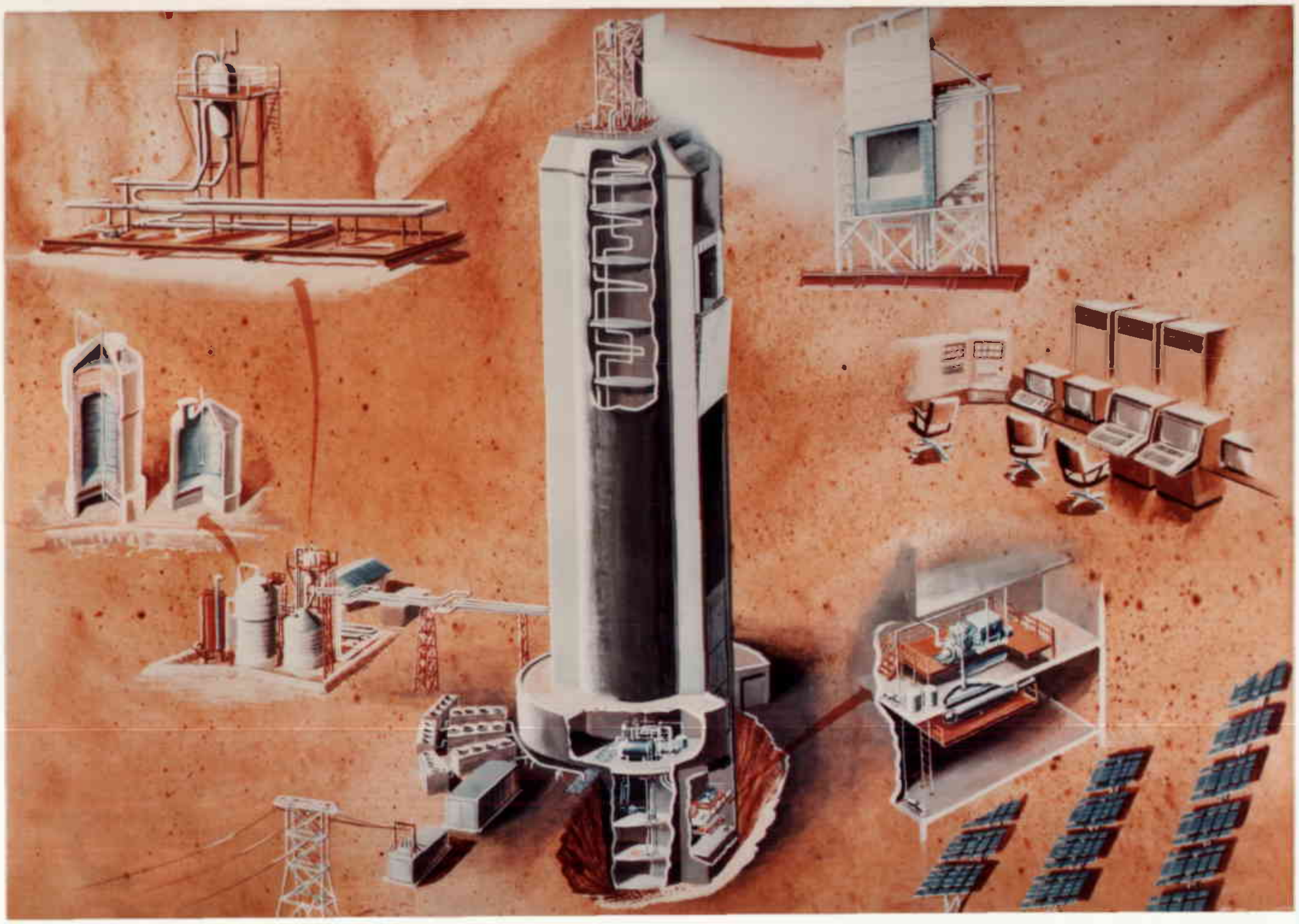

MOLTEN SALT ELECTRIC EXPERIMENT (MSEE)

System Operation

MCDONNELL DOUGLAS CORPORATION

MCDONNELL DOUGLAS CORPORATION

Molten Salt Electric Experiment (MSEE) System Operation

1275

MOLTEN SALT ELECTRIC EXPERIMENT

(MSEE)

SYSTEM OPERATION

31 AUGUST 1984

MCDONNELL DOUGLAS
CORPORATION

FORWARD

This System Operation Plan is one of three documents that describe plans for Phase II of the MSEE Project. These documents are:

MSEE Evaluation Plan
Plan to accomplish MSEE project objectives using Phase I and Phase II test results, analysis and evaluation.

Phase II Test Plan
Plan for tests during Phase II which will provide data needed for evaluation.

System Operation Plan
Plan to operate MSEE by teams of utility and industry operators and obtain their feedback on the MSEE system.

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CONTENTS

CONTENTS

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CONTENTS

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Section 1

INTRODUCTION

1.1 BACKGROUND

Solar thermal central receiver systems have been under development since the early seventies. The first central receiver system in the United States (Solar One) uses water/steam as a heat transfer fluid in the receiver. Subsequent studies and test programs investigated molten salt, liquid sodium, and hot air as heat transfer fluids. They all possess certain advantages over water/steam, but many feel that molten nitrate salt is the most promising heat tranfer fluid, particularly for utility-scale electric power plants with thermal storage.

A complete molten salt system experiment has been built at the Department of Energy (DOE) Central Receiver Test Facility (CRTF) located at Kirtland Air Force Base, Albuquerque, New Mexico. The CRTF heliostat field concentrates reflected solar energy onto a molten salt cooled solar receiver located on top of the 200-foot-tall CRTF test tower. Molten salt is pumped from a "warm" salt storage tank at ground level up the tower to the solar receiver where it is heated by absorbing solar energy and then returns to a "hot" salt storage tank at ground level. A hot salt pump delivers salt from the hot tank to a molten salt steam generator which produces steam to power a turbine/generator which feeds electricity into the local power grid.

This experiment is being conducted in two phases. The Phase I design, construction, installation, checkout, and verification effort has been completed. In Phase II, system characterization tests are being performed and the system will be operated and evaluated by utility and industry personnel. This document provides the data to be utilized by the utility and industry participants in their training and operation. The system may be run for an additional period in a potential third phase.

A consortium consisting of utilities, industries and the Electric Power Research Institute (EPRI), has helped construct and support operation of the experiment. The consortium is supplying half of the project's funding through either cash contributions or donations of in-kind engineering services. The other half is supplied by the DOE, through Sandia.

1.2 OBJECTIVES

The MSEE is designed as a first full-system experiment of future large-scale, central station power plants. The test and evaluation program is designed to provide data to be used in the design and operation of these commercial plants. This will be accomplished by a thorough characterization of the MSEE itself and by identifying features that should be changed in a commercial plant or its prototype. Operation of the MSEE by utility and industry personnel can make a significant contribution to this evaluation as well as provide familiarization with the operation of this type of solar power plant. Accordingly, the specific objectives of this operational phase are:

1. Demonstrate operation of a molten salt cooled central receiver solar power plant to participating utility and industry personnel. This also demonstrates power plant control by a distributed digital central system.

2. Obtain an evaluation by the participants of the MSEE design and operation and of the training methods employed in this program.

SECTION 2 TRAINING CLASS SCHEDULE

Section 2

TRAINING AND OPERATING SESSIONS

APS TEAM (SEPTEMBER 24 - OCTOBER 12, 1984)

Monday, September 24 -- Orientation and Master Control Subsystem

8:00	Introduction -- Conference Room
9:00	CRTF Projects Review and Safety Briefing -- Conference Room
9:30	Break
9:45	MSEE System Overview -- Conference Room
10:00	Tour of MSEE -- Field and Control Room
11:30	Discussion and Questions -- Conference Room
12:00	Master Control Subsystem -- Conference Room (Sections 3.2 and 4)
1:00	Console Operation -- Control Room (Sections 4 and 5.1.1)
4:00	Complete

Tuesday, September 25 -- Receiver and Thermal Storage Subsystems (Sections 3.3 and 3.4)

8:00	Subsystem Description -- Conference Room
9:00	Tour of Receiver and Thermal Storage Subsystems -- Tower and Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operation, Alarms and Trips -- Conference Room
12:00	Training - Receiver Loop Operation -- Conference Room (Section 7 and P&ID) Check Lists Procedures Console Instruction (individually in Control Room) (Sections 5.1.2, 5.1.3, and 5.1.4)
4:00	Complete

Wednesday, September 26 -- Receiver Operations

8:00	Training - Receiver Loop Operation -- Conference Room	
	Receiver Start-up Using Simulation -- Control Room (rotate groups)	
11:00	Test on Receiver Loop Start-up and Operation -- Conference Room	
12:00	Receiver Cold Flow -- Control Room (Section 5.2.1).	
4:00	Complete	

Thursday, September 27 -- Receiver Operation

8:00	Receiver Steady State Operation (Section 5.2.2).
4:00	Complete

Friday, September 28 -- Receiver Loop Operation

8:00	Receiver Cold Flow (Section 5.2.1) -- Control Room
10:00	Receiver Operation with Simulated Clouds (Section 5.2.3) -- Control Room
4:00	Complete

Monday, October 1 -- Steam Generation Subsystem (Sections 3.5 and 3.7)

8:00	Subsystem Description -- Conference Room
9:00	Tour of Steam Generator and HRFS Subsystems -- Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operations, Alarms and Trips -- Conference Room
12:00	Training - Steam Generator Operation -- Conference Room (Section 7 and P&ID) Check Lists Procedures Console Instruction (individually in Control Room (Section 5.1.5)
4:00	Complete

Tuesday, October 2 -- Steam Generator Operation

8:00	Training -- Steam Generator Operation -- Conference Room
11:00	Test on Steam Generator Start-up and Operation -- Conference Room
12:00	Steam Generation Operation (Section 5.2.5) -- Control Room
4:00	Complete

Wednesday, October 3 -- Charge Thermal Storage with Propane Heater, Operate Steam Generator

8:00	Thermal Storage Charging with Propane Heater (Section 5.2.4) -- Control Room
12:00	Steam Generator Operation (Section 5.2.5) -- Control Room
4:00	Complete

Thursday, October 4 -- Electric Power Generation Subsystem (Sections 3.6 and 3.7)

8:00	Subsystem Description -- Conference Room
9:00	Tour of EPGS and HRFS -- Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operations, Alarms and Trips -- Conference Room
12:00	Training - EPGS Operation - Conference Room (Section 7 and P&ID)
4:00	Complete

Friday, October 5 -- Operation of EPGS

8:00	Operation of Full Electric Loop (Section 5.2.6) -- Control Room and field
	Teams will rotate between Control Room and Turbine Room in A.M. and P.M.
4:00	Complete

Monday, October 8 -- System Operation

8:00	Discussion of System Operation -- Conference Room
10:00	System Steady State Operation (Section 5.2.7) -- Control Room and field
	Rotate groups between locations
4:00	Complete

Tuesday, October 9 -- System Operation

8:00	System Steady State Operation (Section 5.2.7)
	EPGS Steady State Performance (Section 5.2.8)
	Rotate groups between Control Room and field
4:00	Complete

Wednesday, October 10 -- System Operation

8:00	System Steady State Operation (Section 5.2.7)
	EPGS Steady State Performance (Section 5.2.8)
	Rotate groups between Control Room and field
4:00	Complete

Thursday, October 11-- System Operation and Debriefing

8:00	System Steady State Operation (Section 5.2.7) -- Control Room and field
12:00	Debriefing -- Conference Room
2:00	Briefing on Solar One
4:00	Complete

Friday, October 12 -- Tour of Solar One

System Operation

Controls

Section 2

TRAINING AND OPERATING SESSIONS

PNM TEAM (SEPTEMBER 4 - 21, 1984)

Tuesday, September 4 -- Orientation and Master Control Subsystem

8:00	Introduction -- Conference Room
9:00	Safety Briefing -- Conference Room
9:30	Break
9:45	MSEE System Overview -- Conference Room
10:00	Tour of MSEE -- Field and Control Room
11:30	Discussion and Questions -- Conference Room
12:00	Master Control Subsystem -- Conference Room (Sections 3.2 and 4)
1:00	Console Operation -- Control Room (Sections 4 and 5.1.1)
4:00	Complete

Wednesday, September 5 -- Receiver and Thermal Storage Subsystems (Sections 3.3 and 3.4)

8:00	Subsystem Description -- Conference Room
9:00	Tour of Receiver and Thermal Storage Subsystems -- Tower and Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operation, Alarms and Trips -- Conference Room (Section 7 and P&ID) Check Lists Procedures Console Instruction (individually in Control Room) (Sections 5.1.2, 5.1.3, and 5.1.4)
4:00	Complete

Thursday, September 6 -- Receiver Operations

8:00	Training - Receiver Loop Operation -- Conference Room Receiver Start-up Using Simulation -- Control Room (rotate groups of two)
11:00	Test on Receiver Loop Start-up and Operation -- Conference Room
12:00	Receiver Cold Flow -- Control Room and Field (Section 5.2.1). Rotate groups of two in Control Room and two in field.
4:00	Complete

Friday, September 7 -- Receiver Operation

8:00	Receiver Steady State Operation (Section 5.2.2). Rotate groups of two in Control Room and two in field.
4:00	Complete

Monday, September 10 -- Steam Generation Subsystem (Sections 3.5 and 3.7)

8:00	Subsystem Description -- Conference Room
9:00	Tour of Steam Generator and HRFS Subsystems -- Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operations, Alarms and Trips -- Conference Room
12:00	Training - Steam Generator Operation -- Conference Room (Section 7 and P&ID) Check Lists Procedures Console Instruction (individually in Control Room) (Section 5.1.5)
4:00	Complete

Tuesday, September 11 -- Steam Generator Operation

8:00	Training -- Steam Generator Operation -- Conference Room
11:00	Test on Steam Generator Start-up and Operation -- Conference Room
12:00	Steam Generation Operation (Section 5.2.5) -- Control Room and Field
	One group of two in Control Room; other group of two in field
4:00	Complete

Wednesday, September 12 -- Charge Thermal Storage with Propane Heater, Operate Steam Generator

8:00	Thermal Storage Charging with Propane Heater (Section 5.2.4) -- Control Room and Field
12:00	Steam Generator Operation (Section 5.2.5) -- Control Room and field. Rotate groups from Tuesday P.M. assignments

Thursday, September 13 -- Receiver Loop Operation

8:00	Receiver Cold Flow (Section 5.2.1) -- Control Room and field
12:00	Receiver Operation with Simulated Clouds (Section 5.2.3) -- Control Room and field
4:00	Complete

Friday, September 14 -- Electric Power Generation Subsystem (Sections 3.6 and 3.7)

8:00	Subsystem Description -- Conference Room
9:00	Tour of EPGS and HRFS -- Field
10:00	Control Loops and Instrumentation -- Conference Room
11:00	Operations, Alarms and Trips -- Conference Room
12:00	Training - EPGS Operation - Conference Room (Section 7 and P&ID)
4:00	Complete

Monday, September 17 -- Operation of EPGS

8:00	Operation of Full Electric Loop (Section 5.2.6) -- Control Room and field Team of two will rotate between Control Room and Turbine Room in A.M. and P.M.
4:00	Complete

Tuesday, September 18 -- System Operation

8:00	Discussion of System Operation -- Conference Room
10:00	System Steady State Operation (Section 5.2.7) -- Control Room and field Rotate groups of two between locations
4:00	Complete

Wednesday, September 19 -- System Operation

8:00	System Steady State Operation (Section 5.2.7) EPGS Steady State Performance (Section 5.2.8) Rotate groups of two between Control Room and field
4:00	Complete

Thursday, September 20 -- System Operation and Debriefing

8:00	System Steady State Operation (Section 5.2.7) -- Control Room and field
12:00	Debriefing -- Conference Room
4:00	Complete

Friday, September 21 -- Tour of Solar One System Operation Controls

Section 3

MSEE SYSTEM DESCRIPTION

The MSEE system is shown as an artist's concept in Figure 3.1. It is designed to demonstrate the conversion of solar energy to electricity using molten salt and water/steam as the working fluids. The molten salt is the energy transfer medium from the receiver through thermal storage to the steam generation subsystem and water/steam is the energy transfer medium from the steam generation subsystem to the electric power generation subsystem. The system schematic is shown in Figure 3.2. The receiver, located at the top of the CRTF tower, receives concentrated solar energy from the collector field. Molten salt from the cold storage tank, located at ground level, is pumped up the tower piping and through the receiver. In the experiment, cold salt is nominally defined to have a temperature of 306°C (580°F). The salt is heated to 1000° in the receiver, flows through a downcomer, and is throttled into the hot salt storage tank. Hot salt is defined to have a nominal temperature of 1000°. Hot salt from storage is pumped through the steam generator superheater and evaporator, and is returned to the cold storage tank. An additional flow of cold salt is injected in the salt line between the superheater and evaporator to reduce the salt temperature entering the evaporator; this is to allow the use of low alloy steel in the evaporator. Main steam from the steam generator is used to drive a conventional steam turbine-generator. There are two principal advantages of this molten salt receiver system over a water/steam receiver system: the steam generator and turbine are decoupled from the receiver by the thermal storage subsystem; and, molten salt from the receiver is used directly as the thermal storage fluid, thus providing an inexpensive source of thermal storage and a constant temperature heat source for the steam generator.

The system is divided into the following subsystems:

a) Collector (CS)
b) Master Control (MCS)
c) Receiver (RS)
d) Thermal Storage (TSS)
e) Steam Generation (SGS)
f) Heat Rejection and Feedwater (HRFS)
g) Electric Power Generation (EPGS)

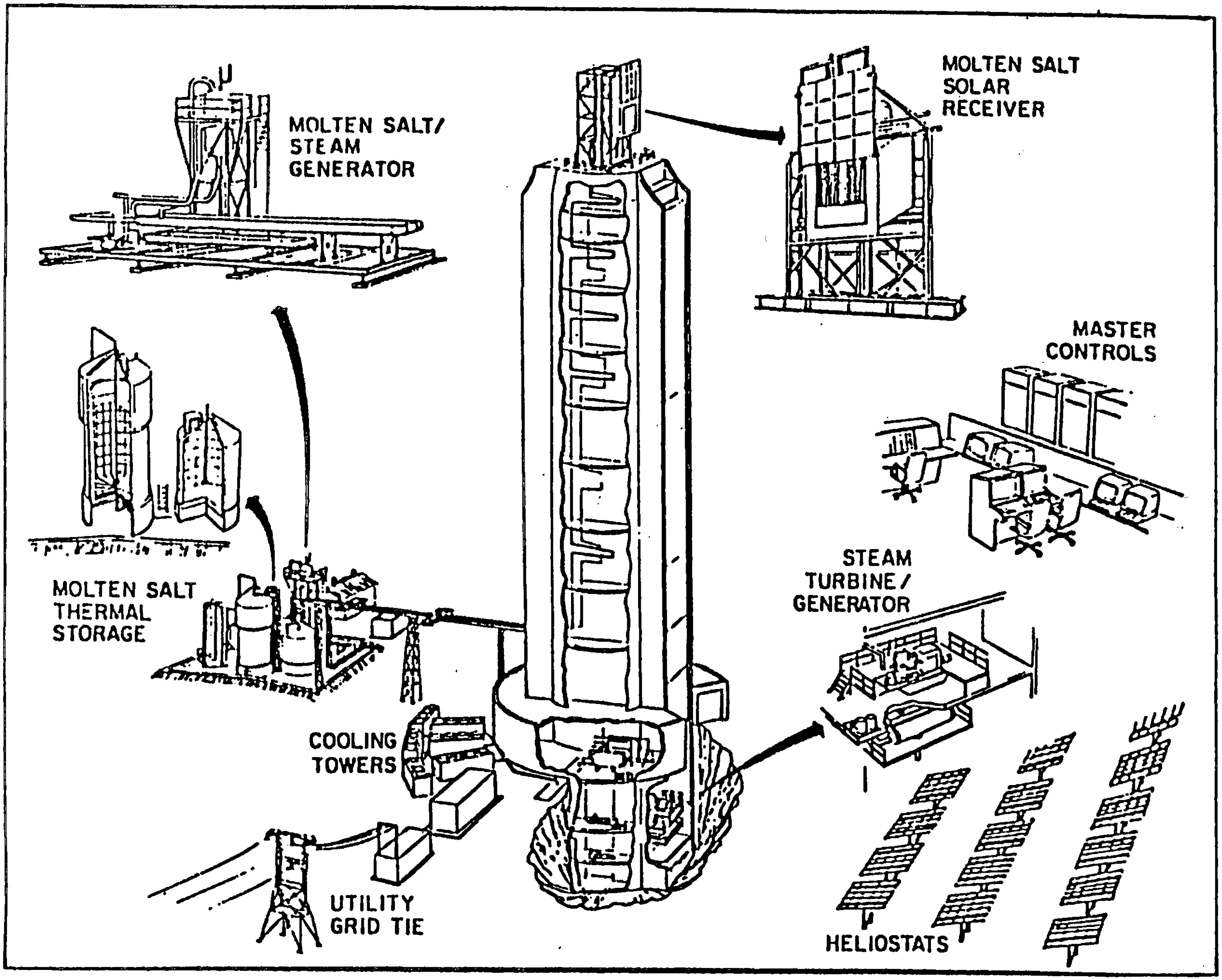

FIGURE 3.1 Artists Concept

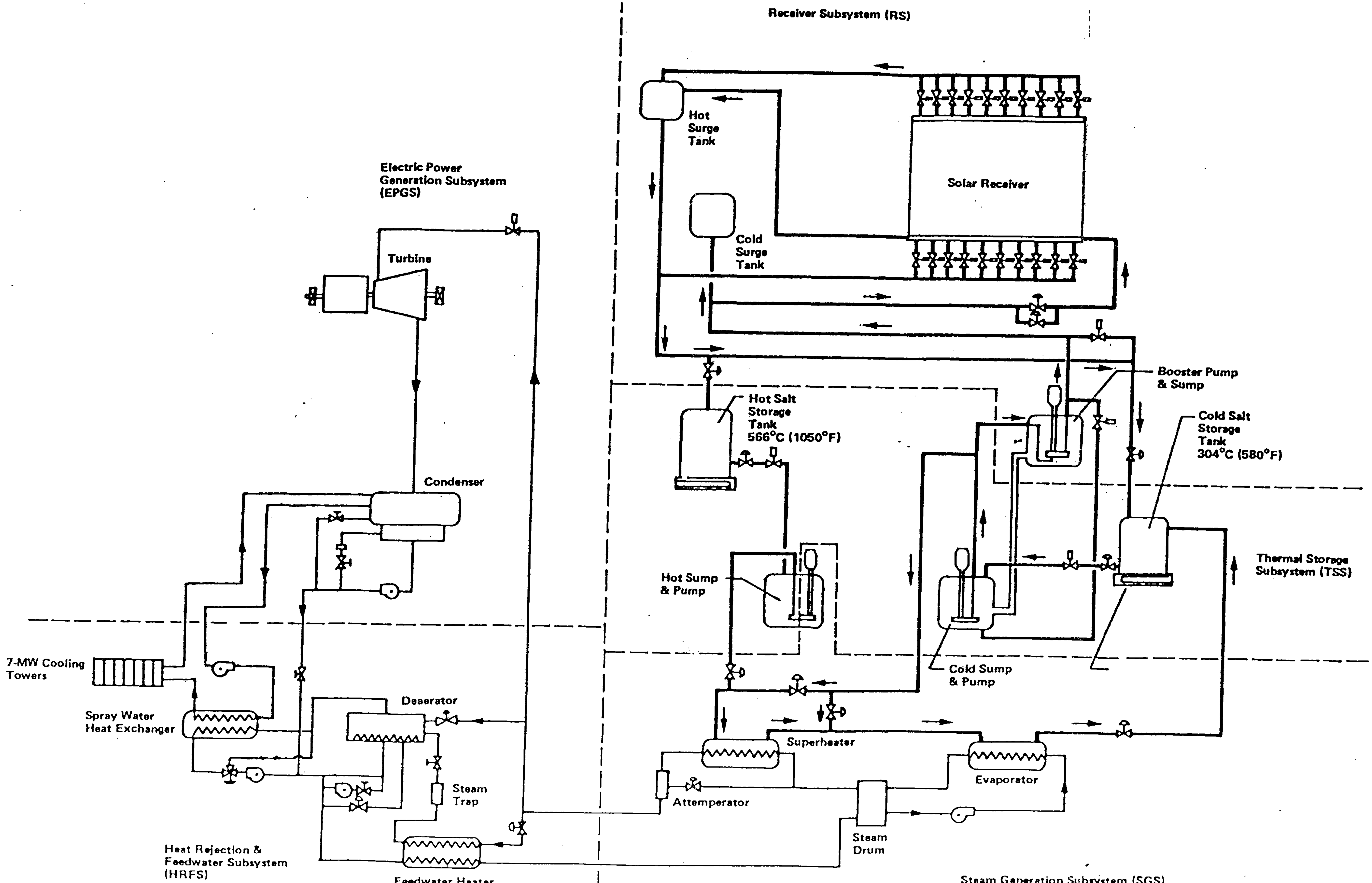

Figure 3.2. MSEE Flow Schematic

A tabulation of data describing the MSEE system is given on Table 3.1. A more detailed description of the MSEE subsystems is contained in the following subsections.

3.1 COLLECTOR SUBSYSTEM

The collector subsystem redirects, concentrates, and focuses solar radiation onto the tower-mounted receiver. The subsystem, which is already in place at the CRTF, consists of 221 two-axis tracking heliostats located north of the receiver tower, and its control system. Under optimum insolation and heliostat conditions, the heliostat field can concentrate approximately 5 MW_t onto the receiver.

Each heliostat has 25 individual mirror facets totaling 37.2 m^2 (400 ft^2) of reflective surface. The facets are mounted on a structure and individually adjusted to provide a concentration ratio of 25 to 1 on the receiver. The structure has motor-driven azimuth and elevation gimbals, which allow it to track the sun during the day.

The heliostats are operated from the control room by the CRTF collector control system. (The CRTF collector control system is separate from the experiment master control subsystem.) The CRTF collector control system analyzes heliostat operating commands from a number of programmed test sequences or from the facility heliostat operator. Control signals are distributed to the heliostats through four heliostat array controllers and four heliostat interface modules. Each heliostat receives azimuth and elevation pointing information once every second and responds with its own status. Commands and data transmitted to the individual heliostats are received and executed by the heliostat control electronics. The electronics keep the drive motor power at the proper level until the gimbal axis encoders indicate that the desired position has been reached.

Table 3.1

MSEE Data

Location -- CRTF; on Kirtland Air Force Base, Albuquerque, NM

Heliostat Field -- Existing field of 221 heliostats each with 400 ft^2 of mirror surface.

Tower -- Existing concrete tower, 200 ft. high with internal lifting module

Master control -- EMCON D-2 distributed digital control system with central consoles; separate equipment protection system.

Receiver -- Refurbished from previous Subsystem Research Experiment.

- Rating: 5 MW_{th}
- Salt temperatures: in - 590°F; out - 1000°F (1050°F with propane heater)
- Configuration: cavity with door
- Absorber: single panel of 3/4 in Incoloy 800 tubes (18 passes, 16 tubes per pass)
- Peak flux: 630 kW/m^2 (200,000 Btu/hr - ft^2)

Thermal Storage -- Existing from previous Subsystem Research Experiment

- Rating: 5.8 MW_{th} Hr when operating between 590°F and 1000°F
- Type: 2-tank
  - Hot tank, internal insulation
  - Cold tank, external insulation

Steam Generator -- Supplied by Babcock and Wilcox

- Type: Forced recirculation
- 2 units: evaporator and superheater (both U-tube, U-shell) with steam drum separator
- Rating: 11,000 lb/hr of steam at 940°F and 1100 psi (3.13 MW_{th})
- Prototypical of commercial design

Turbine Generator -- GE rebuilt unit

- Marine turbine
- 750 kW_e rating (500 kW_e under nominal operating conditions)

Heat Rejection and Feedwater System -- existing at CRTF

- Feedwater treatment only
- 20,000 gallon demineralized water storage
- Dry cooling, 7 MW_{th} capacity
- Spray water heat exchanger to reject heat when turbine not in use or tripped off line

3.2 MASTER CONTROL SUBSYSTEM

The master control subsystem (Figure 3.3) consists of an EMCON-D2 for system control and a equipment protection system. A Bailey network 90-system is used to directly control the SGS. Commands and set points are provided by the EMCON master control subsystem to the Network 90 for SGS operation and control. The equipment protection system is an independent hardwired relay shutdown system. These relay trip devices will shut down the receiver or the power generation ends of the MSEE when critical parameters reach preset limit values. These relay units are independent of the EMCON and network 90 control systems. Additionally, an Accurex Data Logger is used to collect and display all the temperature measurements relating to the heat tracing and data instrumentation.

3.2.1 EMCON System

The EMCON-D2 is a distributed digital control system consisting of two operator consoles, a host computer with its peripheral hardware, a communication control module, and three process control modules distributed among the subsystems. Two EMCON-D2 operator consoles are located in the CRTF main control room. The host computer is an existing DEC PDP 11/34 unit located in the control room. This computer links the operator with the process control modules, and analyzes data from the control modules for presentation on the operator consoles. The peripheral equipment includes two disk drives, an alarm system, and a data analysis system.

A communication control module links the host computer with the three field-located, process control modules. Each process control module is a small digital computer capable of monitoring a number of instrumentation points, and responding with a number of process control signals. Communications between the control modules and host computer are primarily limited to direct operator commands from the console and critical operating information from the subsystems for console display. This distributed control system reduces the number of instrumentation and control links between the subsystems and control room.

The process control module consists of a digital computer control unit, a multiplexer, an analog-to-digital converter, and a digital-to-analog converter. Analog signals from the process instrumentation are converted to

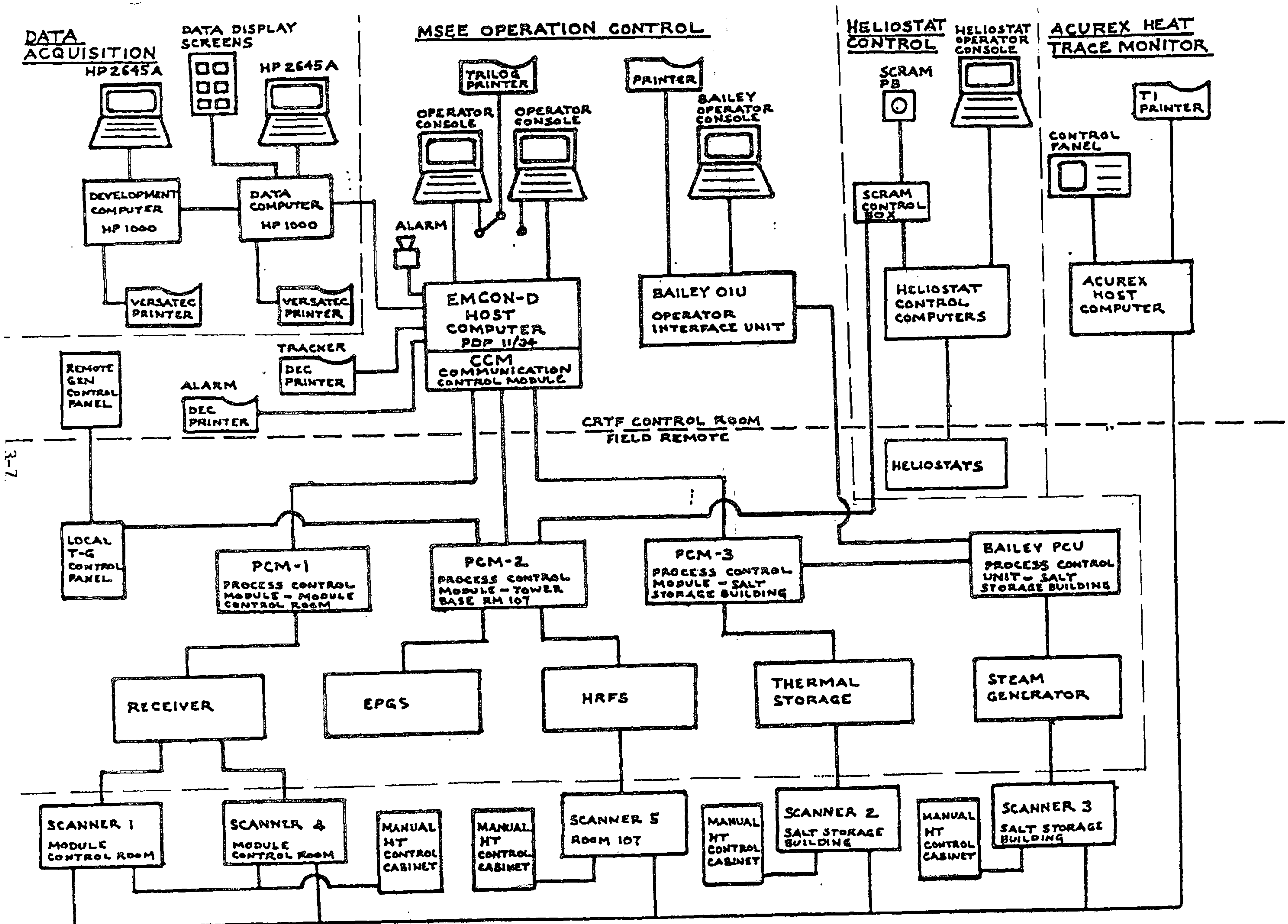

Figure 3.3 Master Control Subsystem

digital signals, selected in rotation by the multiplexer, and analyzed by the control unit. The module responds with an appropriate digital control signal which is passed through the multiplexer and sent to the appropriate controller. Each process control module is capable of monitoring 30 analog signals per second, monitoring 95 thermocouples, generating 20 analog control signals, and controlling over 100 on-off switches.

One process control module (PCM 1), located below the receiver in the tower elevator, is dedicated to the control of the receiver. A second module, (PCM 2) located at the base of the tower, controls the heat rejection and electric power generation subsystem. The third module, (PCM 3), located in the control building adjacent to the salt storage tanks, is used to control the thermal storage subsystem and to command the Network 90 controlled steam generation subsystem.

The receiver subsystem PCM will modulate the salt flow rate to the receiver to maintain, as closely as possible, a constant outlet temperature of 1000°F. Individual thermocouples are located on the receiver to measure intermediate salt temperatures. From this information, the control module estimates the flux on the receiver, and feed-forward a signal to the salt control valves at the receiver inlet. The control module also controls the receiver start-up and shutdown purge and drain valves.

Control of the thermal storage subsystem involves the operation of the two salt downcomer flow control valves, cold salt pumps, salt storage tanks and piping heat tracing, and the propane-fired salt heater. The downcomer throttling valves are controlled by the receiver control system to maintain a constant level in the receiver hot surge tank. Salt equipment heat trace temperatures are monitored continuously by the Acurex Data Logger. The propane-fired salt heater is operated intermittently, under manual control, during subsystem checkouts.

Automatic control of the heat rejection and electric power generation subsystem involves the control of the steam and condensate flows to the deaerator, steam flow to the feedwater heater, and the operation of the cooling water, spray water condensate, and feedwater pumps. The EPGS condenser temperature, level and pressure are monitored by the master control subsystem. The deaerator temperature is maintained by controlling the steam flow from the main steam header. The final feedwater temperature is maintained by controlling the main steam flow to the feedwater heater.

Automatic control of the steam generation subsystem primarily involves the control of steam pressure, steam temperature, drum water level, and the evaporator salt inlet temperature through the network 90 control system. The water level in the drum is controlled by modulating the control valve downstream of the feedwater pump. Control of the main steam pressure is accomplished by modulating the salt flow control valve downstream of the evaporator. Steam temperature is controlled using an attemperator to mix steam from the steam drum with the output of the superheater. The evaporator salt inlet temperature is controlled by monitoring the inlet salt temperature, and modulating the cold salt control valve at the mixing tee between the superheater and evaporator.

3.2.2 Network 90 System

The Bailey Network 90 Control System consists of two units, one process control unit (PCU) and one operation interface unit (OIU).

The PCU architecture is based on two key modules, the Controller Module (COM) and the Logic Master. Together, these modules provide a mix of both modulating and sequential control functions including: base, cascade, or ratio PID control, high/low and rate limiters, engineering units conversion, general function generator, square root, summation, multiplication, lead/lag, and transfer select, or, and, not, time delay, and several others. The controller module can service up to four analog and three digital inputs and two analog and four digital outputs. The COM also provides A/D and D/A conversion, alarm limit checking (absolute and deviation) and notification, point quality checking and interlocking.

The Operator Interface Unit (OIU) provides the high level operator interface for the Network 90 system. The OIU consists of a color CRT-based table-top console, with functional keyboard, mass storage device, and console driver electronics.

In operation, the unit performs the system information display and control requirements. The OIU console includes a CRT keyboard and pushbutton hardware for process overview, alarm indicating, loop control, trending, tuning and configuration functions.

The OIU uses microprocessor, memory and I/O modules to support system functions. It furnishes monitoring, supervisory, recording and display capability at centralized or distributed locations, along with engineering functions.

3.2.3 Data Acquisition

The DAS utilizes both the EMCON-D2 and an HP-1000. EMCON collects the data and HP-1000 stores and displays data. Data collected by the EMCON system is transmitted to the HP-1000 system on a terminal-to-terminal data link. The tag list for the data to be collected is in a file of 180 tags, which are divided into 6 groups of 30 tags. One group of 30 is transmitted every 10 seconds, giving a total update rate of once a minute. The data are then time tagged with day of the year, hour, minute, second, millisecond. Then the data are stored in a data file and/or displayed on one of six CRTs in a graphical form. Also, the data are transmitted in integer format, not floating point, but they are in engineering units. The data files are divided into eight-hour blocks, so if a test runs longer than eight hours, another eight-hour block is assigned to that test's file. Normally an 8-hour data block is stored in 19 tracks out of a maximum usable 1000 tracks.

The live data can be displayed on the 6 CRTs with 3 tags per screen, a time scale of 3 hours 20 minutes, and a Y-scale displayed of the first tag's display range. The other two tags are displayed using their respective ranges, but the scales are not shown on the plot. When the plot is full the plot scrolls left dropping the oldest 1/4 of the time scale data. This leaves 1/4 of the plot blank for new data. These plots can have hard copies made, but not automatically. The print is done by manual switch selection of each screen and a copy page switch.

Recovery of stored data can be done whenever live data files are not being made. These plots have a slightly different format, three being a maximum of five tags per plot, and the Y scale shown is that of the last tags range. These plots are not displayed on a CRT, but directly generated on the printer/plotter.

3.3 RECEIVER SUBSYSTEM

The receiver subsystem (Figure 3.4) captures the insolation redirected from the heliostat field and converts it to thermal energy in the molten salt. The subsystem consists of the receiver absorber panel, cavity enclosure with one vertical aperture door, insulation, heat tracing, cold surge tank, booster pump, hot surge tank, overflow tank, instrumentation, and control valves. The receiver is located at the top of the CRTF tower.

The receiver was tested in a previous subsystem research experiment. Since the initial experiment, the receiver has been refurbished. This refurbishment included instrumentation and control system modifications, minor structural and piping changes, and the replacement of the two original horizontal cavity doors with one vertical aperture door.

The receiver absorber is a single panel with 18 vertical passes having 16 tubes per pass. The tubes are Incoloy 800 with 19 mm (0.75 in.) outside diameter. Purge and drain valves are provided for each pair of passes.

The receiver surge tanks are designed to dampen changes in the salt flow rate and to maintain salt flow through the receiver in the event of a cold salt pump outage. The cold surge tank is pressurized with facility-supplied instrument air to supply the necessary head to force the salt through the receiver in the event of a pump outage, and to provide a surge volume within the tank. The hot surge tank operates at atmospheric pressure, and is vented to an adjacent overflow tank in the event of a control problem in the salt downcomer throttle valve.

The cold salt booster pump takes its suction from the discharge of the cold salt pump and provides the necessary head for the salt as it travels up the tower and through the receiver.

The cold salt line to the receiver starts at the booster pump, rises to the top of the hot storage tank, traverses the distance from the storage tanks to the receiver tower on an elevated pipe bridge, enters the tower, and runs up the east side of the tower in an existing pipe chase to the receiver. The hot salt line leaves the hot surge tank and traverses to the pipe chase. The hot salt downcomer carries the salt to the level of the pipe bridge. The hot salt line traverses the bridge, ending in a control valve which throttles the flow to the hot storage tank. The salt piping is inclined between the storage tanks and the tower to ensure that the piping system will completely drain. The salt piping is electrically heat traced and insulated with calcium silicate and aluminum sheathing.

The receiver components are listed on Table 3.2; valves are described on Table 3.3; instrumentation is listed on Table 3.4; and control loops are described on Table 3.5.

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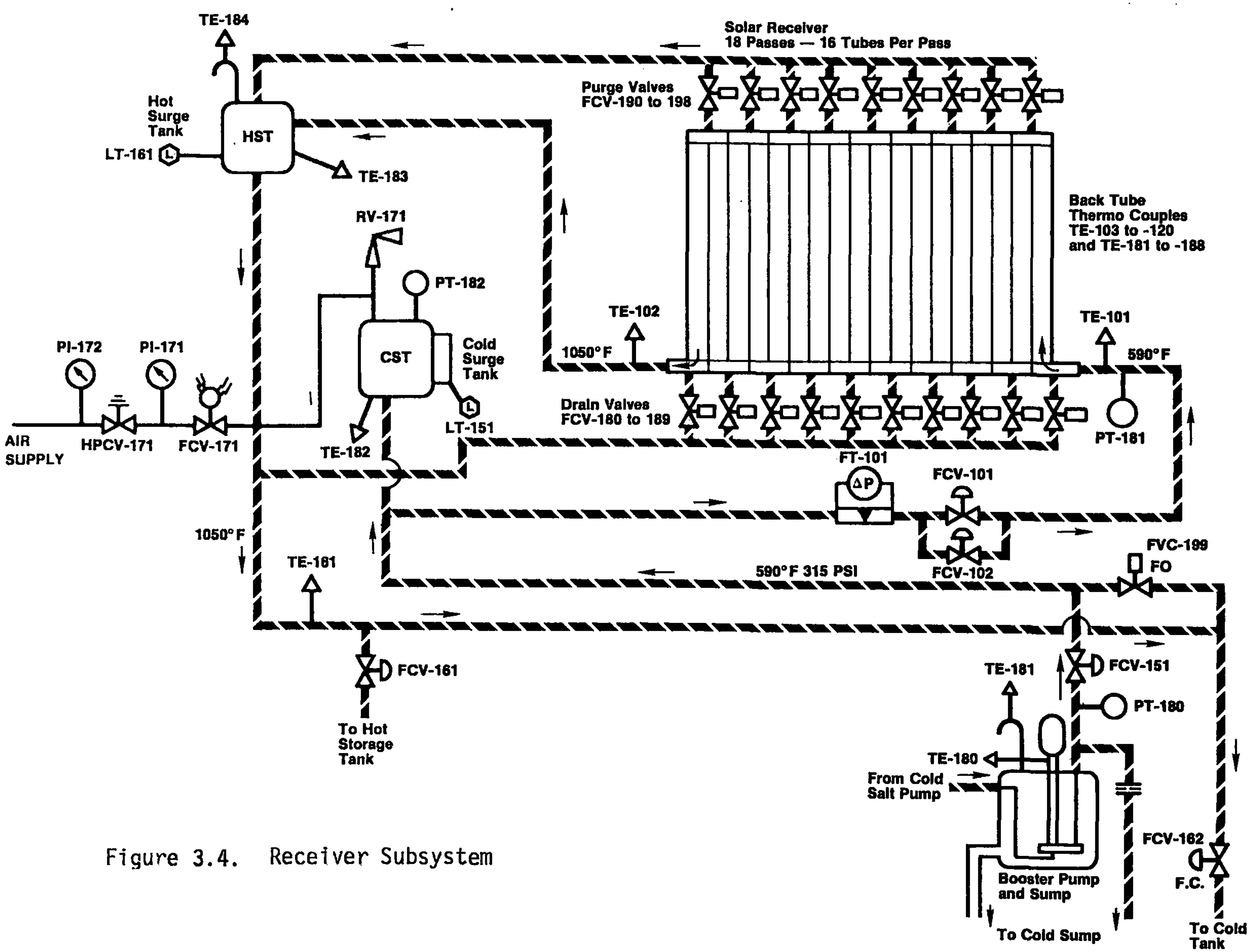

Figure 3.4. Receiver Subsystem

Table 3.2
Receiver Subsystem Components

Component	Description	Function	Nominal Operating Condition
Receiver	- 18 ft wide x 13 ft high panel - 18 serpentine passes Incoloy 800 tubes - 16 tubes per pass - 3/4 in. dia. tubes	- Heat molten salt with solar energy from heliostat field	- 590°F inlet salt - 1050°F outlet salt - 96,867 lb/hr - 5 MW rating
Cold salt booster sump	- Carbon steel cylindrical tank	- Reservoir for cold salt pump	- 590°F salt - Atmospheric pressure
Cold salt booster pump	- Vertical cantilever type	- Supply additional head to outlet of cold salt pump to provide salt circulation through receiver	- 590°F salt - 96,867 lb/hr
Cold surge tank	- Carbon steel cylindrical tank - 3 ft. dia. - 7 ft. high	- Dampen changes in salt flow rate - Provide emergency salt flow through receiver until solar flux can be removed in the event of pump outage	- Pressurized to 125 psi
Hot surge tank	- Stainless steel cylindrical tank - 2 ft. dia. - 7 ft. high	- Dampen changes in salt flow rate	- Atmospheric pressure

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Table 3.3

RECEIVER SUBSYSTEM REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-101 FCV-102	Valtek	2"	CV	FO	Receiver Flow Control	Near Receiver Lower West Corner
FCV-151	Valtek	2"	CV	FC	Receiver Fill Control Cold Surge Level Control	Above Hot Tank
FCV-161	Valtek	2"	CV	FO	Hot Surge Tank Level Control	Above Hot Tank
FCV-162	Valtek	2"	CV	FC	Hot Surge Tank Level Control (Receiver)	Above Hot Tank
FCV-180 thru FCV-189	Kieley-Mueller	1 1/2"	SV	FC	Receiver Fill and Drain	Below Receiver
FCV-190 thru FCV-198	Kieley-Mueller	1 1/2"	SV	FC	Receiver Purge	Above Receiver
FCV-199	Kieley-Mueller	2"	SV ↑ Shutoff valve (also called isolation valve)	FC	Allow Downcomer Backflow During Receiver Fill and Permit Drainage to Cold Storage Tank During Shutdown	Above Hot Tank

CV - Control Valve
SV - Shutoff Valve
FO - Fail Open
FC - Fail Close

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Boost Pump						
PT-180	Discharge pressure - goes to 310 psi before FCV-151 opens & allows flow to receiver	PCM 3	0-400	350	275	PSI	2
TE-180	Bearing temp (normally at 100°F or less)	PCM 3	0-500	190		°F	10
TE-181	Sump vent temp (normally 200-220°F)	PCM 3	0-1200	350		°F	10
	Hot surge tank						
LT-161	Level (normal operation is 20", during [illegible])	PCM 3	0-100	70	15	inch	2
TE-183	Salt temp (normally 1050°F during operation)	PCM 1	0-1200	1070	500	°F	10
TE-184	Vent temp (normally [illegible] 550°F)	PCM 1	0-1200	400		°F	10
	Cold surge tank						
LT-151	Level (normally 50-52 during normal operation)	PCM 1	0-100	90	10	inch	10
TE-182	Salt temp	PCM 1	0-1200	750	500	°F	10
PT-182	Pressure (normally < 150 psi)	PCM 1	0-200	180	10	PSI	10
TE-161	Downcomer outlet temp	PCM 3	0-1200	1070	500	°F	2
Sun	Solar insolation - not in a group, represents power level [illegible]	PCM 3	0-1000			W/M^2	5

Hot surge tank is vented to atmosphere, therefore it is not pressurized

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels		Dimension	Sampling Period (sec)
				High	Low		
	Receiver						
PT-181	Inlet pressure	PCM 1	0-200	125	10	PSI	10
FT-101	Salt flow rate	PCM 1	0-100	100		KLB/hr	
TE-101	Salt inlet temp	PCM 1	0-1200	650	500	°F	2
TE-102	Salt outlet temp	PCM 1	0-1200	1060	500	°F	2
TE-103	Back tube-pass #1 outlet	PCM 1	0-1200	640	500	°F	2
TE-104	Back tube-pass #2 outlet	PCM 1	0-1200	665	500	°F	2
TE-105	Back tube-pass #3 outlet	PCM 1	0-1200	690	500	°F	2
TE-106	Back tube-pass #4 outlet	PCM 1	0-1200	720	500	°F	2
TE-107	Back tube-pass #5 outlet	PCM 1	0-1200	750	500	°F	2
TE-108	Back tube-pass #6 outlet	PCM 1	0-1200	780	500	°F	2
TE-109	Back tube-pass #7 outlet	PCM 1	0-1200	810	500	°F	2
TE-110	Back tube-pass #8 outlet	PCM 1	0-1200	835	500	°F	2
TE-111	Back tube-pass #9 outlet	PCM 1	0-1200	865	500	°F	2
TE-112	Back tube-pass #10 outlet	PCM 1	0-1200	890	500	°F	2
TE-113	Back tube-pass #11 outlet	PCM 1	0-1200	920	500	°F	2

Table 3.4
Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-114	Back tube-pass #11 outlet	PCM 1	0-1200	950	500	°F	2
TE-115	Back tube-pass #12 outlet	PCM 1	0-1200	975	500	°F	2
TE-116	Back tube-pass #13 outlet	PCM 1	0-1200	990	500	°F	2
TE-117	Back tube-pass #14 outlet	PCM 1	0-1200	1010	500	°F	2
TE-118	Back tube-pass #15 outlet	PCM 1	0-1200	1030	500	°F	2
TE-119	Back tube-pass #16 outlet	PCM 1	0-1200	1050	500	°F	2
TE-120	Back tube-pass #17 outlet	PCM 1	0-1200	1070	500	°F	2
TE-131	Back tube-pass #1 upper	PCM 1	0-1200	645	500	°F	10
TE-132	Back tube-pass #5 upper	PCM 1	0-1200	745	500	°F	10
TE-133	Back tube-pass #8 upper	PCM 1	0-1200	815	500	°F	10
TE-134	Back tube-pass #11 upper	PCM 1	0-1200	915	500	°F	10
TE-135	Back tube-pass #14 upper	PCM 1	0-1200	980	500	°F	10
TE-136	Back tube-pass #17 upper	PCM 1	0-1200	1045	500	°F	10
TE-137	Back tube-pass #2 middle	PCM 1	0-1200	680	500	°F	10

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-138	Back tube-pass #6 middle	PCM 1	0-1200	735	500	°F	10
TE-139	Back tube-pass #8 middle	PCM 1	0-1200	825	500	°F	10
TE-140	Back tube-pass #11 middle	PCM 1	0-1200	905	500	°F	10
TE-141	Back tube-pass #14 middle	PCM 1	0-1200	990	500	°F	10
TE-142	Back tube-pass #17 middle	PCM 1	0-1200	1045	500	°F	10
TE-143	Back tube-pass #1 bottom	PCM 1	0-1200	660	500	°F	10
TE-144	Back tube-pass #5 bottom	PCM 1	0-1200	725	500	°F	10
TE-145	Back tube-pass #8 bottom	PCM 1	0-1200	830	500	°F	10
TE-146	Back tube-pass #11 bottom	PCM 1	0-1200	895	500	°F	10
TE-147	Back tube-pass #14 bottom	PCM 1	0-1200	985	500	°F	10
TE-148	Back tube-pass #17 bottom	PCM 1	0-1200	1035	500	°F	10
TE-185	Header-pass #2 outlet	PCM 1	0-1200	665	500	°F	10
TE-186	Header-pass #3 outlet	PCM 1	0-1200	690	500	°F	10

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-187	Header-pass #4 outlet	PCM 1	0-1200	720	500	°F	10
TE-188	Header-pass #5 outlet	PCM 1	0-1200	750	500	°F	10
TE-189	Header-pass #6 outlet	PCM 1	0-1200	780	500	°F	10
TE-190	Header-pass #7 outlet	PCM 1	0-1200	810	500	°F	10
TE-191	Header-pass #8 outlet	PCM 1	0-1200	835	500	°F	10
TE-192	Header-pass #9 outlet	PCM 1	0-1200	865	500	°F	10
TE-193	Header-pass #12 outlet	PCM 1	0-1200	950	500	°F	10
TE-194	Header-pass #13 outlet	PCM 1	0-1200	975	500	°F	10
TE-195	Header-pass #14 outlet	PCM 1	0-1200	990	500	°F	10
TE-196	Header-pass #15 outlet	PCM 1	0-1200	1010	500	°F	10
TE-197	Header-pass #16 outlet	PCM 1	0-1200	1030	500	°F	10
TE-198	Header-pass #17 outlet	PCM 1	0-1200	1050	500	°F	10

Table 3.5

Receiver Subsystem Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Receiver salt flow	Constant flow (start-up & shutdown with receiver control algorithm off scan	30 KLB/hr FD-101	Flow set point (FD-101) Measured flow (FT-101)	FCV-101/102 position
	Constant Outlet Temperature (Receiver control algorithm on)	1000°F SP. SALT	Temperature set point (SP. SALT) Outlet temperature (TE-102) Inlet temperature (TE-101) Salt flow (FT-101) Receiver back tube temperatures (TE-103 thru TE-120)	FCV-101/102 position
Hot surge tank level	Operation	20 in FCV-161 FCV-162	Surge tank level (LT-161) Level set point	FCV-161 or FCV-162 position (selection based on salt temperature)
Receiving storage tank selection	Operation	750°F	Downcomer salt temperature (TE-161)	TE-161 < 750°F Cold storage tank selected TE-161 > 750°F Hot storage tank selected
Cold surge tank level	Operation	~85" LT-151	Cold surge tank level (LT-151) Level set point	FCV-151 position

when TE161 reaches 750°F control goes from FCV161 & FCV162 to only FCV161 (FCV162 closes because you want the salt to go into hot storage tank)

FCV151 is on cascade with LT151

3.4 THERMAL STORAGE SUBSYSTEM

The thermal storage subsystem provides a cold salt source for the receiver for daytime operation, and a hot salt source for the steam generator for day and early evening operation. The TSS can also furnish a source of thermal energy for overnight freeze protection of the receiver, steam generator, and salt piping and for early morning plant start-up. The subsystem includes the hot and cold salt storage tanks, propane-fired salt heater, cold salt pump and cold salt sump. The subsystem schematic is shown on Figure 3.15. Major components are described on Table 3.6; valves are listed on Table 3.7; instrumentation is described on Table 3.8; and control loops are given on Table 3.9.

The salt pump is of a vertical cantilever design. The impeller and casing are suspended below the liquid level in a sump; the bearings are located above the liquid level and do not contact the salt.

The hot salt tank employs a unique design. To allow the use of carbon steel in the structural portions of the tank, an internal refractory insulation is used to limit the temperature of the walls, roof, and floor. A waffled Incoloy liner separates the salt and the internal insulation, and the tank foundation is cooled with circulating water to limit the floor temperature. The outside of the tank is insulated in the conventional manner with calcium silicate and aluminum sheathing. The cold salt tank is similar in design to the hot tank except that it does not require the internal insulation and liner due to its lower operating temperature.

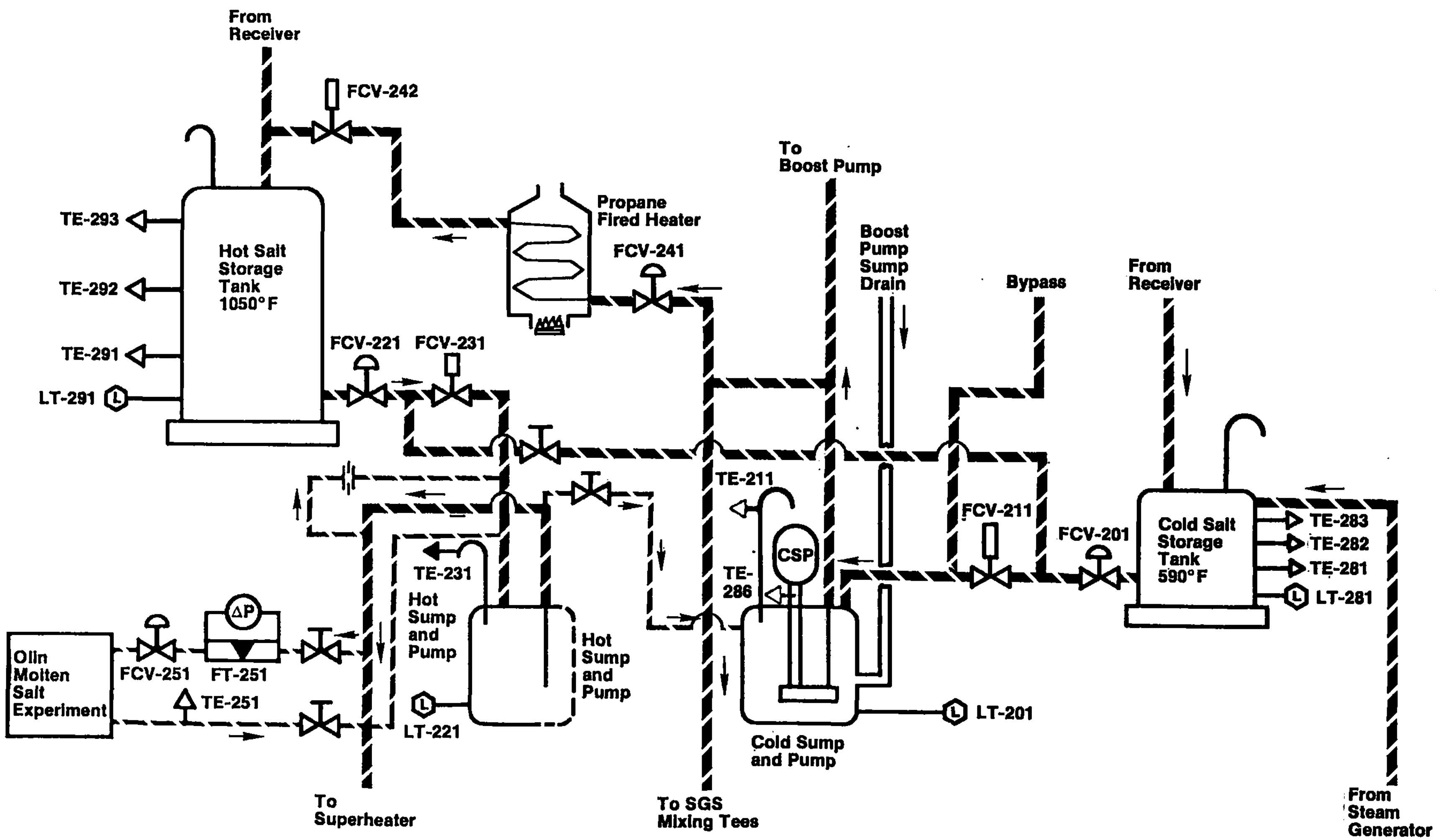

Figure 3-5. Thermal Storage Subsystem Schematic

Table 3.6
Thermal Storage Subsystem Components

Component	Description	Function	Nominal Operating Condition
Cold salt storage tank	- Carbon steel cylindrical tank - 12.3 ft. dia. - 12.3 ft. high - 15 in fibrous external insulation	- Cold salt storage	- 590°F salt
Hot salt storage tank	- Carbon steel cylindrical shell - 12.3 ft. dia. stainless steel liner - 23.6 ft. high - 13-1/2 in. insulating firebrick between shell and liner - 2 in. fibrous external insulation	- Hot salt storage	- 1050°F salt - Approx. 7 MW_t hr storage capacity
Cold salt sump	- Carbon steel cylindrical tank - 59 in. dia. - 66 in. deep	- Pump reservoir	- 590°F salt - Atmospheric pressure
Cold salt pump	- Vertical cantilever type - 60 H.P. driver	- Pump salt from cold storage tank to cold salt booster pump, SGS, or propane heater	- 590°F salt - 96,867 lb/hr

Table 3.6
Thermal Storage Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Hot salt sump	- Stainless steel cylindrical tank - 48 in. dia. - 49 in. deep	- Reservoir for hot salt pump	- 1050°F salt - Atmospheric pressure
Hot salt pump	- Vertical cantilever type - 7-1/2 HP driver	- Provide hot salt circulation through STS	- 1050°F salt - 64,680 lb/hr
Propane heater	- 3 MW propane fired heater - 9 ft. dia. shell - 24 ft. high - One stainless steel heating coil, 2.12 in. dia., 1640 ft. long	- Provide auxiliary salt heating capability	- 59,900 lb/hr salt - 590°F inlet - 1050°F outlet

Table 3.7

THERMAL STORAGE SUBSYSTEM REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-201	Valtek	3"	CV	FC	Cold Sump Level Control	Cold Storage Tank Base South Side
FCV-211	Kieley-Mueller	3"	SV	FC	Cold Sump Isolation	Pump House North Side West End
FCV-221	Valtek	3"	CV	FC	Hot Sump Level Control	Hot Storage Tank Southwest Side
FCV-231	Kieley-Mueller	3"	SV	FC	Hot Sump Isolation	Outside Pumphouse Northeast Corner
FCV-241	Valtek	2"	CV	FC	Propane Heater Flow Control	Line to Propane Heater East of FCV-231
FCV-242	Valtek	1 1/2"	SV	FC	Propane Heater Isolation	Top of Hot Tank

Table 3.8
Thermal Storage Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Cold Storage Tank						
LT-281	Level	PCM 3	0-150	134	15	inch	10
TE-281	Lower temp	PCM 3	0-1200	700	500	°F	10
TE-282	Middle temp	PCM 3	0-1200	700	500	°F	10
TE-283	Upper temp	PCM 3	0-1200	700	500	°F	10
	Hot storage tank						
LT-291	Level	PCM 3	0-200	190	10	inch	10
TE-291	Lower temp	PCM 3	0-1200	1070	500	°F	10
TE-292	Middle temp	PCM 3	0-1200	1070	500	°F	10
TE-293	Upper temp	PCM 3	0-1200	1070	500	°F	10
	Cold salt pump						
LT-201	Sump level	PCM 3	0-60	60	15	inch	2
TE-286	Bearing temp	PCM 3	0-500	190		°F	10
TE-211	Vent temp	PCM 3	0-1200	400		°F	2
	Hot Salt Pump						
LT-221	Sump level	PCM 3	0-48	41	15	inch	2
TE-231	Vent temp	PCM 3	0-1200	400		°F	2

]

Table 3.9

Thermal Storage Subsytem Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Cold sump level	Operation	23 in FCV-201 (45 in fill)	Sump level (LT-201) Level set point	FCV-201 position - Flow from cold storage tank
Hot sump level	Operation	20 in FCV-221	Sump level (LT-221) Level set point	FCV-221 position - Flow from hot storage tank

3.5 STEAM GENERATION SUBSYSTEM

The steam generation subsystem transfers sensible heat from the molten salt to produce superheated steam for the turbine-generator. The subsystem schematic is shown on Figure 3.6. The subsystem includes an evaporator, steam drum, boiler recirculation pump, superheater, and attemperator.

