10 STEAM AND POWER CONVERSION SYSTEM

0278

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LIST OF FIGURES

(At Rear of Section)

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10 STEAM AND POWER CONVERSION SYSTEM

10.1 DESIGN BASES

The steam and power conversion system is designed to accept steam from the NSS. Approximately 75 percent of the steam heat energy supplied by the NSS is used to generate electrical energy. Steam containing the remaining heat energy is transported to the site boundary for process use by Dow. Most of the steam is condensed and returned to the NSS as heated feedwater. The steam not condensed is replaced by treated makeup from Dow.

10.2 SYSTEM DESCRIPTION AND OPERATION

The flow diagram of the system is shown on Figures 10-1 and 10-2.

10.2.1 MAIN STEAM SYSTEM

Two steam generators are provided for each unit. Steam is generated in the shell side of the steam generators. The steam for each unit is then conducted through two main headers to the turbine stop valves. Each main steam header is provided with safety valves which back up the main steam bypass and dump system.

Steam is taken from the main steam lines for use in the turbine steam seals and in the plant auxiliary steam system. Heating steam is taken from the turbine cycle.

The main steam piping is arranged so that the Unit 1 main steam system can be supplied with steam from Unit 2 when the Unit 1 reactor is shut down. This allows continued utilization of process steam for electrical generation, which is more economical then throttling in this condition. A main steam turbine bypass and atmospheric dump system is provided for each unit to automatically dump 100 percent of full load following a turbine trip. A signal from the main steam system actuates the steam dump system. The bypass system to the condensers and atmospheric dump, in conjunction with the reactor coolant pressure control system, is adequate to prevent reactor trip from load rejections of approximately 100 percent. During normal shutdown, steam is dumped to the main condenser for initial decay heat removal and cooldown.

10.2.2 PROCESS STEAM SYSTEM

Process steam is normally furnished from the cycle as follows:

a. 400,000 lb/h at 675 psia, throttled from Unit 1 main steam.

b. 3,650,000 lb/h at 197 psia, from the Unit 1 turbine moisture separators.

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Two headers transport the 197 psia steam to the site boundary. A single header transports the 675 psia steam to the site boundary.

Flow of 197 psia process steam from the Unit 1 turbines is uncontrolled. Nonreturn valves are provided as required in the 197 psia extraction lines for protection of the turbine.

Backup pressure reducing stations supply the 197 psia steam when the Unit 1 turbine is out of service or when the station electrical load demand is too low for the Unit 1 turbine to furnish the required process steam pressure.

10.2.3 TURBINE GENERATORS

Two 1800 rpm, tandem-compound indoor turbines are provided. The steam from the Unit 1 NSS flows through a two-flow high-pressure turbine and then through moisture separator reheaters and combined intercept and stop valves to one double-flow low-pressure turbine which exhausts to the main condenser. The steam from the Unit 2 NSS flows through a two-flow high-pressure turbine and then through moisture separator reheaters and combined intercept and stop valves to two double-flow low-pressure turbines which exhaust to the two main condensers.

Superheated steam is supplied to the throttle of each turbine from the steam generators through four stop valves and the governing control valves.

The lubricating oil system of each turbine supplies oil for lubricating the bearings. A bypass stream of turbine lubricating oil flows continuously through an oil conditioner to remove water and other impurities.

The generators are direct-connected to the turbines and are water- (conductor) and hydrogen- (inner) cooled units. The generators have the capability to accept the gross rated output of the turbine at rated steam conditions. The exciters are of the direct-connected silicon diode rectifier type. The generator glands are oil sealed to prevent hydrogen leakage.

10.2.4 CONDENSATE AND FEED-WATER SYSTEM

One condenser is installed perpendicular to the turbine spindle under each low-pressure cylinder, for a total of three condensers. The condensers are of the deaerating type and are sized to condense exhaust steam from the main turbines, and the feed pump turbine drivers, and, to cool the drains from the two lowest-pressure heaters. The condensers are also capable of condensing bypassed steam from the main steam headers.

Each unit is provided with a twin element steam jet air ejector with inter- and aftercoolers to maintain condenser vacuum. Initial evacuation of the condenser is accomplished by a steam hogging ejector. Air ejector vapor discharge

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is monitored for radioactivity. Air ejector vapor is discharged through the stack.

