuits. One circuit averages the six top high level flux monitors; one averages the six bottom high level flux monitors; and one averages the twelve flux monitors in the galvanometer circuit, Ref. 21.11.3 (coincidence: 2 of 3).

   The over-all trip function can be bypassed, but individual controllers cannot.

ROD SCRAM SAFETY CIRCUIT - 105N (CONT'D)

6. Very High Average Power Level - Three controllers receiving the output signal from one averaging circuit which averages the signals from the 12 high level flux monitors, Ref. 21.11.3 (coincidence: 2 of 3). The over-all trip function can be bypassed, but individual controllers cannot.

7. Process Tube High Flow - 1004 trip controllers monitor for both high and low flow. Each process tube's inlet flow is sensed with a venturi, and individual transducers send analog flow signals to the above controllers, Ref. 21.4.2 (coincidence: 1 of 1004).

   The over-all trip function as well as the individual controllers can be bypassed. Trip points are adjusted with an en masse high trip point adjustment and individual low trip point adjustments.

8. Process Tube Low Flow - See Item 7. Again, the over-all trip function, as well as the individual controllers, can be bypassed.

9. Outlet Bulk Boiling - Four channels of instrumentation, using pressure and temperature sensing from outlet crossover lines 4, 8, 9 and 13 compare effluent temperature with boiling point temperatures, Ref. 21.4.3.2 (coincidence: 2 of 4, if one is bypassed, then 2 of 3).

   A five-position bypass switch permits any single instrument (one at a time) to be bypassed. Also, the over-all trip function can be bypassed.

10. Zone Monitor High Temperature - A trip accumulator circuit which counts trips from 109 monitor units, each sensing an individual RTD in a process tube outlet connector, Ref. 21.4.4.2 (coincidence: 3 of 100+).

   The over-all trip function as well as the individual controllers can be bypassed. Trips are individually adjusted. An en masse bias trip adjustment is also provided to bias individual trips up or down.

11. Rod Cooling Water Low Flow - 87 Flow monitors monitor cooling from each rod, Ref. 21.13.6 (coincidence: 1 of 87 with a time delay which is adjustable from 3 seconds to 20 minutes).

   The over-all trip function can be bypassed. Also, any rod in the full out position is automatically bypassed. Individual low flow trips may also be bypassed by means of plugs in Transducer Rooms 3 and 36.

12. Electric Power Failure - Either the BPA 4160 volt bus or the TG 4160 volt bus, low voltage as sensed by the potential transformers at each bus at 153-N (coincidence: 1 of 2).

   An electrical outage of greater than three seconds will trip the safety circuit. A three-position bypass switch is provided to allow either, but not both, of the trips to be bypassed.

ROD SCRAM SAFETY CIRCUIT - 105N (CONT'D)

13. Primary Loop Extremely High Pressure - Four pressure switches located at the bottom of outlet headers 4, 7, 10, and 13, Ref. 21.4.6.4 (coincidence: 2 of 4, if one is bypassed, then 2 of 3).

    A five-position bypass switch permits any single pressure switch (one at a time) to be bypassed.

14. Primary Pump Low Steam Pressure - Three pressure switches on each half of the drive turbine steam header, Ref. 21.6.1 (coincidence: 2 of 6, if any trips are bypassed, then 2 of those remaining).

    The over-all trip function as well as the individual trips can be bypassed.

15. Circulating Water Low Flow - Four flow monitors monitoring 181 pump flows, Ref. 21.2.1.1 (coincidence: any 2, if one or two trips are bypassed, then 2 of 3 or 2 of 2, respectively). The over-all trip function as well as the individual trips can be bypassed.

16. Steam Generator Extremely Low Liquid Level - Selected one of three liquid level indicators on each of the steam generators, Ref. 21.6.5 (coincidence: 2 of 10).

    The over-all trip function as well as the individual trips can be bypassed.

17. Emergency Cooling Water System - Signal which actuates the emergency cooling water system, Ref. 21.5.

18. Extremely Low Pressurizer Level - Three level indicating instruments located on the pressurizer, Ref. 21.4.7.3 (coincidence: 2 of 3).

    The over-all trip function, but not the individual instruments, can be bypassed.

19. Extremely Low Surge Tank Level - Three level indicating instruments located on the surge tank, Ref. 21.6.3 (coincidence: 2 of 3).

    The over-all trip function, but not the individual instruments, can be bypassed.

20. Ball Drop - Contacts from the 1K3 and 2K3 breakers are in series with the safety circuit main breakers, Ref. 21.12.2-1 (coincidence: 1 of 1).

21. Fuel Element Rupture - Future gross gamma and/or gamma energy rupture indication. The trip is provided but jumpered until experience dictates a need.

There are annunciator drops associated with the above scram trip functions, signal instrumentation, and bypass switches. For a listing of annunciators see Ref. 21.17.2, and for added details see the references in the above listing.

Whenever the safety circuit is made up (energized), the following functions occur or interlocks are in effect.

1. Energizes the rod scram solenoids. This will permit the withdrawal of safety and control rods when starting up.

ROD SCRAM SAFETY CIRCUIT - 105N (CONT'D)

2. De-energizes the circuits to prevent opening the following valves:

V-5 - Outlet Header Flush (two)
V-7 - Diversion System Flush
V-13 - Diversion System Strainer Blowdown
V-18 - Inlet Header Flush (two)
V-24 - LP Flush to River
V-25 - LP Flush to Lift Station
V-27 - Diversion System Flush
V-31 - Diversion System Back Pressure Valve Shutoff
V-37 - Diversion System Decontaminant Effluent Shutoff
V-48 - Helium Leak Detection System Blocking Valves (two)

3. De-energizes the circuits to prevent closing the following valves:

V-6 - Diversion System Blocking Valve
V-22 - LP Flush Line Shutoff to Crib
V-26 - Diversion System Heat Exchanger Shutoff

Note: For items 2 and 3 above, power can be restored to open or close the valves with the exception of the V-48's by bypassing the interlock with the safety circuit. This is done with the bypass switches in the reset circuit which correspond to the same valves.

4. De-energizes the ball drain valve solenoid circuit to prevent opening these valves during operation.

Whenever the safety circuit is tripped (de-energized), the following functions are performed and/or interlocks are in effect.

1. De-energizes the rod scram solenoids. This permits the hydraulic accumulators to scram the rods.

2. Actuates timers (0 to 1200 seconds) which upon timing out will, if the power level has not decayed to less than .001 to 4 MW, actuate a full ball drop.

3. De-energizes the rod control circuit for approximately five seconds to allow rods to scram.

4. De-energizes the "rod off" and "rod withdrawal" selection circuit for approximately five seconds to allow the rods time to scram before being selected for off or withdrawal service. (See Ref. 21.13.4 for full details).

5. Actuates on trip certain other circuits in the heat dissipation system. The functions that are performed by these circuits are:

   a. Start the diesel-driven emergency cooling system pumps, Ref. 21.5.1 and 21.5.2.

   b. Reset the primary coolant flow to 25 per cent. The steam valves to the primary coolant pump drive turbines will close and then open automatically to control at 25 per cent flow, Ref. 21.4.1.

ROD SCRAM SAFETY CIRCUIT - 105N (CONT'D)

c. Start all available injection pumps, Ref. 21.4.7.1

d. Start the afterheat removal fill pumps; Ref. 21.6.9.

e. Initiate a programmed startup of the stand-by boiler, open both motor-operated boiler steam outlet block valves, and start all boiler feed pumps, Ref. 21.5.10.

f. Switch from inlet temperature to a predetermined steam pressure setpoint, Ref. 21.6.1.

g. Open the bypass around the steam generators in the operating loops, Ref. 21.6.9.

h. Close all steam generator secondary side blowdown valves, Ref. 21.6.9.

i. Close all dump condenser steam side vent valves, Ref. 21.6.9.

j. Fully open all secondary coolant normal makeup valves, Ref. 21.6.3.

k. Fully open all secondary coolant emergency fill valves, Ref. 21.6.3.1.

l. Cut off all pressurizer heaters, Ref. 21.4.7.2.

Bypass switches are provided by which each of the items "b" through "l" can be bypassed.

6. Removes the individual ball column bypasses from the ball column drop to rod backup circuit (Ref. 21.12.3) and permits columns of balls to drop on each side of rods that fail to scram 75 per cent "in" within a set time (adjustable from 0.3 to 3 seconds) when there are four or more such failures, or a total of three rods in one column failed, and again bypasses the individual column drops after a set time interval (adjustable from 10 to 30 seconds).

7. De-energizes circuitry in the ball drop circuit which will actuate a full ball drop if the flux level has not fallen below 25 per cent of normal power within a set time interval (adjustable from .75 to 10 seconds).

8. Energizes scram transient recording receptacles (two).

RESET CIRCUIT FOR THE ROD SCRAM SAFETY CIRCUIT - 105N

The rod scram circuit breakers (1K1) and (1K2) must be reset by energizing auxiliary relays (closing coils) which in turn can only be energized by making up the reset circuit. This reset circuit is a series circuit involving 41 contacts which must be closed before the circuit is ready to makeup. When this condition exists, a light so indicates the circuit's "readiness" and the reset circuit can then be made up (energized) by a pushbutton on the reactor console.

The contacts in the reset circuit are listed below. Contacts 1 through 17 are actuated by limit switches on the indicated primary loop valves, while contacts 18 through 22 are actuated by relays or switches in circuitry related to the contact's identifying nomenclature. Contacts 1 through 20 have individual bypass switches and bypass indicating lights on the safety circuit panel. Contacts 23 through 37 are actuated by bypass switches which can be found in circuitry related to the contact's identifying nomenclature. Finally, a parallel pair of "time delay after trip" contacts are in the series circuit and function to prevent any combination of closed contacts and closed bypass switches from placing the circuit in a "ready" condition either during operation or until 10 seconds after a rod scram. The conditions for a closed contact is included in the contact identifying nomenclature in the contact list which follows:

1 and 2	V-5 Outlet header flush (2) closed.
3	V-7 Diversion system flush, closed.
4	V-13 Diversion system strainer blowdown, closed.
5 and 6	V-18 Inlet header flush (2) closed.
7	V-19 Emergency raw water flush, closed.
8	V-22 L. P. flush line crib shutoff, open.
9 and 10	V-23 H. P. dump (2) open to energy dissipator.
11	V-24 L. P. flush to river, closed.
12	V-25 L. P. flush to lift station, closed.
13	V-26 Diversion system heat exchange shutoff, open.
14	V-27 Diversion system flush, closed.
15	V-31 Diversion system back pressure valve bypass, closed.
16	V-37 Diversion system decontamination tank shutoff, closed.
17	V-6 Diversion system blocking valve, open.
18	All ball drain valves closed.
19	All ball hoppers unlocked (master locking switch).
20	Less than five ball hoppers individually locked.
21 and 22	Rod scram accumulator supply manifold pressurized (right and left).
23 and 24	Outlet header, relief valve, selector valve (V-43) must be turned to installed relief valve (left and right sides).
25 thru 30	Emergency cooling water trips not bypassed; any one of four input trips bypassed, not bypassed; test-test and bypass #1, not bypassed; emergency cooling water master bypass, not bypassed; and any one of eight individual emergency cooling water flow bypass, not bypassed.

RESET CIRCUIT FOR THE ROD SCRAM SAFETY CIRCUIT 105N (CONT'D)

31	Ball backup to emergency cooling water system bypass, not bypassed.
32	Excessive neutron flux, intermediate power level bypass, not bypassed.
33	Excessive power rate of rise bypass, not bypassed.
34	Graphite cooling low flow bypass, not bypassed.
35 thru 39	ECW Diesels (5) automatic start, not bypassed.
40-41	Time delay after rod scram, ten seconds (3/4 to 10 seconds) after rod scram.

In order to reset the rod scram safety circuit, the reset circuit must also be "ready" to makeup; that is, all contacts or their bypass switches must be closed to complete the series circuit. When this condition exists, the "readiness" of the reset circuit is indicated by a light; and with the rod scram safety circuit also in a "ready" condition, the main circuit breakers can be pulled-in by pushing the reset makeup button.

ROD SETBACK CIRCUIT - 105N

The rod setback circuit with its auxiliary equipment is designed to automatically reduce the reactor power level if any of the operating parameters specified in the circuit should approach a scram condition. This is to reduce the probability of a rod scram safety circuit actuation, and is done by a stepwise insertion of all rods in setback service.

The setback circuit is a series circuit composed of 13 contacts which must be closed to make up the circuit. The circuit also includes a master three-position switch (setback-normal-bypassed) which is located at the console. The trip functions which will open a contact are listed below together with the signal source and the trip coincidence required.

1. Fast Period Subcritical - Two subcritical flux monitors extending through the top of the reactor into the active zone, Ref. 21.11.1 - (coincidence: 1 of 2). The over-all trip function and the individual instrument trips can be bypassed.
2. Approaching Fast Period, Intermediate Power Level - Three channels of nuclear instrumentation, Ref. 21.11.2 - (coincidence: 2 of 3). The over-all trip function can be bypassed, but the individual instrument trips cannot be bypassed.
3. Approaching Excess Neutron Flux, High Power Level - Twelve recorders fed from the 12 radiation amplifiers which receive the signals from the high level flux monitor ion chambers, Ref. 21.11.3 - (coincidence: 2 of 12). The over-all trip function and the individual instrument trips can be bypassed.
4. Approaching excessive Power Rate of Rise - Three recorders sensing the same signals as fed to the controllers monitoring the same function in the rod scram safety circuit, Ref. 21.11.3 - (coincidence: 2 of 3). The over-all trip function can be bypassed, but the individual instrument trips cannot be bypassed.
5. High Average Power Level - One recorder sensing the output of the averaging circuit for the 12 high level flux monitors, Ref. 21.11.3 - (coincidence: 1 of 1). The over-all trip function can be bypassed.
6. Approaching Outlet Bulk Boiling - The same four channels of boiling point instrumentation as used in rod scram safety circuit, but with separate contacts for setback, Ref. 21.4.3.2 - (coincidence: 2 of 4, if any single instrument is bypassed, then 2 of 3). A five-position bypass switch permits any single instrument (one at a time) to be bypassed; also, the over-all trip function can be bypassed.
7. High Pressure Main Steam Header - Four pressure switches on the main steam header, Ref. 21.6.1 - (coincidence: 2 of 4, if any single instrument is bypassed, then 2 of 3). A five-position bypass switch permits any single instrument (one at a time) to be bypassed. Also, the over-all trip function can be bypassed.
8. Zone Monitor High Temperature - A trip accumulator circuit which counts trips from 109 monitor units, each sensing an individual RTD in a process tube outlet connector, Ref. 21.4.4.2 - (coincidence: 2 of 100+). The over-all trip function can be bypassed, as well as the individual controllers.
9. Primary Loop Very High Pressure - Four pressure switches located at the bottom of outlet headers 4, 7, 10 and 13, Ref. 21.4.6.4 - (coincidence: 2 of 4, if a single instrument is bypassed, then 2 of 3). A five-position bypass switch permits any single instrument (one at a time) to be bypassed. Also, the over-all trip function can be bypassed.

ROD SETBACK CIRCUIT - 105N (CONT'D)

10. Primary Loop Very Low Pressure - Four pressure switches located at the bottom of outlet headers 4, 7, 10 and 13, Ref. 21.4.6.4 - (coincidence: 2 of 4, if a single instrument is bypassed, then 2 of 3). A five-position bypass switch permits any single instrument (one at a time) to be bypassed. Also, the over-all trip function can be bypassed.
11. Pressurizer High Water Level - Three liquid level instruments, Ref. 21.4.7.2 - (coincidence: 2 of 3). The over-all trip function can be bypassed, but the individual instrument trips cannot be bypassed.
12. High Surge Tank Water Level - Three liquid level instruments, Ref. 21.6.3 (coincidence: 2 of 3). The over-all trip functions can be bypassed, but the individual instrument trips cannot be bypassed.
13. High or Low Steam Generator Effluent Temperature - A pair of high and low temperature sensing elements for the effluent from each of the ten steam generators, Ref. 21.4.3.1 - (coincidence: a trip in any of three pair out of ten pair). The over-all trip function and individual steam generator pair trips can be bypassed.
14. Manual - Three-position selector switch on the console.

There are 70 annunciator drops associated with the above setback trip functions, signal instrumentation, and bypass switches. For a listing of these drops, see Ref. 21.17.2. Other details of the setback system are:

1. Rods which are in setback service (that is, rods which will enter the reactor on a setback trip) are: (1) rods assigned to setback by the service selector switches, and (2) rods assigned to any of the six SB1 control switches by the rod control selection pushbuttons, provided that these rods have not been individually bypassed from such service at the same pushbutton station, Ref. 21.13.4.
2. When a rod setback occurs, rod insertion will continue stepwise until the setback signal disappears or is bypassed. At this time, the setback circuit makes up (no manual reset is required) and rod control is returned to normal.
3. Rod insertion speed is at the slow rod control speed with the stepwise insertion period being governed by adjustable delayed pickup and dropout relays (alternating periods of 2/3 of a second insertion time followed by 1/3 of a second hesitation).
4. The setback circuit is interlocked with the power to the rod control switches to prohibit withdrawing rods with these switches during the period of a setback trip. The only control maintained in the switches during setback is for "travel in" (slow or fast).

ROD DRIVE CONTROL SYSTEM

The rod drive control system provides the means for operating personnel to select the type of horizontal rod service and to manually control horizontal rod movement. This is accomplished by the operation of three groups of control switches: The service selector switches, the rod control selection pushbuttons, and the rod control switches. Incorporated in the control circuitry are various interlocks to provide reactor safety. These controls and their functions are detailed below:

1. The service selector switches - There are 87 key-locked, five-position, SB type control switches located on the rod service selector switch panel. These switches are used to assign each rod to one of the following five different types of service:

   a. Assigned Safety Circuit - Rods assigned as safety rods:

      (1) Cannot be withdrawn until the safety circuit is made up, which in turn energizes the scram solenoid valves. With the scram solenoid valves de-energized, the normal rod hydraulic controls will not function to move the rods, as neither side of the rod hydraulic cylinder can be pressurized.

      (2) Must be full-out before rods assigned to manual and setback can be withdrawn. When all safety rods reach their full-our proximity switches, rod-out control power is returned to those rods assigned to manual and power setback.

      (3) Cannot be run in with the control circuit unless reassigned to manual, and can then be run in even though all safety rods are not full-out. An exception to this is the all rod insertion pushbutton, which will insert all rods at either the slow or fast control speed with the exception of rods assigned to OFF or to rod withdrawal.

      (4) Are bypassed from the setback circuit. This is really a second bypass in that safety rods are, in addition, NOT assigned to the setback circuit.

      (5) Automatically cancel their rod control switch (operating switch) selection by removing power from the selection pushbuttons for each rod as the full-out proximity switch is reached.

      (6) Light individual blue indicating lights in the selector pushbuttons for the corresponding rods to indicate their safety rod status.

      (7) Scram into the reactor, as do all rods not assigned to OFF, at the rod scram speed upon a safety circuit trip.

      (8) Actuate a red indicating light on the selector pushbutton panel to indicate that all safety rods are not full-out; and then turn this red light off and an amber light on when all safety rods are full out.

ROD DRIVE CONTROL SYSTEM (CONT'D)

b. Assigned Power Setback - Rods assigned to power setback:

(1) Are automatically inserted stepwise into the reactor at the slow rod speed upon a setback circuit trip. This is accomplished by periodically energizing the normal rod in slow control circuit to the in slow solenoid valve.

(2) Are used for reactor control in the same manner as rods selected for manual service.

(3) Cannot be withdrawn until the safety circuit is made up and all safety rods are full-out.

(4) Scram when the safety circuit is tripped.

(5) Light individual blue indicating lights in the selector pushbuttons for the corresponding rods to indicate their setback status.

c. Manual - Rods assigned to manual:

(1) Cannot be withdrawn until the safety circuit is made up and all safety rods are full out.

(2) Are manually positioned with the rod control system for reactor power level control.

(3) Scram when the safety circuit is tripped.

(4) Are placed in the power setback circuit when assigned to one of the six control switches. A blue indicating lamp lights in the selector pushbuttons to indicate that the rod is in a status of controlled setback. This function can be bypassed with another of the backlighted selector pushbuttons which is labeled, "Controlled Setback Bypass".

d. Rod Withdrawal - To assign a rod to withdrawal, the service selector switch is first turned to the rod withdrawal position. This lights an individual red indicating light in the selector pushbuttons for the corresponding rod to indicate the withdrawal status (not yet attained). An annunciator also drops which warns of any rod in the withdrawal or off status. Next, to actuate the interlocks associated with withdrawal, the selector switch must be pulled out momentarily; five seconds later, amber lights (one on the service selector switch panel and one on the selection pushbutton panel) blink on for half a second and then off, signifying that the rod withdrawal and off energizing circuit has timed out. At this time, a red light (one light for all 87 rods) on each of the above panels lights to indicate that the withdrawal interlocks for the rod are in effect; namely, that the rod scram solenoid valve is being held energized through a bypass circuit and that power to the rod in slow solenoid valve is removed.

ROD DRIVE CONTROL SYSTEM (CONT'D)

Assigning a rod to withdrawal is independent of the safety circuit status except for five seconds after a safety circuit trip, during which time power is off to the rod withdrawal and off energizing circuit.

Thus, rods assigned to withdrawal:

(1) Can be withdrawn (with the safety circuit either made up or tripped) but cannot be inserted with either the normal rod control or the all rod insertion pushbutton.

(2) Can be tested for scram insertion time with the lx safety circuit tripped.

(3) Will scram (during shutdowns with the safety circuit tripped) if four or more rods are placed in a withdrawal or off status. A meter relay counts rods in the off and withdrawal status and de-energizes the scram solenoid valve bypass energizing circuit when more than three rods are placed in such service.

(4) Will scram when the safety circuit is tripped. Upon a safety circuit trip, the withdrawal interlocks are de-energized and cannot be re-energized for five seconds (to give the rods time to scram). To re-energize them, the selector switches must again be pulled out.

(5) Will have their withdrawal interlocks de-energized upon a BPA electrical outage (loss of current from the CX panel).

e. Off - To assign a rod to off, the selector switch must be turned to off and pulled out. The same energizing circuit is used as for rod withdrawal; in fact, the rod withdrawal interlocks are energized. The same annunciator drops and the same amber lights time out with actuation of the same red lights signifying pickup of the relay which places in effect the withdrawal interlocks. In addition, the red light which lights in the corresponding rod selector pushbuttons indicates that the rod off interlock has locked-in to hold the rod scram solenoid energized through a bypass circuit and prevent the rod from scramming.

Thus, rods assigned to off:

(1) Will not scram when the lx safety circuit is tripped. However, this interlock is bypassed if four or more rods are assigned to off.

(2) Will be counted as rods that fail to scram to 75% in for the ball column backup to rods circuit.

(3) Are inoperable. However, following a scram and subsequent startup, the service selector switch must again be pulled out to re-activate the withdrawal-off interlock which removes power to the rod in slow solenoid valve; otherwise, actuation of the all rod insertion button would insert the rods which had been assigned to off during a previous operating period.

ROD DRIVE CONTROL SYSTEM (CONT'D)

2. The Rod Control Selector Pushbuttons - Located on the right of the reactor console is the rod control selector pushbutton panel which has 87 sets of pushbuttons corresponding to the 87 rods. These sets of pushbuttons are arranged in two patterns which are similar to the rod patterns for the right and left side. Each set consists of two rows of four buttons.

   The first button is the white, backlighted cancel button. Pushing this button will release (cancel) any of the other seven magnetically held backlighted pushbuttons; namely, the six control switch selector pushbuttons and the controlled setback bypass pushbutton. This button also indicates the control rod number pertinent to the group of buttons and lights.

   Directly below the cancel button is the blue backlighted pushbutton which can be used to bypass the controlled setback functions for any rod assigned to a rod control switch. The bottom half of this button is a red indicating light which signifies that the service selector switch has been turned to withdrawal.

   The remaining six buttons are alike in that half of each button is an indicating light, while the other half is backlighted (white), to indicate to which rod control switch the rod is assigned when the pushbutton is depressed. The indicating lights in these six buttons indicate when (1) the rod reaches the full out proximity switch (amber light); (2) the rod reaches the full in proximity switch (green light); (3) the rod is selected by the service selector switch for a safety rod, for assigned power setback, or for rod off service (blue, blue, and red lights, respectively); and (4) the rod is in a controlled setback status; that is, the rod is assigned to a rod control switch with the resulting setback feature not bypassed (blue light).

   The main function of each group of pushbuttons is to assign the related rod to one of the six SB rod control switches. It is possible to assign all 87 rods to one switch but not practical.

3. The Rod Control Switches - The six rod control switches are located on the reactor console and are used to manually position the rods. These switches each have five positions:

   1. Rod in Slow
   2. Rod in Fast
   3. Rod Out Slow
   4. Rod Out Fast
   5. Spring Return to Neutral

   When activated and if power is available to these switches, they will in turn make power available to contacts which can be closed by the selection pushbutton relays to finally energize the selected rod travel solenoid valve through the control circuit, providing that none of the earlier rod control interlocks are acting to prevent rod movement.

ROD DRIVE CONTROL SYSTEM (CONT'D)

Power is normally available to each rod control switch rod-in-slow, and rod-in-fast contacts; however, either of two conditions are required to provide power to the circuit to the rod-out-slow and rod-out-fast contacts of each switch. They are:

1. The setback circuit must be made up, or

2. The safety circuit must be tripped. Power is not supplied by this second means until five seconds after a scram.

Additional interlocks are in the power circuit to the rod-out-fast contacts of each switch. They are:

1. Power is removed if the count rate of either sub-critical instrument is less than 10 counts/second. A switch is provided to bypass these interlocks.

2. Power is removed if the period of either sub-critical instrument is less than 20-60 seconds. A switch is provided to bypass these interlocks.

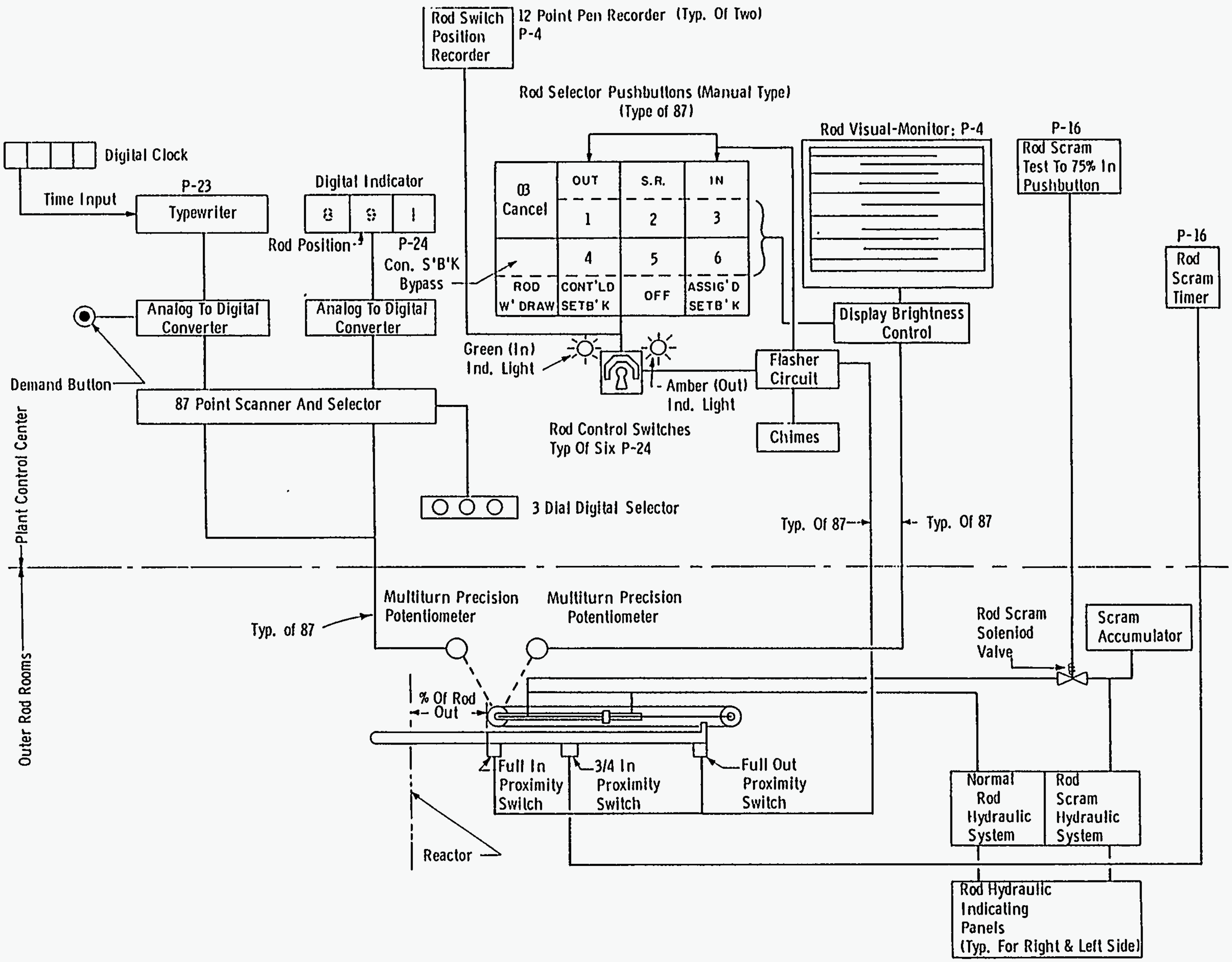
3. Power is removed if a 2 out of 3 coincident trip is received from intermediate flux level instrumentation. A bypass switch is provided for this interlock.

The actuation of a rod control switch also serves to (through a flasher circuit) flash on and off either the amber (out) or the green (in) indicating lights in the selector pushbutton for the corresponding rods being moved, as well as either the amber or green light on each side of the rod control switch being used. In addition, chimes sound whenever a rod is being withdrawn.

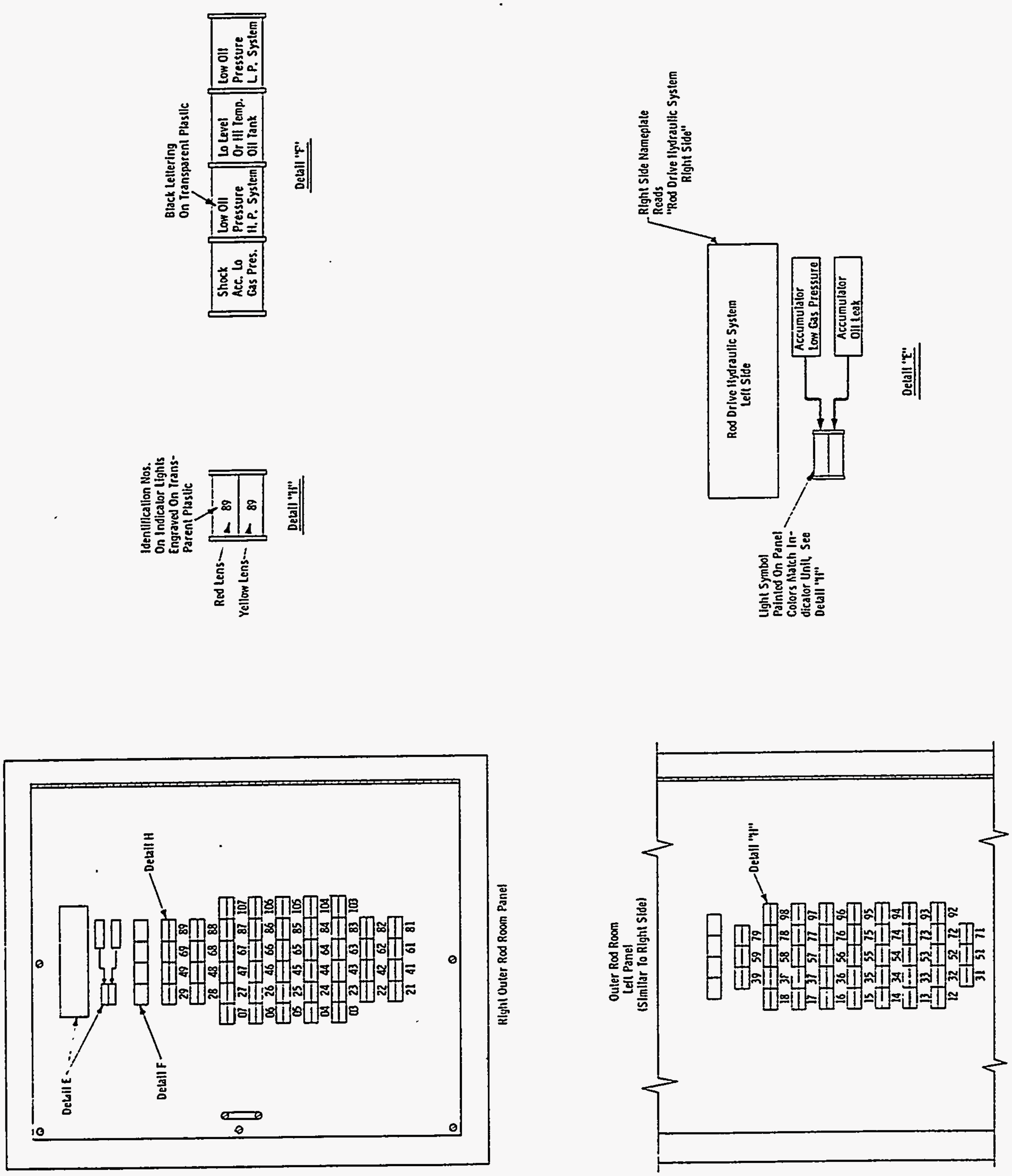
Finally, the all rod insertion button is located on the reactor console with a speed selector switch for normal (fast) and slow rod insertion speeds. Actuating this button will:

1. Insert all rods at the selected slow or fast rod control speed except those assigned to off or withdrawal.

2. Flash the rod "in" indicating lights in the selector pushbuttons for all rods being inserted.



Rod Instrumentation - 105N



Outer Rod Room Panels - 105N
Rod Instrumentation - 105N

AEC-GE RICHLAND, WASH.

ROD INSTRUMENTATION

Instrumentation is provided to:

1. Indicate control rod positions.
2. Log on demand control rod positions.
3. Alarm visually and aurally upon control rod movement.
4. Individually test rod scram speed time.
5. Alarm and indicate hydraulic system malfunctions.

Instrumentation is also provided to indicate rod control status (Ref. 21.13.4) and to monitor rod cooling water flow and temperature (Ref. 21.13.6). Items 1 through 5 are detailed below:

Control Rod Position Indication and Data Logging - Two multi-turn precision potentiometers are geared to each rod mechanism so that the potentiometers are driving through their complete travel for full rod travel.

The anolog signal from one of the potentiometers drives a bar-graph generating device which indicates graphically on a screen (a cathode-ray tube) in three dimensions the entire reactor rod system. Several important details of the system are:

1. Contacts on the individual rod selector pushbuttons cause the rods which are controlled to be displayed brighter than the others.
2. The instrumentation is capable of resolving a four-inch movement and of showing rod position within plus or minus 6.8 inches.
3. The screen is located directly in front of the reactor console for the convenience of the operator.

The anolog signal from the other potentiometer is used for digital indicating and data logging functions.

A scanner selects the anolog signals to be printed. These signals are converted to digital form and logged by a typewriter at the rate of approximately two rod positions per second on a representative format. Other details are:

1. The scanner is controlled by a manual pushbutton which initiates recording of all rod positions.
2. The typewriter will log rod number, rod position in per cent full-out (up to 99.9 per cent), and the time and date.
3. The logged rod position is accurate to within plus or minus 0.7 inches.

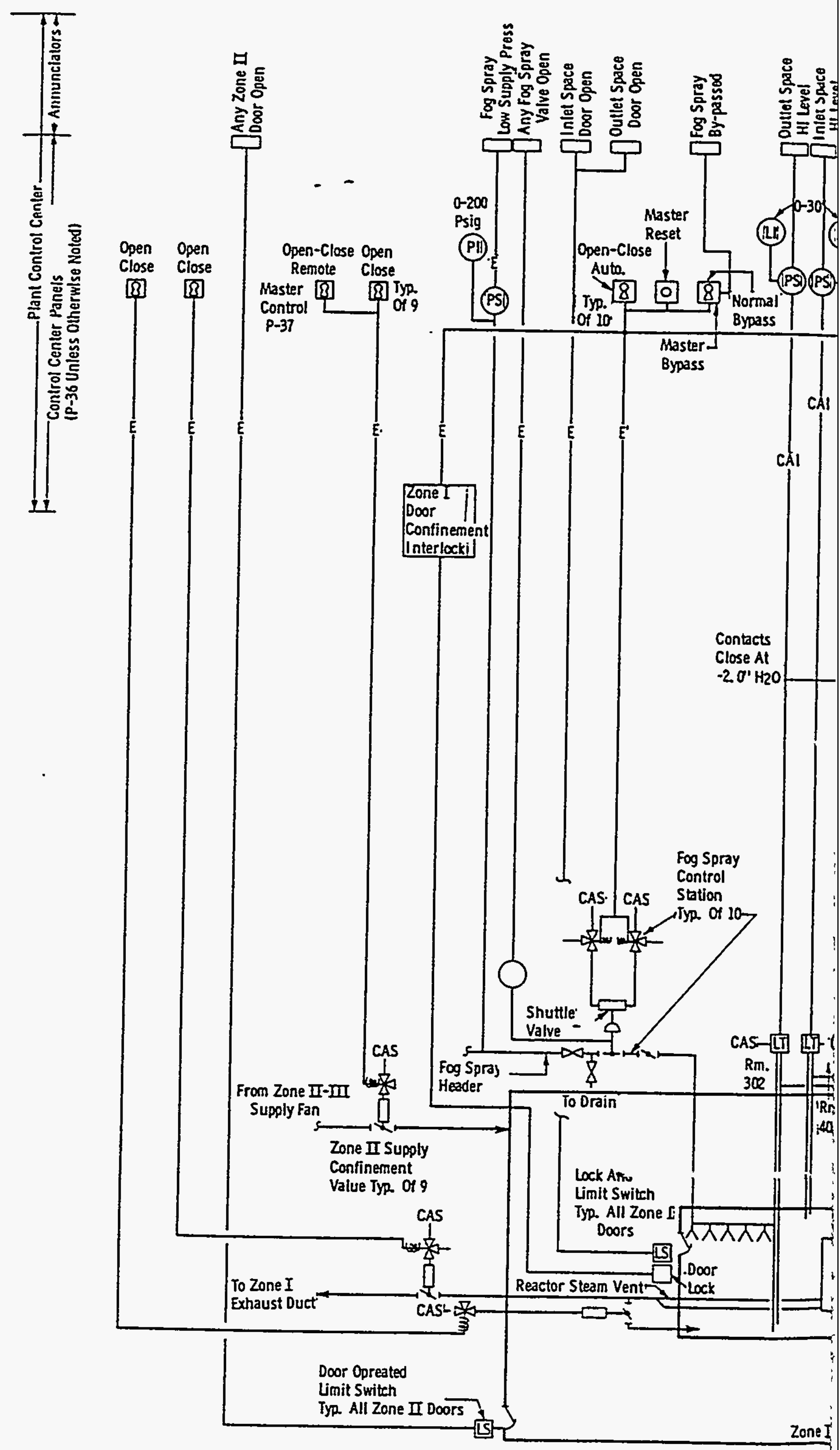
Three selector switch dials, operating through the scanner, are used to select the anolog signal from any one rod potentiometer for conversion to digital form and read-out on a digital indicator. The indicator is located on the reactor console, provides continuous read-out, and is accurate to within plus or minus 1.7 inches. In addition, two 12 point recorders are provided to record the position of each rod control switch; that is, rod-in-slow and fast for six switches and rod-out-slow and fast for six switches. The recorders will indicate the time each switch is in any of any of the above positions.

Visual and Aural Rod Movement Alarm Indications - For visual and aural rod movement alarm indications, a flasher circuit is provided. When actuated, this circuit is alternately energized for one second and de-energized for half a second. The circuit performs the following functions:

ZONE I STEAM VENT VALVE CONTROL SYSTEM 105N & 109N

This system is designed to close the 105N and 109N Zone I steam vent butterfly valves (Ref. 16.3), when a pair of reactor inlet and outlet header pressure switches trip on low pressure. This system also provides controls to initiate inflation of the backup closure device for each steam vent valve. Details of this system are as follows:

1. Two reactor inlet and two reactor outlet headers are monitored for low pressure by four pressure switches. A fifth switch monitors for an approaching low pressure in one outlet header and actuates an annunciator.
2. A normally de-energized coincident trip circuit is actuated when one inlet and one outlet header pressure switch trips on low pressure.
3. The coincident circuit provides signals which close the 105N and 109N Zone I steam vent butterfly valves.
4. The hydraulically-operated, normally-closed, steam vent butterfly valves are controlled by normally-closed hydraulic pilot valves.
5. The action of each pilot valve is controlled by two pair of parallel-acting normally-closed, 125-VDC solenoid valves; A-1, A-2, B-1, and B-2.
6. The steam vent valves are open when solenoid valves A-1 and A-2 are energized (open), and B-1 and B-2 are de-energized (closed). The steam vent valves close when A-1 and A-2 de-energize, and B-1 and B-2 energize. (Note: The valve operator, solenoid valves, and hydraulic pilot valve of each steam vent valve are typical for the Zone II exhaust, and the Zone I supply and exhaust confinement valves, Ref. 21.19.1).
7. For maximum reliability, only one of each pair of solenoid valves is required for operation of the steam vent valve, and the DC supply to solenoids A-1 and B-1 is different from the supply to A-2 and B-2.
8. A keylocked bypass switch is provided on P-36 to prevent automatic closure of all of the steam vent valves. A bypass switch is also provided on the 109N confinement panel, P-39, that will prevent automatic closure of only the 109N steam vent valves.
9. Each 105N steam vent valve is provided with a three-position switch to permit manual operation of the valves. A two-position switch provides the same function for the 109N steam vent valves, with the open position also being the automatic position.
10. Following a steam vent valve closure, and when the primary loop pressure has been returned to normal, the steam vent valves may be opened by actuating a master reset pushbutton on P-36.
11. Each steam vent backup closure device is actuated by a pushbutton, which actuates an explosive valve and a normally-closed solenoid valve.
12. The explosive valve admits nitrogen, and the solenoid valve admits compressed air to inflate the backup closure device.



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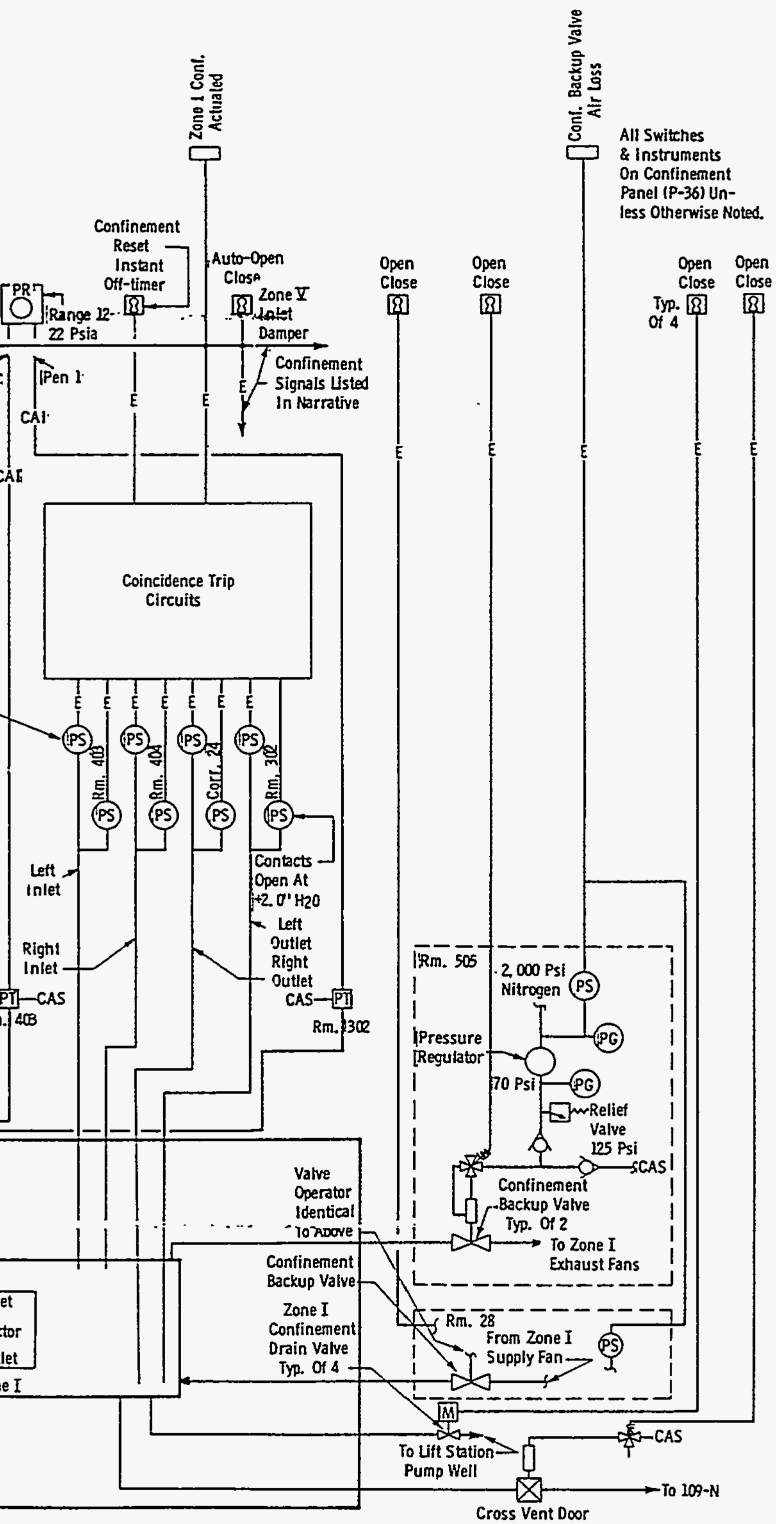


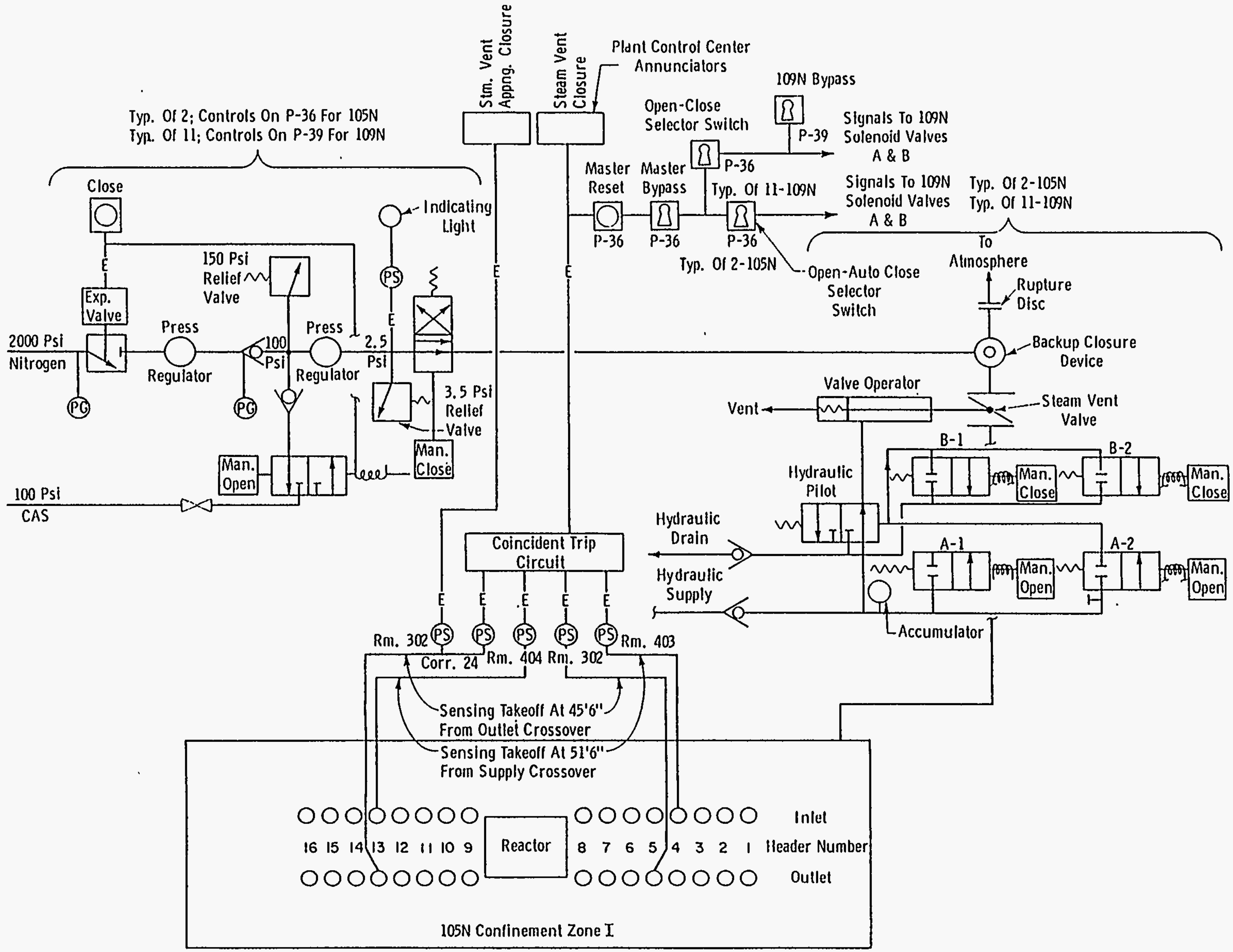
ment Control System - 105N

ROD COOLING WATER FLOW AND TEMPERATURE MONITORING SYSTEM

This system is designed to control bulk flow and monitor bulk flow and temperature of the rod coolant supply, and to monitor the individual flow and temperature of the effluent from each horizontal rod.