The evaporator and superheater are U-tubes, U-shell heat exchangers, with low pressure salt on the shell side and high-pressure water and steam on the tube side. This shell and tube configuration has been selected to minimize thermal stresses, due to differential expansion, in the tubes and tubesheets.

A conventional steam drum, located above the evaporator, separates water droplets from the saturated steam before the latter enters the superheater, and receives feedwater from the feedwater heater. A forced recirculation design was selected, since it is preferred for power plants requiring daily start-up and shutdown.

The superheater outlet steam can be attemperated by mixing with a small amount of saturated steam from the drum. The salt flow from the superheater to the evaporator is also attemperated to 850°F, when necessary, by mixing with salt flow from the cold tank. This allows chrome-moly piping and fittings, rather than stainless steel, to be used in the evaporator.

Warmup of the steam generation subsystem is accomplished by isolating the subsystem and preheating with the subsystem's electrical heater.

Major subsystem components, valves, instrumentation, and control loops are described on Tables 3.10 through 3.13.

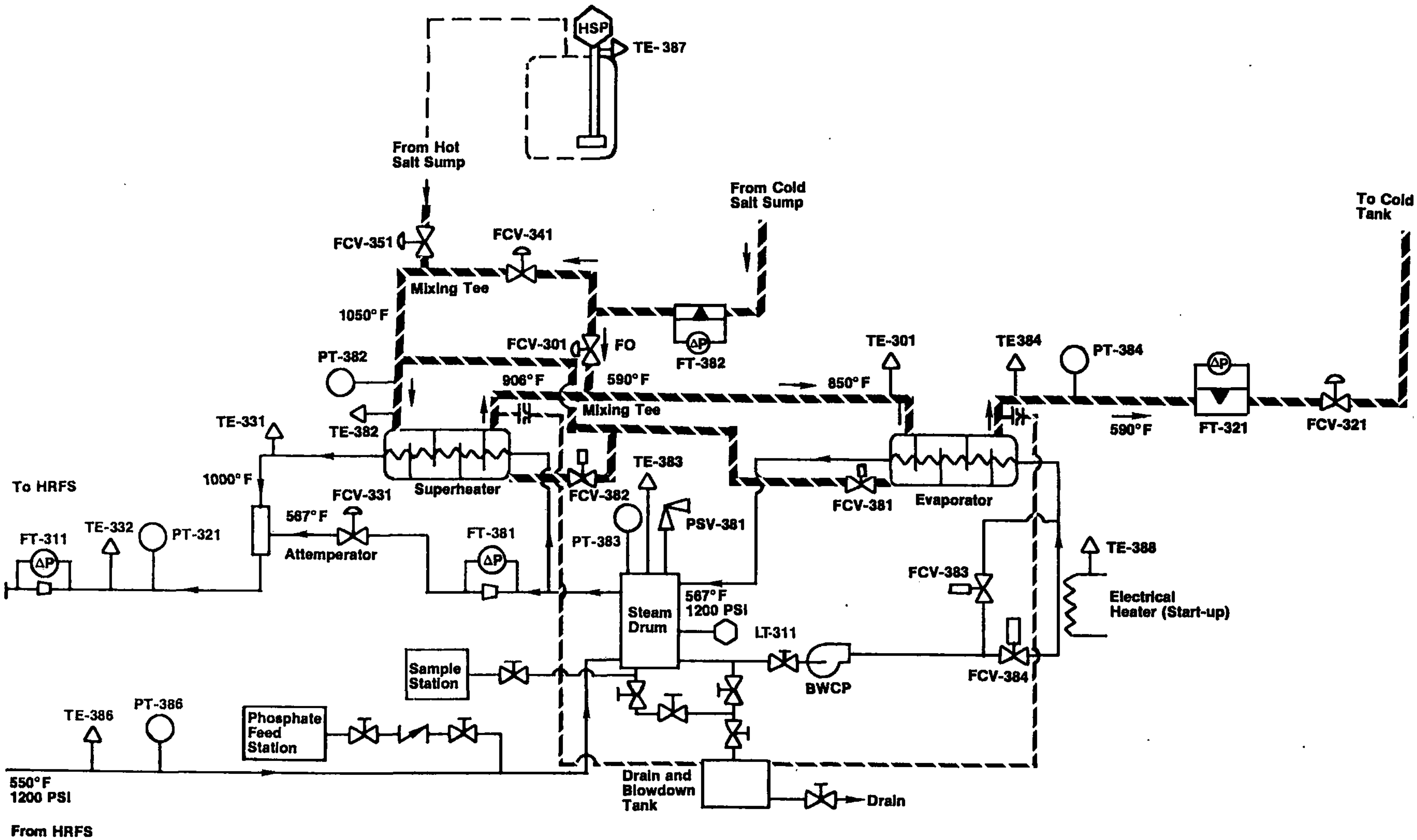

Figure 3.6 . Steam Generation Subsystem Schematic

Table 3.10. Steam Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Evaporator	- U-tube/U-shell counterflow heat exchanger - 8 in. dia. chrome - moly shell (salt) - 27 chrome-moly tubes 0.875 in. dia. 68 ft avg. length (water)	- Evaporate subcooled water to produce saturated steam/water mixture	- 850°F salt inlet - 590°F salt outlet - 78,550 lb/hr salt flow rate - Subcooled water inlet - 567°F, 1200 psi saturated steam/water outlet - 2.15 MW rating
Superheater	- U-tube/U-shell counterflow heat exchanger - 6 in. dia. stainless steel shell (salt) - 23 stainless steel tubes 0.500 in. dia. 33 ft. avg. length (steam)	- Heat saturated steam to superheat condition	- 1050°F salt inlet - 906°F salt outlet - 64,680 lb/hr salt flow rate - 567°F 1175 psi saturated steam inlet - 1000°F. 1100 psi superheated vapor outlet - 10,530 lb/hr steam flow rate - 0.98 MW rating
Steam Drum	- Cylindrical pressure vessel with elliptical heads - 24 in ID - 6 ft 10 in overall height - 2 in thick carbon steel - Contains primary cyclone steam separator and primary & secondary steam scrubbers	- Separate steam/water mixture exiting evaporator - Supply saturated steam to superheater - Provide feedwater surge volume	- 567°F - 1200 psi

Table 3.10. Steam Generation Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Boiler water circulation pump	- Canned centrifugal type - 5 HP driver	- Provide circulation of subcooled water from the steam drum to evaporator. Maintain high recirculation rate over full range of operating conditions.	- 560°F - 119 GPM - 111 ft. head
Start-up heater	- Chamber type electric heater - 3 40-kW heating elements - 2 15-kW heating elements	- Raise temperature and pressure of water during cold start-up to avoid salt freeze-up in evaporator - Heat boiler water to maintain temperature and pressure of water/steam system during diurnal hold	- 150 kW during start-up - Cycled during diurnal hold - Bypassed during normal operation
Steam attemperator	- Mixing tee	- Mix saturated steam from steam drum with super-heated steam from super-heater to control steam delivery tempera-ture to turbine	- 1053 lb/hr dry saturated steam at 567°F - 10,529 lb/hr superheated steam at 1000°F 1100 psi - 11,582 lb/hr delivery steam at 950°F 1100 psi
Salt attemperator (evaporator inlet)	- Mixing tee	- Mix cold salt with superheater outlet salt to limit evaporator inlet salt temperature to 850°F because of Cr-Mo construction	- 64,680 lb/hr at 906°F - 13,870 lb/hr at 590°F - 78,550 lb/hr at 850°F supplied to evaporator

Table 3.10. Steam Generation Subsystem Components - 3

Component	Description	Function	Nominal Operating Condition
Salt start-up attemperator (superheater inlet)	- Mixing tee	- Mix cold salt with hot salt from hot tank to provide a controlled temperature increase of salt entering superheater during start-up	- Full flow of cold salt at start-up - No cold salt flow during operation
Heat tracing	- Electrical heating element - Inconel sheath	- Maintain heat exchangers and salt piping above the freezing point of salt - Provide freeze protection of feedwater piping and instrumentation during shutdown	- Temperature monitored by thermocouples - Cycle as required

Table 3. 11

SGS REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-301	Valtek	1"	CV	FO	Evaporator Salt Temperature Control and Cold Salt Fill	SGS Skid West Side South End
FCV-321	Valtek	2"	CV	FO	Main Salt Flow Control	SGS Skid South End
FCV-331	Fisher	1"	CV	FO	Steam Attemperator Temperature Control	SGS Skid North Side Steam Drum
FCV-341	Valtek	1"	CV	FC	Main Salt Fill	SGS Skid West Side Middle
FCV-351	Valtek	2"	CV	FO	Hot Salt Flow Control	Outside Pumphouse Northeast Corner
FCV-381	Kieley-Mueller	1"	SV	FC	Evaporator Salt Drain	SGS Skid West Side Middle
FCV-382	Kieley-Mueller	1"	SV	FC	Superheater Salt Drain	SGS Skid West Side Below Steam Drum
FCV-383	Dresser	4"	SV	FO	Evaporator Water Supply	SGS Skid Southeast Corner
FCV-384	Valtek	2"	SV	FO	Start-up Heater Supply	SGS Skid Below FCV-383

Table 3.12. SGS Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Feedwater						
PT-386	Pressure	PCM-3/ Bailey	0-1500	1500		PSI	5
TE-386	Temp	PCM-3/ Bailey	0-750	575	500	°F	10
	Steam Drum						
PT-383	Pressure	PCM-3/ Bailey	0-1500	1250	950	PSI	5
TE-383	Fluid temp	PCM-3/ Bailey	0-750	575	500	°F	10
LT-311	Fluid level	PCM-3/ Bailey	-17 to +23	4	-4	inch	2
	Evaporator						
TE-301	Salt inlet temp	PCM-3/ Bailey	0-1200	880	500	°F	2
TE-384	Salt outlet temp	PCM-3/ Bailey	0-1200	640	500	°F	2
PT-384	Salt outlet pressure	PCM-3/ Bailey	0-200			PSI	5
FT-321	Salt flow rate	PCM-3/ Bailey	0-100			KLB/hr	2

Table 3.12. SGS Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels		Dimension	Sampling Period (sec)
				High	Low		
	Superheater						
PT-382	Salt inlet pressure	PCM-3/ Bailey	0-200	100		PSI	5
TE-382	Salt inlet temp	PCM-3/ Bailey	0-1200	1070	500	°F	5
TE-331	Steam outlet temp	PCM-3 Bailey	0-1200		910	°F	2
FT-381	Attemperator steam flow	PCM-3/ Bailey	0-2500			lb/hr	5
FT-382	SGS Cold Salt Supply	PCM-3/ Bailey	0-16			KLB/hr	5
	Steam Delivery						
PT-321	Pressure	PCM-3/ Bailey	0-1500	1150	950	PSI	2
TE-332	Temp	PCM-3/ Bailey	0-1200	990	910	°F	2
FT-311	Flow rate	PCM-3/ Bailey	0-100	12.6	3.2	KLB/hr	2
TE-387	Hot Salt Pump Bearing	PCM-3	0-500	190		°F	10
TE-388	Start-up Heater 5 Element Temp	PCM-3/ Bailey	0-1200	1100	500	°F	10

Table 3.13. SGS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Steam delivery pressure	SGS start-up	1000 psig FCV-491	Delivery pressure (PT-321) pressure set point	FCV-491 position - SGS steam flow
	Boiler following	1100 psig SP. SP	Delivery pressure (PT-321) Pressure set point (SP. SP) Steam flow (FT-311) Salt flow (FT-321)	FCV-321 position - SGS main salt flow
Steam delivery temperature	Operation	950°F SP. ST	Delivery temperature (TE-332) Temperature set point (SP. ST)	FCV-331 position - Steam attemperator flow
Steam drum level	Operation	0 in SP. DL	Drum level (LT-311) Level set point (SP. DL) Feedwater flow (FT-411) Steam flow (FT-311)	FCV-411 position - Feedwater flow
Evaporator salt inlet temperature	Operation	850°F SP. EST	Inlet temperature (TE-301) Temperature set point (SP. EST)	FCV-301 position - Cold salt flow
Boiler water temperature	Diurnal Shutdown	~520°F	Circulation heater outlet temperature (TE-388)	Electric immersion heater elements on/off

3.6 ELECTRIC POWER GENERATION SUBSYSTEM

The electric power generation subsystem converts the enthalpy in the main steam flow to electricity. The subsystem (Figure 3.7) includes the steam turbine, electric generator, electric power equipment, condenser, condensate pump and storage tank. The electrical one-line diagram is shown on Figure 3.8.

The turbine-generator set is a skid-mounted unit located at the north end of the receiver tower complex at the 80 ft. level (20 ft. below grade). This skid consists of a turbine, generator, and auxiliary equipment. The turbine is a seven-stage, single flow machine, operating at 17,400 rpm. Inlet steam conditions are rated at 940°F and 1050 psia. A single reduction gearbox reduces the turbine shaft speed to the generator speed of 1,200 rpm. The 750 kW_e generator operates at 450V, and is cooled by circulating water through air cooling coils located above the generator. The turbine-generator auxiliaries include a lubricating oil pump, lube oil cooler, air ejection vacuum pump and mechanical-hydraulic governor. The allowable rate of change in load is 10 percent per minute from 30 to 100 percent of rated capacity.

A shell and tube condenser, supported by a separate frame, is located directly below the turbine. Access to the condenser is on the floor 40 ft. below ground. Condensate from the hot well of the condenser will be transferred to the deaerator when the water level in the deaerator requires makeup. Otherwise, the condensate is pumped to a storage tank. Condensate from this tank is piped back to the condenser hot well when the hot well level requires water.

Major components of the EPGS, valves, instrumentation, and control loops are described on Tables 3.14 through 3.17.

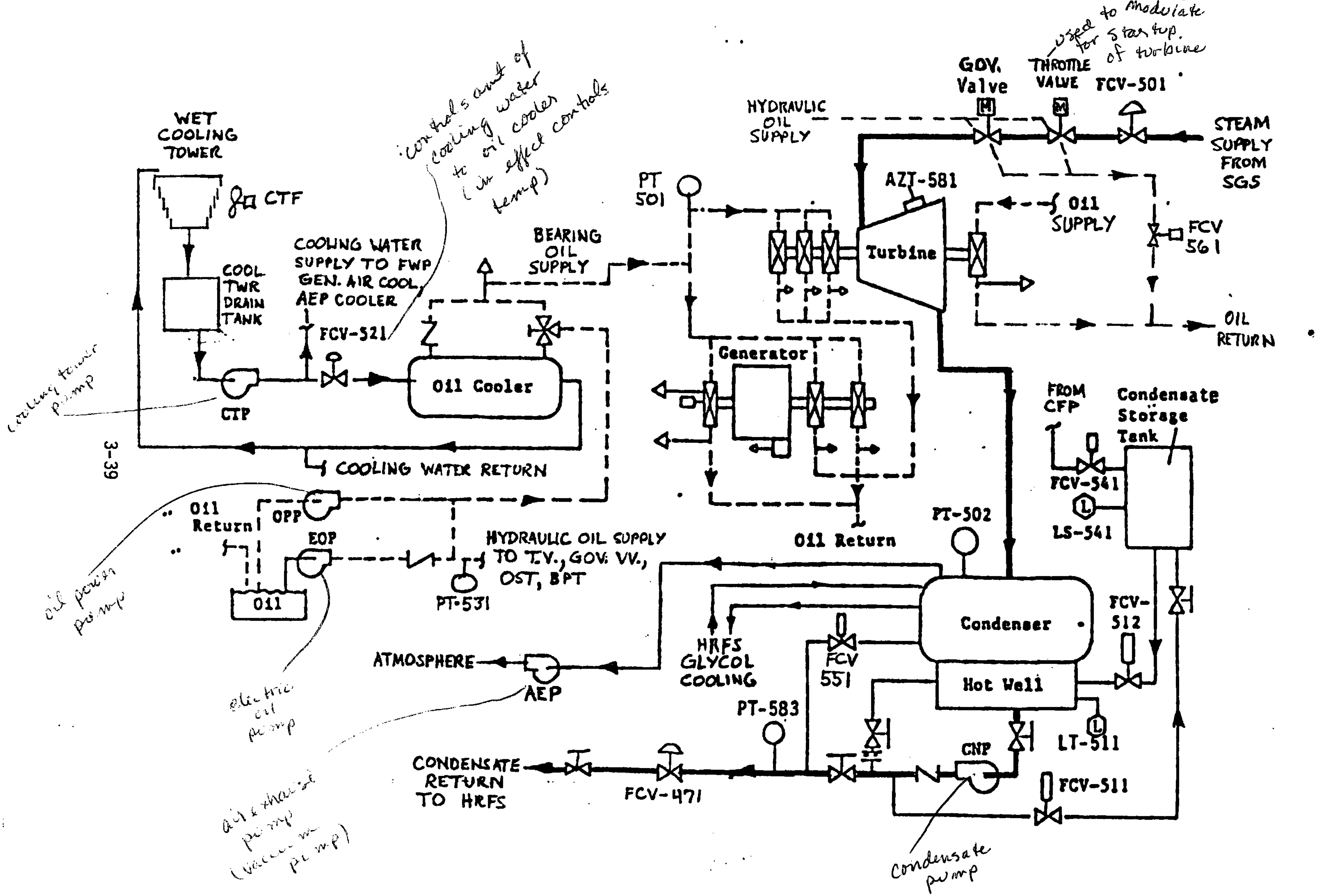

Figure 3.7 . Electric Power Generation Subsystem Schematic

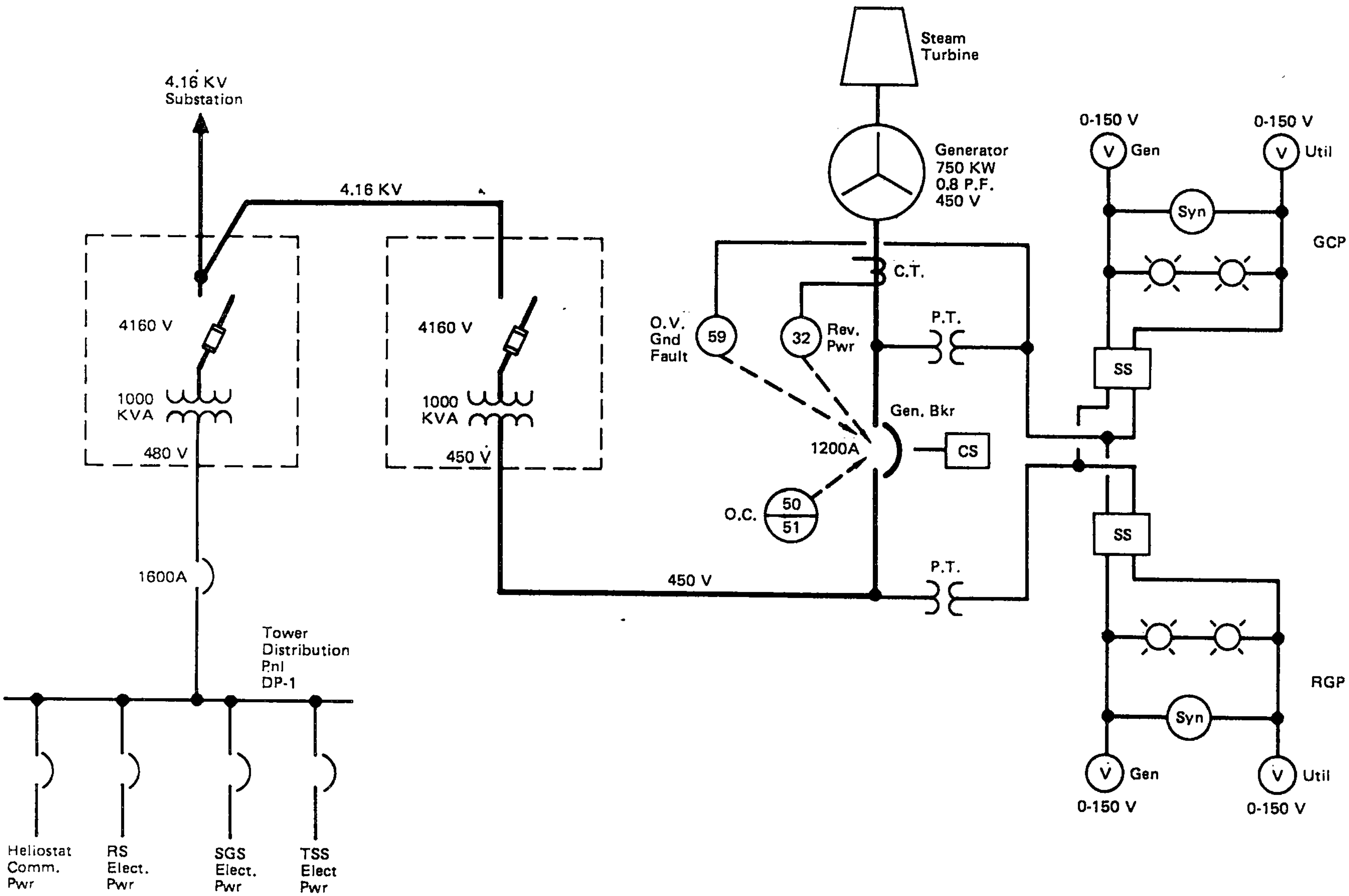

Figure 3.8. MSEE Electric Generator One-Line Diagram

Table 3.14
Electric Power Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Turbine	- Axial flow condensing type - 7 stage	- Expand steam to drive electric generator	- 940°F 1050 psig throttle steam - 133°F 2.5 psia exhaust steam - 7800 lb/hr steam flow - 17,443 RPM - 1000 HP
Electric generator	- AC generator - 450 volt, 3 phase - 1200 RPM - Solid state excitor	- Generate electric power	- 750 kW_e (rating) - 600 kW_e (maximum in MSEE) - 0.8 power factor rating
Condenser	- Crossflow shell and tube heat exchanger - Rectangular shell (condensate) - 438 tubes, 5/8-in. dia. 7-1/2 ft long (glycol/water coolant) - Cylindrical hot well	- Condense turbine exhaust steam - Provide turbine exhaust vacuum	- 2.5 psia saturated steam inlet - 133°F condensate outlet - 7800 lb/hr steam/water flow - 1200 GPM glycol/water coolant flow
Condensate pump	- Turbine type - 2 stage - 20 HP driver	- Pump condensate from hot well to deaerator	- 133°F water - 260 psi head (mfg rating) - 18 GPM (mfg rating)

Table 3.14

Electric Power Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Air exhaust pump	- Nash vacuum pump - 5 HP driver	- Provide condenser vacuum	- 5 in Hg condenser pressure (ABS) - 75 CFM (mfg. rating)
Electric oil pump	- Viking gear pump	- Provide bearing oil pressure during turbine start-up and shutdown (turbine-driven pump provides oil pressure during operation)	- Off during operation
Cooling tower pump	-Aurora centrifugal pump	- Provide coolant circulation through oil cooler	- 35 psi head (mfg. rating) - 120 GPM (mfg. rating)
Wet cooling tower	-Fan forced wet cooler -1/2 HP fan motor	- Reject oil coolant heat	- 110°F coolant outlet temp

Table 3.15

EPGS REMOTE OPERATED VALVES

VALVES	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-501	Valtek	2"	SV	FC	Turbine Steam Isolation	TWR Level 80 North Turbine Northeast Corner
FCV-511	Asco	1/2"	SV	FC	Hotwell Overflow	TWR Level 60 North Condenser Platform Northwest
FCV-512	Asco	3/4"	SV	FC	Hotwell Make-up	TWR Level 80 Northeast Condensate Storage Tank
FCV-521	Masoneilan	2"	CV	FO	Oil Cooler Water Flow Control	TWR Level 80 North Turbine/Generator Overhead
FCV-541	Asco	3/4"	SV	FC	Condenser Storage Tank Make-up	TWR Level 80 Northeast Condensate Storage Tank
FCV-551	Asco	1/2"	SV	FC	Condenser Recirculation	TWR Level 60 North Condenser Platform Northwest
TVM	GE w/auma Actuator	1 1/2"	CV	FC	Turbine Steam Supply Throttle	Turbine North Side
SNM	GE	--	CV	--	Turbine Sync Speed Control	Turbine Center
Fcv-561	ASCO	1/2"	SV	FO	Close throttle valve in emergency trip (dumps hydraulic oil)	Turbine

TABLE 3.17. EPGS INSTRUMENTATION

IDENTIFIER	DESCRIPTION	CONTROL MODULE	DISPLAY RANGE	ALARM LEVELS HIGH	ALARM LEVELS LOW	DIMENSION	SAMPLING PERIOD (sec)
	Turbine						
PT-581	Steam Supply Pressure	PCM 2	0-1500		800	PSI	5
PT-582	Steam Seal Pressure	PCM 2	0-1500			PSI	5
TE-581	Exhaust Temp	PCM 2	0-500			°F	5
TT-583	Steam Supply Temp	PCM 2	0-1200	990	800	°F	5
TT-501	Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TT-502	Inboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TE-503	Gear Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
AZT-581	Vibration	PCM 2	0-100	100		PCT (0-5 g)	5
	Generator						
JT-581	Power	PCM 2	0-960			kw	5
ET-581	Voltage	PCM 2	0-600	480	450	Volt	5
IT-581	Current	PCM 2	0-1200			Amp	5
PFT-581	Power Factor	PCM 2	0-1.0	1.0	0.85	PCT	5
VT-581	VARS	PCM 2	0-960			KVA	5
ST-582	Speed	PCM 2	0-1500	1270		rpm	5
ST-581	Frequency	PCM 2	0-100	60	40	PCT (55-65 Hz)	5
TT-510	Stator Winding 1 Temp	PCM 2	0-500	260		°F	5
TT-511	Stator Winding 2 Temp	PCM 2	0-500	260		°F	5
TT-512	Stator Winding 3 Temp	PCM 2	0-500	260		°F	5
TT-513	Stator Winding 4 Temp	PCM 2	0-500	260		°F	5
TT-514	Stator Winding 5 Temp	PCM 2	0-500	260		°F	5
TT-515	Stator Winding 6 Temp	PCM 2	0-500	260		°F	5
TE-508	Cooling Air Outlet Temp	PCM 2	0-500	100		°F	5
TT-507	Outboard Bearing Oil	PCM 2	0-500	170	110	°F	5
TE-505	Gear Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TE-506	Gear Inboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
PT-502	Condenser Pressure	PCM 2	0-30	15		In Hg	5
PT-583	Condensate Pump Discharge Pressure	PCM 2	0-400	300	240	PSI	5
LT-511	Hot Well Level	PCM 2	0-15	16	8	Inch	2
TE-582	Cooling Tower Pump Discharge Temp	PCM 2	0-500	100	40	°F	5
PT-531	Oil Pump Discharge Pressure	PDM 2	0-200	100	55	PSI	5
TT-521	Bearing Oil Supply Temp	PCM 2	0-500	140	100	°F	2
PT-501	Bearing Oil Supply Press.	PCM 2	0-50	40	10	PSI	5

Table 3-17
EPGS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Condenser hot well level	Remote operation (TCP. MS on) (EN.HLC on)	9 in min 14 in max	Hot well level (LT-511)	FCV-512 open/close - makeup FCV-511 open/close - dump
Condensate storage tank level	Operation	12 in min 30 in max	Storage tank level (LS-541)	FCV-541 open/close - supply from cycle fill pump FCV-542 open/close - CMUP Stand pipe air overpressure
Turbine/generator oil temperature	Remote operation	125°F FCV 521	Oil temperature (TT-521)	FCV-521 position - cooling water flow

3.7 HEAT REJECTION AND FEEDWATER SUBSYSTEM

The heat rejection and feedwater subsystem rejects waste heat to the atmosphere, pressurizes and heats the condensate to the final feedwater temperature. The subsystem (Figure 3.9) includes the cooling towers, circulating water pump, deaerator, spray water heat exchanger, spray water pump, feedwater pump, feedwater heater, demineralizers, chemical feeders, water analyzers, and condensate makeup pump.

The cooling towers consist of six forced-draft, finned-tube water-to-air heat exchangers. They originally were designed as Freon condensers for refrigeration systems.

The deaerator is used as a direct contact feedwater heater and deaerator and to reject steam generated by the SGS. It is a horizontal, cylindrical pressure vessel, designed to operate at 250 psia and 400°F. It includes a steam header with mixing spargers near the bottom of the tank, water spray nozzles across the top, and two immersion electric heaters. Feedwater, stored in the deaerator, is heated by steam from a branch off the SGS mainline to the turbine. The feedwater is circulated by a spray water pump at 400 gpm from the bottom of the deaerator to the spray nozzles in the vapor space at the top of the deaerator where the water condenses the steam and is thereby heated. Oondensate from the turbine condenser, blended into this spray water, is also heated to 400°F and deaerated.

The feedwater heater is a vertical, cylindrical pressure vessel with an internal steam condensing coil. Feedwater from the deaerator is heated on the tube side as steam from a branch of the SGS mainline condenses on the shell side. The saturated liquid from the coil is cascaded down to the deaerator through a steam trap. Main steam is used for feedwater heating in the feedwater heater and the deaerator because there are no external extraction points on the turbine.

Major components, valves, instrumentation, and control loops are described on Tables 3.18 through 3.21.

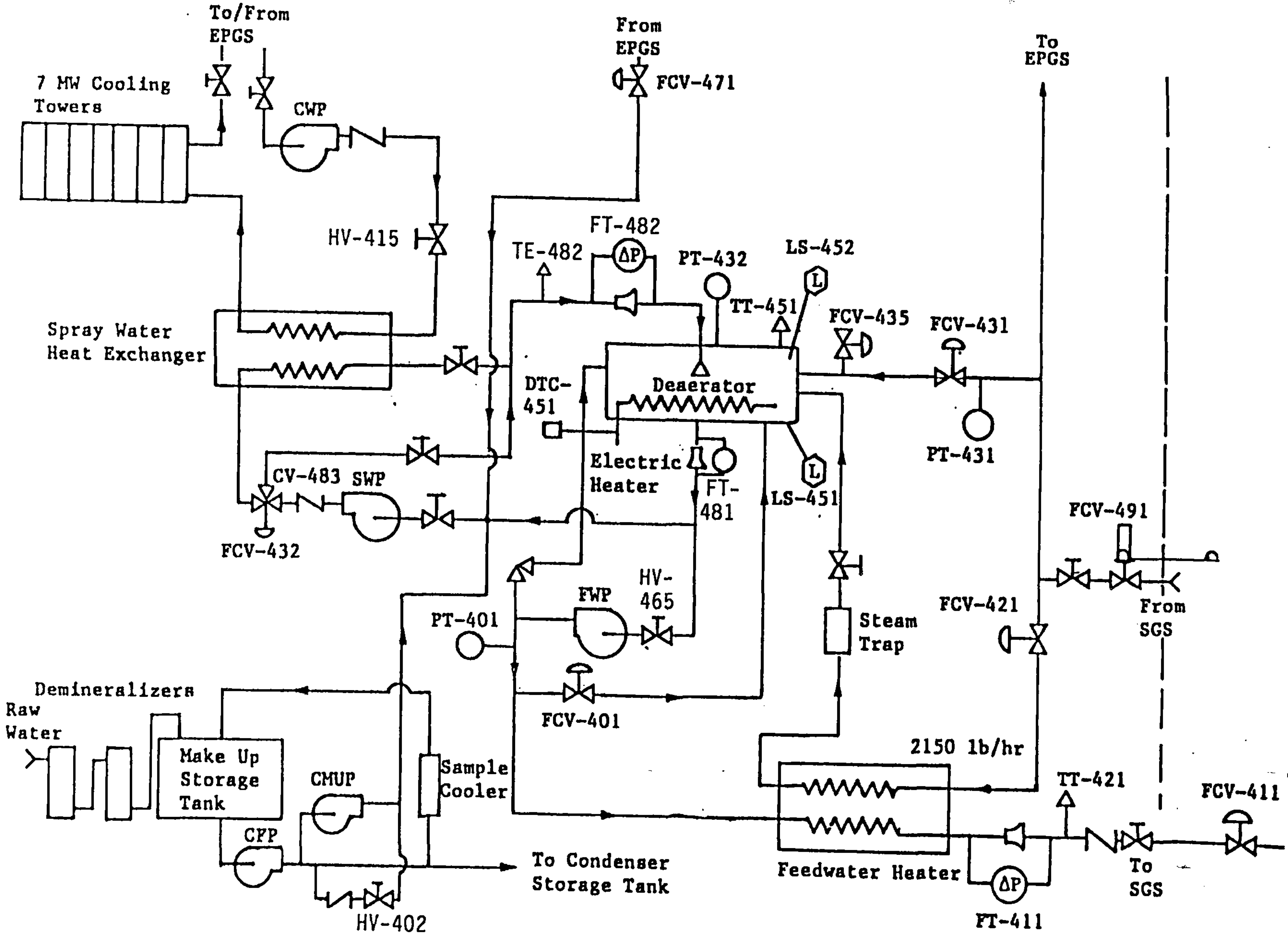

Figure 3.9 . Heat Rejection and Feedwater Subsystem Schematic

Table 3.18
Heat Rejection and Feedwater Subsystem Components

Component	Description	Function	Nominal Operating Condition
Feedwater heater	- Shell and coiled tube counter-flow heat exchanger - 35 in ID 2.5 in thick carbon steel shell (feedwater) - 4 ft 8 in overall height - 30 coiled tubes 0.500 in. dia. 43 ft long (steam)	- Raise feedwater temperature to SGS inlet condition	- 950°F superheated steam inlet - 545°F saturated liquid outlet - 2150 lb/hr steam flow rate - 401°F feedwater inlet - 550°F feedwater outlet - 11,582 lb/hr feedwater flow rate - 0.59 MW heat transfer
Deaerator	- Horizontal tank - 5 ft ID - 12 ft long - Contains 15 submerged mixing nozzles, 1 overhead spray nozzle, 2 147-kW electric immersion heaters	- Degasify condensate - Heat condensate for delivery to feedwater heater - Provide alternate steam dump when turbine is not operating	- 401°F - 250 psi - 0.63 MW heat transfer
Spray water heat exchanger	- Shell and tube heat exchanger - 24 in. dia. shell	- Reject excess heat from deaerator when utilized as alternate steam dump	- No flow from deaerator during normal operation

Table 3.18
Heat Rejection and Feedwater Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Feedwater pump	- High speed centrifugal type - 18,770 pump RPM - 150 HP driver	- Provide high pressure feedwater to the steam generator (through the feedwater heater)	- Inlet: 250 psi, 401°F water - 1450 psi head (mfg rating) - 60 GPM (mfg rating)
Spray water pump	- Vertical turbine type - 3 stage - 7-1/2 HP driver	- Provide circulation from deaerator to spray water heat exchanger and/or its bypass and return to deaerator overhead spray nozzle	- 401°F - 26 psi head (mfg rating) - 300 GPM (mfg rating)
Cooling water pump	- Centrifugal type - 40 HP driver	- Provide glycol/water circulation for spray water heat exchanger - cooling tower - condenser circuit	- 132°F glycol/water - 40 psi head - 1200 GPM
Cooling towers	- 6 units - Forced draft, finned-tube, glycol/water-to-air heat exchangers	- Reject waste heat to atmosphere	- 94°F air - 132°F glycol/water inlet - 120°F glycol/water outlet - 2.4 MW heat rejection

Table 3.19
HRFS REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-401	Fisher	2"	CV	FO	Feedwater Pump Pressure Control	Southwest of Deaerator
FCV-411	Kieley-Mueller	2"	CV	FC	Feedwater Flow Control	SGS Skid Northeast
FCV-421	Kieley-Mueller	2"	CV	FO	Feedwater Heater Temperature Control	Above Feedwater Heater
FCV-431	Kieley-Mueller	2"	CV	FC	Main Steam Pressure Control	Southwest of Deaerator
FCV-432	Kieley-Mueller	3"-3 way	CV	To SWHX	Deaerator Pressure Control	Between Deaerator and Spray Water Heat Exchanger
FCV-471	Valtek	1"	CV	FC	Condensate Control to Deaerator	Above North Door to Spray Water Pump Room
FCV-483	Atkomatic	1"	SV	--	Deaerator Vent Block	Above Deaerator
FCV-484	Atkomatic	1/4"	SV	--	Deaerator Vent Bypass	Above Deaerator
FCV-485	ASCO	2"	SV	--	Demineralized Water Storage Tank Fill	Above Culligan Beds
FCV-491	Kieley-Mueller	2"	CV	FC	SGS Steam Delivery Control During Start-Up	North End of SGS Skid

TABLE 3.20. HRFS INSTRUMENTATION

IDENTIFIER	DESCRIPTION	CONTROL MODULE	DISPLAY RANGE	ALARM LEVELS HIGH	ALARM LEVELS LOW	DIMENSION	SAMPLING PERIOD (sec)
	Main Steam						
PT-431	Pressure	PCM 2	0-1500	1200	900	PSI	2
TE-483	Temp	PCM 2	0-1200	990	850	Inch	10
	Deaerator						
PT-432	Pressure	PCM 2	0-400	250	200	PSI	2
TE-451	Fluid Temp	PCM 2	0-500	400	300	°F	2
TE-481	Steam Temp	PCM 2	0-500	400	300	°F	10
LT-471	Fluid Level	PCM 2	0-30	30	10	Inch	2
	Spray Water						
PT-482	Pressure	PCM 2	0-400	300	200	PSI	5
FT-482	Flow Rate	PCM 2	0-160			KLB/hr	5
TE-482	Temp	PCM 2	0-500	445		°F	10
FT-481	Feed/Spray Water Flow Rate	PCM 2	0-160			KLB/hr	5
	Feedwater						
PT-481	FWP Supply Pressure	PCM 2	0-400		170	PSI	5
PT-401	FWP Discharge Pressure	PCM 2	0-1500	1400	900	PSI	2
PT-484	FWP Coolant Pressure	PCM 2	0-100			PSI	5
PT-483	FWH Outlet Pressure	PCM 2	0-1500	1230	1180	PSI	5
FT-411	Flow Rate	PCM 2/ Bailey	0-160			KLB/hr	2
FT-421	FWH Outlet Temp	PCM 2	0-750	600	400	°F	2
	Cooling Water						
TE-484	SWHX Inlet Temp	PCM 2	0-500	130		°F	10
TE-486	Tower Outlet Temp	PCM 2/	0-500	110	32	°F	10

Table 3.21. HRFS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Feedwater temp.	Operation	520° ~~540~~°F FCV-421	Feedwater temperature (TE-421) Temperature set point	FCV-421 position - Feedwater heater Steam supply flow
Feedwater pressure	Operation	1250 psig FCV-401	Feedwater pressure (PT-401) Pressure set point	FCV-401 position - FWP recirculation flow
Steam delivery pressure	Manual salt flow GSTAT off	1080 psig PT-431	Delivery pressure (PT-431) Pressure set point	FCV-431 position - Deaerator steam dump
Deaerator pressure	Operation - Desuperheating GSTAT off	233 psig PT-432	Deaerator pressure (PT-432) Pressure set point	FCV-432 position - Deaerator dump to SWMX
	Boiler following GSTAT on	233 psig PT-432	Deaerator pressure (PT-432) Pressure set point	FCV-431 position - Deaerator steam supply
Deaerator temp.	Start-up	390°F DTC 451 DTC 452	Deaerator temperature (TE-451) Temperature set point	DTC-451/452 on/off - Electric heater control
Deaerator level	Operation	15 in FY-472 (controls deaerator level) (14 in backup during turbine operation)	Deaerator level (LT-471) Level set point	FY-472 condensate - Makeup pump stroke position
	Turbine Operation	15 in FCV-471	Deaerator level (LT-471) Level set point	FCV-471 position - Turbine condensate return from hot well

3.8 SYSTEM TRIPS

3.8.1 Equipment Protection Subsystem

The Equipment Protection Subsystem (EPS) is a hard-wired system using dedicated sensors and is designed to safe the MSEE in the event of any potentially unsafe condition. Subsequent to the EPS placing the system in a "safe" condition, operator action is required to shut the system down or to change into any other mode. The trip list for the EPS, including actions taken by the EPS and subsequently to be taken by the operator, are shown on Table 3.22, subdivided by subsystem.

3.8.2 Turbine/Generator Trips

Trips built into the turbine/generator are given on Table 3.2.3. Definitions and guidelines are given below.

A. Definitions

1. Turbine Trip - Immediate turbine steam shutoff - manual or auto.

2. Turbine Shutdown - Gradual turbine steam shutoff - manual.

3. Generator Trip - Generator circuit breaker opened - manual or auto.

B. Steam reactions to trips

1. Anticipated - Steam control maintained manually or auto.

2. Upset - Reliance on auto steam control - SGS salt flow will stop and HRFS will attempt to desuperheat steam. Probable HRFS and SGS safety valve lifting if upset is uncontrolled.

C. Trip interlocks

1. A generator breaker trip always initiates a turbine SVC trip (auxiliary relay 32x closes FCV-501) and an EPST TR-586 (32x).

2. A generator breaker trip always initiates a turbine T.V. reset (auxiliary relay 32x resets T.V. closed) w/ZT-581 '0'% open.

3. A turbine T.V. reset and an EPS 2 & 3 reset will reopen FCV-501 unless manually closed (or tripped).

D. All auto trips should be carefully reviewed - determine the cause of the trip and correct the problem before resuming operations.

E. Fail-safe follow-through guidelines
These guidelines present items of concern to fail-safe the EPGS upon a major component failure, after a trip that did not function, or to back up an auto trip. Intimate familiarity with these guidelines is mandatory before EPGS operation to insure safe operation, both from a personnel and equipment standpoint.

1. Three items are of major concern to fail-safe the EPGS and MSEE operating systems:

   a. Steam over-pressurization
   b. Turbine trip
   c. Generator trip

2. Steam system reactions to turbine trips:

   a. Over-pressurization
   b. Possible HRFS/D-D & SGS/steam drum safety valve lifting
   c. Desuperheating by HRFS/FCV-431 switchover to steam control to dump steam to D/D
   d. FCV-432 D/D heat dump through SWHX and dry cooling tower

3. Turbine tripping is redundant-designed and may be fully utilized with these four trips:

a. Actuate ET emergency trip FCV-561	(oil trip)
b. Open generator breaker with breaker C.S.	(electric trip)
c. Actuate EPS T-G trip button from control room	(EPS backup)
d. Manually close throttle valve with hand wheel	(manual)

4. Turbine-generator trip verification:

a. ST-582 speed decreasing	
b. PT-532 hydraulic oil pressure decreasing	(T.V. trip)
c. PT-581 steam pressure drops to zero	(FCV-501 trip)
d. Generator breaker open - green light on	

NOTE

EOP operation is not mandatory upon a turbine trip since the shaft driven oil pump provides adequate oil flow for turbine coast down.

5. Generator trips are redundant-designed with turbine trips. Be aware that:

   a. EPGS UPS provides emergency backup C/B trip power

   b. Exciter voltage shutdown local disconnect switch shuts down all of the generator electrical power.

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
RECEIVER SUBSYSTEM TRIPS

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
--	Operator Manual Trip	--	N/A	EPS - Defocus Heliostats
TR-181	Receiver Salt Outlet Temp High	TE-102A	1080°F	Operator - Control Receiver From The EMCON Console
TR-184	Receiver Tube Temp High During Hot Salt Production	TE-140A and TE-102A	925°F >750°F	
TR-187	Loss of Receiver Door Open Signal	ZSH-DR	Contact Open	
TR-182	Boost Pump Pressure Low During Hot Salt Production	PT-180A and TE-102A	250 PSIG >750°F	EPS - Defocus Heliostats - Close FCV-151 After Time Delay
TR-183	Receiver Salt Inlet Pressure Low During Hot Salt Production	PT-181A and TE-102A	8 PSIG >750°F	Operator - Shutdown Receiver from EMCON Console
TR-185 Heliostats	Hot Surge Tank Level High	LF-161A or TE-184A	80 In 300°F	EPS - Defocus - Close FCV-101 and FCV-102 After Time Delay Operator - Shutdown Receiver From EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
RECEIVER SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-186	Boost Pump Sump Level High	TE-181A	400°F	EPS - Defocus Heliostats - Time Delay - Close FCV-151 - Turn Off Cold Salt Boost Pump - Turn Off Hot Salt Pump EMCON (Automatic) - Maintain Control of Receiver and HRFS Operator - Shut Down the Plant From the EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
THERMAL STORAGE SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-281	Hot Salt Sump Level High	LT-221A or TE-231A	40 In 300°F	EPS - Close Sump Insolation Valve FCV-231 Operator - Allow Time for Hot Salt Pump Operations To Bring Sump Level Down - Shut down SGS, HRFS, and EPGS From EMCON Console
TR-282	Cold Salt Sump Level High	LT-201A or TE-211A	55 In 350°F	EPS - Close Sump Insolation Valve FCV-211 - Defocus Heliostats Operator - Allow Time for Cold Salt Pump Operations To Bring Sump Level Down - Shut down the Plant From The EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
STEAM GENERATOR SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-381	Steam Drum Level Low	LT-311A	-10 In	EPS - Close FCV-501 - Open Generator Circuit Breaker - Turn Off FWP (Drum Level High only) EMCON (Automatic) - Dump Steam To Deaerator
TR-383	Steam Drum Level High and Water Hot	LT-311A and TE-383A	+17 In >250°F	- Maintain Control of HRFS Network 90 - Shut Off Salt Flow (Close FCV-301, 341, and 351) - Turn Off BWCP (Drum Level Low only) Operator - Shut Down SGS, HRFS, and EPGS From EMCON Console
TR-382	Boiler Water Circulation Pump Failure	Motor Current Sensor	Off	EPS - Close FCV-501 - Open Generator Circuit Breaker EMCON (automatic) - Dump Steam to Deaerator - Maintain control of HRFS Network 90 - Shut Off Salt Flow (Close FCV-501, 341, and 351) Operator - Shut down SGS, HRFS, and EPGS from EMCON console

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TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
EPGS TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
	Turbine Overspeed	OST	1320 RPM Generator	EPS - Close FCV-501 Open Generator Circuit Breaker
	Turbine Back Pressure High	TBPT	5 PSIG	
TR-584	Generator Bearing Temp High	TS-501A	180°F	EMCON (Automatic) - Dump Steam to Deaerator - Maintain Control of HRFS
TR-585	Generator Cooling Air Temp High	TS-502A	122°F	Operator - Control System From EMCON Console - Reduce Steam Flow - Shut Down If Necessary
TR-586	Generator Circuit Breaker Trip		-Manual -Low/high Voltage -Low/high frequency	
TR-587	Turbine Vibration High	AZT-581	5g	
TR-588	Steam Energy Low	TE-332 or PT-581A	750°F 770 PSI	
TR-583	Turbine Oil Pressure	PS-501A (LUBE) or PS-531A (HYDR)	6 PSI 50 PSI	
TR-582	Manual T/G Emergency Trip	Control Room PB	Operator Initiate	

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
MASTER CONTROL SUBSYSTEM TRIPS
(Continued)

TRIP CONDITION	ACTION REQUIRED
PCM 1 Microcomputer Failure - Loss of Receiver Displays - Loss of Salt Auto Flow Control - Loss of Cold Surge Tank Auto Level Control	EPS - Defocus Heliostats - Close FCV-151 After Time Delay Operator - Control Receiver from PCM 1 - Drain Receiver If Necessary
PCM 2 Microcomputer Failure - Loss of HRFS and EPGS Displays - Loss of Feedback Control Loops	EPS - Turn Off Hot Salt Pump - Close FCV-301, FCV-341, and FCV-351 - Turn Off FWP - Close FCV-501 and FCV-491 After Steam Pressure Drops - Open Generator Circuit Breaker - Turn Off Condensate Pump Operator - Shut Down SGS From Console - Shut Down HRFS and EPGS From PCM 2
PCM 3 Microcomputer Failure - Loss of TSS Displays - Loss of Feedback Control Loops - Loss of SGS Displays	EPS - Defocus Heliostats - Time Delay - Close FCV-211 - Close FCV-231 - Turn Off Hot and Cold Salt Pumps - Turn Off Cold Salt Boost Pump - Close FCV-151 - Close FCV-501 - Open Generator Circuit Breaker EMCON (Automatic) - Dump Steam To Deaerator - Maintain Control of HRFS Network 90 (Automatic) - Interlocks Will Close FCV-301, FCV-341, and FCV-351 Operator - Shut Down SGS From Network 90 Console - Shut Down Receiver, HRFS, and EPGS from EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
MASTER CONTROL SUBSYSTEM TRIPS
(Continued)

TRIP CONDITION	ACTION REQUIRED
Simultaneous Failure of PCM 1, 2, and 3 Microcomputers - Loss of All Subsystem Control CCM Microcomputer Failure - Loss of PCM/Host Computer Communication Lin - Loss of Console Displays - Loss of Console Control Capability - Loss of Sequencing Operations Involving More Than One PCM Operator Remote Manual Trip	EPS - Defocus Heliostats - Time Delay - Close FCV-211 - Close FCV-231 - Turn Off Hot and Cold Salt Pumps - Turn Off Cold Salt Boost Pump - Close FCV-151 - Turn off FWP - Close FCV-501 and FCV-491 After Steam Pressure Drops - Open Generator Circuit Breaker - Turn Off Condensate Pump Operator - Shut Down the Subsystems From PCM 1, 2, and 3 and Network 90
EMCON Host Computer Failure	PCMs and CCM Continue To Operate and Control The Plant Operator - Shut Down The Subsystems From PCM 1, 2, and 3

Table 3.23. TURBINE/GENERATOR TRIP LIST

MODE	DESCRIPTION	INITIATION
Manual	MGBT - Manual generator breaker trip	Breaker switch opened at local or remote generator control panel
Manual	ET - Emergency trip	ET "on" at EMCON console or local trip button actuated
Manual/auto	SVC - Stop valve closure	Close FCV-501
Manual/auto	OST - Overspeed trip	Local OST button
Manual	MTVC - Manual throttle valve closure	Close throttle valve (TVM)
Auto	GBT - Generator breaker trip	a. Reverse power b. Ground fault c. Overcurrent

A tabulation of data describing the MSEE system is given on Table 3.1. A more detailed description of the MSEE subsystems is contained in the following subsections.

3.1 COLLECTOR SUBSYSTEM

The collector subsystem redirects, concentrates, and focuses solar radiation onto the tower-mounted receiver. The subsystem, which is already in place at the CRTF, consists of 221 two-axis tracking heliostats located north of the receiver tower, and its control system. Under optimum insolation and heliostat conditions, the heliostat field can concentrate approximately 5 MW_t onto the receiver.

Each heliostat has 25 individual mirror facets totaling 37.2 m^2 (400 ft^2) of reflective surface. The facets are mounted on a structure and individually adjusted to provide a concentration ratio of 25 to 1 on the receiver. The structure has motor-driven azimuth and elevation gimbals, which allow it to track the sun during the day.

The heliostats are operated from the control room by the CRTF collector control system. (The CRTF collector control system is separate from the experiment master control subsystem.) The CRTF collector control system analyzes heliostat operating commands from a number of programmed test sequences or from the facility heliostat operator. Control signals are distributed to the heliostats through four heliostat array controllers and four heliostat interface modules. Each heliostat receives azimuth and elevation pointing information once every second and responds with its own status. Commands and data transmitted to the individual heliostats are received and executed by the heliostat control electronics. The electronics keep the drive motor power at the proper level until the gimbal axis encoders indicate that the desired position has been reached.

Table 3.1

MSEE Data

Location -- CRTF; on Kirtland Air Force Base, Albuquerque, NM

Heliostat Field -- Existing field of 221 heliostats each with 400 ft^2 of mirror surface.

Tower -- Existing concrete tower, 200 ft. high with internal lifting module

Master control -- EMCON D-2 distributed digital control system with central consoles; separate equipment protection system.

Receiver -- Refurbished from previous Subsystem Research Experiment.

- o Rating: 5 MW_{th}
- o Salt temperatures: in - 590^{o}F; out - 1000^{o}F (1050°F with propane heater)
- o Configuration: cavity with door
- o Absorber: single panel of 3/4 in Incoloy 800 tubes (18 passes, 16 tubes per pass)
- o Peak flux: 630 kW/m^2 (200,000 Btu/hr - ft^2)

Thermal Storage -- Existing from previous Subsystem Research Experiment

- o Rating: 5.8 MW_{th} Hr when operating between 590^{o}F and 1000^{o}F
- o Type: 2-tank
  - Hot tank, internal insulation
  - Cold tank, external insulation

Steam Generator -- Supplied by Babcock and Wilcox

- o Type: Forced recirculation
- o 2 units: evaporator and superheater (both U-tube, U-shell) with steam drum separator
- o Rating: 11,000 lb/hr of steam at 940^{o}F and 1100 psi (3.13 MW_{th})
- o Prototypical of commercial design

Turbine Generator -- GE rebuilt unit

- o Marine turbine
- o 750 kW_e rating (500 kW_e under nominal operating conditions)

Heat Rejection and Feedwater System -- existing at CRTF

- o Feedwater treatment only
- o 20,000 gallon demineralized water storage
- o Dry cooling, 7 MW_{th} capacity
- o Spray water heat exchanger to reject heat when turbine not in use or tripped off line

3.2 MASTER CONTROL SUBSYSTEM

The master control subsystem (Figure 3.3) consists of an EMCON-D2 for system control and a equipment protection system. A Bailey network 90-system is used to directly control the SGS. Commands and set points are provided by the EMCON master control subsystem to the Network 90 for SGS operation and control. The equipment protection system is an independent hardwired relay shutdown system. These relay trip devices will shut down the receiver or the power generation ends of the MSEE when critical parameters reach preset limit values. These relay units are independent of the EMCON and network 90 control systems. Additionally, an Accurex Data Logger is used to collect and display all the temperature measurements relating to the heat tracing and data instrumentation.

3.2.1 EMCON System

The EMCON-D2 is a distributed digital control system consisting of two operator consoles, a host computer with its peripheral hardware, a communication control module, and three process control modules distributed among the subsystems. Two EMCON-D2 operator consoles are located in the CRTF main control room. The host computer is an existing DEC PDP 11/34 unit located in the control room. This computer links the operator with the process control modules, and analyzes data from the control modules for presentation on the operator consoles. The peripheral equipment includes two disk drives, an alarm system, and a data analysis system.

A communication control module links the host computer with the three field-located, process control modules. Each process control module is a small digital computer capable of monitoring a number of instrumentation points, and responding with a number of process control signals. Communications between the control modules and host computer are primarily limited to direct operator commands from the console and critical operating information from the subsystems for console display. This distributed control system reduces the number of instrumentation and control links between the subsystems and control room.

The process control module consists of a digital computer control unit, a multiplexer, an analog-to-digital converter, and a digital-to-analog converter. Analog signals from the process instrumentation are converted to

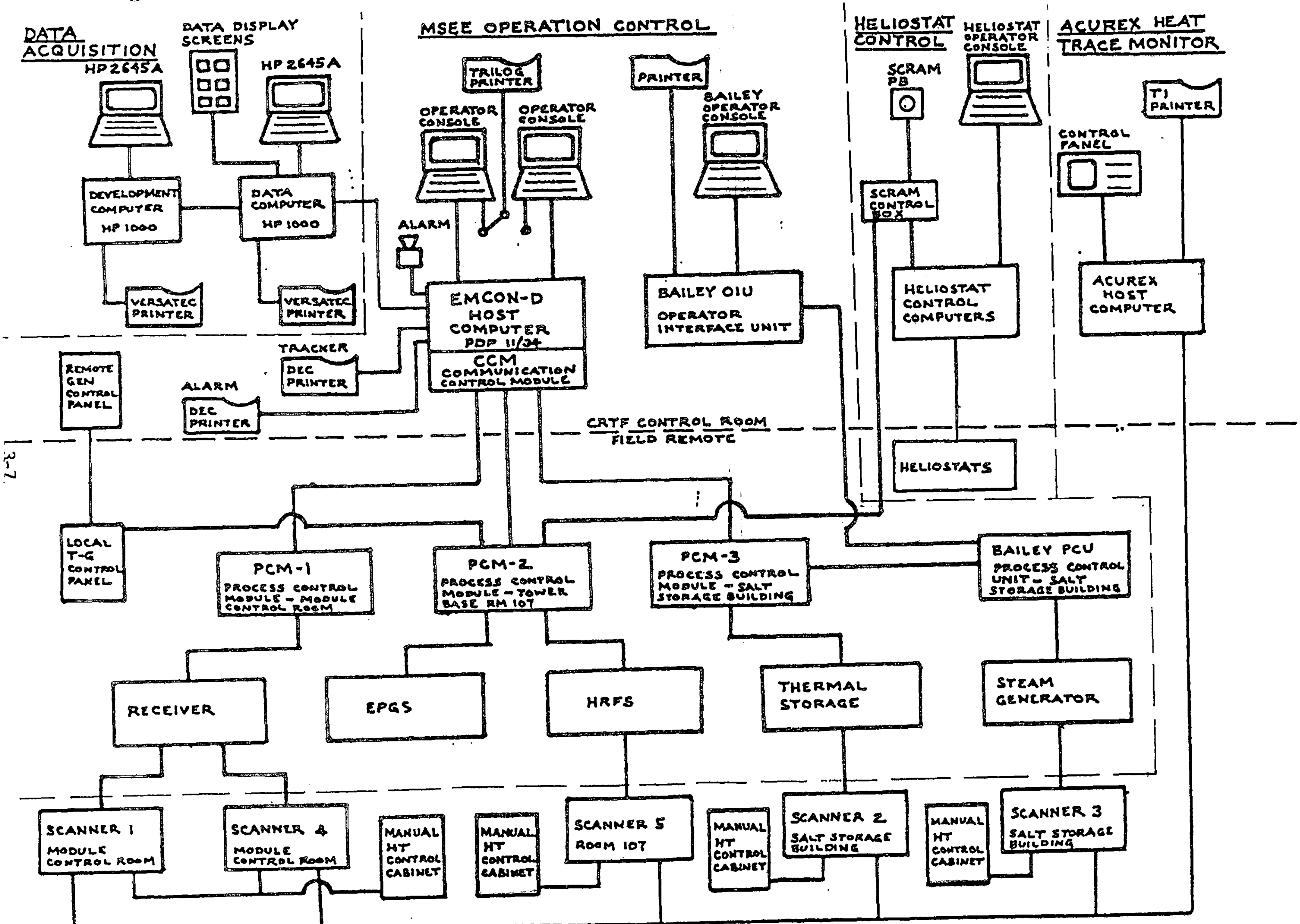

Figure 3.3 Master Control Subsystem

digital signals, selected in rotation by the multiplexer, and analyzed by the control unit. The module responds with an appropriate digital control signal which is passed through the multiplexer and sent to the appropriate controller. Each process control module is capable of monitoring 30 analog signals per second, monitoring 95 thermocouples, generating 20 analog control signals, and controlling over 100 on-off switches.