Each unit is provided with two half-capacity electric motor-driven condensate pumps which pump the condensate through the air ejector, gland steam condenser, demineralizers, and three stages of low-pressure feed-water heaters to the suction of two half-capacity electric motor-driven feed-water booster pumps. The feedwater is pumped through two stages of high-pressure feed-water heaters to the steam generators by the two half-capacity turbine-driven steam generator feed-water pumps of each unit.

Condensate demineralizers are provided for 100 percent of maximum condensate flow in order to meet steam generator water purity requirements. Process returns are normally admitted to the Unit 1 condenser. These are demineralized in the condensate and demineralizers.

The feed pump turbines are supplied with steam from the main turbine cross-arounds downstream of the reheaters with backup supply from the main steam headers.

Two redundant auxiliary feed-water pumps are installed for each unit to supply water to the steam generators during plant start-up and on loss of station power. These pumps are described further in Section 9.8.

The feed-water heater cycle for each unit consists of two parallel trains, each containing five heaters. Each train carries half of the feed-water flow and contains three low-pressure heaters and two high-pressure heaters in series. The last low-pressure heaters are open deaerating heaters. All other heaters are of the closed type.

Flow of feed-water heating extraction steam from the turbine extraction ports is uncontrolled. Air-operated nonreturn valves or check valves are provided as required in the extraction lines for protection of the turbine. The air-operated valves are actuated by heater high water level or turbine overspeed. Extraction spill valves and lines to the condenser are provided for use when the nonreturn valves are closed, to insure continued moisture removal from the turbines.

Drains from the two-stage reheater tube sides are discharged through reheater drain tanks to the feed-water heaters. With the exception of the deaerating heaters, all heaters are arranged so that their drains normally cascade to the next lower heater in the cycle. An automatic drain control valve is provided for normal draining of each closed heater. Alternate drain lines, each with an automatic drain dump valve discharging to the condenser, are also provided for all heaters.

The main feed-water piping is so arranged that the Unit 2 NSS can be supplied with feedwater from the Unit 1 feed-water system when the Unit 1 reactor is shut down.

Valving in the feed-water system is provided to permit bypassing the closed feed-water heaters in each train. Feed-water regulator valves are provided on the supply lines to each steam generator. Feed-water regulation is described in Section 7.

Chemicals are added to the feed-water headers downstream of the condensate pumps for oxygen scavenging and pH control.

A condensate storage tank is provided for each unit. A condensate transfer pump is provided per tank to supply condensate makeup to the various systems. Automatic controls for makeup to and reject from the condensers, maintaining the condenser hot well levels, are provided.

The total flow of process returns, described previously, includes an allowance for normal primary and secondary system losses in addition to replacement of the total process steam delivery.

10.2.5 CIRCULATING WATER SYSTEM

Cooling water is stored in a cooling pond. The pond is enclosed by a dike. Overflow spillways control the maximum pond elevation, and low-level gates provide for periodic blowdown discharge to the Tittabawassee River. Cooling pond makeup water is taken from the river during at least nine months of the year. The pond is sized to allow for all water losses from the pond, without makeup, during the three-month period when river flow is low.

Circulating water for the condensers is taken from the cooling pond. Four vertical, wet pit circulating water pumps, two for each unit are installed adjacent to the screen wells from which they take suction. The circulation water piping is arranged in four parallel lines with one pump discharging through one line to one of the water boxes on the condensers. A chlorinating facility is provided for algae and slime control.

Two pumps on the north dike, adjacent to the river, provide for cooling pond makeup.

10.3 DESIGN EVALUATION

All parts of this system are designed and fabricated in accordance with applicable codes. The components are similar to those which have experienced service in operating power plants. Adequate protective devices and controls are provided to assure reliable and safe operation.

10.3.1 TRIPS AND AUTOMATIC CONTROL ACTIONS

Trips and automatic control actions are described in Section 7.4.

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10.3.2 SYSTEM MALFUNCTIONS

The effects of inadvertent steam relief or steam bypass are covered by the analysis of the steam line failure given in 14.1.2.9. The effects of an inadvertent rapid throttle valve closure are covered by the loss of full load discussion in 14.1.2.8.