Details of the system are as follows:

1. The horizontal rod cooling water system (Ref. 2.4.1) supply pressure is maintained constant by a pressure controller which signals a diaphragm operated valve. The signal to the controller is the coolant supply pressure upstream from the rod coolant strainer.
2. Raw water backup to the rods is controlled by a similar pressure controller and diaphragm operated valve, except that the controller opens the valve at a pressure slightly below the normal coolant supply pressure.
3. The strainer bypass line contains a diaphragm operated butterfly valve. This valve is signaled by a differential pressure controller which receives signals of the coolant supply pressure upstream and downstream of the strainer, and opens the bypass valve when the sensed differential pressure exceeds a set point.
4. The rod coolant bulk inlet temperature is measured in the valve and equipment room, Room 2. This signal is sent to a recorder on the power calculator panel and to the central data logger. The rod coolant bulk outlet temperatures, right and left side, are also sent to a recorder on the power calculator panel.
5. The bulk coolant flow to the left and right outer rod rooms is measured by an orifice in each outer rod room.
6. Individual rod effluent temperatures and flows are measured by thermocouples and orifices.
7. The individual rod effluent temperature signals are sent to the data logger system (Ref. 21.17.1).
8. The pressure signals across the rod orifices are sent to flow monitor units located in transducer rooms, 3 and 36.
9. The flow monitors provide signals to annunciators, selector switch panels, low flow indicating lights, and a relay circuit.
10. Two selector switch panels are provided on the rod and shield cooling water panel. Individual rod flows may be read on a flow indicator used in conjunction with the selector switches.
11. Individual rod low flow signals are series connected and supplied to a relay circuit which actuates two parallel adjustable (0-20 minutes) timers. After the set time has elapsed, the rod scram safety circuit is actuated.
12. The relay circuit is monitored for timer activation. If the timers do not start within 5 seconds of a low flow signal, the rod scram safety circuit is actuated.
13. If the rod is in the full out position, the individual rod low flow signal is automatically bypassed. Low flow signals may also be bypassed by inserting plugs into the individual flow monitors units in Rooms 3 and 36.
14. When the valve supplying raw water backup to the rods opens, an annunciator is actuated.

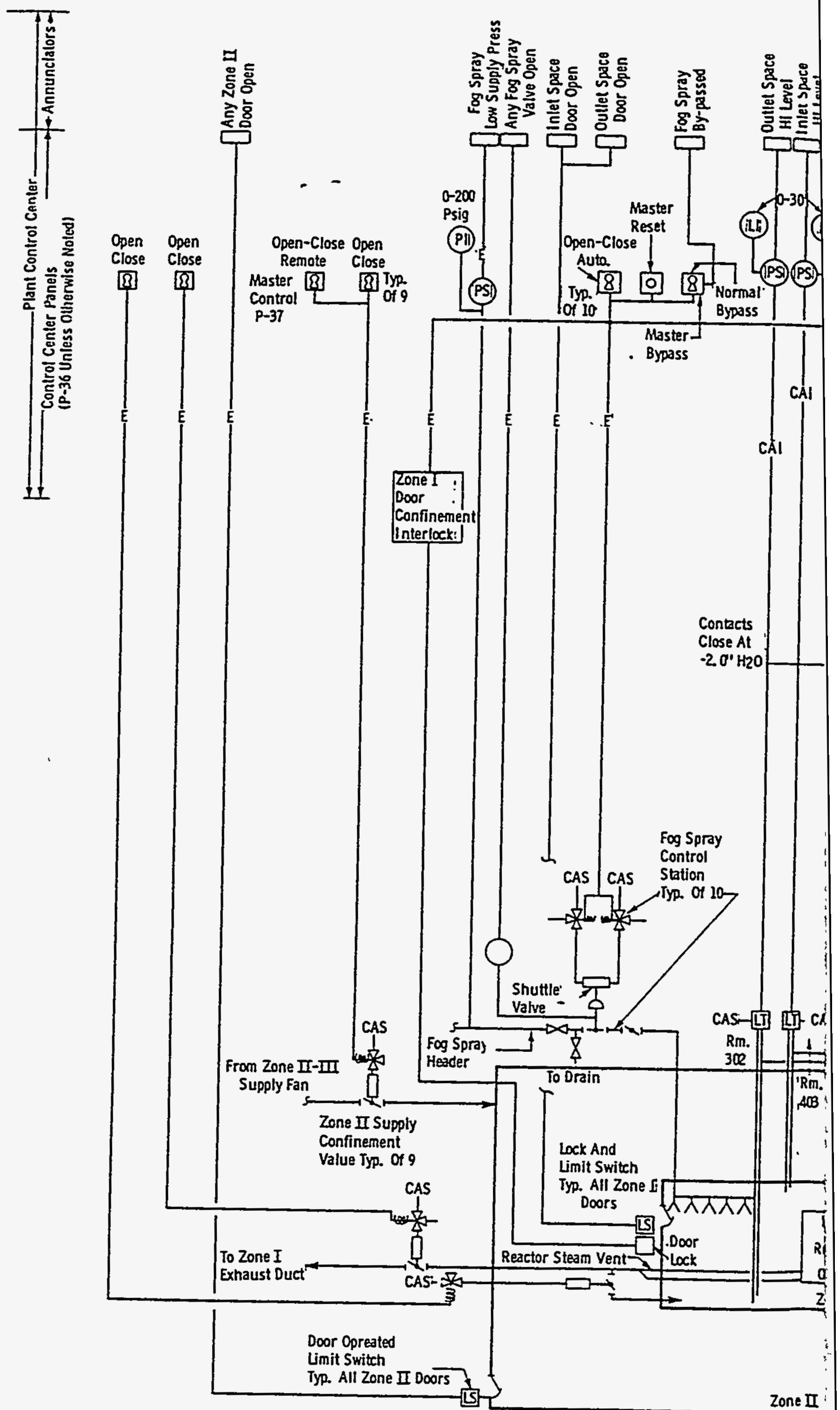


Zone I Steam Vent Control System - 105 and 109N

ZONE I STEAM VENT VALVE CONTROL SYSTEM 105N & 109N

This system is designed to close the 105N and 109N Zone I steam vent butterfly valves (Ref. 16.3), when a pair of reactor inlet and outlet header pressure switches trip on low pressure. This system also provides controls to initiate inflation of the backup closure device for each steam vent valve. Details of this system are as follows:

1. Two reactor inlet and two reactor outlet headers are monitored for low pressure by four pressure switches. A fifth switch monitors for an approaching low pressure in one outlet header and actuates an annunciator.
2. A normally de-energized coincident trip circuit is actuated when one inlet and one outlet header pressure switch trips on low pressure.
3. The coincident circuit provides signals which close the 105N and 109N Zone I steam vent butterfly valves.
4. The hydraulically-operated, normally-closed, steam vent butterfly valves are controlled by normally-closed hydraulic pilot valves.
5. The action of each pilot valve is controlled by two pair of parallel-acting normally-closed, 125-VDC solenoid valves; A-1, A-2, B-1, and B-2.
6. The steam vent valves are open when solenoid valves A-1 and A-2 are energized (open), and B-1 and B-2 are de-energized (closed). The steam vent valves close when A-1 and A-2 de-energize, and B-1 and B-2 energize. (Note: The valve operator, solenoid valves, and hydraulic pilot valve of each steam vent valve are typical for the Zone II exhaust, and the Zone I supply and exhaust confinement valves, Ref. 21.19.1).
7. For maximum reliability, only one of each pair of solenoid valves is required for operation of the steam vent valve, and the DC supply to solenoids A-1 and B-1 is different from the supply to A-2 and B-2.
8. A keylocked bypass switch is provided on P-36 to prevent automatic closure of all of the steam vent valves. A bypass switch is also provided on the 109N confinement panel, P-39, that will prevent automatic closure of only the 109N steam vent valves.
9. Each 105N steam vent valve is provided with a three-position switch to permit manual operation of the valves. A two-position switch provides the same function for the 109N steam vent valves, with the open position also being the automatic position.
10. Following a steam vent valve closure, and when the primary loop pressure has been returned to normal, the steam vent valves may be opened by actuating a master reset pushbutton on P-36.
11. Each steam vent backup closure device is actuated by a pushbutton, which actuates an explosive valve and a normally-closed solenoid valve.
12. The explosive valve admits nitrogen, and the solenoid valve admits compressed air to inflate the backup closure device.



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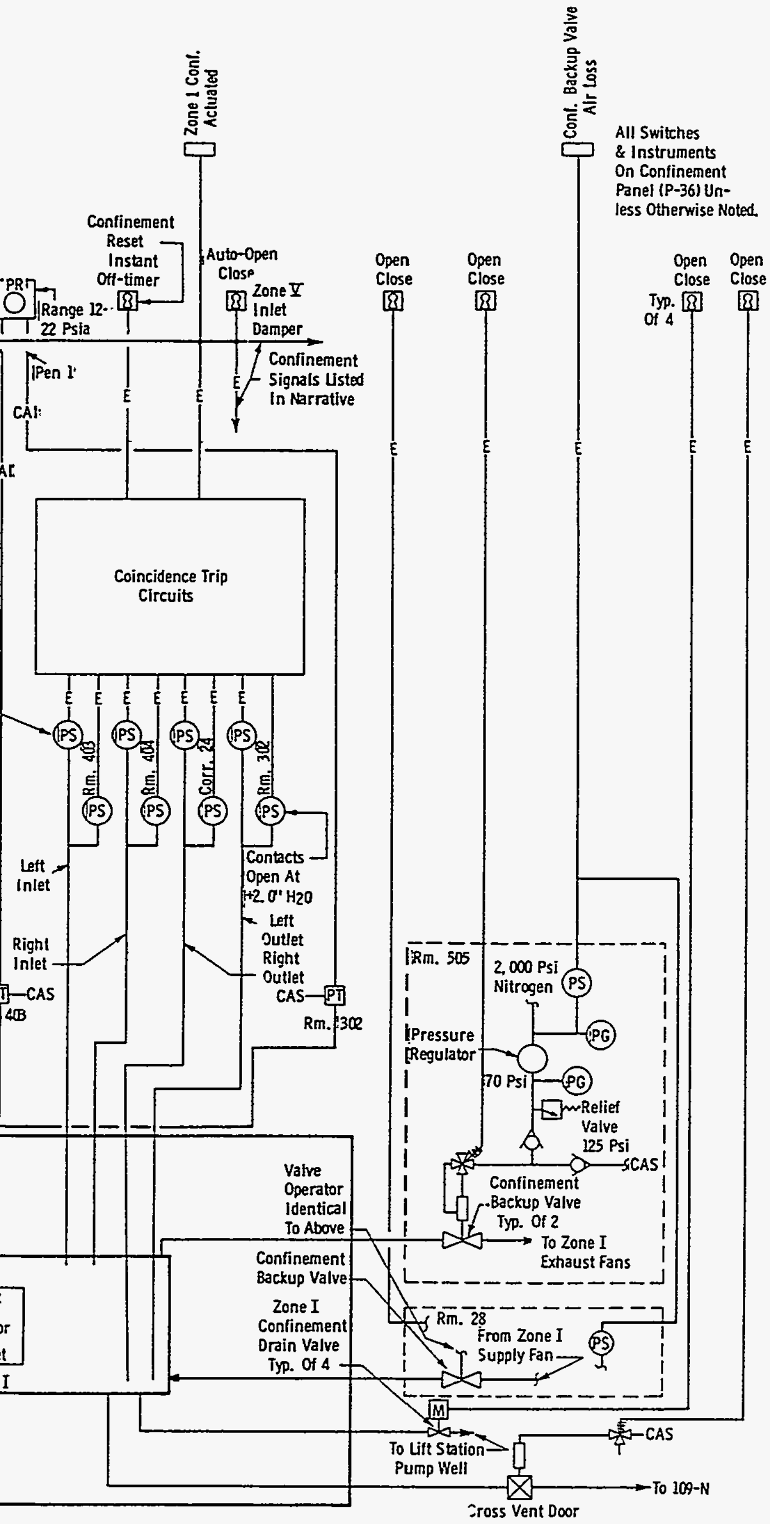


ment Control System - 105N

FOG SPRAY AND VENTILATION CONFINEMENT CONTROL SYSTEM - 105N

This system is designed to monitor 105N Zone I pressure in four locations, two in each of the reactor inlet and outlet pipe spaces, and to initiate a confinement signal when any two of four pressure switches open on high pressure, 2.0"H_2O. The confinement signal initiates the following actions:

1. The Zone I supply, or spare if in use for Zone I, and exhaust fans stop (Ref. 21.19.1).
2. The Zone I supply and exhaust confinement valves close (Ref. 21.19.1).
3. The Zone I exhaust fan discharge dampers open (Ref. 21.19.1).
4. A valve closes in the sensing line between Zone I and the Zones I and II differential pressure transmitters (Ref. 21.19.1).
5. The Zone V inlet and exhaust air dampers close (Ref. 21.19.1).
6. The 105N Zone I doors, except Door 603, are interlocked to prevent opening of the doors (Ref. 17.2.2).
7. The Zone I fog spray control valves are opened (Ref. 16.5.1).

The four high pressure monitoring switches actuate relays which signal two pair of coincident circuits. One pair of these circuits energizes and the other pair de-energizes when signaled. The circuits which energize initiate confinement signals to items 1, 2, 3, 5, and 6; and the circuits which de-energize initiate confinement signals to items 4 and 7. For maximum system reliability, one of each pair of circuits is supplied with DC power from separate sources; and two confinement signals are supplied to all of the above items, one from each power source.

This system is also designed to monitor for low Zone I pressure in the same locations as above, and to reset the two fog spray control circuits and close the fog spray control valves when any two of four pressure switches close on low pressure, -2.0"H_2O. The four low pressure monitoring switches actuate relays which signal two coincident trip circuits, both of which energize. These circuits re-energize (reset) the fog spray control circuits, closing the control valves. For maximum system reliability, each of the coincident trip and fog spray control circuits is supplied with DC power from separate sources; and two reset signals are supplied to each control circuit, one from each power source.

Other details, instrumentation, and controls of this system are as follows:

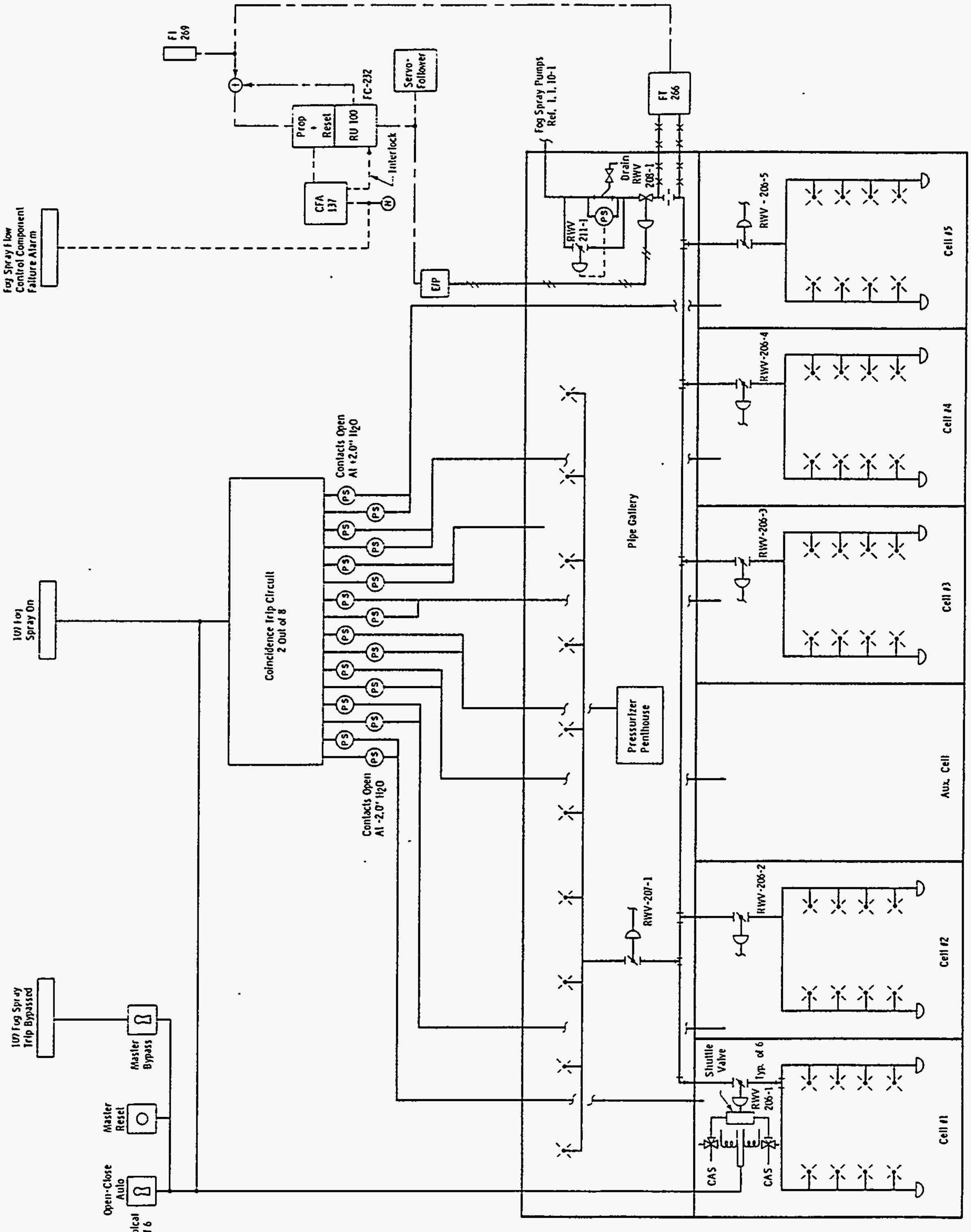
1. Following a confinement signal, when three of the four high pressure switches again close, the action listed in Item 4 above is automatically reversed. At this time, after the confinement reset switch has been actuated, the Zone I exhaust confinement valves and the Zone V inlet and exhaust dampers automatically open; and the Zone I supply and exhaust fans and the supply confinement valve may be manually started and re-opened respectively.
2. The Zone I exhaust confinement valves and the Zone V inlet and exhaust air dampers may be opened manually at any time (Zone V fan must also be running to open the dampers); however, the Zone I supply and exhaust fans, and the supply confinement valve may be started or opened only when Zone I pressure is normal or after manual reset following a confinement signal.
3. The confinement reset switch permits an instantaneous or a delayed reset action, with time adjustable between 15 and 90 minutes when a confinement signal no longer exists.

FOG SPRAY AND VENTILATION CONFINEMENT CONTROL SYSTEM - 105N (CONT'D)

4. Each of the ten fog spray control valves is provided with a three-position switch which permits manual operation of the valves at any time. The closed position of these switches, or use of the fog spray master bypass switch, prevents opening of the fog spray control valves by a confinement signal.
5. Each of the pneumatically-operated fog spray control valves is held closed by two energized solenoid valves in conjunction with a shuttle valve. Only one solenoid valve need be energized to hold the fog spray valve closed.
6. The nine Zone II supply confinement valves are provided with switches for manual operation of the individual valves. A master control switch is also provided which over-rides signals from the individual control switches.
7. The following devices are operated by switches located on the confinement panel:

    a. Zone I supply and exhaust confinement backup closures (Ref. 16.7).
    b. The 105-109N cross vent door (Ref. 16.4).
    c. Four Zone I confinement drain valves (Ref. 8.1.7).
    d. The Zone V inlet and exhaust air dampers (Ref. 21.19.1).
    e. The reactor steam release box valves (Ref. 10.1.3).

8. Instrumentation is provided for liquid level indication and pressure recording, as monitored in the reactor left inlet and left outlet pipe spaces.



Fog Spray Control System - 109N

FOG SPRAY CONTROL SYSTEM - 109N

This system is designed to monitor 109N Zone I pressure in eight locations, and initiates opening of all 109N fog spray valves when any two of the eight high pressure switches open on high pressure (+2"). The system is also designed to close all fog spray valves when any two of the eight low pressure switches open on low pressure (-2"). Pairs of pressure switches are located in cells 1 through 5, the auxiliary cell, the pipe gallery, and the pressurizer penthouse.

Flow control of the raw water to the fog spray system is provided by means of RWV-208-1 and associated controller FC-232. A transmitter measures the flow and sends a proportional DC signal to the flow controller, which in turn positions RWV-208-1 to maintain the setpoint. The controller is a RU-100 with a proportional and fast reset action unit. A CFA monitors the action unit, and transfers the controller from automatic to manual when failure is detected.

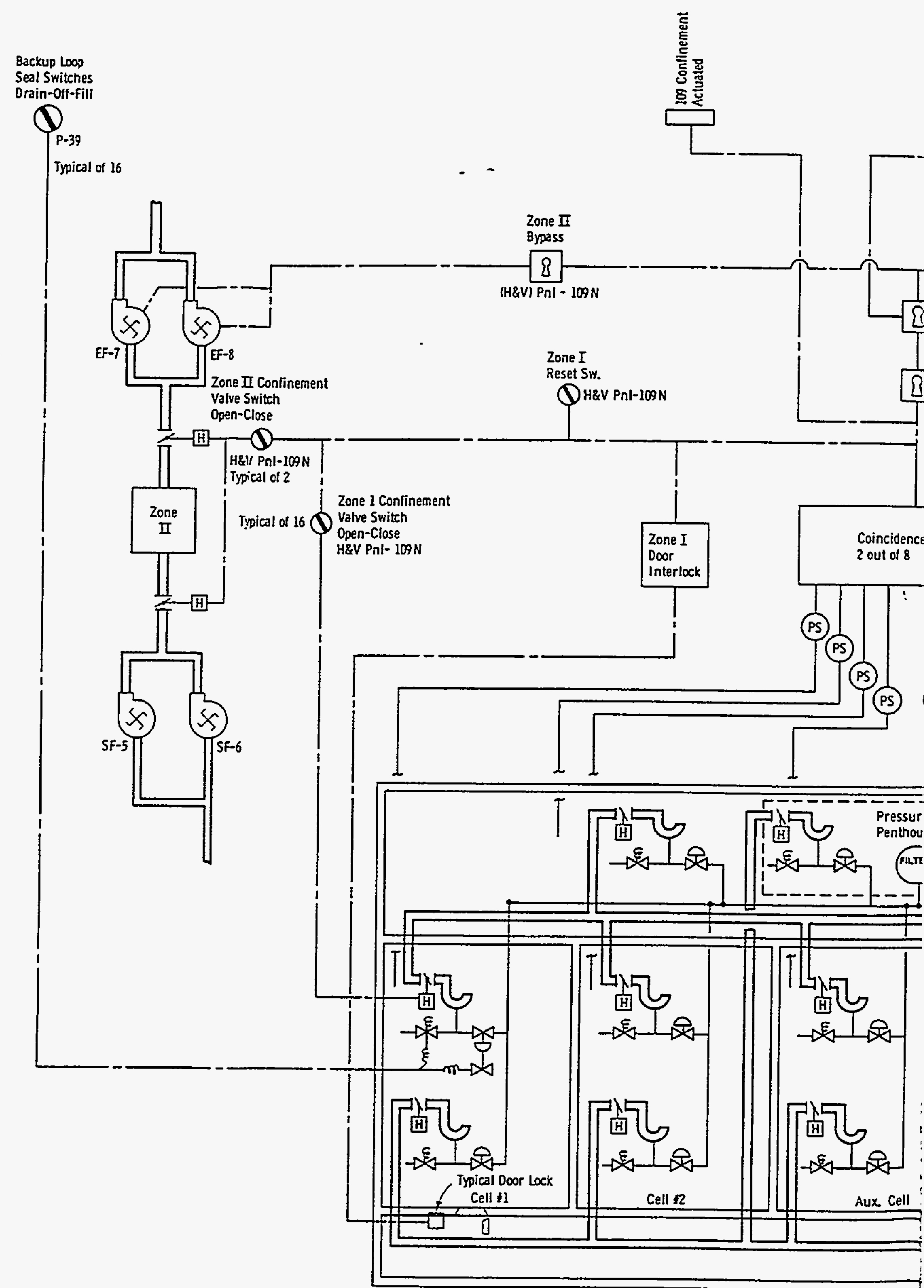
Other details of the system are as follows:

1. A master reset is provided for resetting the fog spray trip.

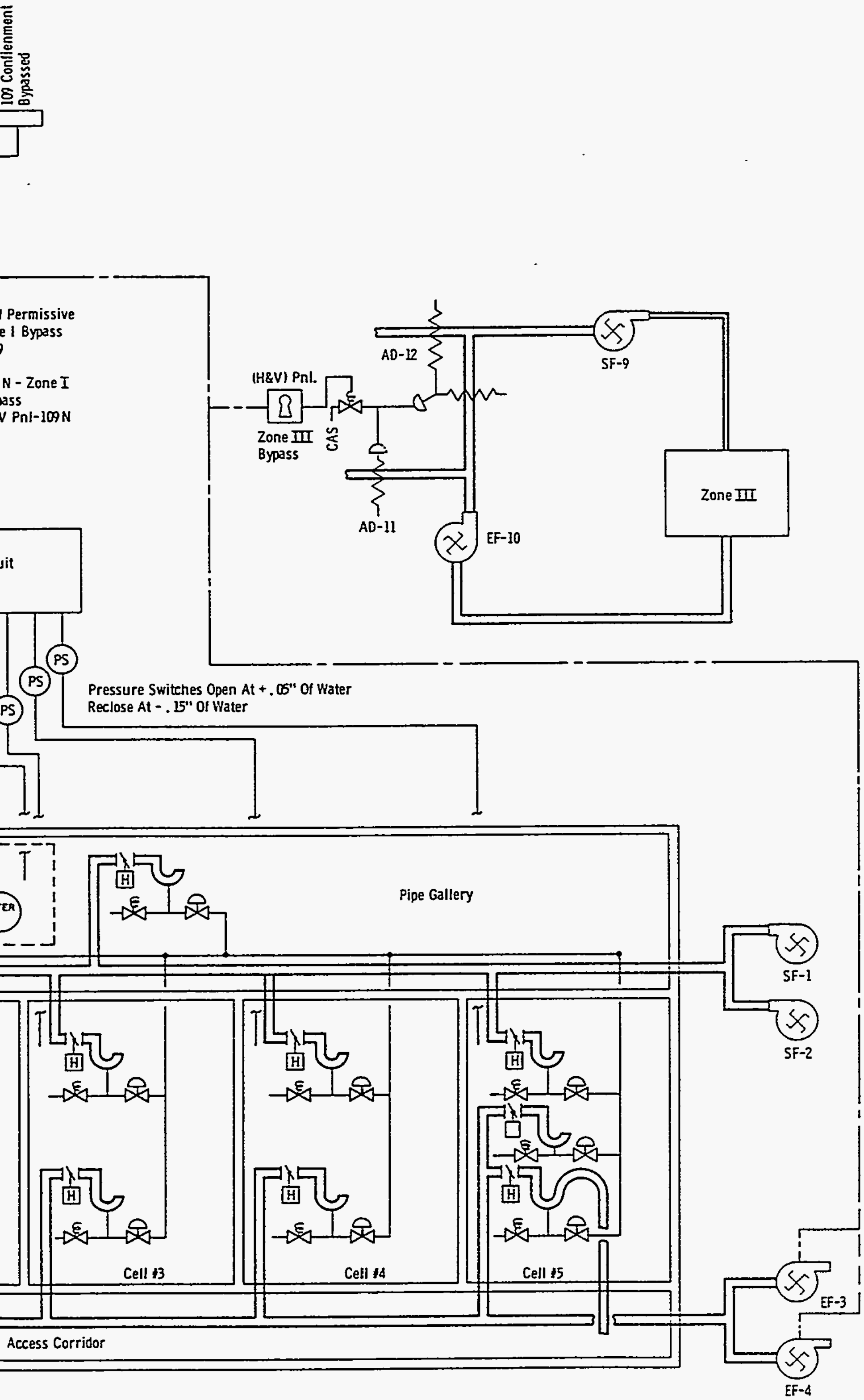
2. Each of the six fog spray control valves is provided with a three-position switch (open-auto-close) which permits manual operation of the valves at any time. The closed position of these switches or use of the fog spray master bypass switch prevents opening of the fog control valve by a fog spray trip. For further details, see Ref. 16.5.3-2.

3. All switches and the fog spray flow controller are located on the 109N confinement panel, P-39, in the plant control center.

4. Annunciation is provided on fog spray trip, master bypass actuation, and fog spray controller action unit malfunction.



Ventilation Confinement



ontrol System - 109N

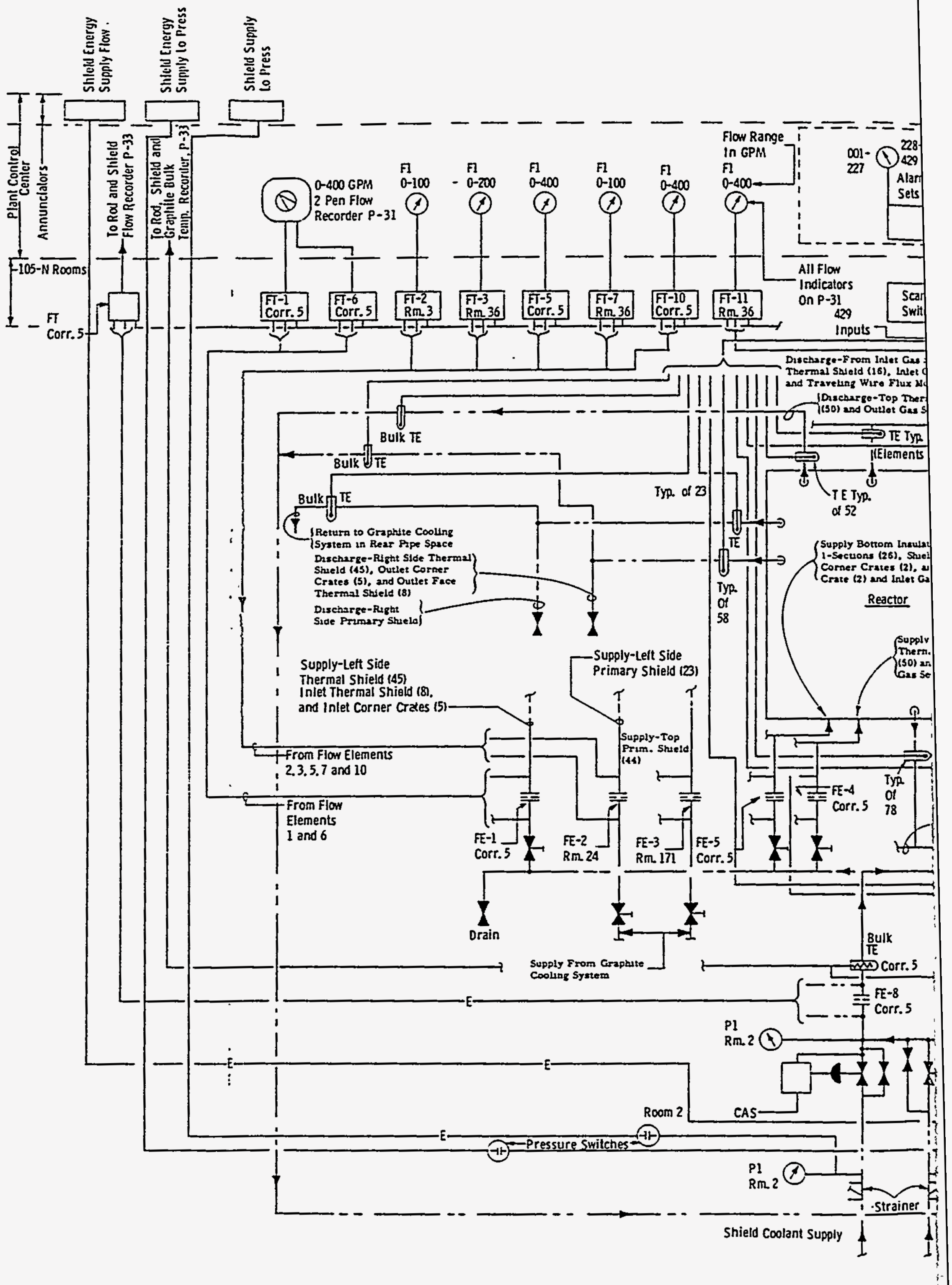
VENTILATION CONFINEMENT CONTROL SYSTEM - 109N

This system is designed to monitor 109N Zone I pressure in eight locations and to initiate a confinement signal when any two of eight pressure switches open on high pressure (+.05 with respect to Zone III). The pressure switches are located in cells 1 through 5, the auxiliary cell, the pipe gallery, and the pressurizer penthouse. The confinement signal initiates the following actions:

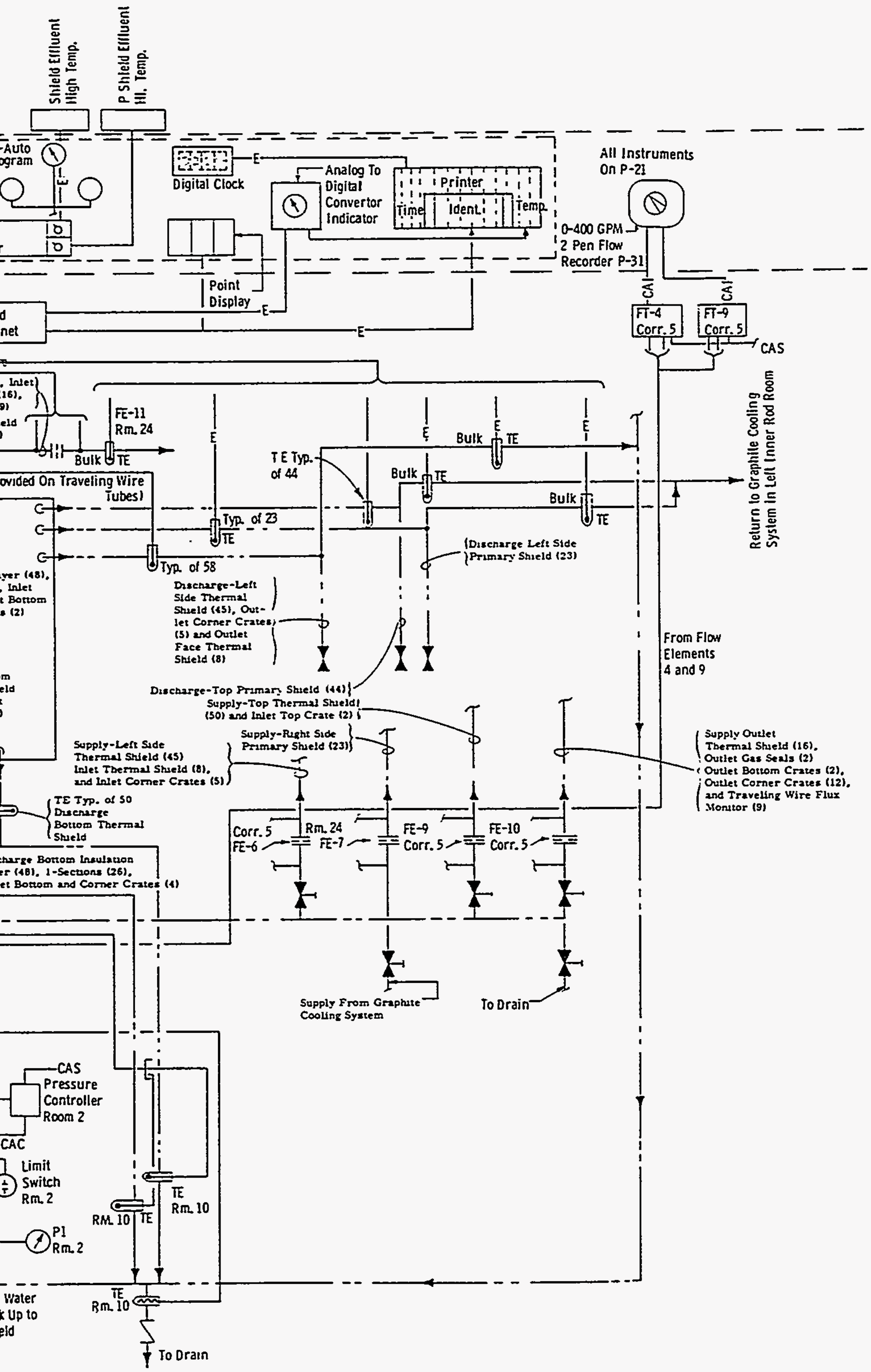
1. The Zone I exhaust fans stop. The discharge dampers will then close and the Zone I supply fans will be tripped (Ref. 18.3-2).
2. The Zone II exhaust fans stop. The discharge damper will then close and the Zone II supply fans will be tripped (Ref. 18.3.1-2).
3. The Zone III dampers are actuated to stop exhaust to atmosphere from EF-10 and start 100 per cent recirculation (Ref. 18.3.2-2).
4. The 109 Zone I doors are interlocked to prevent opening of the doors. They are the cell doors, cell access corridor airlock doors, pipe gallery doors, and pressurizer penthouse doors 501 and 603 (Ref. 17.4.1-1 and 17.2.2-2).
5. The confinement isolation valves in the Zone I supply and exhaust ducts close isolating Zone I. Isolation valves are provided for cells 1 through 5, the auxiliary cell, the pipe gallery, and the cell access corridor (Ref. 18.3-2).
6. The confinement isolation valves close in the Zone II supply and exhaust ducts. (Ref. 18.3.1-2)

Other details of the system are as follows:

a. Following a confinement signal, when seven of the eight Zone I high pressure switches again close, trip signals for items 1 through 4 are automatically reset, e.g. it would be possible to re-start exhaust fans for Zone I, etc. In order to reset Items 5 and 6, it is necessary to operate the Zone I reset switch located on the 109 heating and ventilating panel.
b. It is possible to bypass the confinement trip function for Items 1, 2, and 3 by means of the Zone I bypass switch on the 109 H & V panel, plus the bypass permissive switch located on P-39 in the plant control center.
c. Individual confinement bypass switches are provided for Items 2 and 3 trip functions on the 109N heating and ventilating panel.
d. Switches for the backup loop seals fill and drain solenoids are located on P-39 in the plant control center (Ref. 16.8-3).



Reactor Shield Flow and Cooling W
Systems -



...ter Temperature Monitoring
...105N

REACTOR SHIELD FLOW AND COOLING WATER TEMPERATURE MONITORING SYSTEMS

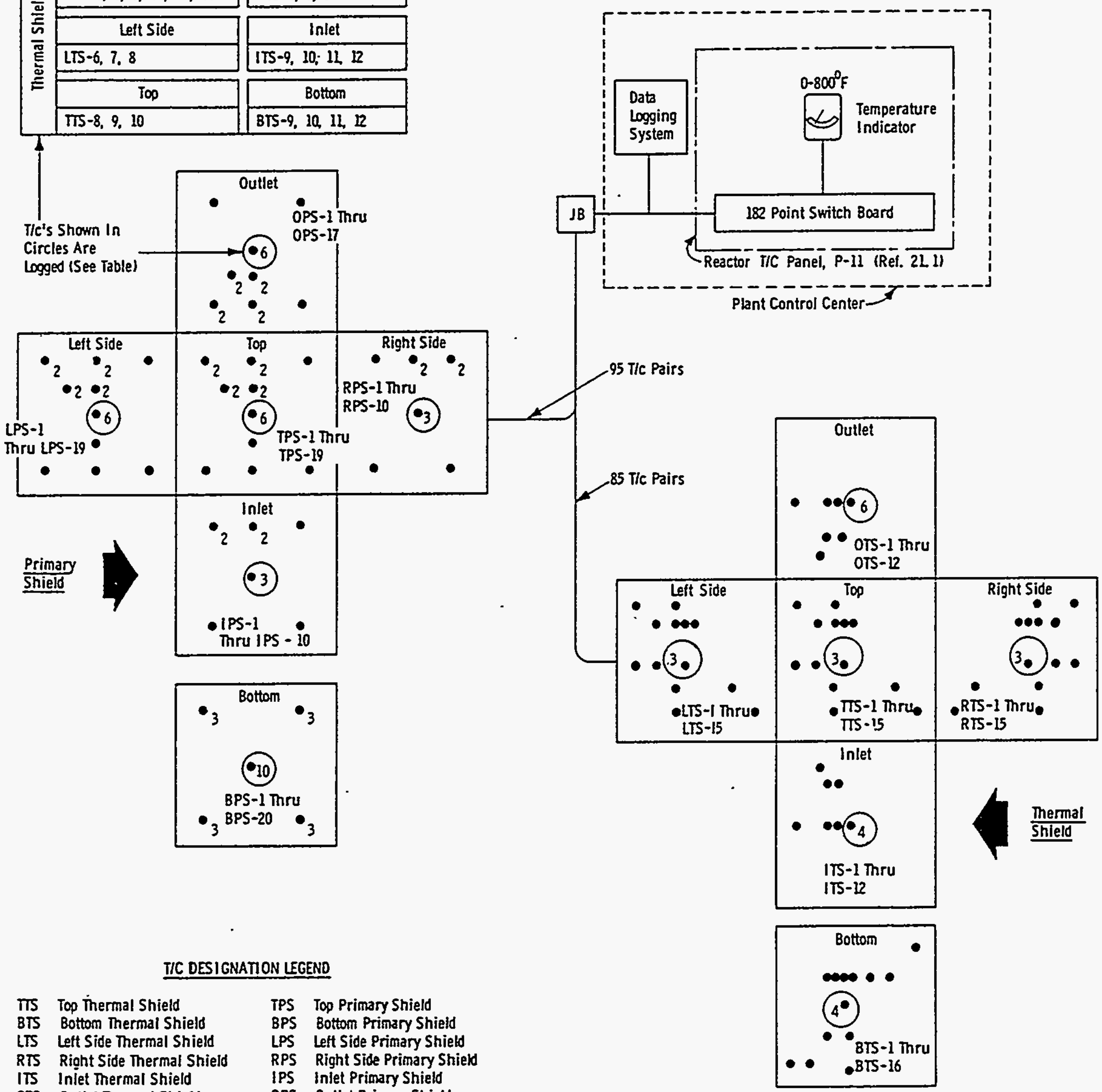
This system is designed to control bulk flow to the reactor thermal and miscellaneous shield cooling water system, to monitor bulk flows and temperatures of the reactor primary, thermal, and miscellaneous shield cooling water systems, and to monitor the temperatures of cooling effluent from each tube of the above systems. As part of the equipment of this system, a continuously operating scanner is provided, which scans individual tube exit temperatures and header bulk temperatures. A printer is also provided to log these temperatures.

Details of the system are as follows:

1. The reactor top and side primary shield coolant supply is from the graphite cooling system (Ref. 3.4 and 3.4.1).
2. The reactor shield and miscellaneous cooling water system (Ref. 2.3.3) supply pressure is maintained constant by a pressure controller which signals a diaphragm operated valve. The signal to the pressure controller is the coolant supply pressure downstream from the control valve.
3. Raw water backup is controlled by a similar controller and valve, except that the controller opens the valve at a pressure slightly below the normal coolant supply pressure.
4. The shield coolant bulk flow and inlet temperatures are measured in corridor 5. Signals are sent to recorders on the power calculator panel (P-33).
5. The bulk flows to the various supply headers are measured by orifices. The location of the orifices, and the shields and numbers of tubes supplied by each header are shown on the opposite page. Bulk flows are indicated or recorded on the rod and shield cooling water panel (P-31).
6. The bulk flow from one drain header is measured and indicated on P-31.
7. Individual header bulk temperatures and individual cooling tube effluent temperatures are measured by well and strap-on type, copper-constantan thermocouples respectively. Signals from these 429 thermocouples are sent to a scanner and switch cabinet located in Room 6, which continuously scans all inputs at a rate of 30 per minute.
8. Scanning is accomplished by 43 stepping switches. Ten inputs are handled by each switch. The point under surveilance is indicated on a digital display.
9. Signals to the scanner and switch cabinet are in two groups (Ref. H-1-32156): 001 through 227 and 228 through 429. The first group includes thermal shield headers and individual tube temperature signals; and the second group includes primary shield, insulation layer, I-section, gas seal, and crate headers and individual tube temperature signals.
10. Individual alarm set points are provided for the two groups of scanner inputs.
11. The scanner sends signals to a self-balancing potentiometer, affixed with a shaft type digitizer (encoder) which signals a high speed printer. The potentiometer has a range of 0 - 220°F.
12. The printer prints all points on demand, or individual temperatures whenever a scanner input exceeds the alarm setpoint (those points exceeding the setpoints are printed in red). During demand printing, the temperature of each point is displayed on an indicator.
13. The printer records ten digits on tape for each point. The first four digits represent the time in hours and minutes. The next three digits are the identifying numbers of each point, and the last three digits are the temperature.
14. The printer has a rate of 3 points (30 digits) per second.