One process control module (PCM 1), located below the receiver in the tower elevator, is dedicated to the control of the receiver. A second module, (PCM 2) located at the base of the tower, controls the heat rejection and electric power generation subsystem. The third module, (PCM 3), located in the control building adjacent to the salt storage tanks, is used to control the thermal storage subsystem and to command the Network 90 controlled steam generation subsystem.

The receiver subsystem PCM will modulate the salt flow rate to the receiver to maintain, as closely as possible, a constant outlet temperature of 1000°F. Individual thermocouples are located on the receiver to measure intermediate salt temperatures. From this information, the control module estimates the flux on the receiver, and feed-forward a signal to the salt control valves at the receiver inlet. The control module also controls the receiver start-up and shutdown purge and drain valves.

Control of the thermal storage subsystem involves the operation of the two salt downcomer flow control valves, cold salt pumps, salt storage tanks and piping heat tracing, and the propane-fired salt heater. The downcomer throttling valves are controlled by the receiver control system to maintain a constant level in the receiver hot surge tank. Salt equipment heat trace temperatures are monitored continuously by the Acurex Data Logger. The propane-fired salt heater is operated intermittently, under manual control, during subsystem checkouts.

Automatic control of the heat rejection and electric power generation subsystem involves the control of the steam and condensate flows to the deaerator, steam flow to the feedwater heater, and the operation of the cooling water, spray water condensate, and feedwater pumps. The EPGS condenser temperature, level and pressure are monitored by the master control subsystem. The deaerator temperature is maintained by controlling the steam flow from the main steam header. The final feedwater temperature is maintained by controlling the main steam flow to the feedwater heater.

Automatic control of the steam generation subsystem primarily involves the control of steam pressure, steam temperature, drum water level, and the evaporator salt inlet temperature through the network 90 control system. The water level in the drum is controlled by modulating the control valve downstream of the feedwater pump. Control of the main steam pressure is accomplished by modulating the salt flow control valve downstream of the evaporator. Steam temperature is controlled using an attemperator to mix steam from the steam drum with the output of the superheater. The evaporator salt inlet temperature is controlled by monitoring the inlet salt temperature, and modulating the cold salt control valve at the mixing tee between the superheater and evaporator.

3.2.2 Network 90 System

The Bailey Network 90 Control System consists of two units, one process control unit (PCU) and one operation interface unit (OIU).

The PCU architecture is based on two key modules, the Controller Module (COM) and the Logic Master. Together, these modules provide a mix of both modulating and sequential control functions including: base, cascade, or ratio PID control, high/low and rate limiters, engineering units conversion, general function generator, square root, summation, multiplication, lead/lag, and transfer select, or, and, not, time delay, and several others. The controller module can service up to four analog and three digital inputs and two analog and four digital outputs. The COM also provides A/D and D/A conversion, alarm limit checking (absolute and deviation) and notification, point quality checking and interlocking.

The Operator Interface Unit (OIU) provides the high level operator interface for the Network 90 system. The OIU consists of a color CRT-based table-top console, with functional keyboard, mass storage device, and console driver electronics.

In operation, the unit performs the system information display and control requirements. The OIU console includes a CRT keyboard and pushbutton hardware for process overview, alarm indicating, loop control, trending, tuning and configuration functions.

The OIU uses microprocessor, memory and I/O modules to support system functions. It furnishes monitoring, supervisory, recording and display capability at centralized or distributed locations, along with engineering functions.

3.2.3 Data Acquisition

The DAS utilizes both the EMCON-D2 and an HP-1000. EMCON collects the data and HP-1000 stores and displays data. Data collected by the EMCON system is transmitted to the HP-1000 system on a terminal-to-terminal data link. The tag list for the data to be collected is in a file of 180 tags, which are divided into 6 groups of 30 tags. One group of 30 is transmitted every 10 seconds, giving a total update rate of once a minute. The data are then time tagged with day of the year, hour, minute, second, millisecond. Then the data are stored in a data file and/or displayed on one of six CRTs in a graphical form. Also, the data are transmitted in integer format, not floating point, but they are in engineering units. The data files are divided into eight-hour blocks, so if a test runs longer than eight hours, another eight-hour block is assigned to that test's file. Normally an 8-hour data block is stored in 19 tracks out of a maximum usable 1000 tracks.

The live data can be displayed on the 6 CRTs with 3 tags per screen, a time scale of 3 hours 20 minutes, and a Y-scale displayed of the first tag's display range. The other two tags are displayed using their respective ranges, but the scales are not shown on the plot. When the plot is full the plot scrolls left dropping the oldest 1/4 of the time scale data. This leaves 1/4 of the plot blank for new data. These plots can have hard copies made, but not automatically. The print is done by manual switch selection of each screen and a copy page switch.

Recovery of stored data can be done whenever live data files are not being made. These plots have a slightly different format, three being a maximum of five tags per plot, and the Y scale shown is that of the last tags range. These plots are not displayed on a CRT, but directly generated on the printer/plotter.

3.3 RECEIVER SUBSYSTEM

The receiver subsystem (Figure 3.4) captures the insolation redirected from the heliostat field and converts it to thermal energy in the molten salt. The subsystem consists of the receiver absorber panel, cavity enclosure with one vertical aperture door, insulation, heat tracing, cold surge tank, booster pump, hot surge tank, overflow tank, instrumentation, and control valves. The receiver is located at the top of the CRTF tower.

The receiver was tested in a previous subsystem research experiment. Since the initial experiment, the receiver has been refurbished. This refurbishment included instrumentation and control system modifications, minor structural and piping changes, and the replacement of the two original horizontal cavity doors with one vertical aperture door.

The receiver absorber is a single panel with 18 vertical passes having 16 tubes per pass. The tubes are Incoloy 800 with 19 mm (0.75 in.) outside diameter. Purge and drain valves are provided for each pair of passes.

The receiver surge tanks are designed to dampen changes in the salt flow rate and to maintain salt flow through the receiver in the event of a cold salt pump outage. The cold surge tank is pressurized with facility-supplied instrument air to supply the necessary head to force the salt through the receiver in the event of a pump outage, and to provide a surge volume within the tank. The hot surge tank operates at atmospheric pressure, and is vented to an adjacent overflow tank in the event of a control problem in the salt downcomer throttle valve.

The cold salt booster pump takes its suction from the discharge of the cold salt pump and provides the necessary head for the salt as it travels up the tower and through the receiver.

The cold salt line to the receiver starts at the booster pump, rises to the top of the hot storage tank, traverses the distance from the storage tanks to the receiver tower on an elevated pipe bridge, enters the tower, and runs up the east side of the tower in an existing pipe chase to the receiver. The hot salt line leaves the hot surge tank and traverses to the pipe chase. The hot salt downcomer carries the salt to the level of the pipe bridge. The hot salt line traverses the bridge, ending in a control valve which throttles the flow to the hot storage tank. The salt piping is inclined between the storage tanks and the tower to ensure that the piping system will completely drain. The salt piping is electrically heat traced and insulated with calcium silicate and aluminum sheathing.

The receiver components are listed on Table 3.2; valves are described on Table 3.3; instrumentation is listed on Table 3.4; and control loops are described on Table 3.5.

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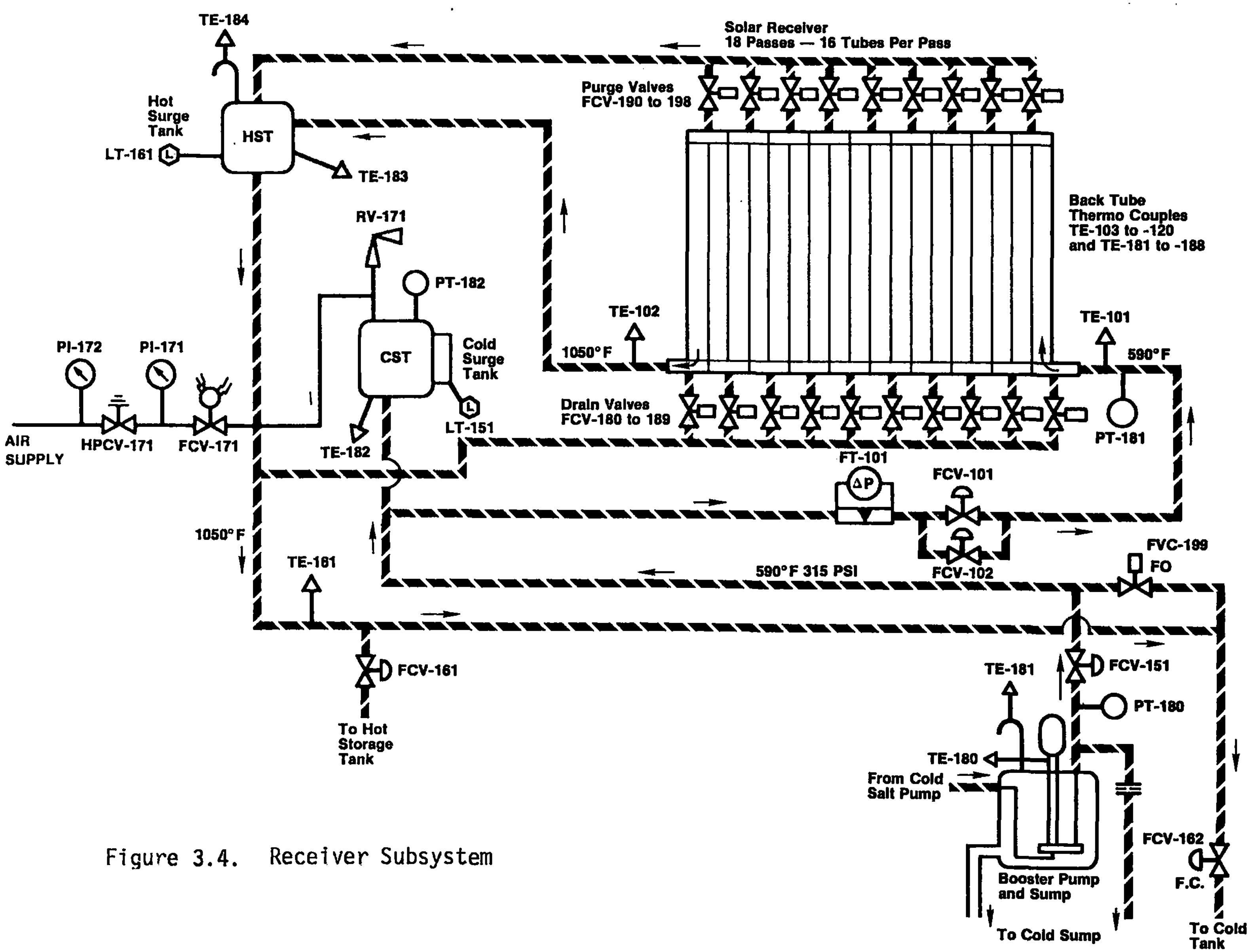


Figure 3.4. Receiver Subsystem

Table 3.2
Receiver Subsystem Components

Component	Description	Function	Nominal Operating Condition
Receiver	- 18 ft wide x 13 ft high panel - 18 serpentine passes Incoloy 800 tubes - 16 tubes per pass - 3/4 in. dia. tubes	- Heat molten salt with solar energy from heliostat field	- 590°F inlet salt - 1050°F outlet salt - 96,867 lb/hr - 5 MW rating
Cold salt booster sump	- Carbon steel cylindrical tank	- Reservoir for cold salt pump	- 590°F salt - Atmospheric pressure
Cold salt booster pump	- Vertical cantilever type	- Supply additional head to outlet of cold salt pump to provide salt circulation through receiver	- 590°F salt - 96,867 lb/hr
Cold surge tank	- Carbon steel cylindrical tank - 3 ft. dia. - 7 ft. high	- Dampen changes in salt flow rate - Provide emergency salt flow through receiver until solar flux can be removed in the event of pump outage	- Pressurized to 125 psi
Hot surge tank	- Stainless steel cylindrical tank - 2 ft. dia. - 7 ft. high	- Dampen changes in salt flow rate	- Atmospheric pressure

Table 3.3

RECEIVER SUBSYSTEM REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-101 FCV-102	Valtek	2"	CV	FO	Receiver Flow Control	Near Receiver Lower West Corner
FCV-151	Valtek	2"	CV	FC	Receiver Fill Control Cold Surge Level Control	Above Hot Tank
FCV-161	Valtek	2"	CV	FO	Hot Surge Tank Level Control	Above Hot Tank
FCV-162	Valtek	2"	CV	FC	Hot Surge Tank Level Control (Receiver)	Above Hot Tank
FCV-180 thru FCV-189	Kieley-Mueller	1 1/2"	SV	FC	Receiver Fill and Drain	Below Receiver
FCV-190 thru FCV-198	Kieley-Mueller	1 1/2"	SV	FC	Receiver Purge	Above Receiver
FCV-199	Kieley-Mueller	2"	SV	FC	Allow Downcomer Backflow During Receiver Fill and Permit Drainage to Cold Storage Tank During Shutdown	Above Hot Tank

↑ Shutoff valve (also called isolation valve)

CV - Control Valve
SV - Shutoff Valve
FO - Fail Open
FC - Fail Close

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Boost Pump						
PT-180	Discharge pressure - *goes to 310 psi before FCV-151 opens & allows flow to receiver*	PCM 3	0-400	350	275	PSI	2
TE-180	Bearing temp *normally at 100 or less*	PCM 3	0-500	190		°F	10
TE-181	Sump vent temp *normally 200 - 220*	PCM 3	0-1200	350		°F	10
	Hot surge tank						
LT-161	Level *normal operation is 20", during* [illegible]	PCM 3	0-100	70	15	inch	2
TE-183	Salt temp *normally 1050°F during operation*	PCM 1	0-1200	1070	500	°F	10
TE-184	Vent temp [illegible]	PCM 1	0-1200	400		°F	10
	Cold surge tank						
LT-151	Level *normally 50-52 during normal operation*	PCM 1	0-100	90	10	inch	10
TE-182	Salt temp	PCM 1	0-1200	750	500	°F	10
PT-182	Pressure *normally ≈ 150 psi*	PCM 1	0-200	180	10	PSI	10
TE-161	Downcomer outlet temp	PCM 3	0-1200	1070	500	°F	2
Sun	Solar insolation - *not in a group, represents power level* [illegible]	PCM 3	0-1000			W/M^2	5

[illegible] tank is vented to atmosphere, therefore it is not pressurized

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver						
PT-181	Inlet pressure - directly related [illegible] should be 30)	PCM 1	0-200	125	10	PSI	10
FT-101	Salt flow rate [illegible] now when called [illegible] calculated value	PCM 1	0-100	100		KLB/hr	
TE-101	Salt inlet temp [illegible]	PCM 1	0-1200	650	500	°F	2
TE-102	Salt outlet temp	PCM 1	0-1200	1060	500	°F	2
TE-103	Back tube-pass #1 outlet	PCM 1	0-1200	640	500	°F	2
TE-104	Back tube-pass #2 outlet	PCM 1	0-1200	665	500	°F	2
TE-105	Back tube-pass #3 outlet	PCM 1	0-1200	690	500	°F	2
TE-106	Back tube-pass #4 outlet	PCM 1	0-1200	720	500	°F	2
TE-107	Back tube-pass #5 outlet	PCM 1	0-1200	750	500	°F	2
TE-108	Back tube-pass #6 outlet	PCM 1	0-1200	780	500	°F	2
TE-109	Back tube-pass #7 outlet	PCM 1	0-1200	810	500	°F	2
TE-110	Back tube-pass #8 outlet	PCM 1	0-1200	835	500	°F	2
TE-111	Back tube-pass #9 outlet	PCM 1	0-1200	865	500	°F	2
TE-112	Back tube-pass #10 outlet	PCM 1	0-1200	890	500	°F	2
TE-113	Back tube-pass #11 outlet	PCM 1	0-1200	920	500	°F	2

Table 3.4
Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-114	Back tube-pass #11 outlet	PCM 1	0-1200	950	500	°F	2
TE-115	Back tube-pass #12 outlet	PCM 1	0-1200	975	500	°F	2
TE-116	Back tube-pass #13 outlet	PCM 1	0-1200	990	500	°F	2
TE-117	Back tube-pass #14 outlet	PCM 1	0-1200	1010	500	°F	2
TE-118	Back tube-pass #15 outlet	PCM 1	0-1200	1030	500	°F	2
TE-119	Back tube-pass #16 outlet	PCM 1	0-1200	1050	500	°F	2
TE-120	Back tube-pass #17 outlet	PCM 1	0-1200	1070	500	°F	2
TE-131	Back tube-pass #1 upper	PCM 1	0-1200	645	500	°F	10
TE-132	Back tube-pass #5 upper	PCM 1	0-1200	745	500	°F	10
TE-133	Back tube-pass #8 upper	PCM 1	0-1200	815	500	°F	10
TE-134	Back tube-pass #11 upper	PCM 1	0-1200	915	500	°F	10
TE-135	Back tube-pass #14 upper	PCM 1	0-1200	980	500	°F	10
TE-136	Back tube-pass #17 upper	PCM 1	0-1200	1045	500	°F	10
TE-137	Back tube-pass #2 middle	PCM 1	0-1200	680	500	°F	10

Table 3.4

Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-138	Back tube-pass #6 middle	PCM 1	0-1200	735	500	°F	10
TE-139	Back tube-pass #8 middle	PCM 1	0-1200	825	500	°F	10
TE-140	Back tube-pass #11 middle	PCM 1	0-1200	905	500	°F	10
TE-141	Back tube-pass #14 middle	PCM 1	0-1200	990	500	°F	10
TE-142	Back tube-pass #17 middle	PCM 1	0-1200	1045	500	°F	10
TE-143	Back tube-pass #1 bottom	PCM 1	0-1200	660	500	°F	10
TE-144	Back tube-pass #5 bottom	PCM 1	0-1200	725	500	°F	10
TE-145	Back tube-pass #8 bottom	PCM 1	0-1200	830	500	°F	10
TE-146	Back tube-pass #11 bottom	PCM 1	0-1200	895	500	°F	10
TE-147	Back tube-pass #14 bottom	PCM 1	0-1200	985	500	°F	10
TE-148	Back tube-pass #17 bottom	PCM 1	0-1200	1035	500	°F	10
TE-185	Header-pass #2 outlet	PCM 1	0-1200	665	500	°F	10
TE-186	Header-pass #3 outlet	PCM 1	0-1200	690	500	°F	10

Table 3.4
Receiver Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Receiver (cont.)						
TE-187	Header-pass #4 outlet	PCM 1	0-1200	720	500	°F	10
TE-188	Header-pass #5 outlet	PCM 1	0-1200	750	500	°F	10
TE-189	Header-pass #6 outlet	PCM 1	0-1200	780	500	°F	10
TE-190	Header-pass #7 outlet	PCM 1	0-1200	810	500	°F	10
TE-191	Header-pass #8 outlet	PCM 1	0-1200	835	500	°F	10
TE-192	Header-pass #9 outlet	PCM 1	0-1200	865	500	°F	10
TE-193	Header-pass #12 outlet	PCM 1	0-1200	950	500	°F	10
TE-194	Header-pass #13 outlet	PCM 1	0-1200	975	500	°F	10
TE-195	Header-pass #14 outlet	PCM 1	0-1200	990	500	°F	10
TE-196	Header-pass #15 outlet	PCM 1	0-1200	1010	500	°F	10
TE-197	Header-pass #16 outlet	PCM 1	0-1200	1030	500	°F	10
TE-198	Header-pass #17 outlet	PCM 1	0-1200	1050	500	°F	10

Table 3.5

Receiver Subsystem Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Receiver salt flow	Constant flow (start-up & shutdown with receiver control algorithm off scan	30 KLB/hr FD-101	Flow set point (FD-101) Measured flow (FT-101)	FCV-101/102 position
	Constant Outlet Temperature (Receiver control algorithm on)	1000°F SP. SALT	Temperature set point (SP. SALT) Outlet temperature (TE-102) Inlet temperature (TE-101) Salt flow (FT-101) Receiver back tube temperatures (TE-103 thru TE-120)	FCV-101/102 position
Hot surge tank level	Operation	20 in FCV-161 FCV-162	Surge tank level (LT-161) Level set point	FCV-161 or FCV-162 position (selection based on salt temperature)
Receiving storage tank selection	Operation	750°F	Downcomer salt temperature (TE-161)	TE-161 < 750°F Cold storage tank selected TE-161 > 750°F Hot storage tank selected
Cold surge tank level	Operation	~85" LT-151	Cold surge tank level (LT-151) Level set point	FCV-151 position

when TE161 reaches 750°F control goes from FCV161 & FCV162 to only FCV161 (FCV162 closes because you want the salt to go into hot storage tank)

FCV151 is in cascade with LT151

3.4 THERMAL STORAGE SUBSYSTEM

The thermal storage subsystem provides a cold salt source for the receiver for daytime operation, and a hot salt source for the steam generator for day and early evening operation. The TSS can also furnish a source of thermal energy for overnight freeze protection of the receiver, steam generator, and salt piping and for early morning plant start-up. The subsystem includes the hot and cold salt storage tanks, propane-fired salt heater, cold salt pump and cold salt sump. The subsystem schematic is shown on Figure 3.15. Major components are described on Table 3.6; valves are listed on Table 3.7; instrumentation is described on Table 3.8; and control loops are given on Table 3.9.

The salt pump is of a vertical cantilever design. The impeller and casing are suspended below the liquid level in a sump; the bearings are located above the liquid level and do not contact the salt.

The hot salt tank employs a unique design. To allow the use of carbon steel in the structural portions of the tank, an internal refractory insulation is used to limit the temperature of the walls, roof, and floor. A waffled Incoloy liner separates the salt and the internal insulation, and the tank foundation is cooled with circulating water to limit the floor temperature. The outside of the tank is insulated in the conventional manner with calcium silicate and aluminum sheathing. The cold salt tank is similar in design to the hot tank except that it does not require the internal insulation and liner due to its lower operating temperature.

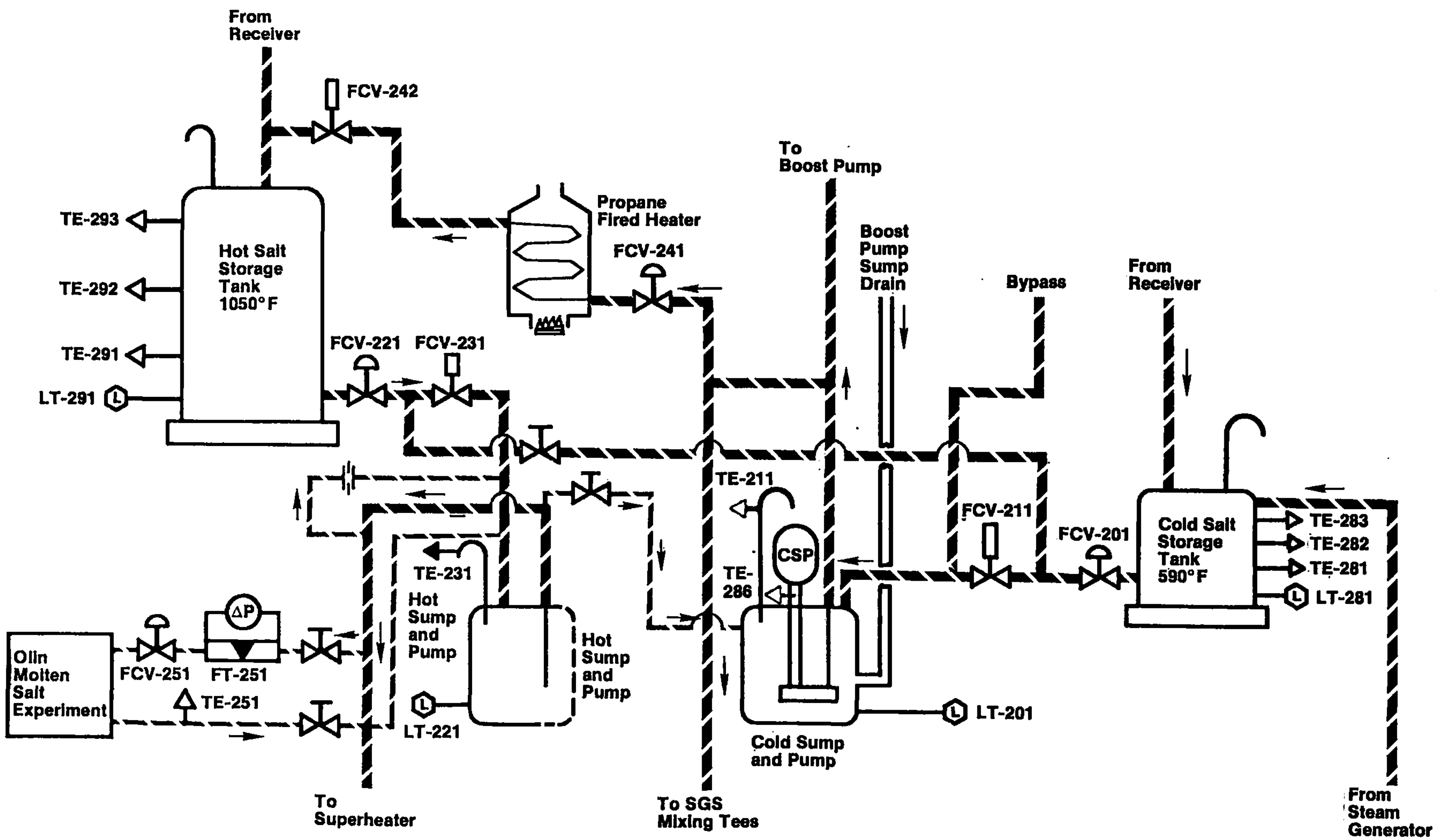


Figure 3-5. Thermal Storage Subsystem Schematic

Table 3.6
Thermal Storage Subsystem Components

Component	Description	Function	Nominal Operating Condition
Cold salt storage tank	- Carbon steel cylindrical tank - 12.3 ft. dia. - 12.3 ft. high - 15 in. fibrous external insulation	- Cold salt storage	- 590°F salt
Hot salt storage tank	- Carbon steel cylindrical shell - 12.3 ft. dia. stainless steel liner - 23.6 ft. high - 13-1/2 in. insulating firebrick between shell and liner - 2 in. fibrous external insulation	- Hot salt storage	- 1050°F salt - Approx. 7 MW_t hr storage capacity
Cold salt sump	- Carbon steel cylindrical tank - 59 in. dia. - 66 in. deep	- Pump reservoir	- 590°F salt - Atmospheric pressure
Cold salt pump	- Vertical cantilever type - 60 H.P. driver	- Pump salt from cold storage tank to cold salt booster pump, SGS, or propane heater	- 590°F salt - 96,867 lb/hr

Table 3.6
Thermal Storage Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Hot salt sump	- Stainless steel cylindrical tank - 48 in. dia. - 49 in. deep	- Reservoir for hot salt pump	- 1050°F salt - Atmospheric pressure
Hot salt pump	- Vertical cantilever type - 7-1/2 HP driver	- Provide hot salt circulation through STS	- 1050°F salt - 64,680 lb/hr
Propane heater	- 3 MW propane fired heater - 9 ft. dia. shell - 24 ft. high - One stainless steel heating coil, 2.12 in. dia., 1640 ft. long	- Provide auxiliary salt heating capability	- 59,900 lb/hr salt - 590°F inlet - 1050°F outlet

Table 3.7

THERMAL STORAGE SUBSYSTEM REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-201	Valtek	3"	CV	FC	Cold Sump Level Control	Cold Storage Tank Base South Side
FCV-211	Kieley-Mueller	3"	SV	FC	Cold Sump Isolation	Pump House North Side West End
FCV-221	Valtek	3"	CV	FC	Hot Sump Level Control	Hot Storage Tank Southwest Side
FCV-231	Kieley-Mueller	3"	SV	FC	Hot Sump Isolation	Outside Pumphouse Northeast Corner
FCV-241	Valtek	2"	CV	FC	Propane Heater Flow Control	Line to Propane Heater East of FCV-231
FCV-242	Valtek	1 1/2"	SV	FC	Propane Heater Isolation	Top of Hot Tank

Table 3.8
Thermal Storage Subsystem Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Cold Storage Tank						
LT-281	Level	PCM 3	0-150	134	15	inch	10
TE-281	Lower temp	PCM 3	0-1200	700	500	°F	10
TE-282	Middle temp	PCM 3	0-1200	700	500	°F	10
TE-283	Upper temp	PCM 3	0-1200	700	500	°F	10
	Hot storage tank						
LT-291	Level	PCM 3	0-200	190	10	inch	10
TE-291	Lower temp	PCM 3	0-1200	1070	500	°F	10
TE-292	Middle temp	PCM 3	0-1200	1070	500	°F	10
TE-293	Upper temp	PCM 3	0-1200	1070	500	°F	10
	Cold salt pump						
LT-201	Sump level	PCM 3	0-60	60	15	inch	2
TE-286	Bearing temp	PCM 3	0-500	190		°F	10
TE-211	Vent temp	PCM 3	0-1200	400		°F	2
	Hot Salt Pump						
LT-221	Sump level	PCM 3	0-48	41	15	inch	2
TE-231	Vent temp	PCM 3	0-1200	400		°F	2

]

Table 3.9

Thermal Storage Subsytem Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Cold sump level	Operation	23 in FCV-201 (45 in fill)	Sump level (LT-201) Level set point	FCV-201 position - Flow from cold storage tank
Hot sump level	Operation	20 in FCV-221	Sump level (LT-221) Level set point	FCV-221 position - Flow from hot storage tank

3.5 STEAM GENERATION SUBSYSTEM

The steam generation subsystem transfers sensible heat from the molten salt to produce superheated steam for the turbine-generator. The subsystem schematic is shown on Figure 3.6. The subsystem includes an evaporator, steam drum, boiler recirculation pump, superheater, and attemperator.

The evaporator and superheater are U-tubes, U-shell heat exchangers, with low pressure salt on the shell side and high-pressure water and steam on the tube side. This shell and tube configuration has been selected to minimize thermal stresses, due to differential expansion, in the tubes and tubesheets.

A conventional steam drum, located above the evaporator, separates water droplets from the saturated steam before the latter enters the superheater, and receives feedwater from the feedwater heater. A forced recirculation design was selected, since it is preferred for power plants requiring daily start-up and shutdown.

The superheater outlet steam can be attemperated by mixing with a small amount of saturated steam from the drum. The salt flow from the superheater to the evaporator is also attemperated to 850°F, when necessary, by mixing with salt flow from the cold tank. This allows chrome-moly piping and fittings, rather than stainless steel, to be used in the evaporator.

Warmup of the steam generation subsystem is accomplished by isolating the subsystem and preheating with the subsystem's electrical heater.

Major subsystem components, valves, instrumentation, and control loops are described on Tables 3.10 through 3.13.

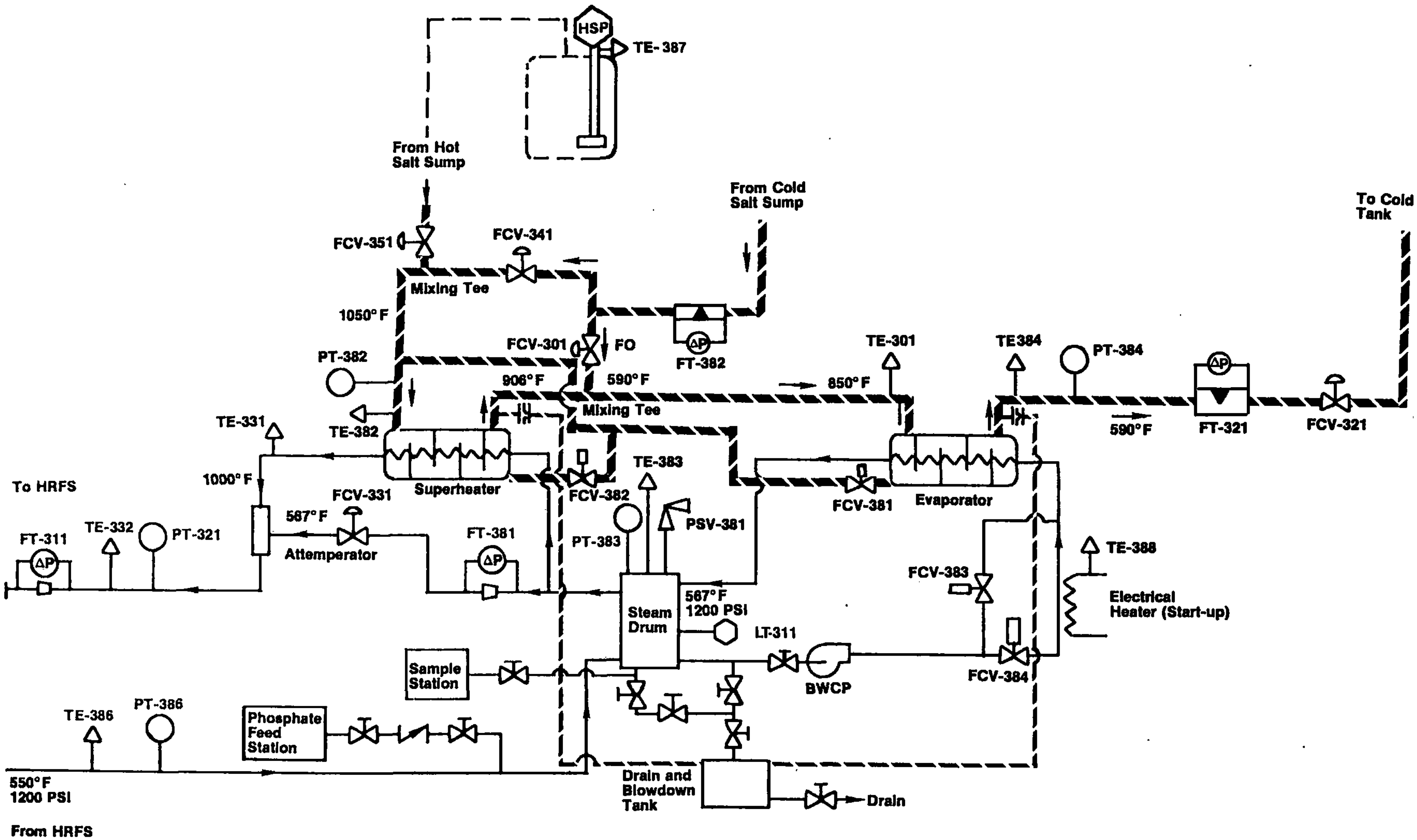


Figure 3.6 . Steam Generation Subsystem Schematic

Table 3.10. Steam Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Evaporator	- U-tube/U-shell counterflow heat exchanger - 8 in. dia. chrome - moly shell (salt) - 27 chrome-moly tubes 0.875 in. dia. 68 ft avg. length (water)	- Evaporate subcooled water to produce saturated steam/water mixture	- 850°F salt inlet - 590°F salt outlet - 78,550 lb/hr salt flow rate - Subcooled water inlet - 567°F, 1200 psi saturated steam/water outlet - 2.15 MW rating
Superheater	- U-tube/U-shell counterflow heat exchanger - 6 in. dia. stainless steel shell (salt) - 23 stainless steel tubes 0.500 in. dia. 33 ft. avg. length (steam)	- Heat saturated steam to superheat condition	- 1050°F salt inlet - 906°F salt outlet - 64,680 lb/hr salt flow rate - 567°F 1175 psi saturated steam inlet - 1000°F. 1100 psi superheated vapor outlet - 10,530 lb/hr steam flow rate - 0.98 MW rating
Steam Drum	- Cylindrical pressure vessel with elliptical heads - 24 in ID - 6 ft 10 in overall height - 2 in thick carbon steel - Contains primary cyclone steam separator and primary & secondary steam scrubbers	- Separate steam/water mixture exiting evaporator - Supply saturated steam to superheater - Provide feedwater surge volume	- 567°F - 1200 psi

Table 3.10. Steam Generation Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Boiler water circulation pump	- Canned centrifugal type - 5 HP driver	- Provide circulation of subcooled water from the steam drum to evaporator. Maintain high recirculation rate over full range of operating conditions.	- 560°F - 119 GPM - 111 ft. head
Start-up heater	- Chamber type electric heater - 3 40-kW heating elements - 2 15-kW heating elements	- Raise temperature and pressure of water during cold start-up to avoid salt freeze-up in evaporator - Heat boiler water to maintain temperature and pressure of water/steam system during diurnal hold	- 150 kW during start-up - Cycled during diurnal hold - Bypassed during normal operation
Steam attemperator	- Mixing tee	- Mix saturated steam from steam drum with super-heated steam from super-heater to control steam delivery tempera-ture to turbine	- 1053 lb/hr dry saturated steam at 567°F - 10,529 lb/hr superheated steam at 1000°F 1100 psi - 11,582 lb/hr delivery steam at 950°F 1100 psi
Salt attemperator (evaporator inlet)	- Mixing tee	- Mix cold salt with superheater outlet salt to limit evaporator inlet salt temperature to 850°F because of Cr-Mo construction	- 64,680 lb/hr at 906°F - 13,870 lb/hr at 590°F - 78,550 lb/hr at 850°F supplied to evaporator

Table 3.10. Steam Generation Subsystem Components - 3

Component	Description	Function	Nominal Operating Condition
Salt start-up attemperator (superheater inlet)	- Mixing tee	- Mix cold salt with hot salt from hot tank to provide a controlled temperature increase of salt entering superheater during start-up	- Full flow of cold salt at start-up - No cold salt flow during operation
Heat tracing	- Electrical heating element - Inconel sheath	- Maintain heat exchangers and salt piping above the freezing point of salt - Provide freeze protection of feedwater piping and instrumentation during shutdown	- Temperature monitored by thermocouples - Cycle as required

Table 3. 11

SGS REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-301	Valtek	1"	CV	FO	Evaporator Salt Temperature Control and Cold Salt Fill	SGS Skid West Side South End
FCV-321	Valtek	2"	CV	FO	Main Salt Flow Control	SGS Skid South End
FCV-331	Fisher	1"	CV	FO	Steam Attemperator Temperature Control	SGS Skid North Side Steam Drum
FCV-341	Valtek	1"	CV	FC	Main Salt Fill	SGS Skid West Side Middle
FCV-351	Valtek	2"	CV	FO	Hot Salt Flow Control	Outside Pumphouse Northeast Corner
FCV-381	Kieley-Mueller	1"	SV	FC	Evaporator Salt Drain	SGS Skid West Side Middle
FCV-382	Kieley-Mueller	1"	SV	FC	Superheater Salt Drain	SGS Skid West Side Below Steam Drum
FCV-383	Dresser	4"	SV	FO	Evaporator Water Supply	SGS Skid Southeast Corner
FCV-384	Valtek	2"	SV	FO	Start-up Heater Supply	SGS Skid Below FCV-383

Table 3.12. SGS Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Feedwater						
PT-386	Pressure	PCM-3/ Bailey	0-1500	1500		PSI	5
TE-386	Temp	PCM-3/ Bailey	0-750	575	500	°F	10
	Steam Drum						
PT-383	Pressure	PCM-3/ Bailey	0-1500	1250	950	PSI	5
TE-383	Fluid temp	PCM-3/ Bailey	0-750	575	500	°F	10
LT-311	Fluid level	PCM-3/ Bailey	-17 to +23	4	-4	inch	2
	Evaporator						
TE-301	Salt inlet temp	PCM-3/ Bailey	0-1200	880	500	°F	2
TE-384	Salt outlet temp	PCM-3/ Bailey	0-1200	640	500	°F	2
PT-384	Salt outlet pressure	PCM-3/ Bailey	0-200			PSI	5
FT-321	Salt flow rate	PCM-3/ Bailey	0-100			KLB/hr	2

Table 3.12. SGS Instrumentation

Identifier	Description	Control Module	Display Range	Alarm Levels High	Alarm Levels Low	Dimension	Sampling Period (sec)
	Superheater						
PT-382	Salt inlet pressure	PCM-3/ Bailey	0-200	100		PSI	5
TE-382	Salt inlet temp	PCM-3/ Bailey	0-1200	1070	500	°F	5
TE-331	Steam outlet temp	PCM-3 Bailey	0-1200		910	°F	2
FT-381	Attemperator steam flow	PCM-3/ Bailey	0-2500			lb/hr	5
FT-382	SGS Cold Salt Supply	PCM-3/ Bailey	0-16			KLB/hr	5
	Steam Delivery						
PT-321	Pressure	PCM-3/ Bailey	0-1500	1150	950	PSI	2
TE-332	Temp	PCM-3/ Bailey	0-1200	990	910	°F	2
FT-311	Flow rate	PCM-3/ Bailey	0-100	12.6	3.2	KLB/hr	2
TE-387	Hot Salt Pump Bearing	PCM-3	0-500	190		°F	10
TE-388	Start-up Heater 5 Element Temp	PCM-3/ Bailey	0-1200	1100	500	°F	10

Table 3.13. SGS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Steam delivery pressure	SGS start-up	1000 psig FCV-491	Delivery pressure (PT-321) pressure set point	FCV-491 position - SGS steam flow
	Boiler following	1100 psig SP. SP	Delivery pressure (PT-321) Pressure set point (SP. SP) Steam flow (FT-311) Salt flow (FT-321)	FCV-321 position - SGS main salt flow
Steam delivery temperature	Operation	950°F SP. ST	Delivery temperature (TE-332) Temperature set point (SP. ST)	FCV-331 position - Steam attemperator flow
Steam drum level	Operation	0 in SP. DL	Drum level (LT-311) Level set point (SP. DL) Feedwater flow (FT-411) Steam flow (FT-311)	FCV-411 position - Feedwater flow
Evaporator salt inlet temperature	Operation	850°F SP. EST	Inlet temperature (TE-301) Temperature set point (SP. EST)	FCV-301 position - Cold salt flow
Boiler water temperature	Diurnal Shutdown	~520°F	Circulation heater outlet temperature (TE-388)	Electric immersion heater elements on/off

3.6 ELECTRIC POWER GENERATION SUBSYSTEM

The electric power generation subsystem converts the enthalpy in the main steam flow to electricity. The subsystem (Figure 3.7) includes the steam turbine, electric generator, electric power equipment, condenser, condensate pump and storage tank. The electrical one-line diagram is shown on Figure 3.8.

The turbine-generator set is a skid-mounted unit located at the north end of the receiver tower complex at the 80 ft. level (20 ft. below grade). This skid consists of a turbine, generator, and auxiliary equipment. The turbine is a seven-stage, single flow machine, operating at 17,400 rpm. Inlet steam conditions are rated at 940°F and 1050 psia. A single reduction gearbox reduces the turbine shaft speed to the generator speed of 1,200 rpm. The 750 kW_e generator operates at 450V, and is cooled by circulating water through air cooling coils located above the generator. The turbine-generator auxiliaries include a lubricating oil pump, lube oil cooler, air ejection vacuum pump and mechanical-hydraulic governor. The allowable rate of change in load is 10 percent per minute from 30 to 100 percent of rated capacity.

A shell and tube condenser, supported by a separate frame, is located directly below the turbine. Access to the condenser is on the floor 40 ft. below ground. Condensate from the hot well of the condenser will be transferred to the deaerator when the water level in the deaerator requires makeup. Otherwise, the condensate is pumped to a storage tank. Condensate from this tank is piped back to the condenser hot well when the hot well level requires water.

Major components of the EPGS, valves, instrumentation, and control loops are described on Tables 3.14 through 3.17.

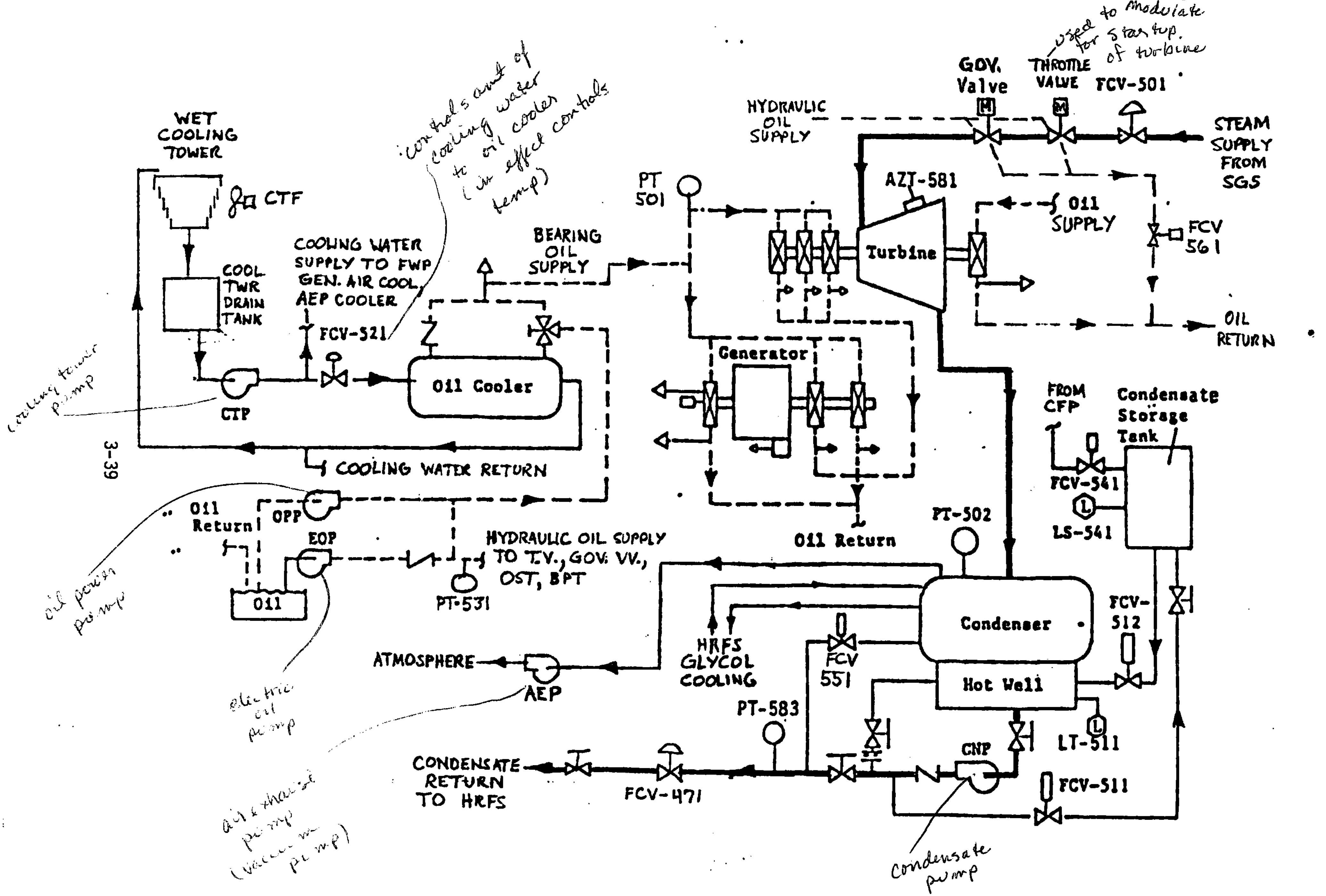


Figure 3.7. Electric Power Generation Subsystem Schematic

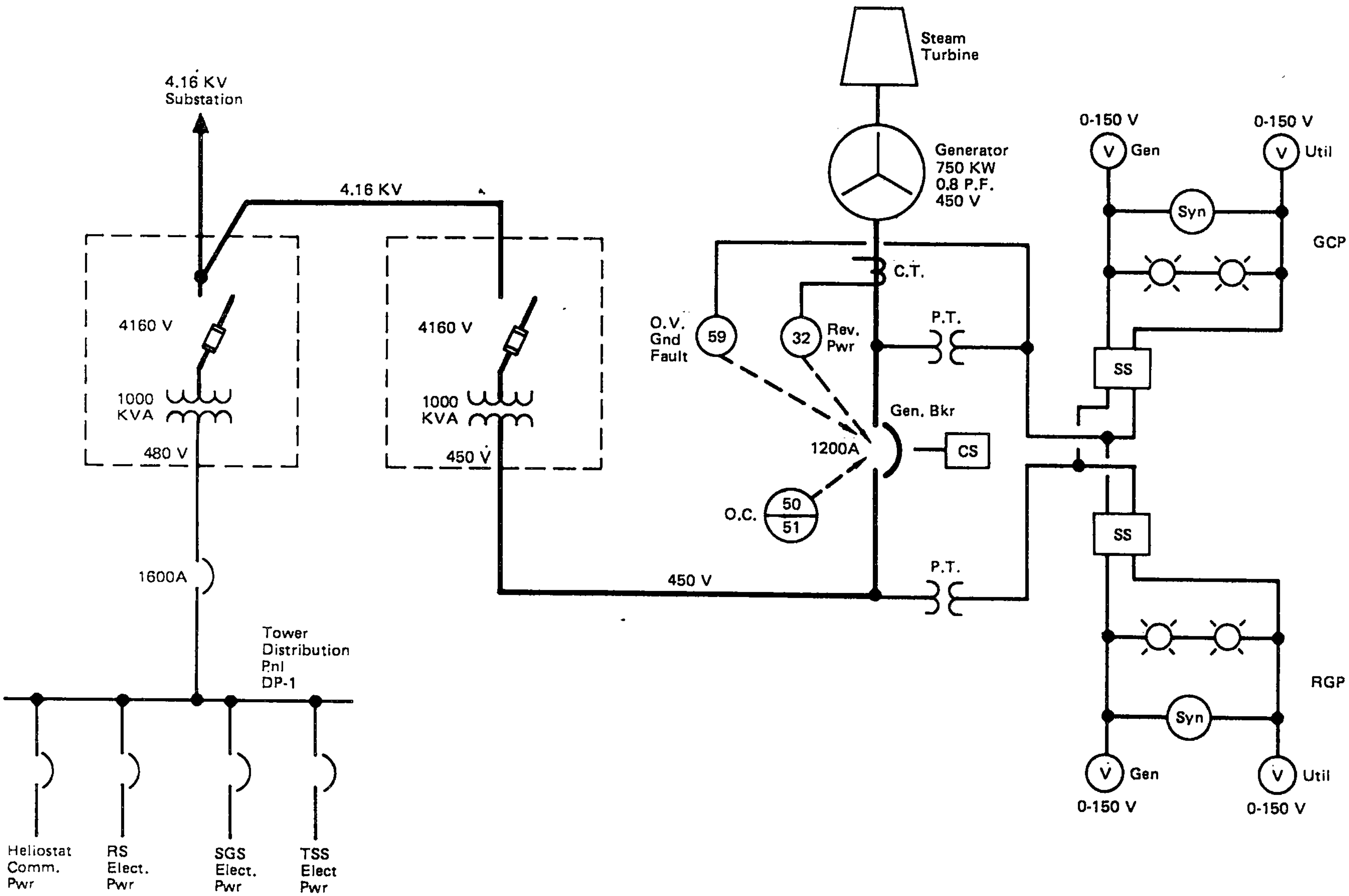


Figure 3.8. MSEE Electric Generator One-Line Diagram

Table 3.14
Electric Power Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Turbine	- Axial flow condensing type - 7 stage	- Expand steam to drive electric generator	- 940°F 1050 psig throttle steam - 133°F 2.5 psia exhaust steam - 7800 lb/hr steam flow - 17,443 RPM - 1000 HP
Electric generator	- AC generator - 450 volt, 3 phase - 1200 RPM - Solid state excitor	- Generate electric power	- 750 kW_e (rating) - 600 kW_e (maximum in MSEE) - 0.8 power factor rating
Condenser	- Crossflow shell and tube heat exchanger - Rectangular shell (condensate) - 438 tubes, 5/8-in. dia. 7-1/2 ft long (glycol/water coolant) - Cylindrical hot well	- Condense turbine exhaust steam - Provide turbine exhaust vacuum	- 2.5 psia saturated steam inlet - 133°F condensate outlet - 7800 lb/hr steam/water flow - 1200 GPM glycol/water coolant flow
Condensate pump	- Turbine type - 2 stage - 20 HP driver	- Pump condensate from hot well to deaerator	- 133°F water - 260 psi head (mfg rating) - 18 GPM (mfg rating)

Table 3.14

Electric Power Generation Subsystem Components

Component	Description	Function	Nominal Operating Condition
Air exhaust pump	- Nash vacuum pump - 5 HP driver	- Provide condenser vacuum	- 5 in Hg condenser pressure (ABS) - 75 CFM (mfg. rating)
Electric oil pump	- Viking gear pump	- Provide bearing oil pressure during turbine start-up and shutdown (turbine-driven pump provides oil pressure during operation)	- Off during operation
Cooling tower pump	-Aurora centrifugal pump	- Provide coolant circulation through oil cooler	- 35 psi head (mfg. rating) - 120 GPM (mfg. rating)
Wet cooling tower	-Fan forced wet cooler -1/2 HP fan motor	- Reject oil coolant heat	- 110°F coolant outlet temp

Table 3.15

EPGS REMOTE OPERATED VALVES

VALVES	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-501	Valtek	2"	SV	FC	Turbine Steam Isolation	TWR Level 80 North Turbine Northeast Corner
FCV-511	Asco	1/2"	SV	FC	Hotwell Overflow	TWR Level 60 North Condenser Platform Northwest
FCV-512	Asco	3/4"	SV	FC	Hotwell Make-up	TWR Level 80 Northeast Condensate Storage Tank
FCV-521	Masoneilan	2"	CV	FO	Oil Cooler Water Flow Control	TWR Level 80 North Turbine/Generator Overhead
FCV-541	Asco	3/4"	SV	FC	Condenser Storage Tank Make-up	TWR Level 80 Northeast Condensate Storage Tank
FCV-551	Asco	1/2"	SV	FC	Condenser Recirculation	TWR Level 60 North Condenser Platform Northwest
TVM	GE w/auma Actuator	1 1/2"	CV	FC	Turbine Steam Supply Throttle	Turbine North Side
SNM	GE	--	CV	--	Turbine Sync Speed Control	Turbine Center
Fcv-561	ASCO	1/2"	SV	FO	Close throttle valve in emergency trip (dumps hydraulic oil)	Turbine

TABLE 3.17. EPGS INSTRUMENTATION

IDENTIFIER	DESCRIPTION	CONTROL MODULE	DISPLAY RANGE	ALARM HIGH	LEVELS LOW	DIMENSION	SAMPLING PERIOD (sec)
	Turbine						
PT-581	Steam Supply Pressure	PCM 2	0-1500		800	PSI	5
PT-582	Steam Seal Pressure	PCM 2	0-1500			PSI	5
TE-581	Exhaust Temp	PCM 2	0-500			°F	5
TT-583	Steam Supply Temp	PCM 2	0-1200	990	800	°F	5
TT-501	Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TT-502	Inboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TE-503	Gear Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
AZT-581	Vibration	PCM 2	0-100	100		PCT (0-5 g)	5
	Generator						
JT-581	Power	PCM 2	0-960			kw	5
ET-581	Voltage	PCM 2	0-600	480	450	Volt	5
IT-581	Current	PCM 2	0-1200			Amp	5
PFT-581	Power Factor	PCM 2	0-1.0	1.0	0.85	PCT	5
VT-581	VARS	PCM 2	0-960			KVA	5
ST-582	Speed	PCM 2	0-1500	1270		rpm	5
ST-581	Frequency	PCM 2	0-100	60	40	PCT (55-65 Hz)	5
TT-510	Stator Winding 1 Temp	PCM 2	0-500	260		°F	5
TT-511	Stator Winding 2 Temp	PCM 2	0-500	260		°F	5
TT-512	Stator Winding 3 Temp	PCM 2	0-500	260		°F	5
TT-513	Stator Winding 4 Temp	PCM 2	0-500	260		°F	5
TT-514	Stator Winding 5 Temp	PCM 2	0-500	260		°F	5
TT-515	Stator Winding 6 Temp	PCM 2	0-500	260		°F	5
TE-508	Cooling Air Outlet Temp	PCM 2	0-500	100		°F	5
TT-507	Outboard Bearing Oil	PCM 2	0-500	170	110	°F	5
TE-505	Gear Outboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
TE-506	Gear Inboard Bearing Oil Temp	PCM 2	0-500	170	110	°F	5
PT-502	Condenser Pressure	PCM 2	0-30	15		In Hg	5
PT-583	Condensate Pump Discharge Pressure	PCM 2	0-400	300	240	PSI	5
LT-511	Hot Well Level	PCM 2	0-15	16	8	Inch	2
TE-582	Cooling Tower Pump Discharge Temp	PCM 2	0-500	100	40	°F	5
PT-531	Oil Pump Discharge Pressure	PDM 2	0-200	100	55	PSI	5
TT-521	Bearing Oil Supply Temp	PCM 2	0-500	140	100	°F	2
PT-501	Bearing Oil Supply Press.	PCM 2	0-50	40	10	PSI	5

Table 3-17
EPGS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Condenser hot well level	Remote operation (TCP. MS on) (EN.HLC on)	9 in min 14 in max	Hot well level (LT-511)	FCV-512 open/close - makeup FCV-511 open/close - dump
Condensate storage tank level	Operation	12 in min 30 in max	Storage tank level (LS-541)	FCV-541 open/close - supply from cycle fill pump FCV-542 open/close - CMUP Stand pipe air overpressure
Turbine/generator oil temperature	Remote operation	125°F FCV-521	Oil temperature (TT-521)	FCV-521 position - cooling water flow

3.7 HEAT REJECTION AND FEEDWATER SUBSYSTEM

The heat rejection and feedwater subsystem rejects waste heat to the atmosphere, pressurizes and heats the condensate to the final feedwater temperature. The subsystem (Figure 3.9) includes the cooling towers, circulating water pump, deaerator, spray water heat exchanger, spray water pump, feedwater pump, feedwater heater, demineralizers, chemical feeders, water analyzers, and condensate makeup pump.

The cooling towers consist of six forced-draft, finned-tube water-to-air heat exchangers. They originally were designed as Freon condensers for refrigeration systems.

The deaerator is used as a direct contact feedwater heater and deaerator and to reject steam generated by the SGS. It is a horizontal, cylindrical pressure vessel, designed to operate at 250 psia and 400^{o}F. It includes a steam header with mixing spargers near the bottom of the tank, water spray nozzles across the top, and two immersion electric heaters. Feedwater, stored in the deaerator, is heated by steam from a branch off the SGS mainline to the turbine. The feedwater is circulated by a spray water pump at 400 gpm from the bottom of the deaerator to the spray nozzles in the vapor space at the top of the deaerator where the water condenses the steam and is thereby heated. Oondensate from the turbine condenser, blended into this spray water, is also heated to 400°F and deaerated.

The feedwater heater is a vertical, cylindrical pressure vessel with an internal steam condensing coil. Feedwater from the deaerator is heated on the tube side as steam from a branch of the SGS mainline condenses on the shell side. The saturated liquid from the coil is cascaded down to the deaerator through a steam trap. Main steam is used for feedwater heating in the feedwater heater and the deaerator because there are no external extraction points on the turbine.