10.3.3 OVERPRESSURE PROTECTION

Pressure relief is required at the system design pressure of 1050 psig, and the first safety valve bank will be set to relieve at this pressure. The design pressure is based on the operating pressure of 925 psia plus a 10 percent allowance for transients and a 4 percent allowance for blowdown. Additional safety valve banks are set at pressures up to 1104 psig, as allowed by the ASME Code.

The pressure relief capacity is such that the energy generated at the rated NSS steam flow can be dissipated through this system.

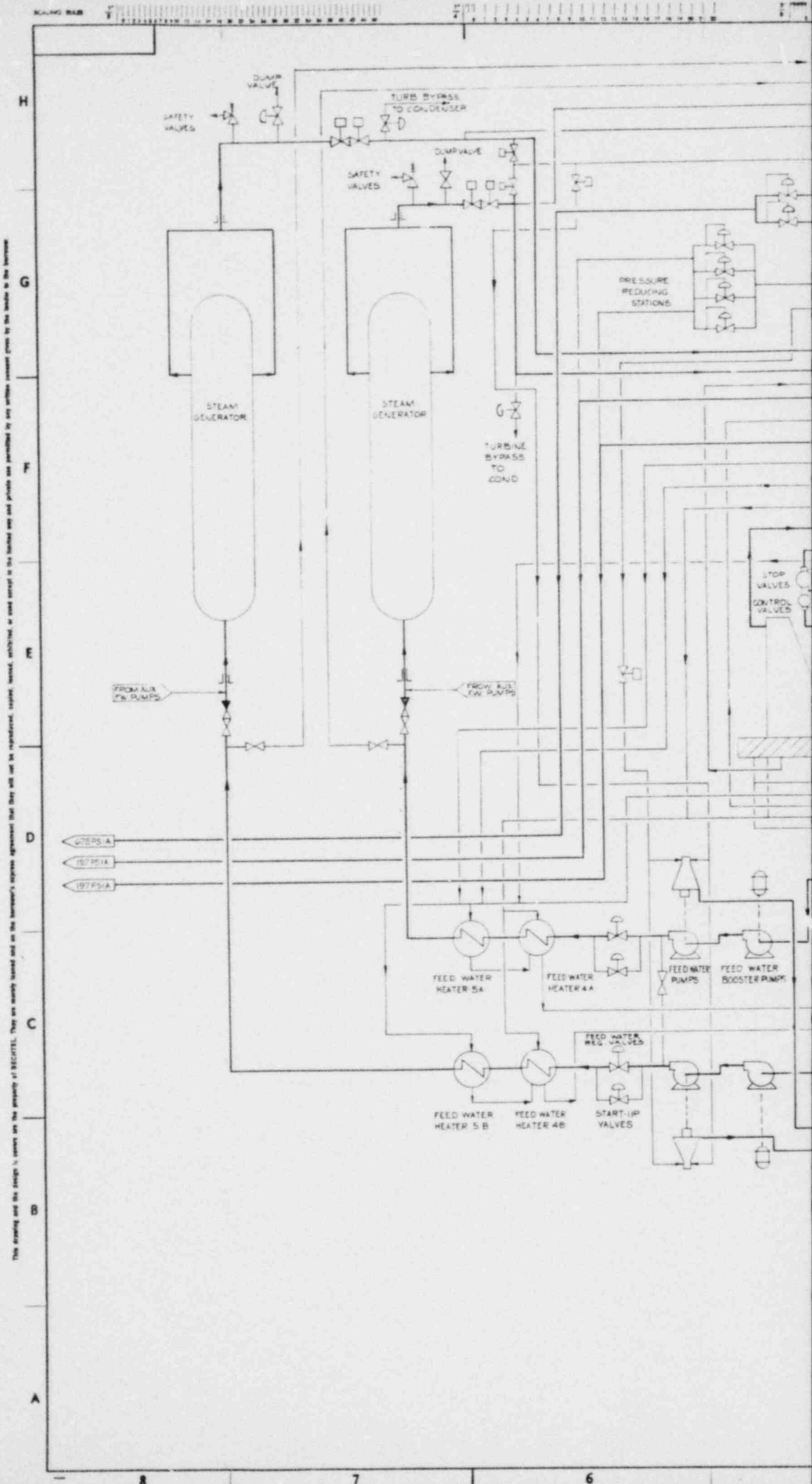
10.4 TESTS AND INSPECTIONS

Equipment, instruments and controls are regularly inspected in order to insure proper functioning of systems.