Logged Temperature Data-57 T/c's

Shield	Location	T/c's	Location	T/c's
Primary Shield	Outlet	OPS-7, 8, 9, 10, 11, 12	Right Side	RPS-4, 5, 6
	Left Side	LPS-8, 9, 10, 11, 12, 13.	Inlet	IPS-8, 9, 10
	Top	TPS-9, 10, 11, 13, 14, 15	Bottom	BPS-7, 8, 9, 10, 11, 12, 13, 14, 15, 16
Thermal Shield	Outlet	OTS-6, 8, 9, 10, 11, 12	Right Side	RTS-6, 7, 8
	Left Side	LTS-6, 7, 8	Inlet	ITS-9, 10, 11, 12
	Top	TTS-8, 9, 10	Bottom	BTS-9, 10, 11, 12



T/C DESIGNATION LEGEND

TTS	Top Thermal Shield	TPS	Top Primary Shield
BTS	Bottom Thermal Shield	BPS	Bottom Primary Shield
LTS	Left Side Thermal Shield	LPS	Left Side Primary Shield
RTS	Right Side Thermal Shield	RPS	Right Side Primary Shield
ITS	Inlet Thermal Shield	IPS	Inlet Primary Shield
OTS	Outlet Thermal Shield	OPS	Outlet Primary Shield

Reactor Shield Thermocouple System - 105N

REACTOR SHIELD THERMOCOUPLE SYSTEM

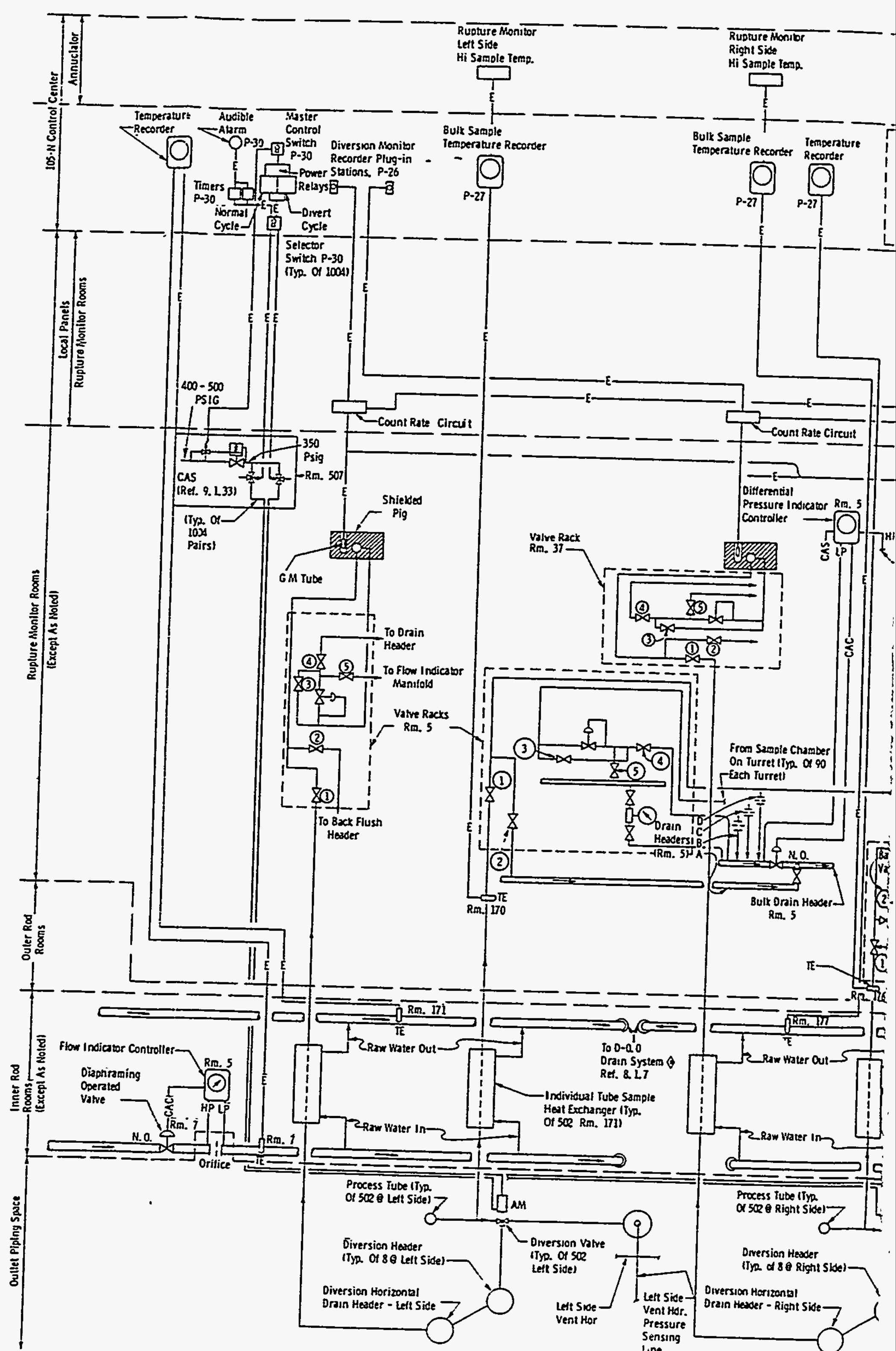
The shield thermocouple system is provided for the measurement and presentation of temperatures sensed in the thermal and primary shields of the reactor. Thermal and primary shield temperatures are required to evaluate the effectiveness of shield cooling and to determine that design temperature limits, which are specified for shield integrity, are not exceeded.

A total of 85 thermocouples are located in the thermal shield as shown schematically on page 21.15.2-1. These are located in selected patterns so that from a relatively few readings the heat distribution may be obtained for the entire shield. At several locations on each face of the thermal shield, thermocouples are located to correspond with the primary shield thermocouples and permit direct differential temperature readings.

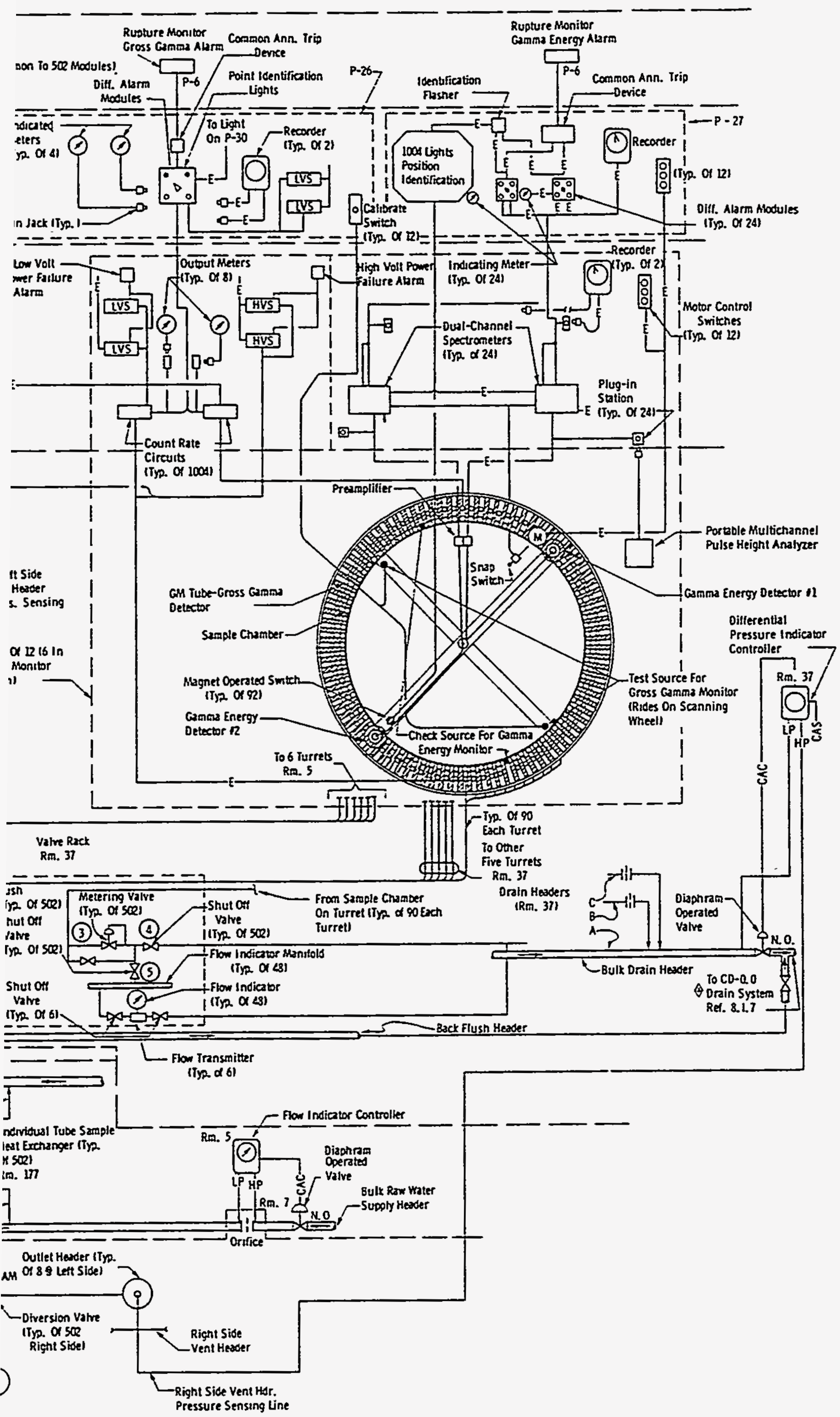
A total of 95 thermocouples are located in the primary shield as shown schematically on page 21.15.2-1. One thermocouple in each location is attached to the inner steel liner of the primary shield. Where more than one thermocouple is shown, the locations are approximately evenly spaced from the liner to the outside edge.

All of the above thermocouples consist of a 1/8-inch diameter Inconel sheath, firmly packed with magnesium oxide insulation, and a pair of 22 AWG chromel-alumel thermocouple wires, which form an integral junction with the measuring end of the sheath welded closure. These thermocouples terminate in junction boxes from which extension wires are routed to the plant control center.

All thermal and primary shield thermocouples are connected to panel P-11 mounted key switches in the plant control center to permit single point readout of any selected thermocouple. Also, 57 thermocouples are connected to the central data logging system where they may be logged on demand.



Fuel Rupture Monito



r System - 105N

FUEL RUPTURE MONITOR SYSTEM - 105N

This system is designed to monitor samples of effluent from each process tube of the reactor, and from the two high pressure effluent headers of the diversion system, for traces of fission products which indicate fuel element jacket failures. The system can reliably detect a "rupture" within 60 to 100 seconds, including a sample transit time of 45 to 80 seconds, when the concentration of uranium and fission products is at least 1×10^{-7} grams per milliliter.

After a fuel element rupture has been detected, the tube flow is diverted from recirculating to once through to avoid fission product contamination of the primary coolant system. Diversion header monitoring provides a confirmatory signal that the diversion valve has functioned and the proper tube has been diverted.

The following services, equipment, and associated instrumentation and controls are provided to accomplish the design intent of the system:

1. Sampling and sample cooling.
2. Rupture Monitor turrets.
3. Sample flow control and disposal.
4. Continuous monitoring of all samples for gross gamma activity.
5. Intermittent monitoring of all process tube samples for selected energy levels of gamma emitting isotopes.
6. Process tube flow diversion.

Sampling and Sample Cooling

Sample line take-offs from each process tube outlet connector are located upstream of the tube diversion valve (V-12). Samples are also taken from the left 6" and right 8" high-pressure diversion system effluent headers at the -6'3" level. These sample lines are 1/4" OD inconel tubing with a 0.049" wall thickness.

The sample lines from each half of the reactor are collected and penetrate the left (right) outlet pipe space to inner rod room wall through a water-cooled penetration (Ref. 16.2). Each penetration has 581 lines: 502 process tube and 1 diversion header sample line, 43 spare and 34 future process tube sample lines, and one sensing line (see sample flow control and disposal) to the primary loop vent system (Ref. 8.1.5). The spare and future process tube sample lines extend only through and are capped on either side of the penetration.

The samples are then cooled to approximately 120°F (Ref. 1.1.10.1.2), and the sample lines are increased to 3/8" OD. These lines are routed from the left (right) inner rod room through a trench to the outer rod room, and then down to valve racks in the left (right) rupture monitor room, Room 5 (Room 37). Thirty-eight spare sample lines are provided between each inner rod room and the rupture monitor room valve racks.

All sample lines revert to 1/4" OD before passing through the floor between the outer rod and rupture monitor rooms. In addition, in the outer rod room trenches, 99 sample lines on the left side (97 on the right side), have an additional 40' section of 1/4" OD tubing (20' on the right side). These sections of additional tubing serve to equalize sample flows due to the different lengths of sample lines between the sampling points and the heat exchanger cabinets.

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

Other details are:

1. Cooling water bulk flow to the sample heat exchangers is monitored and controlled by indicator-controllers located in Room 5.
2. The cooling water bulk inlet and outlet temperatures from the sample heat exchangers is monitored and recorded on P-27.
3. The average temperature of the bundled sample lines is monitored in the outer rod rooms and recorded on P-27.
4. The sample lines are routed through a shielded trench in each outer rod room.
5. The samples to be monitored are routed through shut-off valves at the valve racks in each rupture monitor room. The process tube sample lines are then routed to the rupture monitoring turrets, and the diversion header sample lines are routed to shielded pigs.

Rupture Monitoring Turrets

To provide a satisfactory equipment arrangement for continuous and intermittent monitoring of the process tube samples, the samples are routed through chambers arranged in a circular array similar to a turret. Six turrets are located in each rupture monitor room. Each turret contains 90 sampling chambers, including 6 or 8 spares, and two chambers containing radioactive check sources. Continuous monitoring for gross gamma activity of each sample is accomplished by a GM tube positioned adjacent to each chamber. Intermittent monitoring for selected energy levels of sample gamma radiation activity is accomplished by two scintillation detectors, designated numbers 1 and 2, which are mounted at diametrically opposite points on the periphery of a motor-driven revolving scanning wheel located within each turret. Also mounted on the scanning wheel, at 90° intervals from the scintillation detectors, are two radioactive test source containers. The rotation of the scanning wheel moves the detectors directly over the sample and check source chambers, while the test source containers rotate in line with the sample and check source chambers. The fixed-position check source chambers are used for calibration and response checks of the rotating gamma energy detectors, and the rotating test source containers are used for calibration and response checks of the gross gamma GM tubes.

Lead shielding is provided between and around each sample and check source chamber, and around the detectors and test source containers mounted on the scanning wheel. A 1-1/4" window in the shielding over the sample and check source chambers and under the detectors provides a direct path for the detectors to view each chamber. A 5/8" window in the shielding between the sample chambers and the test source containers provides a direct path between these components.

The two test sources are mounted below the 5/8" shielding windows and on top of push-type solenoids. For GM tube calibration, the solenoids are actuated with switches on P-26, which raises the test sources to a point in line with the shielding windows.

The drive mechanism for each scanning wheel includes a 1/6 HP, 220/440 V reversible motor, a gear motor box, and an indexing mechanism. The drive mechanism is designed to give a dwell time at each chamber of 20 seconds, and to have a dwell to move ratio of 5 to 1. Thus, each scanning wheel makes one complete revolution in approximately 40 minutes. The drive mechanism can be manually de-clutched, and the scanning wheel

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

can be rotated with a crank to manually position the detectors at any selected chamber. An indicator is provided on each turret to show the position of the scanning wheel with respect to the sample chambers.

Power to the Room 5 and Room 37 drive motors is from a load center located in each room, and supplied from the 1A2 bus of MCC-1A and the 2B2 bus of MCC-2B respectively. Switches for starting, stopping, and reversing the drive mechanism motors are located in the rupture monitor rooms and on P-27. The characteristics of the drive mechanism are such that the drive motor will not overtravel the 20 second dwell if the stop switch is actuated within the first five seconds of dwell.

The location of the scanning wheel detectors is indicated by lights on P-27. These lights are actuated by magnetically operated switches, one of which is mounted adjacent to each sample and check source chamber. The switches are actuated by a permanent magnet mounted on the scanning wheel and adjacent to the number 1 scintillation detector.

Each turret is provided with a roller lever snap switch, actuated by a cam-ring, mounted on the drive shaft between the gear motor and indexing mechanism. This switch acts to short out the integration circuits of the gamma energy monitoring spectrometers, during the moving interval of the scanning wheel, to remove any residual counting data before the system starts to monitor the next sample chamber.

Other details are:

1. Each of the 12 turrets is approximately 4' high, 8' in diameter, and weighs 10 tons.
2. The capacity of the sample chambers is approximately 110 cubic centimeters.
3. Sample flow through the vertically mounted sample chambers is in at the bottom and out at the top.
4. The sample chambers for adjacent process tubes and the two check source chambers are mounted 180° apart around each turret. Thus, the scanning wheel detectors are always monitoring adjacent process tube samples or both check source chambers.
5. The sample lines and chambers of the turrets have a design pressure of 1825 psig and a maximum temperature rating of 600°F. All materials in contact with sample fluid are stainless steel.
6. Design considerations of the turrets provide for possible future addition of a fast scanning wheel. These considerations include space and structural strength of supporting members to carry a wheel with two monitoring heads, weighing the same as the initially installed scanning wheel, at a rate of 12 rpm.
7. Sample lines are routed to and from the turrets through shielded trenches in the rupture monitor room floors.
8. After flowing through the sample chambers, the samples flow back to the valve racks.

Sample Flow Control and Disposal

A valve rack is provided in each rupture monitor room to permit sample line shutoff, sample chamber backflushing, and sample flow rate determination and regulation

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

after which the samples are routed to drain headers for disposal. The racks are located behind 3" thick rolling steel doors to keep the radiation background in the monitor rooms at a minimum.

As the sample lines enter the rupture monitor rooms, each is provided with a shutoff valve. The process tube sample lines are then routed to the chambers in the turrets, and then back to the valve racks. The diversion header sample lines are routed from the racks to shielded pigs and then back to the racks.

Other details are:

1. Each valve rack includes 503 valve assemblies for sample flow control and regulation. Each assembly consists of five cam-closing, toggle-operated valves and one flow metering valve. The valve assemblies are arranged in six horizontal rows. Each rack has space for 37 future valve assemblies.
2. Each valve rack includes six flow transmitters, with integral orifices, and 48 flow indicators. Eight flow indicators are actuated by each flow transmitter. The indicators are located to permit an observer to read the flow of any selected sample line at the valve assembly.
3. For normal sample line flows, valves 1 and 4 are open, and 2, 3, and 5 are closed. (See diagram for valve numbers). To read sample line flow, valves 1 and 5 must be open, and valves 2, 3, and 4 closed. To backflush the turret sample chamber, valves 1 and 5 are closed, and valves 2, 3, and 4 are open.
4. Sample disposal from each valve assembly is to one of 3 drain headers on the right side, or to one of 4 drain headers on the left side. Two of the three right side and three of the four left side drain headers are equipped with restricting orifices to assist with flow equalization due to varying lengths of sample tubing. The drain headers on each side dump into a bulk drain header equipped with a normally-open 1-1/2" control valve.
5. The bulk drain header control valve is positioned by an indicating controller which positions the valve according to the differential pressure between the primary loop vent system and the sample drain header upstream of the control valve.
6. The sample flow control and disposal piping, tubing, flow transmitters, and valves have a design pressure of 1825 psig and a maximum temperature rating of 400°F. All materials in contact with sample fluid are stainless steel.

Continuous Sample Monitoring for Gross Gamma Activity

The process tube and diversion header samples are continuously monitored for gross gamma activity. Gamma detection is provided by halogen-quenched GM tubes, mounted adjacent to the process tube sample chambers within the turrets, and within coils of diversion header sample lines inside of shielded pigs. Each GM tube supplies voltage pulses to a count rate circuit (CRC) module, which produces an output DC voltage proportional to the input pulse rate.

The signals from adjacent process tube CRC modules, which are located on panels in the rupture monitor rooms, are supplied to differential alarm (DA) modules located on P-26. These modules detect a difference between the two signals; and when a pre-set difference is reached, an annunciator is actuated. Also, the input which has become greater is identified by light on P-26 and P-30. The diversion header CRC modules

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

supply outputs only to plug-in stations on P-26 for recording when desired.

Other details are:

1. Six low and four high voltage power supplies are provided. Two low and two high voltage power supply units are located on the CRC module racks in each rupture monitor room, and two low voltage units are located on P-26.
2. In the rupture monitor rooms, each low voltage power supply furnishes power to half of the CRC modules on the panel. In case either power supply fails, the other will cut in to supply all modules. Alarm lights are provided to indicate power supply malfunction. The high voltage power supply units in the rupture monitor rooms and the low voltage units on P-26 are similarly arranged.
3. Each CRC module includes an output signal test jack and two low voltage test jacks.
4. In each rupture monitor room, four DC volt meters and four patch cords are provided on the CRC panels for reading the output signal of any CRC module.
5. The input signals (0 to 0.5 volts) to each DA module are the output signals from two CRC modules, which are receiving output signals from GM tubes monitoring adjacent reactor process tube samples.
6. An en-masse DA module trip sensitivity adjustment is located on P-26 for each half of the reactor. The adjustable range of differential voltages is between 0.04 and 0.3 volts. Each module also has a trip sensitivity trimmer adjustment capable of changing the differential trip setting by plus or minus 25% of the range of the en-masse adjustment.
7. Each DA module is provided with an offset adjustment, capable of reducing to 0.04 volts a differential of up to 0.2 volts, to permit a lower setting of the DA trip sensitivity.
8. The alarm outputs of the DA modules are reset on P-26. One button is provided for the modules for each half of the reactor.
9. Each DA module has two input signal test jacks. Patch cords are provided to indicate any four signals on DC voltmeters. In addition, any four signals may also be recorded.
10. Switches are located on P-26 to calibrate or test the process tube gross gamma monitoring circuits. These switches actuate the push-type solenoids on the turret scanning wheels, and elevate radioactive test sources in line with the gamma detecting GM tubes.
11. Transistorized, plug-in modular construction has been used for all major components. Circuits have been designed with failsafe features, so that component failures cause alarms as though gamma activity varied outside of set limits.

Intermittent Monitoring of Samples for Selected Energy Levels of Gamma Emitting Isotopes

All process tube samples are intermittently monitored for selected energy levels of gamma emitting isotopes. Sample monitoring is performed by the two scintillation detectors mounted on the scanning wheels of each rupture monitoring turret.

Each scintillation detector consists of a thallium activated sodium iodide crystal mounted to a photomultiplier tube. The detectors provide voltage pulses which correspond to the energy levels of the gamma rays being absorbed by the detector crystal. The detector outputs are the inputs to dual preamplifiers mounted near each turret.

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

Each preamplifier drives a dual-channel spectrometer. The spectrometers are mounted on panels in each rupture monitor room. Each spectrometer consists of a linear amplifier, which includes a pulse height discriminator (PHD), a pulse height analyzer (PHA), count rate meters (CRM), and integral high and low voltage power supplies. The outputs of the PHD and PHA are known as the reference and signal channels respectively. The PHD is designed to accept voltage pulses above a set level, and these are the inputs to the reference channel CRM. The PHA is designed to accept voltage pulses within set levels, and these are the inputs to the signal channel CRM.

DA modules are located on P-27 to receive the output signals from corresponding signal and reference channel CRM's. These modules detect a difference in the signals and actuate an annunciator and indicating lights when a pre-set difference is reached. The alarms are reset with a button on each DA module. Each module has a trip sensitivity adjustment capable of changing the differential trip setting between the reference and signal channel CRM outputs from 20 to 150% of the CRM output voltages.

Other details are:

1. A dual pen recorder and two patch cords are provided in each rupture monitor room on the spectrometer panels. The patch cords can be plugged into jacks of each GRM for output recording.
2. Plug-in terminals are also provided on the spectrometer panels for use of a portable multi-channel pulse height analyzer (PMPHA).
3. A 200 channel PMPHA is provided so that a full spectrum analysis can be made of the outputs of the turret detector. The unit is designed with a magnetic core memory and a paper tape decimal print out, and can accept inputs from two detectors simultaneously. The capacity of the magnetic memory is 10^5 counts per channel, and there are provisions for analog readout of a visual display. The printout device prints the channel number and five digits of channel count data at a rate of 1 channel per second.
4. The CRM's indicate their pulse rate inputs, and produce a DC output proportional to the input pulse rates.
5. The integration circuits of the CRM's are shorted out during the moving interval of the turret scanning wheel, to remove residual counting data from the previous samples before the detector starts to monitor the next sample.
6. Each signal channel CRM provides an output to a dual-pen recorder on P-27, in addition to the output to the DA modules on the same panel.
7. Indicating lights on the DA modules for the reference and signal channels are actuated when either channel input becomes greater than a preset differential trip setting.
8. Indicating meters and selector switches are provided on P-27 for selecting and indicating the signal or reference channel inputs to each DA module.
9. Once each 180° movement of the turret scanning wheel, the detector heads step to the check source chambers for standardization of the gamma energy instrumentation. Lights on P-27 indicate when standardization is taking place, and the DA module signal channel light is also actuated at this time.
10. Two process tube numbers, one above and one below, are associated with the turret scanner position identification lights on P-27. The tube numbers above the lights correspond to the scanning wheel number 1 detector head, and the numbers below the lights correspond to the number 2 detector head. These lights are actuated by the magnetic switches mounted adjacent to each turret chamber in

FUEL RUPTURE MONITOR SYSTEM - 105N (CONT'D)

conjunction with the magnet mounted near the number 1 detector head; and are at full brilliance when the tube samples are being monitored.

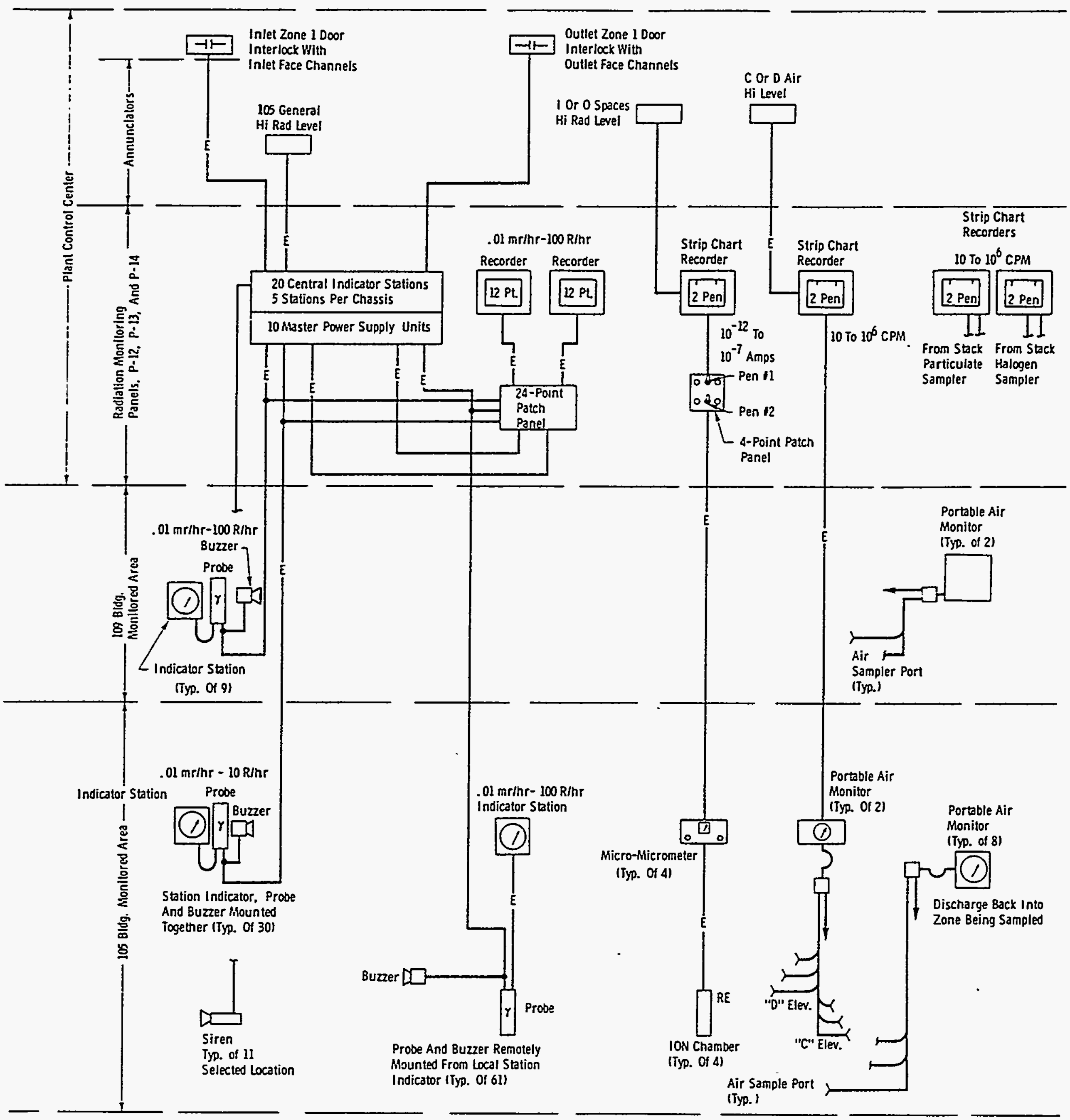
11. A flasher circuit is provided to blink the corresponding position identification lights when a DA module trip point is exceeded.
12. Transistorized, plug-in modular construction has been used for all major components. Circuits have also been designed with failsafe features, so that component failures result alarms as though gamma activity varied outside of set limits

Process Tube Diversion

The diversion of process tube flows from recirculating to once-through (Ref. 4.3.3) is accomplished on P-30. Three-position selector switches are provided on this panel for selecting a diverted or normal flow path for each reactor process tube. Each switch also has a center "off" position. Located above each switch are three lights to indicate a diverted or normal flow condition, and a rupture alarm light which is actuated by the trip action of the gross gamma DA modules on P-26. Once a tube or tubes have been selected for diversion, the control circuits are actuated by a master control switch located on P-30.

Other details are:

1. Selection of a tube for diversion and actuation of the master control switch first energizes the normal (exhaust) port solenoid valve. Three seconds later the diversion (supply) port solenoid valve is energized, and two seconds after this, the normal port solenoid is de-energized and vented. This sequence permits a smooth movement of the valve operator.
2. Operation of the master control switch also actuates a solenoid valve, which loads a control valve, to admit 350 psig air to the diversion-valve solenoid-valve-racks in Room 507.
3. Lights on P-30 indicate the periods when the exhaust and supply port solenoid valves are energized.
4. After a tube has been selected for diversion or normal flow, a light indicates "operate master control switch", and a timer is actuated. If the master control switch is not actuated within five minutes, an alarm sounds.
5. Ten to thirty seconds after a tube has been diverted, a light indicates "return valve to off", and a timer is actuated. If this is not done within five minutes, an alarm sounds.



Space and Air Monitoring Systems - 15 and 109N

SPACE AND AIR MONITORING SYSTEM - 105N & 109N

Space Monitoring System - 105N & 109N - The space monitoring system for 105N is designed to monitor 100 different remote stations simultaneously, to give warning signals, and to record the radiation levels of any 24 of these stations. In addition, four ionization chambers are provided to continuously monitor the reactor inlet and outlet faces and the inner rod rooms, and to continuously record the radiation levels in any two of these areas.

The four ionization chambers are sealed, nonpressurized units which feed out to micro-microammeters with indicating meters calibrated from 10^{-12} to 10^{-7} amperes. The micro-microammeters have on-off switches, calibrate and operate controls, and a polarizing potential for the associated ionization chambers. Outputs from these units feed a four-point patch panel from which two points can be selected for continuous recording on a strip chart recorder on P-12 in the plant control center. The ionization chambers and micro-microammeter units are located as follows:

Ion Chamber Location	Micro-Microammeter Location
Charge Area - Barr. Wall center at 40' El.	Corr. 29A - Inlet valve Op. Gallery Entrance.
Discharge Area - Barr. Wall center at 28' El.	Room 175 - At 0' El.
Right Inner Rod Room - Barr. Wall at 20' El.	Right Outer Rod Room - At 0' El.
Left Inner Rod Room - SW corner at 13' El.	Left Outer Rod Room - SW corner at 0' El.

The 100-channel space monitoring system is a simple, reliable gamma detection system with a range of detection from 0.1 mr/hr to 100 R/hr. This is adequate for most gamma monitoring from normal to hazardous conditions. The system components comprise: 100 local detection probes, 100 local station indicators, 100 local alert-alarm buzzers, 11 local high-level-alarm sirens, and 100 central station indicators mounted on the Space Monitoring Panel (Ref. 21.1, P-13) in the Plant Control Center, together with 10 master power supply units and two 12-point printing recorders with their associated 24-point patchboard.

The reliability of the system is realized by using a halogen-quenched Gieger-Mueller probe with a unique ratemeter circuit which is actually a combination of a logarithmic ratemeter and the mean current of the GM tube itself. Thus, two calibrations are required, one in the ratemeter response range (0.1 to 1 R/hr), and one in the GM current response range (1 to 100 R/hr).

Each of the 100 central station indicators is equipped with an adjustable alarm trip setting; a 0.1 to 100 R/hr meter calibrated in mr/hr; two miniature neon indicating lights, one alert (amber light), and one alarm (red light); and a high-level-alarm reset button. Similarly, the 100 local station indicators are each equipped with an adjustable alert trip setting, a meter calibrated as above, and two indicating lights, one amber and one red. At each of the local stations, a weatherproof buzzer is mounted near the local probe.

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

Some of the more important operational features of this system are:

1. Power Supply - Each of the ten central power supply units accommodate ten channels of detection instrumentation. This includes the probes, local station indicators and alarm buzzers, and the remote or central indicators in the plant control center. The units also supply the power for the output signals to the two 12-point recorders. Power is supplied to all of the radiation monitoring panels, and to these ten power supply units, from the 120/280 volt AC instrument supply panel DS, which is powered through an automatic transfer switch from either of the control instrument buses. The units have three different DC voltage outputs (24, 140 and 480 volts) for operating the system. Each power supply unit has an "ON-OFF", locking type power switch with a white miniature neon power-on indicating light, and a red miniature neon power-low (150 or 480 volt) indicating light. A master meter on each of the ten units is used to indicate (by using a rotary selection switch): (a) any individual channel radiation intensity (mr/hr), (b) probe voltage (480 volts DC), and (c) alarm relay voltage (150 volts DC). Each unit has but one adjustment, a single potentiometer for H.V. which is a screwdriver adjustment. The adjustment is made for 480 volts on the master meter.
2. System Accuracy - An overall accuracy of 10% is typical; however, accuracy of any given dose is dependent upon line voltage (less than 0.015% per 1% change), temperature (less than 0.06% per degree F), calibration drift (less than 0.2% per day), and photon energy (less than ± 20% for 100 kev to 2.5 mev).
3. Response Time - The time constant of the system (63% of a new equilibrium level) is 1.8 seconds with 5 seconds being required to reach 90% of a new equilibrium level.
4. Probe Life Expectancy - This is estimated at 20,000 R for the GM tube. In order to prolong the GM tube life, power should be switched off during reactor operation for those groups of probes that are in inaccessible high level radiation zones. The transistor elements in the probe have a much longer life expectancy (10^6R).
5. System Alarm Logic - When the radiation level reaches the present level on any local indicator, the following occurs: Amber alert lights on both the local and central station indicators, as well as the local buzzer, pulse on-off at six second intervals. This alarm condition is reset automatically only when the radiation level falls below the local present level or the alert setpoint is manually increased on the local indicator.

   When the radiation level reaches the pre-set level on any central station indicator in the plant control center, the following takes place: Red high-level alarm lights on both the central and local indicator stations are turned on; an annunciator (105 General/Hi Rad. Level) in the plant control center signals a high-level alarm condition; and if the high-level alarm condition exists in any of eleven selected locations, a siren will also wail locally in that location. These indicators are not automatically reset, but can be reset manually when the radiation level falls below the present level or the alarm setpoint is increased; however, silencing pushbuttons for each of the sirens are located in a group on the radiation monitoring panel P-13. Also located on the P-13 behind a hinged panel are the indicating lamps, Siren Silence Pushbuttons, and the Lamp Reset Pushbuttons for all eleven sirens. The eleven areas which contain sirens are listed below together with the 26 channels which will actuate the sirens:

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

Below the Reactor	-	Channel(s)	76, 77, or 78
Charge Face	-	"	35, 51, or 52
Discharge Face	-	"	25, 41, or 42
Left Inner Rod Room	-	"	30
Right Inner Rod Room	-	"	46
Top of Reactor	-	"	36 and 38
Transfer Area	-	"	97, 99, or 100
Metal Segregation Area	-	"	69 or 70
Storage Basin (West)	-	"	92 or 93
Storage Basin (East)	-	"	91 or 94
"W" Elevator	-	"	39, 40, 56, or 57

6. Zone I Door Interlocks - The Zone I inlet doors are interlocked with the charge face channels 35, 51 and 52, so that the doors cannot be opened if one of the three channel Alarm Trip Settings are engaged. Likewise, the Zone I outlet doors are interlocked with discharge face channels 25, 41 and 42.

   Channels No. 35, 51 and 52 provide the high radiation interlocks on charge area doors No. 229, 231, 308, 309, 407, 409, 411, 512, and 611. Channels No. 25, 41 and 42 provide the high radiation interlocks on the discharge area doors No. 211, 223, 305, 306, 404, 405, 505, and 610. All of the charge and discharge area door interlocks can be bypassed with a bypass switch on the communication console in the plant control center. Also, upon actuation of a high radiation alarm from any of the six charge or discharge area probes, an annunciator (C or D Conf. or Hi. Rad. Level) is actuated. This annunciator is automatically bypassed when the No. 1 safety circuit is made up.

7. Probe and Station Locations - The following is a tabulation of the probe locations, their assigned number in the plant control center, and the station number which can be used as a cross index in locating probes.

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

No.	Probe Location	Local Indicator Station Location	Ref. Station No.
1.	Rm. 175 - Stairwell 0' Handrail	Same	43
2.	Dummy Decon. - S.W. Corner	Same	33
3.	Metal Prep. - E. Entrance	Corr. 18 - Entrance to Metal Prep.	11
4.	Rm. 116 - Blue Tool Room	Corr. 11A - " " Blue Tool Rm.	8
5.	Rm. 174 - Blue Tool Room	Room 172 - "R" Elevator Lobby at 0'	7
6.	Dryer Room #1 - Entrance	Corr. 20 - Entrance to Dryer Rm. #1	90
7.	" " #2 - Entrance	Corr. 20 - " " " " #2	89
8.	Refrig. Equip. Rm. Entrance	Corr. 20 - " " Refrig. Rm.	88
9.	Gas Instr. Rm. - Entrance	Corr. 20 - " " Gas Instr Rm.	87
10.	Flux Monitor Rm. - E. Wall	Same	75
11.	Rm. 175 - Stairwell at 28'	Same	44
12.	Rm. 404 - Right Trans. Rm.	Corr. 27B - Entrance to Trans. Rm.	42
13.	Rm. 304 - Right Trans. Rm.	Corr. 23B - " " " "	41
14.	Rm. 403 - Left Trans. Rm.	Corr. 27A - " " " "	39
15.	Rm. 303 - " " "	Corr. 23A - " " " "	38
16.	Metal and Dummy Storage - S. Entr.	Corr. 11B - S. Entrance to Storage	17
17.	Inlet Valve Oper. Gallery	Corr. 29A - E. Entr. to Valve Gallery	50
18.	Zone I Exh. Fan Rm.	Corr. 26 - S. Entrance to Fan Rm.	49
19.	Rm 608 - "C" Mach. Rm.	Same	46
20.	Rm 604 - "D" Mach. Rm.	Same	45
21.	Left Rear Pipe Space - 0' Handrail	R Elev. Lobby - Near Dr. 222	55
22.	Left Rear Pipe Space - 14' Handrail	Room 302 - Entrance to Pipe Space	56
23.	" " " " - 28' "	Room 401 - " " " "	57
24.	" " " " - 40' "	Room 502 - " " " "	67
25.	"D" Elev. - Overhead, Left	Same	205
26.	Left Outer Rod Rm. - W. End at 28'	Same	21
27.	" " " " - E. End at 7'	Corr. 14A - Entrance to Rod Room	19
28.	Left Isotope Handling Pit at 7'	Corr. 14A - " " " "	73
29.	Left Outer Rod Rm. - W. End at 14'	Same	20
30.	Left Inner Rod Rm. - Entrance	Left Outer Rod Rm.	77
31.	Left Inlet Pipe Space - 40' Handrl.	Corr. 29A - Entrance to Pipe Space	69
32.	" " " " - 28' "	Corr. 27A - " " " "	63
33.	" " " " - 0' "	Corr. 11A - " " " "	61
34.	" " " " - 14' "	Corr. 23A - " " " "	62
35.	"C" Elev. - Overhead, Left	Same	202
36.	Top of Unit - Left Side Handrail	Left-Side-Zone I-To-Top-of-Unit Handrl.	48
37.	Rear Primary Shield - 40' Center	Top of Unit Near Dr. 506	68
38.	Top of Unit - Right Side Handrail	Right-Side-Zone I-To-Top-of-Unit Handrl.	47
39.	"W" Elev. Handrail - S.E. Corner	Same	13
40.	"W" Elev. Handrail - S.W. Corner	Same	14
41.	"D" Elev. - Overhead, Center	Same	206
42.	"D" Elev. - Overhead, Right	Same	207
43.	Right Rear Pipe Space - 0' Handrl.	Walkway - Entrance to Pipe Space	58
44.	" " " " - 14' "	Stairwell platform - Entrance to Pipe Sp.	59
45.	" " " " - 28' "	Corr. 24 - Entrance to Pipe Space	60

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

No.	Prob Location	Local Indicator Station Location	Ref. Station No.
46.	Right Inner Rod Rm. Entrance	Right Outer Rod Rm. Near Dr. 226	76
47.	Right Isotope Handling Pit at 7'	Corr. 22 - Entrance to Rod Rm.	76
48.	Right Outer Rod Rm. W. End at 7'	Corr. 22	22
49.	Right Outer Rod Rm. E. End at 14'	Right Outer Rod Rm. - Barr. Wall at 14'	23
50.	Right Outer Rod Rm. E. End at 20'	" " " " " " " 28'	24
51.	"C" Elev. - Overhead, Center	Same	203
52.	"C" Elev. - Overhead, Right	Same	204
53.	Right Inlet Pipe Space - 40' Handrl.	Corr. 29B - Entrance to Pipe Space	70
54.	" " " " - 28' "	Corr. 27B - " " " "	66
55.	" " " " - 14' "	Corr. 23B - " " " "	65
56.	"W" Elev. Handrail - N.W. Corner	Same	15
57.	" " " - N.E. Corner	Same	16
58.	Right Inlet Pipe Space - 0' Handrl.	Corr. 11B - Entrance to Pipe Space	64
59.	Metal and Dummy Stor. - N. Entrance	Same	18
60.	Rm. 187 - Blue Tool Room	Same	9
61.	Storage Basin - N. Entrance	Corr. 22 - Entrance to Stor. Basin	25
62.	Dummy Decon. Rm. N.E. Corner	Dummy Decon. Cont. Station	34
63.	Rm. 190-Cask Stor. - S. Entrance	Corr. 22 - Entrance to Dummy Decon.	35
64.	Perm. Hot Storage - Entrance	Corr. 22 - " " " "	36
65.	Room 114 - Hot Shop	Same	10
66.	Room 46. Left Trans. Rm.	Stairwell Outside Rm. 46	37
67.	Room 6. Pile Instr. & Elec. S. Wall	Same	1
68.	Room 6. Pile Instr. & Elec. N. Wall	Same	2
69.	Segregation Basin - E. Handrail	Segregation Walkway - E. Wall	92
70.	" " " "	" " " "	93
71.	Right Rupt. Monitor Rm. - E. Wall	Same	5
72.	" " " " - Entrance	Corr. 4 - Entrance to Rupt. Mon. Rm.	6
73.	Rm. 36 - Right Trans. Rm.	Rm. 39 - Entrance to Trans. Rm.	40
74.	Gas Oper. Gallery - South	Corr. 5 - Entrance to Gas Gallery	85
75.	Gas Oper. Gallery - North	Corr. 5 - " " " "	86
76.	Room 22 - Under Pile - South	Same	79
77.	Room 22 - Under Pile - North	Same	80
78.	Rm. 22 - Ball Equip. Near Skip Hoist	Rm. 4 Ball Control Rm.	12
79.	Left Rupt. Monitor Rm. - S. Wall	Same	3
80.	" " " " - Entrance	Corr. 3 - Entrance to Rupt. Mon. Rm.	4
81.	Spare		201
82.	109N Hot Shop - Entrance	Same	94
83.	109N - 16' Corr. - W. Wall	Same	95
84.	109N Chem. Decon. Prep. Area	Outside Entrance to Chem. Decon. Prep.	96
85.	109N Cell Access. Corr. E. End	" E. Entrance to Chem. Acc. Corr.	97
86.	109N Cell Access. Corr. W. End	" W. " " " " "	98
87.	109N Hot Lab - Entrance	Outside Entrance Dr. to Change Rm.	99
88.	109N Sample Rm. Entrance	" " " " " "	100
89.	Spare		101
90.	Spare		102
91.	Storage Basin - N. Wall, Right	Storage Basin - S. Wall, Right	29
92.	" " N. " Left	" " S. " Left	28
93.	" " S. " Left	" " S. " "	26
94.	" " S. " Right	" " S. " Right	27
95.	View Pit - E. Handrail	Exam. Facility - S. Wall	91

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

No.	Probe Location	Local Indicator Station Location	Ref. Station Number
96.	Lift Station Pump Room	Stairway Dn. to Lift Sta. Pump Rm.	30
97.	Transfer Area Walkway	Same	31
98.	" " N. Entrance	Same	32
99.	" Pit #2	Same	71
100.	" Pit #1	Same	72

Air Monitoring System 105N & 109N - This system provides sampling ports in 37 selected areas, which are subject to airborne contamination for the purpose of providing constant air monitoring as needed. In general, the sample lines are run from the area being sampled to just outside the entrance to the area where an air sample connector is located. One of the eight portable constant air monitoring units provided for the 105N Building can be connected to any one of the 37 sampling connections. These constant air monitors consist of a sampling pump, a sampling pig with filter holder, and mica window GM (beta-gamma) tube detector. In all cases, the monitors exhaust the sample air back through the sample connection into the area being sampled. The monitors are provided with an alarm output jack so that an audible alarm can be extended from the monitor into the work area being sampled.

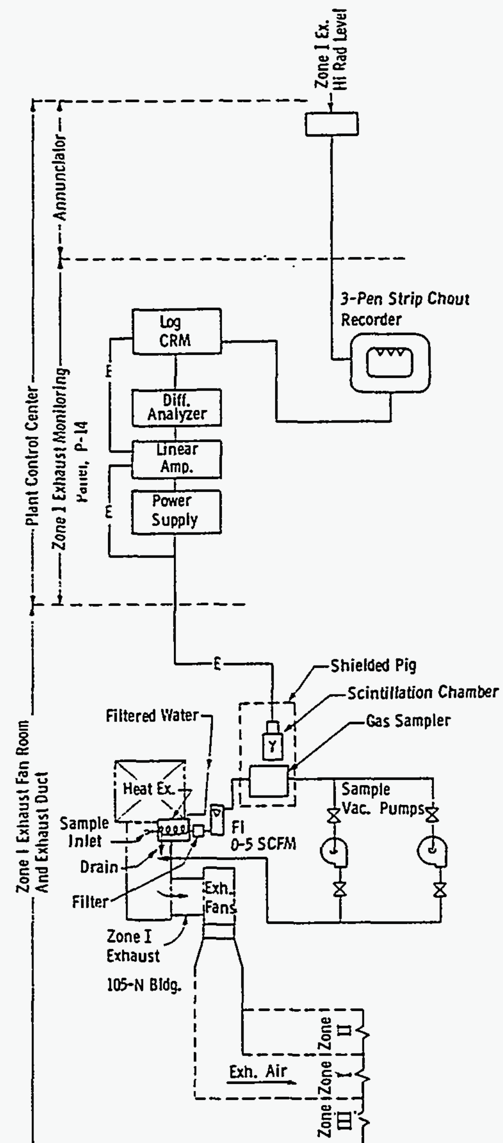
An additional two portable constant air monitors are provided for permanent installation at sample connectors which sample the "C" and "D" elevator locations. These monitors record continuously on a two-pen strip chart recorder on Panel P-12 in the plant control center, with an alarm setpoint for actuating an annunciator (C. or D. Air High Level) should either monitor exceed the setpoint.