Major components, valves, instrumentation, and control loops are described on Tables 3.18 through 3.21.

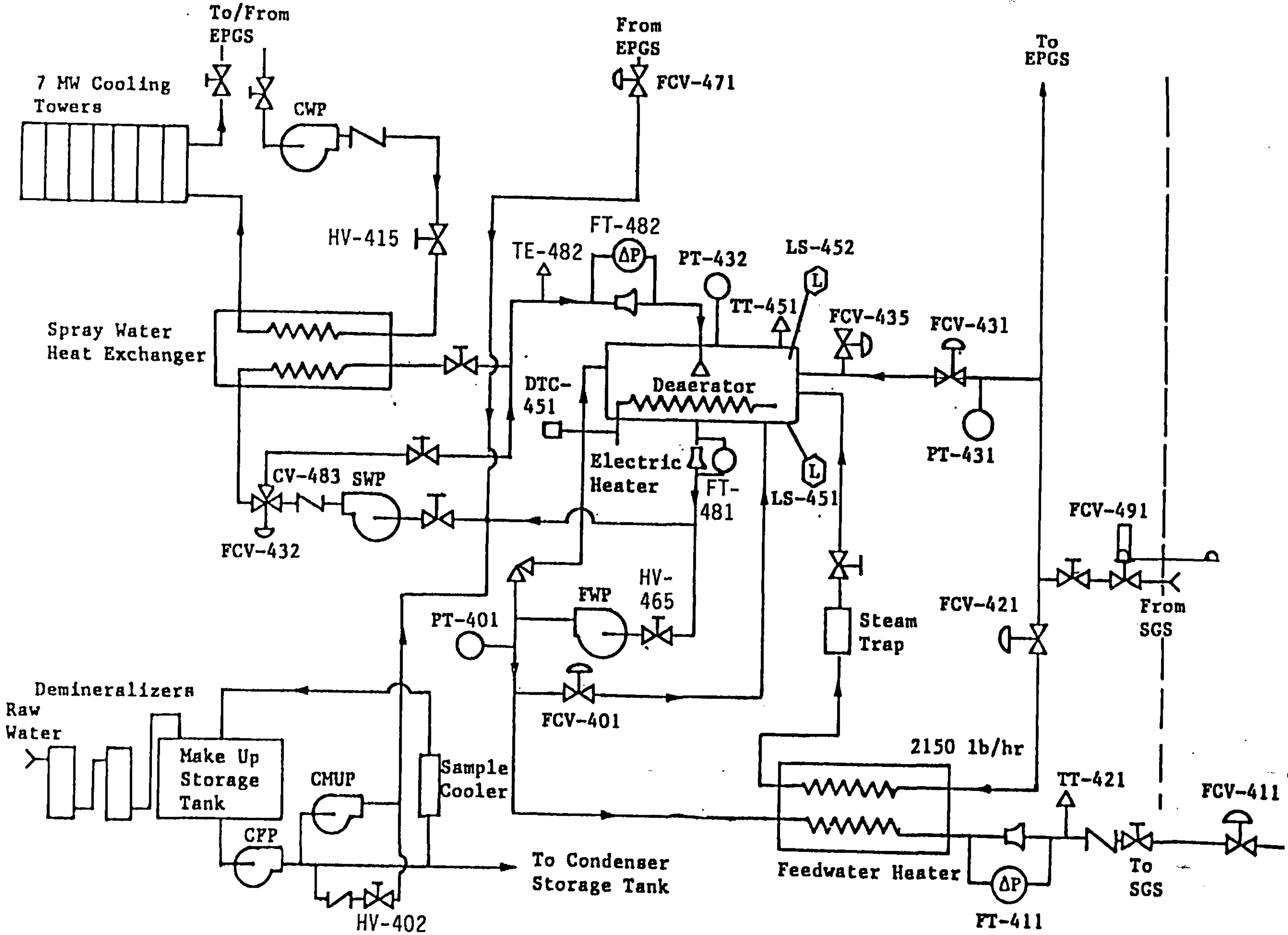


Figure 3.9 . Heat Rejection and Feedwater Subsystem Schematic

Table 3.18
Heat Rejection and Feedwater Subsystem Components

Component	Description	Function	Nominal Operating Condition
Feedwater heater	- Shell and coiled tube counter-flow heat exchanger - 35 in ID 2.5 in thick carbon steel shell (feedwater) - 4 ft 8 in overall height - 30 coiled tubes 0.500 in. dia. 43 ft long (steam)	- Raise feedwater temperature to SGS inlet condition	- 950°F superheated steam inlet - 545°F saturated liquid outlet - 2150 lb/hr steam flow rate - 401°F feedwater inlet - 550°F feedwater outlet - 11,582 lb/hr feedwater flow rate - 0.59 MW heat transfer
Deaerator	- Horizontal tank - 5 ft ID - 12 ft long - Contains 15 submerged mixing nozzles, 1 overhead spray nozzle, 2 147-kW electric immersion heaters	- Degasify condensate - Heat condensate for delivery to feedwater heater - Provide alternate steam dump when turbine is not operating	- 401°F - 250 psi - 0.63 MW heat transfer
Spray water heat exchanger	- Shell and tube heat exchanger - 24 in. dia. shell	- Reject excess heat from deaerator when utilized as alternate steam dump	- No flow from deaerator during normal operation

Table 3.18
Heat Rejection and Feedwater Subsystem Components - 2

Component	Description	Function	Nominal Operating Condition
Feedwater pump	- High speed centrifugal type - 18,770 pump RPM - 150 HP driver	- Provide high pressure feedwater to the steam generator (through the feedwater heater)	- Inlet: 250 psi, 401°F water - 1450 psi head (mfg rating) - 60 GPM (mfg rating)
Spray water pump	- Vertical turbine type - 3 stage - 7-1/2 HP driver	- Provide circulation from deaerator to spray water heat exchanger and/or its bypass and return to deaerator overhead spray nozzle	- 401°F - 26 psi head (mfg rating) - 300 GPM (mfg rating)
Cooling water pump	- Centrifugal type - 40 HP driver	- Provide glycol/water circulation for spray water heat exchanger - cooling tower - condenser circuit	- 132°F glycol/water - 40 psi head - 1200 GPM
Cooling towers	- 6 units - Forced draft, finned-tube, glycol/water-to-air heat exchangers	- Reject waste heat to atmosphere	- 94°F air - 132°F glycol/water inlet - 120°F glycol/water outlet - 2.4 MW heat rejection

Table 3.19
HRFS REMOTE OPERATED VALVES

VALVE	MANUFACTURER	SIZE	TYPE	FAIL POSITION	FUNCTION	LOCATION
FCV-401	Fisher	2"	CV	FO	Feedwater Pump Pressure Control	Southwest of Deaerator
FCV-411	Kieley-Mueller	2"	CV	FC	Feedwater Flow Control	SGS Skid Northeast
FCV-421	Kieley-Mueller	2"	CV	FO	Feedwater Heater Temperature Control	Above Feedwater Heater
FCV-431	Kieley-Mueller	2"	CV	FC	Main Steam Pressure Control	Southwest of Deaerator
FCV-432	Kieley-Mueller	3"-3 way	CV	To SWHX	Deaerator Pressure Control	Between Deaerator and Spray Water Heat Exchanger
FCV-471	Valtek	1"	CV	FC	Condensate Control to Deaerator	Above North Door to Spray Water Pump Room
FCV-483	Atkomatic	1"	SV	--	Deaerator Vent Block	Above Deaerator
FCV-484	Atkomatic	1/4"	SV	--	Deaerator Vent Bypass	Above Deaerator
FCV-485	ASCO	2"	SV	--	Demineralized Water Storage Tank Fill	Above Culligan Beds
FCV-491	Kieley-Mueller	2"	CV	FC	SGS Steam Delivery Control During Start-Up	North End of SGS Skid

TABLE 3.20. HRFS INSTRUMENTATION

IDENTIFIER	DESCRIPTION	CONTROL MODULE	DISPLAY RANGE	ALARM LEVELS HIGH	ALARM LEVELS LOW	DIMENSION	SAMPLING PERIOD (sec)
	Main Steam						
PT-431	Pressure	PCM 2	0-1500	1200	900	PSI	2
TE-483	Temp	PCM 2	0-1200	990	850	Inch	10
	Deaerator						
PT-432	Pressure	PCM 2	0-400	250	200	PSI	2
TE-451	Fluid Temp	PCM 2	0-500	400	300	°F	2
TE-481	Steam Temp	PCM 2	0-500	400	300	°F	10
LT-471	Fluid Level	PCM 2	0-30	30	10	Inch	2
	Spray Water						
PT-482	Pressure	PCM 2	0-400	300	200	PSI	5
FT-482	Flow Rate	PCM 2	0-160			KLB/hr	5
TE-482	Temp	PCM 2	0-500	445		°F	10
FT-481	Feed/Spray Water Flow Rate	PCM 2	0-160			KLB/hr	5
	Feedwater						
PT-481	FWP Supply Pressure	PCM 2	0-400		170	PSI	5
PT-401	FWP Discharge Pressure	PCM 2	0-1500	1400	900	PSI	2
PT-484	FWP Coolant Pressure	PCM 2	0-100			PSI	5
PT-483	FWH Outlet Pressure	PCM 2	0-1500	1230	1180	PSI	5
FT-411	Flow Rate	PCM 2/ Bailey	0-160			KLB/hr	2
FT-421	FWH Outlet Temp	PCM 2	0-750	600	400	°F	2
	Cooling Water						
TE-484	SWHX Inlet Temp	PCM 2	0-500	130		°F	10
TE-486	Tower Outlet Temp	PCM 2/	0-500	110	32	°F	10

Table 3.21. HRFS Control Loops

Controlled Variable	Mode	Set Point	Controller Inputs	Controller Output
Feedwater temp.	Operation	~~540~~ 520°F FCV-421	Feedwater temperature (TE-421) Temperature set point	FCV-421 position - Feedwater heater Steam supply flow
Feedwater pressure	Operation	1250 psig FCV-401	Feedwater pressure (PT-401) Pressure set point	FCV-401 position - FWP recirculation flow
Steam delivery pressure	Manual salt flow GSTAT off	1080 psig PT-431	Delivery pressure (PT-431) Pressure set point	FCV-431 position - Deaerator steam dump
Deaerator pressure	Operation - Desuperheating GSTAT off	233 psig PT-432	Deaerator pressure (PT-432) Pressure set point	FCV-432 position - Deaerator dump to SWMX
	Boiler following GSTAT on	233 psig PT-432	Deaerator pressure (PT-432) Pressure set point	FCV-431 position - Deaerator steam supply
Deaerator temp.	Start-up	390°F DTC 451 DTC 452	Deaerator temperature (TE-451) Temperature set point	DTC-451/452 on/off - Electric heater control
Deaerator level	Operation	15 in FY-472 (controls deaerator level) (14 in backup during turbine operation)	Deaerator level (LT-471) Level set point	FY-472 condensate - Makeup pump stroke position
	Turbine Operation	15 in FCV-471	Deaerator level (LT-471) Level set point	FCV-471 position - Turbine condensate return from hot well

3.8 SYSTEM TRIPS

3.8.1 Equipment Protection Subsystem

The Equipment Protection Subsystem (EPS) is a hard-wired system using dedicated sensors and is designed to safe the MSEE in the event of any potentially unsafe condition. Subsequent to the EPS placing the system in a "safe" condition, operator action is required to shut the system down or to change into any other mode. The trip list for the EPS, including actions taken by the EPS and subsequently to be taken by the operator, are shown on Table 3.22, subdivided by subsystem.

3.8.2 Turbine/Generator Trips

Trips built into the turbine/generator are given on Table 3.2.3. Definitions and guidelines are given below.

A. Definitions

1. Turbine Trip - Immediate turbine steam shutoff - manual or auto.

2. Turbine Shutdown - Gradual turbine steam shutoff - manual.

3. Generator Trip - Generator circuit breaker opened - manual or auto.

B. Steam reactions to trips

1. Anticipated - Steam control maintained manually or auto.

2. Upset - Reliance on auto steam control - SGS salt flow will stop and HRFS will attempt to desuperheat steam. Probable HRFS and SGS safety valve lifting if upset is uncontrolled.

C. Trip interlocks

1. A generator breaker trip always initiates a turbine SVC trip (auxiliary relay 32x closes FCV-501) and an EPST TR-586 (32x).

2. A generator breaker trip always initiates a turbine T.V. reset (auxiliary relay 32x resets T.V. closed) w/ZT-581 '0'% open.

3. A turbine T.V. reset and an EPS 2 & 3 reset will reopen FCV-501 unless manually closed (or tripped).

D. All auto trips should be carefully reviewed - determine the cause of the trip and correct the problem before resuming operations.

E. Fail-safe follow-through guidelines
These guidelines present items of concern to fail-safe the EPGS upon a major component failure, after a trip that did not function, or to back up an auto trip. Intimate familiarity with these guidelines is mandatory before EPGS operation to insure safe operation, both from a personnel and equipment standpoint.

1. Three items are of major concern to fail-safe the EPGS and MSEE operating systems:

   a. Steam over-pressurization
   b. Turbine trip
   c. Generator trip

2. Steam system reactions to turbine trips:

   a. Over-pressurization
   b. Possible HRFS/D-D & SGS/steam drum safety valve lifting
   c. Desuperheating by HRFS/FCV-431 switchover to steam control to dump steam to D/D
   d. FCV-432 D/D heat dump through SWHX and dry cooling tower

3. Turbine tripping is redundant-designed and may be fully utilized with these four trips:

a. Actuate ET emergency trip FCV-561	(oil trip)
b. Open generator breaker with breaker C.S.	(electric trip)
c. Actuate EPS T-G trip button from control room	(EPS backup)
d. Manually close throttle valve with hand wheel	(manual)

4. Turbine-generator trip verification:

a. ST-582 speed decreasing	
b. PT-532 hydraulic oil pressure decreasing	(T.V. trip)
c. PT-581 steam pressure drops to zero	(FCV-501 trip)
d. Generator breaker open - green light on	

<u>NOTE</u>

EOP operation is not mandatory upon a turbine trip since the shaft driven oil pump provides adequate oil flow for turbine coast down.

5. Generator trips are redundant-designed with turbine trips. Be aware that:

   a. EPGS UPS provides emergency backup C/B trip power
   b. Exciter voltage shutdown local disconnect switch shuts down all of the generator electrical power.

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
RECEIVER SUBSYSTEM TRIPS

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
--	Operator Manual Trip	--	N/A	EPS - Defocus Heliostats
TR-181	Receiver Salt Outlet Temp High	TE-102A	1080°F	Operator - Control Receiver From The EMCON Console
TR-184	Receiver Tube Temp High During Hot Salt Production	TE-140A and TE-102A	925°F >750°F	
TR-187	Loss of Receiver Door Open Signal	ZSH-DR	Contact Open	
TR-182	Boost Pump Pressure Low During Hot Salt Production	PT-180A and TE-102A	250 PSIG >750°F	EPS - Defocus Heliostats - Close FCV-151 After Time Delay
TR-183	Receiver Salt Inlet Pressure Low During Hot Salt Production	PT-181A and TE-102A	8 PSIG >750°F	Operator - Shutdown Receiver from EMCON Console
TR-185 Heliostats	Hot Surge Tank Level High	LF-161A or TE-184A	80 In 300°F	EPS - Defocus - Close FCV-101 and FCV-102 After Time Delay Operator - Shutdown Receiver From EMCON Console

Doc. 1694U

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
RECEIVER SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-186	Boost Pump Sump Level High	TE-181A	400°F	EPS - Defocus Heliostats - Time Delay - Close FCV-151 - Turn Off Cold Salt Boost Pump - Turn Off Hot Salt Pump EMCON (Automatic) - Maintain Control of Receiver and HRFS Operator - Shut Down the Plant From the EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
THERMAL STORAGE SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-281	Hot Salt Sump Level High	LT-221A or TE-231A	40 In 300°F	EPS - Close Sump Insolation Valve FCV-231 Operator - Allow Time for Hot Salt Pump Operations To Bring Sump Level Down - Shut down SGS, HRFS, and EPGS From EMCON Console
TR-282	Cold Salt Sump Level High	LT-201A or TE-211A	55 In 350°F	EPS - Close Sump Insolation Valve FCV-211 - Defocus Heliostats Operator - Allow Time for Cold Salt Pump Operations To Bring Sump Level Down - Shut down the Plant From The EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
STEAM GENERATOR SUBSYSTEM TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
TR-381	Steam Drum Level Low	LT-311A	-10 In	EPS - Close FCV-501 - Open Generator Circuit Breaker - Turn Off FWP (Drum Level High only) EMCON (Automatic) - Dump Steam To Deaerator - Maintain Control of HRFS Network 90 - Shut Off Salt Flow (Close FCV-301, 341, and 351) - Turn Off BWCP (Drum Level Low only) Operator - Shut Down SGS, HRFS, and EPGS From EMCON Console
TR-383	Steam Drum Level High and Water Hot	LT-311A and TE-383A	+17 In >250°F	
TR-382	Boiler Water Circulation Pump Failure	Motor Current Sensor	Off	EPS - Close FCV-501 - Open Generator Circuit Breaker EMCON (automatic) - Dump Steam to Deaerator - Maintain control of HRFS Network 90 - Shut Off Salt Flow (Close FCV-501, 341, and 351) Operator - Shut down SGS, HRFS, and EPGS from EMCON console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
EPGS TRIPS
(Continued)

TRIP IDENTIFIER	TRIP CONDITION	INSTRUMENT IDENTIFIER	TRIP LEVEL	ACTION REQUIRED
	Turbine Overspeed	OST	1320 RPM Generator	EPS - Close FCV-501 Open Generator Circuit Breaker
	Turbine Back Pressure High	TBPT	5 PSIG	
TR-584	Generator Bearing Temp High	TS-501A	180°F	EMCON (Automatic) - Dump Steam to Deaerator - Maintain Control of HRFS
TR-585	Generator Cooling Air Temp High	TS-502A	122°F	Operator - Control System From EMCON Console - Reduce Steam Flow - Shut Down If Necessary
TR-586	Generator Circuit Breaker Trip		-Manual -Low/high Voltage -Low/high frequency	
TR-587	Turbine Vibration High	AZT-581	5g	
TR-588	Steam Energy Low	TE-332 or PT-581A	750°F 770 PSI	
TR-583	Turbine Oil Pressure	PS-501A (LUBE) or PS-531A (HYDR)	6 PSI 50 PSI	
TR-582	Manual T/G Emergency Trip	Control Room PB	Operator Initiate	

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
MASTER CONTROL SUBSYSTEM TRIPS
(Continued)

TRIP CONDITION	ACTION REQUIRED
PCM 1 Microcomputer Failure - Loss of Receiver Displays - Loss of Salt Auto Flow Control - Loss of Cold Surge Tank Auto Level Control	EPS - Defocus Heliostats - Close FCV-151 After Time Delay Operator - Control Receiver from PCM 1 - Drain Receiver If Necessary
PCM 2 Microcomputer Failure - Loss of HRFS and EPGS Displays - Loss of Feedback Control Loops	EPS - Turn Off Hot Salt Pump - Close FCV-301, FCV-341, and FCV-351 - Turn Off FWP - Close FCV-501 and FCV-491 After Steam Pressure Drops - Open Generator Circuit Breaker - Turn Off Condensate Pump Operator - Shut Down SGS From Console - Shut Down HRFS and EPGS From PCM 2
PCM 3 Microcomputer Failure - Loss of TSS Displays - Loss of Feedback Control Loops - Loss of SGS Displays	EPS - Defocus Heliostats - Time Delay - Close FCV-211 - Close FCV-231 - Turn Off Hot and Cold Salt Pumps - Turn Off Cold Salt Boost Pump - Close FCV-151 - Close FCV-501 - Open Generator Circuit Breaker EMCON (Automatic) - Dump Steam To Deaerator - Maintain Control of HRFS Network 90 (Automatic) - Interlocks Will Close FCV-301, FCV-341, and FCV-351 Operator - Shut Down SGS From Network 90 Console - Shut Down Receiver, HRFS, and EPGS from EMCON Console

TABLE 3.22. EQUIPMENT PROTECTION SYSTEM
MASTER CONTROL SUBSYSTEM TRIPS
(Continued)

TRIP CONDITION	ACTION REQUIRED
Simultaneous Failure of PCM 1, 2, and 3 Microcomputers - Loss of All Subsystem Control CCM Microcomputer Failure - Loss of PCM/Host Computer Communication Lin - Loss of Console Displays - Loss of Console Control Capability - Loss of Sequencing Operations Involving More Than One PCM Operator Remote Manual Trip	EPS - Defocus Heliostats - Time Delay - Close FCV-211 - Close FCV-231 - Turn Off Hot and Cold Salt Pumps - Turn Off Cold Salt Boost Pump - Close FCV-151 - Turn off FWP - Close FCV-501 and FCV-491 After Steam Pressure Drops - Open Generator Circuit Breaker - Turn Off Condensate Pump Operator - Shut Down the Subsystems From PCM 1, 2, and 3 and Network 90
EMCON Host Computer Failure	PCMs and CCM Continue To Operate and Control The Plant Operator - Shut Down The Subsystems From PCM 1, 2, and 3

Doc. 1694U

Table 3.23. TURBINE/GENERATOR TRIP LIST

MODE	DESCRIPTION	INITIATION
Manual	MGBT - Manual generator breaker trip	Breaker switch opened at local or remote generator control panel
Manual	ET - Emergency trip	ET "on" at EMCON console or local trip button actuated
Manual/auto	SVC - Stop valve closure	Close FCV-501
Manual/auto	OST - Overspeed trip	Local OST button
Manual	MTVC - Manual throttle valve closure	Close throttle valve (TVM)
Auto	GBT - Generator breaker trip	a. Reverse power b. Ground fault c. Overcurrent

SECTION 4 CONSOLE OPERATION

Section 4
CONSOLE OPERATION

A detailed description of the MSEE control system and its operation is contained in this section. The subsystem architecture and functional description was given in Section 3.2.

4.1 EMCON CONSOLE DISPLAY SCREEN

The EMCON color console provides a variety of displays arranged in a hierarchy of system level, subsystem level, group level, and individual point level. For the operation of MSEE the console displays used most often include system and subsystem level color graphic diplays, 4 over 4 group displays, 22 line group displays and the single loop displays. An example of each of these types of displays is shown in Figures 4.1 through 4.5.

The graphic displays are used primarily to observe the status of the entire system or an individual subsystem, particularly to locate trouble areas in the operation. The group level 4 over 4 and 22 line displays are used to observe process variables and to operate controls in a particular area within the system. The single loop display is used to analyze the behavior of an individual process variable and to perform tuning of controls.

The lower left-hand corner of the screen is called the KEYBOARD ECHO AREA. It is here where the keys are displayed as they are hit. Keys are usually displayed in GREEN. Error messages are printed in the keyboard echo area in RED.

The lower right-hand corner of the screen is used to display the current time and date. When the Console KEYLOCK is UNLOCKED (Console Unprotected), the time and date are displayed in RED. When the Keylock is LOCKED, the time and date are displayed in YELLOW.

The remainder of the screen (46 lines high by 80 columns wide) is available for the various displays.

The status of each point (tag name) determines the color in which it is displayed:

1. WHITE - OFF-LINE
2. GREEN - NORMAL
3. BLUE - OFF SCAN, BAD SENSOR, or I/O ERROR
4. RED - LOW or HIGH ABSOLUTE ALARM, RATE-of-CHANGE ALARM
5. YELLOW - DEVIATION ALARM

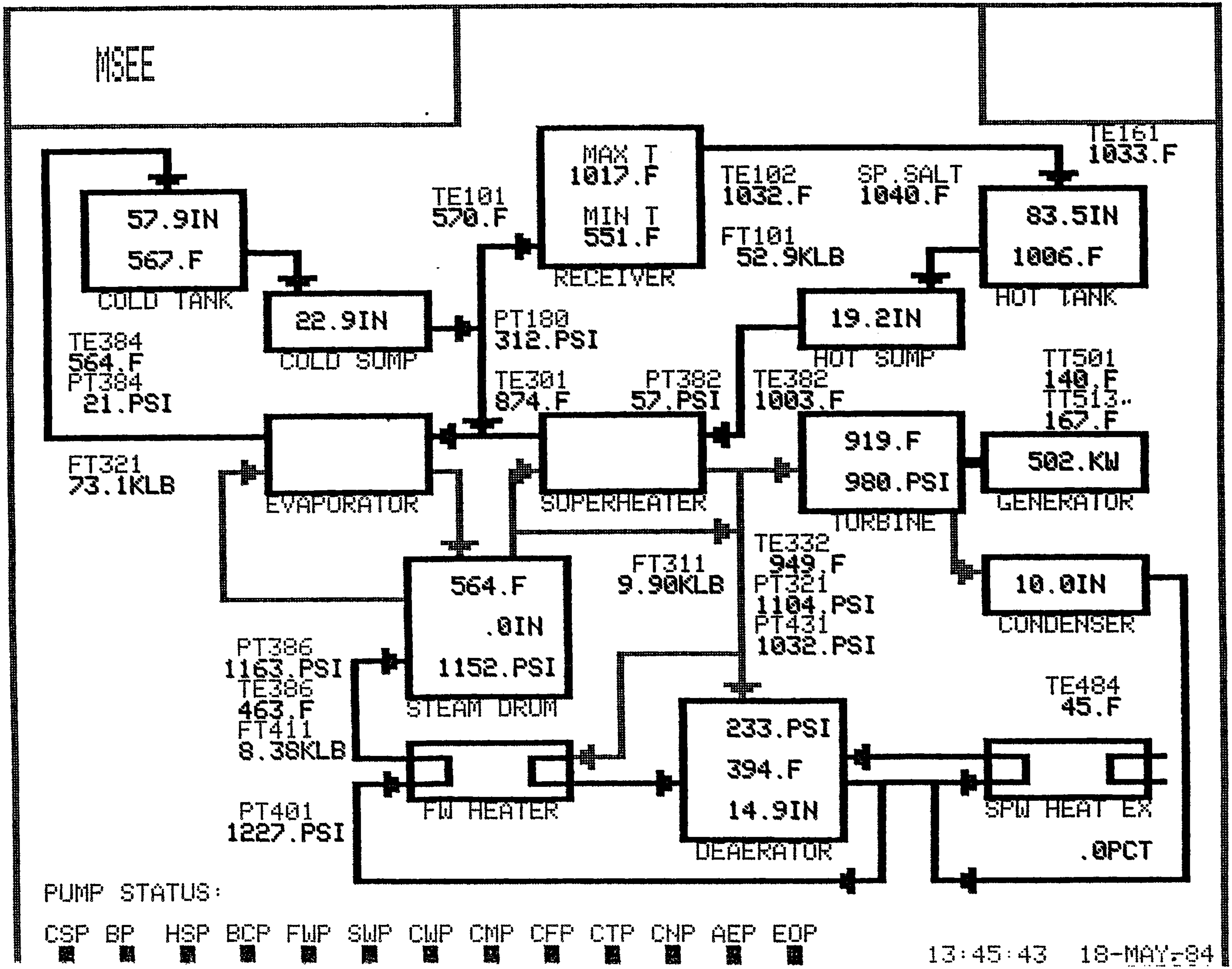


Figure 4.1. System Graphics

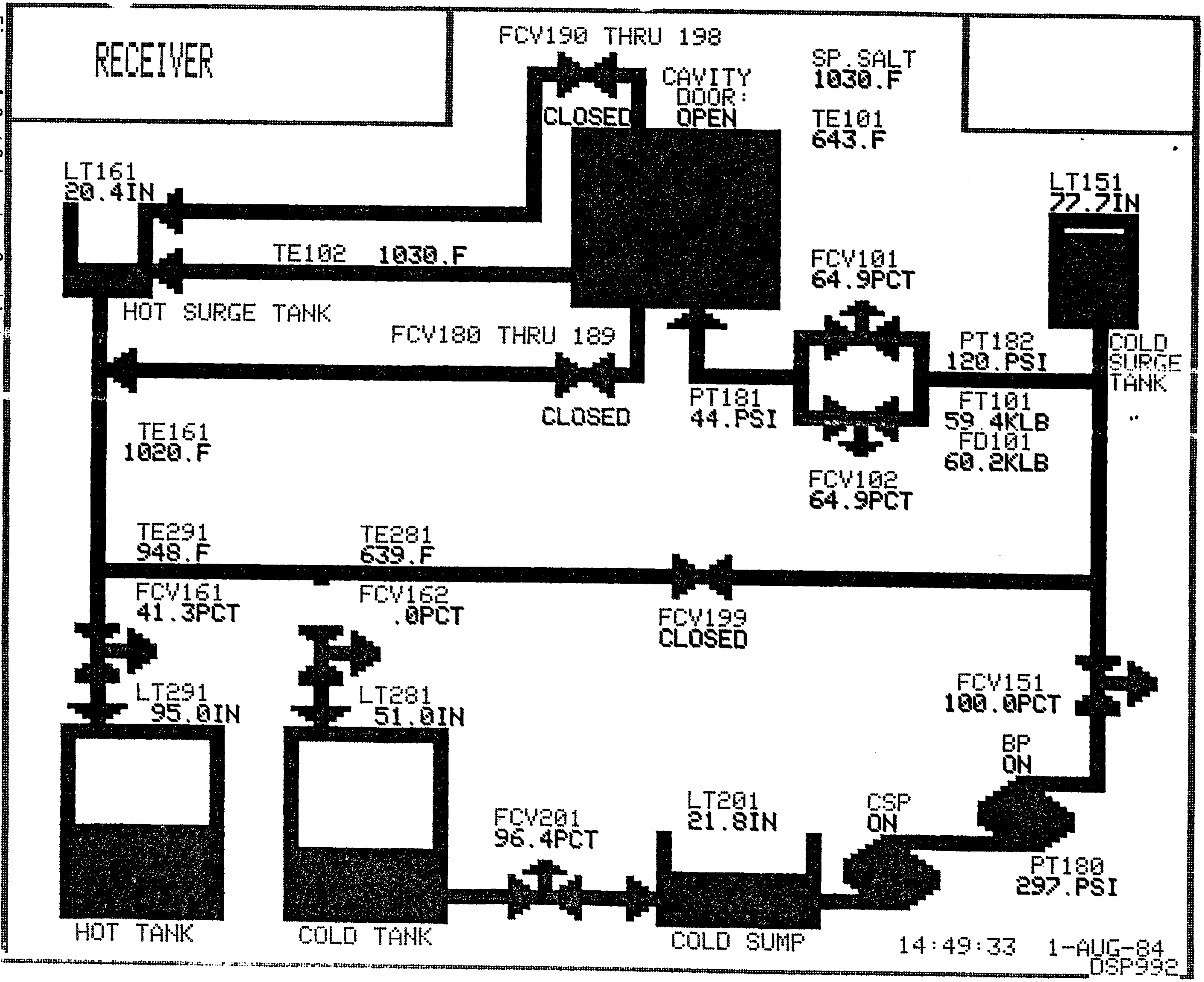


Figure 4.2. Subsystem Graphics

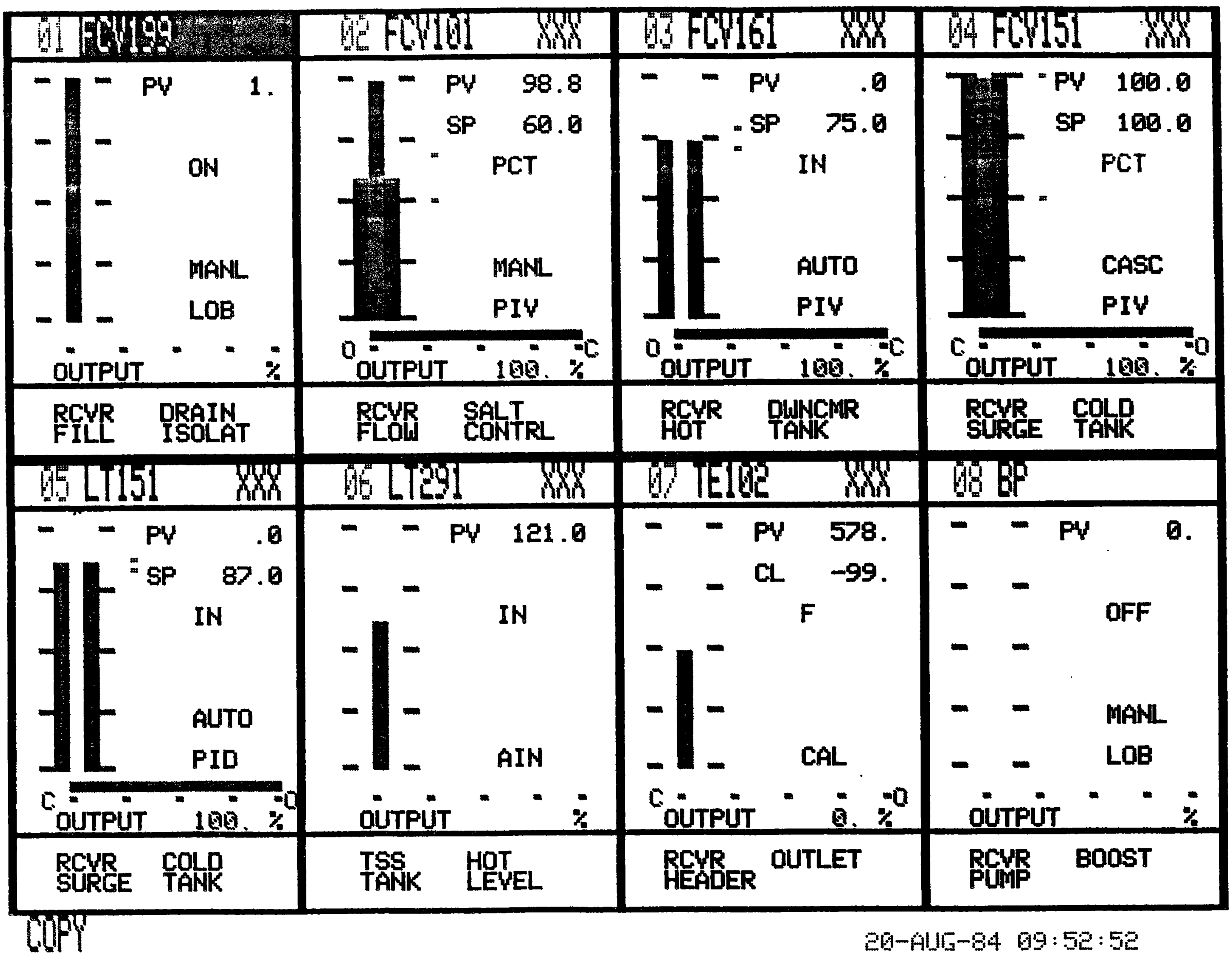


Figure 4.3. 4 over 4 Group

01	PT180	0.PSI		RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	2
02	FCV101	.2PCT	XXX	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
03	FCV102	.1PCT	XXX	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
04	FCV151	.0PCT	XXX	RCVR	COLD	SURGE	TANK	H	100.0	L	.0	PCM	1
05	FCV161	.8IN	XXX	RCVR	DWNCMR	HOT	TANK	H	70.0	L	15.0	PCM	3
06	FCV162	.8IN	XXX	RCVR	DWNCMR	COLD	TANK	H	70.0	L	15.0	PCM	3
07	FCV201	29.8IN	XXX	TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
08	FCV199	0.OFF		RCVR	DRAIN	FILL	ISOLAT					PCM	3
09	FCV171	0.OFF		RCVR	CTANK	AIR	SUPPLY					PCM	1
10	ZSH199	1.ON	XXX	RCVR	DRAIN	FILL	ISOLAT					PCM	3
11	ZSL199	0.OFF	XXX	RCVR	DRAIN	FILL	ISOLAT					PCM	3
12	OPN.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
13	CLS.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
14	ZSH211	0.OFF	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3
15	ZSL211	1.ON	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3
16	DR.OPN	0.OFF		RCVR	CAVITY	DOOR	OPEN					PCM	1
17	DR.CLS	0.OFF		RCVR	CAVITY	DOOR	CLOSE					PCM	1
18	ZSHDR	0.OFF	XXX	RCVR	CAVITY	DOOR	OPEN					PCM	1
19	ZSLDR	1.ON	XXX	RCVR	CAVITY	DOOR	CLOSED					PCM	1
20	LT281	50.2IN	XXX	TSS	COLD	TANK	LEVEL	H	134.0	L	15.0	PCM	3
21	LT291	108.2IN	XXX	TSS	HOT	TANK	LEVEL	H	190.0	L	10.0	PCM	3
22	PS281	1.ON		TSS	SGS	AIR	SUPPLY					PCM	3

COPY

GROUP 02
27-JUL-84 15:45:42

Figure 4.4 22 Line Group

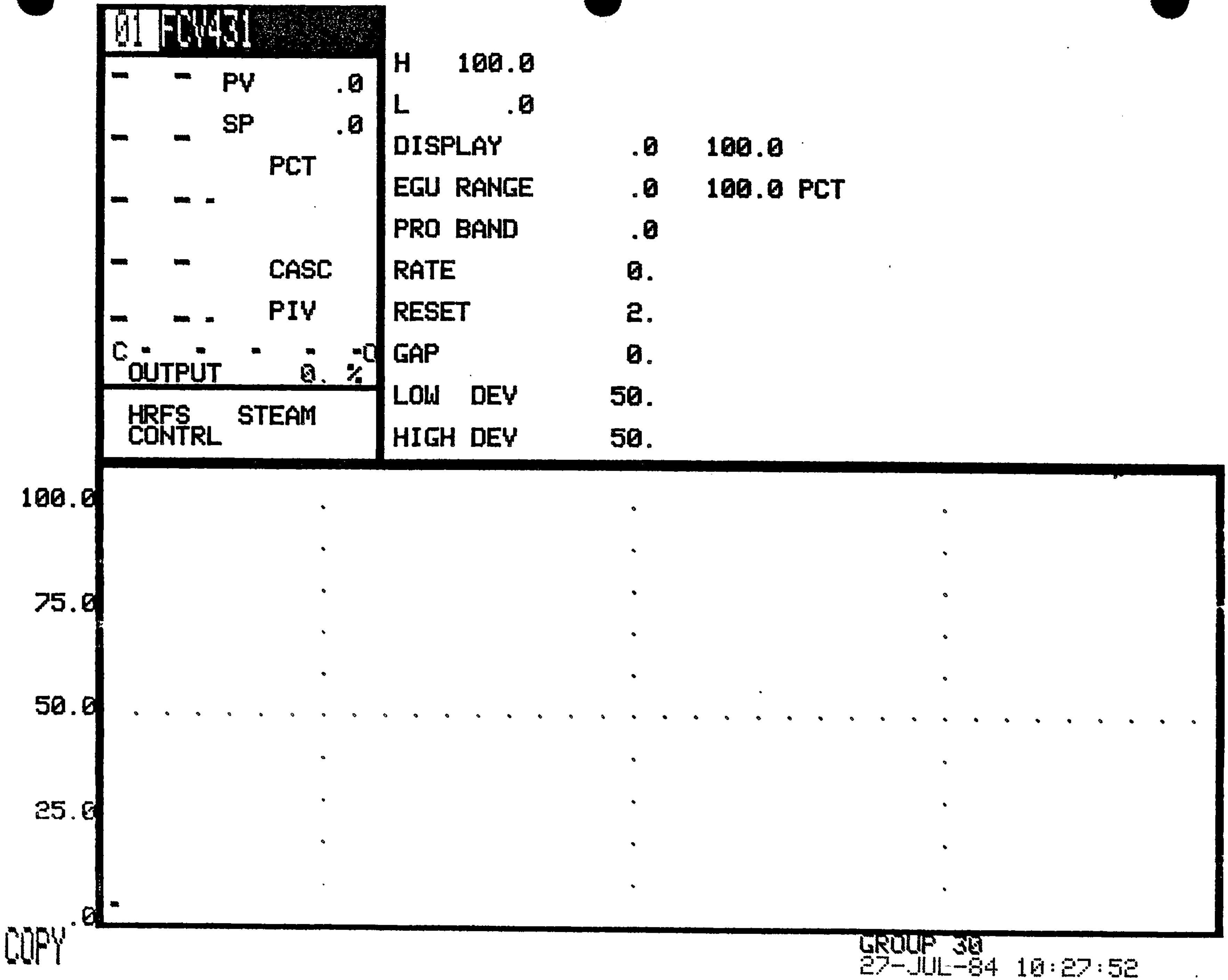


Figure 4.5. Single Loop

4.2 THE EMCON CONSOLE KEYBOARD

Figure 4.6 shows the keyboard layout.

Error Protection and Recovery

The Color Console keyboard is logically constructed to protect the operator from performing nonsense functions. For example, it will not allow the operator to change the setpoint of a contact input bit (because contacts have no setpoints!). If the operator tries to perform a nonsense operation, "WRONG KEY" will be displayed in the Keyboard Echo Area. However, the operator DOES NOT have to hit an "Error Clear" key when an error is encountered. He simply re-enters the correct keys. Likewise, if he makes a typing error, hitting <CLEAR ENTRY> will erase what he has typed and all he has to do is retype the line.

Functionally, the keyboard has several areas:

1. DATA ENTRY - This area contains the NUMBER pad and ALPHABET for bringing points onto the display, entering numeric values, etc.

2. DISPLAY SELECTION - This area contains keys that select the various display modes of the screen.

3. TUNING - This part of the keyboard is used (usually by the process engineer) for tuning control loops. It is usually under keylock (password) protection.

4. OPERATION - This part of the keyboard is used by the process operator for running the process. For example, it places loops in Auto or Manual status, changes Setpoints, etc.

5. SELECTION - (optional). These keys select one of the eight controllers on the screen for tuning purposes.

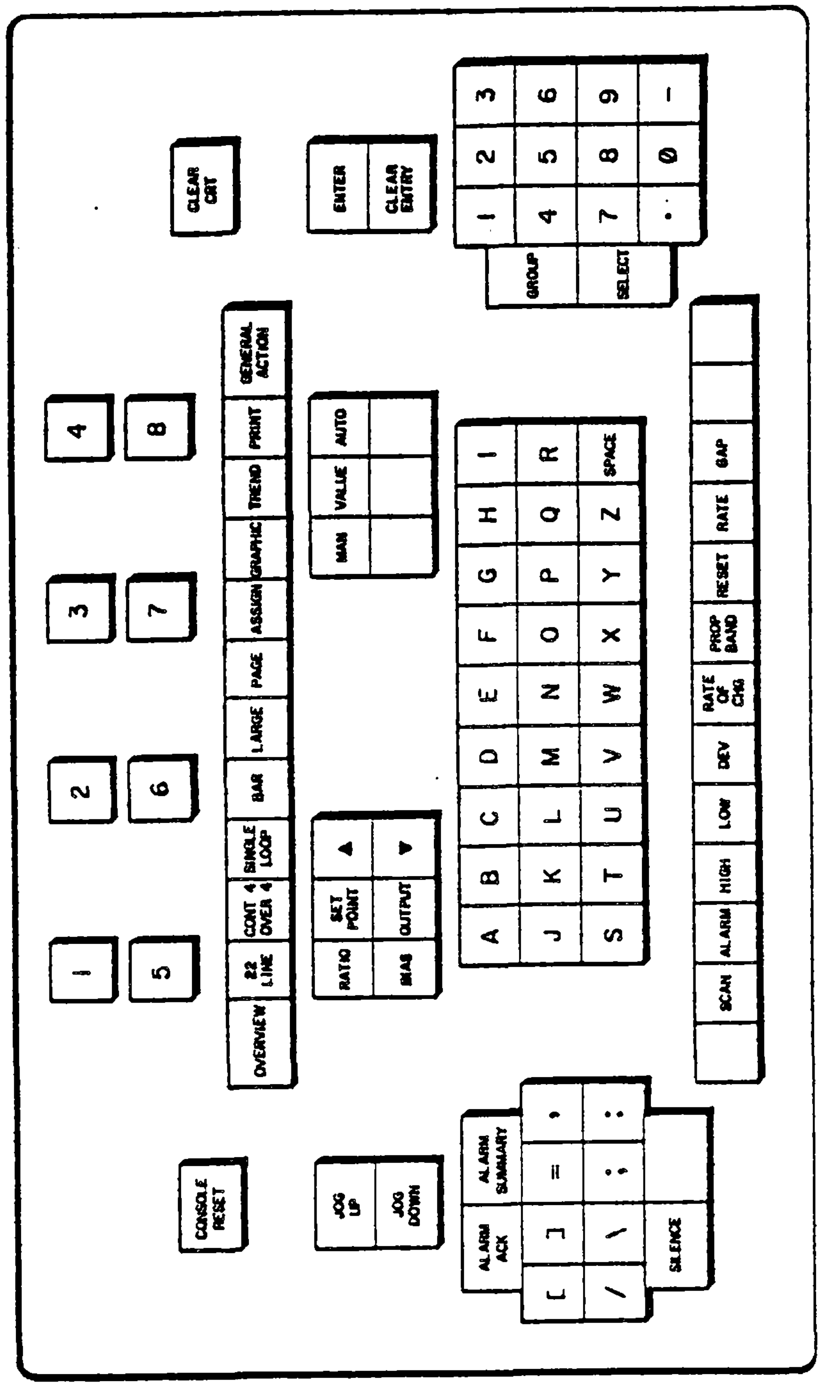


Figure 4.6. EMCON Console Keyboard Layout

There are two types of keys:

Fixed Definition - These are keys that are always legal to hit. They are limited to:

1. DISPLAY KEYS - To change the display format of the screen.
2. CLEAR ENTRY - To erase typing errors and clear previous keyboard entries.

Variable Definition - These keys may be legal or illegal or may perform different functions depending on the display mode of the screen and the type of point that is Selected. These keys are limited to:

1. DATA ENTRY KEYS - For entering point names and data values.
2. POINT MODIFY KEYS - For selecting the tuning parameter to be changed.
3. ALARM SILENCE/ACKNOWLEDGE KEYS - To Silence and Acknowledge Alarms.
4. SELECT KEYS - For Selelcting a line to change.

4.3 USE OF CONSOLE DISPLAYS

4.3.1 Bringing a Point onto the Display

NOTE: A single keystroke is designated by being enclosed in angle brackets < >. On the console itself, these brackets are NOT shown.

The Color Console allows the operator to bring a point or several points onto the display in three ways:

1. GROUPS - by indicating which pre-defined group of points is to be displayed. Table 4.1 lists the pre-defined groups. To display one of these groups, press the <GROUP> key followed by the group number. For example,

   <GROUP> <0> <2>

   will bring group 2, receiver and thermal storage subsystem controls, onto the screen. Most of the pre-defined groups will initially be displayed in the 22 line format.

2. INDIVIDUALLY - by entering the tag name. When calling a point up at random, using the individual method, press the ENTER key after typing the tag name in order to bring the point onto the display. For example,

<F><T><1><0><1><ENTER>

will bring "FT-101" onto the screen.

3. JOGGING - using the "JOG UP" or "JOG DOWN" keys, the user may "step through" the data base either forward or backward.

Table 4.1. MSEE Group List

Group Number	Group Name
01	RS controls with drain and purge valves
02	RS and TSS controls
03	RS and TSS instrumentation
04	TSS pump house
05	TSS storage tanks for propane heater operations
06	RS back tube temp
07	RS header temp
08	RS drain micros
09	RS purge micros
10	RS pass temp
11	Critical instrument readings
12	RS fill and drain sequence
13	SGS operation
14	SGS operations
15	SGS instrumentation
16	SGS heater control
17	SGS valve micros
18	HRFS controls
19	HRFS pump controls
20	HRFS cooling fan controls
21	Turbine operations
22	Turbine operations
23	Generator operations
26	EPS trips
27	EPS trips

4.3.2 Display of an Individually Entered Point

Once the point name is entered, the system will look up the name in the point name table. If it is NOT found, "NOT DEFINED" will be printed in RED in the Echo Area.

If the point name IS found, the point will be displayed:

1. At the TOP of the screen in Standard (22-line) mode.

2. In the TOP LEFT controller faceplate in a 4 over 4 mode.

3. As the single controller in Single Controller mode.

If more points are brought onto the screen than the screen can hold, the NEW points still are displayed as described above, and the OLD points are dropped off:

1. the BOTTOM in Standard (22-line) mode,

2. the BOTTOM RIGHT in 4 over 4 mode,

3. and replaces the single controller in Single Controller mode.

4.3.3 Selecting a Point

The SELECTED POINT is the single line or controller on the screen that is available for change. For example, the "SETPOINT" key will change the Setpoint of the SELECTED POINT.

The SELECTED POINT is always displayed in REVERSE VIDEO. That is, if the point's status were BAD SENSOR, it would usually be displayed in BLUE letters on a BLACK background. If it were the SELECTED POINT, it would be displayed in BLACK letters on a BLUE background.

In the 4 over 4 display, the point name and status of the SELECTEDP OINT are displayed in reverse video. A special display sequence will cause the selected controller to be refreshed (updated) at three times the rate of the other controllers. This provides a faster visual indication of the process, and is especially useful while tuning.

In the 22-line (standard) displays, the entire line of the SELECTED POINT is displayed in reverse video.

You may NOT select a point if graphics are displayed. The Console will remember the SELECTED POINT as you switch from one display mode to the next. For example, you may select controller #4 in 4 over 4 mode, switch to the 22-line mode, and switch back to the 4 over 4 display.

To select a point, simply hit the <SELECT> key, followed by the TWO digit controller or line nuimber. For example,

<SELECT><0><3>

will select line #3 of a 22-line display or controller #3 of a 4 over 4 display.

If the line number is illegal for that particular display (for example, trying to select faceplate #9 on a 4 over 4 display) WRONG KEY will be printed in the Echo Area.

Another method available is the use of individual select keys numbered 1 through 8 on the upper panel. These allow the selection of one of eight faceplates or lines with a single keystroke. Simply press the key on the upper panel (not the Number Pad) to select the desired controller.

4.3.4 Clearing the Screen

In order to erase the screen completely, press <CLEAR CRT>. This also erases the display list and, therefore, you cannot flip back to the previous display.

4.3.5 4 Over 4 Display

To convert the current display to a 4 over 4 display, press <Cont 4-Over-4>. Eight controller faceplates will appear on the screen, and they will be filled in, left-to-right and top-to-bottom, with the first eight points at the top of the screen if the previous display was Standard 22 line.

If the Selected Point on the previous display was between lines one and eight, that point will remain selected. If the Selected Point was out of that range, Controller #1 (the top-left corner) will automatically be selected. The Selected Controller has the upper part of the faceplate, containing the point name and status in Reverse Video. Unacknowledged alarms will have a blinking status.

When in Controller Mode, the Console will refresh the Selected Point at three times the rate of the other points. This gives a faster visual response to operator and process changes.

Each controller faceplate is divided into three areas: upper, middle, and lower.

The upper box contains:

1. Two yellow digits corresponding to the controller number (used for SELECT)

2. The Point name color-coded according to status,

3. The Point status characters, also color-coded. The Point status characters are as follows:

BLANK	-	Normal
H	-	High absolute alarm
L	-	Low absolute alarm
B	-	Bad sensor
O	-	Off scan
*	-	Off line
X	-	Off alarm

As explained earlier, the Point name and Status are displayed in reverse video if the controller is the Selected Controller.

The lower box contains:

1. The four words that comprise the Point Descriptors.

The middle box contains:

1. A green vertical bar that graphically corresponds to the process measurement.

2. Two red vertical bars on either side of the measurement bar that graphically corresponds to the process setpoint.

3. A green horizontal bar that graphically corresponds to the controller output. If the controller is a velocity type and the feedback sensor is bad, a blue horizontal bar appears for the controller output. If a feedback sensor is not specified when the data base is generated, the controller output bar will not appear.

4. The numeric Engineering Units value of the process measurement, prefixed by the letters:

1. "SP" if the controller is a PID controller (with Setpoint)

2. "CL" if the controller is a Calculation block, in which case the value corresponds to the calculation result, in percent, of EGU of PV.

3. The Engineering Units tag or label

4. The Controller type:

    1. AIN for Analog Inputs, scan-only

    2. CIB for Contact inputs

    3. LOB for Latching Contact Outputs

    4. PIV for Velocity-mode PID based on error

    5. PID for Positional-mode PID based on error

    6. CAL for Calculation.

    7. SSL for Signal Select/Limiter

    8. NLV for Non-Linear, Velocity PID based on error

5. The Controller Auto/Manual/Cascase/LOCL status.

6. The numeric value of the output being calculated by the control algorithm, displayed in percent. The direction of value movement is depicted by the "O" and "C" at each end of the output bar.

Some of the items mentioned above may not be displayed on a particular controller, based on the point type and controller type (if any exists).

If the point goes off line (the communications link fails), the bars will disappear and the point name will be displayed in white. When the point returns on line, the controller will be re-drawn.

4.3.6 Single Loop Display

The Single Loop display presents detailed information in a split-screen presentation. The single loop display always presents the SELECTED point. After selecting a point on the screen (from the 22 line or 4 over 4 displays), press <SINGLE LOOP> to view the selected point in Single Loop format.

The upper half of the screen is presented in two quarters:

1. The left quarter contains a single controller faceplate display, containing information as described in the preceding section.

2. The right quarter contains the numeric values of the tuning parameters associated with the point on display. The tuning parameters that are displayed depend on the type of point and control block (if any) that is on the display. These may include:

    1. The high absolute alarm limit

    2. The low absolute alarm limit

    3. The engineering units range

    4. The display range (if scale expansion is used)

    5. Proportional band constant (PB)

    6. Reset time (integral)

    7. Rate time (derivative)

    8. High and Low Deviation Limits

Some of these tuning parameters may be changed from the operator's console keyboard.

The bottom half of the screen is used for a real-time trend of the measurement of the point. The Y-axis is labeled in Engineering Units. The X-axis is the time base. The left margin is the time when the display is first called up, the right margin will be reached after approximately twelve minutes. The graph is plotted, much like a pen recorder, with a sample of the measurement being displayed every five seconds. When the right-hand margin is reached, the screen is erased and the display re-starts at the left margin.

A feature of this display is that the value is plotted in the color of the point status. For example, if the point is "Normal", the dots will be drawn in green. As the point enters its High Absolute Alarm area, the dots will change to red.

If no point is selected when the <SINGLE LOOP> key is hit (for example, when the screen is clear) "OFF LINE" will be displayed in the Keyboard Echo Area. If the point goes off line while on display, the faceplate will be blanked, as in the 4-Over-4 display, and the graph will turn white.

After the Single display mode is selected, other points may be called up at random by entering the Tag name. The screen will be erased and the new point will then be displayed.

You may return to the previous display from the Single display by simply pressing one of the display mode keys.

4.3.7 Standard 22-Line Display

To enter the Standard display mode, press <22-Line>. If a point display was already on the screen (for example, 4-Over-4, or Single) the display will be converted to the 22-line format. If the screen was clear, the Console will wait for points to be called up by entering the tag names.

The Standard display presents:

1. A yellow, two-digit line number

2. The Tag Name

3. The measurement, in Engineering Units

4. The engineering Units label

5. The Point status (blinking if unacknowledged)

6. The four Point Descriptor words

7. The High and Low, Alarm Limits (if applicable)

8. The PCM number where the point is located.

The Selected point is displayed in reverse video, and each line is color-coded according to its status. As points are added to the screen, by entering the tag name or Jogging Up or Down, these points are displayed at the TOP of the screen, and the other points move down and eventually off the bottom of the screen. The 22-line display shows the maximum number of points that may be contained on the screen. Therefore, you may notice for example, that when changing from a 4-Over-4 display to 22-Line, more than eight lines will be on the screen. This feature allows you to group points in such a way that the top eight points are control points, and the bottom fourteen may be used for other points.

4.3.8 Graphic Displays

The graphic displays are called up by pressing the <GRAPHICS> key followed by the number of the desired graphic and the <ENTER> key. For example, <GRAPHIC> <9><9><1><ENTER> will display the MSEE overall system graphic. The available graphic displays are:

990	Receiver Panel Warm Up Temperatures
991	MSEE Overall
992	Receiver Subsystem
993	Thermal Storage Subsystem
994	Steam Generator Subsystem
995	Heat Rejection and Feedwater Subsystem
996	Electric Power Generation Subsystem

The <CLEAR CRT> key must be pressed before the display can be changed. The graphics displays are for observing operations only and cannot be used for control.

4.4 CONTROL

4.4.1 Change Keys, Tuning Keys, Modify Keys

The operator's console supports a full set of keys that modify the characteristics of a loop on line. These keys perform immediate changes to the live point, but they do not effect any changes on the Host disk image of the control data base.

The MODIFY keys are divided into two categories: Process Operator functions and Process Engineer functions.

The Process Operator functions are those normally necessary for the daily operation of the plant. They may be performed by anyone at any time and can be likened to the functions available on the front panel of a typical analog controller. These keys include:

1. Switch to Automatic Control, <AUTO>

2. Switch to Manual Control, <MAN>

3. Change Set point, <SET POINT>

4. Change Output, <OUTPUT>

5. Change Analog or Contact Value, <VALUE>

The Process Engineer functions are those used to change the characteristics of the control operation being performed. These changes must be done under keylock (Password) protection and therefore, are not immediately accessible to the operator.

These functions are parallel to those contained inside an analog controller, where the controller must be removed from its case in order to be changed. These keys include:

1. Change High Alarm LIMIT, <HIGH>

2. Change Low Alarm Limit, <LOW>

3. Change Rate-Of-Change Alarm Limit, <RATE of CHG>

4. Change Deviation Alarm Limits, <DEV>

5. Change Scan Status, <SCAN>

6. Change Host Alarm Status, <ALARM>

7. Change Rate (Derivative), <RATE>

8. Change Reset (Integral), <RESET>

9. Change Proportional Band, <PROP BAND>

10. Change Bias, <RATE>

11. Change Lag Time, <GAIN>

12. Change Ramp Time, <PROP BAND>

13. Change Gap, <GAP>

4.4.2 Success/Error Messages

If the Modify occurs successfully (is accepted by the remote computer)

DONE

will be printed (in green).

If the Modify function fails as a result of a communications link problem,

COMM LINK ERR

will be printed in red.

Other operator messages are discussed in their appropriate section.

4.4.3 Switch To Automatic Control, <AUTO>

In the case of a contact output, pressing <AUTO> will prevent the contact from being turned on or off with the <VALUE> key.

If the selected point is an analog input with a control block attached, pressing <AUTO> will put the output of that block in automatic or cascade mode.

In all other cases, the <AUTO> key is illegal and will print "WRONG KEY" if hit.

4.4.4 Switch To Manual Control, <MANL>

For a contact output, pressing <MANL> will allow the value of the contact to be changed using the <VALUE>.

For an analog input with a control block attached, pressing <MANL> will place the block in manual mode and allow the output of the control block to be changed using the <OUTPUT> key.

For all other blocks, <MANL> is illegal and will print "WRONG KEY" if hit.

4.4.5 Setpoints

The SETPOINT Key

The <SETPOINT> key, from its name, indicates that it will modify the setpoint of any block that has a setpoint.

When the key is pressed, it will print the name of the parameter that it is changing.

If the selected analog point does not have a changeable setpoint field, "NO TUNING" will be printed in red when the key is hit. Digital points will respond with "WRONG KEY".

Note also that the setpoint key is legal only for the 4-Over-4 and Single Controller display. If pressed for any other display, "WRONG KEY" will be printed.

Changing Setpoint -

If the selected point has a 3-term PID block (or one of its variations) attached, the <SETPOINT> key will modify the setpoint of the loop. It will print "SETPOINT" when the key is hit, followed by the current setpoint, in engineering units. For example,

SETPOINT 73.05

The operator may enter the new setpoint, in engineering units, followed by <ENTER>. If he does not wish to enter a new value, he may simply hit <ENTER> and no change will occur.

If the value was entered correctly, "*DONE*" will be printed.

If the value was typed incorrectly or if the value was outside the engineering units range, "CONVERT ERR" will be printed in red. The operator must try again, starting with pressing the <SETPOINT> key.