The turbine stop valves, combined intermediate valves, extraction line non-return valves, main steam bypass system and the auxiliary feed-water pumps may be tested while the turbines are in operation.

Lifting levers are provided on the safety valves, as required by the ASME Boiler and Pressure Vessel Code, Section VIII.

In addition, all equipment, instruments and controls will be thoroughly checked and inspected when these are not in use during refueling periods.


H
G
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A
8
7
6
DUMP VALVE
SAFETY VALVES
TURB BYPASS TO CONDENSER
DUMP VALVE
SAFETY VALVES
PRESSURE REDUCING STATIONS
STEAM GENERATOR
STEAM GENERATOR
TURBINE BYPASS TO COND
STOP VALVES
CONTROL VALVES
FROM AUX FW PUMPS
FROM AUX FW PUMPS
197 PSIA
FEED WATER HEATER 5A
FEED WATER HEATER 4A
FEED WATER PUMPS
FEED WATER BOOSTER PUMPS
FEED WATER REG. VALVES
FEED WATER HEATER 5 B
FEED WATER HEATER 4B
START-UP VALVES

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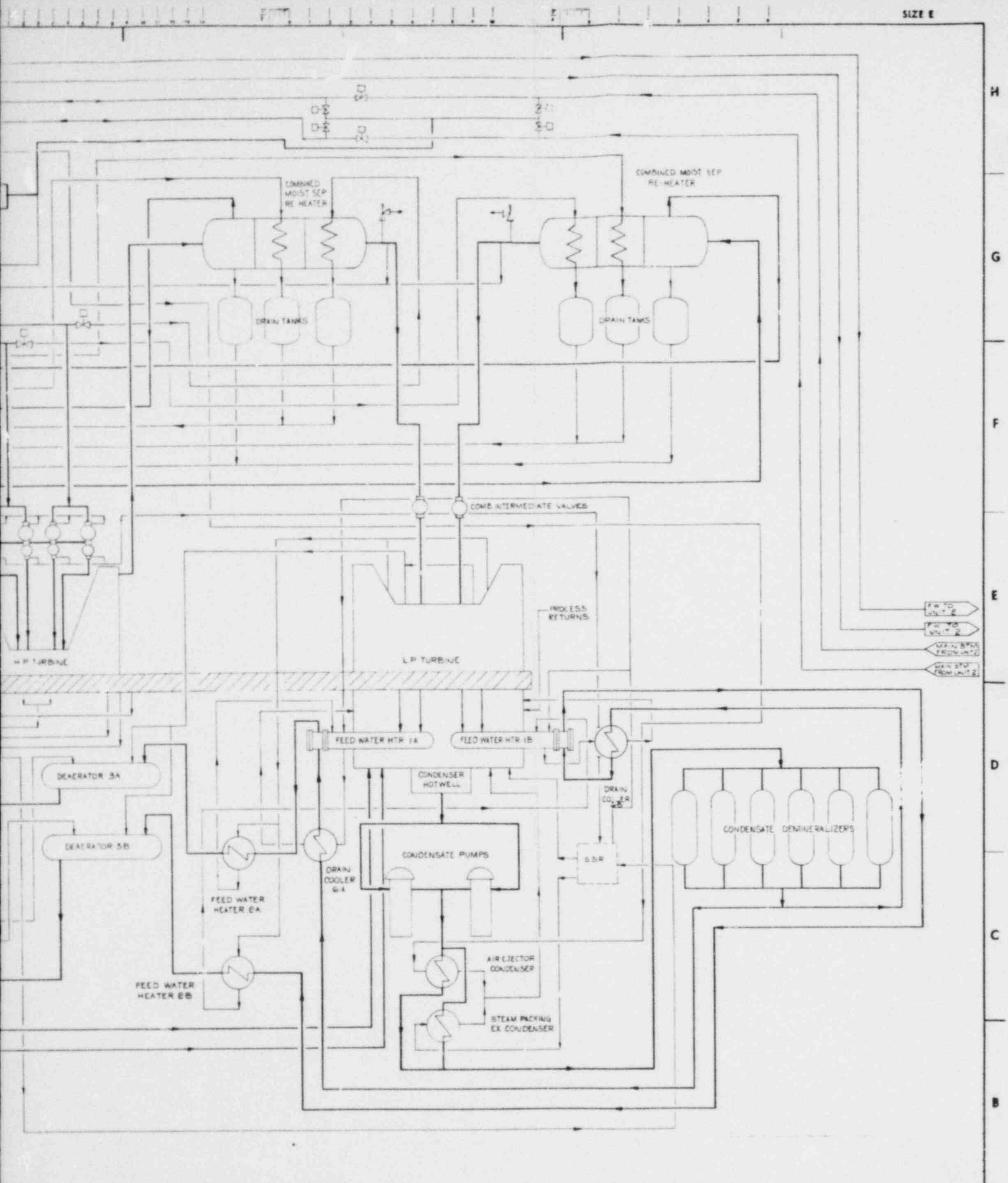