The following table lists the areas sampled, the number of sampling ports, and the sample connector location:

SPACE AND AIR MONITORING SYSTEM - 105N & 109N (CONT'D)

Area Sampled	Sampling Ports	Sample Connector Location
Hot Shop & Soiled Clothes Room	2	Corr. 11A
Blue Tool Rm. & "R" Elev. Lobby	2	Corr. 14A
Blue Tool Rm. & Material Decon.	2	Corr. 11A
"C" Elev. - Overhead, Left-Right-Center	3	Room 521
Flux Monitor Room	1	Left Outer Rod Room
Left Inner Rod Rm. at 14' and 28'	2	Left Outer Rod Room
Left Outer Rod Rm. at 14' and 28'	2	Corr. 14A
Left Rupt. Monitor Rm.	2	Corr. 3
Ball Control Room	1	Corr. 3
Top of Unit - Right and Left (Rear)	2	Corr. 29A
Dryer Rooms, 1 and 2	2	Corr. 20
Refrig. Equipment Room	1	Corr. 20
Gas Inst. Rm.	1	Corr. 20
Right Rupt. Monitor Room	2	Corr. 4
Right Inner Rod Room at 14' and 28'	2	Right Outer Rod Room
Right Outer Rod Room at 14' and 28'	2	Corr. 22
Pickup Chute Area	1	Corr. 7
Cask Stor. and Perm. Hot Storage	2	Corr. 22
"C" Elev. - Overhead, Left-Right-Center	3	Room 520
Dummy Decon. Room	1	Corr. 22
Tech. and Seg. Basins	2	Corr. 22
Top of Unit - Right and Left (Front)	2	Corr. 29A
Transfer Area - N. and S.	2	Transfer Area - N Wall
Left and Right Inlet Pipe Space at 51'	2	Room 521
Left and Right Outlet Pipe Space at 51'	2	Room 520
Right Trans. Room, Room 36	2	Corr. 5
Gas Oper. Gallery - N. and S.	2	Corr. 5
Left Trans. Room - Room 46	2	Stairwell outside Room 46
Right Trans. Room - Room 404	1	Corr. 27B
Left Trans. Room - Room 403	1	Corr. 27A
Left Outlet Pipe Space - 0' Handrail	1	"R" Elev. Lobby
Ball Equip. Room - Collect. Framework	2	Corr. 3
Right Outlet Pipe Space - 0' Handrail	1	Storage Basin Walkway
Left Inlet Pipe Space - 0' Handrail	1	Corr. 11A
Right Inlet Pipe Space - 0' Handrail	1	Corr. 11B
Left Trans. Room - Room 303	1	Corr. 23A
Right Trans. Room - Room 304	1	Corr. 23B

Two portable constant air monitors are also provided for 109N.



Equipment Schematic

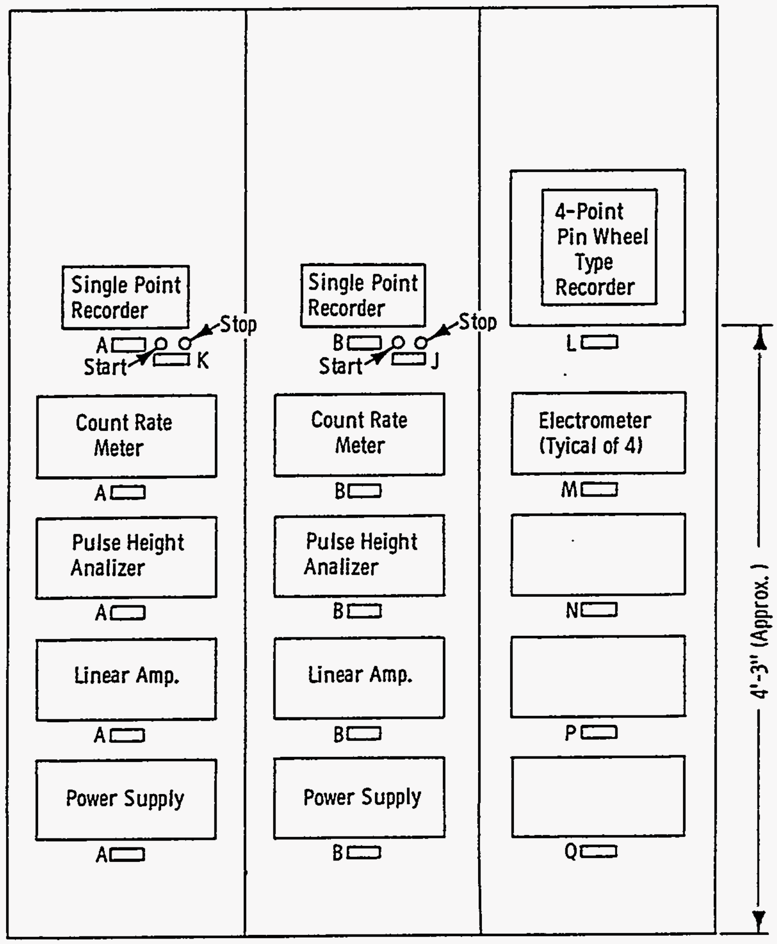
For the purpose of monitoring the 105-N Zone I exhaust air a scintillation detector is provided which consists of a 1" x 1-1/2" crystal, photomultiplier tube, and transistorized preamplifier enclosed in a shielded probe located in the Zone I exhaust fan room and arranged as shown in the above schematic.

The monitoring equipment consists of a single channel analyzer, two linear count ratemeter modules, a special count ratemeter module altered to provide a differential output, a high voltage power supply, two low voltage power supplies, and a multipoint strip chart recorder.

Pulses from the detector preamplifier feed into the single channel analyzer. The amplified pulse is fed to a special discriminator and the normal single channel discriminators. The special discriminator output drives the reference count ratementer and the analyzer comparator output drives the primary count ratementer. In addition to reading their respective counts on their own indicating meters, the reference count ratemeter and the primary or signal count ratemeter feed a differential amplifier which monitors the difference between the signal channel and the reference channel. A variable sensitivity high and low alarm function is provided on this differential channel over the entire range, left and right of zero.

The brown multipoint recorder records the output from the reference channel, the signal channel, and the differential channel (Ref. 21.1, Zone I exhaust monitoring panel).

Zone I Exhaust Air Monitoring System - 105N



Ref. H-1-27521

Name Plate Legend

A Zone I Air Halogen Gas Activity

B Zone II Air Halogen Gas Activity

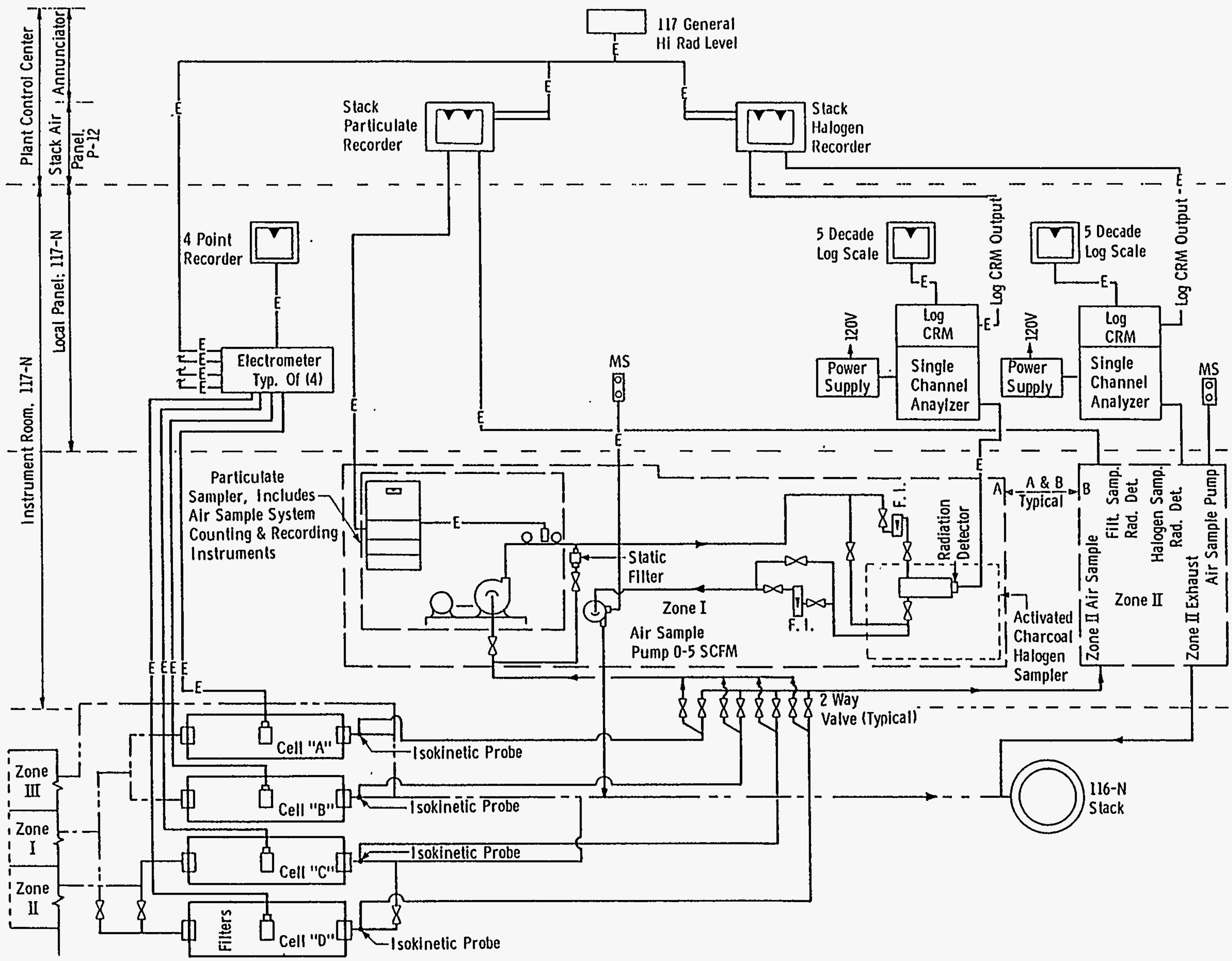
J Zone II Air Sample Pump

K Zone I Air Sample Pump

L Point #1 - Filter Activity Cell "A"
#2 - "B"
#3 - "C"
#4 - "D"

M - Filter Activity Cell "A"
N - "B"
P - "C"
Q - "D"

Stack Air Monitoring Panel
Stack Air Monitoring System - 117N



Stack Air Monitoring System - 117N

STACK AIR MONITORING SYSTEM - 117N

The stack air monitoring system is designed to monitor the exhaust air from the 117N Building filters for halogen activity and for particulate matter prior to stack release, and to continuously record the results for both operational and legal purposes. In addition, ion chambers are located in each of the filter cells to measure and record filter cell activity.

As shown in the schematic, isokinetic sample propes are located in the exhaust stream from each of the four filters. A manifold and valve arrangement makes it possible to route any filter sample to either of two monitoring stations; however, the monitoring stations and their auxiliaries have been designated as Zone I and Zone II; and thus, valving will normally be such that each station monitors air from its respective zone for both halogen and particulate activity.

The following lists some of the more important details of the alarm and indication functions of the system:

1. An annunciator, 117-N General/Hi Rad Level, in the plant control center will be actuated on any of the following conditions:

   a. High particulate activity Zone I.
   b. " " " Zone II.
   c. High halogen activity Zone I.
   d. " " " Zone II.
   e. High filter activity Cell A.
   f. " " " Cell B.
   g. " " " Cell C.
   h. " " " Cell D.

   Items "a" through "h" above are also indicated by red lights on the stack monitoring panel (P-12) in the plant control center so that the specific annunciator cause can be determined.

2. Other items which are indicated by amber lights on P-12 are:

   a. Particulate vacuum pump Zone I "ON"
   b. " " " Zone II "ON"
   c. Halogen vacuum pump Zone I "ON"
   d. " " " Zone II "ON"

3. Still other items which are indicated by red lights on P-12:

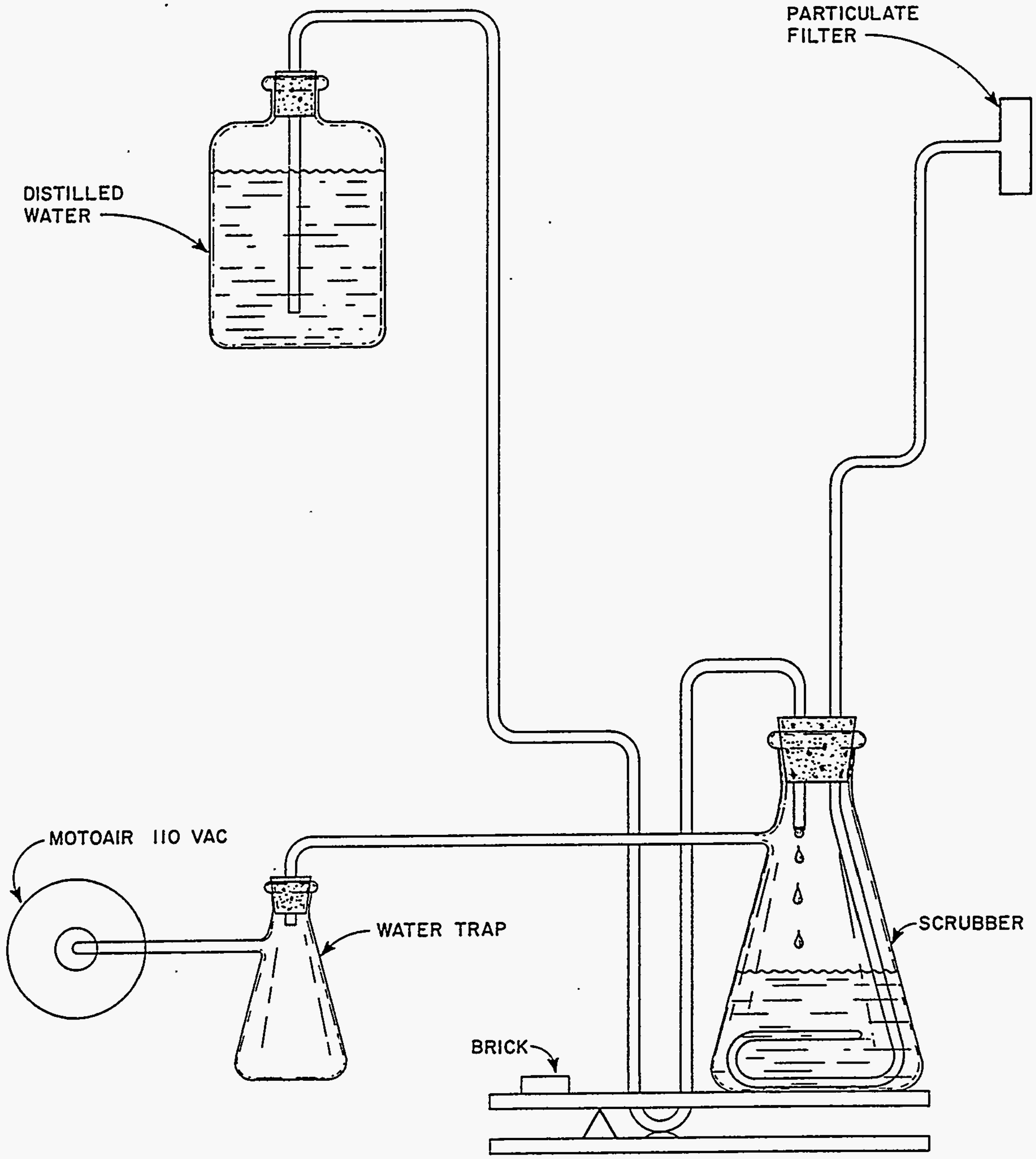
   a. Malfunction Zone I Particulate sampler
   b. " Zone II Particulate sampler
   c. " Zone I Halogen sampler
   d. " Zone II Halogen sampler

LIFT STATION DRAIN LINE MONITORING SYSTEM - 105N

The design intent of this monitoring system is to prevent drainage to the river of waste with above normal activity. The function is based upon relative radiation levels. The electrometer will normally be operated on a very sensitive range, such that background would produce a 10 to 20 per cent upscale reading. Any appreciable increase in the level of activity would actuate the trip circuit.

The system consists of an ion chamber detector and a multi-range linear electrometer. The ion chamber is located next to the lift station to river drain line and between the lift station and the shut-off valve in the drain line (Ref. 8.1.8 and 8.1.11). The electrometer incorporates a high alarm trip circuit which actuates an annunciator (Lift Station Sump Hi Rad.) in the plant control center, and closes the 36" motor operated gate valve in the lift station drain line. A green indicating light in the plant control center on the rod and shield cooling water panel (Panel P-31) will verify valve closure.

There is no interlock to prevent opening of the valve from Panel P-31 or the local control when the alarm point is exceeded; however, the valve will close automatically as long as the high alarm persists, as indicated by the annunciator.



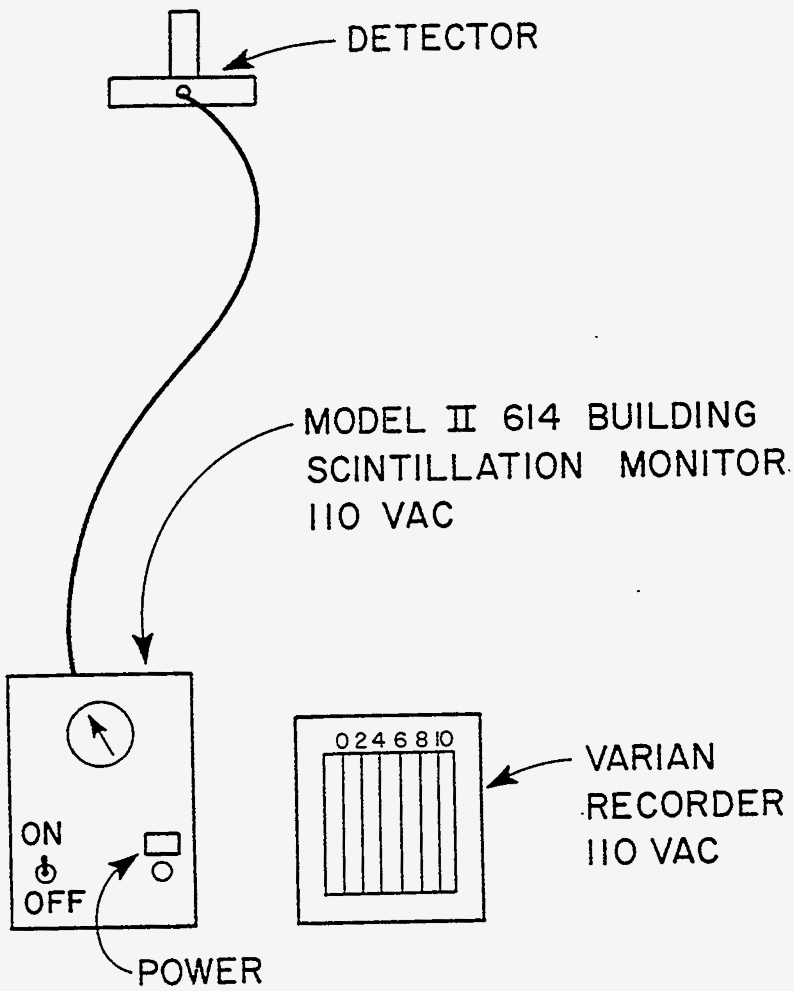
100-N Area Air Sampling System - 1614N

100N AREA AIR SAMPLING AND DOSE RATE RECORDING SYSTEMS - 1614N

Air Sampling System - The 1614 Building in the 100N Area is a monitoring station maintained and operated by Environmental Monitoring Operation to evaluate the radiological status of the environs and assist in the detection and measurement of the radiological consequences of a disaster. The equipment consists of an air sampling system and a recording dose rate meter.

The air sampling system is powered by a 1/2 hp Motoair pump which draws 2.0 cfm of air. The particulates in the air are removed by a 3 x 4 1/2 inch H-70 filter paper which is mounted outside of the building about head height. After passing through the filter, the air is scrubbed by bubbling through a dilute caustic solution which contains an iodine carrier in a filter flask. The filter paper and the scrubber solution are changed weekly and counted for gross beta and I^{131} respectively.

Recording Dose Rate Meter - The recording dose rate meter is the Model II 1614 Building Scintillation Monitor which is a linear response instrument using a RCA 6655-A photomultiplier and a 2 inch in diameter by 3 inch long NE 102 scintillator. This instrument is calibrated to read from 0-200 mr/hour on a 0-20 ua meter and drives a Varian Model G-11A recorder.



ISI 609 SYSTEMS

TIME	CALIBRATION	DEM WTR TK	INJ WTR TOTAL	INJ WTR/PCP SUCT	SEAL WTR/PCP #1 SUCT	SEAL WTR/PCP #2 SUCT	SEAL WTR/PCP #3 SUCT	SEAL WTR/PCP #4 SUCT	SEAL WTR/PCP #5 SUCT			EMERG SEAL/PCP SUCT	PCP SEAL RETURN TOTAL	PCP SEAL #1 IB TOTAL	PCP SEAL #1 OB TOTAL	PCP SEAL #2 IB TOTAL	PCP SEAL #2 OB TOTAL	PCP SEAL #3 IB TOTAL	PCP SEAL #3 OB TOTAL	PCP SEAL #4 IB TOTAL	PCP SEAL #4 OB TOTAL	PCP SEAL #5 IB TOTAL	PCP SEAL #5 OB TOTAL		
	C	L	F	ΔP	ΔP	ΔP	ΔP	ΔP	ΔP			ΔP	F	F	F	F	F	F	F	F	F	F	F		
		.01	10.		.1	.1	.1	.1	.1			.1		.1	.1	.1	.1	.1	.1	.1	.1	.1	.1		
	A01	A02	A03	A04	A05	A06	A07	A08	A09	A10	A11	A12	A13	A14	A15	A16	A17	A18	A19	A20	A21	A22	A23	A24	A25
0100	2048																								
0200	2048																								
0215	2048																								

TIME	CALIBRATION	COND FDWTR TO SG #1A	COND FDWTR TO SG #1B	COND FDWTR TO SG #2A	COND FDWTR TO SG #2B	COND FDWTR TO SG #3A	COND FDWTR TO SG #3B	COND FDWTR TO SG #4A	COND FDWTR TO SG #4B	COND FDWTR TO SG #5A	COND FDWTR TO SG #5B				STM FROM SG #1A	STM FROM SG #1B	STM FROM SG #2A	STM FROM SG #2B	STM FROM SG #3A	STM FROM SG #3B	STM FROM SG #4A	STM FROM SG #4B	STM FROM SG #5A	STM FROM SG #5B	
	C	F	F	F	F	F	F	F	F	F	F				F	F	F	F	F	F	F	F	F	F	
		1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.				1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	1000.	
	B01	B02	B03	B04	B05	B06	B07	B08	B09	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B21	B22	B23	B24	B25
0100	1024																								
0200	1024																								
0215	1024																								

CENTRAL DATA LOG

100 N AREA

Point	Scale	Type	Description
A27			
A28			
A29			
A30			
A31		F	PRIM COOL SPILL
A32		T	PRIM COOL FROM SPILL COOLER
A33	.1	F	PRESZR CYCLING SPRAY WTR
A34		F	PRESZR BK-UP SPRAY WTR
A35		P	PRESZR – HI RANGE
A36		P	PRESZR – LO RANGE
A37		T	PRESZR – LEV COMP
A38	.01	L	PRESZR – WIDE RANGE
A39	100.	F	PC SYS TOTAL
A40	10.	F	PC CELL #1
A41	10.	F	PC CELL #2
A42	10.	F	PC CELL #3
A43	10.	F	PC CELL #4
A44	10.	F	PC CELL #5
A45			
A46			
A47		T	PC TO CELLS AVGD
A48		T	PC TO CELL #1
A49		T	PC TO CELL #2
A50		T	PC TO CELL #3
A51		T	PC TO CELL #4

0042
0045
0046

Point	Scale	Type	Description
B27			
B28			
B29		T	COND FDWTR TO SG #1A
B30		T	COND FDWTR TO SG #1B
B31		T	COND FDWTR TO SG #2A
B32		T	COND FDWTR TO SG #2B
B33		T	COND FDWTR TO SG #3A
B34		T	COND FDWTR TO SG #3B
B35		T	COND FDWTR TO SG #4A
B36		T	COND FDWTR TO SG #4B
B37		T	COND FDWTR TO SG #5A
B38		T	COND FDWTR TO SG #5B
B39			
B40			
B41			
B42			
B43		T	PC FROM SG #1A
B44		T	PC FROM SG #1B
B45		T	PC FROM SG #2A
B46		T	PC FROM SG #2B
B47		T	PC FROM SG #3A
B48		T	PC FROM SG #3B
B49		T	PC FROM SG #4A
B50		T	PC FROM SG #4B
B51		T	PC FROM SG #5A

CENTRAL DATA LOGGER

The central data logger is used to record 525 pressure, temperature, flow and level measurements from data points in 105 and 109. Included are primary coolant pump seal water flow; primary coolant total and individual loop flows; primary coolant temperature and pressure in each cell; condensate feedwater flows to steam generators; steam flow, pressure, and temperature; water level in steam generators; dump condenser water levels and circulating water pressure; horizontal rod coolant temperatures; graphite thermocouple stringer temperatures; shield thermocouple temperatures; graphite coolant temperatures; and other variables. Eight fixed voltages are monitored to provide self-checking for the system.

The heart of the system is a digital computer and computer control device. All incoming information is received by the control device and sent to the computer where it is stored in the memory of the computer. Also stored in the memory are the limits pertaining to the various pressures, temperatures, etc. being monitored. Data points are scanned at a rate of about five points per second, and the value read is compared to acceptable operating limits previously stored in the memory of the computer. If the incoming data is out-of-limits an annunciator is actuated, and the reading from the out-of-limits point is printed on a strip printer. Periodically the reading from all points is typed out on a segmental typewriter. This is accomplished by making the computer scan the memory unit and sending the latest reading from each data point to the segmental typewriter.

All measured information is sent to the central data logger as a small varying d.c. voltage. Transducers are used as necessary to measure pressure, flow, or level and send an electrical signal to the central data logger input terminals in the 105 electrical equipment room. A complete list of the inputs is available on drawing H-1-32123. These inputs are scanned and the readings are transferred into the computer. Scanning can be continuous or one scan can be made every 5, 10, or 15 minutes as desired.

Operator controls are provided at the central data panel (P-25) in the Plant Control Center. Here the scanning interval can be selected, the data from any point can be read out on a four digit indicator, and the segmental typewriter can be started to print a log on demand. The strip printer which automatically prints out-of-limit points is located on a shelf at this panel.

Data from all points measured by the central data logger is periodically recorded by the segmental typewriter. This typewriter is called segmental because it types thirty consecutive readings for any given point in a vertical column at a definite location or segment, of the log sheet (See Page 21.17.1-1). The log sheet itself is about 23 inches wide and 40 inches long. It has 75 columns preprinted with the data point identification, the scale factor and indication of flow (F), pressure (P), or temperature (T), plus a column for the time of day. The typewriter prints the time and 75 data readings in one line across the paper. Each reading will be printed directly under a vertical column labeled A01, A02, etc. through A75. Then, the typewriter moves down about four inches and again prints the time and 75 more readings under columns B01 through B75. This action continues for rows C, D, E, F, G, and H where the machine stops at segment H75. Thus, the log sheet has space for 600 entries, but only 514 are presently assigned to calibration or data points, while the computer is capable of handling 525 inputs. When it is

CENTRAL DATA LOGGER (CONT'D)

time for the next log to be printed the typewriter will return to the time column at the top of the sheet, print the time directly under the previous reading, and then print out a new log with each entry directly below the previous entry. The log sheet has been designed to accommodate normal logging for one day. That is, one log every hour to produce 24 lines plus six lines for demand logs. If desired the machine can be set up to print every two hours instead of every hour. The first number in each row is a calibration point. When the system is working correctly it will always print 2048 under A01, 1024 under B01, 0000 under C01, and other fixed values at D01, E01, etc. to give eight self-check readings.

A system programmer console is located in the 105 electrical equipment room. At this console a punched tape is fed into the computer control system to establish the operating limits which the computer will use in checking for data points out-of-limits. This tape will permanently set-up specified operating limits in the memory of the computer. If a change in limits is desired the key board and controls on the programmer console can be used to make the change, or a new tape can be punched. It is also possible to make the computer solve math problems during the time it is not busy checking data from the usual data points.

ANNUNCIATOR SYSTEMS - 105 & 109-N

The annunciators for 105 and 109-N comprise a system of lights, nameplates, audible alarms, and solid-state logic components designed to transmit identification of off-normal process conditions to the various plant control points. An automatically-programmed print out in the plant control center provides an after-the-fact identification record of 300 selected points by printing on a paper tape the date and time each point alarms or clears.

There are 1164 annunciator points in total, including 16 dummy points, 872 of which are located in the plant control center. The remainder are on local control panels in 109-N.

Each annunciator point consists of a one-inch by three-inch translucent, back-lighted window with an engraved legend to identify it, mounted along with its printed circuit card and lights in 24-to-96-group panels above the control center instrument panels. Receipt on an alarm signal at a particular window starts its light flashing and actuates a common audible alarm to capture the operator's attention. The operator acknowledges the alarm by pressing a console or panel-mounted pushbutton, shutting off the audible alarm and leaving the light burning steadily. Disappearance of the alarm signal turns off the light with no further action required by the operator. Provision is included in the design for "ringback" (requiring the operator to push a reset button to turn off the annunciator light when a signal has cleared), but this will not be connected on the initial installation.

Within the plant control center, the panels of annunciators are grouped functionally. All of the reactor-associated alarms are located above instrument panels in front of the reactor control console; the primary loop alarms are grouped above their corresponding graphic panel; the gas, ventilation, confinement, and graphite cooling system alarms are above their respective panels. Within each block of annunciators, similar alarms are grouped together. Colored lights behind the windows are used to distinguish between special groupings; all points associated with scram trips are red, those for setback are green, ball system trip alarms are yellow, and emergency cooling water alarms are blue. Magenta has been used for gas system alarms. The remainder of the alarm points in the plant control center and all of the locally-mounted annunciators in the 109-N are colored white.

The audible alarms are produced by variable-oscillator tone generators in six distinct combinations. Each is equipped with a time-delay relay to silence the alarm automatically after an adjustable period (6 - 30 seconds) has elapsed. The different tones used for audible alarms in each section of the plant control center and the 109-N building are as follows:

Audible Alarm	Plant Control Center 105-N	109-N
Tone A	Safety Circuit Signal Block	--
Tone B	Remainder at Reactor Control	--
Tone C	Primary Loop Graphic Panels	5 Drive Turbine Panels
Tone D	Secondary Loop Graphic Panels	Decontamination Panel
Tone E	Gas, Ventilation, & Confinement Panels	Ventilation Panels
Tone F	Graphite Coolant Panel	--

In addition to its engraved legend, each annunciator point is identified by a number (01 to 99) engraved in the lower right corner of the window. Each panel of annunciators is assigned a two-digit number (see numbering table), and the resulting four-digit number (panel plus window) is used for point identification on the printout tape.

ANNUNCIATOR SYSTEMS - 105 & 109-N (CONT'D)

Sixteen of the annunciator points in the plant control center are special and operate differently from those previously discussed. These points (10 located above Panel P, and one each on panels B, C, D, E, F, & J) receive a retransmitted "trouble" signal from an annunciator panel at a remote location. They each alarm in the usual manner (flashing light and audible alarm) whenever any of the selected points on the remote annunciator panel alarms. Pressing the control center "acknowledge" button only silences the audible alarm. The light goes from flashing to steady only when it is acknowledged by the operator at the remote location. It goes off when the remote annunciator panel is clear. The purpose of these special points is to alert the control operator to anticipate trouble from remotely controlled equipment, and to detect when the trouble has been acknowledged locally. These points and their functions are tabulated below.

TITLE	LOCATION	ORIGIN
Trouble-D.T. Panel 1	Panel F	Any Annunciator D.T. Control Panel 1, 109 Turb. Bay
" " " 2	" E	" " " " " 2 " " "
" " " 3	" D	" " " " " 3 " " "
" " " 4	" C	" " " " " 4 " " "
" " " 5	" B	" " " " " 5 " " "
" -Turbogenerator	J	" " Turbo-Generator Local Panel 184N
" 182 Pumping Sys.	" P	" Pump Press. Loss Annunciator 182N
" 182 Diesels	" P	" 182N Diesel Trouble Annunciator
" 181 Diesels	" P	" 181 N Diesel Ann.or Loss Screen Wash Pump Power
" C.W. Pump #1	" P	" Annunciator CWP #1 Local Panel
" " " #2	" P	" " " #2 " "
" " " #3	" P	" " " #3 " "
" " " #4	" P	" " " #4 " "
" H & V Panel	" P	" " 109 H & V Control Panel
" Decon.Panel	" P	" " 109 Decon. Control Panel
" 1310 Bldg.	" P	" " 1310 Bldg.

Because high noise levels in the 109 Turbine Bay may mask a local control panel annunciator audible alarm, a centrally-mounted illuminated "signboard" is located on both operating levels. Each signboard is equipped with its own adjustable-volume tone generator and back-lighted windows bearing legends "1", "2", "3", "4", "5", "H & V", and "DECON." The same lighted windows are visible from both sides of the signboard. Upon receipt of an annunciator signal from a local panel, that particular window on the signboard commences to flash and the audible alarm sounds. The audible alarm can be turned off by acknowledging from any local panel. The signboard light remains flashing, however, until the annunciator that initiated the alarm has been acknowledged, at which time the signboard light burns steadily. When the annunciator point clears, the signboard light goes off automatically.

The automatic printout device consists of a Victor adding machine (serial input type) printing on 2-1/4 inch wide precarboned paper tape. The printer is mounted on pull-out slides in a cabinet on P-19, adjacent to the communications console. Each time any of the 300 selected annunciator points alarms, the tape is printed with the date and time (to the nearest second), the number of the annunciated point followed by the letter A (for alarm). When the point clears, the time, number, and letter N (for normal) is printed. The system has a ten point memory and will print sequentially alarms which occur one millisecond apart. If several

ANNUNCIATOR SYSTEMS - 105 & 109-N (CONT'D)

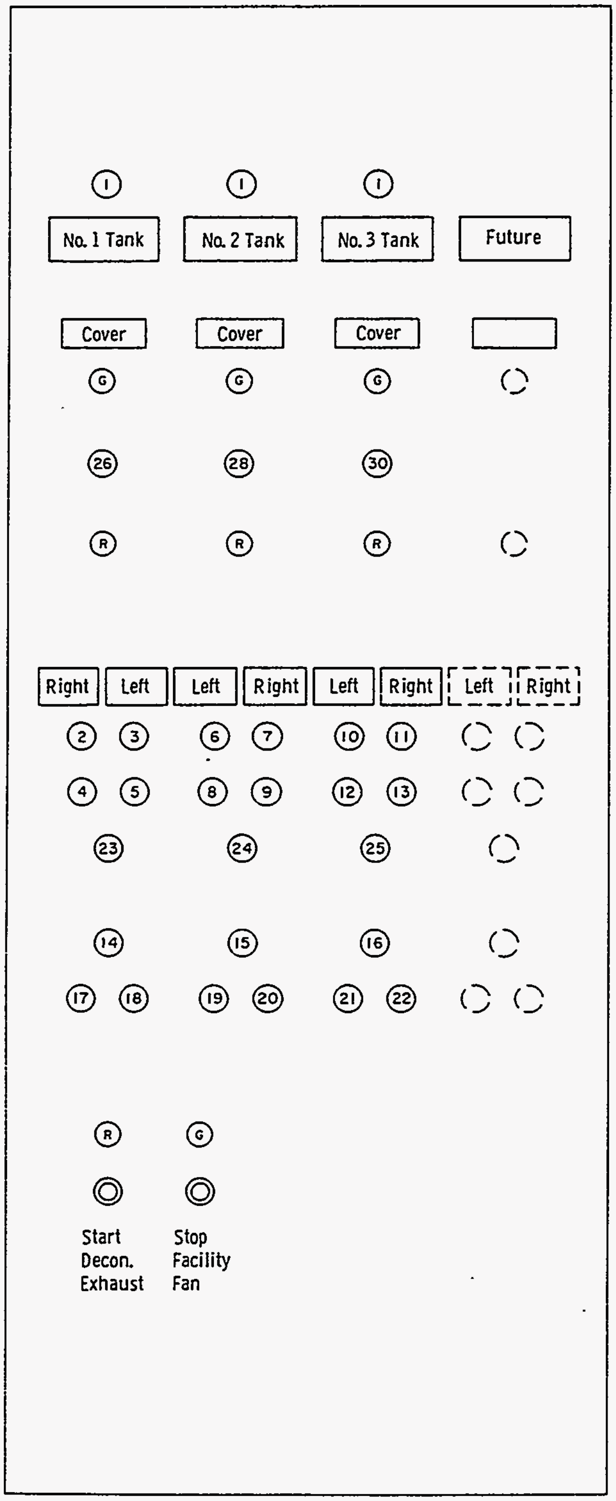
alarms occur within one millisecond, the time that the first one occurs will be printed to the nearest second. The system is expandable to accommodate 600 inputs.

The logic sections (power supply, encoding matrices, memory cards, digital clock), input sections (annunciator logic cards, recording logic cards), and the terminal sections (incoming signal terminals) are housed in cabinets located in Room 6 below the plant control center. Power supply is DC from a power supply which is fed from 120-volt AC power panel DK, with backup from Bus A (primary) or Bus B of the 105-N 125-V DC system. The inverter serves to isolate the annunciator from voltage spikes, and also produces 10-V DC logic power. The 109-located annunciators follow the same arrangement, except that their 125-V DC source is supplied from a separate battery bank.

ANNUNCIATOR PANEL AND WINDOW NUMBER SYSTEM

Panel Location	No. of Points	Arrgt. (Horizontal x Vertical Rows)	Panel Nameplate Number	Window Numbers
3*-105-N	96	8 x 12	1	01-96
4 "	96	8 x 12	2	01-96
4 "	96	8 x 12	3	01-96
5 "	96	8 x 12	4	01-96
A "	60	10 x 6	5	01-60
B "	24	4 x 6	6	01-24
C "	24	4 x 6	7	01-24
D "	24	4 x 6	8	01-24
E "	24	4 x 6	9	01-24
F "	24	4 x 6	10	01-24
J "	60	10 x 6	13	01-60
K "	24	4 x 6	14	01-24
L "	24	4 x 6	15	01-24
M "	24	4 x 6	16	01-24
N "	24	4 x 6	17	01-24
P "	24	4 x 6	18	01-24
38 "	48	8 x 6	19	01-48
37 "	48	8 x 6	20	01-48
39 "	24	4 x 6	21	01-24
32 "	24	4 x 6	0	01-24
D.T.C.P. 1-109-N	30	5 x 6	41	01-30
D.T.C.P. 2 "	30	5 x 6	42	01-30
D.T.C.P. 3 "	30	5 x 6	43	01-30
D.T.C.P. 4 "	30	5 x 6	44	01-30
D.T.C.P. 5 "	30	5 x 6	45	01-30
H & V I "	30	6 x 5	51	01-30
H & V II "	25	5 x 5	52	01-25
H & V III "	20	4 x 5	53	01-20
H & V IV "	15	3 x 5	54	01-15
Decon. Rm. "	36	6 x 6	--	01-36

*Ref. 21.1



Control Station Panel - Room 191

IDENTIFICATION

1 Lights	For Control Power (Amber)
2 Thru 13	Timers, Adjustable 5-60 Minutes with Elapsed Time Pointers
14, 15 & 16	Manual-Off-Auto Switches for both L&R Prop. Motors, I-E-, No. 14 for No. 1 Tank, Both L&R, Etc.
14 Thru 22	Reverse - Forward - Off Switch, One for Each Prop., Manual Only.
23, 24 & 25	Time Cycle Initiate Switch
26, 28 & 30	Selector Switch for Covers, Open - Close - Stop
G	Green Indicating Light, Cover Closed
R	Red Indicating Light, Cover Open

Dummy Decontamination Control System Panel - 105-N

DUMMY DECONTAMINATION CONTROL SYSTEM - 105-N

This system is designed to provide semi-remote control of the dummy decontamination process. Those functions for which remote controls are provided are: (1) filling and draining the cleaning tanks, (2) opening and closing the lids for the cleaning tanks, (3) programing of the quadruple cleaning flow pattern, (4) controlling the ventilation exhaust system, and (5) operating the overhead crane and hoist. In addition, a steam regulating valve automatically controls the cleaning tank solution temperature; and cooling water flow to the agitator seals is automatically supplied through diaphragm-operated valves which automatically open when the agitator motors are started. The addition of chemicals to the tanks, initially turning steam on to the tanks, and final sorting of clean dummies and equipment must all be accomplished manually.

The remote controls for the process are mounted on a local control panel with the exception of the controls for the overhead hoist and crane, which are located on a separate control console. The control panel is divided to accommodate controls for four tanks. However, it is equipped for handling only three tanks. Each section is completely independent and has its own power supply. Starting at the top of the panelboard and going down, the items installed and their functions are as follows:

1. Amber pilot lights, one for each panel section, which glow when the section involved is powered with 110 volts.

2. Nameplates captioned "TANK NUMBERS" and "COVERS".

3. Green pilot lights, one for each tank, which glow only when the cover of the tank involved is completely closed. Each light is actuated by a limit switch on the corresponding tank.

4. Open - Closed selector switches, one for each tank cover. When the selector switch is turned to the center position, the cover motor will stop and remain stationary until the operator rotates the switch either right or left.

5. Red pilot lights, one for each tank, which glow only when the cover of the tank involved is completely open. Each light is actuated by a limit switch on the corresponding tank.

6. Nameplates captioned "LEFT" and "RIGHT' to designate the propeller location on the tanks.

7. Four timers for each tank to program the cycle-time for the following propeller sequencing and resulting quadruple flow pattern:

   Timer #1 - Right propeller reverse (counterclockwise); left propeller forward (clockwise)
   Timer #2 - Right propeller forward (clockwise); left propeller forward (clockwise)
   Timer #3 - Right propeller forward (clockwise); left propeller reverse (counterclockwise)
   Timer #4 - Right propeller reverse (counterclockwise); left propeller reverse (counterclockwise)

DUMMY DECONTAMINATION CONTROL SYSTEM - 105-N (CONT'D)

Each timer is independently adjustable. Time settings are made by turning the knob on the front of the timer face. The time settings should not be adjusted unless the amber pilot light is glowing, showing that the panel is powered. Each timer is equipped with two pointers. When timed out and standing by, both pointers are together and indicate the time interval. When a timer is powered and initiated to go into timing, the orange pointer will travel toward zero. At the elapse of the set timing the orange pointer will strike zero and immediately reset and fly back to coincidence with the black pointer and stand-by awaiting the next initiating impulse.

The setting procedure is as follows:

a. Set each of the four timers for the desired operating time for that particular cycle. No timer should be set for a shorter period of time than the shaded area of the face, which for these timers is approximately five minutes.
b. To start the cycle, press the "initiate button" which is the line of buttons below the timers. Timer #1 will start timing as will be indicated by travel of the orange pointer.
c. When the orange pointer arrives at zero, timer #2 is initiated simultaneously with the return of the orange pointer at timer #1.
d. The orange pointer on timer #2 will now start to travel, and the sequence goes through all four timers.
e. When the orange pointer of timer #4 arrives at zero, the sequence for this run is finished. The orange pointer of timer #4 will fly back and the sequence will not start again until the initiate button is again depressed.
f. If power failure to this section occurs during the timing cycle, all pointers fly back to zero for a complete cycle repeat.

8. The cycle initiate pushbuttons referred to above. The agitator motors cannot be started unless the tank lid covers are closed as indicated by the green indicating light. There is a pause or delay between motor re-operation between timers. This pause may run from ten to fifteen seconds and is for the purpose of preventing instant reversal of the propeller motors.

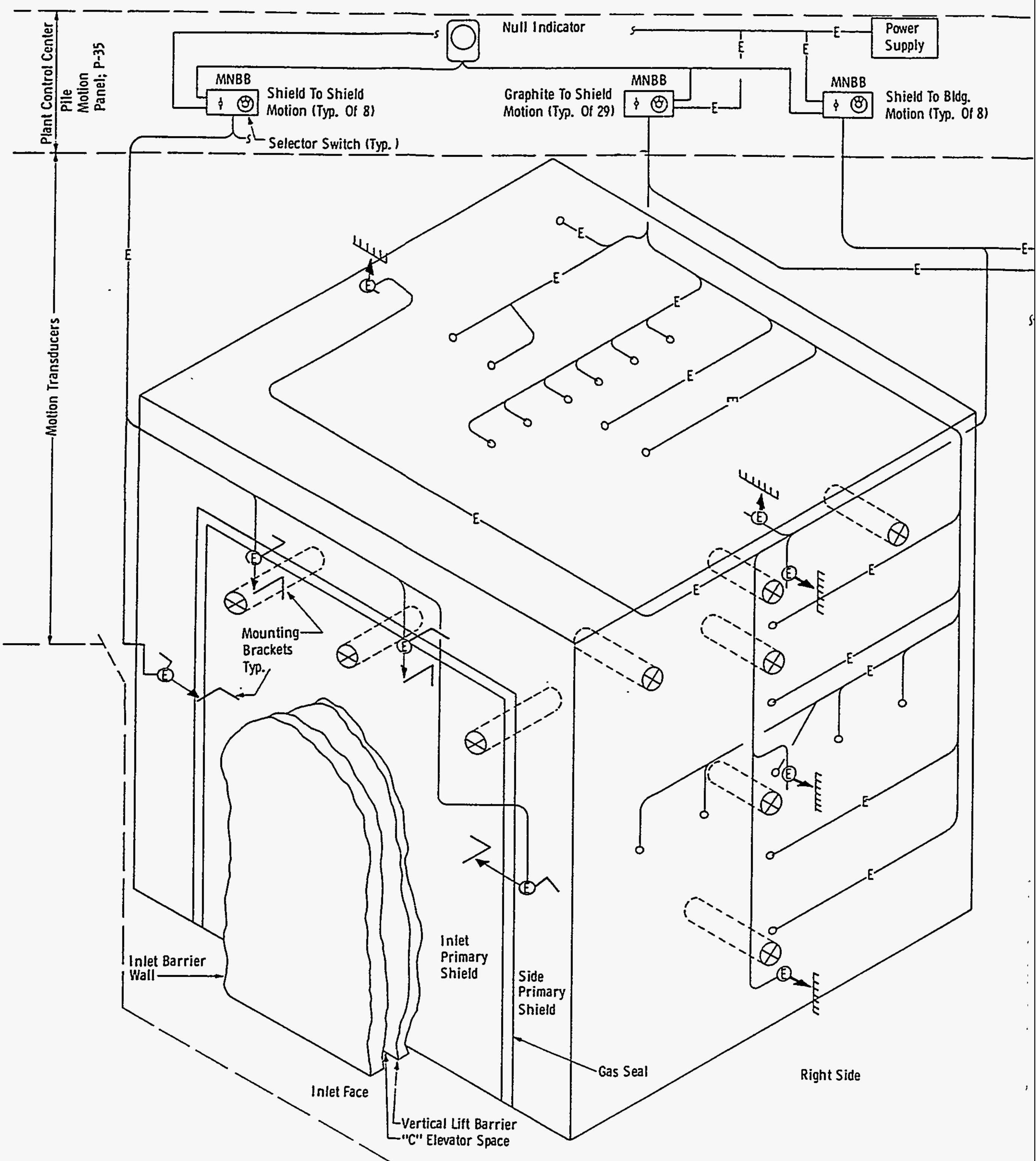
9. Manual-Automatic-Off selector switches, one for each tank, which allow operational selection of the propeller motors as follows:

   a. In the automatic position the motors cycle through the preset time cycle described above. It is necessary that these switches be set in the automatic position in order to accomplish an automatic cycle.
   b. In the manual position the direction of operation of the motors is subject to the selector switches in 10 below.