Cascaded Setpoints -

In some cases, the setpoint of the slave (or downstream) loop will be determined by the output of a master (or upstream) loop. For example, suppose the downstream loop is selected and the cascade is closed ("CASC" is displayed on the controller). When the <SETPOINT> key is hit, you will see:

WARNING: CASCADE CLOSED.

The operator may still enter a new value, but it will be replaced by the new upstream setpoint when the upstream block is scanned.

To change the downstream setpoint, the operator should put the upstream block in "MANUAL" to open the cascade. He may then:

1. Change the "OUTPUT" of the upstream block, thereby changing the downstream setpoint. This can be done only if the upstream block a PID-Type block.

2. Change the "SETPOINT" of the downstream block, using the <SETPT> key. The warning message will not be shown.

Jogging Setpoints -

After pressing the <SETPOINT> key, the "INCREMENT /ON" DECREMENT/OFF" (up-arrow and down-arrow etchings, respectively) are defined to increase or decrease the setpoint by one percent of the full engineering units range each time they are hit. This is similar to holding a Bat-Handle to RAMP a setpoint.

For example:

<SETPOINT><INC-ON><INC-ON>

will increase the setpoint by two percent of full range. The change occurs each time the key is pressed; holding the <INC-ON> key down, for example, will not cause a continuing increase.

The setpoint value will not increase past 100 percent of full Engineering Units range nor decrease below zero percent.

4.4.6 Positional Output Commands

The OUTPUT Key

The <OUTPUT> key changes the output of a control block. When the <OUTPUT> key is pressed, one of the following prompts are given: "Positional Output" or "Incremental Output". Positional output requires the entry to be the absolute position between 0 and 100 percent. Incremental output requires the entry to be incremented or decremented from its current position. Entry range from -100 to 100%.

If the controller is in "AUTO" or "CASC" mode, then the output is being calculated by the controller's algorithm and is not changeable with the output key. An attempt to do so will cause

BLOCK IN AUTO

to be printed in RED.

Therefore, you must set the controller in manual mode using the <MAN> key.

The <OUTPUT> key is only valid for displays where controller output is shown (4-over-4 and single controller). If <OUTPUT> is struck on any other display, "WRONG KEY" will be printed.

If the selected block does not have a control block or if its control block does not have a changeable output, "NO OUTPUT" will be displayed when <OUTPUT> is hit.

Entering A New Output Value

After pressing the <OUTPUT> key, the operator may change the output by entering a new numeric value followed by <ENTER>. For positional output, the value is the absolute position between 0.0 and 100.0 percent of full output from 35 percent to 60 percent, the operator strikes:

<OUTPUT><6><0><ENTER>

For incremental output, the entry would be:

<OUTPUT><2><5><ENTER>

Jogging Outputs

Once the <OUTPUT> key is hit, the "INCREMENT/ON" (UPARROW) and "DECREMENT/OFF" (DOWNARROW) keys are defined to change the current output by one percent each time they are hit.

To decrease the output by 3 percent for example, the operator hits:

<OUTPUT><DEC-OFF><DEC-OFF><DEC-OFF>

The output will not decrease below zero, nor increase above 100 percent of output range.

4.4.7 Digital Output Commands

The <VALUE> key

The <VALUE> key is used for changing the value of a contact output (on/off or open/close commands).

If the selected point is a contact output, pressing the <VALUE> key will set the keyboard such that:

1. Pressing <INCREMENT/ON> will turn the contact on (set its value to 1)

2. Pressing <DECREMENT/OFF> will turn the contact off (set its value to 0).

For example, to turn a contact on, hit

<VALUE><INC-ON>

You can now immediately turn the contact off by striking <DEC-OFF> without having to strike the <VALUE> key, for example:

<VALUE><INC-ON><DEC-OFF>

The contact output must be in MANUAL mode to change its output using the <VALUE> key.

4.5 MISCELLANEOUS KEYS

4.5.1 Print Key

When the console has a standard 22 line display on the screen, the operator may press this key to have the display duplicated on the operator tracking typer. This is not an exact copy but a remake of the display by the tracking program. When all packets have been sent to the tracking program, the console will tell the operator that the task has been completed by displaying '*DONE*' in the keyboard echo area. The typing may continue depending on the speed of the typer.

For example:

<PRINT> *DONE*

4.5.2 COPY Key

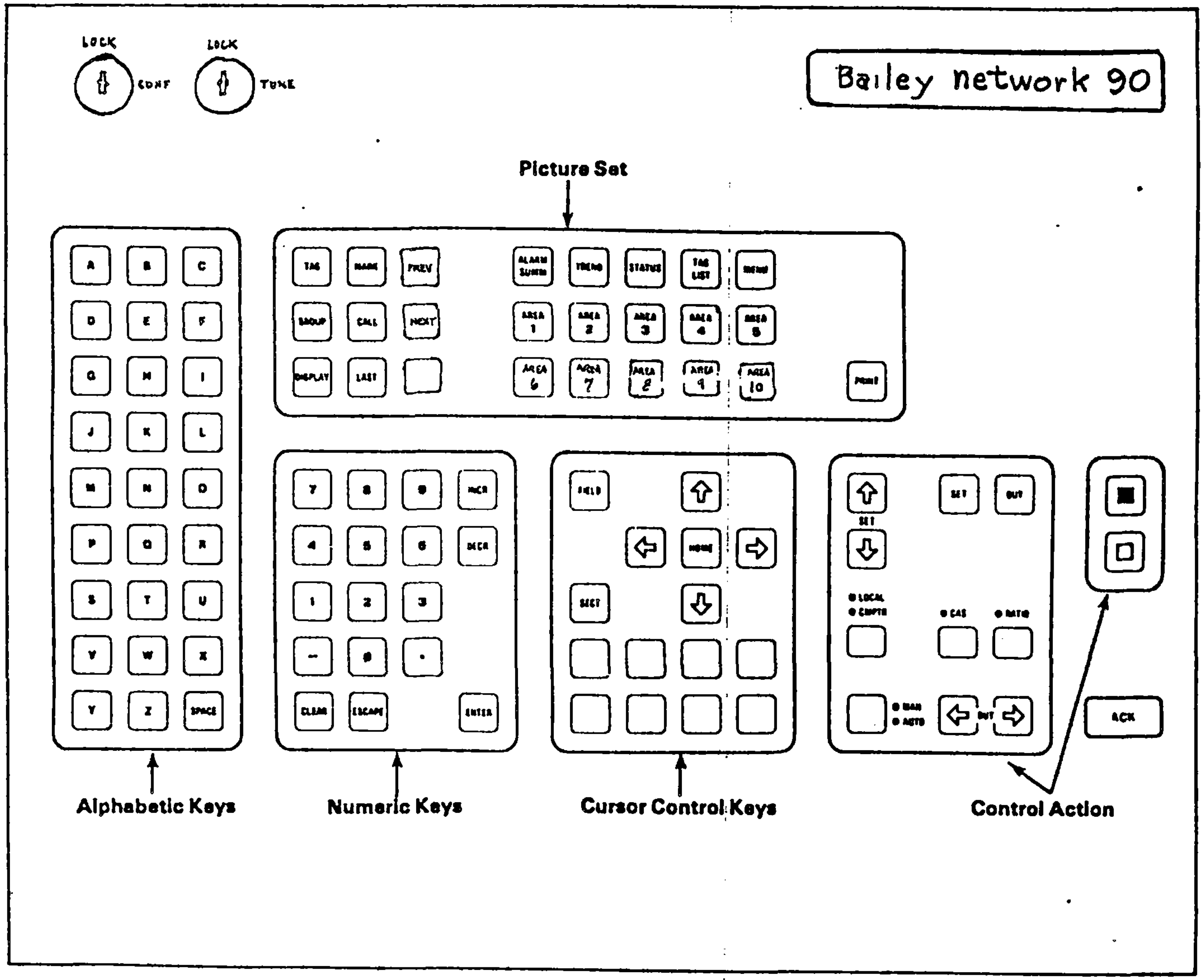
This key is for the copying of the CRT screen to the hard copy graphics printer. When this key is pressed, the console will echo 'COPY' at which time the screen will freeze until the copying process is finished. When the screen becomes unfrozen and the copying is done, the console will display in the echo area '*DONE*' indicating that the copying process is complete.

For example:

<COPY> *DONE*

4.6 BAILEY NETWORK 90 CONSOLE

The Bailey Network 90 keyboard is shown in Figure 4.7. The Network 90 is used primarily as a display during SGS operation. Two displays are illustrated on Figures 4.8 & 4.9. Only one operational command is made from this system. Hence, full console operation will not be covered in this program.



Keyboard Layout

Figure 4.7

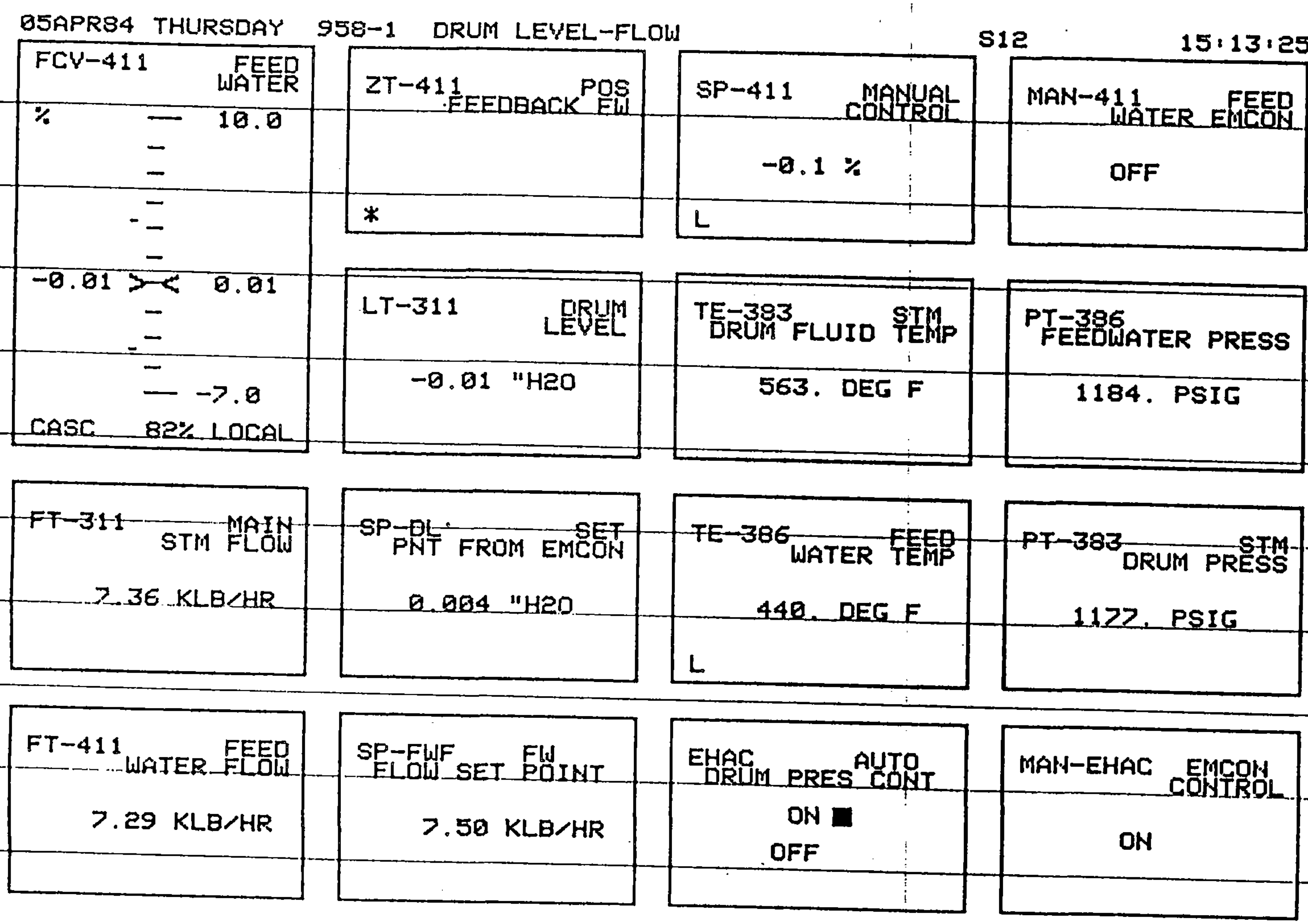


Figure 4.8

Bailey Network 90 Status Display

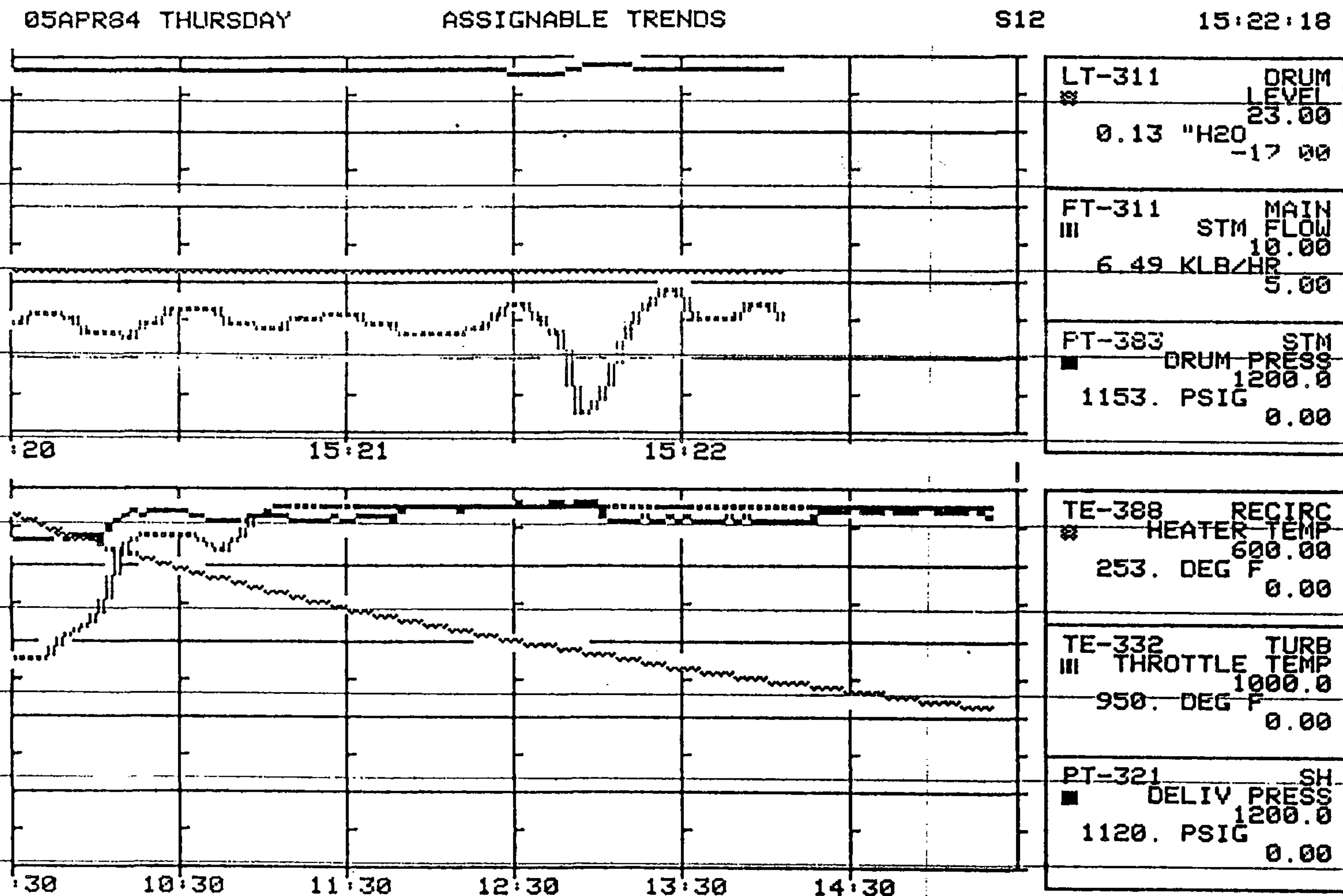


Figure 4.9
Bailey Network 90 Trend Display

Section 5
TRAINING MATERIAL

This section contains exercises to be conducted as part of the training and operating program.

5.1 PRE-OPERATIONAL CONTROL ROOM EXERCISES

5.1.1 EMCON Console Introduction

Part 1 - Display Familiarization

	KEY	SECTION	COMPLETED
1) Choose and call up a group from the group list	GROUP	4.3.1	________
2) Place the group into a 4 over 4 display	cont 4 over 4	4.3.5	________
3) Select a point		4.3.3	________
a) Using the select key	SELECT		
b) Using the individual select keys	UPPER PANEL 1 - 8		

	KEY	SECTION	COMPLETED
4) Place the selected point into a single loop display	SINGLE LOOP	4.3.6	______
5) Return to the 22 line display	22 LINE	4.3.7	______
6) Call up an individual point by entering the point name	ENTER	4.3.1	______
7) Call up each of the system and subsystem graphic displays. Press "CLEAR CRT" key when completed	GRAPHIC	4.3.8	______
8) Change a groups 4 over 4 display	PAGE		______
a) Call up group 14 (note position of FCV-431)			
b) Place the group into a 4 over 4 display			
c) Press "PAGE" key twice (note display changes)			
d) Return to 22 line display (note position of FCV-431)			
9) Print a.22 line display	PRINT	4.5.1	______
10) Copy a 4 over 4 display	COPY	4.5.2	______

	KEY	SECTION	COMPLETED
1) Change a valve position	OUTPUT	4.4.6	________
a) Call up group 14 and include FCV-421 in a 4 over 4 display			
b) Select FCV-421			
c) Place in manual control	MAN	4.4.4	
d) Change valve position to 40% open by entering the proper value	ENTER		
e) Change the valve position by using the "UPARROW" and "DOWNARROW" keys	Δ ∇		
f) Close the valve (0%)			
g) Return valve to auto position			
2) Change a setpoint	SET POINT	4.4.5	________
a) Call up group 14 and include FCV-432 in a 4 over 4 display			
b) Select FCV-432			
c) Change the set point to 200 PSI by entering the value			

	KEY	SECTION	COMPLETED
d) Change the set point using the "UPARROW" and "DOWNARROW" keys			
e) Change the set point to 233 PSI			
3) Turn on a pump	VALUE	4.4.7	________
a) Call up group 19 and select CFP.EN (cycle fill pump enable)			
b) Turn CFP.EN on	Δ		
c) Select CFP			
d) Turn CFP on			
e) Verify ZSHCFP "on"			
f) Turn pump off	∇		
g) Verify ZSHCFP "off"			
h) Turn CFP.EN off			

	KEY	SECTION	COMPLETED
4) Open receiver cavity door	VALUE	4.4.7	________

a) Call up group 02

b) Verify DR.CLS "off" (cavity door close)

c) Verify DR.OPN "off" (cavity door open)

d) Verify ZSHDR "off" (door open micro)

e) Turn DR.OPN "on" and observe door on video monitor

f) When ZSHDR indicates that door is fully open immediately turn DR.OPN "off"

	KEY	SECTION	COMPLETED
5) Close receiver cavity door	VALUE	4.4.7	________

a) Verify DR.CLS "off"

b) Verify DR.OPN "off"

c) Verify ZSLDR "off"

d) Turn DR.CLS "on"

e) When ZSLDR indicates that door is fully closed, immediately turn DR.CLS "off"

5.1.2 Acurex Data System Familiarization

1. The Acurex data is displayed on page 02. If this page is not displayed on the display screen, ue the "PAGE FWD" or "PAGE BACK" key as required to change to this page.

2. Check the receiver purge and drain valve temperatures and verify that all are above 480°F.

   a. Determine the channel numbers corresponding to the purge and drain valve thermocouples (see Rs heat trace instrumentation list).

   b. Use the arrows on the keypad to move the cursor to the top channel number on the display screen.

   c. Key in the first channel in the series of channels that you wish to display and press the "ENTER" key.

   d. Repeat step c to check the remaining purge and drain valve temperatures.

3. Check FCV-101 and FCV-102 temperatures and verify that they are above 480°F.

4. Check channels 100-142. Note the thermocouple locations on the instrumentation list. Record any temperatures less than 480°F along with the corresponding channel.

5.1.3 Receiver Subsystem Instrumentation and Control

Completed

1. Review group 1 and locate the instrumentation and valve tag names on the P&ID. ________

2. Repeat step 1 for group 2. ________

3. Repeat step 1 for group 3. ________

Repeat step 1 for group 12. ________

4. Manual control of a cascaded valve from an upstream control block. CB

   a) On Acurex verify that FCV-151 temperature is above 480°F. Verified:________

   b) Place FCV-151 in cascade. (Group 2)

   c) Place LT-151 in manual and output the valve that will position FCV-151 25% open.

   d) Close FCV-151 and return LT-151 to auto.

5. Manual control of a cascaded valve from the downstream control block. CB

   a) Place LT-151 in manual.

   b) With FCV-151 in auto, change the set point to position the valve 25% open.

   c) Return FCV-151 to closed position.

   d) Return LT-151 to auto; note FCV-151 change to cascade.

Completed

6. Manual valve control GB

a) Place FCV-151 in manual.

b) Output the proper value to position the valve 25% open.

c) Return FCV-151 to cascade.

7. Change the salt outlet temperature set point GB

Note: The receiver control algorithm would have have to be "ON SCAN" to control the outlet temperature. However for this exercise, RCA will remain off.

a) Change SP.SALT to 1000°F.

b) Change SP.SALT to 750°F.

8. Constant receiver flow

a) On Acurex verify that FCV-101 and FCV-102 temperatures are above 480°F. Verified:__________ GB

b) Place FCV-101 and FCV-102 in cascade.

c) Change FD-101 set point to 40 KLB/hr (~~FD-10~~ RCA must be off scan).

d) Return FD-101 set point to 30 KLB/hr.

e) Return FCV-101 and FCV-102 to manual control.

5.1.4 Thermal Storage Subsystem Instrumentation and Control

Completed

1. Review groupl 4 and locate the instrumentation and valve tag names on the P&ID. __________

2. Repeat step 1 for group 5. __________

3. Complete the following table.

Day__________ Time____________

Description	Tag Name	Value
Hot storage tank level		
Cold storage tank level		
Hot sump level		
Cold sump level		
Cold storage tank bottom temp		
Hot sump temp (Acurex)		
Cold sump temp (Acurex)		

4. How is the set point changed for the hot and cold sump levels?

5.1.5 SGS Instrumentation and Control

Completed

1. Review group 13 and locate the instrumentation and valve tag names on the P&ID. __________

2. Repeat step 1 for group 14.

3. Repeat step 1 for group 15.

4. Manual control of a Network 90 controlled valve. __________

   a) On Acurex verify that FCV-321 temperature is above 480°F. Verified:__________

   b) Turn/verify MAN.321 on. (Group 13)

   c) Change SP.321 setpoint to position the valve 25% open.

   d) Change SP.321 setpoint to close the valve.

   e) Change SP.321 to fully open valve (set to [illegible])

5. Automatic control of a Network 90 controlled valve. __________

   a) Turn MAN. 321 off.

   b) FCV-321 will now control the main steam pressure to SP.SP setpoint. Change this setpoint to 1075 PSI.

   c) Change SP.SP setpoint to 1100 PSI.

   d) Return MAN.321 to on.

Completed

6. Control of a Network 90 controlled isolation valve. __________

   a) On Acurex verify that FCV-381 and FCV-382 temperatures are above 480°F. Verified:__________

   b) FCV-381 and FCV-382 are controlled together. (Group 13)

   c) Turn FCV38182 on to open the valves.

   d) Check micros to verify valves open (Group 17).

   e) Turn FCV38182 off to close FCV-381 and FCV-382.

   f) Turn MAN.38182 off.

7. Change the position of FCV-331 using step, 4 as a guide. Return the valve position to 10% open when finished. __________

5.2.2 Receiver Steady State Operation

Description

o Operate receiver with heliostats on target to heat cold salt and charge the hot salt storage tank.

Objectives

o Introduce the oprator to hot salt production
o Calculate receiver power output
o Determine collector/receiver efficiency

Initial System Conditions

o RS2- Receiver drained with trace heat on
o RSS2- Hot and cold salt tanks warm and ready for operation with hot tank level less than 20 inches.
o SGS not applicable
o EPGS not applicable

Procedure

Completed

1. Advise data system operator to load system data package. ______

2. Advise data system operator to display the following on the data display screens: ______

LT-281	Cold storage tank level
LT-291	Hot storage tank level
TE-101	Receiver inlet salt temp
TE-102	Receiver outlet salt temp
TE-291	Hot storage tank temp
FT-101	Receiver salt flow rate

3. Confirm receiver technician is completing receiver pretest checklist (ROP #1).

4. Confirm thermal storage technician is completing TSS pretest checklist (TOP #1).

5. Complete control room pretest checklist (COP #1) Sections I - VI. ________

6. Fill receiver and establish serpentine flow with receiver in solar charging configuration, SP.SALT at 750°F, and warm up heliostats on target (ROP #2). ________

7. Increase heliostat field in increments of 12-1/2% until salt flow rate exceeds 60 KLB/hr. ________

8. Increase SP.SALT to 850°F. Stabilize and confirm salt outlet temperature and flow switchover to hot tank. ________

9 Complete Table 5.1 after stabilizing at each of the noted operating conditions. Calculate the power and efficiency for each case as follows. ________

- o Direct insolation power

$$P_D \text{ (watts)} = A \times N \times (\text{sun})$$

where: A = heliostat mirror surface area = 37.2m_2
N = number of heliostats on target
Sun = solar insolation in W/M_2

- o Receiver power output

$$P_R = C_p \, m \Delta T$$

$$P_R \text{ (watts)} = 108 \text{ (FT-101)[(TE-102) - (TE-101)]}$$

where: FT-101 = salt flow rate in KLB/hr
TE-102 = receiver outlet salt temp in °F
TE-101 = receiver inlet salt temp in °F

- o CS/RS efficiency

$$\eta = \frac{P_R}{P_D}$$

Procedure	Completed
10. Scram heliostats and set receiver flow demand to 30 KLB/hr. Confirm flow switchback to cold tank at 700°F.	________
11. Shut down receiver (ROP #3).	________

Table 5.1. Receiver Steady State Operation

Operating Conditions		Data							Calculate		
SP. SALT	Heliostat Field (pct)	Number of Heliostats on Target	Time of Day	Solar Insolation (Sun)	Salt Inlet Temp (TE-101)	Salt Outlet Temp (TE-102)	Flow Rate (FT-101)	Direct Insolation Power	Receiver Power Output	CS/RS Efficiency
850	50%									
900	50%									
850	75%									
900	75%									
950	75%									
900	100%									
950	100%									
1000	100%									

	Begin	End
Ambient Air Temp	________	________
Relative Humidity	________	________
Barometric Pressure	________	________
Wind Speed	________	________
Wind Direction	________	________

5.2.3 Receiver Operation with Simulated Clouds

Description

- o During receiver loop operation, simulate passing clouds by ramping heliostats on and off of the receiver.

Objectives

- o Demonstrate receiver operation through simulated cloud passage.
- o Familiarize operator with receiver control algorithm.

Initial System Conditions

- o RS2 - Receiver drained with trace heat on
- o TSS2 Hot and cold salt tanks warm and ready for operation with hot tank level less than 20 inches
- o SGS not applicable
- o EPGS not applicable

Procedure — Completed

1. Advise data system operator to load receiver data package. ________

2. Advise data system operator to display the following on the data display screens: ________

   LT-281 Cold storage tank level
   LT-291 Hot storage tank level
   TE-102 Receiver outlet salt temp
   FT-101 Receiver salt flow rate

3 Confirm receiver technician is completing receiver pretest checklist (ROP #1) ________

4 Confirm thermal storage technician is completing TSS pretest checklist (TOP #1) ________

5 Complete control room pretest checklist (COP #1) Sections I - VI. __________

6 Fill receiver, establish serpentine flow with receiver in solar charging configuration SP.SALT at 900°F, and 25 percent of the heliostats on target. __________

7. Complete Table 5.2 for each of the noted transient cases. Allow receiver to stabilize before each case. __________

8. Shut down receiver (ROP #3). __________

Table 5.2. Receiver Operation with Simulated Clouds

Initial Conditions		Heliostat Transient				Data		
SP.SALT	Heliostat Field (Pct)	Final Heliostat Field (Pct)	Heliostat Increment (Pct)	Time Increment (Sec)	Time of First Heliostat Command	Salt Inlet Temp (TE-101)	Initial Salt Outlet Temp (TE-1012	Maximum Salt Outlet Temp (TE-102)
900	25	75	12 1/2	60				
900	25	75	25	60				
900	25	75	25	30				
900	25	75	50	-				
950	50	100	12 1/2	60				
950	50	100	25	60				
950	50	100	50	-				
1000	50	100	12 1/2	60				

	Begin	End
Ambient Air Temp	______	______
Relative Humidity	______	______
Barometric Pressure	______	______
Wind Speed	______	______
Wind Direccion	______	______

5.2.4 Thermal Storage Charging with Propane Heater

Description

- o Charge the hot salt tank using the propane heater.

Objective

- o Familiarize operator with propane heater loop equipment and controls.

Initial System Conditions

- o RS not applicable
- o TSS2 - Hot and cold salt tanks warm and ready for operation with cold tank level greater than 80 inches.
- o SGS not applicable
- o EPGS not applicable

Completed

Procedure

1. Advise data system operator to load system data package. ________
2. Advise data system operator to display the following on the data display screens: ________

LT-281	Cold storage tank level
LT-291	Hot storage tank level
TE-291	Hot storage tank temp

3. Confirm thermal storage technician is completing TSS pretest checklist (TOP #1)

Completed

4. Complete control room pretest checklist (COP #1) Sections I - IV and VI ✓

5. Start up propane heater (TOP #2) ✓

6. Complete the following table for future reference:

ask tech for this temp

Salt Outlet Temp (Ch 142)	Stack Temp. (°F)	FCV-241 Position
over shot — 800		
900		
990	1105	53%
1000		

8. Shut down propane heater (TOP #3) ______

Doc. 1843U

5.2.5 Steam Generator Steady State Operation

Description

- o Operate the steam generator using hot salt from storage, rejecting the steam through HRFS.

Objectives

- o Introduce the operator to SGS start-up and steady state and shutdown operations.

- o Familiarize the operator SGS equipment and controls.

Initial System Conditions

- o RS not applicable
- o TSS2 - Hot and cold salt tanks warm and ready for operation with hot tank level greater than 80 inches and cold tank level greater than 30 inches.
- o SGS2- SGS warm and salt drained (diurnal shutdown).
- o EPGS not available

Procedure	Completed
1. Advise data system operator to load system data package.	________
2. Advise data system operator to display the following on the data display screens:	________

LT-281	Cold storage tank level
LT-291	Hot storage tank level
FT-321	SGS salt flow rate
FT-311	Steam flow rate
TE-382	Superheater salt inlet temp
TE-332	Main steam temp

3. Confirm thermal storage technician is completing TSS pretest checklist (TOP #1).

4. Confirm steam generator technician is completing SGS pretest checklist (SOP #1).

5. Complete control room pretest checklist (COP #1) Sections I - IV, VI, VII and Section VIII if not previously completed. ________

6. Start up SGS and establish approximately 3 KLB/hr steam flow in boiler following mode (SOP #2). ________

7. Increase the steam demand by manually ramping FCV-431 open to simulate turbine loading. Stabilize at each of the steam load conditions listed in the following table and complete the table for future reference.

Nominal Steam Load (KLB/hr)	Actual Steam Flow (FT-311)	FCV-431 Commanded Position (Pct)	Salt Flow (FT-321)	FCV-321 Position (Pct)

Feedwater temp (TE-386) ________

Superheater salt inlet temp (TE-382) ________

8. Shut down SGS (SOP #3)

5.2.6 Operation of Full Electric Loop

Description

- Generate steam using hot salt from storage and supply steam to EPGS to operate turbine and generate electricity.

Objectives

- Introduce the operator to EPGS operations.
- Familiarize the operator with EPGS equipment and controls.

Initial System Conditions

- RS not applicable
- TSS2- Hot and cold salt tanks warm and ready for operation with hot tank level greater than 80 inches and temperature above 900°F.
- SGS2- SGS warm and salt drained (diurnal shutdown).
- EPGS2- EPGS pumps on (turbine standby).

Procedure	Completed
1. Advise data system operator to load system data package.	________

Procedure	Completed
2. Advise data system operator to display the following on the data display screen.	________

LT-281 Cold storage tank level
LT-291 Hot storage tank level
FT-321 SGS salt flow rate
FT-311 Steam flow rate
JT-581 Generator power output
ST-582 Generator RPM

3. Confirm thermal storge technician is completing TSS pretest checklist (TOp #1).

4. Confirm steam generator technician is completing SGS pretest checklist (SOP #1).

5. Confirm EPGS technician is completing EPGS pretest checklist (POP #1).

6. Complete control room pretest checklist (COP #1) Sections I - IV and VI - IX except Section VIII if previously completed. ________

7. Start up SGS (SOP #2)/

8. Start up EPGS and locally synchronize generator to power grid. ________

9. Transfer generator control to remote (control room) panel (POP #2). ________

10. Ramp up generator load to 500 kW. Stabilize and complete the following table.

Generator output (JT-581)	________kW
Date/time	________
Turbine steam pressure (PT-581)	________PSI
Turbine steam temp (TT-583)	________°F
Main steamm flow rate (FT-311)	________KLB/hr
Superheater salt inlet temp (TE-382)	________°F
Salt flow rate (FT-321)	________KLB/hr

11. Shut down EPGS (POP #3).

12. Shut down SGS (SOP #3).

5.2.8 EPGS Steady State Performance

Description

- Operate steam generator and turbine/generator at various steady state loads for performance evaluation.

Objectives

- Determine the following:

  Turbine heat rate
  EPGS/HRFS thermal efficiency
  Turbine/generator efficiency

Initial System Conditions

- SGS steady state operation
- HRFS steady state operation
- EPGS steady state operation

Procedure

1. Review the supplementary material provided at the end of this section.

2. Record the water, steam, and generator operating data on the EPGS performance worksheet (Figure 5.3).
   Note: Space is provided for three steady state operating conditions.

3. Determine the water and steam enthalpy as follows and record on the worksheet.

- Main steam (h_0) and throttle steam (h_1)

  For the steam conditions locate the intersection of the constant pressure and constant temperature lines on the Mollier Chart (Figure 5.4). Read the enthalpy on the vertical scale.

- Constant entropy exhaust steam (h_x)

  Locate the throttle steam conditions on the Mollier Chart and follow a vertical line (constant entropy) from this point downward to its intersection with the exhaust pressure (PT-502) line. Read the enthalpy at this intersection.

- Saturated liquid at exhaust pressure (h_f)

$$h_f \ \frac{\text{BTU}}{\text{lb}} = 83.0 + 8.1\ [(\text{PT-502}) - 3.0]$$

PT-502 in inches of Hg

- Condensate (h_2)

$$h_2 \ \frac{\text{BTU}}{\text{lb}} = (\text{TI-582}) - 32$$

TJ-582 in °F

- Feedwater (h_3)

$$h_3 \ \frac{\text{BTU}}{\text{lb}} = (\text{TI-582}) - 32$$

TE-386 in °F

4. Calculate the fraction of the main steam supplied to the turbine, X, and the steam flow, W_1, as shown on the worksheet.

5. Calculate the performance and efficiency as shown on the worksheet and compare to ratings.

Day______

Case	Time
1	
2	
3	

Main steam fraction to turbine

$$x = \frac{h_3 - h_2}{h_1 - h_2}$$

1.______
2.______
3.______

Heat rate (14200 BTU/kWhr rating)

$$= \frac{W_1\,(h_1 - h_f)}{P}$$

1.______
2.______
3.______

EPGS/HRFS thermal efficiency

$$= \frac{3.413\ P}{(\text{FT-311})(h_1 - h_4)}$$

1.______
2.______
3.______

Turbine/generator efficiency (64% rating)

$$= \frac{3.413\ P}{W_1\,(h_1 - h_s)}$$

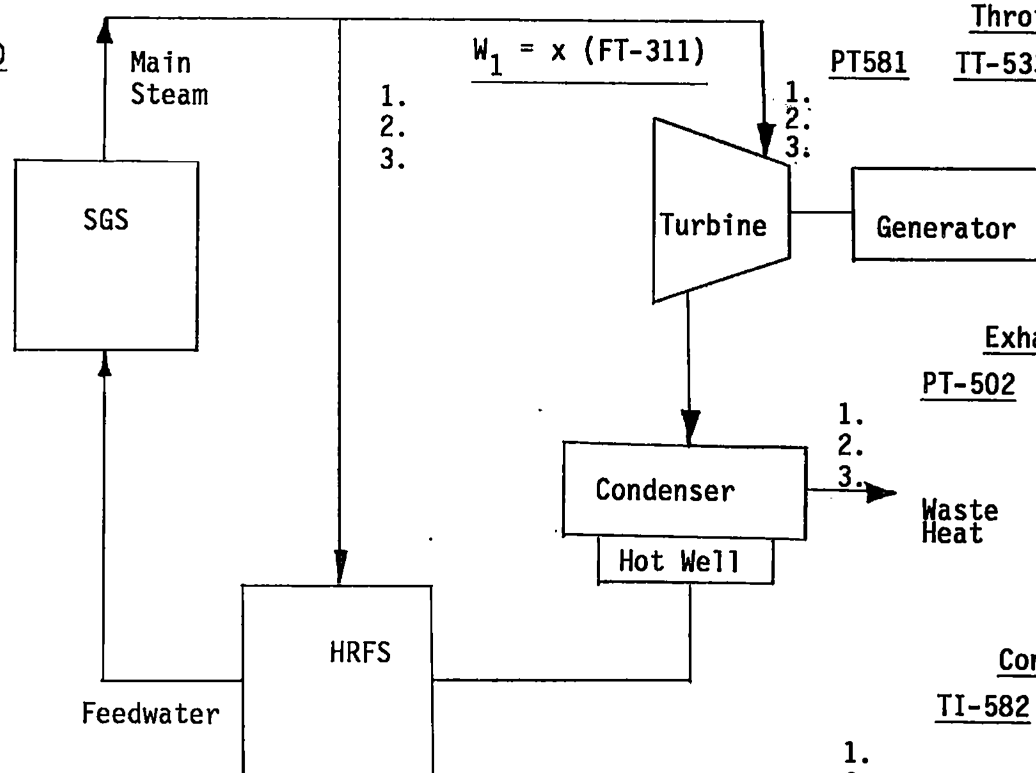
1.______
2.______
3.______

Main Steam

	FT-311	PT-321	TE-332	h_0
1.				
2.				
3.				

Feedwater

	PT-386	TE-386	h_3
1.			
2.			
3.			



Throttle Steam

	PT581	TT-533	h_1
1.			
2.			
3.			

P = JT-581

1.
2.
3.

Exhaust

	PT-502	TE-581	h_f	h_s
1.				
2.				
3.				

Condensate

	TI-582	h_2
1.		
2.		
3.		

Figure 5.3 EPGS Performance Worksheet

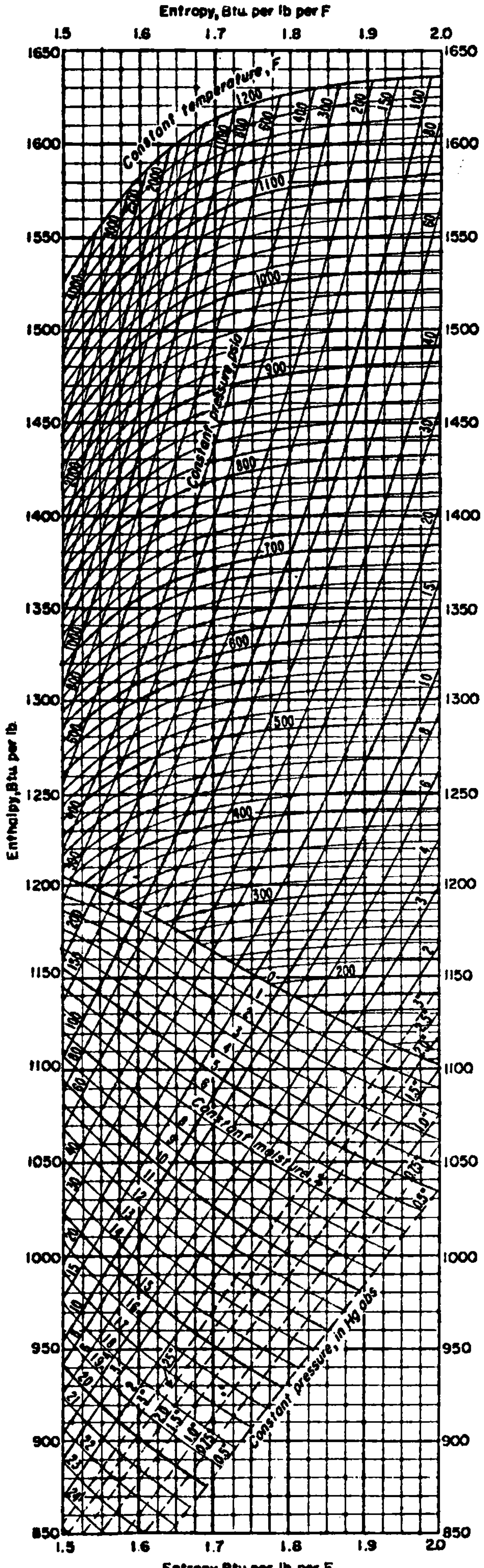


Figure 5.4 Mollier Chart

MEASURING STEAM

What are the yardsticks for steam? First if we have a fixed amount of steam in a closed space, we can measure weight or volume. Usually we measure steam *flow* in lb per hr. **STEAM PROPERTIES.** Certain other measurements identify the *kind* of steam as distinct from the *amount*. These are (1) temperature (2) pressure (3) quality — expressed as percent moisture or percent vapor of wet steam (4) degree of superheat — degrees F above saturation temperature (5) specific volume — cu ft per lb steam (6) enthalpy — Btu per lb (7) entropy and (8) internal energy. The two most commonly measured are temperature and pressure. With these two (plus an estimate of quality in the case of wet steam) the other properties can be read directly from steam tables. **SATURATION PAIRS.** When water is boiling, both the water and steam in contact with the water have the same temperature — called the saturation temperature. For each boiling pressure there is only one saturation temperature and vice versa. If you know one you can find the other in the steam tables. Thus for boiling water and steam in contact, 14.7 psi abs and 212 F, 50 psi abs and 281 F, 100 psi abs and 328 F, etc. are saturation pairs.

ENTHALPY ("HEAT") DEFINED

For reasons too long to explain here the term "heat content" is in bad repute with the steam experts. The quantities formerly known as the "heat" of liquid, "heat" of evaporation and "total heat" of steam are now technically known as the *enthalpy of the* (saturated) *liquid, enthalpy of evaporation, enthalpy of saturated vapor and enthalpy of the superheated vapor.*

The enthalpy of water or steam is the *heat that must be added, Btu per lb, to bring it from liquid at 32 F to its present temperature, pressure and condition.* Enthalpy of evaporation is the enthalpy difference between saturated liquid and dry saturated vapor.

In Table 1, for example, turn to the line for atmospheric pressure, 14.7 psi abs, corresponding to a saturation temperature of 212 F. Enthalpy of the liquid is given as 180.0 Btu. This means that if you hold 1 lb of water at a constant pressure of 14.7 psi abs and heat it from 32 F to 212 F the heat supplied will be 180 Btu.

For low pressures and temperatures, enthalpy of water can be estimated by subtracting 32 from water temperature. (To reduce error at higher pressures, use saturation tables like those on p 91, or complete ones. For maximum accuracy, use compressed-liquid table. For example, take water at 300 F and 1000 psia. Rule of thumb shows 300 − 32 = 268 Btu, saturation table 269.6. Applying correction from compressed-liquid table gives true 271.4 Btu.)

The same line tabulates the enthalpy of evaporation as 970.4 Btu. This means that (at 14.7 psi abs and 212 F) it takes 970.4 Btu to convert one pound of boiling water into dry saturated steam. If the flow of heat is reversed, as when this same steam condenses at atmospheric pressure, 970.4 Btu will flow out as each pound of dry saturated steam at 212 F is reconverted to a pound of liquid at 212 F.

Next add 180.0 and 970.4 to give 1150.4 Btu, the total heat that must be supplied to convert one pound of water at 32 F into dry saturated steam. The table lists this figure as the *enthalpy of the saturated vapor.*

If, now, the steam is taken away from the presence of the boiling water and is then heated in a superheater, its temperature will rise above the saturation temperature, and its enthalpy will increase by the amount of heat supplied per pound. Total enthalpy of superheated steam is given in Table 3.

HELPFUL HINTS

THROTTLING. When steam expands without doing mechanical work, *its enthalpy does not change.* This type of expansion is called throttling, and occurs whenever flowing steam encounters fixed resistances such as orifices, throttling valves, pipe friction or cramped fittings. Examples of how to figure what happens when steam is throttled are shown on the next two pages, along with examples of how to use the following practical hints.

HEATING OR COOLING WATER. Amount of heat supplied or removed to heat or cool one pound of water is simply the change in enthalpy. For all cases within range of everyday operation in low- and medium-pressure steam plants take enthalpy change in the water as equal to the temperature change.

STEAM GENERATION, CONDENSATION. Heat supplied by a steam generator to convert feedwater into steam is merely the enthalpy of the final steam minus the enthalpy of the feedwater.

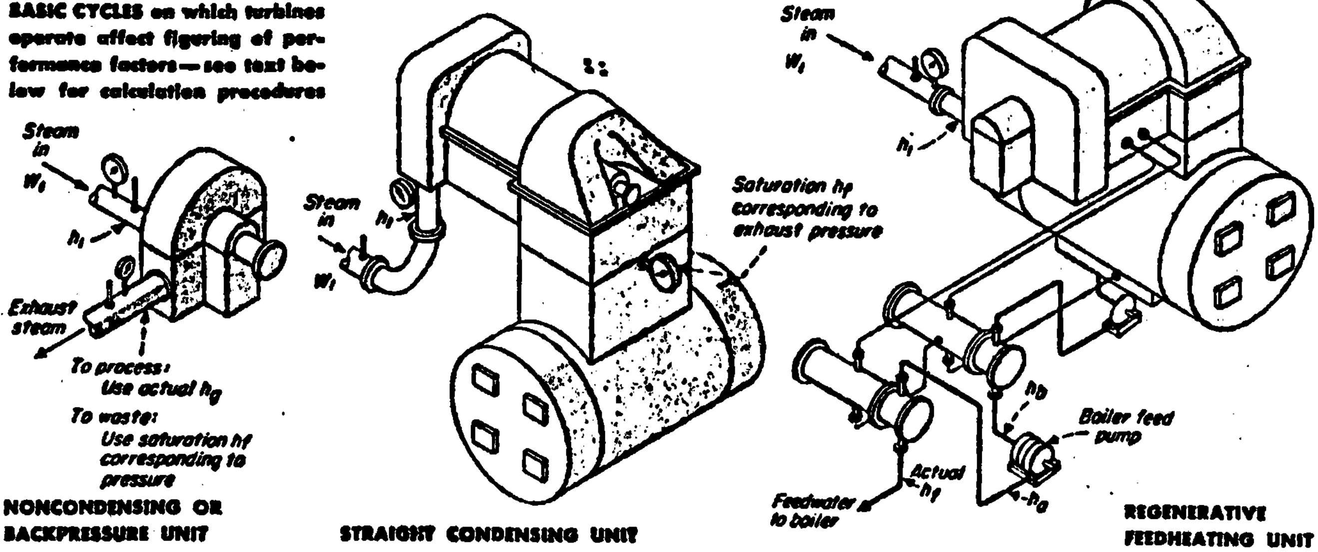
Heat removed from a pound of exhaust steam by a condenser is the enthalpy of the exhaust steam minus the enthalpy of water entering the hot well. Note, however, that the exhaust steam is almost always wet, so its enthalpy cannot be taken directly from the table.

The enthalpy of wet steam is the enthalpy of the liquid *plus* the dryness percent multiplied by the enthalpy of the evaporation. It can also be figured as the enthalpy of the saturated vapor *minus* the percent moisture multiplied by the enthalpy of evaporation.

EFFICIENCY. The thermal efficiency of any device is its output divided by its input. In the case of a steam generator the output is the heat required to convert the feedwater into the delivered steam. The input is the heat in the fuel.

FIGURING TURBINE PERFORMANCE

BASIC CYCLES on which turbines operate affect figuring of performance factors—see text below for calculation procedures



Turbines convert energy in steam to shaft energy. In selecting and operating them, we're always interested in how effectively this is done. Turbine performance is measured in various ways. Here are common ones:

STEAM RATE is amount of steam required by a turbine to produce a given unit output—usually expressed in lb per kwhr. It is of direct practical concern in figuring boiler steam needs and performance changes of individual turbines. It has only limited value for comparing different turbines because it doesn't reflect changes in throttle pressure, as does heat rate.

HEAT RATE is amount of *energy* to produce a given unit output—usually expressed as Btu per kwhr. Because it deals with basic heat units, it is better than steam rate for comparing turbines.

THERMAL EFFICIENCY is ratio of energy output to energy input. It is directly related to heat rate: thermal efficiency =3413/heat rate. See chart.

ENGINE EFFICIENCY is measure of how well an actual turbine compares with an ideal one. Expanding from given throttle to exhaust conditions, a lb of steam does maximum work if expansion is at constant entropy. This ideal condition is never obtained. When actual work done by a lb of expanding steam is divided by ideal expansion work, the resulting ratio is engine efficiency. It serves as a measure of design effectiveness.

FOR ALL TYPES OF TURBINES:

Steam rate, lb per kwhr

$$= \frac{\text{steam flow, lb per hr } (W_1)}{\text{generator or shaft output, kwhr } (P)}$$

FOR BACKPRESSURE TURBINES:

Heat rate, Btu per kwhr

$$= \frac{W_1\ (h_1 - h')}{P}$$

h_1 = steam enthalpy entering turbine, Btu per lb (see diagram)

when steam exhausts to process:

h' = actual exhaust enthalpy, Btu per lb

when steam exhausts to waste:

h' = saturated-water enthalpy at exhaust pressure, Btu per lb (see diagram)

Engine efficiency

$$= \frac{3413\ P}{(W_1 - W_s)\ (h_1 - h_e) + W_s\ (h_1 - h_{es})}$$

W_s = steam leaving turbine system from glands and leaks, lb per hr

h_e = exhaust-steam enthalpy at entropy of initial steam, Btu per lb

h_{es} = leakoff steam enthalpy at entropy of initial steam, Btu per lb

FOR STRAIGHT-CONDENSING TURBINES

Heat rate, Btu per kwhr

$$= \frac{(W_1 - W_s)\ (h_1 - h_f) + W_s\ (h_1 - h_{fs})}{P}$$

h_f = saturated-water enthalpy at exhaust pressure, Btu per lb (see diagram)

h_{fs} = vaporization enthalpy of leakoff steam at discharge press, Btu per lb

Engine efficiency

$$= \frac{3413\ P}{(W_1 - W_s)\ (h_1 - h_e) + W_s\ (h_1 - h_{es})}$$

FOR REGENERATIVE TURBINES:

Heat rate, Btu per kwhr

$$= \frac{W_1\ (h_1 - h_f) + (W_1\ h_d - h_b)}{P}$$

h_f = enthalpy of feedwater leaving last heater, Btu per lb

h_d = enthalpy of feedwater leaving boiler-feed pump, Btu per lb

h_b = enthalpy of feedwater entering boiler-feed pump, Btu per lb (see diagram)

Engine efficiency

$$= \frac{3413\ P}{W_{b1}\ (h_1 - h_{sb1}) + W_{b2}\ (h_1 - h_{sb2}) + \ldots + W_{bn}\ (h_1 - h_{sbn}) + W_e\ (h_1 - h_{se}) + W_s\ (h_1 - h_{es})}$$

W_{b1}, W_{b2}, W_{bn} = bleed steam flows, lb per hr

h_{sb1}, h_{sb2}, h_{sbn} = enthalpies of bleed steam at initial steam entropy, Btu per lb

W_e = exhaust steam flow, lb per hr

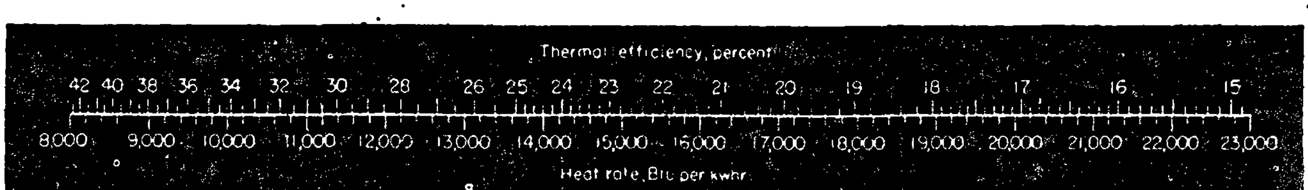
h_{se} = exhaust steam enthalpy at initial steam entropy, Btu per lb

FOR ALL TYPES OF TURBINES:

$$\text{Thermal efficiency} = \frac{3413}{\text{Heat rate, Btu per kwhr}}$$

PERFORMANCE VARIATIONS. Steam rate, heat rate, thermal efficiency and engine efficiency plotted against shaft or generator output in kw show turbine-performance variation with load. Common method for showing performance for automatic-extraction and mixed-pressure turbines plots total hourly steam flow against output for a range of extraction flows.

Turbine performance changes with variations in steam pressure, and temperature, exhaust pressure, makeup-water flow, etc. For methods of figuring corrections for these factors see *Test Code for Steam Turbines*, PTC 6-1949, published by ASME, 29 West 39th St., New York 18, N. Y.



CONVERSION SCALE permits quick transfer from thermal efficiency (percent) to heat rate (Btu per kwhr) for usual range

SECTION 6

MODES OF OPERATION AND TRANSITIONS

The operating modes and transitions for each subsystem are described below:

Receiver Operating Modes

RS1	Receiver cold and drained
RS2	Receiver drained with trace heat on
RS3	Receiver drained with trace heat on and warm-up heliostats
RS4	Receiver cold flow with trace heat on and warm-up heliostats
RS5	Receiver cold flow with trace heat on, no warm-up heliostats and receiver door closed
RS6	Receiver operation, manual with flow control
RS7	Receiver operation, temperature control

Receiver Transitions

o Start-up	RS1 to RS2 -	Turn on trace heaters
	RS2 to RS3 -	Drained and warm to warm-up heliostats
	RS3 to RS4 -	Warm-up heliostats to cold flow through receiver
	RS4 to RS5 -	Cold flow through receiver with receiver door closed
	to RS6 -	To salt flow through receiver with flow control
	to RS7 -	To salt flow through receiver with temperature control
	RS6 to RS7 -	Salt flow with flow control to temperature control
o Shutdown	RS7 to RS6 -	Salt flow with temperature control to flow control
	to RS5 -	Salt flow with temperature control to cold flow with door closed
	to RS2 -	Salt flow with temperature control to drained with trace heat on

RS6 to RS5 - Salt flow with flow control to cold flow with door closed

to RS2 - Salt flow with flow control to drained with trace heat on

RS5 to RS2 - Cold flow with door closed to drained with trace heat on

RS4 to RS2 - Cold flow with warm-up heliostats to drained with trace heat on

RS3 to RS2 - Drained with warm-up heliostats to drained with trace heat

RS2 to RS1 - Turn off trace heaters

Thermal Storage Operating Modes

TSS1	Hot tank drained and cold
TSS2	Hot and cold salt tanks warm and ready for operation
TSS3	Charging with propane heater

Thermal Storage Transitions

- o Start-up
  - TSS1 to TSS2 - Pre-test check lists to pre-conditioning hot salt tank
  - TSS2 to TSS3 - Pre-test check lists to charging hot salt tank
- o Shutdown
  - TSS3 to TSS2 - Charging hot salt tank to shutdown, salt in both tanks
  - TSS2 to TSS1 - Drain hot tank

Steam Generator Subsystem Operating Modes

SGS1	SGS cold and drained
SGS2	SGS warm and salt drained (diurnal shutdown)
SGS3	SGS warm standby (cold salt flow)
SGS4	SGS operating in boiler following mode
SGS5	SGS operating in turbine following mode

Steam Generator Transitions

- o Start-up
  - SGS1 to SGS2 - Pre-test check lists, pre-heat to diurnal shutdown

SGS2 to SGS3 - Diurnal shutdown to cold salt flow
SGS3 to SGS4 - Cold salt flow to boiler following mode
SGS4 to SGS5 - Boiler following to turbine following mode

- o Shutdown SGS5 to SGS4 - Turbine following to boiler following mode
  SGS4 to SGS3 - Boiler following mode to cold salt flow
  SGS3 to SGS2 - Cold salt flow to diurnal shutdown
  SGS2 to SGS1 - Diurnal shutdown to drained and cold

Electic Power Generation Subsystem Operating Modes

EPGS1	Shutdown
EPGS2	(Turbine standby) EPGS pumps on
EPGS3	EPGS standby (operating - offline)
EPGS 4	EPGS on-line (operating - synchronized)

Electric Power Generation Subsystem Transitions

- o Start-up EPGS 1 to EPGS 2 - Pre-test check lists, pre-op and start-up pumps
  EPGS 2 to EPGS 3 - Turbine standby to EPGS standby
  EPGS 3 to EPGS 4 - EPGS standby to on-line

- o Shutdown EPGS 4 to EPGS 3 - On-line to standby
  EPGS 3 to EPGS 2 - EPGS standby to turbine standby
  EPGS 2 to EPGS 1 - Turbine standby to shutdown

Valve alignments for remote-operated valves are given in Table 6.1 for pretest, operating, and post-test modes.