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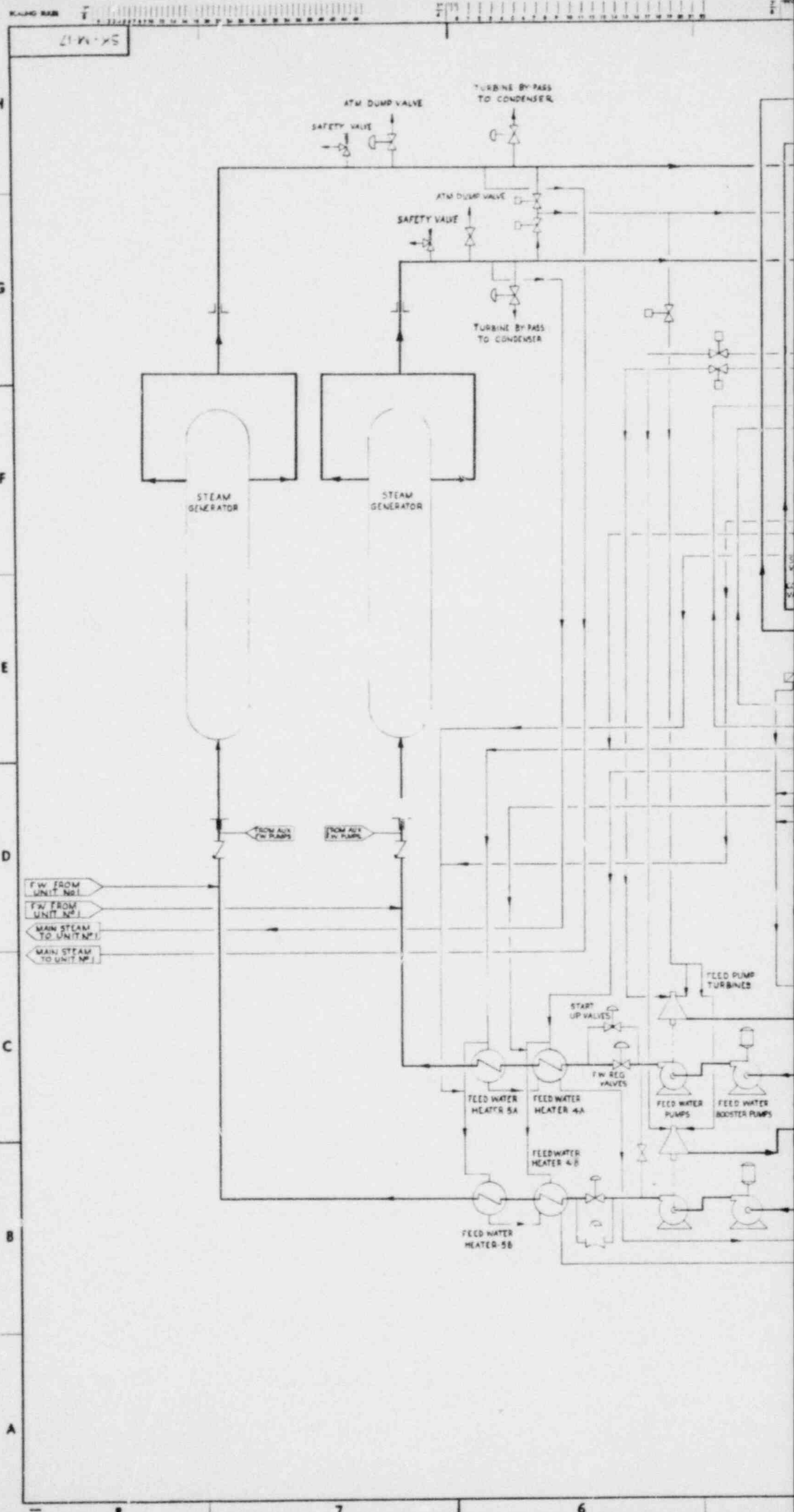
MIDLAND PLANT UNITS 1 & 2
CONSUMERS POWER COMPANY