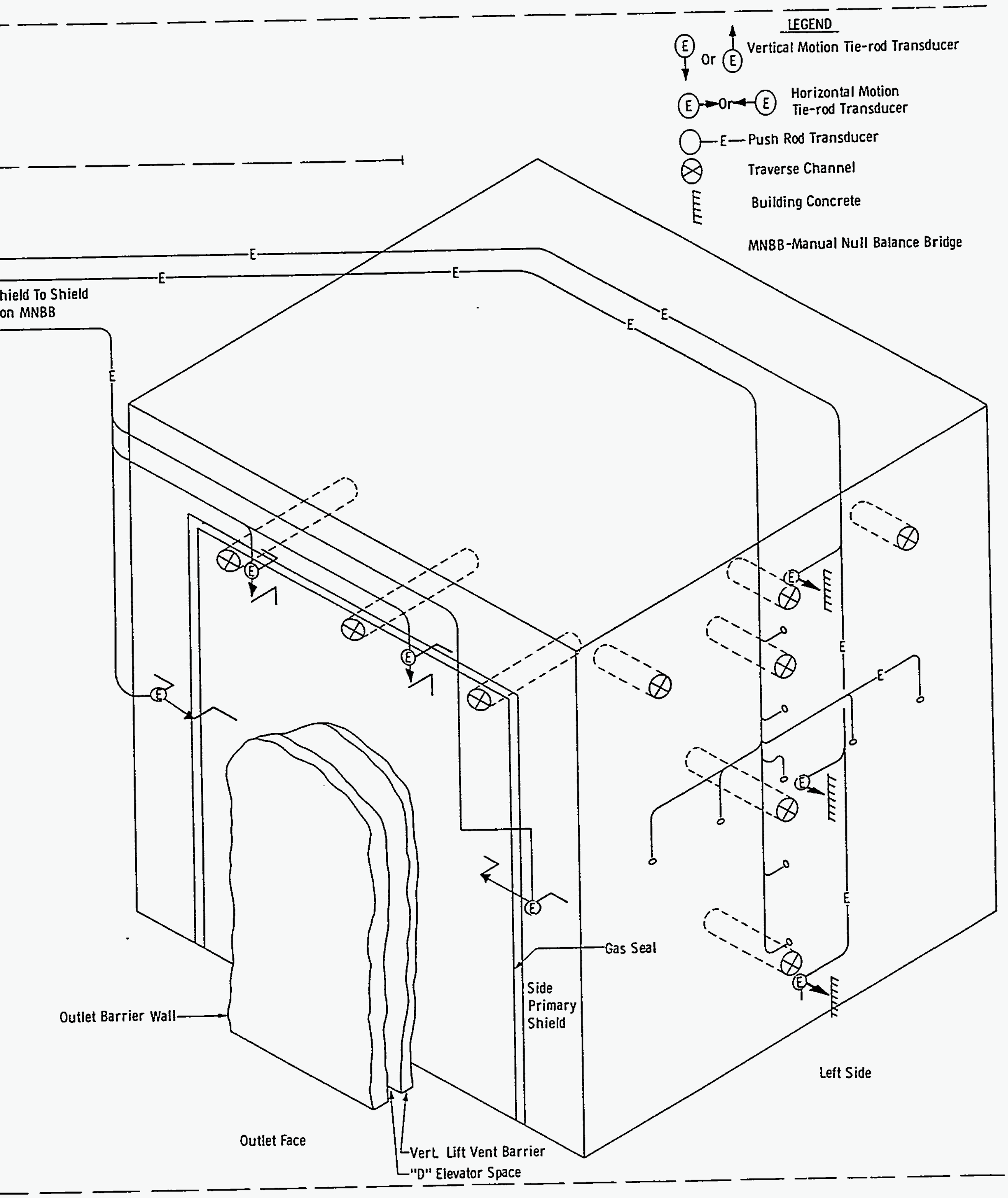
10. Reverse-Forward-Off manual selector switches for each propeller motor. When selector switch in 9 above is in the manual position, these manual selector switches allow the appropriate motor to be driven either forward or reverse as selected.

11. Individual tank fill and drain controls.

12. Ventilation exhaust fan start-stop controls, and individual tank exhaust damper controls (Ref. 18.1.5).



Pile Motion Meas



rement System

PILE MOTION MEASUREMENT SYSTEM

This system is designed to measure and indicate motion of:

1. The graphite relative to the top primary shield.
2. The graphite relative to the side primary shields.
3. The inlet and outlet primary shields relative to the side and top primary shields.
4. The side and top primary shields relative to the building.

The system is also designed with side-to-side and front-to-rear traverse channels through which vertical and horizontal contours of the graphite can be measured.

Vertical motion of the graphite relative to the top primary shield is measured by means of push-rods resting on the graphite and extending through the shielding to motion transducers mounted on top of the reactor. Horizontal motion of the graphite relative to the side shields is also measured by means of push-rods in contact with the graphite and extending through the side shielding into the inner rod rooms to motion transducers affixed to the sides of the primary shield. Eleven push-rod transducer stations are located at nominal five-foot spacings on top of the reactor, and nine are located on each side to give contours in the region of the pile center lines. Top contours are side-to-side and front-to-rear while side contours are top-to-bottom and front-to-rear.

Motion of the inlet and outlet primary shields relative to the top and side primary shields is measured by eight motion transducers affixed to brackets which span the expansion joints. Horizontal motion (side-to-side) is measured at one position on each side of both the inlet and outlet primary shields. Vertical motion is measured at two positions, one on each side of the center line at the top of both the inlet and outlet shields.

Dishing and bowing (horizontal motion) of each of the side primary shields is measured at three locations on a vertical line approximately equidistant between the inlet and outlet faces by tie-rods extending from the side primary shield to motion transducers affixed to the inner rod room barrier wall. This will give a top to bottom contour.

Dishing and bowing (vertical motion) of the top primary shield is measured at two locations, one near each side shield and approximately midway between the front and rear face, by tie-rods extending from the top primary shield to transducers affixed to the Zone I roof. These rods must be removed if the top of the unit crane is used.

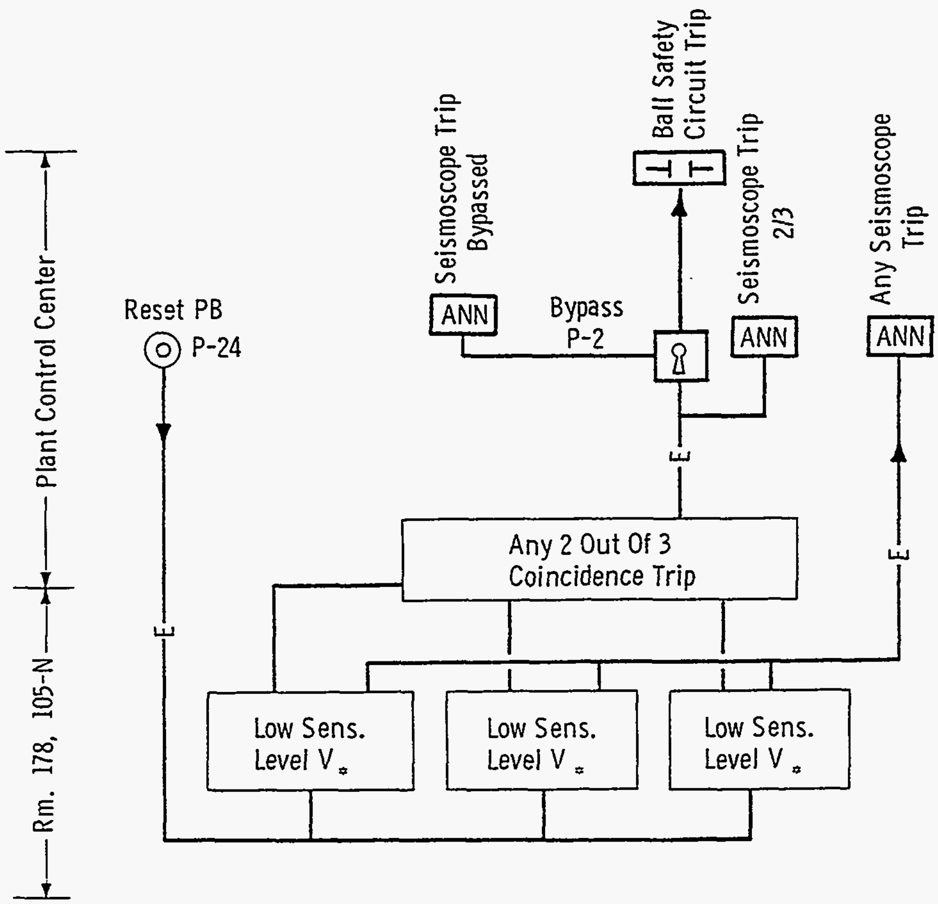
All motion transducers are accurate to 0.05 inch and are capable of resolving 0.01 inch. All transducers are arranged so that they can be replaced. The output from any of the 45 transducers can be selected by the corresponding selector switch on the respective manual null balance bridge for read-out on a null indicator on the pile motion panel (P-35) in the plant control center.

Finally, a portable traversing mechanism is provided for traversing a process tube or channel or any of the three front-to-rear or six side-to-side traverse channels. The traversing mechanism is designed to give data in both the horizontal and vertical planes (deflection and displacement data) and to be accurate to 0.125 inch.

The seismoscope system is designed to detect earthquakes that are of sufficient intensity to affect the structual integrity of either the reactor, the reactor building, or the service facilities and to either alarm or both alarm and shutdown the reactor by tripping the ball safety circuit.

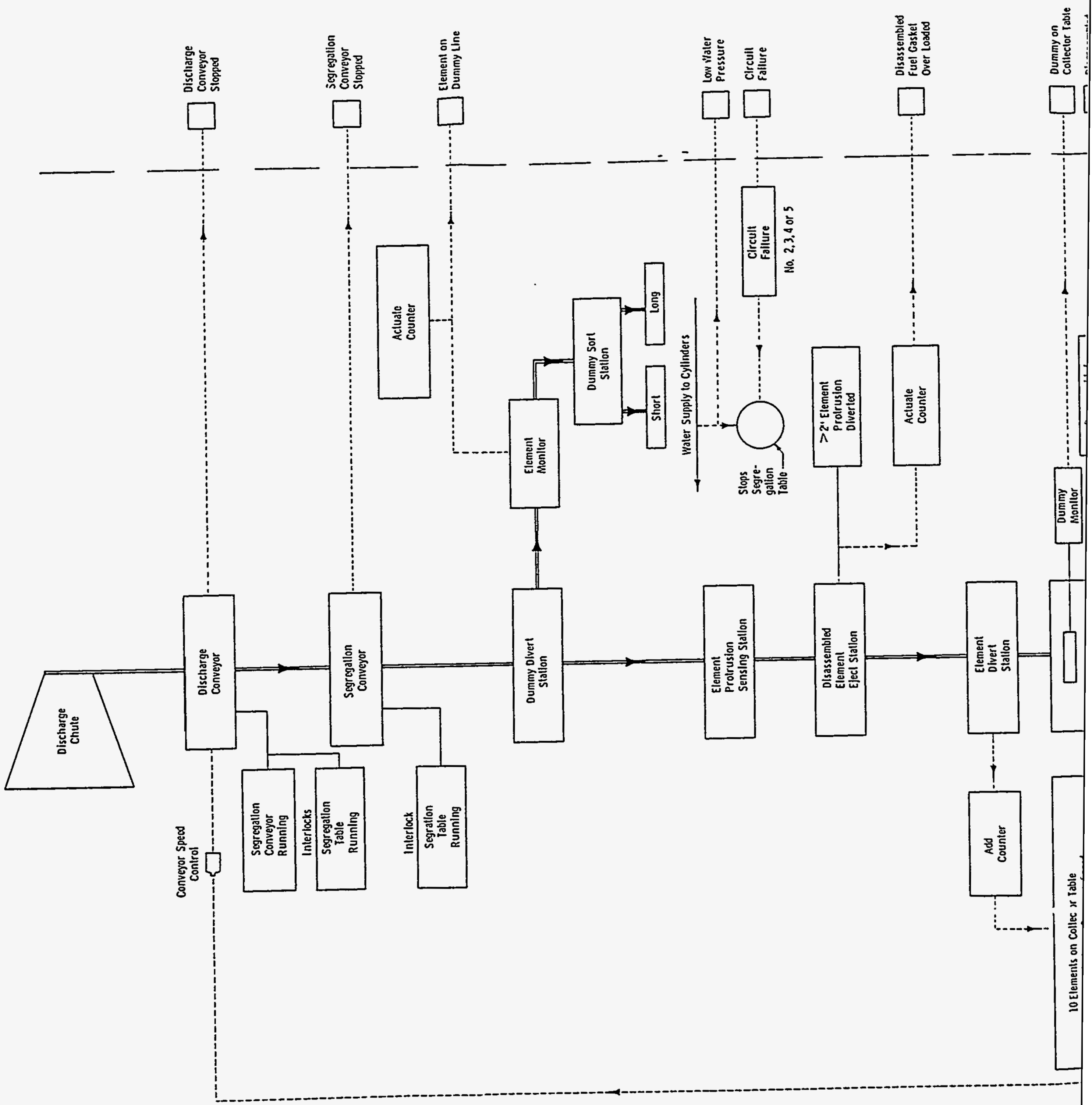
The seismoscope system consists of three independent pendulum switches and relays mounted on the same base in the flux monitor room, Rm. 178. Each pendulum switch and relay makeup a complete detection circuit. The pendulum switches detect any motion of the earth in a lateral direction and are adjusted to close contact when the horizontal component of earthquake intensity reaches "five" on the Modified Mercalli Scale.

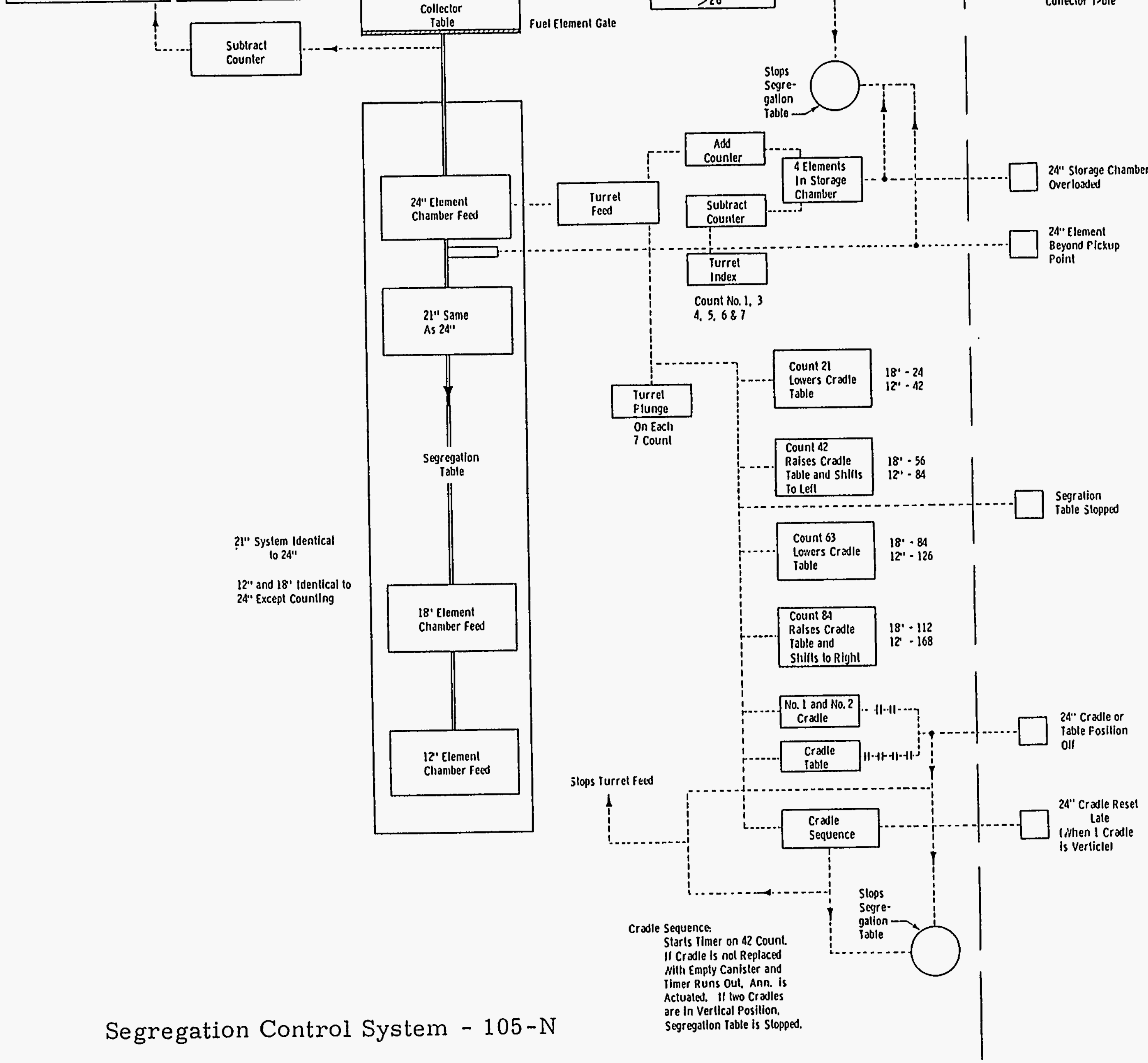
A momentary contact of one of the switches "locks in" the corresponding relay which in turn operates contacts to actuate an annunciator drop in the control room. When any two of the three seismoscope relays "Lock In", the ball safety circuit is also tripped. Since the seismoscope relays "Lock In" on tripping, they must be manually reset by the seismoscope reset pushbutton on the reactor console in order to return the system to normal.



*Modified Mercalli Scale

Seismoscope System - 105-N


Discharge Conveyor Stopped
Segregation Conveyor Stoppd
Element on Dummy Line
Low Water Pressure
Circuit Failure
Disassembled Fuel Gasket Over Loaded
Dummy on Collector Table
Actuate Counter
Dummy Sort Station
Long
Short
Circuit Failure
No. 2,3,4 or 5
Water Supply to Cylinders
Element Monitor
Stops Segre-gation Table
>2" Element Protrusion Diverted
Actuate Counter
Dummy Monitor
Discharge Chute
Discharge Conveyor
Segregation Conveyor
Dummy Divert Station
Element Protrusion Sensing Station
Disassembled Element Eject Station
Element Divert Station
Add Counter
Conveyor Speed Control
Segregation Conveyor Running
Interlocks
Segregation Table Running
Interlock
Segration Table Running



Segregation Control System - 105-N

UNCLASSIFIED

HW-69000 Vol.II

SEGREGATION CONTROL SYSTEM - 105-N

The purpose of the irradiated fuel and dummy segregation system is to convey, segregate and load elements under water, on a continuous semi-automatic basis from the discharge area through the segregation area.

The entire process is dependent on the actuation of hydraulic cylinders which respond automatically or manually by control switches on the Control Panel, located on O'Level directly above the segregation area.

The cycle time for all the cylinders is critical during automatic operation. Cycle time for each cylinder can be verified by the cylinder timers on the Control Panel.

Each cylinder is provided with two flow control valves located beneath the hydraulic manifolds. Cylinder advance speed is controlled by the right hand control valve and cylinder retract speed is controlled by the left hand flow control valve. Counterclockwise rotation of the control valve stem increases cylinder speed and clockwise stem rotation decreases cylinder speed.

The following is a list of the cylinders and their specific function:

Cylinder No.	Function
1	Diverts Dummies
2	Diverts Disassembled Elements
3	Diverts Fuel Elements
4, 12, 20, & 28	Feeds Elements into Storage Chambers
5, 13, 21, & 29	Feeds Elements into Turrets
6, 14, 22, & 30	Index Turrets
7, 15, 23, & 31	Plunges Elements from Turrets into Canisters
8, 16, 24, & 32	Positions Canister Table Vertically
9, 17, 25, & 33	Positions Canister Table Horizontally
10, 18, 26, & 34	Tilts Cradle No. 1
11, 19-27, & 35	Tilts Cradle No. 2
36	Positions Long Dummy Cart
37	Positions Short Dummy Cart

In addition to the cylinders, the segregation system drive equipment consists of three varidrive motors.

The discharge conveyor is driven by a 15 H.P. varidrive electric motor which can be reversed and adjusted to various speeds. The alignment conveyor is also driven by this motor through appropriate gearing. The following control instrumentation and interlocks are provided:

1. Start-Stop Pushbuttons
2. Forward and Reverse Pushbuttons
3. Tachometer
4. Speed Controller (At Panel)
5. Direction Indicating Lights
6. "Conveyor Stopped" Annunciator
7. Speed Control Interlock with Segregation Table Counter
8. Interlock to Stop Conveyor if Either the Segregation Conveyor or Table Stops
9. Provides Interlock to Change Machine

SEGREGATION CONTROL SYSTEM - 105-N (CONT'D)

The segregation conveyor is driven by a 5 H.P. varidrive motor. The following control instrumentation and interlocks are provided:

1. Start-Stop Pushbuttons
2. Forward and Reverse Pushbuttons
3. Direction Indicating Lights
4. "Conveyor Stopped" Annunciator
5. Speed Control (At Motor)
6. Interlock to Stop Conveyor if Segregation Table is Stopped

The segregation and collector tables are driven by a 10 H.P. varidrive motor with the following control instrumentation and interlocks:

1. Start-Stop Pushbuttons
2. Speed Control (At Motor)
3. "Segregation Table Stop" Annunciator
4. Interlocks to Stop the Table on the Following Conditions:
   a. Low cylinder pressure
   b. Circuit failure
   c. Disassembled fuel element on collector table
   d. Element beyond pickup point
   e. Four or more elements in storage chamber
   f. Table or cradle out of position
   g. Cradle reset late (2 canisters loaded and in vertical position)

The proper sequencing of the operation is controlled by 30 adjustable timers, 100 relays including time delay relays, 103 limit switches, 3 proximity switches, counters and programmers.

The entire system can be operated automatically or manually by the manual, sequential actuation of appropriate cylinders from the manual portion of the Control Panel.

The following is typical of the sequence of events of a complete traverse of elements and dummies through the entire system.

Dummy Processing - A magnetic sensitive proximity switch differentiates dummies from elements. The proximity switch actuates a timer which delays the operation of the dummy diverter until the dummy is properly positioned for diverting.

A fuel element monitor is provided on the dummy conveyor. A proximity switch actuates a timing circuit when an element is sensed which actuates an annunciator and a counter. The short and long dummy baskets must be periodically observed and when full are replaced with an empty basket by positioning the "in-out" control switch on the Control Panel to the appropriate position.

Fuel Element Processing - Fuel elements with a front or rear end protrusion of the inner tube greater than 2" are diverted. Each disassembled fuel element that is diverted actuates a counter. When the preset number of elements is diverted, indicating basket is full, an annunciator is actuated. After basket is replaced with an empty, the counter must be manually reset to zero which clears the annunciator.

Should a dummy inadvertently be missed at the dummy diverting station and wind up on the element collector table, it will be sensed by a proximity switch which actuates a counter and an annunciator. Dummy must be removed. Alarm and annunciator clear upon manual acknowledgement.

Should a fuel element become disassembled during traverse a backup monitor on the collection table will actuate an annunciator and stop the segregation table. When

SEGREGATION CONTROL SYSTEM - 105-N (CONT'D)

the disassembled element is removed, annunciator may be cleared and the vari-motor drives started in their proper sequence.

All the fuel elements diverted to the collection table and all the elements leaving the collection table are counted separately and indicated on the Control Panel. The discrepancy in count provides a signal to control the speed of the discharge conveyor. When the error count is 10, the conveyor is cut to half speed. When the error (number of elements on collection table) returns to 3 the discharge conveyor resumes its normal speed.

The 4 fuel element loading stations are identical except for the counting features which control the canister cradle and table positioning. The following is for 24" elements. As a fuel element is transferred into the storage chamber its presence is indicated by a counter on the Control Panel. As the elements are transferred from the chamber to the turret the count is subtracted from the counter. During the plunge operation fuel elements are stored in the storage chamber. Should a total of 4 elements enter the chamber before the turret plunger is retracted (which would indicate a malfunction) an annunciator is actuated and the segregation table is stopped. This of course stops the entire system. System must be cleared by manual operation prior to returning to automatic.

After the first element is fed into the turret, the turret is indexed and the (Turret No. 1 position) light will go out. The (step switch in position No. 1) light will go out simultaneously. As each fuel element is fed into the turret the cumulative number is indicated on the element programmer. When a total of 7 elements is fed into the turret the (turret No. 1 position) and (step switch in position No. 1) lights will come on and the plunger will transfer the 7 elements into the canister. At the start of the plunge operation the (turret plunge retracted) light will go out. Upon complete retraction the (turret plunge retracted) light comes on. This is repeated after each group of 7 elements is fed into the turret.

When 21 fuel elements have been fed into the lower half of canister No. 1 indicated by a count of 21 of the Element Programmer Counter, the canister storage table will lower. When count 42 is registered the table will rise, shift to the left and cradle No. 1 will rotate to the vertical position. This action also actuates a timer. The operator must remove canister No. 1, replace it with an empty and depress the (reset cradle) button to reposition canister No. 1 to the horizontal position. The same sequence occurs with canister No. 2 and same operator action is required.

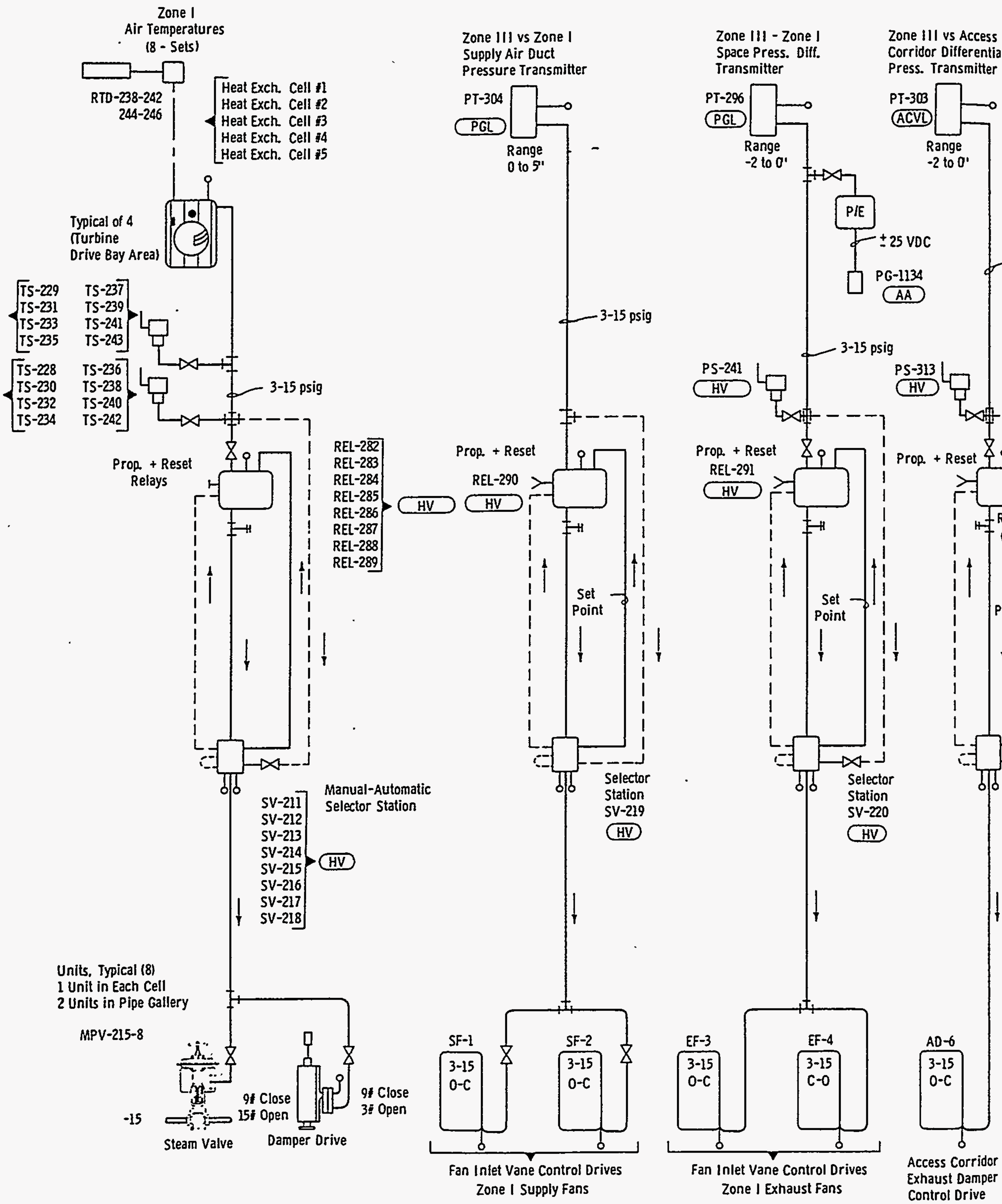
After either canister is rotated to the vertical position the operator has a specific time in which to replace the full canister with an empty and depress the (reset cradle) button. Canister replacement time for each loading station is:

21 and 24" station -- 120 seconds
18" station -- 166 seconds
12" station -- 260 seconds

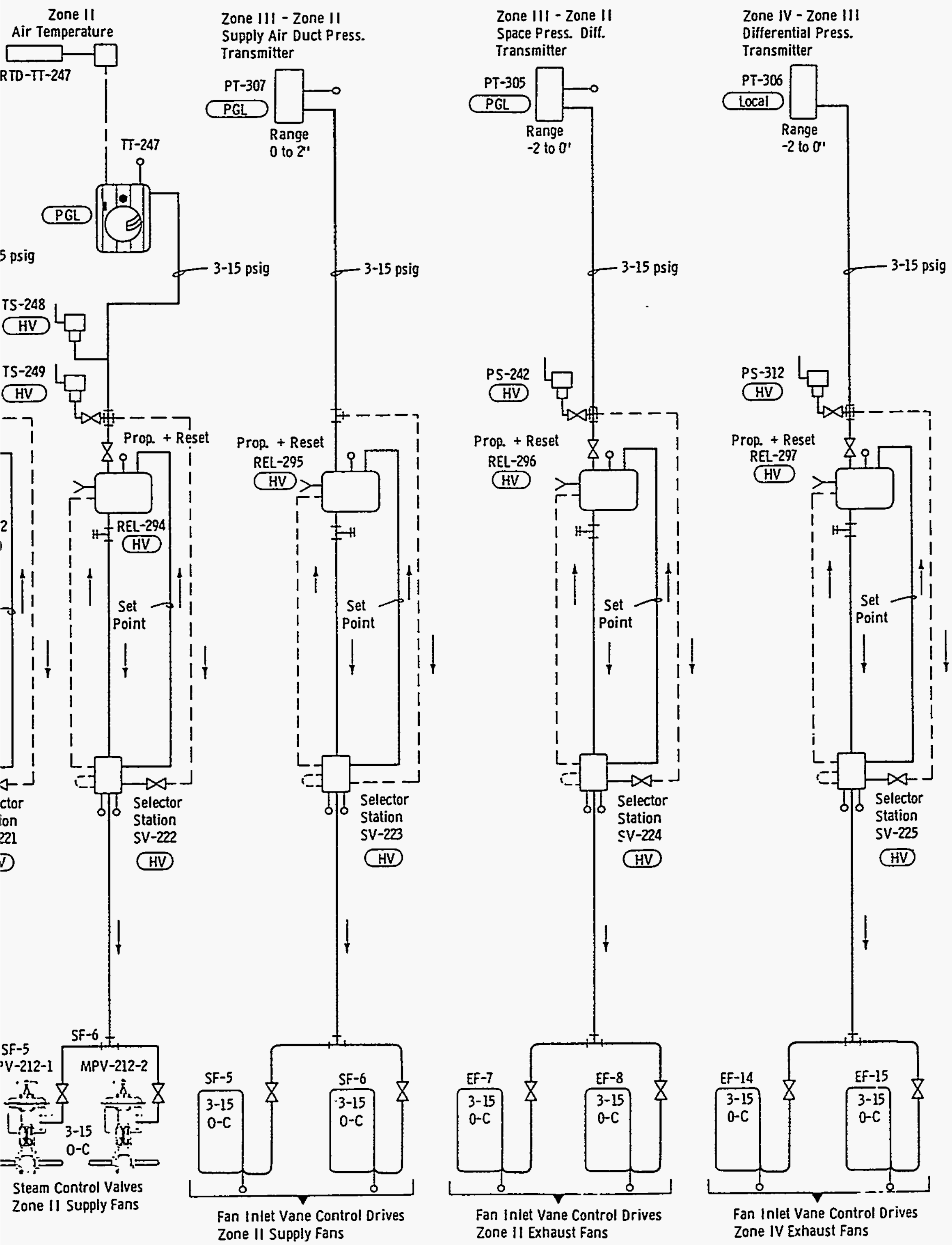
Should the operator fail to complete this operation within the time specified, the timer which was actuated when the first canister went vertical will actuate an annunciator. If both canisters are vertical the timer will automatically stop the system.

Both cradle horizontal positions and the upper, lower, left and right cradle table positions are monitored. If after actuation of a timer a pre-set time elapsed before the cradle or table are properly positioned an annunciator will be actuated and the system is automatically stopped.

For mechanical details see Ref. 19.2 of Systems Descriptions and 21.18.5-1 for Control Schematic.



Heating and Ventilating C



trol System - 109-N

CHARGING MACHINE CONTROL SYSTEM - 105-N

This system provides controls and interlocks for the safe operation of the reactor process tube charging machine. The following description is a typical cycle for charging ten magazines.

Basic Relationships (Ref. 19.1.1)

The transfer arm notches, idler rollers, and drive rollers are numbered from west (far or right) to east (near or left) from 1 through 10, 1 through 5, and 1 through 3 respectively. By definition the four transfer arm positions are numbered from 1 through 4, from full west to full east. The following table establishes the relationships between the transfer arm notches, the idler rollers, and the drive rollers in the four positions of the transfer arms:

Transfer Arm Position #1 (Full West)

```
                  10  9  8  7  6        5  4  3  2  1     TA Notches
                   5  4  3  2  1                          IR Numbers
                   3     2     1                          DR Numbers
```

Transfer Arm Position #2

```
               10  9  8  7  6        5  4  3  2  1        TA Notches
                   5  4  3  2  1                          IR Numbers
                   3     2     1                          DR Numbers
```

Transfer Arm Position #3

```
10  9  8  7  6        5  4  3  2  1                       TA Notches
                   5  4  3  2  1                          IR Numbers
                   3     2     1                          DR Numbers
```

Transfer Arm Position #4 (Full East)

```
   10  9  8  7  6        5  4  3  2  1                    TA Notches
                         5  4  3  2  1                    IR Numbers
                         3     2     1                    DR Numbers
```

Initial Conditions: The charging machine is centrally located on W-elevator with the transfer arms empty and in position #1. Switches are located on the charging machine consoles except as noted.

1. Turn machine power and hydraulic motor power on.

   Interlock: Control power switch on P-19 must be on.

2. Actuate cross travel near (far) to desired locations for removal of barrier wall shield plugs.

   Interlocks: Selsyn power on; magazines or shield plugs not extended beyond machine; not loading or unloading transfer arms; transfer arms in position #1 (#4) or tips of transfer arms more than 3' from east (west) edge of elevator.

CHARGING MACHINE CONTROL SYSTEM - 105-N (CONT'D)

Charging machine vertical lift (continuous up or down) or elevator movement may also be required.

Interlocks for machine vertical lift continuous up: Vertical lift not full up; W-elevator not less than 5' from top of travel; ends of transfer arms not within 3' of either edge of elevator or transfer arms must be in full opposite position from edge of elevator that machine is next to; magazines or shield plugs not extended beyond machine.

Interlocks for machine vertical lift continuous down: Vertical lift not full down; ends of transfer arms not within 3' of either edge of elevator or transfer arms must be in full opposite position from edge of elevator that machine is next to; magazines or shield plugs not extended beyond machine.

Interlocks for W-elevator travel down: Ends of transfer arms not within 3' of either edge of elevator or transfer arms must be in full opposite position from edge of elevator that machine is next to; magaz ines or shield plugs not extended.

Interlocks for W-elevator travel up: Same as for travel down; and elevator not less than 5' from top of travel or charging machine vertical lift full down.

3. Move near (far) plug conveyor forward (south) to engage shield plugs.

   Interlocks: Charging machine not driving east or west; elevator not requested to move up or down.

4. Move near (far) plug conveyor backward (north) to remove shield plug.

   Interlock: Plug conveyor not full.

5. Repeat Steps 2, 3, and 4 required number of times.

6. Actuate cross travel full near in preparation for loading transfer arms.

   Interlocks: Same as Step 2.

7. Raise (lower) charging machine, vertical lift position up (down), to place near transfer arms at a below rack position.

   Interlocks: Charging machine vertical lift not full up and W-elevator not less than 5' from top of travel (vertical lift not full down); near side of transfer arms, notches 6 through 10, are empty; transfer arms are not at a below rack position; transfer arms are in position #1; charging machine is full near; magazines or shield plugs are not extended beyond the machine.

8. Move transfer arms from position #1 to position #4 - full east. (Inserts transfer arms between magazine storage racks in preparation for loading.)

   Interlocks: Transfer arms are at position #1, #2, or #3; transfer arms are at a below rack position; near side of transfer arms are empty; the idler rollers are down or the idler rollers are up and both sides of transfer arms

CHARGING MACHINE CONTROL SYSTEM - 105-N (CONT'D)

are empty; vertical lift up or down not requested; magazines are not extended beyond the machine.

9. Raise charging machine (vertical lift position up) to load transfer arms (notches 6 through 10). Upward motion stops at an above rack position.

   Interlocks: Charging machine vertical lift not full up; W-elevator not less than 5' from top of travel; near side of transfer arms are being loaded inside wall racks; transfer arms at position #4; charging machine is full near; magazines or shield plugs are not extended beyond the machine.

10. Move transfer arms from position #4 to position #1.

   Interlocks: Transfer arms are at position #2, #3, or #4; tips of far transfer arms not within 3' of west edge of elevator; idler rollers are full down; vertical lift up or down not requested; magazines are not extended beyond the machine.

11. Raise idler rollers to pick-up magazines (see table) lined up with transfer arm position #1.

   Interlocks: Transfer arms in position #1, #2, #3, or #4; transfer arms not requested to move.

12. Raise charging machine (vertical lift position up) to place near transfer arms at a below rack position.

   Interlocks: Same as Step 7.

13. Same as Step 8.

14. Same as Step 9.

   Status: Transfer arms in position #4, idler rollers up and loaded, and transfer arm notches 6 through 10 loaded.

15. Actuate cross travel far to desired location and stop.

   Interlocks: Same as Step 2.

   Charging machine vertical lift (continuous up or down) or elevator movement may also be required.

   Interlocks: As stated in Step 2.

16. Raise front (south) drive rollers #1, #2, and #3 (individual switches).

   Interlocks: Idler rollers are up; not requesting drive rollers down.

17. Drive front (south) drive rollers forward (south) - drives magazines from transfer arm notches 1, 3, and 5.

CHARGING MACHINE CONTROL SYSTEM - 105-N (CONT'D)

Interlock: Magazines not forward of hydraulic connections.

18. Raise and connect hydraulic connectors.

    Interlocks: Magazines are forward of hydraulic connections; request not made to lower idler rollers; charge water off not actuated; idler rollers are up.

19. Turn charge water on (individual switches). Charging is complete when indicating light is actuated.

    Interlocks: Segregation system discharge conveyor is running; charge water off not actuated; hydraulic connector is against rear of magazine; charging machine permissive charge switch (P-19) actuated; inlet and outlet thermal barrier doors are open; Zone I outlet doors are closed; D-elevator is up.

20. Turn charge water off. Action also lowers hydraulic connectors.

21. Drive front (south) drive rollers backward (north).

22. Lower front drive rollers.

23. Lower idler rollers.

    Interlocks: Magazines not extended beyond charging machine; hydraulic connectors are fully down; transfer arms are in position #1, #2, #3, or #4; transfer arms not requested to move.

24. Reposition transfer arms to position #3 from position #4 (movement far).

    Interlocks: Same as Step 10.

25. Cross travel near (or far), raise or lower machine (vertical lift continuous up or down), or raise or lower elevator to next charging position.

    Interlocks: Same as Step 2.

26. Raise idler rollers (see table).

    Interlocks: Same as Step 11.

27. Repeat Steps 16 through 23. (Charge magazines from transfer arm notches 2 and 4.)

28. Reposition transfer arms to position #2 from position #3.

    Interlocks: Same as Step 10.

29. Repeat Steps 25 through 27. (Charge magazines from transfer arm notches 7 and 9.)

30. Reposition transfer arms to position #1 from position #2.

    Interlocks: Same as Step 10.

31. Repeat Steps 25 through 27. (Charge magazines from transfer arm notches 6, 8, and 10.)

    Status: Transfer arms in position #1, idler rollers down.

CHARGING MACHINE CONTROL SYSTEM - 105-N (CONT'D)

32. Cross travel full near in preparation for unloading transfer arms.

Interlocks: Same as Step 2.

33. Raise (lower) charging machine, vertical lift position up (down), to place transfer arms at an empty above rack position.

Interlocks: Vertical lift not full up and W-elevator not less than 5' from top of travel (vertical lift not full down); transfer arms not at an empty above rack position; near end of transfer arms are loaded; transfer arms are at position #1; charging machine is full near; magazines or plugs are not extended beyond the machine.

34. Move transfer arms from position #1 to position #4 - full east. (Inserts transfer arms between magazine storage racks in preparation for unloading.)

Interlocks: Transfer arms are at position #1, #2, or #3; transfer arms are at an empty above rack position; the idler rollers are down; vertical lift up or down not requested; magazines are not extended beyond the machine.

35. Lower charging machine (vertical lift position down) to unload transfer arms (notches 6 through 10). Downward motion stops at a below rack position when magazines are placed on wall racks.

Interlocks: Charging machine not full down; near side of transfer arms are being unloaded inside of wall racks; transfer arms are at position #4, charging machine is full near; magazines or shield plugs are not extended beyond the machine.

36. Raise idler rollers to pick up magazines (see table).

Interlocks: Same as Step 11.

37. Move transfer arms from position #4 to position #1.

Interlocks: Same as Step 10.

38. Lower idler rollers.

Interlocks: Same as Step 23.

39. Repeat Steps 33, 34, and 35.

40. Actuate cross travel far to desired locations for replacement of barrier wall shield plugs.

Interlocks: Same as Step 2.

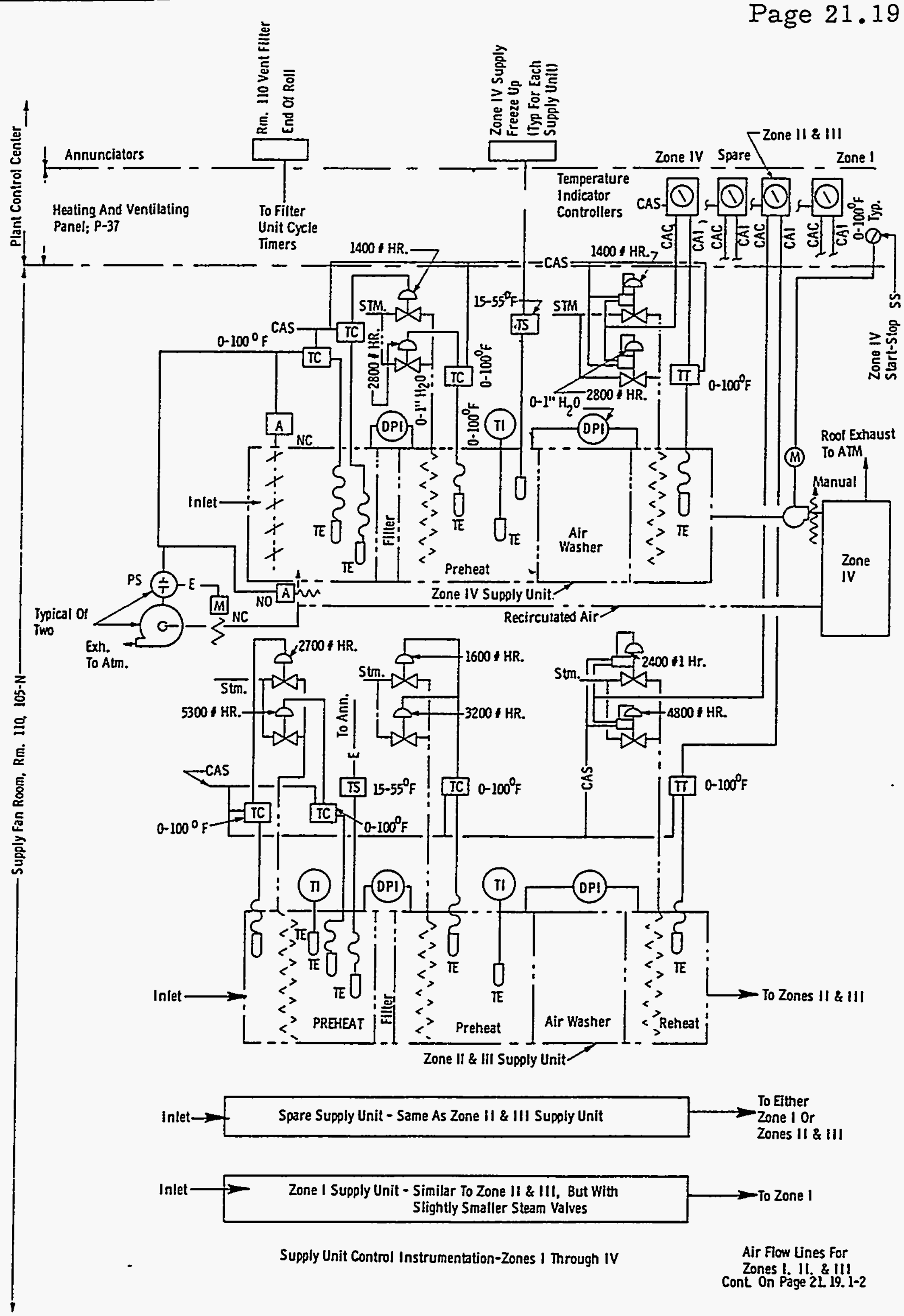
41. Move near (far) plug conveyor forward to replace shield plug.

Interlocks: Same as Step 3.

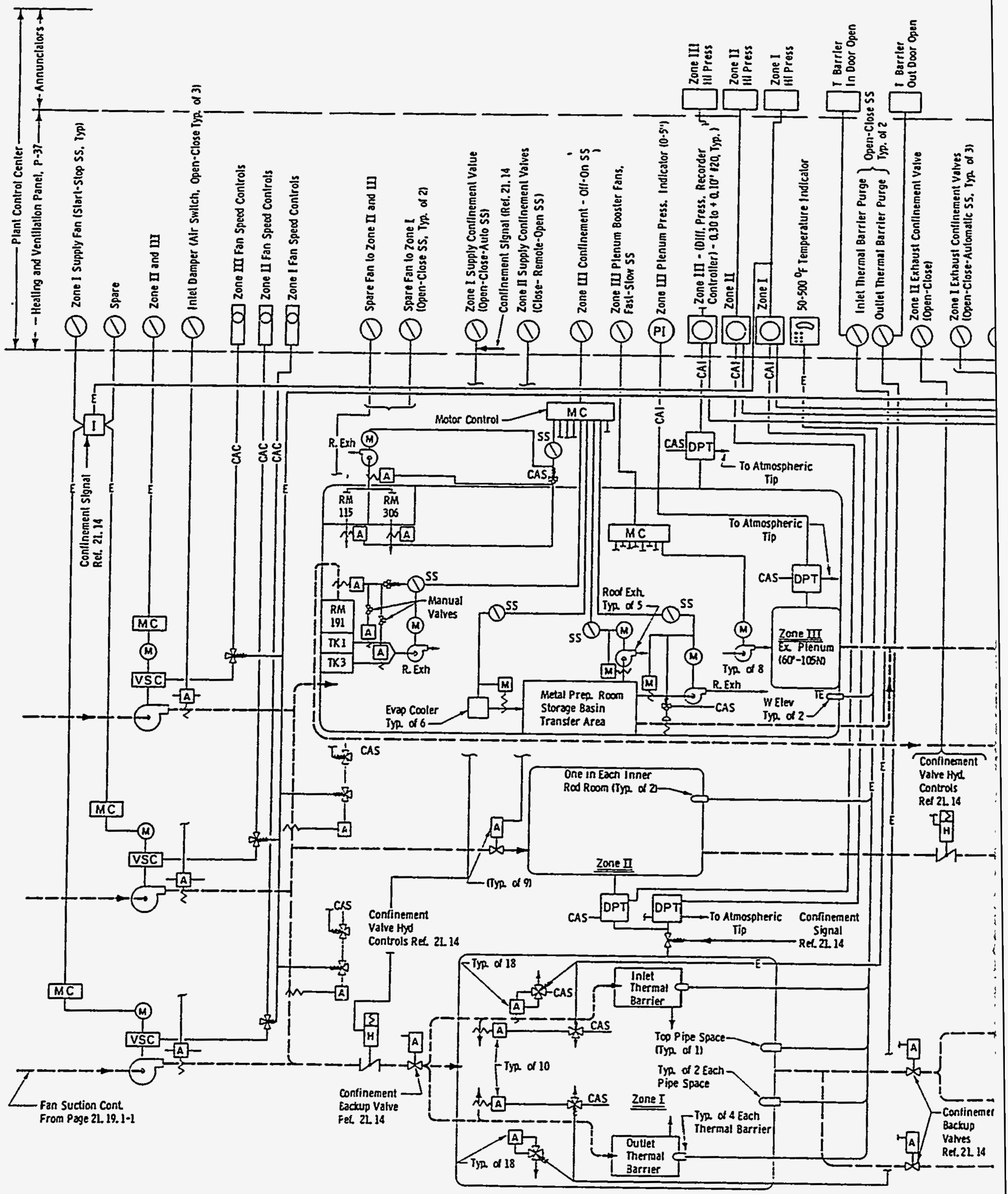
42. Lift and move near (far) plug conveyor backward - leaves shield plug positioned in wall.