FIGURE 6.1 MSEE REMOTE OPERATED VALVE ALIGNMENT

VALVE	FUNCTION	PRETEST			OPERATION		POST TEST
		BASIC FULL SYSTEM	MODIFICATION TO OPERATE 1. W/O RECVR 2. W/ OR W/O PROPANE HTR	MODIFICATION TO OPERATE 1. RECVR ONLY -OR- 2. PROPANE HTR ONLY	BASIC FULL SYSTEM	MODIFICATION TO OPERATE 1. W/O RECVR -AND- 2. W/PROPANE HTR	
FCV-101	RECVR FLOW CTRL	○ MAN			© CASC SP, SALT SP 1000 °F	○ MAN	○ MAN
FCV-102	RECVR FLOW CTRL	○ MAN			© CASC SP, SALT SP 1000 °F	○ MAN	○ MAN
FCV-151	CST LEVEL CTRL	● MAN	●L MAN	●L MAN (W/ HTR)	© CASC LT-151 SP 87"	●L MAN	○ MAN
FCV-161	HST LEVEL CTRL	● AUTO SP 75"	●L MAN	●L MAN (W/ HTR)	© AUTO SP 20"	●L MAN	○ MAN
FCV-162	HST LEVEL CTRL	● AUTO SP 20"	○ MAN	○ MAN (W/ HTR)	● AUTO SP 20"	○ MAN	○ MAN
FCV-180-189	RECVR DRAIN	○			●		●
FCV-190-198	RECVR PURGE	○			●		●
FCV-199	RECVR DRAIN & FILL	○			●		○
FCV-201	COLD SUMP LEVEL CTRL	● AUTO SP 23"			© AUTO SP 23"		● MAN
FCV-211	COLD SUMP ISOLATE	●L			○		●L
FCV-221	HOT SUMP LEVEL CTRL	● AUTO SP 20"			© AUTO SP 20"		● MAN
FCV-231	HOT SUMP ISOLATE	●L			○		●L
FCV-241	PROPANE HTR FLOW CTRL	●L			●L	◒ x% MAN	●
FCV-242	PROPANE HTR ISOLATE	●L	● (W/HTR)	● (W/HTR)	●L	○	●
FCV-301	EVAP SALT TEMP CTRL	● MAN ON		●L MAN ON	© MAN OFF N90 CASC		● MAN ON
FCV-321	SGS SALT FLOW CTRL	○ MAN ON			© MAN OFF N90 CASC		○ MAN ON
FCV-331	STEAM TEMP CTRL	◒ 10% MAN ON			© MAN OFF N90 CASC		◒ 10% MAN ON
FCV-341	SGS COLD SALT FILL CTRL	● MAN ON		●L MAN ON	● MAN ON		● MAN ON
FCV-351	SGS HOT SALT FILL CTRL	● MAN ON			○ MAN ON		● MAN ON
FCV-381	EVAP SALT DRAIN	○ MAN ON			● MAN ON		● MAN ON
FCV-382	SUPHTR SALT DRAIN						
FCV-383	START-UP HTR BYPASS	● MAN ON			○ MAN ON		● MAN ON
FCV-384	START-UP HTR ISOLATE	○ MAN ON			● MAN ON		○ MAN ON
FCV-401	FWP PRESSURE CTRL	● AUTO SP 1250			© AUTO SP 1250		● AUTO SP 1250
FCV-411	FEEDWTR FLOW CTRL	● MAN ON			© MAN OFF N90 CASC		● MAN ON
FCV-421	FWH TEMP CTRL	○ AUTO SP 520°F			© AUTO SP 520°F		○ AUTO SP 520°F
FCV-431	DA OR STEAM PRESS CTRL	● CASC PT-431 SP 1080			© CASC PT-432 SP 233		● CASC PT-431 SP 1080
FCV-432	DA PRESSURE CTRL	○ AUTO SP 233			© AUTO SP 240		○ AUTO SP 233
FCV-471	DA LEVEL CTRL	● AUTO SP 0"			© AUTO SP 15"		● AUTO SP 0"
FCV-483	DA VENT NO. 1	○ LOCAL			○ LOCAL		● LOCAL
FCV-484	DA VENT NO. 2	● LOCAL			● LOCAL		● LOCAL
FCV-485	DEMIN WATER TANK FILL	● LOCAL			● LOCAL		● LOCAL
FCV-491	START-UP STEAM CTRL	● AUTO SP 1000			○ AUTO SP 1000		● AUTO SP 1000
FCV-501	TURBINE STOP	●			○		●
FCV-511	HOT WELL OVERFLOW	● EN. HLC OFF			© EN. HLC ON		● EN. HLC OFF
FCV-512	HOTWELL MAKE-UP	● (LOCAL CNTRL)			© (AUTO CNTRL)		● (LOCAL CNTRL)
FCV-521	OIL COOLANT FLOW CTRL	● AUTO SP 120°F			© AUTO SP 120°F		● MAN
FCV-541	CNST MAKE-UP	● LOCAL CNTRL			LOCAL CNTRL		● LOCAL CNTRL
FCV-551	CONDENSATE RECIRC	●			●		●
FCV-561	TURBINE TRIP	● ET OFF			● ET OFF		● ET OFF
TVM	TURBINE THROTTLE	●			©		●

● L — ● CLOSED, L LOCKED; ○ OPEN; © CONTROLLING

7.1 CONSOLE OPERATING PROCEDURES

	TEST DATE
COP #1 CONTROL ROOM PRETEST CHECKLIST	9/18/84

This Console operating procedure will be utilized to verify process control integrity prior to all tests. It is unnecessary to verify control integrity of subsystems not used (not applicable). This checklist shall be completed by the control room process console operator.

I. Test Description ______________________

Start Time

II. Responsible operating personnel

	Primary	Backup
Test Conductor (MDAC)	Stan Saloff	
Heliostat Operator	Arleen Vance	
Console Operator	Evans/Nelson	
Operation/Safety Engineer	John Holmes	
Subsystem Technicians		
RS	Jerome Griego	
TSS	Matt Matthews	
SGS	Matt Matthews	
HRFS	Jay Holton	
EPGS	Jay Holton	

III. Safety Checklist — O/S

Complete this checklist for all operations.

1. Site occupants

   A. Verify that all test personnel have been briefed on the scheduled test description, objectives, individual responsibilities, and expected response to emergencies ______

   B. Communications established to all manned control points ______

   C. Safety equipment in place:

      1. OSHA protective gloves ______

      2. Fire retardant coveralls ______

      3. Hard hats/Face shields ______

      4. Approved fire extinguishers ______

2. Solar only

   A. "Test In Progress" lights on in the tower ______

   B. Non-Test personnel informed and in secure location ______

   C. Diesel-Generator on and frequency OK ______

   D. Field monitor on call after solar start-up ______

   E. Communications established ______

   F. Tower top barricade up ______

   G. Gates closed and posted with red lights or signs ______

   H. Field clear and ready for start-up ______

3. Control Room locked ______

4. Beam up command shall be given only after above checklist is completed by O/S Engineer ______

STEP	DESCRIPTION	VERIFICATION

Notice

Four items that impact system start-up significantly and should be verified and/or corrected first are:

a. Emcon operation
b. Acurex temperatures
c. D/D level and temp. D/D = Deaerator Drum
d. Steam drum level and temp.

IV. MASTER CONTROL SUBSYSTEM

A. EMCON D/2 HOST START UP CHECKLIST
Complete this checklist for all operations.

1. Equipment powered up:

   a) Host cabinet
   b) Operator Console 1
   c) Operator Console 2
   d) (2) LA-120 Terminals
   e) VT-100 Terminal
   f) Tri-log printer ____✓____

2. Disk Packs (2) installed in drives, disk drives running with "READY" lamp lit. ____✓____

3. EMCON system booted and "START-UP" command file executed:

   a) Correct date and time
   b) Disk unit DLI mounted
   c) CCM, PCMs loaded (optional)
   d) EMCON host programs running

      1. SPNCOL 5. CONSL2
      2. POWER 6. CONSL1
      3. ALRMMX 7. SYSMON
      4. ALARMS 8. TRACKR ____✓____

4. MSSND program executing when data logging display is required on the Auxiliary Data Logging/Display System. ____✓____

5. Unlock Console to allow activation of operational alarms and Receiver Control Algorithm. ________

6. Enable general alarms by turning GAL on. ________

STEP	DESCRIPTION	VERIFICATION

B. ACUREX START-UP CHECKLIST
Complete this checklist for all operations using salt.

1. Equipment powered up:

   a) Host chassis - Autodate Ten/50
   b) Electrohome monitor
   c) GT-100 Terminal
   d) Texas Instruments 820 RO Terminal ______

2. Tape Cassette loaded in host drive. ______

3. Recent (within 60 minutes) logout of temperatures available on TI printer. ______ Last Print Time

4. Set scan rate to every 60 minutes. ______

C. AUXILIARY DATA LOGGING/DISPLAY SYSTEM
Data acquisition checklist completion optional as required.

1. Equipment powered up:

   a) H-P 1000 Cabinet
   b) H-P 2645 Terminal
   c) H-P 2621 Terminal
   d) Tektronix 4014 Terminal
   e) Tektronix 463 hard-copy unit
   f) (6) Display CRTs
   g) Versatec Video Copier
   h) Versatec Printer
   i) H-P 7925 Disc Drive ______

2. Disk pack installed in drive, disc drive running with "READY" lamp lit. ______

3. System booted:

   a) Correct date and time
   b) Transfer file IMSRP executed ______

4. MSPAS program executing when data logging/display is required and MSSN2 has been started on the EMCON host. ______

5. Following support programs available for execut:

   a) MSRTP
   b) MSPSU
   c) MSDSD
   d) MSSL1 through MSSL6
   e) MSCDT ______

6. Label file used:__________ ______

7. Data file used:__________ ______

STEP	DESCRIPTION	VERIFICATION

D. NETWORK 90 SETUP CHECKLIST
Complete this checklist for operation with SGS.

1. Verify equipment powered up and operational.

   a) Bailey PCU
   b) Operator Interface Drive Unit
   *c) Keyboard Console
   *d) Printer

*These components may be turned off when not in use. ________

V. RS - RECEIVER SUBSYSTEM
Complete this checklist for operation with Receiver.

1. Verify acceptable limits on winds (less than 30 MPH), solar insolation (above 600 W/m^2) and cloud condition (partly cloudy or clear). ✓

2. Verify TV cameras are on and operational. ✓

3. Verify the Control Room SCRAM and EPS power supplies behind Weather Monitor Panel are On and set at 24VDC. ✓

02 4. Open the Receiver cavity door upon the request of the RS technician for the RS pretest check. Reclose or leave open as required. (DR.OPN/CLS). *

07 5. Verify Emcon RS header temperatures are above 480°F. (TE-188 inoperable). ✓ ✓

6. Verify the Acurex RS trace heaters are operating and the temperatures are above 480°F (Table A). NOTE EXCEPTIONS. If required, heat tracing control can be taken over locally at the module control room. ______ 10:35 Time

7. Align/verify the following valve alignment; confirm valve temps are acceptable before moving. (to avoid bellows damage) Coordinate with Receiver technician. RCK 'ON' may be used to auto align these, turning itself off when complete. ✓

	Valve	Description	Position		
	FCV-101	Salt flow control	Man/Open/N ✓		
01	FCV-102	Salt flow control	Man/Open/N		
	FCV-180-189	Drain valves	On/Open/N	(ZSH180-189 On)	08
	FCV-190-198	Purge valves	On/Open/N	(ZSH190-198 On)	09
04	CSP.EN	Enable CSP control	On ✓		
	BP.EN	Enable BP control	ON		

STEP	DESCRIPTION	VERIFICATION

VI. TSS - THERMAL STORAGE SUBSYSTEM

Complete this checklist for all operations using salt.

1. Verify that the Acurex TSS trace heaters are operating and the temperatures are above 480°F (Table B). NOTE EXCEPTIONS. If req'd heat tracing control can be controlled locally at salt storage control building. ✓ 11:00 Time

2. If operating Propane Heater without SGS, verify that these Acurex SGS inlet trace heaters are above 480°F (Ref. Table C): ____

Channel	Channel	Local Temp. Verific.
~~204~~	~~255~~	~~FCV-241~~
205	256	Hot Tank inlet line
206	257	
	258	

3. Verify salt levels in storage tanks and sumps are commensurate with test requirements ✓

— LT-201 Cold Sump 47.3 in. (60" max)**@ ~~631.2~~ 639.4 °F (Acurex Chan 124,125)

LT-281 Cold Tank 5[illegible].3 in. (40" min)* @ ~~542.2~~ 562.9 °F (Acurex Chan 110-112)

03 LT-221 Hot Sump 41.6 in. (45" max)**@ ~~7[illegible].6~~ 722.6 °F (Acurex Chan 126,127)

— LT-291 Hot Tank 95.6 in. @ ~~[illegible]~~ 662.6 °F (Acurex Chan 134-136)

*Minimum level req'd to maintain cold sump level during fill operations.
**Maximum levels require vent checks; advise technician.

4. Align/verify the following valves for operation with RS, with SGS, & without Propane Heater. Confirm valve temps are accept. before moving. Coordinate with thermal storage technician. TCK 'ON" may be used to auto align these, turning itself off when complete. ✓

	Valve	Description	Position	
—	*FCV-151	CST Level Control	Man/Closed/N ✓	
02	FCV-161	HST Level Control(Hot)	Man/Closed/N ✓	
	FCV-162	HST Level Control(Cold)	Man/Closed/N ✓	
	FCV-199	Bypass valve	Off/Open /N ✓	(ZSH199 on)
—	FCV-201	Cold Sump Level Control	Auto/Closed/N SP 23" ✓	
04	FCV-211	Cold Sump Isol. (OPN/CLS.211)	Closed/Locked ✓	(ZSL211 on)
	FCV-221	Hot Sump Level Control	Auto/Closed/N SP 20" ✓	
	FCV-231	Hot Sump Isol. (OPN/CLS.231)	Closed/Locked ✓	(ZSL231 on)
—	FCV-241	Propane Heater Inlet	Man/Closed/Locked ✓	
05	FCV-242	Propane Heater Isolation	Off/Closed/Locked ✓	(ZSL242 on)
—	FCV-301	Bypass Salt Flow	Closed/N ✓	(MAN on, SP Auto 0%
13	FCV-341	Cold Salt Isol.	Closed/N ✓	(MAN on, SP Auto 0%
	FCV-351	Hot Salt Isol.	Closed/N ✓	(MAN on, SP Auto 0%
04	CSP.EN	Enable CSP Control	On ✓	

*Bad signal (blue) can indicate EPS closure. Clear trips and reset EPS1 & EPS3 to regain control.

STEP	DESCRIPTION	VERIFICATION

5. For operation with Propane Heater instead of Receiver OR for SGS alone, Modify the valve alignment of step 4 as follows: ________

	Valve	Position
—	FCV-151	Locked
02	FCV-161	Locked
	FCV-162	Man/Open/N
05	FCV-242	Nuetral

6. For operation without SGS, Modify the valve alignment of step 4 as follows: ________

	Valve	Position
13	FCV-301	Locked
	FCV-341	Locked

04 7. Verify pump bearing temp's are less than 190°F (TE 180, 286, & 387 on EMCON) and alarms on. ________

VII. SGS - STEAM GENERATION SUBSYSTEM

Complete this checklist for operation with SGS.

1. Verify that the Acurex SGS trace heaters are operating and the temperatures are above 480°F (Table C). NOTE EXCEPTIONS. If required, heat tracing control can be taken over locally at the salt storage control building Acurex cabinet back. ________ ________ Time

2. Align/verify the following valve positions. Confirm valve temps are accept. before moving. Coordinate with thermal storage technician. All SGS control valve MAN signals should be On. (Emcon commands not applicable from Net 90) SCK 'ON' may be used to auto align these, turning itself off when complete. ________

	Emcon Command	Valve Description	Position
—	MAN.321 On/ SP-321 Auto 100%	Main Salt Flow	Open
	MAN.331 On/ SP-331 Auto 10%	Steam Attemp.	10% Open
13	MAN.38182 On/FCV-38182 On	Salt Drain	Open
	*MAN.384 On/ FCV-384 On	Circ Htr Supply	Open
	*MAN.383 On/ FCV-383 Off	Circ Htr Bypass	Closed
04	HSP.EN	Enable HSP Control	On

*Open FCV-384 before closing FCV-383 to avoid SGS Pump and Heater Shut-off

STEP	DESCRIPTION	VERIFICATION

Complete the following steps after completing HRFS startup. (Presuming SGS is in Diurnal Shutdown).

3. If SGS F.W. inlet pipe temp. (Acurex Channel 132) is below 200°F, increase bridge pipe feedwater temperature:

   a) Verify D/D TE-451 is above 250°F ________

   b) Advise the SGS technician to open the bridge feedwater drain HV-370, then open FCV-411 to 20% (Emcon MAN.411 on/SP Auto 20%) ________

   c) Verify Acurex channel 132 increases above 200°F (Approx 5 min after opening FCV-411) ________

   d. Reclose HV-370 and FCV-411 ________

4. Verify drum level LT-311 is at 0.0 inches. If drum level is below 0.0 inches; open HV-488, then open FCV-411 to 20% and fill to 0.0". Close FCV-411 and HV-488 to avoid FW leakage into drum. ________

5. Verify that the boiler water circulation pump (BWCP) <u>is</u> running (ZSHBCP). If it is <u>not</u> running:

   a) Review overnight data to determine reason and correct.

   b) Start BWCP

   c) Start circulation heater (pulse EHAC.ON) ________

6. If freezing ambient temperatures have been experienced, resolve any suspicious instr. transmitter readings with the SGS technician. Be skeptical of all readings until proven. ________

COP #1 CONTROL ROOM PRETEST CHECKLIST

STEP	DESCRIPTION	VERIFICATION

VIII. HRFS - HEAT REJECTION AND FEEDWATER SUBSYSTEM
Complete this checklist for all water system operations.

1. Set/Verify the following control devices in the listed positions: HCK 'ON' may be used to auto align these, turning itself off when complete. ____________

	Identifier	Description	Command	Position
call up	GSTAT	D/D Press Enable	Off	N/A
	EN.DTC451	D/D Heater 1 Enable	Off	N/A
	EN.DTC452	D/D Heater 2 Enable	Off	N/A
	DTC-451	D/D Heater 1	Auto SP 390 or 400°F	Not Enabled
	DTC-452	D/D Heater 2	Auto SP 390 or 400°F	Not Enabled
	FCV-401	FWP Press Recirc	Auto SP 1250 psi	Closed
	FCV-411	Feedwater Delivery	MAN.411 On/SP-411 AUTO 0%	Closed
	FCV-421	FWH Steam Supply	Man	Closed
18	FCV-431	D/D Steam Inlet	Auto/Casc to PT-431	Closed
	PT-431	Steam Line Press	Auto SP 1080 psi	N/A
	PT-432	D/D Press	Auto SP 233 psi	N/A
	FCV-432	SWHX Divert	Auto SP 240 psi	Open to Bypass
	FCV-471	T-G Condensate Return	Auto SP 0%	Closed
	FY-472	CMUP Stroke Positioner	Auto SP 0%	Closed
	FCV-491	SGS Steam Delivery	Auto SP 900 psi	Closed
	*FCV-501	Main Steam Stop	Off/ZSL-501 On	Closed
	*TVM	Turbine Steam	TVM.OPN Off/ZT-581 0% Open	Closed
19/20	FWP.EN/SWP.EN/CWP.EN/CMP.EN/CFP.EN/CF1.EN thru CF6.EN			On

*Note EMCON control for these valves is disabled if TCPMS is in local (off).

IX. EPGS ELECTRIC POWER GENERATION SUBSYSTEM

19 20 21 1. PP.EN SIGNALS ON-CTP.EN,CTF.EN,EOP:.EN,AEP.EN, CWP.EN,FCV-521 Auto SP 120, FCV-501 off, EN. HLC off, VIB.OVR on. PCK may be used to auto align these, turning itself off when complete. ____________

1.1 Verify RGP Gen Breaker green (open) light is on. ____________

21 2. Confirm correct selection of EPGS operating mode, Remote (TCPMS On) or Local (TCPMS Off). ____________

3. Verify Generator operator has procured the Sync switch handle from the MSEE key box. ____________

4. Disable auto hotwell level control by turning EN.HLC off. ____________

5. Override EPS vibration trips by turning VIB.OVR on. ____________

26 6. Momentarily enable EPS3.RST and EPS2.RST. ____________

21 7. Verify FCV-521 Oil Cooler C.W. is in Auto with a SP of 120°F Closed. (Emcon control disabled if TCPMS is in local (off)). ____________

T/C	DESCRIPTION	ACUREX CHANNEL	T/C	DESCRIPTION	ACUREX CHANNEL
TEH-190	Purge Valve #1	000	TEH-157	Receiver Outlet-Heater R	027
TEH-191	Purge Valve #2	001	TEH-158	Receiver Outlet-Heater R	028
TEH-192	Purge Valve #3	002	TEH-153	Hot Surge Tank Inlet-Heater N	029
TEH-193	Purge Valve #4	003	TEH-159	Hot Surge Tank Outlet-Heater N	030
TEH-194	Purge Valve #5	004	TEH-152	Cold Surge Tank Inlet-Heater O	031
TEH-195	Purge Valve #6	005	TEH-156	Cold Surge Tank-Heater O	032
TEH-196	Purge Valve #7	006	TEH-150	Receiver Inlet-Heater P	033
TEH-197	Purge Valve #8	007	TEH-151	Receiver Inlet-Heater P	034
TEH-198	Purge Valve #9	008	TEH-162	FCV-101-Heater Q	035
TEH-180	Drain Valve #1	009	TEH-163	FCV-102-Heater Q	036
TEH-181	Drain Valve #2	010	TEH-154	Drain Line-Heater T	037
TEH-182	Drain Valve #3	011	TEH-155	Drain Line-Heater T	038
TEH-183	Drain Valve #4	012	TEH-166	Hot Surge-Heater U	039
TEH-184	Drain Valve #5	013	TEH-167	Hot Surge-Heater U	040
TEH-185	Drain Valve #6	014	TEH-164	Cold Surge-Heaster V	041
TEH-186	Drain Valve #7	015 (Bad)	TEH-165	Cold Surge-Heater V	042
TEH-187	Drain Valve #8	016	TEH-131	Riser-Heater H	300
TEH-188	Drain Valve #9	017	TEH-133	Riser-Heater I	301
TEH-189	Drain Valve #10	018	TEH-134	Riser-Heater I	302
TEH-160	Purge Line-Heater S	019	TEH-135	Riser-Heater J	303
TEH-161	Purge Line-Heater S	020	TEH-136	Riser-Heater J	304
TEH-176	Drain Line	021	TEH-130	Downcomer-Heater K	305
TEH-177	Drain Line	022	TEH-132	Downcomer-Heater L	306
TEH-172	Outlet of Pass #1 (Header)	023	TEH-137	Downcomer-Heater M	307
TEH-173	Pass #10	024	TEH-138	Downcomer-Heater M	308
TEH-174	Pass #11	025	TEH-139	Downcomer-Heater L	(Skip) 309
TEH-175	Pass #18	026			

TABLE A RS HEAT TRACE INSTRUMENTATION

7-11

TSS Heat Trace Instrumentation

T/C	DESCRIPTION	ACUREX CHANNEL	T/C	DESCRIPTION	ACUREX CHANNEL
TEH-218	Hot Tank Outlet	(B)100	TEH-207	Boost Pump Outlet - Heater A	122 450.4
TEH-216	FCV-211, Line X	(B)101	TEH-208	Boost Pump Outlet - Heater A	123
TEH-219	Hot Sump Outlet	(B)102	TEH-227	Cold Sump	*124
TEH-222	Hot Sump	(B)103	TEH-228	Cold Sump	*125
TEH-225	Cold Sump Outlet	104	TEH-220	Hot Sump	(B)*126
TEH-230	Cold Tank Inlet	105	TEH-221	Hot Sump	(B)*127
TEH-201	Boost Sump Drain - Heater D	106 (Low)	TEH-211	Riser - Storage End - Heater H	128
TEH-202	Cold Pump Outlet - Heater C	107 (Low)	TEH-241	FCV-151, Heater H	(A)129
TEH-265	Cold Sump Outlet	108	TEH-212	Downcomer - Storage - Heater K	130
TEH-229	Cold Sump Inlet	109	TEH-240	FCV-161, Heaters A-Y, K	131
TEH-233	Cold Tank #1, CT-1 thru 7	*110	TEH-213	Hot Tank #1	*134
TEH-234	Cold Tank #2, CT--1 thru 7	*111	TEH-214	Hot Tank #2	*135
TEH-235	Cold Tank #3, CT-1 thru 7	*112	TEH-215	Hot Tank #3	*136
TEH-231	FCV-201	113	TEH-217	Cold/Hot Tank Bypass-Heater AA	(A,B)137
TEH-232	Cold Tank Outlet	114	TEH-223	Propane Heater	(A)138 472
TEH-205	Boost Suump - Heater W	115 (SKIP)	TEH-224	Propane Heater	(A)139 479.0
TEH-206	Boost Sump - Herater W	116	TEH-236	Cold/Hot Tank Bypass, Heater AA	(A,B)140 good enough
TEH-203	Boost Pump Bypass - Heater E	117	TEH-238	FCV-242	141 432
TEH-204	Boost Pump Outlet - Heater B	118 (Low)	TEH-239	Propane Heater Outlet	(A)142
TEH-209	Cold Tank Inlet - Heater F	(B)119			
TEH-210	Cold Tank Bypass - Heater G	120			
TEH-237	FCV-162, Heater F	(B)121			

* Record for TSS Step 2, stored salt temp's

(A) Normally not operating during system operation

(B) Not required for Propane Heater operation

Table B TSS Heat Trace Instrumentation

T/C	DESCRIPTION	ACUREX CHANNEL	
TEH-305, 306	Hot Salt Inlet Lines	200, 201	
TEH-307, 308	Salt Piping Between SH and EV	202, 203	
TEH-309 thru 311	Cold Salt Inlet Lines	204 thru 206	
TEH-312 thru 314	EV Salt Outlet	207 thru 209	
TEH-315 thru 317	Salt Drain Lines	210 thru 212	
TEH-318, 319	SH and EV Outlet Overpressure	**213, 214	
TEH-320, 321	Superheater	215, 216	
TEH-322. 323	Evaporator	217, 218	
6005 thru 6009	Misc. Salt Lines (info.)	230 thru 234	233 (Skip) 234 (O.R.)
6011 thru 6016	Superheater (info.)	##236 thru 241	
----	FCV-351 Body, Bonnet	242,/243	
6020 thru 6025	Evaporator (info.)	##245 thru 250	
6026 thru 6029	Hot Salt Inlet (info.)	251 thru 254	
6030, 6031	FCV-341 Body, Bonnet	255,/256	
6032, 6033	FCV-301 Body, Bonnet	257, 258	
6034, 6035	FCV-321 Body, Bonnet	259, 260	
6036, 6037	FCV-381 Body, Bonnet	261, 262	
6038, 6039	FCV-382 Body, Bonnet	263, 264	
6040 thru 6042	Salt Drain Lines (info.)	##265 thru 267	
6043	SH Drain (info.)	**268	
6044 thru 6053	Misc. Lines (info.)	269 thru 278	275 (Skip) 277 (O.R.)

**These will normally be below salt freezing temperature (no problem).

##These may be below 480°F - But they should be above 400°F prior to salt flow.

TABLE C SGS HEAT TRACE INSTRUMENTATION

TABLE D GROUP ALARM LIST

GAL GENERAL ALARMS

LT-201	TE-180	TE-383	TE-508	LS-541	LV-28
LT-221	TE-181	387	-509	PS-281	LV-481
LT-281	TE-184	388	-581	PS-485	LV-N91
LT-291	TE-211	TE-481		TS-501	N90-AL
LT-311	TE-231	484		TS-502	
LT-471	TE-281	486			
LT-511	TE-286				

RAL RECEIVER OPERATIONAL ALARMS

FT-101	LT-151	TE-101	PT-181
	LT-161	TE-102	PT-182
		TE-161	
		RS TE's	

SAL STEAM GENERATOR OPERATIONAL ALARMS

TE-301	TE-384	PT-321	PT-431
TE-331	386	382	432
332	421	383	483
TE-382	483	384	
		386	

PAL ELECT. POWER OPERATIONAL ALARMS

ET-581	TT-501	TE-505	TT-521	PT-501	PT-531
ST-581	TT-502	TE-506	TT-583	502	581
ZSH-AEP	TE-503	TT-507			583

TABLE E MSEE REMOTE OPERATED VALVE ALIGNMENT

VALVE	FUNCTION	PRETEST: BASIC FULL SYSTEM	PRETEST: MODIFICATION TO OPERATE 1. W/O RECVR 2. W/ OR W/O PROPANE HTR	PRETEST: MODIFICATION TO OPERATE 1. RECVR ONLY -OR- 2. PROPANE HTR ONLY	OPERATION: BASIC FULL SYSTEM	OPERATION: MODIFICATION TO OPERATE 1. W/O RECVR -AND- 2. W/PROPANE HTR	POST TEST
FCV-101	RECVR FLOW CTRL	○ MAN			© CASC SP SALT SP 1000°F	○ MAN	○ MAN
FCV-102	RECVR FLOW CTRL	○ MAN			© CASC SP SALT SP 1000°F	○ MAN	○ MAN
FCV-151	CST LEVEL CTRL	● MAN	● L MAN	● L MAN (W/ HTR)	© CASC LT-151 SP 87″	● L MAN	○ MAN
FCV-161	HST LEVEL CTRL	● MAN ~~[illegible]~~	● L MAN	● L MAN (W/ HTR)	© AUTO SP 20″	● L MAN	○ MAN
FCV-162	HST LEVEL CTRL	● ~~[illegible]~~ MAN	○ MAN	○ MAN (W/ HTR)	● AUTO SP 20″	○ MAN	○ MAN
FCV-180-189	RECVR DRAIN	○			●		●
FCV-190-198	RECVR PURGE	○			●		●
FCV-501	TURBINE STOP	●			○		●
FCV-511	HOT WELL OVERFLOW	● EN,HLC OFF			© EN,HLC ON		● ~~[illegible]~~
FCV-512	HOTWELL MAKE-UP	● (LOCAL CNTRL)			© (AUTO CNTRL)		● (LOCAL CNTRL)
FCV-521	OIL COOLANT FLOW CTRL	● AUTO SP 120°F			© AUTO SP 120°F		● MAN
FCV-541	CNST MAKE-UP	● LOCAL CNTRL			LOCAL CNTRL		● LOCAL CNTRL
FCV-551	CONDENSATE RECIRC	●			●		●
FCV-561	TURBINE TRIP	● ET OFF			● ET OFF		● ET OFF
TVM	TURBINE THROTTLE	●			©		●

● L — LOCKED; ● — CLOSED; ○ — OPEN; © — CONTROLLING

Test Date
9/22/84

COP #2 CONTROL ROOM POST-TEST CHECKLIST

This Console operating procedure will be utilized to secure the process controls following all tests. This checklist shall be completed by the Control Room process console operator.

STEP	DESCRIPTION	VERIFICATION

I. HELIOSTAT SUBSYSTEM

1. Verify system returned to a safe condition; (Helioststs, salt, steam, water) __________

II. RS RECEIVER SUBSYSTEM

1. Verify the following valve alignment: __________

___	FCV-101	Man/Open		
01	FCV-102	Man/Open		
	FCV-180 thru 189	Off/Closed	(ZSL's on)	08
___	FCV-190 thru 198	Off/Closed	(ZSL's on)	09

02 2. Verify the receiver cavity door is fully closed (ZSLDR on). __________

3. Verify RS secured from technician - post test checklist completed (ROP #4). __________

III. TSS THERMAL STORAGE SUBSYSTEM

1. Verify the following valve alignment in MAN:

___	FCV-151 Open	04	FCV-211 Closed/Locked
02	FCV-161 Open	04	FCV-221 Closed
	FCV-162 Open	04	FCV-231 Closed/Locked
	FCV-199 Open	05	FCV-241 Closed
04	FCV-201 Closed	05	FCV-242 Closed
___	CSP.EN Off, BP.EN Off, HSP.EN Off		

____

2. Record the following salt levels & temp's:

___	LT-201 Cold sump ________	in.	@ ________ °F	(Acurex Chan 124,125)
	LT-281 Cold tank ________	in.	@ ________ °F	(Acurex Chan 110-112)
03	LT-221 Hot sump ________	in.	@ ________ °F	(Acurex Chan 126,127)
___	LT-291 Hot tank ________	in.	@ ________ °F	(Acurex Chan 134-136)

3. Verify TSS secured from technician - post test checklist completed (TOP #4). __________

STEP	DESCRIPTION			VERIFICATION
	IV. SGS STEAM GENERATION SUBSYSTEM			
	1. Verify the following valve alignment:			______
13	*FCV-301	Closed	MAN.384 On	
	*FCV-321	Open	FCV.384 On (open)	
	*FCV-331	10% Open	MAN.38182 On	
	*FCV-341	Closed	FCV.38182 Off (closed)	
	*FCV-351	Closed		
	*Emcon commands - MAN signals on with SP in Auto to the positions noted.			
	2. Verify SGS secured from technician - post test checklist completed (SOP #4).			______
	V. HRFS HEAT REJECTION AND FEEDWATER SUBSYSTEM			
	1. Verify the following device alignment:			
	EN.DTC451	--	Off	
	EN.DTC452	--	Off	
	GSTAT	--	Off	
	FCV-431	Closed	Casc	
18	FCV-432	Open	Auto SP 233 or 240 psi	
	FCV-471	Closed	Auto SP 0%	
	FY-472	Closed	Auto SP 0%	
	FCV-411	Closed	MAN.411 On/SP.411 Auto 0%	
	FCV-491	Closed	Auto Closed	
	FCV-501	Closed	Off/ZSL-501 On	______
19	Pump EN Signals		Off	
20	2. Verify HRFS secured from technician - post test checklist completed (HOP #4).			______
	VI. EPGS ELECTRIC POWER GENERATION SUBSYSTEM			
21	1. Verify TCRMS is off.			______
	2. If used, reset bkr control switch to green flag, remove the RGP Sync switch handle and return it to the MSEE key box. Set Run Volt and Speed controls down.			______
	3. Verify EPGS secured from technician - post test checklist completed (POP #4).			______
	VII. MCS MASTER CONTROL SUBSYSTEM			
	1. Disable general alarms by turning GAL off.			______
	2. Safe the Emcon and Net. 90 control consoles to eliminate any inadvertant control inputs. (Lock-up)			______

STEP	DESCRIPTION	VERIFICATION
1.	EMCON System Shutdown	
	a) Terminate MSSND execution	________
	b) Execute "SHUT UP" command file	
	1) No device modifications	________
	c) Spin down disk drives	________
	d) Turn off power to equipment	________
2.	Acurex System Shutdown	
	a) Terminate host operation via key switch control	________
	b) Turn off power to equipment	________
3.	Data System Shutdown	
	a) Terminate programs	________
	b) Spin down disc drive	________
	c) Turn off power to equipment	________
4.	Net-90	

7.2 RECEIVER OPERATING PROCEDURES

ROP #1 RECEIVER PRETEST CHECKLIST	Test Date 6/7/84

This Receiver operating procedure will be utilized to verify RS intregrity prior to all tests that use the Receiver. This checklist shall be completed by the RS technician.

STEP	DESCRIPTION	VERIFICATION
1.	Turn on the Tower Air Compressor in continuous duty. Verify pneumatic air is available at 80 psig min. Note it may already be on for HRFS or Facility.	__________
2.	Verify air is being supplied to the Cold Surge Tank and backup air supply for the Drain/Purge Valves (separate manifolds) as follows: a. Open valves on supply bottles. b. Verify supply bottles at 300 psig minimum. c. Adjust HPCV-171 to read 200 psig on the Cold Surge Tank regulator. d. Adjust the backup air supply regulator to 65 psig	__________
3.	Verify the EPS and 2 each control panel power supplies are ON with each set to 24 volts.	__________
4.	Verify the receiver uninterruptible power supply (UPS) is ready and operational (battery gage greater than 90V).	__________
5.	Set up remote camera.	__________
6.	Verify/adjust the pneumatic activated valve air set on the Drain and Purge valves (FCV 180 - 198) to 30 psig outlet pressure (should be done with valves open).	__________

CAUTION

Verify valve temp's with control room prior to cycling.

7. Align/verify valve positions as specified - coordinate with EMCON operator; verify pneumatic pressure to the valves (FCVs)

FCV 101	Salt Flow Control	Open/N
FCV 102	Salt Flow Control	Open/N
FCV 180-189	Drain Valves	Open/N
FCV 190-198	Purge Valves	Open/N

____

8. Using a probe, verify the Hot Surge Tank Vent is free of frozen salt (not blocked). __________

9. Check Flux Gage Coolant Pump, and radiator for leaks. Verify level in radiator is within 2" of top. __________

STEP	DESCRIPTION	VERIFICATION
10.	Verify coolant flow through Flux Gages.(indication on flowmeter.)	________
11.	Visually check the Receiver Cavity Door, Cavity Walls, and the door supports for evidence of scorching. Coordinate RS cavity door operation with Emcon operator.	________
12.	Check for visual evidence of blown fuses, burned relays or burned electrical components in the power junction box and generally through out the receiver subsystem.	________
13.	Inspect the salt system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected (i.e. salt leak, etc.), a more thorough inspection will be required. o RS tower piping o Surge Tanks (2 ea) o Valves (21 ea) o Receiver Assembly (Panel)	________
14.	Advise the control room that the RS pre-test checklist has been completed.	________

THE RECEIVER SUBSYSTEM IS READY FOR STARTUP

This Receiver operating procedure shall be performed by the Emcon operator. Periodically advise the RS technician of status.

	STEP	DESCRIPTION	VERIFICATION
	1.	Verify completion of the following checklists: o CS Pretest Activity (Heliostats to Line Bottom) o COP #1 Control Room Pretest Checklist ✓ o ROP #1 RS Pretest Checklist ✓ o TOP #1 TSS Pretest Checklist ✓	✓ ✓

WARNING

Only operating personnel are allowed in the salt storage and receiver areas while system is operating. Access is to be controlled by the test conductor. Protective clothing must be worn by personnel working in these areas during operation. All other personnel are to keep clear of these areas.

	STEP	DESCRIPTION	VERIFICATION
	2.	Advise the Heliostat operator to Bring the Heliostat Field up to Far Standby.	✓ ✓
02	3.	Open the Receiver Cavity Door (DR.OPN). Verify visually and by micro indications (ZSHDR on).	✓
26	4.	Reset EPS Racks 1 and 3 (turn EPS1.RST and EPS3.RST on then off). Verify Emcon SCRAM disable signal is On.	✓
	5.	Advise the Heliostat operator to Direct Warmup A Heliostat Group at the receiver. (Use CRTF's OP-78-03 for specific steps.)	

NOTE

Graphic 990

Receiver panel temperatures (TE-131 thru TE-148) must be greater than 450°F prior to opening FCV 151 (step 19) during manual startup or starting RS.Fill automatic sequence (step 11) during automatic startup.

CAUTION

o Receiver maximum temperature: 1050°F

If any receiver temperatures remain below 450°F, heliostats may need to be added to increase the temperature of that portion of the panel. Conversely, if any temperatures start approaching 1000°F, heliostats will have to be removed to limit the flux to that portion of the panel.

STEP	DESCRIPTION	VERIFICATION
6.	Advise the salt storage tech. to unlock FCV-211.	✓
04 7.	When unlocked, check FCV 201 open FCV 211, verify micros. (If Cold Sump level LT-201 is equal to or greater then 50 inches, this step should be delayed until just prior to starting the CSP to avoid leakage and possible sump overflow.	✓
8.	Enable cold sump level control and fill sump as follows to prime CSP for starting and provide an adequate salt reservoir for fill operations:	
04	a. Activate FCV-201 with a SP of 48" b. Verify sump level is 50" min. (60" max.) c. Reset FCV-201 SP to 45"	✓
9.	Reverify salt path temperatures are acceptable:	
06	° Receiver Panel — TE-131 thru 148	
10	° Receiver Pass Outlet — TE-101 thru 120	
07	° Receiver Header — TE-182 thru 198	
	° Acurex RS — (COP #1 Table A)	
	° Acurex TSS — (COP #1 Table B)	✓

NOTE

12 The auto fill sequence starts here. Start-up can be accomplished using the auto start sequence

GR 992 (RS.FILL On) or manually from the Emcon console. For auto fill verify RS.MAN OFF — MAN (AUTO)

STEP	DESCRIPTION	VERIFICATION
10.	Activate the FCV 161 Hot Surge Tank Level Control with a set point of 75 inches.	
11.	Activate the FCV 162 Hot Surge Tank Level Control with a set point of 56 inches. In manual fill RS.MAN must be enabled to permit a SP change different than 20".	

NOTE

RS.MAN is available to override FCV-161/162's transfer control.

STEP	DESCRIPTION	VERIFICATION
12.	Start the Cold Salt Pump (CSP).	________
13.	Start the Boost Pump (BP).	________
14.	Enable pump pressure alarm PT180.	________
15.	When the PT-180 Pump Outlet pressure is greater than 310 psi, incrementally open FCV 151 to 50% in 10% steps.	________

NOTE

Monitor the Receiver sequential fill.
Pipes fill (TE-161), CST level rises (LT-151),
Flow starts (FT-101), HST level rises (LT-161).

STEP	DESCRIPTION	VERIFICATION
16.	Close FCV-199 (FCV-199 on) when HST level LT-161 reaches 10" (after 50" CST level). Verify micro ZSL199 on.	________
17.	When the LT-161 Hot Surge Tank level approaches 55 inches, Verify FCV-162 is in auto and maintaining 56 inches.	________
18.	Close drain valves FCV-180 thru 189 (off). Verify closure.	________
19.	Sequentially close the following Purge Valves at 10 sec. intervals (off) to establish serpentine flow. Verify closure. FCV-190 FCV-193 FCV-196 FCV-191 FCV-194 FCV-197 FCV-192 FCV-195 FCV-198	________
20.	Reset the FCV-162 Hot Surge Tank Level set point to 20".	________
21.	Reset the FCV-201 Cold Sump Level set point to 23".	________
22.	Establish Receiver manual salt flow control: a. Take RCA off scan. b. Activate FCV-101/102 CASC control (from FD-101) c. Verify FD-101 is in auto and adjust SP to 30 Klb/hr. Verify flow below 35Klb/hr.	________
23.	Activate the FCV 151 casc. Cold Surge Tank Level Control, then update auto. LT 151 level control with a set point of 87 inches.	________

STEP	DESCRIPTION	VERIFICATION
24.	Activate the Receiver Temperature Control by putting RCA on scan. (Temperature set point SP.SALT will automatically come up at 750°F. This will maintain a low salt flow rate through the receiver with only the warm-up Heliostats on target. FD-101 is automatically controlled from RCA.)	______
25.	Enable Receiver operational alarms by turning RAL on.	______
26.	Verify/Turn off RS.FILL if it was used. (Turns itself off when auto fill is complete).	______

THIS IS THE END OF THE AUTOMATIC SEQUENCE. THE R.S. IS NOW OPERATIONAL (WARM STANDBY) AWAITING START OF SOLAR CHARGING ACTIVITY.

NOTE

Receiver minimum flow rate is auto limited to 30 klb/hr.

27. To maintain the Warm Standby condition (cold flow) for an extended period of time:

    a. Deactivate the Receiver Control Algorithm by taking RCA off scan.

01 b. Reset the FD-101 Salt Flow Control set point to 30 klb/hr or to desired flow rate.

    c. Remove the warmup heliostats from the receiver.

02 d. Close the receiver cavity door amd verify.

Extended Warm Stdby

28. Prepare for solar charging by verifying:

    a. Receiver cavity door is open.
    b. Warm-up Heliostats are on Receiver.
    c. RCA Receiver temperature control algorithm is activated - scan on.
    d. SP.SALT setpoint is initially set to 750°F. ______

29. Conduct solar charging by advising the Heliostat operator to direct incremental Heliostat groups onto the Receiver per operating condition requirements. (Eighth of the field increments are standard). Adjust/Step-up SP.SALT accordingly (1050°F max.) and be alert for cloud and process transients.

Solar Charging

STEP	DESCRIPTION	VERIFICATION
30.	When individual heat trace thermocouple temperatures exceed 750°F, verify the following Acurex channels indicate CLSD (circuit automatically turned off):	

Channel	Area
*063	Upper and Lower Headers
*064	Secondary Headers
065	Header East End
066	Receiver outlet
069	Hot Surge Tank
451	Downcomer and Hot Tank inlet

*The switch on the Module Control Room local control panel must be in REMOTE to allow Acurex automatic control to turn these off. __________

THE RS IS NOW ON LINE IN SOLAR CHARGING CONFIGURATION.

NOTE

During RS Solar operations, intermittantly monitor these parameters:

-- Solar Insolation above 600 W/M^2 - (CF) Control Room Weather Monitor Panel - (TSS) Emcon 'SUN'

-- Cavity Door Temperatures - Acurex channels 45,46, & 47

	Test Date
ROP #3 RECEIVER SHUTDOWN	9/22/84

This Receiver operating procedure shall be performed by the Emcon operator. Periodically advise the RS and TSS technicians of status.

	STEP	DESCRIPTION	VERIFICATION
	1.	Defocus the heliostats.	________
01	2.	Verify/Adjust SP.SALT to 750°F, FCV-201 SP to 23".	________
02	3.	When FT-101 drops to less than 30 Klb/hr, close the receiver cavity door and verify micros.	________
01 02	4.	Deactivate the Receiver Control Algorithm (by taking RCA off scan) and set the FD-101 set point to 60 Klb/hr. Wait 3 minutes minimum and continue when TE-161 is less than 700°F. Verify FCV-162 is open and maintaining level in HST.	________
02	5.	Deactivate FCV-161 control and close.	________
	6.	Check Acurex Ch 000-018, if below 480°F advise RS technician to turn heat trace to local 'ON' until acceptable. When individual heat trace thermocouple temperatures drop below 700°F, verify the following Acurex channels indicate OPEN (circuit automatically turns on):	

*063	Upper and Lower Headers
*064	SecondaryHeaders
065	Header East End
066	Receiver Outlet
069	Hot Surge Tank Inlet

*The switch on the Module Control Room local control panel must be in REMOTE to allow Acurex automatic control to turn these on. ________

THE RS IS NOW IN WARM STANDBY. SALT FLOW MAY BE VARIED TO PROVIDE DESIRED TEMPERATURE/FLOW THROUGH THE RECEIVER.

NOTE

12
GR 992 The RS.DRAIN Auto Drain Sequence starts here. Shutdown can be accomplished using the Auto sequence or manually from the EMCON console. Note Auto seq. steps are not performed in the exact order that follows.

	STEP	DESCRIPTION	MAN	AUTO
01	7.	Set FD-101 setpoint to 30 Klb/hr. Wait for flowmeter FT-101 to stabilize at 30 Klb/hr + 3 Klb/hr, then cont.	________	

STEP	DESCRIPTION	VERIFICATION
8.	Open the following purge and drain valves (on). Verify open micros ZSH 180 thru 198 on. FCV-180-189 FCV-194 FCV-190 FCV-195 FCV-191 FCV-196 FCV-192 FCV-197 FCV-193 FCV-198	______
9.	Disable RAL by turning it off.	______
10.	Deactivate FCV-101 & 102 auto control. Close FCV-101 & 102. Verify closed micros. Wait 30 seconds before continuing. (Note Auto sequence leaves these in Auto).	______
11.	Change LT-151 set point to zero. Verify FCV-151 closed.	______
12.	Deactivate FCV-151 auto control.	______
13.	Verify FCV-162 closed (in Auto). The RS is now bottled up and stagnant.	______ ______

CAUTION

The next three steps initiate salt drain back to the Cold Salt Tank and must be accomplished following the sequence described. An early response could cause an overflow of the hot surge tank. A late response could cause damage to the receiver piping.

WARNING

Only operating personnel are allowed in the salt storage and receiver areas while system is draining. Access is to be controlled by the test conductor. All other personnel are to keep clear of these areas.

STEP	DESCRIPTION	VERIFICATION
14.	To drain HST and downcomer, Deactivate FCV-162 auto control, ramp open FCV-162 to 100% in 20% increments 5 seconds apart, verify open micro, continue when LT-161 reaches 0" or stops decreasing.	______
15.	Open FCV-199 to drain CST and riser, observe LT-151 at 15 inches, then wait 5 seconds.	______
16.	Open FCV-101 & 102 5% to drain Receiver residual salt, Record time. (Ref. step 24).	______ TIME

STEP	DESCRIPTION	VERIFICATION
17.	Deleted.	

NOTE

If SGS is operating (ZSH.HSP ON), go to Step 24.

	STEP	DESCRIPTION	VERIFICATION
	18.	Disable PT-180 pump pressure alarm.	________
	19.	Turn off boost pump.	________
	20.	Turn off cold salt pump.	________
	21.	Change FCV-201 set point to zero, wait 15 seconds.	________
	22.	Put FCV-201 into manual.	________
	23.	Close FCV-211 and manually lock it closed.	________
	24.	Open FCV-101 & 102 100%, approximately 2 minutes after completing Step 16.	________ TIME
	25.	Verify/Turn off RS.DRAIN. (Turns itself off when Auto Drain is complete)	________

THIS IS THE END OF THE AUTOMATIC DRAIN SEQUENCE.
THE RS IS AWAITING RESIDUAL SALT DRAINBACK.

	STEP	DESCRIPTION	VERIFICATION
02	26.	If the SGS is not in operation, 15 minutes after completing Step 24, open: FCV-151 FCV-161 (only if hot tank has salt level)	________
01	27.	If the SGS is not in operation, 20 minutes after completing Step 24, close the following valves: FCV-180-189 FCV-194 FCV-190 FCV-195 FCV-191 FCV-196 FCV-192 FCV-197 FCV-193 FCV-198	________
	28.	Advise RS tech to turn trace heat back to remote, if turned on locally in step 6.	________
	29.	Advise the RS and TSS technicans to complete their post test checklists (ROP #4 & TOP #4). if no further RS or TSS operation planned.	

THE RS IS NOW SHUTDOWN AND DRAINED.

ROP #4 RECEIVER POST TEST CHECKLIST

This Receiver operating procedure will be utilized to verify RS integrity following all tests that use the Receiver. This checklist shall be completed by the RS technician.

STEP	DESCRIPTION	VERIFICATION
1.	Inspect the salt system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected (i.e. salt leak, etc.), a more thorough inspection will be required. o RS tower piping o Surge Tanks (2 ea) o Valves (21 ea)	______
2.	Verify the following valve alignment. Coordinate with Emcon operator. FCV-101 OPEN FCV-102 OPEN FCV-180 thru 189 CLOSED FCV-190 thru 198 CLOSED	______
3.	Open the Receiver Cavity Door and inspect Receiver Assembly for evidence of leaks (white on black surface) and general condition. Close the door when the inspection is complete. Coordinate with Control Room.	______
4.	Secure remote camera.	______
5.	Close the Cold Surge Tank and Receiver pneumatic backup supply bottles handvalves. Record values, CST = ______ p/Air = ______.	______
6.	Turn off the Tower Air Compressor only after obtaining clearance from Control Room. (It may still be in use for HRFS or Facility).	______
7.	Note any items or abnormalities encountered during test activities.	
8.	Advise the control room that RS post-test checklist has been completed and the RS is secure.	______

7.3 THERMAL STORAGE OPERATING PROCEDURES

Test Date
6/20/84

TOP #1 TSS PRETEST CHECKLIST

This Thermal Storage operating procedure will be utilized to verify TSS integrity prior to all tests that use Molten Salt. It shall be performed by the TSS tech.

STEP	DESCRIPTION	VERIFICATION
1.	Inspect the salt system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected, a more thorough inspection will be required. o TSS salt piping o Hot, Cold, and Booster Pumps and Sumps o Vents o Valves	__________
2.	Check for visual evidence of blown fuses, burned relays or burned electrical components in the power junction boxes and generally throughout the TSS.	__________
3.	Verify that the EPS Power Supply (lower part of rack) is set to 24 VDC and is ON.	__________
4.	Start/verify the air compressors are ON with a 80 psig supply pressure. Drain water from old compress tank.	__________
5.	Inspect the fan and louvers in the pump house for proper operation. Verify that the fan thermostat is set to 70°F.	__________
6.	Open the hand valve HV-284 at the old air compressor	__________
7.	Verify coolant flow through the HSP and BP bearings (piping will be cold with indication on the flow meter).	__________
8.	Verify the HSP, CSP and BP circuit breakers are off and the shafts of all three pumps are free. (Bump BP to verify freedom with C.B. On in local).	__________
9.	Turn on the HSP, CSP and BP circuit breakers and place the controls for the pumps in Auto. and verify air flow through the Cold Salt Pump bearings.	__________
10.	Using a probe, verify the C.S., C.T., H.S., H.T., and Booster Pump Sump vents are free of frozen salt. During routine operation, only intermittant verification is required. Particularly verify prior to restart after a shutdown or if pluggage is suspected from high salt levels (CS 60", HS 45").	__________

STEP	DESCRIPTION	VERIFICATION

11. Turn ON the TSS/SGS backup pneumatic air supply as follows:

    a) Verify supply bottles are at 300 psig minimum
    b) Open the valves on the supply bottles and main isolation valve
    c) Adjust the regulator to 50 psig ________

12. Check coolant pumps and radiators for leaks and proper operation. Verify that HV-290, 291, 292, and 293 are open. At the beginning of each month, check the level in the radiators and fill if necessary. ________

13. Align/verify the valve positions listed below. Coordinate with Emcon operator. ________

Valve	Description	Position	Air Press.
FCV-151	Cold Surge Level	Closed/N	
FCV-161	Hot Tank Inlet	Closed/N	
FCV-162	Cold Tank Inlet	Closed/N	
FCV-199	Bypass	Open/N	30 psi
FCV-201	Cold Sump Level	Closed/N	
FCV-211	Cold Sump Isolation	Closed/Locked	40 psi
FCV-221	Hot Sump Level	Closed/N	
FCV-231	Hot Sump Isolation	Closed/Locked	40 psi
FCV-241	Propane Heater Flow	Closed/Locked	
FCV-242	Propane Heater Isolation	Closed/Locked	30 psi
FCV-301	Bypass Salt Flow Control	Closed/N	
FCV-341	Cold Salt Isolation	Closed/N	
FCV-351	Hot Salt Isolation	Closed/N	

14. For operation with Propane Heater instead of Receiver, OR for SGS alone, Modify the valve alignment of step 13 as follows: ________

FCV-151	Locked
FCV-161	Locked
FCV-162	Open/N
FCV-242	Nuetral

15. For operation without SGS, Modify the valve alignment of step 13 as follows: ________

FCV-301	Locked
FCV-341	Locked

STEP	DESCRIPTION	VERIFICATION
16.	Align/Verify the hand valve positions listed below: HV-280 HS/CS Tie Closed HV-281 HT/CT Tie Closed	________
17.	Determine if the OLIN Salt Test Loop is to be used. If it is, align these HV's accordingly (with SGS only): HV-282 Salt Inlet Open HV-283 Salt Outlet Open	________
18.	Set up the Eppley sun meter insolation instrument. It is located on a post south of the TSS. (Emcon 'SUN'). a) Rotate platform of tracker (by hand) to acquire sun. Fine adjust using azimuth and elev. screw adjust. (Sun dot should be in center of target on rear of instr.) b) Open door of timer box located on post. Rotate timer (turn on) to appropiate run time. (Adjust to approx. one half hour past shut-down). Close timer door c) Verify operation. Listen for tracker motor running. Recheck sun target on Eppley, readjust using thumb screws. Tighten lock screws.	________
19.	Advise the Control Room that the TSS Pretest checklist has been completed.	________

NOTE

Complete the SGS pretest checklist (SOP #1) and/or Local Propane Heater startup (TOP #2A) as required.

The Propane Heater is used to charge hot salt when weather conditions do not allow adequate solar charging or when the Receiver or Collector subsystems are not on line.

This Thermal Storage operating procedure shall be performed by the Emcon operator. Periodically advise the TSS technician of status.

Turn on propane inlet and outlet lines trace heater circuits (TEH 223, TEH 224, and TEH 239 for temperature readings) a minimum of 10 hours prior to intended usage of the Propane Heater.
ch 138, 139, 142

STEP	DESCRIPTION	VERIFICATION
1.	Verify completion of the following checklists: ° COP #1 Control Room pretest checklist ✓ ° TOP #1 TSS pretest checklist	✓
2.	Instruct/Confirm TOP #2A Local Propane Heater Start-up.	✓
3.	Record the time upon notification from the TSS technician that the Propane Heater is on Main Flame with 700°F stack outlet temperature. (Ref. steps 10 and 12).	12:03 TIME
05 4.	Verify Cold Tank level LT-281 is greater than 30 inches. If the SGS is operating (on-line) continue at step 11.	
5.	Verify Cold Sump Level LT-201 is less than 60 inches.	
6.	Place FCV-211 in neutral and fully open; verify micros.	✓
7.	Verify/increase the Cold Sump Level to 50 inches.	
8.	Activate the FCV-201 Cold Sump Level Control with a set point of 23 inches.	
9.	Verify LT-201 alarm is activated.	✓
04 10.	14 minutes after MAIN FLAME (step 3) start Cold Pump.	✓✓
11.	Verify Cold Pump outlet pressure PT-180 increases to greater than 170 psi.	✓

NOTE

The Hot Tank must be precharged to 750°F prior to introduction of any high temp. salt. During precharge, leave FCV-221/231 open until the Hot Sump level increases (40" max.), then quickly close FCV-221/231.

STEP	DESCRIPTION	VERIFICATION
05 12.	Initiate salt flow through the Propane Heater 15 minutes after completing step 3; Unlock and open FCV-241 to to 50% open.	✓
13.	Open FCV-242. Record Time.	12:55 Time

NOTE

It will take approximately 10 minutes for the salt to flow through the Propane Heater. Monitor Acurex channel 142 and LT-291 for verifing flow through the heater.

14. Advise the TSS technician to turn off the trace heater L6-1 and inlet to Hot Tank if TEH-239 salt temperature will be exceeding 750°F. Verify. ch 142 ✓

15. Adjust the Propane Heater for a 1050°F (or desired temperature) salt outlet temperature by accomplishing the following after salt flow into hot tank verified (LT-291 10 minutes later):

    a. Advise the TSS technician to set the Burner Temperature control to 1100-1200°F stack temperature. ________

    b. Use TEH-239 (Acurex channel 142) as the actual salt salt outlet temperature indication (1040°F max.). Actual temperature approximately 50°F higher than channel 142 read-out at high (1000 °F) temperatures; approximately 20°F higher at low (700°F) temperatures.

    c. Adjust FCV 241 to TBD% (approximately 40 to 55% for 750-900 F salt and 35-40% for 900-1050 salt). If 1050 salt is desired place stack tempature at 1250 and start with FCV 241 at 50% and adjust accordingly. ________

    d. Monitor Acurex channels 134/136 as hot tank salt temperature and EMCON TE-291.

THE PROPANE HEATER IS NOW ON-LINE AND CHARGING SALT

	Test Date
TOP #2A LOCAL PROPANE HEATER START UP	6/6/84

This Thermal Storage operating procedure will be utilized to locally operate the Propane Heater in conjunction with Emcon (Propane Heater) process operation. This procedure shall be performed by the TSS technician.

STEP	DESCRIPTION	VERIFICATION
1.	Place switch on local console to off position and temperature control to 200°F.	________
2.	Check level of the Propane Tank and verify sufficient propane for present test - 15% or 900 gallons minimum.	________
3.	Check/ignite pilot lights of propane evaporators:	
	A. If vaporizers are not lit, then remove small square cover on south side. Turn knob to pilot.	________
	B. Open center cover (west side) to get to pilot. Pilot is located between metal cylinders at the bottom.	________
	C. While holding knob on south side in full C.C.W. position, light pilot.	________
	D. Hold in this position for 30 to 60 seconds, then turn to on position. Replace covers slowly or flame may go out.	________
4.	Open all three evaporator outlet hand valves (top east side of evaporators) fully. Pressure guage at Heater inlet should read 55 to 60 psi.	________
5.	Check pressure gauge bottom north side of heater. The reading should be about 8 oz.	________
6.	Place Burner switch on local console to preheat.	________
7.	Turn on power switch - red power and timer light should come on.	________
8.	Timer light will remain on for about 2 min. as system is purged prior to introduction of pilot flame gas. Timer light will then go off and about 20 sec. later both timer and pilot light will come on to ignite the pilot flame. If IR scanner does not datect a pilot flame within 6 sec., the start sequence will be stopped and the timer will reset and start over. When the pilot flame is achieved, the PILOT LIGHT will come on.	________

STEP	DESCRIPTION	VERIFICATION
	WARNING If pilot flame does not light after two tries, close valve on vaporizer and troubleshoot system.	
9.	After pilot is lit for about 1 minute, switch to main flame, set temperature control to 250°F and allow to soak for three minutes minimum.	______
10.	Slowly advance temperature control to 700°F - do this slowly to avoid screeching of heater. Main flame light should stay lit.	______
11.	Notify Control Room that the Propane Heater is on Main Flame with a 700°F stack outlet temperature (awaiting 15 min. heat soak prior to process operation).	______

TROUBLE SHOOTING GUIDE

Signs of trouble are:

1. Low or very high reading at pressure gauge.
2. Stack temperature varies or stays low.
3. Unit will not start, no pilot.

All the above can be caused by the vaporizers not being lit. Any vaporizer that is out can cause these troubles.

If the heater is running and frost can be noted on the fuel lines, DO NOT TURN HEATER OFF. Relight the vaporizer(s) that are out and continue to run at reduced temperature until the frost is gone.

If you cannot get the vaporizer to light, turn off the hand valve and let the heater run until frost has left the lines. Heater will run on one vaporizer at reduced output. Try to get at least one lit to help remove the liquid propane from the lines.

If the heater will not light, check to see if the ignition wire on bottom of the heater is on the plug.

Test Date 8/02/84

TOP #3 PROPANE HEATER PROCESS SHUT-DOWN

This Thermal Storage operating procedure shall be completed by the Emcon operator. Periodically advise the TSS technician of status.

STEP DESCRIPTION — VERIFICATION

NOTE

When shutting down the Propane Heater in conjunction with the SGS (both in operation), perform SOP #5 - not this procedure.