FLOW DIAGRAM UNIT No 1
MAIN STEAM, FEED WATER, CONDENSATE & PROCESS STEAM SYSTEMS SH 1 OF 2

BECHTEL	7220	FIG 10-1

AMENDMENT 2



SK-M-17
ATM DUMP VALVE
TURBINE BY PASS
TO CONDENSER
SAFETY VALVE
ATM DUMP VALVE
SAFETY VALVE
TURBINE BY PASS
TO CONDENSER
STEAM
GENERATOR
STEAM
GENERATOR
FROM AUX
F.W. PUMPS
FROM AUX
F.W. PUMPS
F.W. FROM
UNIT No1
F.W. FROM
UNIT No1
MAIN STEAM
TO UNIT No1
MAIN STEAM
TO UNIT No1
FEED PUMP
TURBINES
START
UP VALVES
F.W. REG
VALVES
FEED WATER
HEATER 5A
FEED WATER
HEATER 4A
FEED WATER
PUMPS
FEED WATER
BOOSTER PUMPS
FEEDWATER
HEATER 4B
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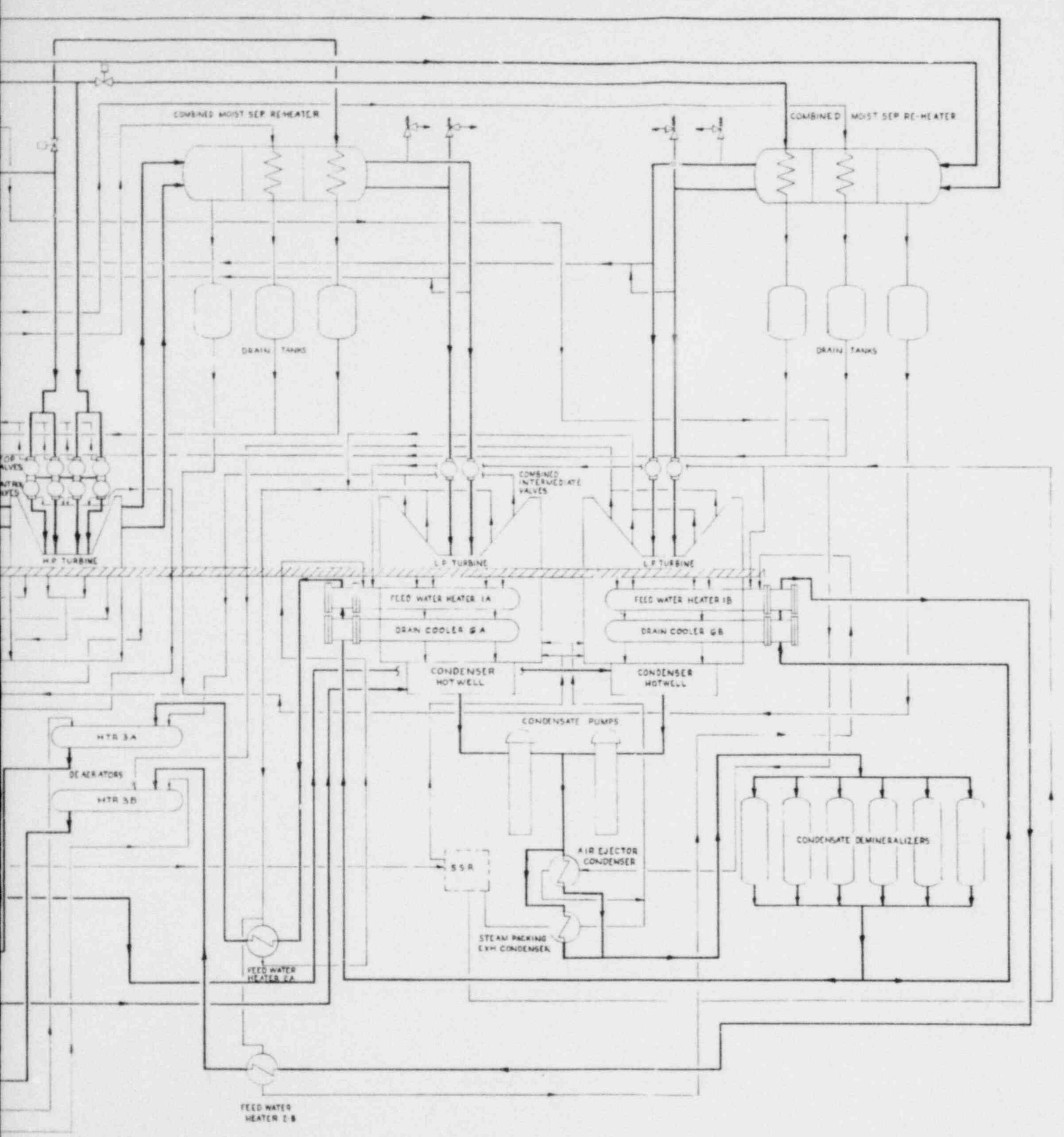