Interlocks: Same as Step 4.

43. Repeat Steps 40, 41, and 42 the required number of times.



Supply Unit Control Instrumentation - Zones I Through IV
Heating and Ventilating Control System - 105N



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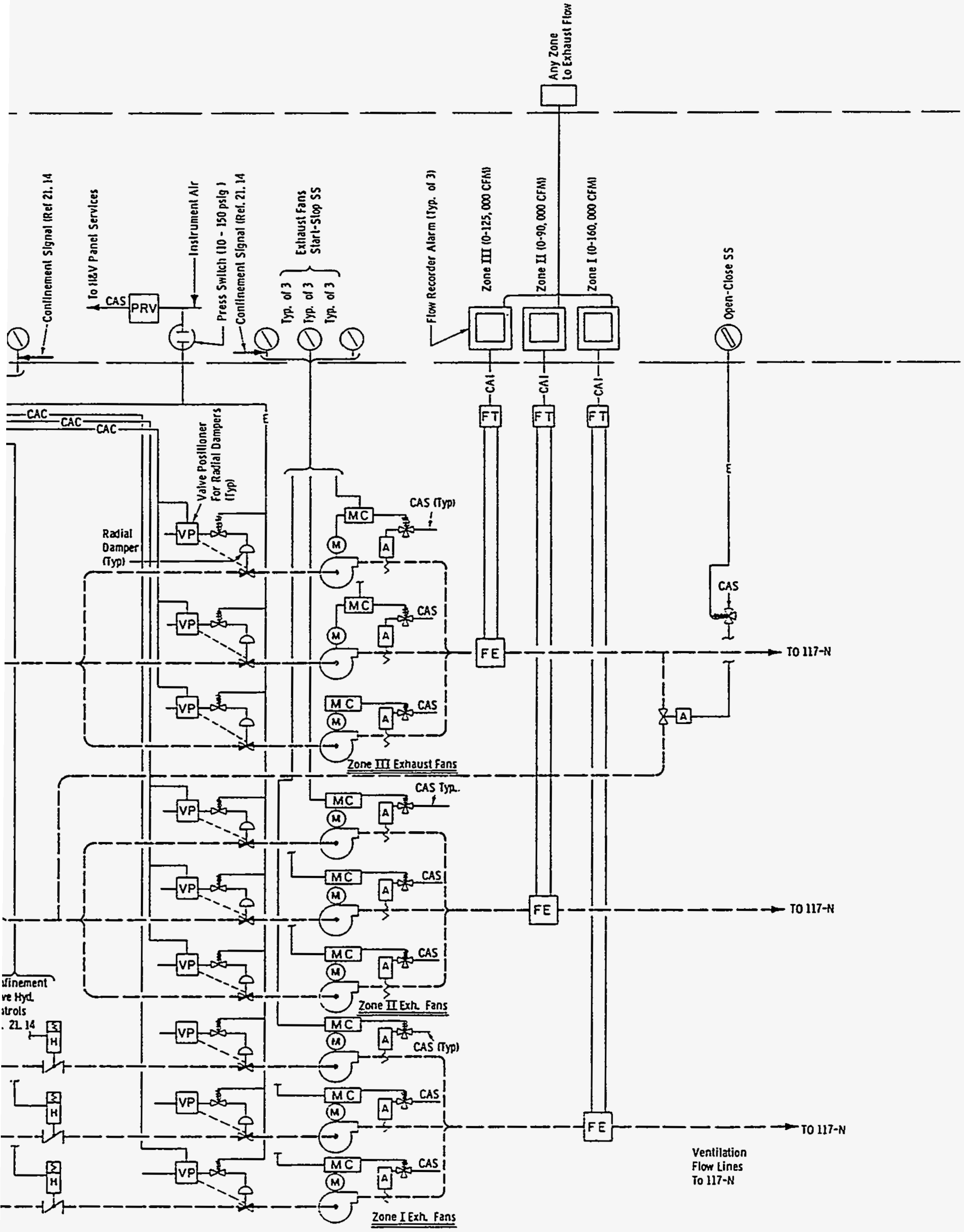

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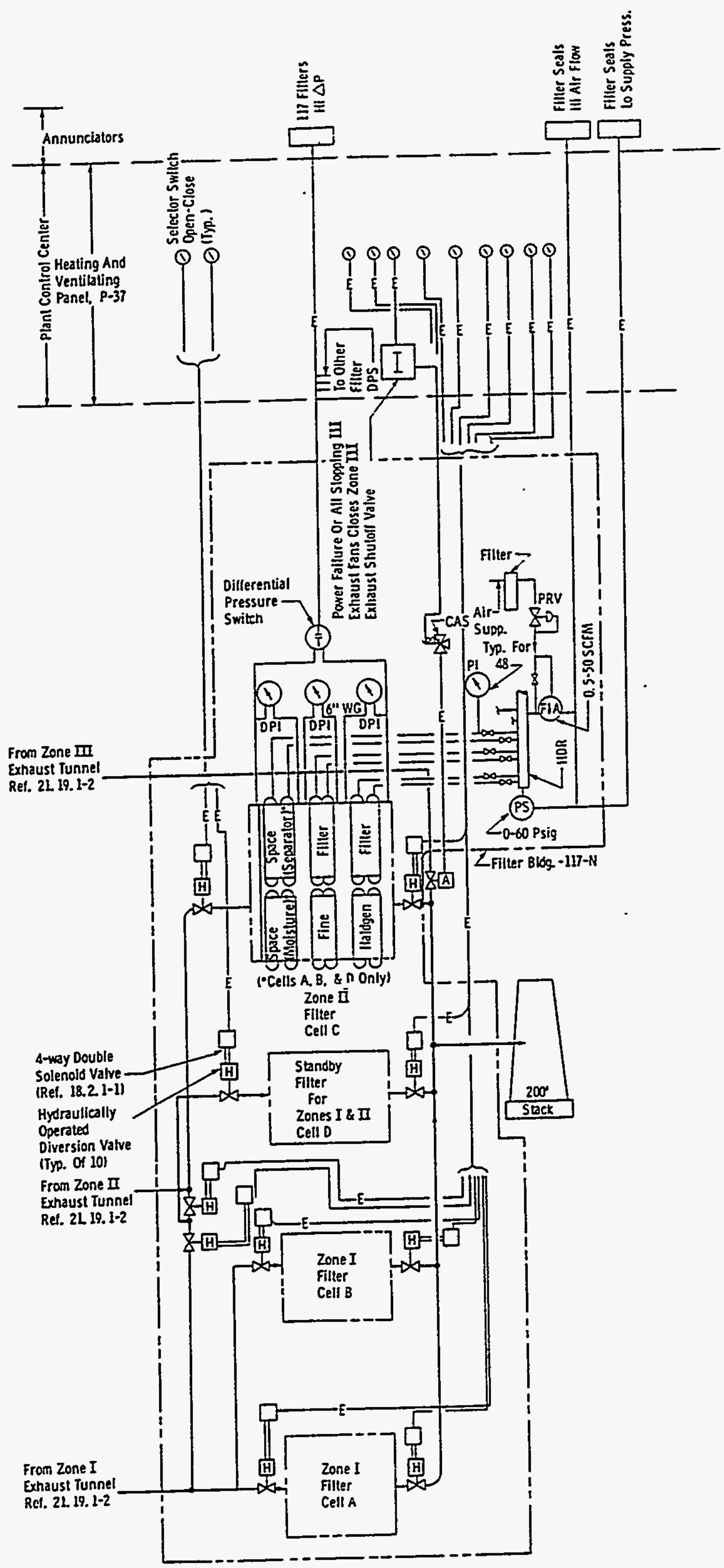
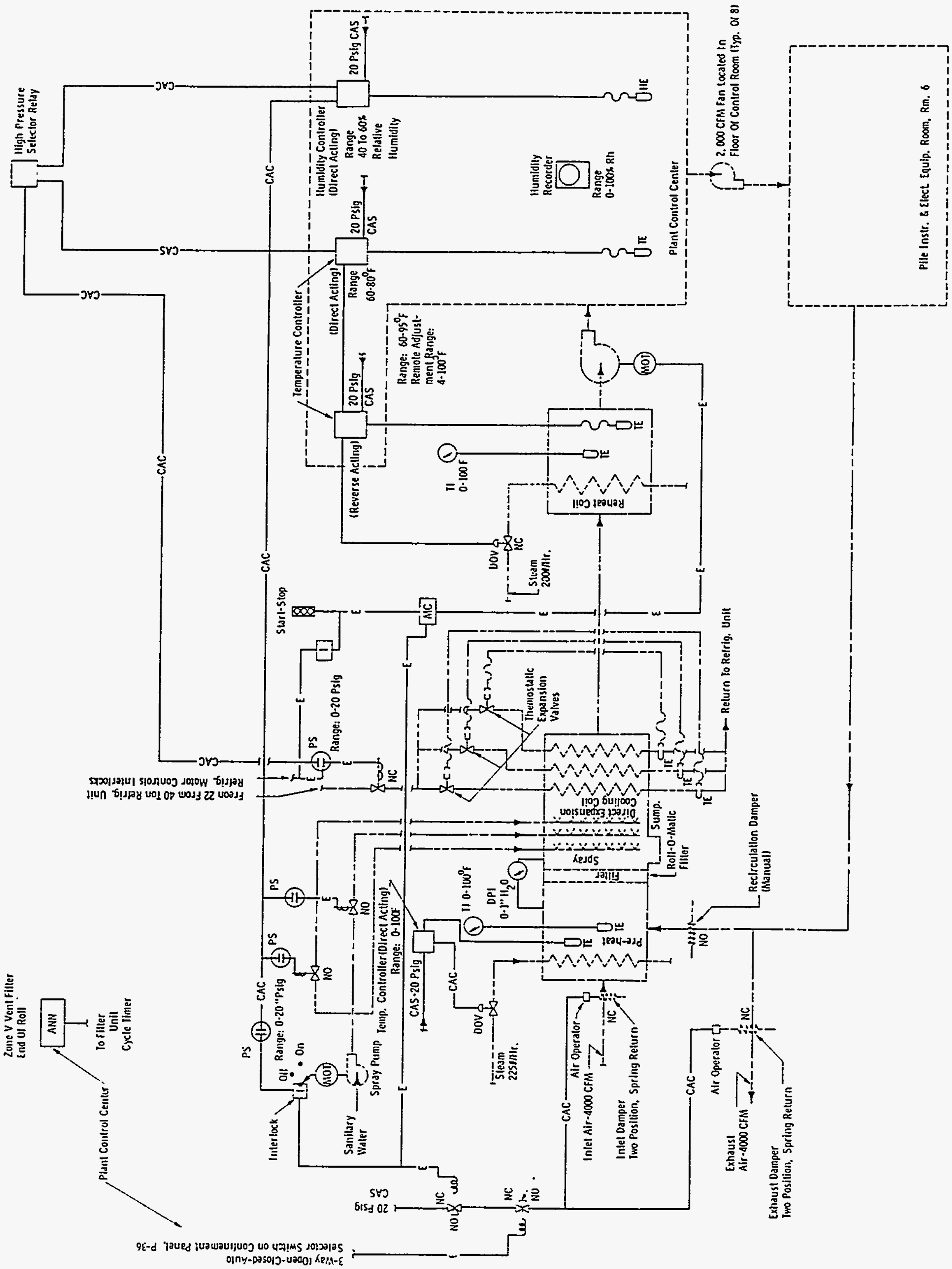
ontrol System - 105N



Exhaust Filter Instrumentation
Heating and Ventilating Control System - 105N



Zone V Air Conditioning Control Instrumentation
Heating and Ventilating Control System - 105N

HEATING AND VENTILATING CONTROL SYSTEM - 105N

The heating and ventilating control system for the five confinement zones in the 105N Building is designed to (1) control the quality of dust-free air circulated throughout the building by dry filtration of the inlet air; (2) control the temperatures in the five building zones; (3) control the pressures in Zones I, II, and III by maintaining a pressure differential between these zones so that the flow of air, where leakage occurs, will be towards Zone I; (4) control the release of contaminants to atmosphere by continuous filtration of the exhaust air from Zones I and II, and from Zone III when desired; and (5) include confinement features to maintain the confinement integrity of the building during any conceivable incident.

The heating and ventilating system assists in normal building contamination control and forms a vital part of the confinement system. The mechanical details and layout of the system are described in Ref. 18.1. The details for the systems instrumentation are as follows:

Supply Unit Control Instrumentation - Zones I through IV - The Zone I, II and III, and spare supply units have identical instrumentation with the exception that the Zone I steam control valves are slightly smaller. The Zone IV supply unit is similarly instrumented; however, there is only one stage of preheat, and controls are provided for partial recirculation.

In each of the four supply units, the first preheat coil is protected against freeze-up by means of a positive action thermostat with a remote bulb located in the fresh air intake. When the outdoor air temperature drops below 35°F, this thermostat causes snap-action operation of the one-third capacity steam valve supplying steam to the coil. A second thermostat with a remote bulb located down stream of the first preheat coil, modulates a second steam control valve to maintain the air temperature leaving the coil at approximately 40°F. As an added protection against freeze-up, a third thermostat, with a remote bulb located downstream of the first preheat coil, will actuate an annunciator in the plant control center when the air temperature drops to 34°F.

In each of the four supply units, Roll-O-Matic filters are used for continuous dry filtration of the building air supply. Each filter drive unit is controlled by two adjustable timers. The primary timer, based on the corresponding ventilation fan operating time, will initiate the filter cycle, and the duration of the cycle (movement of the filter curtain) is controlled by the second timer. When the filter media is exhausted, an annunciator is actuated in the plant control center, as well as indicating lights on the respective local filter media control box. A manual operation over-ride is then necessary to bypass the media limit controls, which interrupt the automatic cycle to insure that media will not be removed from the filter face, in order to replace the used filter. The filter units are placed in service with local on-off disconnect boxes.

The steam to the second preheat coil in each of the Zone I, spare, and Zone II and III supply units is regulated by a local temperature controller with adjustable proportional band and setpoint. This temperature controller modulates two steam valves in a two stage arrangement, the first valve being modulated until it is wide open before the second valve begins to open. The air temperature leaving the coils is controlled at approximately 55°F.

HEATING AND VENTILATING CONTROL SYSTEM - 105N (CONT'D)

The pump spray motors for the air washers in all four units are interlocked with their corresponding supply fan and start when their supply fan is started; however, no interlocks are provided for stopping these pump motors. A manual shutdown is necessary.

The air leaving the reheat coil in each of the four supply units is controlled to approximately 70°F by means of four indicator-controllers located in the plant control center. Two stage valve operation is used here as on the second preheat control.

The recirculation controls for Zone IV consist of a snap-acting thermostat, sensing incoming air temperature which will open the return air damper, close the exhaust dampers, stop the exhaust fans, and close the inlet damper to a preset minimum air position when the inlet air temperature drops below 60°F. The reverse action occurs when the temperature rises above 63°F.

Local temperature indicators are installed to indicate temperature of the air leaving each of the preheat coils in all four units. In addition, local differential pressure gages are installed across each filter and each air washer on all units.

Flow and Pressure Instrumentation - Zones I through IV - The flow of air to Zones I, and II and III is adjusted by means of variable-speed fluid-drive units. Remote manual controls are located in the plant control center on the 105 Heating and Ventilating Panel (P-37) for speed adjustment of these supply fans.

The adjustment of air flow to Zone IV is manual by means of a lever at the Zone IV supply damper.

The static pressures in Zones I, II, and III are automatically controlled to minus 0.4 to 0.5, 0.25 to 0.35 and 0.10 to 0.20 inches of water respectively. Zones I and III are each controlled with respect to atmosphere pressure, while Zone II is controlled with respect to Zone I by means of differential pressure indicating controllers located on P-37. These differential pressure indicating controllers modulate the radial inlet dampers of the exhaust fans to maintain the required differential pressures. All of the controllers have alarm trip contacts which annunciate on high pressure.

A special pressure sensing tip on the 105N roof is used to sense atmospheric pressure for the base reference for the above pressure control (it is also used for the base reference for the reactor gas pressure control).

The air flow from each of Zones I, II and III is measured by means of pitot-type flow elements in the exhaust tunnels. Flow is recorded on miniature strip chart recorders on P-37, and alarm contacts actuate a common annunciator upon low air flow from any zone. Air flow is not measured on Zone IV nor is pressure controlled. Zone IV is, therefore, essentially atmospheric.

Temperature Instrumentation - Zones I through IV - The air temperature leaving the supply units is controlled, as described above, at the temperature setpoint of the reheat controllers located on P-37. In certain portions of the supply ducts, steam is modulated to booster heaters to maintain the final air temperature in the spaces being supplied (see Ref. 18.1 for booster heater locations). A proportional action thermostat, using air as the control medium to control each booster heater, is located in the space being served so as to minimize convection and other local heat source effects.

HEATING AND VENTILATING CONTROL SYSTEM - 105N (CONT'D)

All unit heaters, with one exception, throughout the building are controlled by means of an On-Off type electric thermostat. The unit heaters serving Room 193 (Transfer Area are large capacity and are controlled by proportional action air operated thermostats, as in the case of the booster heaters.

The air temperatures in 25 selected locations in Zones I, II, and III are measured by means of thermocouples, and any single point may be switched to an indicator on P-37.

Confinement Interlocks and Controls - A confinement signal (see Ref. 21.14.2) will initiate the following events in the ventilation system, as shown on page 21.19.1-2.

1. The Zone I supply and exhaust fans stop.
2. The Zone I confinement valves close.
3. A valve closes in the sensing line to the Zone I differential pressure transmitters.

Other controls are vested in the ventilation system on the ventilation panel for confinement purposes. However, they must be manually actuated. They are:

1. Nine Zone II supply confinement valves are controlled with separate selector switches (Ref. 21.14.2) or as a group with a master switch on P-37.

2. The master Zone II exhaust confinement valve may be opened or closed with a selector switch on P-37.

3. All Zone III roof exhauster and evaporative cooler dampers can be closed from a single selector switch on P-37.

4. The confinement valves which close on a confinement signal have three-position selector switches on P-37 (open-close-automatic), and the valves can be manually opened or closed at any time, except for the Zone I supply confinement valve which can be opened only when the Zone I pressure is normal, but can be closed at any time.

Fan and Damper Controls - The following itemizes some of more important details for the ventilation fan and damper controls:

1. Supply and Exhaust Fans - Start-Stop controls for the Zone I, II and III, spare, and IV supply fans and auxiliary equipment are located locally and on P-37. This is also true for the Zone I, II, and III exhaust fans. The earlier mentioned interlocks with the confinement system apply as well to starting the fans as to tripping them. When supplying Zone I, the spare fan is subject to the same interlocks as the Zone I supply fan.
2. Supply Fan Discharge Dampers - These dampers are used to isolate the fan and prevent air from entering the unit when it is not operating. They are manually controlled from air switches on P-37 and do not operate in conjunction with the associated fan.
3. Supply Plenum Dampers - These are used to allow the spare fan to supply either Zone I or II and III and are controlled from selector switches on P-37.

HEATING AND VENTILATING CONTROL SYSTEM - 105N (CONT'D)

4. Exhaust Fan Discharge Dampers - These dampers operate automatically in conjunction with their associated fans. When the fan motor de-energizes, the dampers close. Zone I has an exception in that when all the exhaust fans stop, all dampers open.
5. Thermal Barrier Purge Doors and Pipe Space Dampers - During normal operation, air is delivered to the inlet pipe space through ten dampers (five each side). At such a time as it is desired to purge the spaces inside the thermo-barriers, these dampers are closed and eighteen purge doors (nine each side) are opened, admitting air directly to the spaces inside the thermal barrier by a selector switch on P-37. Ten dampers and eighteen purge doors are also located in the outlet pipe space. Their operation is the same as for the inlet pipe space. The controls for the thermal barrier foors and lower hinged panels are also on the same panel.
6. Zone III and IV Exhausters and Evaporative Cooler Discharge Dampers - These dampers operate automatically in conjunction with their associated equipment. When the fan motor is de-energized, the damper closes.

Instrument Air Failure - The loss of instrument air to the ventilation controls as listed below, will cause the specified actions to occur:

1. The exhaust air modulating radial dampers, controlling static air pressure for Zones I, II, and III, remain in the position held prior to air failure.
2. The supply and exhaust fan isolation dampers for Zone I, II, and III open on loss of air to the operator.
3. The Zone I, II, and III supply fan speed controls remain in the position held prior to air failure.
4. The supply plenum dampers remain in their position prior to the air failure.
5. The Zone IV and V supply isolation dampers open on air failure.

Electrical Power - The Zone I exhaust fans are powered from two sources in order to assure that at least one source of power is available for the two normally required fans during an outage of either power source. The normal Zone I supply fan is powered from the other source, thus making it possible to supply 100% of the Zone I air requirements upon failure of either power source. The normally used Zone II and III supply and exhaust fans are powered from a common source so that a failure of the power source causes all ventilation equipment serving these zones to stop. The spare Zone II and III exhaust fans are powered from two sources, to permit transfer to either source for maintenance operation.

Exhaust Filter Instrumentation (Ref. 21.19.1-3) - The pressure drop across each of the three filters in each of the 117N four filter sections is measured and indicated locally. The total pressure drop across each of the four filter sections is sensed by a differential pressure switch and a common annunciator actuated in the plant control center when the drop across any of the four exceeds a pre-set value.

Selector switches are provided on P-37 for the operation of the valves which provide emergency filtration of Zone III exhaust air, and for valve operation to put the Zone I emergency filter in operation when required, as well as to take any filter out of service.

The Zone III exhaust duct valve is interlocked with the Zone III exhaust fans to close when the fans are stopped.

HEATING AND VENTILATING CONTROL SYSTEM - 105N (CONT'D)

Zone V Air Conditioning Control Instrumentation (Ref. 21.19.1-4) - The control instrumentation for the Zone V air conditioning equipment automatically controls the temperature and humidity of the control room and of the instrument and electrical equipment room below the control room.

In general, an inlet air temperature controller regulates the steam flow to the preheat coils and controls the inlet air temperature. The air then passes through the filter and air washer. The water spray to the washer is controlled by the humidity controller so that, as the humidty in the control room increases, successive banks of sprays are turned off with the water spray pump being turned off last. If the humidity still exceeds the control point, further de-humidification is obtained by on-off control by the humidity controller of the refrigerant to the expansion cooling coils.

The temperature of the final control room air is controlled by modulation of the steam flow to the reheat coil, if heat is required, or by on-off control of refrigerant to the expansion coils, if cooling is required. A submaster type temperature controller, sensing temperature downstream of the reheat coil, controls the steam flow rate to the reheat coil. A master temperature controller, sensing the temperature of the control room air, remotely adjusts the setpoint of the submaster controller and also sends a control signal to a high pressure selector relay which selects the highest of the two signals from the control room temperature controller and the humidity controller for control of refrigerant to the expansion coils.

Other details of the control instrumentation for the system are as follows:

1. The start-stop controls for the Zone V ventilation fan are located in Room 143. The fan is powered from MCC-2A1.
2. The inlet and exhaust air dampers for Zone V are used to isolate this zone for confinement purposes or when the Zone V exhaust fan is not operating. The dampers are of the two-position spring-return, normally-closed, type, and are controlled by two three-way solenoid valves in the air supply line to the damper operators. One solenoid valve is controlled by a three-way selector switch (open-closed-auto) which, when in the automatic position, will interlock with the confinement trip circuit, (Ref. 21.14.2) and serve to close the solenoid valve on confinement trip, closing off control air and resulting in closure of the spring return inlet and exhaust air dampers. The other solenoid valve is interlocked with the Zone V ventilation fan's motor controls so that this solenoid valve is closed when the fan is stopped, again resulting in closure of the dampers.
3. The Roll-O-Matic filter cycle and movement are again controlled by two adjustable timers. The primary timer, based on the ventilation fan operating time, will initiate the filter cycle; and the duration of the cycle (movement of filter curtain) is controlled by the second timer. The filter media is driven by a 1/6 hp. motor powered from lighting panel L. Indicating lights on the filter control box indicate when the filter media is exhausted. A manual limit switch override is then needed to remove the media from the filter face for filter removal or servicing. The Roll-O-Matic filter is placed in service by an on-off automatic selector switch.
4. The spray pump motor is controlled by an on-off automatic selector switch, located in Room 143. The automatic position is interlocked with the motor controls

HEATING AND VENTILATING CONTROL SYSTEM - 105N (CONT'D)

for the Zone V ventilation fan and functions only when the fan is running to turn the pump motor on and off with a pressure switch actuated by the humidity controller in the plant control center.

5. The motor controls for the refrigeration compressor are interlocked with the motor controls for the Zone V ventilation fan and functions only when the fan is running to turn the compressor motor on and off in conjunction with a pressure switch actuated by the high pressure relay selector in the plant control center. Other compressor motor interlocks include a low oil pressure cut-out switch (with delayed timer) and refrigerant high discharge and low suction pressure cut-out switches.
6. A portable humidity recorder is used in the plant control center.
7. Duct air temperature indicators are located downstream of each bank of heating coils.
8. A local differential pressure indicator for the filter media is located in Room 143.
9. The eight, 1/6 hp. exhaust fans in the control room floor are powered from lighting panel L.

HEATING AND VENTILATING CONTROL SYSTEM - 109N

The heating and ventilating (H and V) control system for the four confinement zones in the 109N Building is designed to (1) control the quality of dust-free air circulated through the building by dry filtration of the inlet air; (2) control temperatures in the four zones and specific areas within; (3) control the pressures in Zones I, II and IV by maintaining differential pressures relative to Zone III so air flow, where leakage occurs, is towards Zone I; (4) control the release of contaminants to the atmosphere by system isolation and release to the 105 confinement system during any conceivable incident; (5) assist in normal contamination control. System mechanical details and controls are described in Ref. 18.3 and 21.19.2-1.

ZONE I CONTROL SYSTEM

Supply Fan Air Washers - The supply unit air washers (AW) are interlocked to start and stop with their associated supply unit. Selector switches for AW-1 and 2 are located on the 109N Heating and Ventilating Panel (HV). Failure of the running AW motor is annunciated at the HV Panel. Pump motor AW-1 is supplied from MCC No. 19 (BPA), and AW-2 motor is supplied from MCC No. 20 (TG).

Zone Dry Filters - As in the 105H and V system, the dry filters are of the Roll-O-Matic type. The filter drive unit is controlled by a locally mounted pressure switch which is set to maintain the operating differential pressure (DP) across the filter between 0.40 and 0.50 inches H_2O. When high DP is sensed, the filter media is automatically advanced until the normal DP is indicated. Fan filter high DP and filter media "end of roll" are annunciated at the HV Panel. Selector switches for the filters are located on the HV Panel. Electric power is supplied to filter drive motors from lighting panels "J" and "M" respectively.

Temperature Control - The steam supply to the preheat coil (PHC) and the heating coil (HC) in the No. 1 and 2 supply fan units is controlled by locally mounted temperature controllers (TC) 215, 216, 217 and 218. Low temperature (less than 55°F) downstream of the PHC is annunciated at the HV Panel by actuation of temperature switches TS-211 and 212. The PHC is designed to heat the inlet air from a -10°F to +55°F. The HC is designed to heat the washed air from 34°F to a maximum outlet temperature of 70°. Low supply air temperature (less than 70°) is annunciated at the HV Panel by actuation of TS-244 and 245.

Supplementary controls are provided to the supply fan temperature control system to maintain temperature and pressure in specific Zone I areas. Eight RTD's monitor local temperatures. One for each of the six cells and two for the pipe gallery. The cells temperatures are transmitted and indicated on the cell ventilation local panels (CVL) 2, 3, and 5 in the turbine drive bay area. The pipe gallery temperatures are transmitted and indicated on the pipe gallery local panel.

The eight temperature signals are transmitted to individual Bailey controllers (SV-211 through 218) on the HV Panel in the turbine bay area. Individual space temperatures can be maintained either automatically or manually from these controllers by the sequential operation of a steam supply valve and damper control in the individual space supply duct. High and low temperature switches actuate annunciators on the HV Panel for each of the eight areas.

HEATING AND VENTILATING CONTROL SYSTEM - 109N (CONT'D)

Pressure and Flow Control - Zone I is maintained at a negative pressure of -0.45" H_2O relative to Zone III. Zone I supply air duct pressure is referenced to Zone III. A DP transmitter (PT-304) and a DP indicator are on the PGL Panel. The DP signal supplies input to controller SV-219 on the HV Panel. This controller automatically or manually controls the DP by positioning the fan inlet vortex dampers on Zone I supply fans SF-1 and SF-2.

Zone I space pressure is also referenced to Zone III. A DP transmitter (PT-296) and a DP indicator are on the PGL Panel. This signal is the input to controller SV-220 on the HV Panel. This controller automatically or manually controls the DP by positioning the fan inlet vortex damper on the Zone I exhaust fans EF-3 and EF-4. A pressure switch (PS-241) actuates an annunciator on the HV Panel on low DP and trips the Zone I supply fans. The DP signal is also indicated and recorded on P-39 in the plant control center.

The -16' access corridor pressure in Zone I is also referenced to Zone III. A DP transmitter (PT-303) and indicator are located on the auxiliary cell ventilation local panel (ACVL) in the turbine drive bay area. This DP signal is the input to controller SV-221 on the HV Panel. This controller automatically or manually controls the DP by positioning the access corridor exhaust damper AD-6.

Supply and Exhaust Fan Interlocks - The selection for the operating and standby fans (supply and exhaust) is made by selector switches on the HV Panel. The fans are electrically interlocked so that the failure of either the operating supply or exhaust fan will automatically start the associated standby fan. The supply fans trip out if both exhaust fans fail. An automatic start of either standby fan and fan motor failure are annunciated at the HV Panel. The supply fans also trip out on low Zone I to Zone III DP, as discussed previously.

Confinement Actions - Zone I - In the event of a 109 confinement trip, the Zone I exhaust and supply fans are tripped and their associated dampers close.

ZONE II CONTROL SYSTEM

The Zone II supply and exhaust fans (SF-5 and SF-6, and EF-7 and EF-8) are electrically interlocked to provide 100% backup, the same as Zone I. The supply unit dry filters (F-3 and F-4), air washers (AW-3 and AW-4), and the preheat coils (PHC-13 and PHC-14) are controlled and annunciated the same as Zone I.

Temperature Control - Zone II temperature is monitored by RTD-247 in the 24" exhaust duct. Temperature transmitter TT-247 and an indicator are located on the PGL Panel. This signal is the input to controller SV-222 on the HV Panel which automatically or manually controls the steam supply valves (MPV-212-1 and 2) to the Zone II supply fan (SF-5 and SF-6) heaters. Two temperature switches actuate annunciators on either high or low service bay area temperature.

Pressure Control - Zone II supply air duct pressure is referenced to Zone III. A DP transmitter (PT-307) and an indicator are located on the PGL Panel. This signal is the input to controller SV-223, which automatically or manually controls the position of the Zone II supply fans (SF-5 and SF-6) inlet vortex dampers.

HEATING AND VENTILATING CONTROL SYSTEM - 109N (CONT'D)

Zone II space pressure is also referenced to Zone III. A DP transmitter (PT-305) and an indicator are located on the PGL Panel. This signal is the input to controller SV-224 on the HV Panel, which automatically or manually positions the Zone II exhaust fans (EF-7 and EF-8) inlet vortex dampers. A pressure switch, PS-242, actuates an annunciator on the HV Panel and simultaneously shuts off the Zone II supply fans on low DP pressure (high Zone II pressure).

Confinement Actions - Zone II - In the event of a 109 confinement trip, the Zone II exhaust and supply fans are tripped and their associated dampers close.

ZONE III CONTROL SYSTEM

Zone III is a recirculating system. Outside air temperature sensed downstream of the fresh air intake controls the operation of the AW-5 pump motor. Low inlet air temperature (less then 55°F) will stop AW-5, and high inlet air temperature will start it. Automatic start and stop of AW-5 is controlled by a locally mounted temperature switch (TS-216). Low temperature downstream of the PHC is annunciated at the HV Panel by TS-215. High filter DP is annunciated by PS-310.

In addition to the Zone III supply unit, 20 locally controlled reheat coils in the supply ducts supplement the zone heating system. RHC-19 through 25, which are controlled by TC-222 through 228, are designed to heat the supply air to 65°F maximum. RHC-26, 38 and 39, which are controlled by TC-249, 250 and 251 are designed to deliver air at 83°F maximum. RHC-27 through 36, which are controlled by TC-230 through 238 and TC-246, are designed to deliver air at 99°F to 102°F maximum. Recirculation of Zone III air through the supply system is controlled by temperatures sensed downstream of the supply unit HC and just upstream of main exhaust fan EF-10. When the zone exhaust temperature is decreasing to 60°F, the steam valves supplying the supply unit HC are automatically adjusted to heat the air to 55°F via TC-239 and 240.

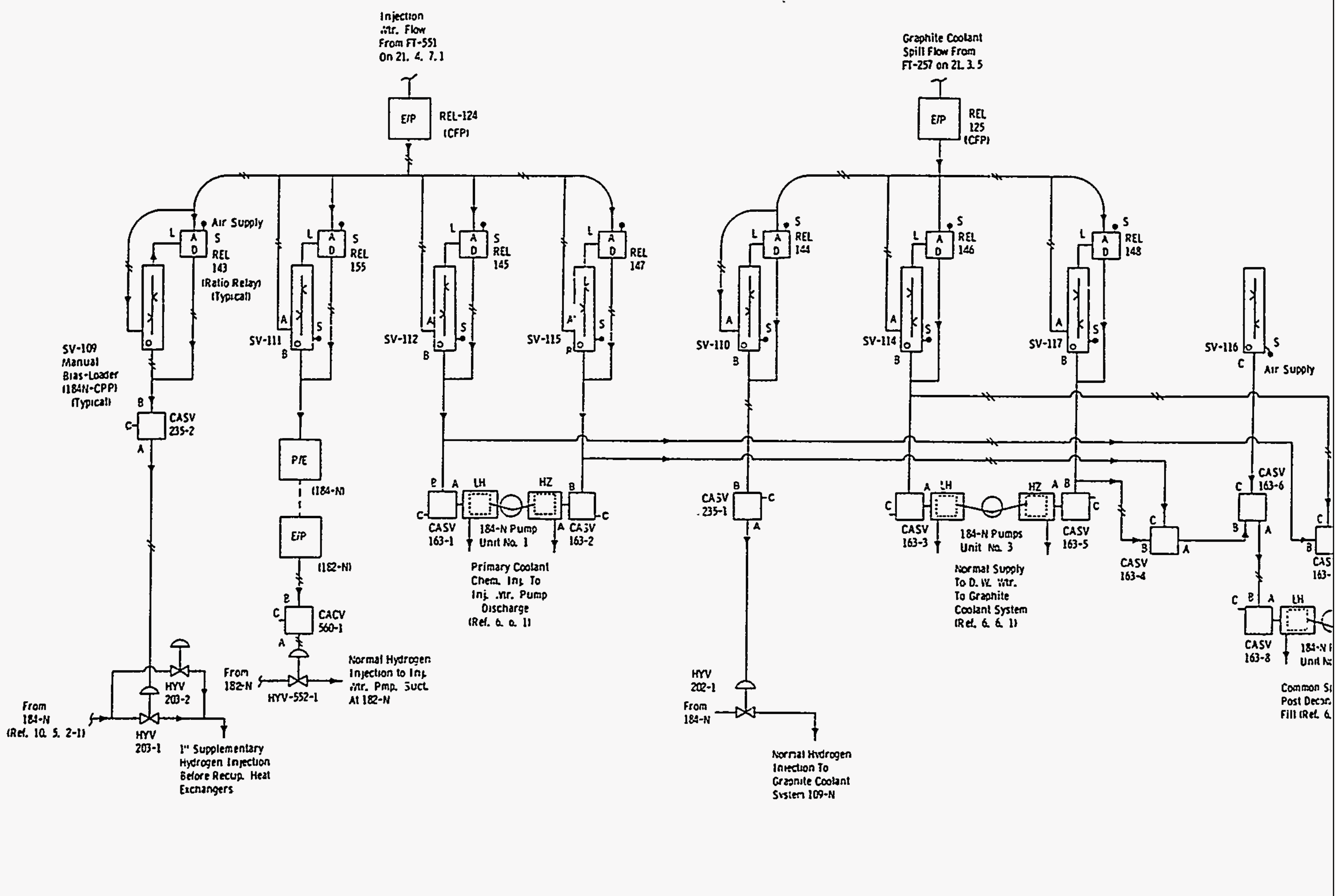
As the zone exhaust temperature drops below 60°F, the steam valves are adjusted to heat the air to 70°F. As the zone exhaust temperature increases to 75°F, the supply system discharge temperature is controlled to 70°F. When the zone exhaust temperature exceeds 75°F, the supply system discharge temperature is automatically reduced to 55°F. Signals from TC-239 and 240 also control the actions of automatic exhaust (AD-11), recirculation (AD-12-2), and fresh air intake dampers (AD-12-1). A duplex exhaust system, EF-11 and EF-12, serves the Hot Water Quality Laboratory rooms. Selector switches for the two fans are located on the HV Panel. One fan is normally in operation at all times. The fans are interlocked so that the standby fan will come on automatically on failure of the operating fan. The fan inlet vortex dampers are controlled by PC-214 located in Room 106. PC-214 senses atmospheric pressure and maintains the Hot Water Quality Laboratory areas slightly negative with respect to atmosphere as an aid in controlling possible contamination spread to other Zone III spaces.

ZONE IV CONTROL SYSTEM

Zone IV is served by a duplex exhaust system (EF-14 and EF-15). The fans draw air from the outside through a supply system consisting of a HC and a Roll-O-Matic type dry filter. The steam supply to the HC is controlled by TC-248, sensing temperature just downstream of the HC. High and low inlet temperature is annunciated on

HEATING AND VENTILATING CONTROL SYSTEM - 109N (CONT'D)

the HV Panel by TS-218 and TS-219, respectively. High filter DP is annunciated by action of locally mounted PS-311. Control switches for the F-6 motor and EF-14, 15 and 17 are located on the HV Panel. Zone IV pressure is also referenced to Zone III. A DP transmitter (PT-306) and indicator are mounted locally. This DP signal is the input to controller SV-225 on the HV Panel which automatically or manually controls the Zone IV exhaust fan (EF-14 and EF-15) inlet dampers. Pressure switch PS-312 actuates an annunciator on the HV Panel on low DP (high Zone IV pressure).



Chemical Injection Controls for P
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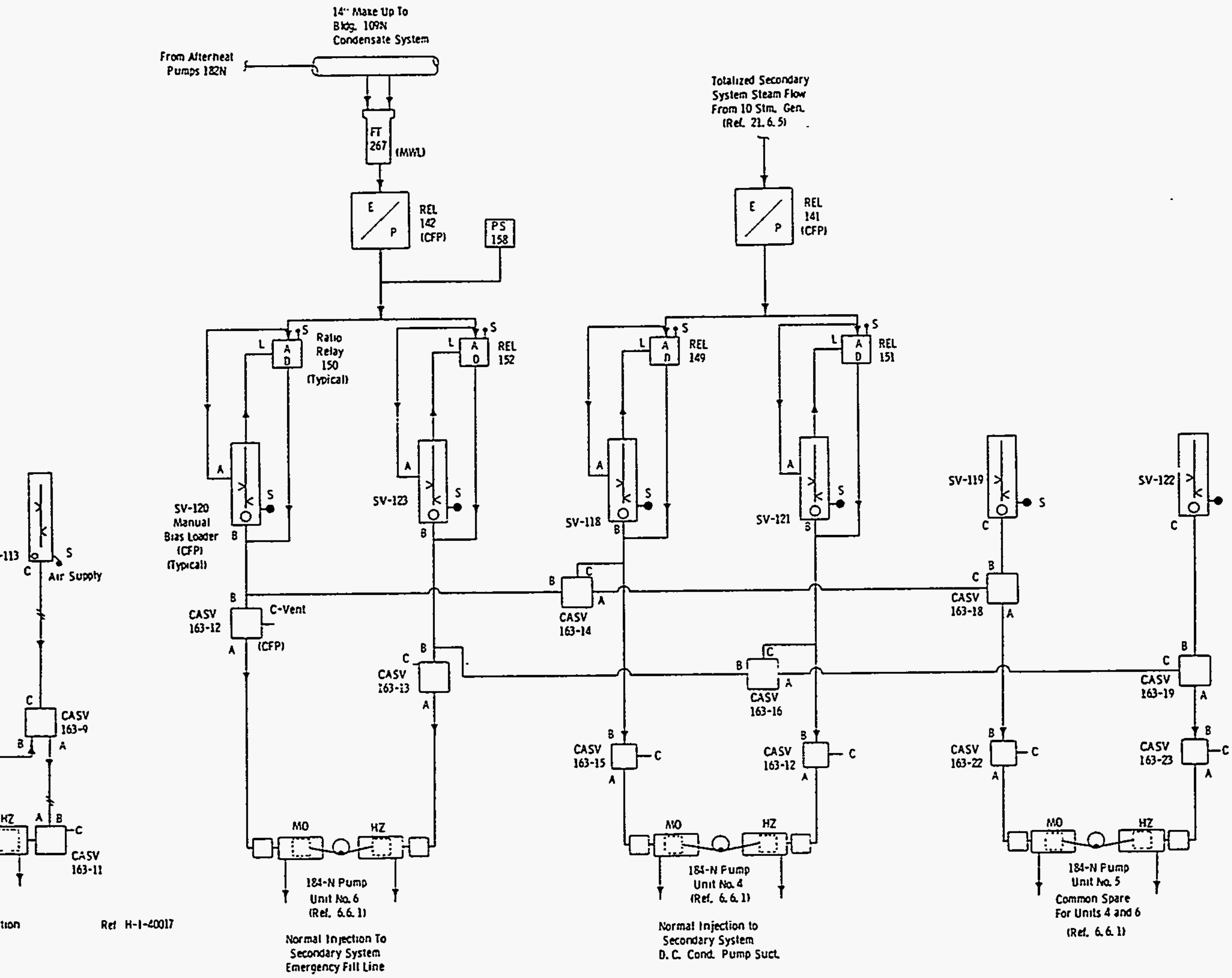


mary, Graphite, and Secondary
mination Systems

CHEMICAL INJECTION CONTROLS FOR PRIMARY, GRAPHITE, AND SECONDARY COOLANT, AND DECONTAMINATION SYSTEMS

This system provides controls for the injection of hydrogen (H_2), lithium hydroxide (LH), hydrazine (HZ), and morpholine (MO) for water quality control as follows:

	System	Chemicals	Inj. Unit or Valves
(1)	Primary coolant at high pressure injection pump discharge header	(a) LH and HZ (b) H_2	(a) Unit #1 (b) HYV-203-1 and 2
(2)	Primary coolant at high pressure injection pump suction header	H_2	HYV-552-1
(3)	Graphite coolant at low pressure injection pump discharge header	(a) LH and HZ (b) H_2	(a) Unit #3 (b) HYV-202-1
(4)	Same as 1 or 3, or decontamination system downstream of ion exchanger	LH and HZ	Unit #2
(5)	Secondary coolant at dump condenser condensate pump suction and normal makeup headers	MO and HZ	Unit #4
(6)	Secondary coolant emergency fill and water-to-water supply header	MO and HZ	Unit #6
(7)	Same as 5 or 6	MO and HZ	Unit #5

Switches are provided on the chemical feed panel in 184-N for starting the pumps and actuating the solenoid valves of this system. The outputs of the pumps vary from 0 to 100% according to the length of piston travel which is adjusted by the loading signal. Unit #2 (#5) can be selected for use in conjection with either of units #1 (#4) or #3 (#6), with loadings from the biasing loaders of units #1 (#4) or #3 (#6). Unit #2 can also be used for injection into the decontamination system with loadings from separate setpoint manual loaders; and unit #5 can be selected for manual control with loadings from separate setpoint manual loaders.

In most cases the amount of chemical injection is established by pre-determined ratios between the chemical and some measured variable, and this ratio may then be biased by manual loaders. Units 2 and 5 when selected for the decontamination system and manual control respectively, are the exceptions; and chemical injection from these units is then according to the setpoints of manual loaders as noted above. The measured variables for each system are as follows:

	System	Measured Variable
(1)	Primary coolant system	Primary coolant total injection flow
(2)	Graphite coolant system	Graphite coolant spill flow
(3)	Secondary coolant system (normal)	Total steam flow to 46" header
(4)	Secondary coolant emergency and water fill	Emergency and water-to-water fill flow

SYSTEMS DESCRIPTIONS

SECTION 22

N REACTOR PLANT GLOSSARY

AND LEGENDS

N REACTOR PLANT GLOSSARY

A. - Atomic weight.

Absorber - (1) A sheet or other body of material placed between a source of radiation and a detector for purposes such as: (a) determining the nature or energy of radiation; (b) reducing intensity of the radiation at the detector, as in shielding; or (c) giving the radiation some desired characteristic, as by preferential transmission of one component of the radiation. (2) In a nuclear reactor, a substance that absorbs neutrons without reproducing them. Such a substance may be useful in control of a reactor (see absorption control) or, if unavoidably present, may produce an undesired impairment in neutron economy. Neutron absorption is an important function of the shield surrounding a reactor.

Accumulator - A device for storing energy. These usually take the form of a liquid stored in a vessel under gas pressure for the purpose of providing emergency, short term hydraulic power.

An accumulator is also located in the 182-N Building on the fog spray system to provide water pressure until the diesel engines start and accelerate to required pumping speed.

Active Tube - A reactor (or pile) process tube which contains a charge of fissionable material. The term is applied almost exclusively to reactor process tubes containing uranium fuel.

Active Zone or Region - The volume of the pile bounded by the ends of the uranium columns (front and rear) and by planes one-half lattice unit beyond the row and column centerlines (top, bottom, right and left).

ADC - Analog Digital Converter - An instrument which converts process tube temperature and flow signals into digital form for recording.

Air Systems - The following compressed air systems are supplied by compressors in N Plant.