05 1. Advise the TSS technician to adjust the burner temperature Control to 600°F stack temperature when the Hot Tank level LT-291 is within 12 inches of the desired level (or within 7 inches of desired level in the Cold Tank). ______

2. Open FCV-241 to 60%. ______

3. When 2 inches from desired level, or when channel 142 reads 800°F, deactivate FCV-201 Cold Sump Level Control. ______

4. Close FCV-201 and FCV-211 (manually lock closed). ______

04 5. Turn off the Cold Pump when it cavitates. (PT-180 drops below 165 psig, LT-201 approx. 11.5"). Record Time. (Ref. steps 7 and 8). ______ TIME

05 6. Open FCV-241 to 100% open. ______

02 7. Wait 2 minutes to allow salt drainage, then unlock and open FCV-151 and FCV 161. ______

NOTE

LT-201 will increase to approximately 58 inches during propane heater draining.

8. Advise the TSS technician to shutdown the Propane Heater 30 minutes after Cold Pump shutoff (step 5) with TOP #3A. ______

05 9. Close FCV-241, FCV-242. ______

10. Advise the TSS technician of the following days operating requirements for heat trace actuation. ______

11. Verify Propane Heater shutdown from TSS technician. ______

12. Advise the TSS tech to complete TOP #4 as required. ______

This Thermal Storage operating procedure will be utilized to locally shut down the Propane Heater after Emcon (Propane Heater) process operation. This procedure shall be performed by the TSS technician.

STEP	DESCRIPTION	VERIFICATION
1.	Turn stack temperature control to 600°F when directed to do so by Emcon operator.	________
2.	After cold salt pump has been turned off, allow a minimum of 30 minutes to drain.	________

NOTE

If shutdown includes SGS,
the Cold Pump may be restarted
to deplete the cold sump.
Allow full 30 minutes drain time.

STEP	DESCRIPTION	VERIFICATION
3.	Turn main flame/preheat switch to preheat.	________
4.	Turn temperature to 200°F.	________
5.	Turn power off.	________
6.	Close the 3 evaporator outlet hand valves to avoid the collection of liquid propane in the line.	________
7.	Adjust the Propane Heater heat tracing as follows:	
	a. For Propane Heater use the following day, Turn on the Propane Heater outlet line LG-1 and Hot Tank inlet heat trace.	________
	b. If Propane Heater is <u>not</u> to be used the following day, turn <u>off</u> the Propane Heater inlet line heat trace (TEH-223, 224).	________
8.	Advise the Control Room that the Propane Heater is shutdown.	________

	Test Date
TOP #4 TSS POST TEST CHECKLIST	6/12/84

This Thermal Storage Operating procedure will be utilized to verify TSS integrity following all tests that use the TSS. This checklist shall be completed by the TSS technician.

STEP	DESCRIPTION	VERIFICATION
1.	Complete the SGS post test checklist SOP #4 (first) if no further SGS operation planned.	________
2.	Inspoect the salt system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected, a more thorough inspection will be required. Particularly inspect: ° TSS salt piping ° Hot, Cold, and Booster Pumps and Sumps ° Vents ° Valves	________
3.	Check for visible evidence of blown fuses, burned relays, or burned electrical components in the power junction boxes and generally throughout the TSS.	________
4.	Close and Lock these valves, Verify. FCV-211 Close/Lock FCV-231 Close/Lock	________
5.	If the Olin test loop was used, close HV-282 and HV-283.	________
6.	Turn off the CSP,BP, and HSP local starter circuit breakers.	________
7.	Turn off the CSP bearing cooling air HV-284.	________
8.	Secure the TSS/SGS back-up pneumatic air by closing the supply bottles HV's.	________
9.	Leave both Air Compressors On.	________
10.	Leave TSS coolant pump and radiator On.	________
11.	Advise the Control Room that the TSS post test checklist is complete and the TSS is secure.	________

Test Date 8/02/84

A. HOT TANK TO COLD TANK

I. Gravity Transfer (700 F maximum)

1. Verify completion of the following checklists. Particularly verify TSS heat trace temp's and valve align.
   - COP #1 Control Room pretest checklist
   - TOP #1 TSS pretest checklist ____________
2. Verify FCV-211 and 231 manually closed and locked. ____________
3. Open HV-281. ____________
4. Open FCV-201 and 221. ____________

(Salt flow rate starts to lessen when LT-291 passes 50". Gravity transfer can take the Hot Tank down to approx. 30".)

II. C.S. Pumped Transfer to C.T.

1. Verify RS heat trace temps are OK (COP #1 Table A). ____________
2. Start off with Gravity Transfer to ensure proper flow ____________
3. Close FCV-101/102. (For safety - not really required) ____________
4. Open FCV-162 and FCV-199 (verify micro's). ____________
5. Unlock and place FCV 211-in neutral. ____________
6. Ensure LT-201 is greater than 50" (Open/close FCV-211). ____________
7. Start the CSP and BP verify PT-180 increases to over 300 psi. ____________
8. Close FCV-201. ____________
9. Open FCV-211. ____________
10. Incrementally open FCV-151 to approximately 40%. ____________

NOTE

Maintain Cold Sump level at 25" by varying FCV-151 setting. (Setting will need to decrease as LT-291 decreases.)

III. Shutdown

11. When reaching desired LT-291 level, perform the next steps expeditiously:
    a. Close FCV-151
    b. Turn off the CSP and BP
    c. Close FCV-221 and FCV-201
    d. Close FCV-211 (and manually lock it).
    e. Close HV-281. ____________
12. After 2 minutes, Open FCV-151, 101, 102, (and FCV-161 if elbow is above 480°F) to drain back residual salt. ____________
13. After 5 minutes, close FCV-151, 161, and 162. ____________

B. HOT SUMP TO COLD TANK

I. C.S. Pumped Transfer to C.T.

1. Valve Configuration per COP #1 Part VI TSS. ________
2. Verify transfer line and HV-280 are greater than 450°F by local T/C check. ________
3. Close FCV 101/102 (for safety not really required.) ________
4. Verify FCV-221 and 231 manual closed and lock FCV-231. ________
5. Open FCV-162 and FCV-199 (verify micros). ________
6. Place FCV-201 in Automatic Control with a set point of 50 inches. ________
7. Unlock and place FCV-211 in neutral. ________
8. Open FCV-211. ________
9. Ensure LT-201 is approximately 50 inches and change FCV-201 set point to 25 inches. ________
10. Start the CSP and BP and verify PT-180 increases to over 300 psi. ________
11. In 10% increments open FCV-151 to approximately 40%. ________

NOTE

Circulation of salt must stabilize at a sump level (LT-201) of approximately 25 inches. Monitor LT-151 and LT-161 levels.

II. H.S. Pumped Transfer to C.S.

12. Open HV-280. ________
13. Turn on Hot Salt Pump. ________

III. Shutdown

14. When reaching desired LT-221 level:

    a) Turn off Hot Salt Pump
    b) Close HV-280 ________

15. When LT-201 stabilizes at approximately 25 inches:

    a) Close FCV-151
    b) Turn off BP and CSP
    c) Close FCV-211 (and manually lock it)
    d) Deactivate and manually close FCV-201 ________

16. After 2 min., open FCV-151, 101, 102 (and FCV-161 if elbow is above 480°F) to drain back residual salt. ________
17. After 5 min., close FCV-151, 161 and 162. ________

7.4 STEAM GENERATOR OPERATING PROCEDURES

Test Date
6/25/84

SOP #1 SGS PRETEST CHECKLIST

This Steam Generation operating procedure will be utilized to verify SGS integrity prior to all tests that use the SGS. This checklist shall be completed by the SGS technician. This checklist presumes SGS is in Diurnal Shutdown.

STEP	DESCRIPTION	VERIFICATION
1.	Verify completion of TOP #1 TSS pretest checklist.	________

2. Inspect the salt system for evidence of leaks or damage. This is a general inspection for any condition that appears abnormal. If a problem is detected, a more thorough inspection will be required.

   - All SGS salt piping
   - Valves
   - Superheater and Evaporator

3. Inspect the water/steam system similarly: ________

   - SGS piping
   - Valves, traps
   - BWCP
   - Flange Connestions
   - Drain Plugs
   - Superheater
   - Evaporator
   - Steam Drum
   - Attemperator
   - Drain and Blowdown Tank

4. Check for visual evidence of blown fuses, burned relays or burned electrical components in the power junction box and generally throughout the SGS. ________

5. Intermittantly verify these amperages with a clamp-on Ammeter. Caution - 480V.

A.	Circ. Heater	EH-1	28A	
		EH-2	28A	
		EH-3	16A	
		EH-4	16A	
		EH-5	16A	________
B.	BWCP	Each Phase	7.8A	________

6. If freezing ambient temperatures have been experienced, Verify operability - Unthaw the following:

   A. Instrument Transmitters - particularly LT-311 - open xmtr piping drain valves for 10-15 sec. intervals - work with system temp. increases. ________

   B. Steam Traps - T-481/HV-491 and T-482/HV-487 - open 1/4 turn and listen for flow. Externally heat as necessary. Open fully after 10 minutes. ________

STEP	DESCRIPTION	VERIFICATION

7. SGS water chemistry sampling -

   A. Obtain a drum water sample by opening HV-386, flushing the sample station lines for 10 minutes, then filling a one liter sample bottle. __________

   B. Analyze and Evaluate the sample per HOP #6. __________

   C. Conduct a Millipore filter sampling and analysis for suspended iron. Results of this must be added to the HOP #6 dissolved iron determination for comparison to the 500 ppb limit. __________

   D. Close HV-386 upon completion of sampling and Open the vent HV-384 located adjacent to HV-386 to drain the sample line, particularly to protect against freezing. Close the vent HV-384 after totally draining the line. __________

8. SGS Phosphate injection -

   A. As determined by water chemistry sampling of step 7, phosphates can be added to the SGS with the chemical feed station on the SGS skid (HV-387/388). Injection should be started as early as possible. __________

   B. The phosphate injection mixture consists of 175 grams of granular Trisodium Phosphate and 50 grams of powdery Disodium Phosphate mixed with 2 and 1/2 gallons of demineralized water __________

9. Align/Verify the valve positions listed below. Coordinate with Emcon operator.

Valve	Description	Position
FCV-321	Main Salt Flow	Open
FCV-331	Steam Attemperator	10% Open
FCV-381	Evap. Salt Drain	Open
FCV-382	Superhtr. Salt Drain	Open
FCV-383	Circ. Htr. Bypass	Closed
FCV-384	Circ. Htr. Supply	Open
FCV-491	Steam Delivery	Closed

____

STEP	DESCRIPTION	VERIFICATION

10. Align/Verify the following valve positions.

Valve	Description	Position
HV-370	Bridge Feedwater Drain	Closed
HV-371	Circ. Heater Drain	Closed
HV-372	BWCP Volute Drain	Closed
HV-373	BWCP Bearing Cavity	Closed
HV-375	SGS Air Supply	Open
HV-381	Drain	Closed
HV-382	Blowdown Control	Closed
HV-383	Blowdown Isolation	Closed
HV-384	Pump Isolation	Open/Locked
HV-385	Steam Drum Vent	Closed
HV-386	Sample Line Isolation	Closed
HV-387	Chemical Feed Metering	As needed
HV-388	Chemical Feed Isol.	As needed
HV-389	Chemical Feed Drain	Closed
HV-390	Drum N_2 Inlet	Closed
HV-481	Steam Delivery Isol.	Closed
HV-485	Steam Delivery Drain	Closed
HV-486	Steam Delivery Drain	Closed
HV-487	Trap Isolation	Open
HV-488	Feedwater Supply Isol.	Closed
HV-491	Steam Trap Isol.	Open

11. After HRFS start-up, coordinate with the Control Room to replenish SGS water. Particularly operate HV-370 and HV-488 as needed. Leave HV-370 closed and HV-488 Open. __________

12. Advise the Control Room operator that the SGS pretest checklist has been completed. __________

NOTE

After operation is established and consent obtained from the Control Room, Blowdown the steam drum to reduce high Iron and TDS concentrations found by the water chemistry analysis. The blowdown period using HV-382 and HV-383 shall be as follows:

Iron (ppm)	TDS (ppm)	Blowdown Time
200	50	0 Minute
200 to 300	50 to 100	1 Minute
300 to 500	100	2 Minute

Blowdown will only help remove dissolved solids Periodically drain certain dead legs in the SGS using HV-371 and HV-372 to remove suspended solids.

This Steam Generation Operating Procedure shall be performed by the Emcon operator. Periodically advise the SGS technician of status. This procedure assumes SGS is in Diurnal Shutdown.

STEP DESCRIPTION — **VERIFICATION**

A. DIURNAL SHUTDOWN TO WARM STANDBY MODE

1. Verify completion of the following checklists:

   - COP #1 Control Room pretest checklist
   - TOP #1 TSS pretest checklist
   - SOP #1 SGS pretest checklist
   - HOP #1 HRFS pretest checklist and local startup
   - HOP #2 HRFS startup __________

CAUTION

If freezing temperatures have been experienced, be aware of possible bad SGS instrument readings.

18 2. Verify D/D temp TE-451 (DTC PV) is above 250°F, then position FCV-431 to Manual Open to start steam pipe heat-up with D/D steam. __________

02 3. If R.S. is not operational, check Acurex channels 121, 129, and 131 are above 480°F and reverify FCV-151 and 161 are closed and locked, FCV-162 is open. __________

16 4. Place/verify MAN.EHAC and EHAC are ON. This places the Circulation Heater in Automatic Pressure Control. Also, verify MAN.ESH-1 thru MAN.ESH-5 are off. __________

13 5. Verify that SP.DL is set at 0.0" , that MAN.411 is off, FCV-411 is in cascade at Net 90, and that drum level is being maintained at 0.0 inches + or - .5 inches. __________

6. Place/verify SDC and MAN.SDC are both OFF. (These may have to be on to override Hi steam drum levels) __________

7. Place/verify FCV-321, and 331 are in cascade, at the N90 console Groups H & F, (COT/C). (Ready for N90 control after EMCON deact) __________

8. Verify the following set points:

	SP.EST	850°F	Evaporator Salt Temperature	(FCV-301)
13	SP.SP	1100 psi	Steam Delivery Pressure	(FCV-321)
	SP.ST	950°F	Steam Delivery Temperature	(FCV-331)

____

STEP	DESCRIPTION	VERIFICATION
18 9.	Verify D/D Feedwater Temperature at TE451 is above 250°F. Change DTC-451 and DTC-452 set points to 300°F.	________
10.	Note the Steam Drum Temperature at TE-383. The temperature must be above 500°F to initiate salt flow. If the temperature is below 500°F, wait for circulation heaters to increase the temperature above 500°F prior to proceeding.	________
11.	Verify cold sump temp. Accurex channel 124 and 125 are within 100°F of TE-383 to prevent shocking the superheater. If difference is over 100°F, continue to heat SGS to within 100°F with circulation heaters.	________
12.	Reverify salt path temperatures are acceptable Ref. COP #1 Table B & C.	________
13.	Reset FCV-201 SP to 45" and stabilize.	________
14.	Advise the SGS technician to open HV-481 (ahead of FCV-491) and Verify HV-488 is Open.	________
15.	Have field technician unlock FCV-211.	________
16.	Activate FCV-431 casc. control via PT-431 SP 1080 psi.	________
17.	Activate FCV-491 automatic control with SP 1000 psi.	________
18.	Monitor PT-321 and reduce set point of FCV-491 as required to maintain a constant level during auto SGS.CF sequence.	________
19.	During auto SGS.CF sequence when LT-311 reaches 6" turn on MAN.SDC and SDC.	________
20.	Close salt drain valves after verifying Acurex channel 265 is above 480°F by turning FCV-38182 and MAN.38182 off. Verify closure. NOTE The SGS cold flow auto sequence starts here. Monitor 'Control Room' Notes during auto sequence and perform as required.	
21.	Activate SGS.CF 'ON' to start auto sequence.	________
GR 994 22.	Activate the FCV-201 level control with a set point of 50 inches. Open FCV-211. When level reaches 50 inches, change the setpoint to 23 inches.	________
23.	Start the cold pump; PT-180 greater than 150 PSI before continuing.	________
24.	Activate the following alarms: LT-311 PT-180 TE-301 TE-384 PT-383 TE-383	

STEP	DESCRIPTION	VERIFICATION

25. Set SP.341 to 100% to fully open FCV-341 and verify the position. This fills the SGS with cold salt in approx. 12 minutes.

NOTE (CONTROL ROOM)

______ TIME (REF STEP 25)

1. Monitor LT-201 to maintain sump level above 17 inches Do not cavitate pumps.

2. If salt temps are low (550°F) turn on Net 90 heater 1 to protect against freezing. Heater 1 will turn off upon FCV-383/384 switchover.

NOTE (CONTROL ROOM)

After opening FCV-341 monitor the SGS temperatures on Acurex and EMCON as listed below to verify that salt is flowing thru the SGS. Each Acurex chanel or EMCON Thermocouple read the same as the Cold Salt Temperature in the order listed:

204
255
270
254
TE382 (EMCON)
216
215
241
203
TE301 (EMCON)
250
TE384 (EMCON)
208

______ °F
TE-382

______ °F
COLD SALT TEMP
(ACUREX CH 124/125)

If these channels do not appear to be consistent with the Cold Salt Temperature, a blockage may exist. If so, OPEN FCV-301 fully to improve flow temporarily then CLOSE FCV-301 and monitor FT-321 to determine if the blockage has cleared.

NOTE (CONTROL ROOM)

When auto ramp is complete and LT-311 is below 7" turn off MAN.SDC and SDC.

26. Once superheater is filled with salt, TE-301 should read cold salt temp (approx. 5 minutes after step 24). Open FCV-301 with SP.301 to 100% and verify position. ______

27. When FT-321 flow is greater than 10 Klb/hr., set SP.301 to 0% and turn MAN.301 OFF. Verify that FCV-301 closes. ______

NOTE

The SGS.CF cold flow auto sequence stops here. The next few steps will be performed manually.

STEP	DESCRIPTION	VERIFICATION

28. Place FCV-301 in Cascade at the Network 90 to control Evaporator salt temperature at SP.EST.

NOTE

Reactivate FCV-301 at Net 90 after any trip.

SGS IS NOW IN WARM STANDBY AWAITING INTRODUCTION OF HOT SALT

B. WARM STANDBY TO THE ON-LINE CONDITION

1. Verify FCV-221 is closed.

2. Verify the Hot Sump level (LT-221) is less than 48 inches.

13 3. Set MAN.331 to OFF to activate the FCV-331 Steam Delivery Temperature Control at SP.ST. Verify that FCV-331 closes and is in Casc. at Net. 90.

4. Verify/place FCV-231 in neutral.

NOTE

The SGS.ON auto ramp sequence starts here.

5. Activate SGS.ON 'ON' to start auto ramp sequence.

6. Set MAN.383 to ON and FCV-383 ON (Open) and verify Micro.

7. Set MAN.384 to ON and FCV.384 to OFF (Closed) and verify micro; verify that all circulation heater circuits are off.

8. Verify the CSP is operating and FCV-341 is open 100%

9. Activate the FCV-221 Hot Sump Level Control with a set point of 40 inches.

10. Open FCV-231 by turning OPN.231 on, then off. Verify open micro.

11. When Hot Sump level reaches 40 inches, reset FCV-221 set point to 20 inches.

12. Close FCV-231 (CLS.231 ON, then off).

NOTE (CONTROL ROOM)

When LT-221 reaches 30" open FCV-231 to allow hot salt to enter the hot sump. Operate as required to maintain level.

13. Turn on the Hot Salt Pump.

STEP | DESCRIPTION | VERIFICATION

NOTE

During the following activity of increasing salt temperature, verify the operation of FCV-432 so that deaerator pressure is held constant at 233 psi and all excess energy is being rejected by the cooling water circuit.

CAUTION

Monitor PT-382. If PT-382 pressure goes above 85 psig, close FCV-351.

14. Open FCV-351 then close FCV-341 in series using the following incremental steps to increase superheater inlet temperature (TE-382). The Operator shall monitor TE-382 to assure that TE-382 does not increase more than 100°F in any 6-minute period.

FCV-351 to 2% for 2 minutes
" to 3% " " "
" to 4% " " "
" to 5% " " "
" to 6% " " "
" to 7% " " "
" to 8% " " "
" to 9% " " "
" to 10% " " " ; maintains 10% position

_______ °F
TE-382 TEMP

_______ °F
Hot Salt Temp
(Acurex Ch 126/127)

FCV-341 to 80% for 1 minute
" to 60% " " "
" to 40% " " "
" to 20% " " "
" to 10% " " "
" to 05% " " "
" to 2.5% " " "
" to 1.0% " " "
" to 0% " " " ; maintain closed _______

15. Close FCV-321 to 50% by setting SP.321, wait 5 sec. then set SP.321 to 10%. Wait 5 sec., then set SP.351 to 50%. Wait 5 sec., then set SP.351 to 100%. _______

16. Set the TSS, SGS, and HRFS operational alarms and wait 30 seconds.

PT-431	LT-221
PT-432	LT-281
	LT-291
TE-483	LT-471

____

STEP	DESCRIPTION	VERIFICATION
17.	Set SP.321 to 20%, wait 20 seconds.	________
18.	Set SP.321 to 30%, wait 20 seconds.	________
19.	Set SP.321 to 40%, wait 20 seconds.	________

NOTE

The SGS.ON auto ramp sequence stops here

20. Verify/Turn off SGS.ON if it was used. ________

THE SGS IS NOW ON-LINE IN SALT FLOW CONTROL
(FCV-321 manually controlling SGS salt flow
and FCV-431 auto controlling HRFS steam pressure
via PT-431 SP normally 1080 psi.)

21. Advise the SGS technician that drum blowdown may now be performed if required. (As determined by his SGS pretest checklist water chemistry analysis.) ________

NOTE

The Turbine/Generator will be brought on line at this point in later testing(POP#2). To simulate the Turbine loading, complete the transfer from HRFS pressure control to SGS pressure control (steps 22 & 23) and manually position FCV-431 to change the steam dump to the deaerator.

22. Set MAN.321 to OFF to activate SGS Steam Press. control. (FCV-321 auto controlling steam pressure at SP.SP 1100 psi. ________

23. Deactivate the FCV-431 HRFS Steam Pressure Control and manually position valve to establish minimum steam flow (approx. 3 Klb/Hr.) and simulate steam loading. ________

THE SGS IS NOW ON LINE IN AUTOMATIC BOILER FOLLOWING MODE.

REFERENCE INFORMATION

Steam Load	FCV-431-% Open	FCV-321-%
30% 3.45Klb/Hr	55%	
60% 7 Klb/Hr	74%	
FW Temp 400°F 100% 9.8Klb/Hr	85%	102%

This Steam Generation operating procedure shall be performed by the Emcon operator. Periodically advise the SGS technician of status.

STEP DESCRIPTION VERIFICATION

1. When steam demand has dropped to less than 3500 lbs/hr, switchover from SGS pressure control to flow control:

   a) Set SP.321 value to the same value as shown on ZT321, or 50%.

   b) Activate the FCV-431 HRFS Steam Pressure Control (using PT-431) with a set point of 1080 psig. Turn off GSTAT, Reset FCV-432 SP to 233 psi.

   c. Deactivate the SGS Steam Pressure Control by turning MAN.321 ON. ____________

2. Close FCV-351 to 10% and open FCV-321 to 100% in the following steps. Set SP.351 to 50% wait 5 seconds, then set SP.321 to 10%. After 5 seconds, set SP.321 to 50%, wait 5 seconds then set SP.321 to 100%. ____________

NOTE

The SGS.OFF auto ramp may be used to complete step 3.

____
MAN AUTO

3. Open FCV-341 then close FCV-351 in series using the following incremental steps to decrease superheater inlet temperature (TE-382). The operator shall monitor TE-382 to assure that it does not decrease more than 100F° in any six minute period. Record start time. ____________
Time

SP.341 to 10% for 1 minute
" " to 20% " " "
" " to 30% " " "
" " to 40% " " "
" " to 50% " " "
" " to 60% " " "
" " to 70% " " "
" " to 80% " " "
" " to 90% " " "
" " to 100% " " "; maintain open

____________ °F
TE-382

STEP	DESCRIPTION	VERIFICATION
3.	Hot salt ramp down (cont'd). SP.351 to 6% for 1 minute " " to 4% " 3 " " " to 2% " " " " " to 1.5% " " " " " to 1% " " " " " to 0.5% " " " " " to 0% " " "; maintain closed Verify/Turn off SGS.OFF if it was used. (USED--NOT USED)	________
04 4.	Turn off the Hot Salt Pump. N90 will hold FCV-351 closed if the Hot Salt Pump is not running.	________
5.	Deactivate automatic control and close FCV-221. Verify closed.	________
6.	Close FCV-231. If sump level (LT-221) shows indication of leakage (slow rise), manually lock FCV-231 closed.	________
13 7.	Deactivate the FCV-331 Steam Delivery Temperature Control by setting SP.331 to 10% and turning MAN.331 to ON.	________
8.	Set FCV-384 to ON (Open) and verify the position on the micros.	________
9.	Set FCV-383 to OFF (Close) and verify the position on the micros.	________
10.	Verify MAN.EHAC ON, EHAC OFF and then back ON (pulse signal). TE-383 must be below 500°F.	________

THE SGS IS NOW IN WARM STANDBY

NOTE

To maintain the Warm Standby condition accomplish the following:

a) Verify salt system temperatures (COP #1 Tables A & B) are 480°F minimum.

b) To maintain water/steam pressure at 1100 psig, reduce salt flow thru FCV-341 to lowest compatible with stable flow (still maintaining PT-383 at 1100 psig).

Extended Warm Stdby

STEP DESCRIPTION VERIFICATION

13 11. Deactivate the FCV-301 Evaporator Salt Inlet Temperature Control by setting SP.301 at 0% and turning MAN.301 ON. ________

15 12. Deactivate the following Alarms:
18

TE-301	LT-221	PT-383
TE-383	LT-281	PT-432
TE-384	LT-291	PT-483
TE-483	LT-311	
	LT-471	

____

04 13. Turn off the boost pump and cold salt pump. Verify FCV-341 closed. N-90 will hold FCV-341 and FCV-301 closed if the Cold Salt Pump is not running. ________

13 14. Place/verify the following setpoints:

SP.301	0%
SP.341	0%
SP.351	0%

____

04 15. Deactivate automatic control and close FCV-201. ________

16. Close FCV-211. If sump level shows indication of leakage (slow rise), manually lock FCV-211 closed. ________

17. Turn MAN.SDC and SDC ON. This MUST be accomplished to allow opening of the Salt Valves for drainage. ________

18. Record sump levels and time prior to SGS drainback.

LT-201 Cold sump ________ , LT-221 Hot sump ________ ________
Time

13 19. Open the Cold Salt and Salt Drain Valves by setting the following controls and verify correct valve position.

SP.301	100%
SP.341	100%
MAN.38182	On
FCV-38182	On

____

20. Wait 5 minutes from step 18 to allow drainage of salt to the Cold Sump prior to proceeding to step 21. Cold sump level should increase 6 to 10" during drainback. ________

STEP	DESCRIPTION	VERIFICATION
21.	Open the Hot Salt Valve by setting SP.351 to100%. Verify the valve postion and expect a hot sump level change of approximately 16 inches.	________
22.	Verify FCV-491 is closed in auto with a SP of 980 psi.	________
23.	Fill the drum with Feedwater to a level of +15 inches by setting SP.411 to 20% and turning Man.411 ON. When the level has reached +15 inches, set SP.411 to 0%.	________

NOTE

HRFS is no longer needed to support SGS and may be shutdown now if not seperately required.

13 24. 20 minutes after step 18, set the controls in the following postions and verify the correct valve position: ________

SP.341	0%
SP.301	0%
SP.351	0%
FCV-38182	OFF

25. Turn SDC and MAN.SDC OFF. ________

NOTE

If ambient temperature conditions either are or expected to be less than 32F°, assure that water side freeze protection circuits are operational and that no water/steam transmitter signals (particularly LT-311) are frozen prior to leaving the system unattended. If there is any indication that LT-311 may not provide a valid signal during unattended diurnal shutdown, due to freezing or any other reason, the circulation heater should be de-energized.

02 26. If FCV-151, FCV-161, and FCV-162 have not been manually locked closed during the SGS salt flow activity, an acumulation of salt will leak by and stagnate. Open FCV-151, FCV-161, and FCV-162 and allow the salt to drain. ________

27. Advise the SGS technician to complete the SGS posttest checklist (SOP #4) if no further SGS operation is planned, and the TSS posttest checklist (TOP #4) if no further TSS operation is on-going or planned. ________

SGS IS NOW IN DIURNAL SHUTDOWN WITH THE SALT SYSTEM DRAINED.

NOTE

This procedure will not detail the steps to take the SGS from Diurnal Shutdown to the Empty Condition because it is not a planned part of the SGS testing. Refer to the SGS Manual Section 3.10 (Operating Procedures) for these detailed steps.

Test Date
6/23/84

This Steam Generation operating procedure will be utilized to verify SGS integrity following all tests that use the SGS. It shall be performed by the SGS technician.

STEP	DESCRIPTION	VERIFICATION

CAUTION

Salt and water/steam temperatures will normally be maintained above 500°F. If repairs are required, a shut down to the Empty condition may be required.

1. Close the following isolation valves:

HV-481	St. Deliv.	HV-488	Feedwater
HV-487	T-482	HV-491	T-481

____

2. Inspect the salt system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected, a more thorough inspection will be required.

   - o All SGS salt piping
   - o Valves
   - o Superheater and Evaporator

____

3. Inspect the water/steam system for evidence of leaks and insulation damage. This is a general inspection for any condition that appears abnormal. If a problem is detected, a more thorough inspection will be required.

o SGS piping	o Superheater
o Valves, traps	o Evaporator
o BWCP	o Steam Drum
o Flange connections	o Attemperator
o Drain Plugs	o Drain & Blowdown Tank

____

4. Check for visual evidence of blown fuses, burned relays or burned electrical components in the power junction box and generally throughout the SGS/TSS. __________

5. Verify operation of the SGS skid coolant pump and radiator. __________

6. Secure the boiler water sample station (HV-386). __________

7. Turn off/verify the chemical feed pump and close HV-387. __________

8. Note any abnormalities encountered during test activities. __________

9. Advise the Control Room that the SGS post test has been completed and the SGS is secure. __________

10. Complete the TSS post test checklist (TOP #4) if no further TSS operation is planned. __________

SOP #5 SGS and Propane Heater Shutdown

Test Date
8/02/84

This procedure will only be used for shutdown when the SGS <u>and</u> Propane Heater are in simultaneous operation. Due to the volume of salt that must be drained into the Cold Sump from the Propane Heater, salt will be bottled up in the SGS for approximately 20 minutes prior to drain. Perform steps 16 through 27 expeditiously.

STEP	DESCRIPTION	VERIFICATION
1.	Advise the TSS technician to adjust the Propane Heater stack temperature control to 600°F. Propane Heater salt outlet temperature (Acurex channel 142) will decrease over a period of time.	______
13 2.	When steam demand has dropped to less than 3500 lbs/hr, switchover from SGS pressure control to flow control.	
	a) Set SP.321 value to the same value as shown on ZT321.	
	b) Activate the FCV 431 HRFS Steam Pressure Control (using PT-431) with a set point of 1100 psig.	
	c) Deactivate the Steam Pressure Control by turning MAN.321 on.	______
3.	Close FCV 351 to 10% and open FCV 321 to 100% in the following steps: Set SP.351 to 50%, wait 5 seconds; then set SP.351 to 10%; after 5 seconds, set SP.321 to 50%; wait 5 seconds, then set SP.321 to 100%.	______
4.	Open FCV 341; then close FCV 351 in series using the following incremental steps to decrease superheater inlet temperature (TE382). The operator will monitor TE382 to assure that TE382 does not decrease more than 100°F in any 6-minute period. Record start time.	______ Time

SP.341 to 10% for 1 minute
" " to 20% for " "
" " to 30% for " "
" " to 40% for " "
" " to 50% for " "
" " to 60% for 1 minute
" " to 70% for " "
" " to 80% for " "
" " to 90% for " "
" " to 100% for " " ; maintain full open

STEP	DESCRIPTION	VERIFICATION
	SP.351 to 6% for 1 minute " " to 4% for 3 minutes " " to 2% for 3 minutes " " to 1.5% for 3 minutes " " to 1% for 3 minutes " " to 0.5% for 3 minutes " " to 0% for 3 minutes; maintain closed	________
04 5.	Turn off the Hot Salt Pump. N90 will hold FCV351 closed if the Hot Salt Pump is not running.	________
6.	Deactivate hot sump level control and close FCV 221. Verify closed.	________
7.	Close FCV231. If sump level (LT-221) shows indication of leakage (slow rise), manually lock FCV231 closed.	________
13 8.	Deactivate the FCV331 Steam Delivery Temperature Control by setting SP.331 to 10% and turning MAN.331 On.	________
9. 14	Set FCV384 to ON (open) and verify the position on the micros.	________
13 10.	Set FCV383 to OFF (closed) and verify the position on the micros.	________
11.	Verify MAN.EHAC ON. Turn EHAC off and then back on (pulse signal)	________

SGS IS NOW IN WARM STANDBY

NOTE

To maintain the Warm Standby condition accomplish the following:

a) Verify salt system temperatures (COP #1 Table A & B) are 480 F minimum.
b) To maintain water/steam pressure at 1100 psig, reduce salt flow thru FCV341 to lowest compatible with stable flow (still maintaining PT-383 at 1100 psig).

Extended Warm Stdby

STEP | DESCRIPTION | VERIFICATION

13 12. Deactivate the FCV-301 Evaporator Salt inlet temperature control by setting SP.301 at 0% and turning MAN.301 on. ______

04 13. Deactivate cold sump level control and close FCV 201. ______

14. Close FCV 211 and manually lock it closed. ______

CAUTION

The salt in the SGS will be bottled up until the cold salt valves are opened in Step 26. Do not delay in performing the following steps:

15. Turn off the Cold Salt Pump and Boost Pump when the PT-180 pump outlet pressure drops below 150 psig (LT-201 approx. 11.5 in.) N90 interlock will close FCV 301 and FCV 341 - verify. ______

05 16. Start Propane Heater drain by Opening FCV 241 to 100% open. Verify position. ______

NOTE

There are two ways to deplete cold sump level after propane heater has been drained back to the cold sump. The best way is thru FCV-151, FCV-199, FCV-162 and back to the cold tank. The alternate way is to go thru SGS. Some if the following steps will have two parts; one for depleting the cold sump via FCV-151, or one for depleting cold sump via SGS.

17. Place the FCV-151 handwheel in neutral. (This step isn't necessary if SGS will be used for depleting cold sump) ______

18. Continue to monitor LT-201. When it stabilizes at 55", close FCV 241 and manually lock it closed. ______

04 19. Start the Cold Salt Pump and Boost Pump and verify PT-180 increases to greater than 170 psig. ______

20. Incrementally open FCV 151 to 40%. ______

SOP #5 SGS AND PROPANE HEATER SHUTDOWN

STEP DESCRIPTION VERIFICATION

13 21. If SGS is used to deplete cold sump,
Open FCV-301 and FCV-341.

04 22. Turn off the Cold Salt Pump and Boost Pump
when LT-201 reaches approx. 25".

02 23. Close FCV 151, if used.

24. Turn MAN.SDC and SDC ON. This MUST BE accomplished to allow opening of the Salt Valves for drainage.

13 25. Open the Salt and Salt Drain Valves by
setting the following controls.
Verify correct valve position.

MAN.301 On/SP.301 100%	MAN.38182 On
MAN.341 On/SP.341 100%	FCV.38182 On

NOTE

Monitor LT201 Cold Sump level during salt drainage. The level should increase by approx 6 inches.

26. Open the Hot Salt Valve by setting SP.351 to 100%. Verify the valve position and expect a hot sump level change of approximately 16 inches. Do not exceed 40" on LT-221.

27. Verify FCV491 is closed in auto with a SP of 1050 psi.

28. Fill the drum with Feedwater to a level of +15 inches, set SP.411 to 20% and turning MAN.411 ON. When the level has reached +15 inches, set SP.411 to 0%.

NOTE

HRFS is no longer needed to support SGS and may be shutdown now if not seperately required.

SOP #5 SGS AND PROPANE HEATER SHUTDOWN

STEP | DESCRIPTION | VERIFICATION

29. Advise the TSS technician to complete TOP #3A Local Propane Heater Shutdown. ____________

13 30. Close the following valves as follows:
02
05

SP.341	0%	FCV 151	Closed
SP.301	0%	FCV 162	Closed
SP.351	0%	FCV 241	Closed
FCV.38182	OFF	FCV 242	Closed

____

31. Lock the following valves closed:

FCV 301
FCV 341
FCV 241
FCV 242

____

32. Turn SDC and MAN.SDC OFF. ____________

NOTE

If ambient temperature conditions either are or are expected to be less than 32 F, assure that water side freeze protection circuits are operational and that no water/steam transmitter signals (particularly LT-311) are frozen prior to leaving the system unattended. If there is any indication that LT-311 may not provide a valid signal during unattended dirnal shutdown, due to freezing or any other reason, the circ. heater should be deenergized.

02 33. If FCV-151, FCV-161, & FCV-162 have not been manually locked closed during the SGS salt flow activity, an accumulation of salt will leak by and stagnate. Open FCV-151, 161, & 162 to allow the salt to drain. ____________

34. Advise the TSS/SGS technicians to complete the SGS and TSS posttest checklists (SOP #4 & TOP #4) if no further TSS/SGS operation planned. ____________

SGS IS NOW IN DIURNAL SHUTDOWN WITH THE SALT SYSTEM DRAINED

NOTE

This procedure will not detail the steps to take the SGS from Diurnal Shutdown to the Empty Codition because it is not a planned part of the SGS testing. Refer to the SGS Manual Section 3.10 (Operating Procedures) for these detailed steps.

7.5 ELECTRIC POWER GENERATION OPERATING PROCEDURES

Test Date 6/19/84

POP #1 EPGS PRETEST CHECKLIST

This electric Power generation operating procedure will be utilized to verify EPGS integrity prior to all tests that use the EPGS. This checklist shall be completed by the EPGS technician.

STEP	DESCRIPTION	VERIFICATION

NOTE 1. Be advised that these valve positions are verified correct in HRFS check-lists:

HV-501	Main Steam Isolation	(Open)
HV-577A & B	FWP Cooling Water	(As Req'd)
FCV-471	Condensate Return	(Closed from EMCON)

NOTE 2. Inspect for evidence of water and oil leaks or other abnormalities as you complete this checklist. (Verify none found in Setp 34).

A. Condenser Platform - 60' Level

1. These valves remain closed. Check only if you suspect they have been opened. __________
   - a. HV-593 Condenser inlet waterbox vent
   - b. HV-594 Condenser inlet waterbox drain
   - c. HV-597 Condenser blind waterbox drain
   - d. HV-598 Condenser blind waterbox vent

2. Verify these valves are open: __________
   - a. HV-584 Hotwell outlet/CNP suction
   - b. HV-581 CNP discharge
   - c. HV-582 CNP discharge orifice recirculation
   - d. HV-583 Condenser vacuum exhaust isolation
   - e. HV-586 Turbine steam seal exhaust isolation

3. Record hotwell level from sight glass LI-581, leave isolation HV-595 & 596 open. Lvl. _____ "

B. 60' Level

4. Verify these valves are open: __________
   - a. HV-578 AEP seperator tank make-up
   - b. HV-588A AEP cooler cooling water supply
   - c. HV-588B AEP cooler cooling water return

5. Verify AEP separator tank level is between 4 & 6" at sight glass LI-583 (auto LV-581 M-U) __________

6. Verify CNP and AEP local disconnect switches are closed. __________

STEP	DESCRIPTION	VERIFICATION
C.	Control Area - 80' Level	
7.	Verify EPGS UPS has 2 Green lights on.	________
8.	Turn on exciter cabinets vent fans with switch on side of VRP. Verify vent fan operation at VRP, rectifier cabinet, resistor cabinet, and at isolation transformer enclosure (L4 Bkr. 12).	________
9.	Verify generator breaker is racked in, charged, and open.	________
10.	Verify electrical power is (always) on: a. TCP - Timer display on (L4 bkr 9) b. GCP - Generator Breaker green light on (L4 bkr 15) c. Generator heater - Local starter on/TCP sw in Auto d. Oil heater - Local starter on/TCP sw in Auto	________
11.	Close TCP sw.'s for FCV-501, 511, 512, 541, & 551	________
12.	Determine where the EPGS will be operated from - 'local' at T-G or 'remote' at Emcon Console. Reposition mode select switch, if required, in the next step.	________ Local Remote
13.	Determine if CTP is operating for HRFS/FWP (TCP red light) a. CTP off - Position TCP mode select switch in the control mode determined in Step 12.	________ CTP off
	b. CTP on - Verify TCP mode select sitch is positioned in agreement with Step 12. Correct switch position, if necessary, only with Emcon operator permission (to avoid FWP trip).	________ CTP on
14.	Turn on all local starters except Exciter disc., 8 total, and verify 5 TCP indicating lights on.	________
15.	Verify compressed air is available and controls functional by stroking FCV-521 from oper. mode cont'l location. Verify local air venting or valve motion and Emcon ZT-521 operation. Close FCV-521 and confirm after function check.	________
16.	Assure turbine oil temperature is above 60°F. Conduct POP #1A Part A - Turbine oil temp. ck., if necessary, to determine oil temperature and/or warm oil.	________

STEP	DESCRIPTION	VERIFICATION
D.	T-G Platform - 80' Level	
17.	Verify HV-592 steam line drain valve is closed.	________
18.	Verify these valves are open: a. HV-575 Steam line trap b. HV-576 Steam seal (1/4 turn open) c. HV-587 Generator cooling water supply d. HV-521 Lube oil cooler oil diverting (open to cool.) e. HV-574 Throttle Valve trap	________
19.	Verify OST mechanism is reset.	________
20.	Verify Throttle Valve is reset closed by inspection - no un-threaded rod showing on cylinder screw.	________
21.	Verify FCV-501 is closed by inspection.	________
22.	Verify EOP local disconnect switch is closed.	________
23.	Verify turbine oil reservoir level is 2 1/2", + 1/2", above normal operating level mark at dipstick LI-582; or if EOP is on for oil heating, verify dipstick LI-582 normal operating level is maintained.	________
24.	Verify excitor bearing oil reservoir is full by removing wing-nut reservoir plug & inspecting.	________
25.	Verify duplex oil strainers are operational. Alternate strainer selection weekly.	________
E.	Tank Area - 80' Level	
26.	Verify CTP local disconnect switch is closed.	________
27.	These valves remain closed. Check only if you suspect they have been opened. a. HV-580 CNST drain b. HV-590 CTDT make-up c. HV-591 CTDT drain d. HV-599 CNST make-up isolation	________
28.	Open these valves:	________
	a. HV-579 Hotwell make-up b. HV-585 Hotwell dump c. HV-589 CTP suction	________

STEP	DESCRIPTION	VERIFICATION
29.	Verify CTDT is full by overflow when M-U water is added thru HV-590; or if CTP is on for HRFS/FWP, verify CTDT maintains normal operating level of 18" between 16 and 20" at sight glass LI-585.	________
30.	Assure hotwell water quality is acceptable. Conduct (HRFS) water chemistry analysis as necessary to insure iron is less than 500 ppb. Record, if measured. Drain and refill hotwell if required to correct, Ref. POP #1A Parts B & C.	________ ppb. Iron
31.	Verify hotwell and CNST levels are correct. Conduct POP #1A Parts B & C, Hotwell and CNST level adjustment, if necessary, to correct.	
	a. Hotwell level 12" (betw. 9 & 14") at condenser sight glass LI-581, initially recorded in Step 3.	________
	b. CNST level between 12 & 30" at tank sight glass LI-584.	________
	c. Verify agreement between TCP meter LT-511 and LI-581 sight glass hotwell level.	________

F. CMUP Room - 80' Level

STEP	DESCRIPTION	VERIFICATION
32.	Verify FCV-471 is closed by inspection.	________
33.	Open HV-406 condensate return to HRFS.	________
34.	Verify no water or oil leaks or other abnormalities found.	________
35.	Advise control room that EPGS Pre-test checklist has been completed. (Turbine oil temperature & hotwell are okay).	________

"EPGS PRE-TEST CHECKLIST COMPLETE"

STEP	DESCRIPTION	VERIFICATION
A.	Turbine Oil Temperature Check, as Required. Reference EPGS Pretest Checklist Step 16.	
1.	Complete pretest checklist (Steps 10,14)	______
2.	Verify Turbine oil reservoir level is 2 1/2" + 1/2" above normal operating level mark at dipstick LI-582	______
3.	Verify EOP local disconnect switch is on.	______
4.	Conduct the following operations from the control location selected at the TCP mode select switch (TCPMS).	Local Remote
5.	Start EOP.	______
6.	Verify PT-501 oil pressure increases above 6 psi.	______
7.	Wait 1 minute, then check TT-521 oil temperature. If desired, confirm locally at TI-586.	______
8.	Check is complete if TT-521 oil temperature is above 70°F. Turn off EOP.	______
9.	If TT-521 oil temperature is below 70°F, leave on EOP and oil heater until temperature increases above 70°F, then turn off EOP.	______

NOTE

Pre-test checks may be continued during oil heating.

10.	Note in remote Emcon control, the oil heater auto control may be overridden and the heater forced on, if desired, by enabling 'OH.ON'.	Enable OH.ON
11.	Disable OH.ON and return heater control to auto after oil is warm.	Disable OH.ON

STEP	DESCRIPTION	VERIFICATION
B.	**Hotwell Level Adjust**, as Required	
1.	Complete pretest checklist (Steps 1 - 30)	________
2.	Transfer record of hotwell level here from POP #1 EPGS Pretest checklist Step 3.	Lvl. ____ "
3.	Verify remote Emcon EN.HLC auto hotwell level control is off.	________
4.	Make up Hotwell if less than 9"	________
	a. Attempt to determine cause of level loss (leaky pipes, improperly opened valves, shutdown). Correct as required. b. From TCP control location selected, open make-up FCV-512. c. Fill till hotwell level sight glass LI-581 is 12". d. If CNST did not have enough water to complete fill, close FCV-512, conduct CNST make-up (POP #1A Part C), then resume fill. e. Close FCV-512.	
5.	Dump Hotwell if above 14".	________
	a. Attempt to determine cause of level increase (improperly opened valves). Correct as required. b. Start CNP. c. Open FCV-511. d. Dump till hotwell level sight glass LT-581 is 12" e. Close FCV-511. f. Stop CNP.	
6.	Alternate dump if above 14" or to correct water quality (wastes condensate). Open CNP inlet strainer S-581 HV till LI-581 is 12", or if draining, Zero".	________
7.	Verify agreement between LT-511 TCP meter and LI-581 sight glass hotwell level. Record level as left.	Lvl. ____ "

STEP	DESCRIPTION	VERIFICATION

C. CNST Level Adjustment, as Required

1. Verify CNST level is between 12 and 30" at sight glass LI-584. __________

2. Dump if above 30" by draining through HV-580 into floor drain. The preferred dump is into the hotwell (POP #1A Part B, Step 4), but it is assumed here that the hotwell level is already properly adjusted. __________

3. Fill if lower than 12". __________

NOTE

This fill procedure will deplete the CMUP stand pipe. If CMUP is operating, do not allow this to happen by reducing the stand pipe air overpressure, either by relief valve manual blow-off or regulator adjustment.

a. Verify HRFS/Cycle Fill Pump is on.
b. Open CNST M-U FCV-541 with TCP switch.
c. Open M-U HV-599.
d. When filled, close HV-599 and FCV-541.
e. Readjust CMUP stand pipe level.

NOTE

Hydrazine can be added to the CNST as determined from a Water Quality Analysis by filling a beaker at the HRFS Hydrazine Feed Tank drain and pouring it into the CNST LS-541 flange opening.

This is all local from 7-65 thru to 7-72

STEP	DESCRIPTION	VERIFICATION

A. **EPGS PUMP S/U**

1. Verify:
   - Synch sw. handle has been procured as required.
   - POP #1 EPGS Pretest Checklist is complete.
   - EPGS control is in local (Do not disrupt CNP oper.). ______
2. Start CTP, if not already on. Verify on. ______
3. Start CTF if ambient temp. is above freezing. Verify. ______
4. Confirm LT-511 hotwell level is 12" (or between 9 & 14"). ______
5. Open FCV-551 for CNP recirculation. ______
6. Start CNP. Verify on, LT-511 hotwell level will drop 1". Note EPS will lock this out upon prior SGS BCP shutdown. Advise the Emcon operator to reset EPS 3 and 2 to clear. ______
7. Start AEP. Verify on, PT-502 condenser pressure should decrease to less than 15" Hg. ______
8. Confirm oil cooling FCV-521 closed (Emcon ZT-521). ______
9. Place EOP select. sw. in auto. Start EOP. Verify on. PT-501 oil bearing pressure should increase above 8 psi. ______
10. Wait 1 minute, then verify TT-521 oil temperature is above 60°F. ______
11. Reset Emerg. trip ETR (FCV-561) and verify PT-531 Hydraulic oil pressure is above 50 psig. ______

'EPGS PUMPS ON'

STEP DESCRIPTION VERIFICATION

B. T-G SET-UP

1. Verify from Emcon operator that condenser cooling water temp. TE-486 is below 100°F. ______

2. Verify SGS steam production from Emcon operator. ______

a. PT-431 Steam pressure above 1000 psi
b. TE-483 Steam temperature above 600°F and rising ______

3. Verify from Emcon operator that SGS is in manual salt flow control (5 klb/hr min. steam flow) and FCV-431 is controlling steam pressure. ______

4. Advise the Emcon operator to transfer primary D/D level control from CMUP to CNP by activating FCV-471 with a SP of 15" and resetting the SP of FY-472 to 14". ______

5. ~~Close~~ CLOSE CNP recirc. FCV-551. ______

6. Verify EPGS turbine start-up readiness

a. (sight windows) FI-501 & 502 brg. oil flow
b. TT-521 oil temperature above 60°F
c. PT-501 brg. oil press above 8 psig
d. PT-502 condenser vacuum below 15" Hg.
e. LT-511 hotwell level at 12" (betw 9 & 14")
f. PT-531 hydraulic oil press above 50 psig ______

7. Drain steam pipe condensate by opening HV-592A & B until dry steam emerges. Reclose. Open Traps. ______

8. Verify TT-583 turb. steam temp. is above 550°F. ______

9. Open FCV-501 to allow steam up to throttle valve. ______

10. Verify PT-581 turb. steam press. increases above 850 PSI. ______

11. Record time of day and wait 2 min. to warm pipe before starting turbine. ______ Time

12. Establish LT-511 12" hotwell lvl. control betw. 9 & 14"

1. Continuously monitor LT-511 hotwell lvl.

2. Dump if LT-511 above 14" by opening FCV-511 until level drops to 12".

3. Make-up if LT-511 below 9" by opening FCV-512 until level rises to 11". (Continuous)

13. Establish FCV-521 120°F cool. oil temp. cont'l.

1. Continuously monitor TT-521 oil temp.

2. Adjust FCV-521 position to maintain TT-521 oil temp. at 120°F (betw. 110-130°) (Continuous)

STEP **DESCRIPTION** **VERIFICATION**

WARNING

Clear non-involved personnel
away from the T-G for safety.

CAUTION

Trip Turbine if operation abnormal with ET - Emerg. Trip

NOTES

1. Maintain coordination between T-G and Steam operations.

2. Verify proper turbine operation as follows:

   a. Field monitor

      1. Turbine rolling
      2. No abnormal rubbing or noise (rod ck)
      3. No unusually excessive vibration (5 G Trip)
      4. FI-501 & 502 bearing oil flowing (sight windows)

   b. Instruments

      1. ST-582 generator speed below 1250 rpm
      2. AZT-581 turbine vibration not abnormal (Emcon VIB.OVR override available)
      3. TT-501, 502, 507 (also TE-503, 505, 506 at Emcon). Bearing oil temp.'s equalize within 20° of each other, within 50° of TT-521, and betw. 60 - 170°F limits.
      4. PT-502 cond'r vacuum below 15" Hg.
      5. PT-582 steam seal press. above ___ PSI.
      6. TT-583 steam temperature above 700°F
      7. PT-581 steam pressure above 850 PSI

   c. Controls

      1. LT-511 hotwell level between 9 & 14"
      2. TT-521 cooling oil temp. between 60 & 130°F.
      3. EOP controlling hydraulic oil press. at 120 psi. (On at lo pressures, Off when shaft pump operating).

3. Verify ET/OST Turbine trips as follows:

   a. PT-531 hydraulic oil press drops to '0' PSI
   b. ST-582 generator speed decreasing
   c. Turbine physically slowing down
   d. FCV-501 closed (ZSL-501 on)

4. Conduct the following 3 test trips to verify their functional operation & preheat the Turbine.

STEP DESCRIPTION VERIFICATION

C. T-G START-UP

1. Start the 1st Turbine roll to half speed, after 2 minute pipe warming, by opening throttle valve to 25% with motor. Continue opening throttle valve manually untill roll starts, then close slightly to roll-out very slowly and smoothly. Progressively and very slowly increase speed to 600 RPM. Verify proper Turbine operation (Note 2). ________

2. Conduct test trip 1 - Lo speed MOST (Man. Overspeed Trip):

   a. Hit OST trip button on turbine
   b. Verify turbine tripped (Note 3)
   c. Reset OST mechanism
   d. Reset throttle valve closed TVM.CLS, ZT-581 0% open
   e. Reset EPS2.RST
   f. Verify trip reset by PT-531 hydraulic oil pressure above 50 psi ________

3. Restart Turbine a 2nd time to half speed, if trip functioned properly and before turbine stops, by reopening FCV-501 and throttle valve until generator again slowly reaches 600 RPM. Reverify proper Turbine operation (Note 2). ________

4 Conduct test trip 2 - Lo speed ET (Emerg. Trip):

   a. Actuate ET Emerg. Trip
   b. Verify Turbine tripped (Note 3)
   c. Reset ETR FCV-561 (ET off)
   d. Reset throttle valve closed TVM.CLS, ZT-581 0% open
   e. Reset EPS2.RST
   e. Verify trip reset by PT-531 hydraulic oil pressure above 50 psi

5. Restart Turbine a 3rd time to full speed, if trip functioned properly and before turbine stops, by reopening FCV-501 and throttle valve until generator slowly reaches 1200 RPM. Locally guarantee ST-582 gen. speed does not exceed 1200 rpm and that govern. control holds it at 1200 rpm. Reverify proper turb. operation (Note 2). Do not prolong full speed operation unless TT-521 above 100°F ________

6. Conduct test trip 3 - Full speed trip. On alternate day start-ups, repeat either the MOST, the ET, or the EPS T-G trip (Control Room PB). MOST ET PB

7. Restart Turbine a 4th time to full speed by reopening FCV-501 and throttle valve 100%. Locally guarantee ST-582 gen. speed holds at 1200 rpm. ________

STEP	DESCRIPTION	VERIFICATION
8.	Reverify proper turbine operation (Note 2). Continue manually controlling LT-511 and FCV-521. Confirm CTF is on and EOP is off.	________

CAUTION

Do not continue full speed oper. unless TT-521 oil temperature quickly increases above 110°F (within 5 minutes)

9.	Locally turn on Exciter Disc. Sw. to start Generator voltage build-up.	________
10.	Verify generator no-load operation: a. 460V at GCP meter or Emcon ET-581 b. 'O'A at GCP meter or Emcon IT-581 c. Generator air temperature below 120°F (Emcon TE-508) d. Emcon gen. stator temp.'s equalize within 5°F below 180°F. (Emcon TT-510 thru 515)	________

CAUTION

Synchronize the generator ASAP after achieving turbine full speed and generator voltage to minimize high turbine exhaust temperatures. TI-581 or TE-581 should be kept below 150°F.

NOTE

During the turbine heat soak, SGS salt flow can be reduced to the minimum required to maintain 1100 psi steam (controlled by HRFS FCV-431) to conserve hot salt.

STEP	DESCRIPTION	VERIFICATION

D. GENERATOR SYNCHRONIZING / LOCAL OR EMCON

1. Verify that T-G operation is established and then continue to complete this synch. procedure ASAP. A control transfer from local to Emcon may be done at this point. Local Emcon

NOTE

Synchronizing control location coincides with turbine control location (i.e., Local - GCP or Remote - RGP) as determined by TCPMS.

2. Advise the steam operator to prepare for Gen. Sync. by increasing SGS salt flow to 10 klbs/hr, (FCV-321 in flow control), and insuring that HRFS FCV-431 is in steam press. control. Verify that he has done so before proceeding. ______

3. Verify gen. speed above 1150 rpm and adjust to rated speed of 1200 rpm and freq. of 60 HZ with the governor control sw. ______

4. Adjust the generator sync voltage using the voltage control switch until the running volts equals incoming volts at approximately 120 v. + 2 V. ______

5. Install the sync sw handle and place the sync sw in the ON position. Verify sync LT's and synchroscope operation. ______

6. Adjust the generator speed with the governor control switch until the pointer on the synchroscope slowly rotates in a clockwise (fast) direct. ______

CAUTION

The generator must be in sync prior to closing the generator circuit breaker.

7. When the pointer is just before 12 o'clock with the sync lights out, close the generator circuit breaker. ______

8. Verify the generator C/B closes by red light on. ______

9. Partially load the generator to about 25 KW by raising the turb. gov. setting with the governor control switch. ______

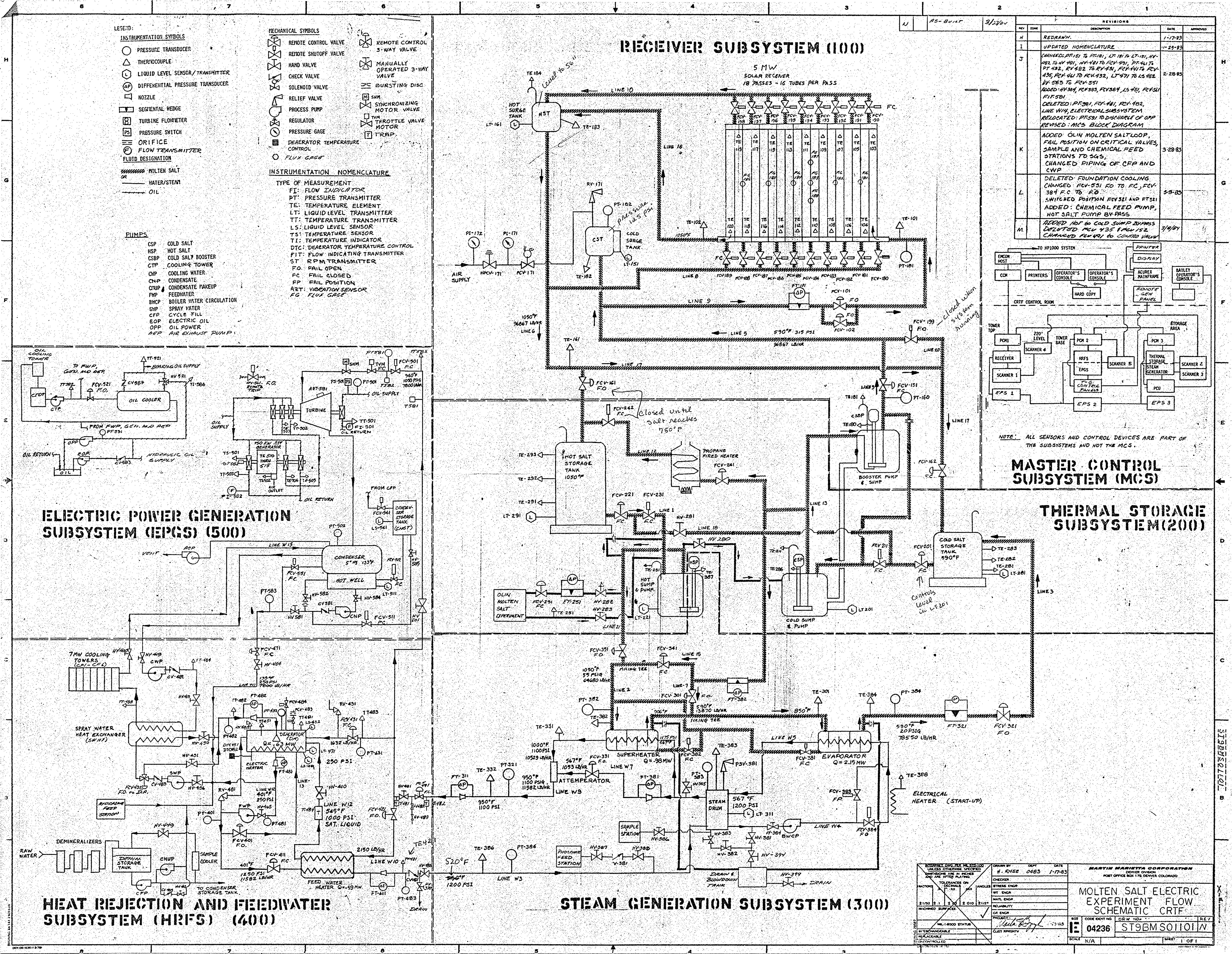
10. Adjust the power factor between 1 and .8 lag with the voltage control switch (5 - 10 KVARS at VT-581). ______

11. Turn off the sync switch, record time and heat soak the Turbine for 15 minutes at this load. A control transfer from local to Emcon may be done at this point. ______ Time

12. Start conducting T-G hourly checks. ______

CAUTION

On-line generator breaker trips automatically initiate a turbine trip by FCV-501 closure.