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MIDLAND PLANT UNITS 1 & 2
CONSUMERS POWER COMPANY

FLOW DIAGRAM UNIT 2
MAIN STEAM FEEDWATER CONDENSATE SYSTEMS SHEET 2 OF 2

7220 FIG 10-2

AMENDMENT 2

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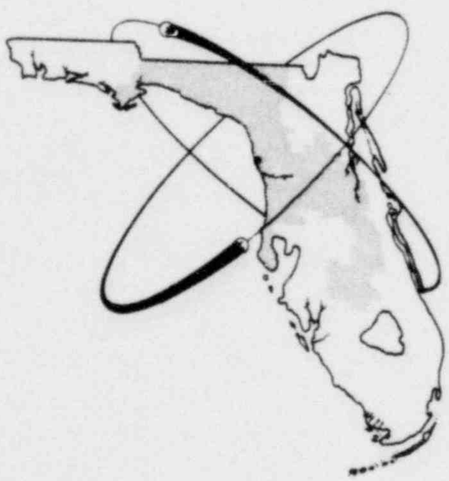
Crystal River Units 3 & 4 Nuclear Generating Plant



PRELIMINARY

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REPORT

VOLUME 3

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FPC
FLORIDA
POWER
CORPORATION

2-12-68

Docket Nos. 50-302
50-303
February 7, 1968

AMENDMENT NO. 2

FLORIDA POWER CORPORATION

Crystal River Plant Units 3 & 4

Amendment No. 2 to the Florida Power Corporation's Preliminary Safety Analysis Report includes both insert pages, as listed below, and Supplement No. 1. Supplement No. 1 consists of the response to the letter dated January 19, 1968 from Dr. Peter A. Morris, Director, Division of Reactor Licensing. The supplement also contains answers to the "Requested Additional Information" by D.R.L. on January 19, 1968 (1.0 through 9.15).

NOTE

Inclosed herewith, immediately following the instruction sheets, you will find a title sheet entitled "Appendices" and a complete Table of Contents (pages "i" through "vii"). These sheets are to be inserted in the binder entitled "APPENDICES which accompanies this amendment.

Remove the contents in existing Volume 4--from the tab entitled "APPENDIX" to the end of the volume (Appendix 12A)--and insert all appendices in the binder entitled "APPENDICES." (The title sheet and table of contents in existing Volume 4 should remain in place.)

The following sheets of the Florida Power Corporation's Preliminary Safety Analysis Report are to be deleted and, where appropriate, revised sheets dated 2-7-68 should be inserted.