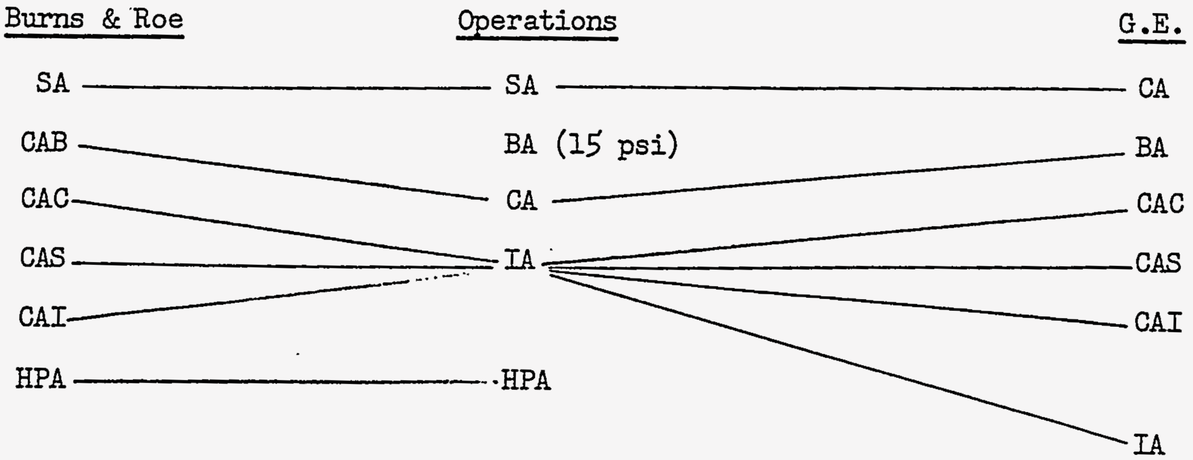
Burns & Roe Dwg. Legend	Service	Pressure	Type	Use
SA	Service Air	115	Not oil or water free	Power tools - Other uses when reduced
CAB	Breathing Air	115	Oil free, not dried	General
CAC	Compressed Air from Inst. PRV to Primary Inst.	115	Oil free, dried	Inst.
CAS	Control Air System	115	Oil free, dried	Inst.
CAI	Inst. Air to Ignition Oil Day Tank	115	Oil free, dried	Inst.
HPA	High Pressure	615		Starting air

N REACTOR PLANT GLOSSARY (CONT'D)

G.E. Dwg. Legend	Service	Pressure	Type	Use
CA	Compressed Air	150	Not oil or water free	
BA	Breathing Air	150	Oil free, not dried	General
CAC	Control Air	Varies	Oil free, dried	Inst.
CAS	Supply Air	Varies	Oil free, dried	Inst.
CAI	Signal Air	Varies	Oil free, dried	Inst.
IA	Instrument Air	Varies	Oil and water free	All instruments

Operations Usage

SA	Service Air	100-150	Not oil or water free	Power Tools
CA	Compressed Air	100-150	Oil free	When dried for instruments. Breathing air when reduced.
IA	Instrument Air	0-60	Oil & water free	All instruments
BA	Breathing Air	15	Oil free-reduced in pressure to 10	Breathing fresh air
HPA	High Pressure Air	615	Not oil or water free	Diesel starting air



Air Tube - A reactor process tube channel which is disconnected from the coolant water supply and which may or may not contain an empty or unloaded process tube. (Also referred to as an air channel or blank channel if the tube has been removed.)

Alpha emitter - A radionuclide that undergoes transformation by alpha-particle emission.

N REACTOR PLANT GLOSSARY (CONT'D)

Alpha Particle - A positively charged particle emitted from a nucleus and composed of two protons and two neutrons. It is identical in all measured properties with the nucleus of a helium atom.

Apparent Period - The time required for the neutron flux to increase by a factor of e as a result of two effects: (1) Actual pile multiplication due to a given reactivity status and (2) Increasing neutron background level due to decreased neutron absorption by controls.

The stable period reflects only the first effect; the apparent period decays to the stable period after control movement stops.

The reactor period is by definition

$$\frac{\theta}{d\theta dt} \qquad \frac{\text{(Flux}}{\text{(Change in flux with time)}}$$

For the apparent period θ/dθdt is the sum of the two effects described. Therefore, the apparent period must always be shorter than the stable period.

Atomic Mass - The mass of a neutral atom of a nuclide. It is usually expressed in terms of the physical scale of atomic masses, that is, in atomic mass units. The atomic mass unit, amu, is exactly one-sixteenth of the mass of a neutral atom of the most abundant isotope of oxygen, O^{16}; 1 amu = 1.657×10^{-24} gm = 931 Mev = 0.999728 awu. (See atomic weight.)

Atomic Number - An integer Z that expresses the positive charge of the nucleus in multiples of the electronic charge e. In present theory, it is the number of protons in the nucleus and also equals the number of electrons outside the nucleus of the neutral atom.

Atomic Weight - The weighted mean of the masses of the neutral atoms of an element expressed in atomic weight units. Unless otherwise specified it refers to a naturally occurring form of the element. The atomic weight unit, awu, is exactly one-sixteenth of the weighted mean of the masses of the neutral atoms of oxygen of isotopic composition found in fresh lake or rain water; 1 awu = 1.660×10^{-24} gm = 1.000272 amu.

Attenuation - (1) In radiation theory, the reduction in the flux density, or power per unit area, with distance from the source; it may be due to absorption, to scattering, or to both processes. (2) In nuclear physics, the reduction in the intensity of radiation upon passage through matter; in general, caused by a combination of scattering and absorption.

Augmentation Distance - A distance beyond the active zone of a reactor at which the neutron flux extrapolates to zero. The extrapolation is made by fitting a cosine or bessel function to data taken in the active zone.

N REACTOR PLANT GLOSSARY (CONT'D)

Background - Ever-present effects in physical apparatus above which a phenomenon must manifest itself in order to be measured. "Background" can take various forms, depending on the nature of the measurement. In electrical measurements or radioactivity and nuclear phenomena, the term usually refers to those undesired counts or currents that arise from cosmic rays, local contaminating radioactivity, insulator leakage, amplifier noise, power-line fluctuations, and so on. In nuclear work and photographic emulsions, the term refers to developable grains unrelated to the tracks under investigation.

Back-seat - Any means by which the material (charge) in a reactor process tube is moved toward the upstream (or front-face) end of the tube.

Back-up - A secondary system which functions upon loss of the normal system.

Ball Safety System - A safety system that when activated will drop a hopperful of boron-steel or equivalent ceramic balls into each vertical ball channel from a hopper mounted at the top of each channel.

Barn - The unit of area used in expressing a nuclear cross section. 1 barn = 10^{-24} cm^2.

Barrier - See Inlet Barrier Wall and Thermal Barrier.

Beta Particle - A negative electron or a positive electron (positron) emitted from a nucleus during beta decay.

Biological Shield - A shield used to reduce the intensity of radiation transmitted to an amount physiologically permissible. (See Primary Reactor Shield.)

Blackness - That characteristic of a material describing the probability that a thermal neutron incident upon it will be absorbed, expressed in Barns.

Blowback - A term referring to the difference between the opening and reclosure pressure of a relief valve - sometimes referred to as blowdown.

BPF - An abbreviation for Blue Print File. The term generally indicates a file of manufacturers; literature, blueprints, and performance curves for a particular piece of equipment. These files are assigned a BPF file number and are kept in the BPF file.

Bottom Shield - The bottom shield consists of two layers of concrete. A layer serpentine concrete 17" thick is nearest the core and 96" of structural concrete is below the serpentine layer. The serpentine concrete can withstand temperature of 100 C.

Brine Chiller - A packaged chiller for the gas facility refrigeration system in 105-N used to cool the gas leaving the reactor under certain emergency conditions. It has a capacity of 15 tons, cooling 24 gpm of "brine" from 46°F to 32°F when supplied with 70°F condensing water. The "brine" used in the system is 20% (by volume) methyl alcohol.

N REACTOR PLANT GLOSSARY (CONT'D)

Buckling - A measure of the curvature of the neutron density distribution. (See Principles of Nuclear Reactor Engineering, Glasstone, p. 170.)

Burn-up - Conversion of atoms by neutron bombardment; the term may be applied to fuel or other materials.

Cadmium Ratio - The ratio of the neutron-induced saturated activity in an unshielded foil (thermal + fast neutrons) to the saturated activity of the same foil when it is covered with cadmium (fast neutrons).

Canister - A fuel element container used for storing irradiated metal in the storage basin.

Cell - Any one of six rooms housing portions of the primary cooling system or the moderator cooling system and with heavy concrete walls for radiation shielding or pressure confinement. Each of the five primary cooling system cells contain two steam generators (in parallel), a circulating pump and associated piping, valving and instrumentation. The sixth cell contains three recirculating pumps and four heat exchangers for the moderator cooling system.

Central Data Logging System - A system which records data from several processes and miscellaneous measurements not requiring continuous monitoring. Included are: Reactor thermocouples, control rod outlet water temperature and Building 109-N data.

Ceramic Balls - Balls used in the ball safety system, composed of an aluminum matrix containing a minimum of 0.345 grams of natural samarium oxide per cubic centimeter.

Charge - The fissionable material or fuel placed in a reactor (or process tube) to produce a chain reaction; to assemble the charge in the reactor.

Chain Reaction - A reaction in which one of the agents necessary to the reaction is itself produced by the reaction so as to cause like reactions. In the neutron-fission chain reaction, a neutron plus a fissionable atom causes a fission resulting in a number of neutrons which in turn cause other fissions.

Channel - That instrumentation deriving a signal from a given primary detector.

Chemicals - The following chemicals are used in N Plant:

Water Treatment

Alum - A water solution of $Al_2(SO_4)_3$ added to water to cause coagulation of turbidity.

Chlorine - Cl_2 - A poisonous gas received in the liquid state and used for control of algae and other water organisms.

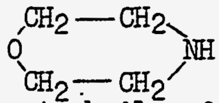
Disodium Phosphate, Na_2HPO_4 - A white highly alkaline solid used to control scale formation in steam generators in case of raw water leakage into the system.

N REACTOR PLANT GLOSSARY (CONT'D)

Chemicals (Cont'd)

Hydrazine, N_2H_4 - A powerful reducing agent added to the condensate returning to the steam generators to maintain zero oxygen. It is also used, during reactor shutdown, in the primary cooling system and the graphite moderator cooling system to control oxygen.

Lithium Hydroxide, LiOH - A white, highly alkaline solid used for pH control in the primary loop and graphite cooling system.

Morpholine -  - An alkaline colorless liquid which may be used as an additive to boiler feedwater and the secondary coolant system to maintain required pH.

Ammonium Hydroxide - NH_4OH - A colorless alkaline liquid with strong ammonia odor which may be used to control pH in secondary coolant system (may be used in primary coolant system also).

Separan - A white granular solid; it is a partially hydrolized polyacrylamide used as a filter aid.

Sodium Dichromate $Na_2Cr_2O_7$ - An orange colored, mildly acid solid, used as an inhibitor against corrosion primarily in HCR's and storage basin water treatment.

Sodium Hydroxide - NaOH - A light amber colored liquid, used for the regeneration of demineralizer anion resins and solution preparation for decontamination purposes.

Sodium Sulfite - Na_2SO_3 - An anhydrous cream-colored powder prepared in solution as an additive to filtered water for the reduction of oxygen concentration when used for reactor once-through cooling.

Sulfuric Acid - H_2SO_4 - A liquid used in the regeneration of demineralizer cation resins.

Decontamination - The following chemicals are used for dissolving ruptured slug material:

Hydrogen Peroxide H_2O_2 - A strong liquid oxidizing agent.

Sodium Bicarbonate $NaHCO_3$ - A white mild alkaline solid.

Sodium Carbonate Na_2CO_3 - A white mild alkaline solid.

Duponal - A white solid detergent.

8-Hydroxyquinoline - An organic material.

EDTA - Ethylene Diamine Tetra Acetic Acid - A white solid complexing material.

N REACTOR PLANT GLOSSARY (CONT'D)

Chemicals (Cont'd)

Corrosion Product Removal Agents

Potassium Permanganate $KMnO_4$ - A purple solid strong oxidizing agent.

Sodium Hydroxide - See description under water treatment.

Turco 4512 - A liquid phosphoric acid solution with additives.

Turco 4306C - A solid sulfamic acid mixture with additives.

Wyandotte 1112 - This is a powdered acid sodium bisulphate mixture with additives.

Chemical Waste Tank - A vessel to collect and/or store waste radioactive decontamination chemicals.

Circulating Raw Water System - The system which removes the waste heat from the condensers and rejects it to the Columbia River. Four river water pumps provide water through two large steel pipes to the 109-N Building. This water is delivered to each of 16 dump condensers and each of five turbine condensers, the turbine-generator set condenser in 184-N, as well as to 183-N Building for the filter plant.

Cold Clean Reactivity - (Which may also be noted as: CC_R or R_{CC}) The excess reactivity that a cold, xenon-free pile would have if there were no control or safety rods inserted, no poison columns, and no flattening material. The value, as commonly used, includes the enrichment in the pile at the time and assumes that all other columns are charged with (irradiated) natural uranium. The initial cold clean reactivity is the excess available when the pile was first completely loaded with every tube containing natural uranium. It is the difference between the material and geometrical bucklings.

Cold Start-Up - (1) Initial cold start-up; any attempted start-up while the pile reactivity is increasing. (2) Secondary cold start-up; any attempted start-up while pile reactivity is decreasing, and if the outage continued, the excess reactivity would eventually fall to not less than 100 c-mk. An example of (1) is any start-up after the minimum downtime; an example of (2) is a start-up after a scram before the pile has operated very long.

Collision - A close approach of two or more objects (particles, photons, atomic or nuclear systems) during which an interchange of quantities such as energy, momentum, and charge takes place.

Collision, elastic - A collision in which there is no change either in the internal energy of each participating system or in the sum of their kinetic energies of translation.

Collision, inelastic - A collision in which there are changes both in the internal energy of one or more of the colliding systems and in the sums of the kinetic energies of translation before and after the collision.

N REACTOR PLANT GLOSSARY (CONT'D)

Communications - The following communications systems are provided for N Plant:

1. GPT - General Plant Telephone System.
2. PAX - Private Automatic Exchange - Telephone and paging system.
3. CAC - Contaminated Area Communications System 105-N.
4. HCC - Contaminated Area Communications System 109-N.
5. WPC - Water Plant Communications System.
6. DL - Emergency Sound Powered Communications System.
7. KLX - Klaxon Evacuation Alarm System.
8. RTC - Radiation Timekeeping Communications System.
9. TV - Closed Circuit Television System.
10. MC - Maintenance Communications System.
    a. I - Instrument System.
    b. E - Electrical System.
    c. L - Elevator System.
    d. C - Control Rods and Ball System.
    e. T - Television Audio System.
    f. G - Gas Leak Detection System.
    g. P - Pumping Plant System.
    h. H - 109-N System.
    i. R - Riser Pump House System.
    j. S - Turbo-Generator System.
    k. W - Water Treatment System
11. FA - Fire Alarm System.
12. HIT - Health Instrument Telemetering.
13. EC - Elevator Communications System 105-N.
14. BRC - Ball Return Communications System.
15. TSC - Two Stations Amplified Sound System 105-N.

Condensers - The apparatus for condensing reactor steam as a part of the over-all heat dissipation system. In addition to numerous small condensers there are 16 "dump" condensers and six "turbine" condensers cooled by untreated Columbia River water.

Conductivity Analyzer - An electrical instrument used to measure the electrical resistance (or conductivity) of water of relatively high purity. The instrument is usually calibrated in terms of ohms per square centimeter per centimeter or in mhos (the reciprocal of ohms) per square centimeter per centimeter.

Confinement - The confinement system is provided to protect the reactor plant environs from unacceptably high levels of radioactive contamination under all credible combinations of reactor mis-operation and equipment failure. The system will also provide protection for operating personnel. Confinement does not require a continuous pressure shell around the reactor as in the case with containment, but instead uses a concept of positive air flow from the vicinity of the reactor through particulate filters and halogen removers with fog spray provided at the discharge face of the reactor.

N REACTOR PLANT GLOSSARY (CONT'D)

Control Rod - Any rod used to control the reaction rate in a nuclear reactor. The rod accomplishes this by changing the effective multiplication constant and hence the reaction rate's time derivative.

Control System Components

Adjustable Power Supply, Adjustable Bias Supply, Fixed Power Supply - These power and bias supplies receive regulated 118 volts a-c and deliver d-c outputs for various services in electric control systems. Each supply is a standard Bailey module two units wide, suitable for plugging into a standard cabinet mounting case. Supplies are furnished with one, two, or three independent output circuits.

Auto-Balance Selector Stations - Auto-Balance Selector Stations are used to transfer an electric control system from manual to automatic and from automatic to manual control without requiring manual balancing of the controller and manual signals before transfer. Each type of Auto-Balance Selector Station also provides the means for manual control of the control system when in the HAND position.
The Type RU1 Selector Station includes an independent, manually-controlled set-point voltage (-25 to +25 volts d-c range) for establishing the control set-point for the system. The Type RU2 Selector Station provides only the transfer and manual control features listed above. The Type RU3 Selector Station also includes an independent, manually controlled power supply which is used to bias (increase or decrease) the signal to the final control element when in the AUTO position.

Averaging Control Action Unit - The averaging control action unit totalizes up to four input variables, and produces an output voltage which is the average of the input signals.

Control Action Units - A control action unit is an electronic computing relay designed to receive an electric control system signal, or signals (-25 to +25 volts d-c range), from a transmitter, controller, or other action unit and produce an output signal which is some function of its input signal or signals. Included are Proportional and Summing, Proportional Plus Reset, Rate, and Time Lag Control Action Units.

D-C Operational Amplifier - The D-C Operational Amplifier, which is used with each type of Bailey Control Action Unit, consists of a printed circuit assembly and four transformers mounted integrally with the specific unit. The amplifier itself is identical for each type of Action Unit. Different feedback and input networks convert the amplifier to a summing, proportional, reset, rate or other type of Control Action Unit.

Demodulator - The demodulator is used with various Bailey Meter Co. electric transmitters to produce an output d-c voltage representing core position within a movable core transformer in the transmitter. The output signal, from the ± 25 volts d-c demodulator, is thus proportional to the measured variable.

N REACTOR PLANT GLOSSARY (CONT'D)

Control System Components (Cont'd)

Electric-Pneumatic Converter - The electric-pneumatic converter is used to convert a d-c voltage signal ranging from -25 to +25 volts d-c to a proportional pneumatic control pressure ranging from 3-27 psig, 5-25 psig or 3-15 psig. The pneumatic control signal is used to operate a pneumatic control drive or valve operator.

Fixed Signal Limiter and Power Supply - The fixed signal limiter and power supply is a device which can limit an electric control signal (± 25 volts d-c) and place a bias on this signal.

Low Level AC-DC Signal Converter - The Transistorized Low Level AC-DC Signal Converter converts an A-C millivolt input into a standard ± 25 volt D-C output signal, without the use of receiving units or retransmitting elements.

Manual-Balance Selector Stations - Type RU Manual Balance Selector Stations provide indications and controls necessary for remote manual operation of an electric control system and for transferring from hand to automatic operation. These selectors may be used in single or multi-element electric control systems which have a signal range of -25 volts to +25 volts d-c.

Servo-Follower - The Servo-Follower is normally used in the control system with an automatic-balance type Selector Station and an Electric-Pneumatic Converter to provide a smooth transfer when going from hand to automatic operation and vice versa. The module also provides the control signal to the Electric-Pneumatic Converter when on hand operation.

Square Root Extractor - The square root extractor converts input signals, ranging from ± 25 volts d-c, to an output signal which is a square root function of the input signal.

Summing Point Monitor - The summing point monitor is basically an oscillator driving an external alarm control circuit. It is used in the control system to monitor the operation of a Bailey Control Action Unit. If there is a failure in the Action Unit, the oscillator will cease oscillating, causing an alarm condition in the external control circuit.

Transfer Relay Modules - Transfer relay modules are general purpose relay modules primarily designed for transferring circuits associated with the Type RU Auto-Balance Selector Station. They are also used for other switching applications within the limits of their contact capacity.

Type RS Manual Loaders - Type RS Manual Loaders are essentially adjustable power supplies which produce an output d-c voltage signal which is proportional either to the setting of a hand adjustment or to an applied voltage signal.

Velocity Limiter - The Velocity Limiter provides an output voltage which follows the magnitude of the input voltage, but at a controlled rate.

N REACTOR PLANT GLOSSARY (CONT'D)

Core - The body of fuel or moderator and fuel in a nuclear reactor.

Corn-Popper - An electronic temperature monitoring system which provides a rapid scan of the temperatures of the outlet water from a small selected group of process tubes.

Counting Rate Meter - A device which gives a continuous indication of the average of ionizing events. Frequently the log of the counting rate is provided (LCRM). When plotted, the slope can be interpreted as the reactor period. The log of the counting rate may be differentiated to provide a direct indication of period.

Crib - A ditch or basin located to the northeast of 100-N Area for the disposal of radioactive water. The crib acts as a seepage pit to give a filtering action for the removal of radioactive particulates, and also serves as a time delay route for radioactive liquids.

Criteria - A standard of judging a rule or test by which anything is tried in forming a correct judgment respecting it.

Critical - The condition existing when the effective multiplication constant for a reactor is exactly unity (or 1) so that a self-supporting fission chain reaction can be maintained. As commonly used, this means "delayed critical" and the reaction is dependent upon both prompt and delayed neutrons. In the prompt critical state the reactor is capable of sustaining a chain reaction without the aid of delayed neutrons and should never be achieved in Hanford reactors. This means a reactivity excess of 0.006 $\frac{k}{k}$; this is exposure - dependent in the Hanford piles - see delayed neutrons.

Critical Mass - The mass of fissionable material in a critical reactor.

Cross Section - A measure σ of the probability of occurence of a given reaction. For a particular nuclear reaction, σ may be greater or smaller than the geometric cross section πR^2. If the reaction cannot take place, the cross section is zero. For any collision reaction between nuclear or atomic particles or systems, σ is an area such that the number of reactions taking place is equal to the product of the number of incident particles that would pass through this area at normal incidence and the number of target particles or systems.

Curie - A unit of radioactivity, symbol c, equal to 3.7×10^{10} disintegrations per second. It is approximately the activity of 1 gm of radium.

Cycling - A continuous periodic shifting of heat concentration or power density within the reactor, accompanied by reactivity changes induced by temperature and fission-product concentration fluctuations.

Danger Coefficient - The change in reactivity caused by inserting a particular material into the reactor. The danger coefficient depends on the amount and distribution of the material inserted and is usually quoted as reactivity change/column for the central position in the reactor. This is normally called the "nominal" reactivity for the specific material.

N REACTOR PLANT GLOSSARY (CONT'D)

Data Accumulation - Process and other data accumulated manually and from data logging systems and stored for future use.

Data Processing - The use of accumulated data for process analysis or for planning plant operations.

Decay Heat - The heat generated in a reactor following shutdown. Immediately after shutdown the major heating is caused by fissions from the delayed neutron fraction until it decays to a negligible value compared to the much longer term heating created from the absorption of β and γ radiation associated with the radioactive decay of fission products in the reactor.

Decontamination Injection System - A system which provides a means to chemically remove radioactive film from the primary coolant system piping, or the moderator cooling system. It is also possible to decontaminate the secondary system if necessary.

Delayed Neutrons - Those neutrons with an emission time after the fission process that is characterized by the half-life of certain fission products (precursors). An arbitrary time limit exists (10^{-14} sec.) to distinguish between prompt and delayed neutrons. The delayed neutron fractions and half-lives are different for the various fissionable isotopes. This means that the delayed neutron characteristics of a pile are exposure-dependent.

Demineralization - The removal from solution of dissolved salts by means of ion exchange on resins of both cations and anions that comprise the salts.

Anion - A negatively charged ion; for example, the chloride portion of sodium chloride.
Cation - A positively charged ion; for example, the sodium ion of sodium chloride.

Regeneration - Restoration of the ability of an ion exchange resin to remove dissolved impurities from water. This is accomplished by providing an excess of the desired ions (for example, hydrogen or hydroxyl) thereby reversing the normal ion exchange process and driving the undesirable impurities off of the resin.

Resin - At the NPR, man-made beads of organic material which have the ability to loosely hold certain ions, then exchange these ions for others under some conditions. These beads are very insoluble in water. They are colored amber to brown.

Vacuum-Deaerator - A piece of equipment that receives heated water from a steam heat exchanger downstream of the primary ion exchanger, and in a two stage process removes dissolved gases from the water through the steam jet extractors, and discharges the de-gasified water to the secondary ion exchanger.

N REACTOR PLANT GLOSSARY (CONT'D)

Raschig Rings - Open end cylinders of varying length and wall thickness, with the diameter equal to the length. (Likened to unthreaded pipe nipples.) Raschig rings are used in the Vacuum-Deaerator in the 163-N Building, to provide a maximum of water filming surface for the removal of dissolved gases. The Vacuum-Deaerator will have two beds of Raschig rings of varying lengths. The first stage bed, or upper bed, is 6'10" deep. Layers from top to bottom - 1' of 1" plastic rings; 4'10" of 1" ceramic rings; 6" of 2" ceramic rings. The second stage bed or lower bed is 9'3" deep. Layers from top to bottom - 8'9" of 1" ceramic rings; and 6" of 1½" ceramic rings. The rings in all layers are placed at random.

Depleted Uranium - Uranium fuel with less than 0.712% U-235. The depletion may result from burnup of U-235 while under irradiation or from removal of some of the U-235 in a diffusion process.

Detector - An instrument element used to monitor normal and signal abnormal conditions in a system (flux monitor, outlet temperature, process flow, etc.). In lubrication systems a temperature element or probe to monitor bearing temperature and annunciate over-heating. In fire systems the probes or temperature elements that continuously monitor temperatures and sends an impulse to actuate the system in case of need.

Diesel Engines - Emergency diesel engines are provided as follows:

2 at 181-N to operate emergency raw water pumps.
3 at 182-N to operate high pressure raw water pumps.
2 at 182-N to operate fog spray pumps.
1 at 182-N to operate fire system pump.
1 at 182-N to operate emergency generator.

Diesel Oil - A light distillate fuel. Diesel oil is used as fuel for the diesel engines and as ignition fuel for the standby boiler.

Diffusion length - A measure of the average distance a thermal neutron travels from the point of its formation to the point where it is absorbed. The term is usually defined in terms of its square, the diffusion area, which is one-sixth of the mean square distance a thermal neutron travels from source to capture. (Broadly speaking, the terms "diffusion length" and "diffusion area" can apply equally well to any particle, but are usually confined to thermal neutrons in reactor jargon.)

Diversion Headers - The vertical diversion headers on the rear face receive effluent from diverted process tubes. There are eight of these 6" lines on each side of the rear face and they are identified as 1-D to 16-D, reactor left side to reactor right side (See "Left Side" definition).

Diversion Valve - A remote operated three-way valve which permits diversion of the outlet water from a particular process tube to a contaminated water disposal system to minimize spread of radioactive materials through the primary cooling loop in event of a fuel element failure.

N REACTOR PLANT GLOSSARY (CONT'D)

Doppler Broadening - As applied to nuclear reactors, the extension of the resonance energy span with increasing temperatures due to the increased random motion of the target nuclei. This results in a higher probability that an incident neutron will be captured by the resonant absorber (normally U-238) and consequently in a reactivity decrease. The phenomenon is reflected in the so-called "metal temperature effect" in Hanford reactors. (See Principles of Nuclear Reactor Engineering, Glasstone, p. 257.)

Downcomer - The 18" pipe section into which each rear outlet header discharges in the discharge area. Coolant flows through the downcomer to the mixing manifold. The downcomers are identified as DC-1 through DC-16, reactor left side to reactor right side. (See "Left Side" definition.)

Drip Cells - See drip leg below.

Drip Leg or Drip Cells - The small basin(s) or tank(s) in the lowest portions of a gas, air or steam line for collecting water that is condensed or otherwise released from the carrier in the line.
In the reactor gas lines, drip legs are installed to collect water that drains from the graphite stack. Automatic alarms are energized when water is present in the reactor drip legs or cells.

Dry Pipe System - A fire protection system using automatic sprinklers where normally the piping system is kept dry and the entire system is energized by a master valve activated by temperature detectors.

Dryer - The term dryer refers to the gas drying facility, or to the silica gel tower, a part of the facility.

Dummy - An inexact term applied to tubular or perforated tubular pieces, all of which are non-fissionable. It is used most commonly for the upstream and downstream seating charges (dummy pattern - see below).

Dummy Pattern - The pre-determined order in which dummies are charged into the process tube upstream or downstream of the uranium fuel elements. Their principle use is to center the fuel charge in the active zone.

Dump Condenser - See Condensers.

Dump Tank - See Energy Dissipator.

Dump Valve - Eight 10-inch cone valves from a cross-tie line connecting the bottom of the rear downcomers which open upon a signal of certain failures in the primary coolant system and initiate emergency once-through cooling.

ECT - Effective Central Tubes - The ratio of total pile power output to the average power output of the ten most productive tubes.

Effective Reactivity - (Re) - The effect upon pile reactivity that a material has for a given configuration of the material in the pile in a particular location.

N REACTOR PLANT GLOSSARY (CONT'D)

EFT - Effective Flow Tubes - The ratio of total process-tube water flow to average flow/tube for the central flow zone.

Elastic Scattering - Scattering effected through the agency of elastic collisions and therefore with conservation of kinetic energy of the system.

Electron - An elementary particle of rest mass m_e equal to 9.107 X 10^{-28} gm. Its charge may be either positive or negative. The positive electron is usually called a positron; the negative electron is sometimes called the negatron. Most frequently the term electron means negatron. The negative electron is a consitituent of all atoms. In a neutral atom the number of electrons is equal to the atomic number Z.

Electron Volt - A unit of energy, symbol ev, equal to the energy gained by a particle having one electronic charge when it passes in a vacuum through a potential difference of 1 volt; 1 ev = 1.60 X 10^{-12} erg.

Element - (1) A substance all of whose atoms have the same atomic number. (2) A naturally occurring mixture of isotopes.

Elevators and Work Platforms - 105-N

C Work Platform - Provides a movable working space and access to all points on the inlet face of the reactor. Capacity 40,000 lbs. live load.

D Work Platform - Provides a movable working space and access to all elements on the outlet face of the reactor. Capacity 40,000 lbs. live load.

F Elevator - Functions as a personnel and material carrier between the following elevations: - 15', 0', 14'6", 28'3", 40' and 51'. Capacity 10,000 lbs. live load.

R Elevator - Functions as a personnel and material carrier between the following elevations: - 15', 5', 16'6", 28'3", 40' and 60'6". Capacity 10,000 lbs. live load.

S Elevator - Functions as a personnel and material carrier during the charging and maintenance operation between elevations - 15' level, 0' level and any elevation of W Work Platform. Capacity 10,000 lbs. live load.

W Work Platform - This is a moving platform used to raise and lower the charging machines and to provide a work space for operating the machine. Capacity 80,000 lbs. live load.

Emergency Raw Water System - A separate independent untreated water system is provided for emergency single pass cooling of the reactor. This emergency supply is intended for use only in case the normal recirculating water heat removal system is disabled by loss of all sources of pumping power or by a major rupture in the primary coolant piping. This system is also referred to as "the last ditch cooling system".

N REACTOR PLANT GLOSSARY (CONT'D)

Energy Dissipator - Also called quench tank or dump tank. The energy dissipator, or energy absorber is an underground tank facility provided to handle the liquid discharged, and the vapor created, upon the emergency depressurization of the coolant system. Fluid from the energy dissipator is later pumped to the crib facility.

Enriched Reactor - A nuclear reactor in which the fuel may be uranium increased in U-235 content beyond the normal isotopic concentration or other concentrated fuel such as plutonium or U-233 or a combination of these.

Enrichment - A material which adds more reactivity to the pile than natural uranium when placed in the active zone of the pile; e.g. enriched uranium.

Equilibrium - The operation of a reactor in steady state; that is, a reactor which is operating so that the rate of production of xenon, its burnout, and decay are constant. The effective multiplication factor is unity and changes only very slowly with time.

Excess Reactivity - The phrase "excess reactivity" is nearly always qualified in one way or another. For example: The excess reactivity held in xenon is the poison value of the xenon; the excess reactivity held in the rods is the poison value of the inserted rods. The cold, clean, green, excess reactivity is conventionally understood to be the effective multiplication factor of the pile minus one without any controls, poison, or xenon inserted or in place. The unit of measurement is the mk. (See mk.)

Factors - F, F^2 and F^3; F_i is the ratio of the i^{th} tube power to the average tube power; F^2 and F^3 are the second and third powers respectively of F. f, f^2 and f^3 are the pile fractions usually associated with discharges of uranium.

$$f = \frac{\sum^{n} F_1}{\sum F_1} \qquad f^2 = \frac{\sum^{n} F_1^2}{\sum^{N} F_i^2} \qquad f^3 = \frac{\sum^{n} F_1^3}{\sum^{N} F_i^3}$$

Fast Neutrons - Neutrons having energies greater than that of intermediate neutrons, that is, energies exceeding about 0.1 mev. Sometimes a different lower limit is used.

Filler Block - The 4" x 4" solid blocks in the reflector graphite of the N Reactor are called filler blocks.

First Indication Time - The time when the most sensitive instrumentation shows the first evidence that the reactor is super-critical during a start-up.

Fission Heat - See Heat of Fission.

Fission, Nuclear - The division of a heavy nucleus into two approximately equal parts. For the heaviest nuclei the reaction is highly exothermic, the release of energy being about 170 mev per fission.

N REACTOR PLANT GLOSSARY (CONT'D)

Fission Poisons - Fission fragments which have appreciable capture cross section for neutrons. A famous example would be Xe-135 which has an absorption cross section of 3.5 million barns for slow neutrons.

Fission Product - A nucleus produced in the fission process.

Flattening - Any material which when charged in place of a normal fuel loading reduces the overall pile reactivity and the tube powers surrounding the flattening charge. Also, the act of charging such material so as to achieve a more desirable (usually more uniform) tube power distribution. NOTE that flux and tube power are not interchangeable; also, natural uranium will not be the normal fuel charge in the NPR. (In the NPR, natural uranium is considered to be a flattening charge itself.)

Flow Decay - Measured decrease of flow rate after loss of pumping power.

Flux - (Neutron Flux) - The product nv where n is the number of neutrons per cm^3 and v is their mean velocity in cm/sec.

Flux Cycle - A periodic change or shift in the concentration of neutron flux within the reactor.

Flux Traverse - The distribution of flux along a line through the reactor as determined by the in-core flux monitor system or other methods.

Foamite System - A chemical fire protection system which produces foam and smothers out a fire. It is used effectively on oil fires and in N Area will be used to protect the diesel and fuel oil storage.

Fog Spray System - A system provided to condense steam which would be released within Zone I in the event of a primary cooling system leak and to control confiner pressure in event of a major accident. A second fog spray system is provided beneath the D Work Platform to spray the rear face of the reactor in case a fuel element accidently lodges there and burns.

Front Connectors - The 2-5/8" OD carbon steel lines witn 0.260 inch wall thickness that connect the process nozzles to the inlet supply headers. Each connector is identified by its respective tube number.

Front or Front Face - The face of a reactor through which the cooling water enters the process tubes.

Fuel - A fissionable material of reasonably long life used or usable in producing energy in a nuclear reactor. The term frequently is applied to a mixture, such as natural uranium in which only part of the atoms are fissionable, if it can maintain a self-sustaining chain reaction under the proper conditions.

Fuel Element - A single unit of charge; the NPR fuel element will be a metallic uranium tube-in-tube coextruded in zircalloy -2 jackets.

Fuel Oil - The fuel for the standby boiler. Fuel oil lines are identified F.O.S. and F.O.R., fuel oil supply, and fuel oil return, respectively.

N REACTOR PLANT GLOSSARY (CONT'D)

Fuel Rupture Monitor - A system to detect traces of fission products from defected fuel elements. Individual sample lines are provided at the outlet of each process tube from which a 0.4 gpm effluent sample flows continuously to a gross gamma detector.

Galvanometer - An instrument for measuring small electric currents by the movement of a coil in a magnetic field. Ion chambers placed in the active zone of a reactor and connected to the No. 1 and No. 2 Galvanometers indicate the approximate power level at which the reactor is operating. No. 1 Galvanometer deflects in direct proportion to neutron flux, while No. 2 Galvanometer shows the deviation of the flux from an arbitrary level. (A potentiometer provides the reference voltage.)

Gamma-Neutron (γ-n) Background - The result of a photonuclear reactor (multiplied many times) in which a gamma-ray photon is the incident particle and results in neutron expulsion. A Hanford reactor produces several fission products which emit gamma rays of sufficient energy (2.21 mev) to produce photo-neutrons from the deuterium in the cooling water. Two important isotopes are I-135 and La-140, each with a fairly short half life; thus, the background neutron activity in the shutdown pile varies with time after shutdown.

Gamma Ray (γ ray) - (1) A quantum of electromagnetic radiation emitted by a nucleus, each such photon being emitted as the result of a quantum transition between two energy levels of the nucleus. (2) Sometimes, loosely, an X-ray photon of high energy, exceeding about 1 mev, or an annihilation radiation photon, each of which differs from a gamma ray, in sense (1), only in its mode of origin.

Gases - The following gases are used at N Plant:

Acetylene - Welding.

Argon - Welding.

Hydrogen - Additive to primary coolant for oxygen scavenging, also for a cooling media for the turbine generator in 184-N.

Helium - Reactor gas atmosphere - pressurize graphite moderator cooling system.

Inert Gas - A gas which does not readily react chemically, generally nitrogen or one of the "noble" gases (helium, argon, xenon, krypton, neon, or radon).

Oxygen - Welding.

Nitrogen - Testing and for rod accumulator pressurizing and critical valve actuation.

Carbon Dioxide - For fire fighting, and for purging hydrogen system in 184 Building.

Chlorine - Additive to raw water in 183 Building.

N REACTOR PLANT GLOSSARY (CONT'D)

Gilsulate - A solidified hydrocarbon of high resin content, granular in form and is poured directly around hot pipes for insulation and corrosion protection. After pouring it forms three zones; zone one is fused to the pipe, zone two is sintered, and zone three is unconsolidated gilsulate particles.

Graphic Panel - Displays process system arrangement and status of system components to provide control and process information to the control operators.

Graphic Panel Color Code - A standardized color coding for graphic presentations on the NPR control and instrumentation panels has been adopted. In the legend that follows, numbers in parenthesis refer to the location at which it is used, as:

1. Primary Water Graphic Panel, Main Control Room 105.
2. Heat Dissipation Graphic Panel, Main Control Room 105.
3. Control Console Graphics, Main Control Room 105.
4. Decontamination Graphic, 109 Control Room.
5. Boiler Control Console, 184 Control Room.

COLOR LEGEND

Solid Colors

1.	Light Red	Diversion Water (1)
2.	Dark Red	Emergency Cooling Water (1) Chemical Decontamination (4)
3.	Pink	Main Steam (2) (3) (4) (5)
4.	Orange	Graphite Coolant (1) (3)
5.	Yellow	Helium Feed (3)
6.	Light Brown	Circulating Water (2) (3) (5)
7.	Dark Brown	Filtered Water (2) (3)
8.	Vista Green	Primary Coolant, Reactor (Inlet from Steam Generator) (1) (2) (3)
9.	Dark Green	Primary Coolant, Reactor (Outlet to Steam Generator)(1) (2) (3)
10.	Light Blue	Demineralized Water (4)
11.	Dark Blue	Helium Leak Detection (1)
12.	Purple	Water-to-Water (2) (3)
13.	Black	Drains (1) (2) (3)
14.	White	Instrument Sensing (1) (2) (3) (4)
15.	Silver	Instrument Air (1) (2) (3) (4)
16.	Gold	Ventilation (3)
17.	Gray-Brown	Chemical Injection (1)

Combination Colors (Diagonally striped secondary color)

1.	Black with Dark Green	Vents (1) (2) (3) (4)
2.	Black with Pink	Blowdown (3)
3.	Black with Vista Green	Spill Water
4.	Light Blue with Pink	Condensate (2) (3)
5.	Light Blue with Purple	Makeup Water (2) (3)
6.	Light Blue with Vista Green	Injection Water (2) (3)

N REACTOR PLANT GLOSSARY (CONT'D)

Graphic Panel Color Code (Cont'd)

Combination Colors (Cont'd)

7.	Yellow and Dark Brown	Dry Decon. Chemical (4)
8.	Yellow and Dark Green	NaOH (4)
9.	Yellow and Dark Blue	H_3PO_4 (4)
10.	Yellow and Black	H_2O_2
11.	Yellow and Red	Decontaminant Mix (4)
12.	Yellow and Pink	Morpholine (3)
13.	Yellow and Green	Hydrazine (3)

NOTE that the combination colors follow a logical pattern. For example, black (drain color) with pink (steam) denotes blowdown (wasted steam). Similarly, light blue (demineralized water) with pink (steam) denotes condensate.

Graphite Blocks - Highly purified graphite (carbon) extruded and machined into block form for lay-up purposes; all active zone blocks are spaced and interlocked with each other in both horizontal directions by a series of notches located on top and bottom faces of each bar.

Graphite Coefficient - The moderator temperature coefficient of reactivity reflecting reactivity changes due to density and cross section variations with temperature for convenience sake normally expressed as a power coefficient of reactivity (Cg) in MK/MW.

Graphite Contribution (Commonly written C_G or W_{C_g}) - The pile reactivity effect obtained by multiplying C_g by the pile power level.

Graphite Heat - The heat that is transferred to the graphite stack by gamma rays and neutrons as a result of the fission process.

Graphite Moderator Cooling System - A secondary cooling system which provides a means of controlling the graphite temperatures in the N Reactor. It also acts as an independent heat sink for the reactor in the event of the "maximum credible" accident.

Graphite Stringers - Graphite rod with a string of thermocouples running through the center. Used to determine pile graphite temperatures.

Gunbarrel - See Tube Sleeve.

Half-life - The time t required for the decay of one-half the atoms of a sample of a radioactive substance. Each radionuclide has a unique half-life.

Heat Dissipation System - The overall system for removing process heat; it includes the primary coolant system, the secondary coolant system, the raw water circulating system and other systems and facilities involved in removal of heat from the reactor.

N REACTOR PLANT GLOSSARY (CONT'D)

Heat Exchangers - Units of various kinds used to remove heat from coolant systems. These include:

Heat Exchanger	System	Numbered
DHX	Diesel Engine HEX 181, 182 Bldg.	
DWHX	Demineralized Water HEX 1900 Area	
ESHX	Emergency Seal Water Cooler	1 - 5
FHX	Fuel Oil HEX	1
GHX	Graphite Moderator Cooling	1 - 4
HHX	Gas Cooler	1
RHX	Recuperative HEX Primary	1 - 2
SHX	Spill Cooler, Primary	1
THX	Turbine Oil Cooler 109, 184 Bldg.	
VHX	Vent System Blowdown HEX	1

Heat Fission - The energy released by the fission process and which can be converted to heat. This specifically excludes the neutrino energy. The value given in Glasstone and Edlund is 191 mev/fission. This means that about 3×10^{10} fissions/sec. will produce a pile power of one watt.

Heavy Metal - (Hanfordese) - A term loosely applied to the solid cylindrical natural uranium fuel elements.

Heise - The name of the firm which manufactures the pressure gauges used to measure the water pressure in crossheaders at Hanford reactors. When speaking of a "Heise" the speaker is usually referring to the gauge for measuring water pressure at the reactor or to the actual monitoring procedure.

Helium Leak Detection System - A system used to detect leakage of process gas from the reactor or its associated piping and to locate leaks in water tubes when the occasion demands.

HCR - Horizontal Control Rod System - The operating control (and safety) system consisting of 87 control rods. Each is a long cylindrical aluminum shell with an outer titanium sheath containing a boron carbide grit and powder mixture. The rods enter the reactor from both the right and left sides. Filtered water coolant is used to maintain certain rod temperatures.

Hot Start-up - Any start-up attempted while the pile reactivity is decreasing, and if the outage continued, the excess reactivity would eventually fall to less than 100 C-MK.

Ignition Oil - The diesel oil that is used to ignite the standby boiler fire. Identification of lines is by IO.

Index - With reference to the electrical systems, the word Index denotes the system of indexing electrical blueprints and the components indicated in the circuitry.

N REACTOR PLANT GLOSSARY (CONT'D)

Indicator Lights - Light displays are provided to indicate the status of machines, processes, and equipment throughout N Plant. The colors used, and their meanings are shown below:

Color	Meaning
Green	Safe; De-energized; Normal; Off
Amber	On; Normal; Energized
Red	DANGER; "NO GO"; OUT of Tolerance; Abnormal
Blue	Commands performance of control action from other equipment stations
White	Status functions with no implication of normal or abnormal condition; for example, power on

Inlet Barrier Wall - A barrier to reduce radiation emanating from the primary shield and reactor coolant system to safe biological levels for personnel located on the W Work Platform. It acts as barrier to the leakage of contaminated air and steam from the inlet piping space in case of an incident. It assists in locating and supporting equipment for operating the reactor and adjacent platforms. The inlet barrier wall is three feet thick and is made from 220 lb/ft^3 magnetite concrete.

Inlet Cross-Over - Connecting pipes between the rear inlet supply riser and the inlet (front) supply header.

Inlet Manifold - Receives water from the steam generators and discharge through the rear supply headers. This is the starting point when tracing the primary coolant system and this manifold is located in the pipe gallery 109 Building.

Inlet Supply Header - The inlet supply headers are the 18" vertical headers, eight on either side of the front face of the reactor which supply coolant to the process tube nozzle connectors. They are identified as 1-I to 16-I, left to right.

Insertion Order - See Withdrawal Order.

Instrument Response Time - Time lag between an actual physical change and the detection of the change by the monitoring instrument.

Insulation Layer - The insulation layer is located between the bottom thermal shield and the reactor foundation. It consists of:

1. A 1/2-inch thick steel membrane plate which forms the gas seal for the bottom of the reactor.
2. Twenty-six fabricated structural sections called "I-Sections", which transmit the weight of the graphite stack to the foundation.
3. A 16-inch layer of serpentine shielding concrete poured in the space between adjacent I-Sections to provide additional shielding protection for the foundation.

Intermediate Neutrons - Neutrons having energies in a roughly defined range that is often considered to extend from about 10^2 to about 10^5 ev. They are more energetic than epithermal neutrons, but less energetic than fast neutrons.

N REACTOR PLANT GLOSSARY (CONT'D)

Inventory - The total amount of any quantity present in a reactor at some instant of time. The neutron inventory is the total number of neutrons present; the fissionable material inventory, the total amount of fissionable material present; etc.

Iodine - (Also noted as M) - A fission product generated in roughly six percent of all fissions; it decays with a 6.68 hour half-life to xenon-135. Since the Xe has a considerable poison effect due to its large capture cross section, the I-135 is significant as a source for Xe-135 and must, therefore, be considered in all reactivity calculations, particularly during start-up.

Ion Exchanger - See Demineralizer.

Ionization - The process of stripping an atom of some or all of its electrons causing it to take on an electrical charge. This frequently results when a material undergoes irradiation.

Iso-Kinetic Probe - An air sampler capable of removing an accurate representative sample from an air stream.

Isotope - One of several nuclides having the same number of protons in their nuclei, and hence belonging to the same element, but differing in the number of neutrons and therefore in mass number A: For example, ${}_6C^{12}$, ${}_6C^{13}$, and ${}_6C^{14}$ are isotopes.

Isotope Production Facility - Selected HCR's with special tip sections for irradiation of special targets and subsequent formation of useful isotopes; this function is in addition to implementing reactor control.

Last Ditch Coolant System - The combined diesel driven pumps, storage facilities, and connecting lines from which the reactor is supplied raw water for single-pass emergency cooling of the process tubes. Also referred to as the Emergency Raw Water System.

Last Ditch Water - See Water - Once-Through Water.

Lattice Unit - The smallest indivisible unit, characteristic of the entire core, into which the reactor may be broken down. Commonly, the distance from the center of a column of metal to the center of an adjacent column of metal taken vertically or horizontally along the front or rear face is used synonymously with the term "lattice unit"; however, the true lattice unit is a square, retangular, triangular, or some other two-dimensional component.

Leakage - (1) Loss of neutrons by outward diffusion from the core of a reactor. When there is a reflector, leakage refers to net loss of neutrons that leave the core and are not reflected back into it. (2) Escape of neutrons or radiation through a shield, especially by way of holes or cracks through the shield.

Left Side - The side of the reactor to the left of the vertical reactor centerline as observed when standing at the center of C work platform and facing the reactor.

N REACTOR PLANT GLOSSARY (CONT'D)

LCRM - (Log Count Rate Meter) - See Counting Rate Meter.

Long Term Gains - The net increase or gain in reactivity shown over a long operating period by a reactor charged with "green" uranium fuel due to the following four factors: (1) U-235 burnout; (2) Pu-239 production and burnout, (3) Sm-149 buildup, and (4) burnout of impurities in the graphite stack.

Magazine - Also known as monotube. Consists of a carbon steel pipe 53'3" long, 3.135" outside diameter and 3.115" inside diameter. The inside is lined with a permanently attached 0.215" thick polyethylene liner. The purpose of the magazine is to act as a storage container for one process tube charge. It also serves as a hydraulic charging cylinder and a means of conveying a charge of metal through the barrier wall to the front face nozzle.

Magazine Support - A movable, expansion trough device used on the C work platform for supporting the magazines (or monotubes) in spanning the space between the barrier wall to the front tube nozzle. The magazine supports (6 provided) are suspended by overhead hoists on the C work platform and positioned from tube to tube as required during the charge-discharge operation.

Magnus Fuel Oil Inhibitor - Sludge solvent additive for Bunker "C" fuel oil.

Mass Number - The integer, symbol A, nearest in value to the atomic mass when the latter is expressed in atomic mass units. According to present theory, the mass number represents the total number of nucleons in the nucleus and hence is equal to the sum of the atomic number and the neutron number. In the symbol for a nuclide, the mass number is usually shown as a superscript following the element symbol; thus, in U^{235}, A is 235.

M.A.W.P. - The maximum allowable working pressure for a vessel or piping system is the maximum pressure permissible at the top of the vessel in its normal position or in the piping system at the operating temperature specified for that pressure.

MWD - Megawatt-Day - Unit of production or exposure equivalent to 1,000,000 watts for a 24-hour period.

MWD/AT - Unit of exposure called Megawatt-Day per Adjacent Ton. This term applies when the exposure of the adjacent material which does not generate appreciable heat itself.

MWD/T - Unit of exposure per ton of fuel material.

MWD/Tube - Unit of specific exposure called Megawatt-Day per Tube which indicated the average exposure of the material in a process tube.

Metal Coefficient - (Cm) - The metal temperature coefficient of reactivity; however, for convenience sake, it is expressed as a power coefficient of reactivity (Cm) in mk/mw. It is caused primarily by the Doppler broadening phenomena. (See Doppler Broadening.)

N REACTOR PLANT GLOSSARY (CONT'D)

Metal Contribution - (CM or WC_m) - The pile reactivity effect obtained by multiplying the metal coefficient by the pile power level.

Mev - The symbol for 1 million electronvolts, or 10^6 ev.

Migration Area - One-sixth the mean square distance that a neutron travels from its birth in fission until its absorption. The medium is assumed to be of infinite extent. In Fermi age theory of thermal reactors, the migration area is the sum of the age and the square of the thermal diffusion length. In multigroup theories of thermal reactors, the migration area is the sum of the squares of the diffusion lengths for the various groups.

mk - milli-k - A measure of the pile excess reactivity. 1 mk = 1000 (k effective -1) where k effective is the number of neutrons in one "generation" divided by the number of neutrons in the immediately preceding "generation".

mrad - milli-rad - 1/1000 rad - The rad is the unit of absorbed dose and is 100 ergs/g. One millirad (1 mrad) is one thousandth of one rad. The absorbed dose of any ionizing radiation is the amount of energy imparted to matter by ionizing particles per unit mass of irradiated material at the place of interest. It is expressed in "rads".

mrem - milli-rem - 1/1000 rem - It has been found convenient in practice to express doses of radiation of different specific ionizations in terms of a unit that embodies both the magnitude of the dose and its biological effectiveness. The unit is called the rem. The rem is the quantity of any ionizing radiation such that the energy imparted to a biological system (cell, tissue, or organ) per gram of living matter by the ionizing particles present in the region of interest, has the same biological effectiveness as an absorbed dose of one rad of X-radiation with average specific ionization of 100 ion pairs per micron of water in the same region.

mr - milliroentgen - 1/1000 roentgen. One roentgen is the quantity of X - or gamma radiation such that the associated corpuscular emission per 0.001293 gr of air produces, in air, ions carrying one electrostatic unit of quantity of electricity of either sign. One milliroentgen (1 mr) is one thousandth of one roentgen.

Minimum Downtime - The time in hours required for the pile reactivity to pass through a minimum and increase to the extent that the pile would become critical if the rods were withdrawn.

Mixing Manifold - A special piping manifold located in the 109-N pipe gallery. The purpose of this manifold is to mix the water of varying temperatures coming from the reactor downcomers, and distribute water of a uniform temperature to the steam generator cells.

Moderator - A material of low atomic weight and low absorption cross section used for slowing down neutrons. Graphite is used as the moderator in the N Reactor.

N REACTOR PLANT GLOSSARY (CONT'D)

Multiplication Factor - k - The ratio of the number of neutrons present at a given time to the number present one average neutron lifetime (or generation) earlier. k_{oo} is the multiplication factor in a theoretically infinite array of the reactor lattice under consideration· thus it is defined by the characteristics of the lattice only. $k_{effective}$ is the multiplication factor in a finite-sized reactor, and is obtained from k_{oo} by accounting for the neutrons which escape from the reactor faces. k_{ex} is conventionally considered to be k_{eff} minus one, but is normally qualified as for example cold, clean green k_{ex}.

Natural Uranium - Uranium with the following isotopic composition by weight:

U-234	0.006%
U-235	0.712%
U-238	99.282%

Neptunium - A man-made element with 93 protons in the nucleus. Np is formed when the U-238 captures a slow neutron and the U-239 decays by beta emission (23 minutes half-life) to Neptunium-239. The neptunium then decays by beta emission with a 2.3 day half-life, to Pu-239.

Neutron - A neutral elementary particle of mass number 1. It is believed to be a constituent particle of all nuclei of mass number greater than 1. It is unstable with respect to beta decay, with a half-life of about 12 min. It produces no detectable primary ionization in its passage through matter, but interacts with matter predominantly by collisions and, to a lesser extent, magnetically.

Neutron Flux - See Flux.

Nominal Reactivity - The effect on pile reactivity that a known amount of a given material would have if charged into the central tube of the unflattened reactor.

North

Hanford Works Grid North - An artificial grid north for Hanford Works. This grid was set up somewhat arbitrarily at the start of the project. Hanford Works Grid North is near to true north.

Magnetic North - The direction which a free-floating magnetized needle will point. In the Pacific Northwest, Magnetic North is approximately 22 degrees east of true north. This value varies from time to time since the Magnetic North Pole moves. It is accidental that N Area North is within a few degrees of Magnetic North.

N Area North - An artificial grid north for N Area. Most of the 100-N Buildings are constructed "square" with this grid. N Area North is 23 degrees east of the Hanford Works Grid North.

True North - That one of the four cardinal points of the compass which lies in a plane of the true meridian and on the left hand side of a person facing due east. The direction of the North Pole of the earth.

Nozzle - An adapter or fixture at each end of a reactor process tube through which the cooling water and slugs enter into and exit from the process tubes.

N REACTOR PLANT GLOSSARY (CONT'D)

Nozzle Caps - Process tube closures, front and rear.

Outlet Crossover - The piping between the top of the rear outlet header and the top of the downcomer.

Overall Coefficient - (Also noted as C_o) - The algebraic sum of metal coefficient (C_m) and graphite coefficient (C_g), and water coefficient (C_w).

Overbore - The relative size of annular gap between the process tube and the graphite blocks through which it passes. This gap controls the heat flow from the graphite to the process tube· thus, the graphite temperature distribution is controlled by the overbore pattern (if any) and the composition of pile atmosphere.

Parent-daughter - A terminology used in describing radioactive decay schemes. The parent is the original nuclide that upon radioactive decay forms a different nuclide called the daughter.

Period - The time (usually in seconds) required for the neutron flux in a reactor to change by a factor of e. The pile period or reactor period is represented by T or (tau).

Period Meter - A device from which an operator may read the reactor period in seconds. It may operate interlocks and scram the reactor if the period is dangerous; that is, a few seconds or less. The device actually measures d (log neutron flux) /dt, which is the reciprocal of the period. (See Counting Rate.)

pH - Defined as the logarithm of the reciprocal of the hydrogen ion concentration in a given solution. For instance, if a given solution contains 1 x 10^{-10} moles per liter of hydrogen ions, its pH is 10. pH has little meaning unless the temperature is known. In pressurized water reactor work, all pH figures are assumed to be at 25 C.
It takes 10 times as much base to change pH from 9 to 10 as it does to change from 8 to 9.

Phase Operation

Phase I - Operation of NPR for plutonium production only.

Phase II - Operation of the NPR for both plutonium production and by-product electrical power generation.

Phase III - Operation of the NPR for electrical power generation only.

Planning Terminology

Planning - Set engineered methods and time standards for all unique tasks of work within an operation. Place information on IBM planning master cards. This applies equally well for individuals and teams of men.

Scheduling - Establishing sequence of planned jobs for performance in any given time period. To be performed by Planning and Scheduling personnel and continually updated. These people arrange for completing the maximum amount of work in minimum elapsed time with minimum number of people.

N REACTOR PLANT GLOSSARY (CONT'D)

Planning Terminology (Cont'd)

Dispatching - First line supervisors direct men to the scheduled work. In cases of bench work, supervisors may dispatch work to the men rather than men to the work. This operation of dispatching places an hour's worth of work in front of each man for each paid hour.

Voucher - An IBM card, prepared by the scheduling people from the master planning cards, and given to each man each time period as a part of dispatching. The voucher tells the employee what is to be done, the sequence, and how long the work should take. At the completion of each time period, the employee returns the voucher to the supervisor with the employee's penciled notation of time required to perform each task.

Loading - Sometimes used in conjunction with dispatching. In concept, the loaded machine is working 8 hours per shift with no idle machine time. Also, the loaded man is turning in 8 hours of actual time for each 8 hours of planned time according to voucher.

Measurement - This "closes the loop". The voucher with actual time listed by the employee is returned to scheduling. The IBM voucher card is put through key punch, the actual time is punched in, and all vouchers for the time period are processed by the IBM machine according to machine programs which produce the various kinds of variance reports needed by various levels of management.

Control - This is the action taken by management at all levels, based on cognizance of the variance reports, to effect improvements in the business component.

Plant Control Center - Generally referred to as the main control room in 105 Building. It has greater significance at 100-N since all 105-109 functions, all communications, and part of the 181, 182, 163, 183 and 184 operations are controlled from or indicated at this location.

Plutonium - (Pu) - An element artificially produced, atomic number 94, discovered in 1940 by G. T. Seaborg, E. M. McMillan, A. C. Wahl, and J. W. Kennedy. They first prepared 90 year Pu-238 by the reaction:

$$\text{U-238 (d,2n) Np-238} \xrightarrow[2.10_d]{\beta^-} \text{Pu-238}$$

The 2.41 X 10^4 year Pu-239, which is fissionable with slow neutrons, is the one prepared in nuclear reactors by the following series of reactions:

$$\text{U-238 (n,) U-239} \xrightarrow[23.5\text{m}]{\beta^-} \text{Np-239} \xrightarrow[2.33\text{d}]{\beta^-} \text{Pu-239}$$

N REACTOR PLANT GLOSSARY (CONT'D)

Poison - (Also noted as "P") - Any material which produces a reactivity loss relative to natural uranium (compared to N fuel, natural uranium is a "poison").

Potable Water System - The system for providing drinkable water. The potable, or sanitary water system, is kept separate from all other water systems.

Power Density - Power generation per unit volume of reactor core. In Hanford reactors, the units would be kw/ft of lattice cell for example.

Power Setback - A non-emergency system used to reduce reactor level when certain operating conditions occur. The system operates by driving in increments of selected HCR's in response to a "setback" signal; the insertion is terminated when the cause of the signal is corrected.

Power Traverse - A plot of the powers of the tubes in a single plane, side-to-side or top-to-bottom, through a reactor.

Precursor - One that precedes; in nuclear physics a precursor is a radioactive nuclide that decays to the one of immediate interest; that is, U-239 is the precursor of Np-239 which in turn is the precursor of Pu-239. The most common use of the word is with reference to delayed neutrons where the half-life or the precursor determines the apparent half-life of the delayed neutron which is actually emitted promptly from the daughter of the precursor. An example is Br-87 which decays with a 55.6 second half-life to Kr-87 which in turn promptly emits a neutron. The apparent half-life of this delayed neutron is thus the 55.6 second half-life of the Br-87 precursor.

Prediction Error - The difference between the observed pile reactivity and the calculated pile reactivity at the time when a reactor first begins to operate or indicate excess reactivity during a start-up.

Pressurizer - A surge vessel connected directly to the reactor outlet piping in the 109-N pipe gallery, used to control primary coolant system pressure and volume surges caused by coolant density changes during transients in reactor heat output. It also maintains primary loop pressure.

Primary Coolant System - A multi-loop recirculating system providing for the recirculation of pressurized, high temperature, demineralized water coolant through the reactor process tubes and through steam generators.

Primary Reactor Shield - A radiation barrier surrounding the reactor core, reflector, and thermal shield. It reduces the neutron and gamma levels originating in the cores to acceptable levels and assists in locating and supporting such members as thermal shield, process tube assemblies, control rods, ball hoppers, etc. It acts as a barrier to the leakage of inert gas from inside of the reactor, and as container for reactor materials and gases in case of an earthquake or other incident. High density concrete is used on all sides and the top of the reactor, and ordinary concrete on the bottom. Thicknesses range from 40 to 72 inches.

Process Cell 109-N - Units of the overall heat dissipation system. Five of the six 109 cells house the steam generators and pumps for the primary system. The sixth cell houses the coolant heat exchangers and pumps for the graphite moderator cooling system.

N REACTOR PLANT GLOSSARY (CONT'D)

Programmer - Instrumentation used to automatically sequence a series of functions required for a safe start-up or shutdown of a process system.

Promethium - The mother (precursor) element or isotope from which samarium is produced by beta emission.

$$Nd^{149} \xrightarrow[1.7\ hr.]{\beta} Pm \xrightarrow[42\ hr.]{\beta} Sm^{149}$$

This occurs in about 1.4% of fissions.

Prompt Critical - The condition of a nuclear reactor that is critical because of prompt neutrons alone without requiring the contribution of delayed neutrons. If a reactor is super-critical on prompt neutrons the reaction rate will rise rapidly because the time required for the average neutron cycle is extremely short. A reactor in this condition is very difficult to control.

Purity Bleed-off - Quality of the primary recirculating coolant is maintained by a continuous bleed-off or withdrawal in conjunction with a simultaneous equal make-up of freshly demineralized and tempered water. The process is called bleed-off.

Push - ("Hanfordese") - An act of discharging material from a reactor or may mean the discharged material itself.

Quench Tank - See Energy Dissipator.

Rad - See m-rad.

Radiation - (1) The emission and propagation of energy through space or through a material medium in the form of waves; for instance, the emission and propagation of electromagnetic waves, or of sound and elastic waves. (2) The energy propagated through space or through a material medium as waves; for example, energy in the form of electromagnetic waves or of elastic waves. The term radiation, or radiant energy, when unqualified, usually refers to electromagnetic radiation; such radiation commonly is classified, according to frequency, as Hertzian, infrared, visible (light), ultraviolet, X-ray, and gamma ray. (3) By extension, corpuscular emissions, such as alpha and beta radiation, or rays of mixed or unknown type, as cosmic radiation.

Radioactivity - Spontaneous nuclear disintegration with emission of corpuscular or electromagnetic radiations.

Reactivity - A measure of the departure of a reactor from critical such that positive values of reactivity correspond to reactors above critical and negative values to reactors below critical. Often represented by (a) the multiplication constant minus one (k_{eff}), (b) a quantity proportional to the inverse asymptotic period (mk). Sometimes used interchangeably with the term multiplication constant.

N REACTOR PLANT GLOSSARY (CONT'D)

Reactivity Transient - The variation of "available excess reactivity" with time. Since the reactor is normally operated with a nearly constant power level (that is, Kex equal to 1.000) the reactivity transient is the variation with time of the amount of control rod, plus any supplementary control in the reactor, necessary to maintain the reactor exactly critical.

Reactor - An assembly capable of sustaining a fission chain reaction.

Reactor Flow and Temperature Data Logging System - A system which records in digital form the flow and outlet temperature data from each process tube.

Reactor Nuclear Instrumentation - The system which provides indications of neutron flux level, the flux distribution, and the rate of change of neutron flux to the reactor operation. It also monitors the neutron flux level, the reactor period and the rate of power rise. It can be set to initiate power setback or reactor scrams whenever specified conditions are exceeded.

Reactor Thermocouple System - The system consists of thermocouples for measuring the temperatures of the active zone graphite, thermal shield, and biological shield.

Rear Connectors - Fittings of the same size and material as the front connector, which connect the rear process nozzles to the rear outlet headers. They are identified by their respective tube numbers. Each rear connector is equipped with a remotely operated diversion valve which permits diversion of the outlet water to the diversion header.

Rear Face - The face of the reactor through which the material is discharged from the process tubes and through which the cooling water exits; the outlet face of the reactor.

Rear Outlet Header - The rear outlet headers are the 18" vertical headers, eight on either side of the rear face into which the coolant flows from the outlet nozzle connectors. These are identified as 1-O to 16-O, reactor left side to reactor right side. (See "Left Side" definition, page 22.1-23.)

Rear Supply Riser - The 18" vertical headers, eight on either side of the rear face of the reactor, which supply coolant from the inlet manifold to the inlet supply headers through the supply header crossovers. They are identified as 1-RI to 16-RI, reactor left side to reactor right side. (See "Left Side" definition.)

Redundant - Duplication of circuits or components to provide increased reliability. In N Area, refers to rod scram, safety and other critical control circuits.

Reflector - The "extra" moderator around the active zone of a reactor which reduces the leakage of neutrons from the reactor by reflecting some of them back into the active zone.

Reflector Blocks, Front and Rear - Graphite blocks used in the reflector areas of the graphite stacks.

Rem - See m-rem.

N REACTOR PLANT GLOSSARY (CONT'D)

Replaceable Side to Side Stringers - Any of seven replaceable graphite thermocouple stringers, each having five thermocouples.

Right Side - The side of the reactor to the right of the vertical reactor center line as observed when standing at the center of C work platform and facing the reactor.

RM Systems - The overall system for monitoring radiation levels in all parts of the 105-109 Buildings. The system includes space monitors, air monitors, underwater gamma monitor, pile gas activity monitor, and stack air monitoring.

R_{OO} - The reactivity that a reactor would have after a sufficient time of non-operation for complete cooling of the metal and graphite in the pile and for complete decay of iodine and xenon.

Rod-Swap - The act of inserting one horizontal control rod while simultaneously withdrawing another, generally during operation of the reactor in order to gain an improved flux distribution.

Roentgen - See mr.

Rupture Disk - A pressure relief device used in piping systems, often used in conjunction with a regular pressure relief valve.

Rupture Products Trap - A barrier or trap in the tube diversion drain line which entraps the heavier rupture products present in the line as a result of fuel element failure. Two additional fission products traps of the removable cask type are located where the primary flush and diversion drain lines leave the 105-N Building. These traps are necessary because the invert elevation of the drain line is lower than the level of the lines to the crib.

Safety Circuit - The overall electrical circuit which must remain intact if controls are to be withdrawn and remain outside the reactor. Any interruption in current, due to any one of several component trips, initiates a rapid reactor shutdown by insertion of the full HCR system, or, under conditions of emergency, the full ball safety system.

Safety Rods - Certain specified HCR's which are separated from operating HCR's, and are retained outside the core to provide shutdown control.

Samarium - A stable isotope (Sm-149) or nuclide resulting from the decay of Promethium-149. Its absorption cross section for thermal neutrons is 53,000 barns and, therefore, it must be accounted for in reactivity calculations.

Scaler - A device that produces an output pulse whenever a prescribed number of input pulses have been received. The number of input pulses per output pulse of a scaling circuit is termed the scaling factor. A binary scaler is a scaler whose scaling factor is two. A decade scaler is a scaler whose scaling factor is ten.

Scope - Range of view, intent or extent; scope drawings or scope documents.

N REACTOR PLANT GLOSSARY (CONT'D)

Scram - Sudden shutting down of a nuclear reactor, usually by insertion of safety rods. This may be arranged to occur automatically at a predetermined neutron flux or under other dangerous conditions, the reaching of which causes the monitors and associated equipment to generate a scram signal. To shut down a reactor by causing a scram.

Scram Recovery Time - The maximum time within which a reactor will start-up and continue to operate after a scram has occurred. This time is dependent upon the level of operation and time operated before the scram. It reaches its minimum value as the reactor reaches equilibrium. For reporting purposes the time is measured from scram to the latest time at which the pile must go critical (and follow specified hot start-up procedures) to attain the scram recovery level.

Seals - Devices provided around all wires, tubing, piping, access ports and equipment entering or leaving Zones I, II, and the reactor block to maintain the confinement zones.
Gas seals are provided for all penetrations into the reactor such as process tubes, moderator cooling tubes, control rods, ball safety system and instrument openings to prevent gas leakage from the reactor to atmosphere. (Also see Shield Expansion Joint Gas Seal.)

Secondary Coolant System - The heat dissipation system that removes the reactor heat from the primary cooling system and transfers it to the river via the dump condenser system. A portion of the steam developed in the steam generator is utilized by the primary pump drive turbines in 109-N and the turbine generator set in 184-N.

Segregation System - The segregation system is part of the underwater fuel element handling system which conveys discharged fuel elements and dummies to the storage basin, separates metal from dummies, sorts dummies into two lengths and puts each into containers, sorts fuel elements into four lengths and puts each length into canisters.

Sensitivity - (As used in Pile Physics) - The pile power level in watts or kilowatts at which a particular neutron-sensing instrument first shows an indication of super-criticality during the start-up procedure.

Shadowing - A term commonly applied to the effect noted from the following condition: When a non-fissionable strong neutron absorber is placed in a reactor, there is a reduction in the neutron flux in the region; if a second absorber is inserted in the region it will produce a different reactivity effect than if the first absorber were not present, due to the significant changes from the original flux distribution caused by insertion of the first absorber. The effect of the two absorbers may be smaller or in some cases larger than the sum of the two individual effects.

Shield - Any material used to reduce the amount of radiation reaching one region of space from another region of space.

N REACTOR PLANT GLOSSARY (CONT'D)

Shield Expansion Joint Gas Seal - A special steel and elastomer arrangement provides a continuous gas seal around the periphery of the hot portion of the inlet and outlet primary shields. The elastomer portion of the seal accommodates the relatively large thermal expansion movements of the hot shield face while the curved metal portion of the seal is designed to withstand the severe temperature gradient between the hot shield face and the cold elastomer clamps.

Shield Plugs - Shield plugs are used to fill the penetrations through the primary shields that are not initially utilized by process tube assemblies.

Shutdown - A term applied to a pile when it is sub-critical and with a neutron-induced power of less than one megawatt. Operations considers shutdown time as extending from the time rods are in to first indication. For Pile Physics purposes, it is necessary to consider the effective time of shutdown as the time when the pile power level was reduced to 50% during the shutdown procedure.

Shutdown Data Sheets - (SDS) - Prepared forms on which the area physicist records the data concerning a shutdown of longer than scram duration.

Skip Hoist - The return elevator for the ball safety system from the ball washer and drier; the balls flow into the skip hoist for return to the ball distribution system on top of the reactor.

Spares

Maintenance Spare - A piece of equipment that can be out of service for maintenance work or PM (Preventative Maintenance) and still provide an operational spare.

Operational Spare - A piece of equipment provided for standby and not required under normal operating conditions but can replace an operating unit when required.

Professional Spare - An equipment piece when used as a spare is powered by an electrical motor whose power source can be readily selected from either B.P.A. or turbine-generator power without need of synchronization or danger of paralleling the sources.

Specific Power - Power produced per unit mass of fuel present in a reactor. Common Hanford units are kw/ft of slug, kw/slug and MW/ton.

Specification - A statement containing a minute description or enumeration of particulars, as of terms of a contract, details of construction not shown in an architects or designers drawing; also, any item of such a statement.

Standby Boiler - A single oil fired boiler provided to supply standby steam to power the primary coolant pump drive turbines in order to start the reactor. It is also used to operate the turbine generator set and meet other area demands in the event of loss of normal (reactor) steam.

Starting Air - High pressure air system used in N Area at 181 and 182 Buildings as an aid in starting diesel engines.

N REACTOR PLANT GLOSSARY (CONT'D)

Start-up - The act of withdrawing the horizontal safety control rods from the reactor in such a manner that the chain reaction fission process will begin in the reactor at a controllable level. This starting-up period is the most crucial portion of operating time because of the increased possibility for personnel errors and greater number of uncertainties in reactivity factors.

Steam Jet Air Ejector (SJAE) - A device used for removing non-condensables from the condensing side of a condenser. It has no moving parts; it uses a steam jet for pumping power.

Stellite - A high cobalt content alloy used for valve seating surfaces.

Stop Gate - See Stop Log.

Stop Log - A piece of material (wood or metal) when placed between slots in opposite sides of a liquid container forms a dam and changes the flow direction of the liquid. The stop log may be used to separate the liquid (usually water) into two or more bodies, divert the flow, form a weir or any combination of these.

Stress Corrosion - A type of corrosion which takes place only on materials which are under stress. A condition of internal stress, such as may result from cold working, severeheat treatment, local overheating as welding may also serve to accentuate the destructive effect of what otherwise might be a mild corrosive attack.

Sub-Critical - The state of a pile having an effective multiplication constant less than one so that a self-supporting chain reaction cannot be maintained.

Sub-Critical Monitor - An electronic system whose primary function is the monitoring of the neutron flux level while the K_{eff} is less than unity. The system consists of a fission chamber in the active zone of the reactor connected to an amplified scaler, etc.

Super-Critical - The state of a pile having an effective multiplication constant greater than one so that the rate of reaction increases.

Supply Crossover - The piping between the vertical rear supply header and the vertical front supply header is called the supply crossover. Each crossover line contains a check valve that prevents backflow during once-through cooling.

Surge Tank - A vessel in a recirculating loop, acting as a reservoir and gas pressurizer to accommodate sudden changes in loop volume. One is provided in the moderator coolant system, another in the secondary coolant system. The former is pressurized with a helium gas gap, the latter with steam from the main steam header.

System Identification Legend

AAS - Atmospheric Radioactive Area Sensing
AC - Acetylene
ADR - Acid Drain
AE - Air Extraction

N REACTOR PLANT GLOSSARY (CONT'D)

System Identification Legend (Cont'd)

AL - Liquid Alum
AR - Argon
BA - Breathing Air
BD - Blow Down
BD-1 - Blow Down System #1
BD-2 - Blow Down System #2
BE - Brine
BF - Boiler Feed
BWR - Back Wash Return
CA - Compressed Air
CAB - Breathing Air
CAE - High Pressure Starting Air
CAS - Controlled Air Supply
CAC - Compressed Air Controlled
CAI - Compressed Air Instrumentation
CD - Contaminated Drain
CD-0.0 - Contaminated Drain 0.0 psig confinement
CD-0.2 - Contaminated Drain 0.2 psig confinement
CD-0.5 - Contaminated Drain 0.5 psig confinement
CD-5.0 - Contaminated Drain 5.0 psig confinement
CDR - Contaminated Drain
Chem - Chemical Injection
CHP - Hydrogen Peroxide
CHD - Confinement Hydraulic Oil Drain
CHS - Confinement Hydraulic Oil Supply
CL - Chlorine
CL-1 - Chlorine System #1
CL-2 - Chlorine System #2
CL-3 - Chlorine System #3
COND - Condensate
COND-1 - Condensate System #1
COND-2 - Condensate System #2
COND-3 - Condensate System #3
COND-4 - Condensate System #4
COND-5 - Condensate System #5
CO_2 - Carbon Dioxide
CPA - Phosphoric Acid
CPH - Potassium Hydroxide
COA - Coagulant Aid (Separan)
CW - Cold Water
D 0.0 - Clean Drain
DCF - Decontamination Chemical Feed
DCF-1 - Decontamination Chemical Feed System #1
DE - Diesel Exhaust
DCR - Decontamination Chemical Return
DCR-1 - Decontamination Chemical Return System #1
DCR-2 - Decontamination Chemical Return System #2
DCS - Decontamination Chemical Supply
DI - Diesel Air Intake
DMW - Demineralized Water

N REACTOR PLANT GLOSSARY (CONT'D)

System Identification Legend (Cont'd)

DOR - Diesel Oil Return
DOS - Diesel Oil Supply
DR - Drains, Miscellaneous
DS - Diversion System
DS(EHP) - Diversion System Effluent High Pressure
DS(ELP) - Diversion System Effluent Low Pressure
DS(DR) - Diversion System Drain
DW - Demineralized Water
DW-1 - Demineralized Water System #1
DW-2 - Demineralized Water System #2
DW-3 - Demineralized Water System #3
DW-4 - Demineralized Water System #4
ECWS - Emergency Coolant Water System 105-N
ERW - Emergency Raw Water
ERWS - Emergency Raw Water Supply
ERW(HP) - Emergency Raw Water High Pressure
ERW(F) - Emergency Raw Water Flush
F - Fire Protection
FOAM - Fire Protection Foam
FOS - Fuel Oil Supply
FOR - Fuel Oil Return
FL(HP) - Flush Line (High Pressure)
FL(LP) - Flush Line (Low Pressure)
FL(DR) - Flush Line (Drain)
FPD - Feed Water Pump Discharge
FPS - Feed Water Pump Suction
FW - Filtered Water
FW-1 - Filtered Water System #1
FW-2 - Filtered Water System #2
GCS - Graphite Cooling Supply
GCR - Graphite Cooling Return
GCD - Graphite Cooling Drain
GCV - Graphite Cooling Vent
HE - Helium
HLD - Helium Leak Detection
HO-1 - Hydraulic Oil (confinement) System #1
HO-2 - Hydraulic Oil (confinement) System #2
HP - High Pressure Steam
HPA - High Pressure Starting Air
HPR - High Pressure Condensate Return
HSW - Hot Sanitary Water
HW - Hot Water
HY-1 - Hydrogen
HY-2 - Hydrogen
HZ-1 - Hydrazine
HZ-2 - Hydrazine
HZ-3 - Hydrazine
HZ-4 - Hydrazine
IA - Instrument Air
IPF - Isotope Production

N REACTOR PLANT GLOSSARY (CONT'D)

System Identification Legend (Cont'd)

IO - Ignition Oil
IOS - Ignition Oil Supply
IOR - Ignition Oil Return
IW-1 - Injection Water System #1
IW-2 - Injection Water System #2
IW-3 - Injection Water System #3
JW - Jacket Water
LH-1 - Lithium Hydroxide
LH-2 - Lithium Hydroxide
LH-3 - Lithium Hydroxide
LO - Lube Oil
LP - Low Pressure Steam
LPR - Low Pressure Condensate Return
MDR - Miscellaneous Drains
MO - Morpholine
MP - Medium Pressure Steam
MPR - Medium Pressure Condensate Return
MW - Make-up Water
PBD - Purity Blowdown
PC - Primary Coolant
PCS - Primary Coolant Supply
PCR - Primary Coolant Return
PC(CT) - Primary Coolant, Cross Tie
PR - Pressurizer Supply and Return
PW - Potable Water
RD - Roof Drains
RDR - Radioactive Drain
RC - Rod Cooling
RCS - Rod Cooling Supply
RCD - Rod Cooling Drain
RSC - Rupture Sample Cold
RSH - Rupture Sample Hot
RVT - Radioactive Vent
RW - Raw Water
RWD - Raw Water Drain
RWS - Raw Water Supply
RWR - Raw Water Return
RWS-1 - Raw Water System #1
RWS-2 - Raw Water System #2
RWS-3 - Raw Water System #3
RWR-1 - Raw Water Return
SA - Service Air
SA-1 - Service Air System #1
SA-2 - Service Air System #2
SA-3 - Service Air System #3
SCS - Shield Cooling Supply
SCD - Shield Cooling Drain
SCV - Shield Cooling Vent
SC - Supplementary Coolant Supply, Graphite Coolant System Backup to ECWS

N REACTOR PLANT GLOSSARY (CONT'D)

System Identification Legend (Cont'd)

S(CT) - Safety Cross Tie
S(FC) - Safety Flow Control Legs
SDI - Sodium Dichromate
SNS - Sanitary Drain
SOH - Sodium Hydroxide
SUF - Sodium Sulfite
SUL - Sulfuric Acid
SWW - Screen Wash Water
TO - Turbine Oil
VT - Drain
VL - Gas and Air Vent Line
VL(HP) - Gas and Air Vent Line (High Pressure)
VL(LP) - Gas and Air Vent Line (Low Pressure)
VL(DR) - Gas and Air Vent Line (Drain)
VVLP - Ventilation Vent Low Pressure
WO - Waste Oil System
WW - Water-to-Water

Temperature Coefficient of Reactivity - Variations of reactivity due to temperature-dependent effects - mainly, for N Reactor, these temperature effects are relative to inlet water temperature change - (includes Doppler effect), moderator temperature change +, and power change - (fuel temperature change and t change of coolant).

Temperature Map - A printed form on which the exit temperatures of the reactor cooling water are recorded automatically by the data processing system.

T_f and T_r - The graphite temperature falling and rising periods respectively; that is, T_f is the time it will take for the graphite reactivity contribution to fall by a factor of e when the reactor is shutdown, and T_r is the period associated with the exponential increase in the graphite reactivity contribution when the reactor is starting up.

Thermal Neutrons - Neutrons in thermal equilibrium with the substance in which they exist; most commonly, neutrons of kinetic energy about 0.025 ev, which is the mean kinetic energy of a molecule at 15°C.

Thermal Shield - A radiation shield and heat barrier, the main purpose of which is to protect the primary shield from excessive radiation and heat. It is located between the primary shield and the graphite reflector. The side thermal shield is a 1" thick carbon steel plate containing a minimum of 1.1% natural boron by weight. The front and rear thermal shields consist of 8" thick cast iron blocks covering the active zone and 1" thick boron steel plate covering the remainder of the face. The top and bottom thermal shields consist of 1" minimum 1.1% boron steel plate. The boron steel absorbs more than 99% of the thermal neutrons incident upon it. The heat generated in or transferred to the boron steel portions of the thermal shield is removed by 222 stainless steel pipes welded to the boron steel plate. Heat generated in the carbon blocks is transferred to the primary coolant through the wall of the tube sleeves and process tubes.

N REACTOR PLANT GLOSSARY (CONT'D)

Thermal Transients - As temperatures, heat-transfer charactersitics, coolant flows, heat-generation rates, etc., are changed, thermal gradients in a system will change. The rate of change, duration of the transients, magnitude of the change, maximum temperature difference, and frequency and number of cycles influence the severity of thermal stresses developed in materials and the effect they have on service.

Thermal Utilization - The probability that a thermal neutron which is absorbed is absorbed usefully; usually used to describe the probability that a neutron is absorbed in fissionable material.

Thermo-Barrier - A shield to protect concrete surfaces and certain materials and equipment in spaces containing primary coolant piping from high temperatures. To accomplish this, insulation of individual pipe lines are provided in all locations except for the nozzles and connectors and a portion of the main riser at each reactor face. These lines are insulated as a group in a thermo-barrier. The barrier is a six-inch thick layer of insulating material attached to the walls of the piping areas involved. Access inside the barrier is made only during reactor outages.

Thermocouple - T/C - A classical device used to measure a wide variety of temperatures at inaccessible points in and around the reactor. The most common couples used are iron-constantan and chromel-alumel; platinum and platinum-rhodium are used on rare occasions. The emf is almost invariably measured by an electronic potentiometer and read directly in ^{o}C.

Thermohm - A registered trademark (Leeds & Northrup) for a resistance thermometer. RTD (resistance temperature detector) is another commonly used term.

Thorium - An element from which Uranium-233 is produced by (n, γ) reaction and beta emission.

$$ {}^{232}_{90}\mathrm{TH} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{233}_{90}\mathrm{th} + \gamma $$

$$ {}^{233}_{90}\mathrm{TH} \rightarrow {}^{233}_{91}\mathrm{pa} + \beta^{-} $$

$$ {}^{233}_{91}\mathrm{Pa} \rightarrow {}^{233}_{92}\mathrm{U} + \beta^{-} $$

T_i - (May also be noted as I_T) - The temperature of the cooling water as measured just before it enters the reactor process tubes.

T_o - (May also be noted as ^{O}T) - The temperature of the cooling water as measured just as it exits from the reactor process tubes. May also refer to the reactor bulk outlet temperature.

T.O.E. - Time Operated Efficiency - A value which is calculated as the total hours operated during a month divided by the total number of hours in the month x 100.

N REACTOR PLANT GLOSSARY (CONT'D)

Total Solids - The amount of solid impurities in water. It includes both dissolved solids and undissolved solids. At N Area the demineralizer effluent should not contain more than 0.2 parts per million of total solids with less than 0.22 ppm chloride and less than 0.22 ppm silica.

Trampoline - A submerged chain net provided to absorb the impact of free falling fuel elements being discharged from the reactor.

Transducer - A device actuated by power from one system and supplying power to a second system; an instrument which converts pressure differential signals into electrical signals to indicate flow, or to operate circuit trips or alarms.

Trip-Switch Function - The operation of a relay contact(s) or recorder limit switch contact(s) when a given signal increases or decreases beyond pre-set limits.

Tube Sleeves - A steel sleeve (pipe) extending through the primary shield into the graphite reflector and through which the process tube passes. A sleeve at each end of a process tube acts as a bearing for the tube and supports the nozzles.

Turbines - Any of the six engines driving primary pumps and generators; turbines that drive primary pumps are numbered 1-5, and the generator drive turbine 184-N Building is No. 6. Emergency seal water pump is also turbine driven.

Turbo-Generator - A turbine driven generator set provided to supply approximately half of the electrical power used in N Plant.

Turnaround - (or T.A.) - A term referring to the maximum and minimum points in the curve of pile reactivity vs. time. The term is most commonly used in referring to the maximum burnout and buildup and heating the graphite.

Turning Gear - Self contained motor driven unit capable of continuously turning the complete rotating elements of turbine driven equipment. It has three uses; to rotate the rotor at about two or three rpm so as to reduce the possibility of distortion when the turbine is cooling off; to jack the rotor small amounts for inspection; to turn the rotor when starting so that less steam is required to overcome inertia. Safety devices are installed to prevent operation without proper lubrication.

Vacuum Relief Port - Vacuum relief ports are provided in Zone I to prevent the pressures in the zone from becoming more negative than -1.7 psig.

Valves

Cone Valve - Special carbon steel, cone type, plug valves are used in the primary coolant system to provide leak-tight isolation service. This type valve is used in some "in-line" locations where the leak-tight stipulation is relaxed somewhat, although leakage is to be maintained at a minimum.
The basic design of the cone valve is that of a plug cock of the type wherein a conical shaped plug is rotated within a matching, slightly tapered body by an attached mechanism which first imparts axial motion to lift and unseat the plug, then rotates it 90° to open or close the valve, and finally axially lowers and tightly reseats the plug into the valve body. The leak tight closure of the valve is accomplished without a sealing lubricant.

N REACTOR PLANT GLOSSARY (CONT'D)

Valves (Cont'd)

Relief Valve - Handles non-compressible fluid - liquids such as oil and water. A relief valve differs from a safety valve in that immediate full-flow discharge is not needed since a very small flow significantly reduces over-pressure. Relief valve plug and seat opens and closes slowly, allowing liquid discharge back to some low-pressure point in the system to conserve the liquid.

Safety Valve - Is for compressible fluid - steam and other gases. This compressibility demands quick over-pressure relief. For this reason, safety valves have "pop" seats and plugs which open quickly on over-pressure, thus relieving at full flow. Safety valves may discharge to atmosphere in the case of steam, back into the system in the case of a costly or toxic gas.

Safety-Relief Valve - An automatic pressure actuated relieving device installed for use either as a safety valve or relief valve, depending upon its application.

See "Valves" book for definition and description of various other types of valves and their uses.

Vane Switch - A magnetically operated proximity switch used on the charge machine and the horizontal rod system as limit switches or as position indicators. The armless, leverless, and shaftless vane switch has no moving parts except for magnetic reed contacts which are hermetically sealed in an inert gas. Operation is accomplished by passage of a steel operating vane (attached to a moving part) through the vane slot (attached to a stationary part). The moving part does not come into direct contact with the stationary part. For this reason there is practically no mechanical wear involved in the operation of the vane switch.

Vents - Passages and/or special pressure relief devices installed to relieve excessive pressures. Confinement vents are provided to release steam generated by the rupture of any pressurized water line in 105 and 109 Buildings. A cross vent area between the 105 and 109 Buildings provides a means of minimizing the number of vents needed to atmosphere.
Steam vented from the graphite stack when a process tube ruptures will discharge through Zone I filters and out the stack.
Irradiation-created gases collecting in the high point pockets in the primary coolant system piping are vented into the pressurizer through bleed lines from the vent collection headers above adjacent groups of risers, vertical headers, or downcomers. In this manner automatic venting of the gas in the primary coolant piping is possible with no loss of demineralized water coolant.
Larger vents are installed on the piping to provide fast venting of entrapped air during the initial filling of the system.
Float type air vent valves are installed at all high points of the raw water emergency coolant supply lines and all other uncontaminated lines which operate under fully flooded condition. The air is discharged to atmosphere.

Venturi - A device for monitoring individual tube flow installed in the inlet connector to each process tube close to the inlet risers just downstream from the inlet butterfly valves.

N REACTOR PLANT GLOSSARY (CONT'D)

Water - The listing is not intended to be complete. Certain waters are adequately described by their names.

Afterheat Removal Water - Water used for the purpose of converting the secondary (steam) system to a recirculating water system for the purpose of transferring the nuclear afterheat of the reactor during shutdown from the primary system to the circulating water system. This water is stored especially for this purpose and is kept at the same quality as normal boiler water.

Backup Water - Any water which may be used for cooling a certain system in the event of failure of the normal cooling supply.

Circulating Water - The circulating water is the condenser cooling water. It is untreated (except for a coarse screening) Columbia River water. (Chlorine addition may be made intermittently.)

Demineralized Water - Water which has had almost all dissolved and undissolved materials removed. This term used in the 100-N Plant will generally signify that the water is also highly de-gassed since this is done during the demineralization process.

Emergency Backup Water - Any backup water which is used in event of a lack or failure of both the normal and secondary supplies.

Filtered Water - This term signifies water which has been chemically coagulated and filtered by the filter plant.

High Pressure Filtered Water - Filtered water supplied at a pressure of approximately 225 psi for the purpose of cooling the horizontal control rods.

High Pressure Injection Water - That high purity water pumped to a pressure approximately 50 psi higher than the primary coolant system pressure for injection into the primary coolant system. In addition to being supplied as makeup for normal operating losses in the primary coolant system, the water is also used to maintain a constant volume of primary coolant during temperature reduction, as a makeup for normal losses during charge-discharge operations and may be used to fill the primary coolant loop.

Low Pressure Filtered Water - Filtered water supplied at a pressure of approximately 110 psi for several purposes.

Low Pressure Injection Water - That high purity water pumped to a pressure of approximately 175 psi for the purpose of injection into the graphite cooling system. This water is also supplied to several other demineralized water uses.

Once-Through Water - The reactor is normally cooled by recirculating demineralized water. In the event that the recirculating supply should fail, the reactor is cooled by raw water which passes through the reactor only once and is termed "emergency once-through coolant" or "last ditch".
During periods of reactor shutdown, under planned conditions, special filtered water may be valved into the recirculating system and used as once-through coolant.

N REACTOR PLANT GLOSSARY (CONT'D)

Water (Cont'd)

Process Water - This term has a special meaning at Hanford. It is used to indicate filtered water with sodium dichromate added and intended for a special purpose. Although the 105-N Reactor control rods will be cooled by water of this quality, the use of the term "process water" should be avoided at the 100-N site.

Primary Water - Primary water is that of the quality normally contained in the primary loop. It is a high-purity, oxygen-free water with pH adjusted to 10 with lithium hydroxide (or ammonium hydroxide).

Raw Water - This term signifies untreated Columbia River Water. It may be strained or screened to remove trash and/or part of the undissolved material.

Sanitary (Potable) Water - This is filtered water with a small amount of chlorine added and suitable for drinking, cooking, etc.

Secondary Water - Secondary water is that of the quality normally contained in the secondary (boiling) loop. It is a high purity boiler water.

Service Water - This is the normal, non-potable water supply for the area. It is used for chemical makeup, cooling in some heat exchangers, lawn watering, valve operation, equipment washing, etc. The water is filtered water; the distinction being that "filtered water" is descriptive of quality, "service water" is indicative of the use for which it is intended.

Tempered Water - Water which has been warmed before injection into a hot system to ease thermal shock.

Related Terms - The following are some terms related to water supply:

Bleed - This term should be used to describe the water taken from the primary loop for the purpose of controlling primary water quality.

Blowdown - This term should be reserved to describe the water taken from the secondary side of the steam generators for the purpose of controlling secondary water quality.

Spill - This term indicates the water taken from the primary system to relieve a rise in pressurizer water level.

Injection - This indicates water put into the primary system at high pressure.

Weasel - The instrument used for measuring the radioactivity of a slug (or slugs), or the act of measuring with a weasel. This may be done under water through an air column with special equipment, or in air if the activity is not too great.

Weephole - A free "bleed off" hole, a free vent hole between a safety valve and a rupture disk. A gas circulation passage drilled in reactor graphite blocks, a method of minimizing gas stagnation around a process tube, a drainage hole in a graphite block to let leakage water into the gas channel.

N REACTOR PLANT GLOSSARY (CONT'D)

Withdrawal Order - A term referring to the sequence of movement of the HCR's during a start-up. After a reactor has started up or during the process of starting up, the HCR's are withdrawn in a definite sequence or "withdrawal order". Then as the reactivity increases due to Xe burnout, buildup, and heating of the graphite, the HCR's must be inserted to control the reactivity. This is called the insertion order and is the reverse order until such time as temperature effects dictate otherwise.

Xenon - (Also noted as L) - A nuclide formed mostly by the two-stage decay of the direct fission product Tellurium-135. Te-135 has a half-life of two minutes, and the decay product, I-135, has a half-life of 6.7 hours. Because of its large neutron capture cross section, xenon is poisonous to pile reactivity and must be accounted for in calculating pile reactivity.

Z - A symbol for atomic number.

Zircaloy-2 - Zirconium modified with small amount of tin and traces of other metals is the best material developed to date for reactor process tube and moderator cooling tube use that will meet the requirements for NPR operating conditions.

Zone Temperature Monitor - An instrument in the rod safety circuit system which will provide a fast scan of selected process tube outlet temperatures. This device will provide near-instantaneous tube-power distribution information by monitoring a well-distributed fraction of the active tubes in the pile and shutdown the reactor if preset limits are exceeded.

Zones - Divisions or classifications of the reactor complex; with reference to confinement, Zone I includes radiation and primary confinement zones, including space adjacent to the reactor block and primary coolant piping. This zone is designed to withstand internal pressures of -2.0 to +5.0 psig.

Zone II - Includes radiation zones or potentially contaminated areas, including space adjacent to the reactor blocks or connected thereto by pipes and tunnels, but not containing primary coolant piping. This zone is designed to withstand internal pressures of -0.1 to +0.5 psig.

Zone III - Includes those areas immediately surrounding all of Zone I and portions of Zone II. This zone is designed to withstand internal pressures of -0.1 to +0.2 psig.

23 - A code number for $_{92}U^{233}$, the first digit of the code referring to the second digit of the Atomic Number of $_{92}U^{233}$, and the second digit of the code referring to the last digit of the Mass Number of $_{92}U^{233}$.

25 - A code number for $_{92}U^{235}$ formed in the same manner as the preceding code number for $_{92}U^{233}$.

28 - A code number for $_{92}U^{238}$ formed in the same manner as the code number for $_{92}U^{233}$.

49 - A code number for $_{94}U^{239}$ formed in the same manner as the code number for $_{92}U^{233}$.

240 - The code number indicating $_{94}Pu^{240}$.