Remove the following sheets:	Insert the following sheets:
Pages: Table of contents - vii (one each in Volumes 1, 2, 3, and 4)	Pages: Table of contents - vii (one each in Volumes 1, 2, 3, and 4)
Pages: 1-27, 1-28, 1-29, 1-30, 1-35, and 1-36.	Pages: 1-27, 1-28, 1-29, 1-30, 1-35, and 1-36.
Figures: 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-9, and 1-12.	Figures: 1-2, 1-3, 1-4, 1-5, 1-6, 1-7, 1-9, and 1-12.
Pages: 5-17, 5-18, and 5-19.	Pages: 5-17, 5-18, and 5-19.
Figure: 5-6.	Figure: 5-6.

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<u>Remove the following sheets:</u>

<u>Pages</u>: 6-1, 6-2, 6-3, 6-4, 6-5, 6-6, 6-7, 6-8, 6-9, 6-10, 6-11, 6-12, 6-17, 6-18, 6-21, and 6-22.

<u>Figures</u>: 6-1, 6-2, 6-4, and 6-5.

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<u>Figure</u>: 7-2.

<u>Pages</u>: 8-1, 8-2, 8-5, 8-6, 8-7, 8-8, 8-9, 8-10, 8-11, and 8-12.

<u>Figures</u>: 8-1 and 8-2.

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<u>Pages</u>: 14-7, 14-8, 14-29, 14-30, 14-37, 14-38, 14-41d, 14-42, 14-45, and 14-46.

<u>Figures</u>: 14-37 and 14-38.

<u>Pages</u>: 1A-9 and 1A-10.

<u>Pages</u>: 5A-1 and 5A-2.

<u>Insert the following sheets:</u>

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<u>Figures</u>: 14-37 and 14-38.

<u>Pages</u>: 1A-9 and 1A-10.

<u>Pages</u>: 5A-1 and 5A-2.

<u>Supplement 1</u>

Insert entire Supplement 1 in Volume 4.

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Docket Nos. 50-302
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1-23-68

AMENDMENT NO. 1

FLORIDA POWER CORPORATION

Crystal River Plant Units 3 & 4

The following sheets of the Florida Power Corporation's Preliminary Safety Analysis Report are to be deleted; and, where appropriate, revised sheets dated 1-15-68 should be inserted.

Remove the following sheets:

Pages: Table of contents - iv and vi (one each in volumes 1, 2, 3, and 4).

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Figure: 10-1.

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Figures: 9-3, 9-4, 9-8, ~~and 9-10.~~

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Figure: 10-1.

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Figure: 12-1.

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Pages: Cover Sheet--Appendix 2C	Pages: Cover Sheet--Appendix 2C and all sheets up to and including Cover Sheet--"2. Flood Studies for Crystal River Nuclear Power Plant." NOTE Your revised Appendix 2C will now include two separate sections: (1) "Plant Protection Against Hurricane Wave Action"...this is a new section included with this amendment and not found in the original P.S.A.R. (2) "Flood Studies for Crystal River Nuclear Power Plant"...the original Appendix 2C, which now becomes Section 2 of Appendix 2C.
Pages: 2G-1 to and including 2G-85.	Pages: 2G-1 to and including 2G-119.
Figures: 2G-1, 2G-6, 2G-7, and 2G-8.	Figures: 2G-1, 2G-6, 2G-7, and 2G-8.
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Figure:	Figure: 5A-1.
Pages: 5B-1, 5B-2, 5B-3, 5B-4, and 5B-5.	Pages: 5B-1, 5B-2, 5B-3, 5B-4, 5B-5, 5B-6, 5B-7, 5B-8, 5B-9, 5B-10, 5B-11, 5B-12, 5B-13, and 5B-14.
Figures:	Figures: 5B-1, 5B-2, 5B-3, 5B-4, 5B-5, 5B-6, 5B-7, and 5B-8.

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Docket Nos. 50-302
50-303

Remove the following sheets:

Pages: 5C-1 and 5C-2.

Figure:

Pages: 5D-1, 5D-2, 5D-3, 5D-4, 5D-5, 5D-6, and 5D-7.

Insert the following sheets:

Pages: 5C-1, 5C-2, 5C-2a, and 5C-2b.

Figure: 5C-1.

Pages: 5D-1, 5D-2, 5D-3, 5D-4, 5D-5, 5D-6, 5D-7, 5D-8, 5D-9, and 5D-10.

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