LEGEND:
INSTRUMENTATION SYMBOLS
PRESSURE TRANSDUCER
THERMOCOUPLE
LIQUID LEVEL SENSOR/TRANSMITTER
DIFFERENTIAL PRESSURE TRANSDUCER
NOZZLE
SEGMENTAL WEDGE
TURBINE FLOWMETER
PRESSURE SWITCH
ORIFICE
FLOW TRANSMITTER
FLUID DESIGNATION
MOLTEN SALT
WATER/STEAM
OIL
MECHANICAL SYMBOLS
REMOTE CONTROL VALVE
REMOTE SHUTOFF VALVE
HAND VALVE
CHECK VALVE
SOLENOID VALVE
RELIEF VALVE
PROCESS PUMP
REGULATOR
PRESSURE GAGE
DEAERATOR TEMPERATURE CONTROL
FLUX GAGE
REMOTE CONTROL 3-WAY VALVE
MANUALLY OPERATED 3-WAY VALVE
BURSTING DISC
SYNCHRONIZING MOTOR VALVE
THROTTLE VALVE MOTOR
TRAP
INSTRUMENTATION NOMENCLATURE
TYPE OF MEASUREMENT
FI: FLOW INDICATOR
PT: PRESSURE TRANSMITTER
TE: TEMPERATURE ELEMENT
LT: LIQUID LEVEL TRANSMITTER
TT: TEMPERATURE TRANSMITTER
LS: LIQUID LEVEL SENSOR
TS: TEMPERATURE SENSOR
TI: TEMPERATURE INDICATOR
DTC: DEAERATOR TEMPERATURE CONTROL
FIT: FLOW INDICATING TRANSMITTER
ST: RPM TRANSMITTER
FO: FAIL OPEN
FC: FAIL CLOSED
FP: FAIL POSITION
AZT: VIBRATION SENSOR
FG: FLUX GAGE
PUMPS
CSP COLD SALT
HSP HOT SALT
CSBP COLD SALT BOOSTER
CTP COOLING TOWER
CWP COOLING WATER
CNP CONDENSATE
CMUP CONDENSATE MAKEUP
FWP FEEDWATER
BWCP BOILER WATER CIRCULATION
SWP SPRAY WATER
CFP CYCLE FILL
EOP ELECTRIC OIL
OPP OIL POWER
AEP AIR EXHAUST PUMP
RECEIVER SUBSYSTEM (100)
5 MW SOLAR RECEIVER
18 PASSES – 16 TUBES PER PASS
HOT SURGE TANK
COLD SURGE TANK
AIR SUPPLY
pressure 125 psi
level to 56"
1050°F 96667 LB/HR
590°F 315 PSI 96667 LB/HR
closed when system running
closed until salt reaches 750°F
HOT SALT STORAGE TANK 1050°F
PROPANE FIRED HEATER
BOOSTER PUMP & SUMP
COLD SALT STORAGE TANK 590°F
HOT SUMP & PUMP
COLD SUMP & PUMP
OLIN MOLTEN SALT EXPERIMENT
Controls level in LT 201
THERMAL STORAGE SUBSYSTEM (200)
MASTER CONTROL SUBSYSTEM (MCS)
NOTE: ALL SENSORS AND CONTROL DEVICES ARE PART OF THE SUBSYSTEMS AND NOT THE MCS.
TO HP1000 SYSTEM
EMCON HOST
CCM
PRINTERS
OPERATOR'S CONSOLE
HARD COPY
ACUREX MAINFRAME
BAILEY OPERATOR'S CONSOLE
PRINTER
DISPLAY
REMOTE GEN PANEL
CRTF CONTROL ROOM
TOWER TOP
TOWER BASE
STORAGE AREA
RECEIVER
SCANNER 1
SCANNER 2
SCANNER 3
SCANNER 4
SCANNER 5
THERMAL STORAGE STEAM GENERATOR
EPGS
HRFS
EPS 1
EPS 2
EPS 3
ELECTRIC POWER GENERATION SUBSYSTEM (EPGS) (500)
OIL COOLING TOWER
OIL COOLER
TURBINE
750 KW 3Ø GENERATOR
CONDENSER 5 M² 133°F
HOT WELL
CONDENSATE STORAGE TANK (CNST)
HYDRAULIC OIL SUPPLY
OIL RETURN
OIL SUPPLY
HEAT REJECTION AND FEEDWATER SUBSYSTEM (HRFS) (400)
7 MW COOLING TOWERS (CP1 – CP6)
SPRAY WATER HEAT EXCHANGER (SWHE)
DEAERATOR (DA) Q = .63 MW
ELECTRIC HEATER
250 PSI
LINE W12 545°F 1000 PSI SAT. LIQUID
HYDRAZINE FEED STATION
DEMINERALIZERS
RAW WATER
DEMIN. STORAGE TANK
SAMPLE COOLER
TO CONDENSER STORAGE TANK
FEED WATER HEATER Q = .69 MW
401°F 1250 PSI 11582 LB/HR
2150 LB/HR
520°F 1200 PSI
STEAM GENERATION SUBSYSTEM (300)
SUPERHEATER Q = .98 MW
ATTEMPERATOR
EVAPORATOR Q = 2.15 MW
STEAM DRUM 567°F 1200 PSI
MIXING TEE
1050°F 55 PSIG 64680 LB/HR
590°F 13870 LB/HR
850°F
590°F 20 PSIG 78550 LB/HR
1000°F 1100 PSI 10529 LB/HR
950°F 1100 PSIG 11582 LB/HR
950°F 1100 PSI
ELECTRICAL HEATER (START-UP)
SAMPLE STATION
PHOSPHATE FEED STATION
DRAIN & BLOWDOWN TANK
DRAIN
REVISIONS
N AS-BUILT 3/27/84
H REDRAWN. 1-17-83
I UPDATED NOMENCLATURE 1-25-83
J CHANGED: PT-151 TO PT-181, LT 181 TO LT-151, HV-482 TO HV 401, HV-481 TO FCV-491, PT-461 TO PT 432, RV 482 TO RV 431, FCV-441 TO FCV-436, FCV-461 TO FCV-432, LT 471 TO LS 452, HV-583 TO FCV-551. ADDED: HV 384, FCV 383, FCV 384, LS 451, FCV-511, FIT-581. DELETED: PT-381, FCV-481, FCV-482, LINE W14, ELECTRICAL SUBSYSTEM. RELOCATED: PT-581 TO DISCHARGE OF OPP. REVISED: MCS BLOCK DIAGRAM 2-28-83
K ADDED OLIN MOLTEN SALT LOOP, FAIL POSITION ON CRITICAL VALVES, SAMPLE AND CHEMICAL FEED STATIONS TO SGS, CHANGED PIPING OF CFP AND CWP 3-28-83
L DELETED FOUNDATION COOLING. CHANGED FCV-531 FO TO FC, FCV-384 F.C TO F.O. SWITCHED POSITION FCV 321 AND FT 321. ADDED: CHEMICAL FEED PUMP, HOT SALT PUMP BY-PASS 5-5-83
M ADDED Hot to Cold Sump Bypass. Deleted FCV 435 & FCV 152. Changed FCV 491 to control valve 3/8/84
DRAWN BY H. RHEE 0483 1-17-83
MARTIN MARIETTA CORPORATION
DENVER DIVISION
POST OFFICE BOX 179, DENVER COLORADO
MOLTEN SALT ELECTRIC EXPERIMENT FLOW SCHEMATIC CRTF
SIZE E CODE IDENT NO. 04236 DRW NO. ST9BMS01101 REV N
SCALE N/A SHEET 1 OF 1

TEST DATE

POP #2A EPGS HOURLY OPERATING CHECK-LIST   UPDATED 6/20/84

Verify all Parameters ½ Hourly or Hourly as shown.
Record Values for Parameters indicated 'R'.
Primarily Monitor Guage Values,
Compare & Confirm TCP & EMCON values

AREA	PARAMETER	LOCAL	TCP/EMC	EMCON	VALUE	V	1 (TIME, ½ HR)	2 (TIME, ½ HR)	3 (TIME, 1 HR)	4 (TIME, 1 HR)	5 (TIME, 1 HR)	6 (TIME)
COND'R	COND'R VAC.	PI-584	PT-502		< 15" Hg.	R						
	COND'R (STEAM) TEMP.	TI-581				R						
	HOTWELL (CONDENSATE) TEMP.	TI-582			100-150°F	R						
	HOTWELL LVL.	LI-581	LT-511		9-14"							
	COND'R GLYCOL C.W. IN	TI-584			< 120°F	R						
	COND'R GLYCOL C.W. OUT	TI-583			< 120°F	R						
	COND'R GLYCOL C.W.	PI-586			16 PSI	R						
60' LVL	AEP SEP. TK LVL.	LI-583			4-6"							
	AEP C.W. TEMP	TI-590			< 120°F	R						
	CNP SUCT.	PI-585				R						
	CNP DISCH.			PT-583		R						
TANKS	CNST LVL.	LI-584			12-30"							
	CTDT LVL	LI-585			16-20"							
	CTP SUCT	PI-588			1" Hg. Vac.							
	CTP DISCH	PI-587			30-35 PSI	R						
	C.W.			TE-582		R						

AREA	PARAMETER	LOCAL	TCP/EMC	EMCON	VALUE	V	1	2	3	4	5	6
TURB	OIL LVL.	DIPSTICK LI-582			OPER. LVL MARK							
	OIL FLOW	FI-501			FLOW							
		FI-502			FLOW							
	OIL PRESS BRG.	PI-581	PT-501		>6 PSI							
	OIL PRESS HYD.	PI-582	PT-531		>50 PSI							
	BRG OIL TEMP.		TT-501		110-170°F	R						
			TT-502		110-170°F	R						
				TE-503	110-170°F	R						
				TE-505	110-170°F	R						
				TE-506	110-170°F	R						
			TT-507		110-170°F	R						
	COOLER OIL TEMP.	TI-586	TT-521		80-130°F	R						
	COOLER C.W TEMP IN	TI-588			<120°F	R						
	COOLER C.W TEMP OUT	TI-587			<120°F	R						
	MAIN ST.		PT-581		850 PSI	R						
			TT-583		750°F	R						
	ST. SEAL	PI-583				R						
			PT-582			R						
GEN	AIR TEMP	TI-580		TE-508	<100°F <40°C	R						
	C.W. TEMP	TI-589			<120°F	R						
	STATOR TEMP				<260°F	R						
					<260°F	R						
					<260°F	R						
					<260°F	R						
					<260°F	R						
					<260°F	R						
GEN ELECT. ★	WATTS		JT-581		<750 KW	R						
	VARS		VT-581		<100 KVAR							
	VOLT		ET-581		460V							
	CURRENT		IT-581		<1200 A							
	POWER FACTOR		PFT-581		1 To .8 Lag							
	FREQ.		ST-581		60 Hz							

★ INSTR's Listed are at GCP/EMC.

STEP	DESCRIPTION	VERIFICATION

A. LOCAL START-UP COORDINATION

Complete these items at the request of the local EPGS operator.

1. Momentarily enable EPS3.RST and EPS2.RST if required. ____________
2. Verify Condenser C.W. temperature TE-486 is below 100°F. ____________
3. Transfer primary D/D level control from CMUP to CNP by activating FCV-471 with a SP of 15" and resetting the SP of FY-472 to 14". ____________
4. Verify PT-431 above 1000 psi and TE-483 above 600°F. ____________
5. Place/confirm SGS in manual salt flow control (5 klb/hr min. steam flow) with FCV-431 activated and MAN.321 on. ____________

B. EPGS CONTROL TRANSFER CHECKLIST

Complete this checklist before transferring EPGS control from Local to Emcon (TCPMS 'OFF' to 'ON') after T-G operation is locally established (POP #2A). PCK may be used to auto align these, turning itself off when complete.

1. Turn on FCV-501. ____________
2. Enable the auto. hotwell level control EN.HLC. ____________
3. Verify that lube oil cooling FCV-521 is in auto S.P. 120°F. ____________
4. Turn on the following enable and control signals:

(19)	(20)	(21)
CTP	CTF	CNP
CTP.EN	CTF.EN	CNP.EN
		AEP
		AEP.EN
		EOP
		EOP.EN

____

5. Enable EPGS operational alarms PAL. ____________

NOTE

Control transfer may be completed before or after synchronizing. Follow POP #2A guidelines to synch.

6. Coordinate transfer with EPGS technician, accomplished by him switching TCP key switch from local to remote. ____________

STEP DESCRIPTION VERIFICATION

C. STEAM CONTROL TRANSFER

1. Transfer SGS steam control from manual salt flow to boiler following mode.

   a. Assure steam flow FT-311 is 5 klb/hr or more with FCV-321 in manual (SGS in manual flow control, FCV-431 is controlling steam line pressure). ________

   b. Load turbine generator to 50-100 KW, 10-20 KVARS. ________

   c. Verify FCV-321 is cascaded at Net 90 in preparation for it to assume control. ________

   d. Turn off MAN.321. This puts FCV-321 in auto, controlling steam pressure at 1100 psi. (SGS in boiler following mode). Note FCV-431 is also in auto SP 1080 psi at this time. ________

   e. Once FCV-321 has stabilized, (ZT-321 doesn't fluctuate too much), immediately continue on. (Otherwise deactivate FCV-431 & manually control.) ________

2. Prepare for Gen. Loading by completing the following to actuate GSTAT (Gen. status). GSTAT is only used when the T-G is on-line. Its function is to shift FCV-431 casc. control from steam line pressure PT-431 to D/D press. PT-432. D/D overpress. is limited by FCV-432.

   a. Verify PT-432 is in auto SP 225 psi. When PT-432 goes above 225 psi, turn on GSTAT. ________

   b. Continue to monitor FCV-321, FCV-431, FCV-432 to ensure GSTAT is functioning properly. ________

D. GENERATOR LOADING

CAUTION

Coord. gen. load changes with the steam system and do not increase gen load faster than 75 kw/min. SGS load following cannot exceed a steam flow ramp rate of 10%/min.

1. Determine & adjust generator load to required load conditions using the gov. and volt. control switches. ________

CAUTION

Do not exceed rated load conditions of 750 KW at 0.8 P.F. lag (between 0.8 & 1.0 lag)

2. Monitor the attached list of T-G operating parameters. Verify the local T-G hourly checklist is being completed. ________

Monitor these parameters intermittantly during T-G operation from Emcon:

GROUP	PARAMETER	DESCRIPTION	VALUE	PARTICULARLY
23	JT-581 VT-581	KW generation KVAR generation	0 - 750 KW 10 - 20 KVAR	Watch for creep Adjust with load
22	TT-501 TT-502 TE-503 TE-505 TE-506 TT-507	Brg. oil temps	110 - 160 °F	Establish stability
23	TT-510 TT-511 TT-512 TT-513 TT-514 TT-515	Gen. stator temps	150 - 200 °F	Establish stability
22	PT-581 TT-583	Steam pressure Steam temp.	above 750 psi above 750 °F	Trip parameter Trip parameter
call-up	TT-509	Gen. air temp	below 110 °F	Trip parameter
22	PT-502	Condenser vacuum	below 15 "Hg.	Affects KW generation
22 21	LT-511 FCV-521	Hotwell level Oil temp. control	9 - 14 " 120 °F	Controls check Controls check
call-up	TE-581	Turb. exh. temp	130 -150 °F	Minimize overtemp.

STEP DESCRIPTION | VERIFICATION

A. T-G Manual Emerg. trip

NOTE

Initiate emerg shutdown only if necessary, but do not hesitate if emerg. conditions exist. Advise all operators of actions ASAP. If possible, try to reduce generator load before trip with governor control switch.

1. Open generator breaker with breaker CS
or Actuate ET
or Actuate EPS T-G trip button from control room.
(Operate all 3 for safety) C.S. ET. EPSTGT

CAUTION

Stay clear of T-G/generator breaker for safety. Expect HRFS & SGS safety relief valves to open. SGS salt flow will stop and HRFS will attempt to desuperheat steam.

2. Verify trip; turbine speed decreasing, gen. breaker open. ________

3. When safe and orderly, proceed with manual shutdown Step 6. ________

B. T-G Normal Shutdown

1. Establish communications with Emcon operator to coordinate generator load shedding with steam reduction operations. ________

2. Reduce generator load by lowering governor contol switch and voltage control switch. Do not reduce load faster than 75 kw/min. (Do not exceed an SGS steam flow reduction rate of 10%/min.) ________

NOTE

Opening the gen. bkr CS automatically initiates a turb. trip by FCV-501 closure.

3. Shutdown the T-G by opening the generator breaker with the breaker control switch as generator load is reduced to zero with the governor control switch. ________

4. Verify generator breaker open by green light on. ________

	STEP	DESCRIPTION	VERIFICATION
	5.	Verify turbine trip by FCV-501 closure (Emcon ZSL501 on), turbine steam press PT-581 decrease to zero and generator speed ST-582 decreasing. Manually close FCV-501 control switches also.	
	[redacted]		xxxxx
	7.	Verify T-G speed ST-582 decreases to zero.	
	8.	Verify throttle valve reset closed by ZT-581 0% open.	
18	9.	Emcon operator deactivate FCV-471 and change FY-472 SP to 15"	
	10.	Record time of day to allow 20 min. turbine/condensor vapor extraction before AEP shutdown (Step 16). As req'd, continue with shutdown up to that step.	Time
	11.	Emcon operator turn off GSTAT and deactivate alarms (PAL off). A control transfer may be done at this point.	

'T-G SHUTDOWN'

C. EPGS Shutdown

	STEP	DESCRIPTION	VERIFICATION
21	12.	Turn off EOP.	
	13.	Close cooling oil temp control FCV-521 a. TCP local control mode - Use FCV-521 dial. b. TCP remote control mode - Emcon operator place FCV-521 in manual close.	
22	14.	If operating remotely, Verify LT-511 hotwell level is between 9& 14", then disable EN.HLC.	
	15.	If operating locally, adjust LT-511 hotwell level to 12", then close TCP switches for FCV-501, 511, 512, 541, & 551.	
21	16.	Turn off CNP.	
	17.	Insure 20 min. have elapsed after T-G shutdown (Step 10) before proceeding.	
	18.	Turn off AEP.	
20	19.	Turn off CTF.	
19	20.	Turn off CTP, unless still required for HRFS/FWP.	
	21.	Complete the EPGS post test check-list.	As req'd

'EPGS SHUTDOWN'

Test Date
6/19/84

POP #4 EPGS POST-TEST CHECKLIST

This electric Power generation operating procedure will be utilized to verify EPGS integrity following all tests that use the EPGS. This checklist shall be completed by the EPGS technician.

STEP	DESCRIPTION	VERIFICATION
1.	If used, remove the GCP synchronizing switch handle and return it to the MSEE key box.	________
2.	Turn off local starters. Do <u>not</u> turn off CTP if being used for HRFS/FWP. a. CTF b. CTP c. AEP d. EOP e. CNP f. Exciter Disconnect g. Throttle Valve Disconnect	________
3.	Verify oil heater and generator heater local starters are on, TCP switches are in auto, and Emcon 'OH.ON' is off.	________
4.	Turn off Exciter cabinet vent fans.	________
5.	Verify EPGS UPS has 2 green lights on.	________
6.	Record, then Reset any trip functions.	________
7.	Verify throttle valve is reset closed by inspection. No unthreaded rod showing on cylinder screw.	________
8.	Verify FCV-501 is closed by inspection.	________
9.	Close these valves: a. HV-579 Hotwell make-up Tanks at 80' Level b. HV-585 Hotwell dump Tank at 80' Level c. HV-406 Condensate to HRFS CMUP room at 80'	________
10.	Drain hotwell through CNP S-581 HV if extended shutdown planned (longer than 1 week).	________
11.	Verify no evidence of leaks or other abnormalities found.	________
12.	Notify control room that the EPGS post-test has been completed.	________

'EPGS SECURED"

Section 8

EMCON Graphics and Groups

This section contains reproductions of the EMCON graphic displays and the pre-defined groups in the 22 line format. This material is arranged as follows:

Graphic Displays

Pre-defined Groups

RECEIVER PANEL

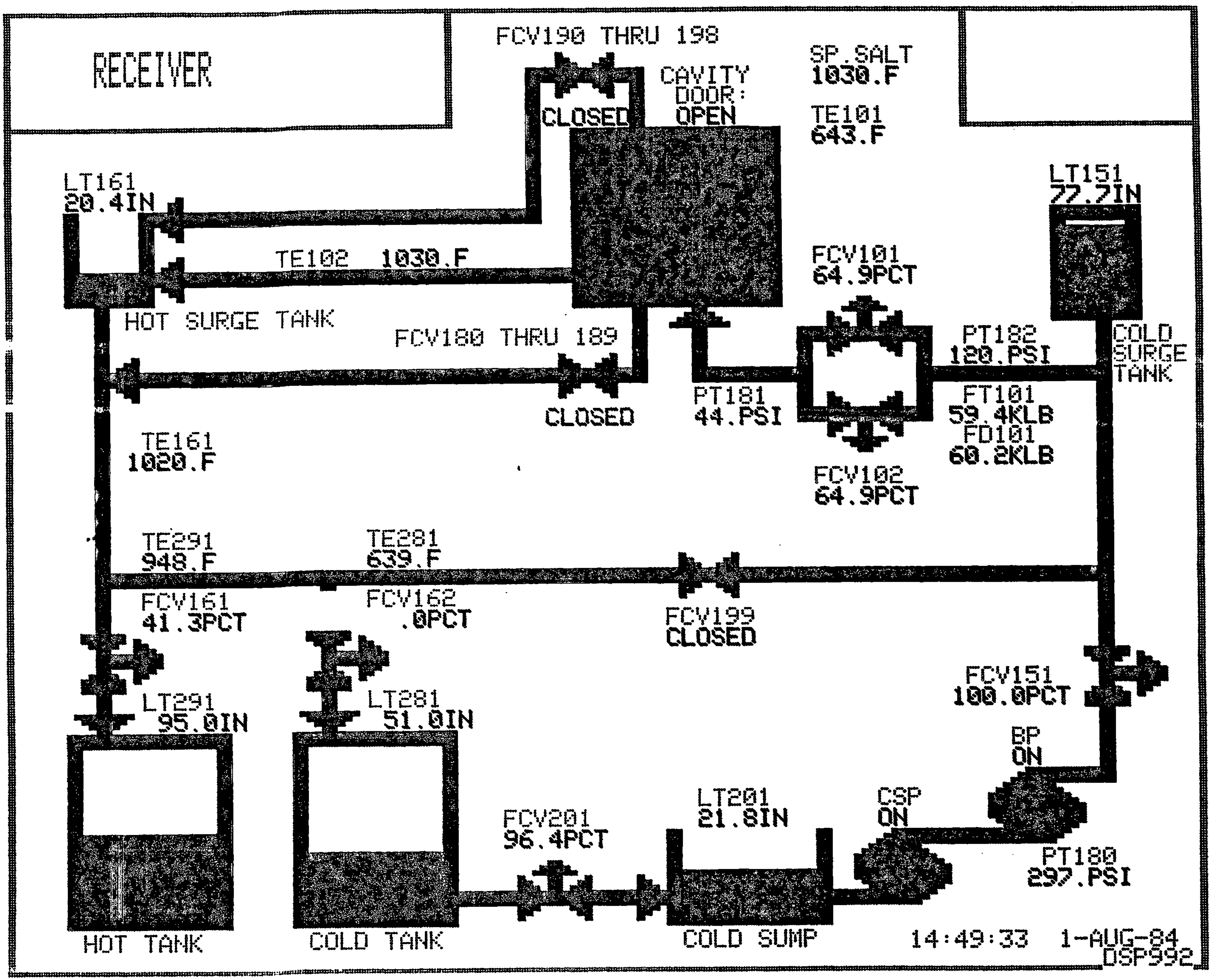
MAX T: 848.F MIN T: 486.F

EAST | WEST

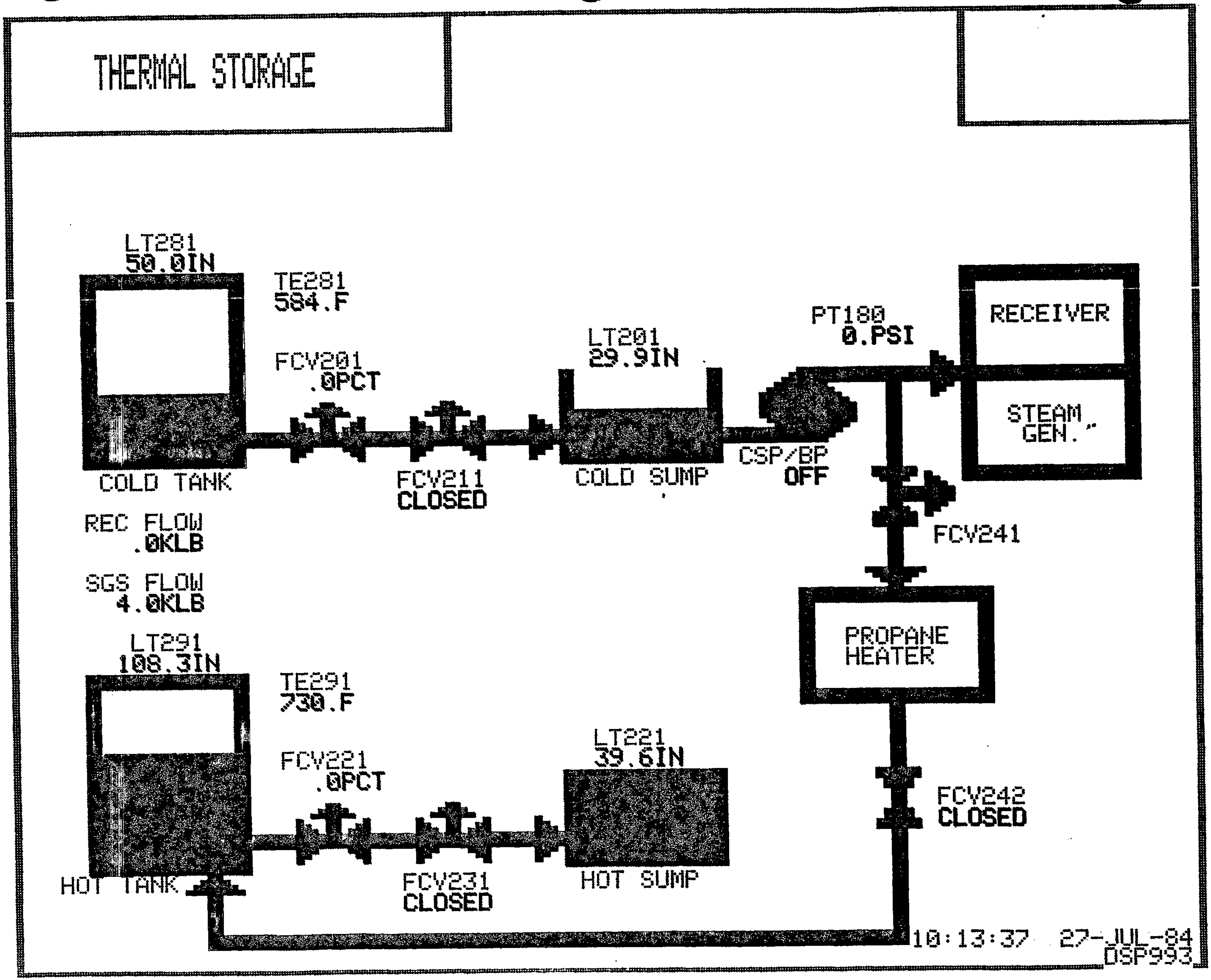
TE136	TE135	TE134	TE133	TE132	TE131
850.F	696.F	675.F	559.F	566.F	498.F
TE142	TE141	TE140	TE139	TE138	TE137
837.F	792.F	528.F	644.F	688.F	641.F
TE148	TE147	TE146	TE145	TE144	TE143
600.F	819.F	613.F	649.F	730.F	487.F

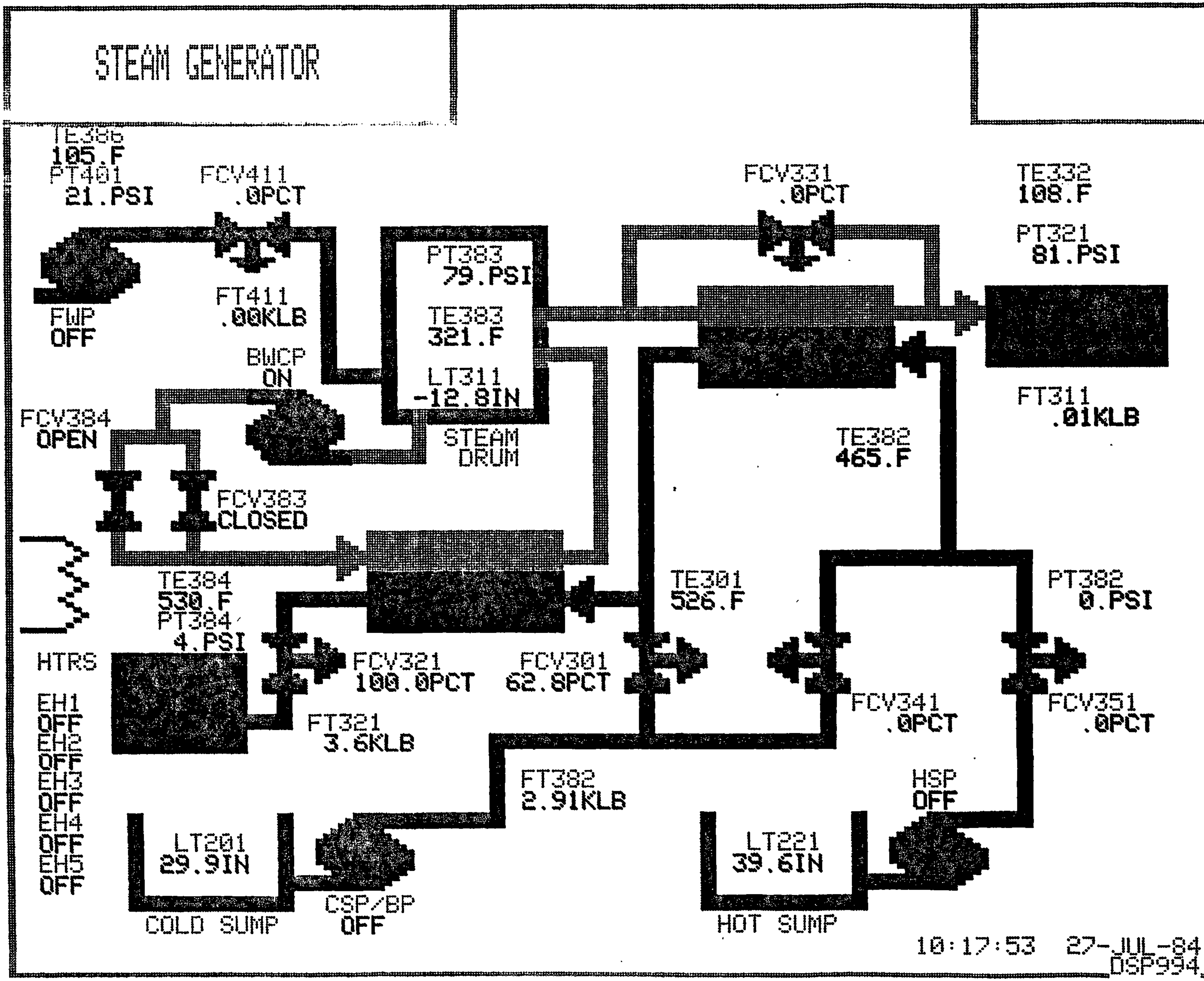
09:36:03 30-JUL-84

DSP990



RECEIVER
FCV190 THRU 198
CLOSED
CAVITY
DOOR:
OPEN
SP.SALT
1030.F
TE101
643.F
LT161
20.4IN
TE102 1030.F
HOT SURGE TANK
FCV180 THRU 189
CLOSED
LT151
77.7IN
FCV101
64.9PCT
PT182
120.PSI
COLD
SURGE
TANK
PT181
44.PSI
FT101
59.4KLB
FD101
60.2KLB
FCV102
64.9PCT
TE161
1020.F
TE291
948.F
TE281
639.F
FCV161
41.3PCT
FCV162
.0PCT
FCV199
CLOSED
FCV151
100.0PCT
LT291
95.0IN
LT281
51.0IN
BP
ON
CSP
ON
LT201
21.8IN
FCV201
96.4PCT
PT180
297.PSI
HOT TANK
COLD TANK
COLD SUMP
14:49:33 1-AUG-84
DSP992


THERMAL STORAGE
LT281
50.0IN
TE281
584.F
COLD TANK
FCV201
.0PCT
FCV211
CLOSED
LT201
29.9IN
COLD SUMP
CSP/BP
OFF
PT180
0.PSI
RECEIVER
STEAM GEN.
FCV241
REC FLOW
.0KLB
SGS FLOW
4.0KLB
LT291
108.3IN
TE291
730.F
HOT TANK
FCV221
.0PCT
FCV231
CLOSED
LT221
39.6IN
HOT SUMP
PROPANE HEATER
FCV242
CLOSED
10:13:37 27-JUL-84
DSP993


STEAM GENERATOR
TE386
105.F
PT401
21.PSI
FCV411
.0PCT
FT411
.00KLB
FWP
OFF
PT383
79.PSI
TE383
321.F
LT311
-12.8IN
STEAM
DRUM
BWCP
ON
FCV384
OPEN
FCV383
CLOSED
FCV331
.0PCT
TE332
108.F
PT321
81.PSI
FT311
.01KLB
TE382
465.F
TE384
530.F
PT384
4.PSI
HTRS
EH1
OFF
EH2
OFF
EH3
OFF
EH4
OFF
EH5
OFF
FCV321
100.0PCT
FT321
3.6KLB
FCV301
62.8PCT
TE301
526.F
PT382
0.PSI
FCV341
.0PCT
FCV351
.0PCT
FT382
2.91KLB
HSP
OFF
LT201
29.9IN
COLD SUMP
CSP/BP
OFF
LT221
39.6IN
HOT SUMP
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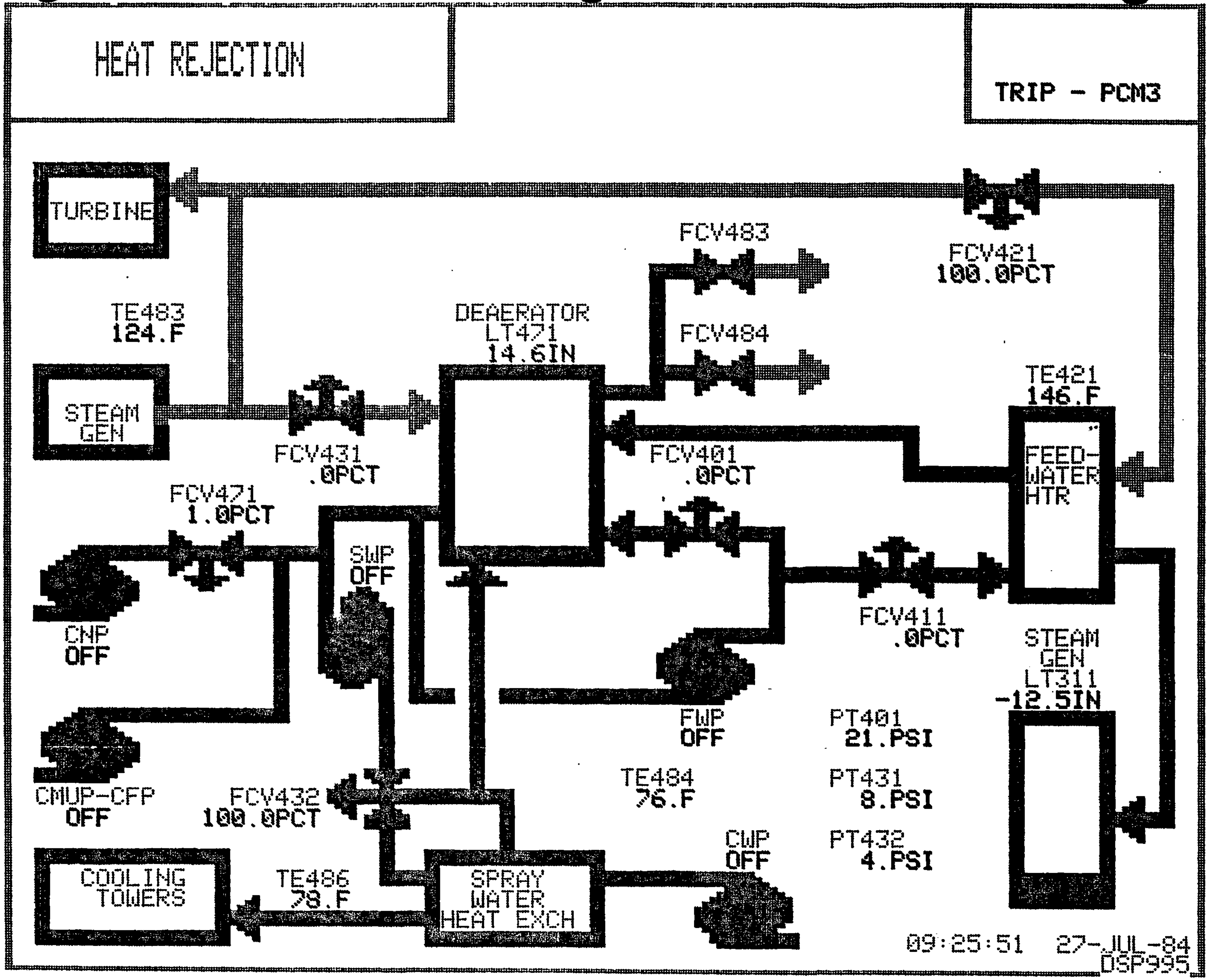
DSP994


HEAT REJECTION
TRIP - PCM3
TURBINE
FCV483
FCV421
100.0PCT
TE483
124.F
DEAERATOR
LT471
14.6IN
FCV484
TE421
146.F
STEAM
GEN
FCV431
.0PCT
FCV401
.0PCT
FEED-
WATER
HTR
FCV471
1.0PCT
SWP
OFF
CNP
OFF
FCV411
.0PCT
STEAM
GEN
LT311
-12.5IN
FWP
OFF
PT401
21.PSI
CMUP-CFP
OFF
FCV432
100.0PCT
TE484
76.F
PT431
8.PSI
CWP
OFF
PT432
4.PSI
COOLING
TOWERS
TE486
78.F
SPRAY
WATER
HEAT EXCH
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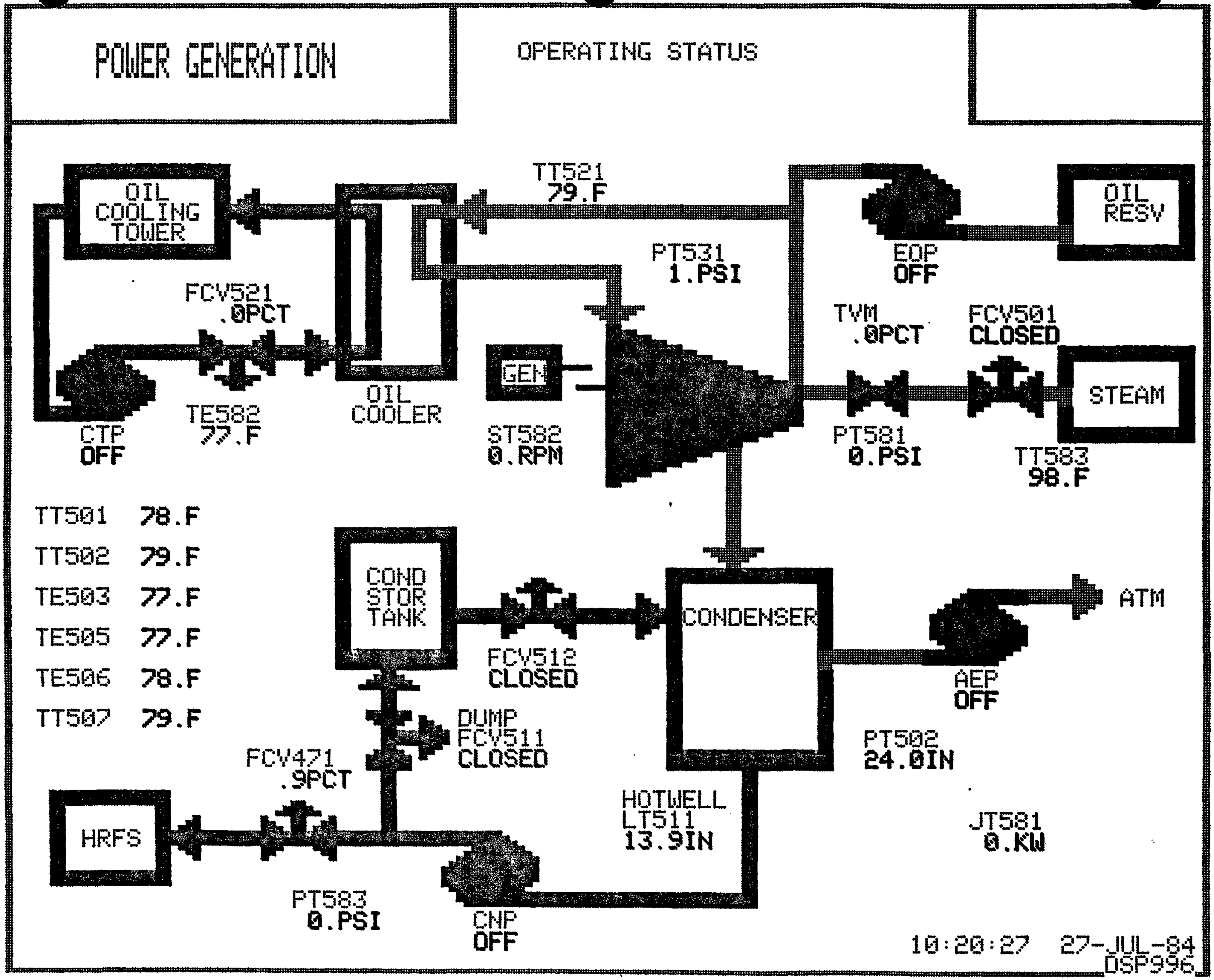
DSP995


POWER GENERATION
OPERATING STATUS
OIL COOLING TOWER
TT521 79.F
OIL RESV
PT531 1.PSI
EOP OFF
FCV521 .0PCT
TVM .0PCT
FCV501 CLOSED
GEN
STEAM
OIL COOLER
TE582 77.F
CTP OFF
ST582 0.RPM
PT581 0.PSI
TT583 98.F
TT501 78.F
TT502 79.F
TE503 77.F
TE505 77.F
TE506 78.F
TT507 79.F
COND STOR TANK
CONDENSER
ATM
FCV512 CLOSED
AEP OFF
DUMP FCV511 CLOSED
FCV471 .9PCT
PT502 24.0IN
HRFS
HOTWELL LT511 13.9IN
JT581 0.KW
PT583 0.PSI
CNP OFF
10:20:27 27-JUL-84
DSP996

01	FCV101	.2PCT	[illegible]	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
02	FCV102	.1PCT	XXX	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
03	FT101	.0KLB	XXX	RCVR	SALT	FLOW		H	100.0	L	20.0	PCM	1
04	FD101	.0KLB	XXX	FLOW	DEMAND			H	100.0	L	.0	PCM	1
05	RCA	.0KLB	OFF	RCVR	CONTRL	ALGORM		H	100.0	L	.0	PCM	1
06	SP.SALT	750.F	XXX	RCVR	SALT	TEMP	SETPT	H	1060.	L	700.	PCM	1
07	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
08	PT181	0.PSI	XXX	RCVR	INLET	PRESS		H	125.	L	10.	PCM	1
09	TE101	632.F	XXX	RCVR	INLET	HEADER		H	650.	L	500.	PCM	1
10	TE102	531.F	XXX	RCVR	OUTLET	HEADER		H	1060.	L	500.	PCM	1
11	FCV180T89	0.OFF		RCVR	DRAIN	VALVES						PCM	1
12	FCV190	0.OFF		PURGE	VALVE	PANELS	01.02					PCM	1
13	FCV191	0.OFF		PURGE	VALVE	PANELS	03.04					PCM	1
14	FCV192	0.OFF		PURGE	VALVE	PANELS	05.06					PCM	1
15	FCV193	0.OFF		PURGE	VALVE	PANELS	07.08					PCM	1
16	FCV194	0.OFF		PURGE	VALVE	PANELS	09.10					PCM	1
17	FCV195	0.OFF		PURGE	VALVE	PANELS	11.12					PCM	1
18	FCV196	0.OFF		PURGE	VALVE	PANELS	13.14					PCM	1
19	FCV197	0.OFF		PURGE	VALVE	PANELS	15.16					PCM	1
20	FCV198	0.OFF		PURGE	VALVE	PANELS	17.18					PCM	1
21	LT151	.0IN	XXX	RCVR	COLD	SURGE	TANK	H	90.0	L	10.0	PCM	1
22	LT161	1.0IN	XXX	RCVR	HOT	SURGE	TANK	H	70.0	L	15.0	PCM	3

COPY

GROUP 01
27-JUL-84 15:41:54

01	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	2
02	FCV101	98.4PCT	XXX	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
03	FCV102	98.6PCT	XXX	RCVR	SALT	FLOW	CONTRL	H	100.0	L	.0	PCM	1
04	FCV151	.1PCT	XXX	RCVR	COLD	SURGE	TANK	H	100.0	L	.0	PCM	1
05	FCV161	1.4IN	XXX	RCVR	DWNCMR	HOT	TANK	H	70.0	L	15.0	PCM	3
06	FCV162	1.4IN	XXX	RCVR	DWNCMR	COLD	TANK	H	70.0	L	15.0	PCM	3
07	FCV201	26.4IN	XXX	TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
08	FCV199	0.OFF		RCVR	DRAIN	FILL	ISOLAT					PCM	3
09	FCV171	0.OFF		RCVR	CTANK	AIR	SUPPLY					PCM	1
10	ZSH199	1.ON	XXX	RCVR	DRAIN	FILL	ISOLAT					PCM	3
11	ZSL199	0.OFF	XXX	RCVR	DRAIN	FILL	ISOLAT					PCM	3
12	OPN.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
13	CLS.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
14	ZSH211	0.OFF	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3
15	ZSL211	1.ON	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3
16	DR.OPN	0.OFF		RCVR	CAVITY	DOOR	OPEN					PCM	1
17	DR.CLS	0.OFF		RCVR	CAVITY	DOOR	CLOSE					PCM	1
18	ZSHDR	0.OFF	XXX	RCVR	CAVITY	DOOR	OPEN					PCM	1
19	ZSLDR	1.ON	XXX	RCVR	CAVITY	DOOR	CLOSED					PCM	1
20	LT281	124.9IN		TSS	COLD	TANK	LEVEL	H	134.0	L	15.0	PCM	3
21	LT291	.9IN	LOA	TSS	HOT	TANK	LEVEL	H	190.0	L	10.0	PCM	3
22	PS281	1.ON		TSS	SGS	AIR	SUPPLY					PCM	3

COPY

GROUP 02

01	LT151	.0IN		RCVR	COLD	SURGE	TANK	H	90.0	L	10.0	PCM	1
02	LT161	.7IN	XXX	RCVR	HOT	SURGE	TANK	H	70.0	L	15.0	PCM	3
03	LT201	29.8IN		TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
04	LT221	39.8IN	XXX	TSS	HOT	SUMP	LEVEL	H	41.0	L	15.0	PCM	3
05	LT281	50.2IN	XXX	TSS	COLD	TANK	LEVEL	H	134.0	L	15.0	PCM	3
06	LT291	108.2IN	XXX	TSS	HOT	TANK	LEVEL	H	190.0	L	10.0	PCM	3
07	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
08	PT181	0.PSI	XXX	RCVR	INLET	PRESS		H	125.	L	10.	PCM	1
09	PT182	0.PSI	XXX	RCVR	COLD	SURGE	TANK	H	180.	L	10.	PCM	1
10	FT101	.0KLB	XXX	RCVR	SALT	FLOW		H	100.0	L	20.0	PCM	1
11	TE101	598.F	XXX	RCVR	INLET	HEADER		H	650.	L	500.	PCM	1
12	TE102	526.F	XXX	RCVR	OUTLET	HEADER		H	1060.	L	500.	PCM	1
13	TE180	94.F	XXX	BOOST	PUMP	BEARNG	TEMP	H	190.	L	-99.	PCM	3
14	TE181	178.F	XXX	BOOST	PUMP	SUMP	VENT	H	350.	L	-99.	PCM	3
15	TE182	563.F	XXX	RCVR	COLD	SURGE	TANK	H	750.	L	500.	PCM	1
16	TE183	488.F	XXX	RCVR	HOT	SURGE	TANK	H	1070.	L	500.	PCM	1
17	TE184	274.F	XXX	RCVR	HOT	SURGE	VENT	H	400.	L	-99.	PCM	1
18	TE211	175.F	XXX	TSS	COLD	SUMP	VENT	H	400.	L	-99.	PCM	3
19	TE231	96.F	XXX	TSS	HOT	SUMP	VENT	H	400.	L	-99.	PCM	3
20	TE281	584.F	XXX	TSS	CTANK	RAKE	LOWER	H	750.	L	500.	PCM	3
21	TE283	568.F	XXX	TSS	CTANK	RAKE	UPPER	H	750.	L	500.	PCM	3

COPY

GROUP 03
27-JUL-84 15:47:45

01	FCV211	[illegible]	XXX	TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM 3
02	OPN.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM 3
03	CLS.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM 3
04	ZSH211	0.OFF	XXX	TSS	COLD	SUMP	ISOLAT					PCM 3
05	ZSL211	1.ON	XXX	TSS	COLD	SUMP	ISOLAT					PCM 3
06	FCV221	39.9IN	XXX	TSS	HOT	SUMP	LEVEL	H	100.0	L	.0	PCM 3
07	OPN.231	0.OFF		TSS	HOT	SUMP	ISOLAT					PCM 3
08	CLS.231	0.OFF		TSS	HOT	SUMP	ISOLAT					PCM 3
09	ZSH231	0.OFF	XXX	TSS	HOT	SUMP	ISOLAT					PCM 3
10	ZSL231	1.ON	XXX	TSS	HOT	SUMP	ISOLAT					PCM 3
11	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM 3
12	CSP	0.OFF		TSS	COLD	SALT	PUMP					PCM 3
13	CSP.EN	0.OFF		TSS	CSP	ENABLE						PCM 3
14	BP	0.OFF		RCVR	BOOST	PUMP						PCM 3
15	BP.EN	0.OFF		RCVR	BP	ENABLE						PCM 3
16	ZSHCSP	0.OFF	XXX	TSS	COLD	SALT	PUMP					PCM 3
17	ZSHBP	0.OFF	XXX	RCVR	SALT	BOOST	PUMP					PCM 3
18	HSP	0.OFF		TSS	HOT	SALT	PUMP					PCM 3
19	HSP.EN	0.OFF		TSS	HSP	ENABLE						PCM 3
20	ZSHHSP	0.OFF	XXX	TSS	HOT	SALT	PUMP					PCM 3
21	TE180	94.F	XXX	BOOST	PUMP	BEARNG	TEMP	H	190.	L	-99.	PCM 3
22	TE286	156.F	XXX	TSS	COLD	PUMP	BEARNG	H	190.	L	-99.	PCM 3

COPY

GROUP 04
27-JUL-84 15:50:03

01	FCV241	1.1PCT		TSS	PRPANE	HEATER	FLOW	H	100.0	L	.0	PCM	3
02	FCV242	0.OFF		TSS	PRPANE	HEATER	ISOLAT					PCM	3
03	FCV201	29.9IN	XXX	TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
04	FCV221	39.8IN	XXX	TSS	HOT	SUMP	LEVEL	H	100.0	L	.0	PCM	3
05	PT180	0.PSI	XXX	RCYR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
06	OPN.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
07	CLS.211	0.OFF		TSS	COLD	SUMP	ISOLAT					PCM	3
08	LT201	29.9IN		TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
09	LT221	39.9IN	XXX	TSS	HOT	SUMP	LEVEL	H	41.0	L	15.0	PCM	3
10	LT281	50.2IN	XXX	TSS	COLD	TANK	LEVEL	H	134.0	L	15.0	PCM	3
11	TE281	585.F	XXX	TSS	CTANK	RAKE	LOWER	H	750.	L	500.	PCM	3
12	TE282	570.F	XXX	TSS	CTANK	RAKE	MIDDLE	H	750.	L	500.	PCM	3
13	TE283	568.F	XXX	TSS	CTANK	RAKE	UPPER	H	750.	L	500.	PCM	3
14	LT291	108.0IN	XXX	TSS	HOT	TANK	LEVEL	H	190.0	L	10.0	PCM	3
15	TE291	722.F	XXX	TSS	HTANK	RAKE	LOWER	H	1070.	L	500.	PCM	3
16	TE292	702.F	XXX	TSS	HTANK	RAKE	MIDDLE	H	1070.	L	500.	PCM	3
17	TE293	698.F	XXX	TSS	HTANK	RAKE	UPPER	H	1070.	L	500.	PCM	3
18	ZT241	94.2PCT	XXX	TSS	PRPANE	HEATER	FLOW	H	100.0	L	.0	PCM	3
19	ZSH242	0.OFF	XXX	TSS	PRPANE	HEATER	ISOLAT					PCM	3
20	ZSL242	1.ON	XXX	TSS	PRPANE	HEATER	ISOLAT					PCM	3
21	ZSH211	0.OFF	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3
22	ZSL211	1.ON	XXX	TSS	COLD	SUMP	ISOLAT					PCM	3

COPY

GROUP 05
27-JUL-84 15:56:17

01	TE131	214.F		RCVR	PANEL	BACK	UPPER	H	665.	L	500.	PCM	1
02	TE132	98.F	XXX	RCVR	PANEL	BACK	UPPER	H	745.	L	500.	PCM	1
03	TE133	105.F	XXX	RCVR	PANEL	BACK	UPPER	H	815.	L	500.	PCM	1
04	TE134	92.F	XXX	RCVR	PANEL	BACK	UPPER	H	915.	L	500.	PCM	1
05	TE135	135.F	XXX	RCVR	PANEL	BACK	UPPER	H	980.	L	500.	PCM	1
06	TE136	228.F	XXX	RCVR	PANEL	BACK	UPPER	H	1045.	L	500.	PCM	1
07	TE137	100.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	680.	L	500.	PCM	1
08	TE138	133.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	735.	L	500.	PCM	1
09	TE139	94.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	825.	L	500.	PCM	1
10	TE140	91.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	905.	L	500.	PCM	1
11	TE141	128.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	990.	L	500.	PCM	1
12	TE142	153.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	1045.	L	500.	PCM	1
13	TE143	161.F	XXX	RCVR	PANEL	BACK	LOWER	H	660.	L	500.	PCM	1
14	TE144	158.F	XXX	RCVR	PANEL	BACK	LOWER	H	725.	L	500.	PCM	1
15	TE145	176.F	XXX	RCVR	PANEL	BACK	LOWER	H	830.	L	500.	PCM	1
16	TE146	110.F	XXX	RCVR	PANEL	BACK	LOWER	H	895.	L	500.	PCM	1
17	TE147	133.F	XXX	RCVR	PANEL	BACK	LOWER	H	985.	L	500.	PCM	1
18	TE148	269.F	XXX	RCVR	PANEL	BACK	LOWER	H	1035.	L	500.	PCM	1
19	RMAXT	270.F	XXX	RCVR	PANEL	MAX	TEMP	H	1080.	L	500.	PCM	1
20	RMINT	92.F	XXX	RCVR	PANEL	MIN	TEMP	H	1080.	L	500.	PCM	1

COPY

GROUP 06
27-JUL-84 15:59:07

01	TE182	563.F		RCVR	COLD	SURGE	TANK	H	750.	L	500.	PCM	1
02	TE183	473.F	XXX	RCVR	HOT	SURGE	TANK	H	1070.	L	500.	PCM	1
03	TE185	311.F	XXX	RCVR	PASS02	OUTLET	TEMP	H	665.	L	500.	PCM	1
04	TE186	598.F	XXX	RCVR	PASS03	OUTLET	TEMP	H	690.	L	500.	PCM	1
05	TE187	237.F	XXX	RCVR	PASS04	OUTLET	TEMP	H	720.	L	500.	PCM	1
06	TE188	177.F	XXX	RCVR	PASS05	OUTLET	TEMP	H	750.	L	500.	PCM	1
07	TE189	406.F	XXX	RCVR	PASS06	OUTLET	TEMP	H	780.	L	500.	PCM	1
08	TE190	642.F	XXX	RCVR	PASS07	OUTLET	TEMP	H	810.	L	500.	PCM	1
09	TE191	337.F	XXX	RCVR	PASS08	OUTLET	TEMP	H	835.	L	500.	PCM	1
10	TE192	615.F	XXX	RCVR	PASS09	OUTLET	TEMP	H	865.	L	500.	PCM	1
11	TE193	361.F	XXX	RCVR	PASS12	OUTLET	TEMP	H	950.	L	500.	PCM	1
12	TE194	672.F	XXX	RCVR	PASS13	OUTLET	TEMP	H	975.	L	500.	PCM	1
13	TE195	443.F	XXX	RCVR	PASS14	OUTLET	TEMP	H	990.	L	500.	PCM	1
14	TE196	655.F	XXX	RCVR	PASS15	OUTLET	TEMP	H	1010.	L	500.	PCM	1
15	TE197	343.F	XXX	RCVR	PASS16	OUTLET	TEMP	H	1030.	L	500.	PCM	1
16	TE198	566.F	XXX	RCVR	PASS17	OUTLET	TEMP	H	1050.	L	500.	PCM	1

COPY

GROUP 07
27-JUL-84 16:00:34

01	ZSH180	0.OFF		RCVR	DRAIN	NO.1	OPEN	PCM 1
02	ZSH181	0.OFF	XXX	RCVR	DRAIN	NO.2	OPEN	PCM 1
03	ZSH182	0.OFF	XXX	RCVR	DRAIN	NO.3	OPEN	PCM 1
04	ZSH183	0.OFF	XXX	RCVR	DRAIN	NO.4	OPEN	PCM 1
05	ZSH184	0.OFF	XXX	RCVR	DRAIN	NO.5	OPEN	PCM 1
06	ZSH185	0.OFF	XXX	RCVR	DRAIN	NO.6	OPEN	PCM 1
07	ZSH186	0.OFF	XXX	RCVR	DRAIN	NO.7	OPEN	PCM 1
08	ZSH187	0.OFF	XXX	RCVR	DRAIN	NO.8	OPEN	PCM 1
09	ZSH188	0.OFF	XXX	RCVR	DRAIN	NO.9	OPEN	PCM 1
10	ZSH189	0.OFF	XXX	RCVR	DRAIN	NO.10	OPEN	PCM 1
11	ZSL180	1.ON	XXX	RCVR	DRAIN	NO.1	CLOSED	PCM 1
12	ZSL181	1.ON	XXX	RCVR	DRAIN	NO.2	CLOSED	PCM 1
13	ZSL182	1.ON	XXX	RCVR	DRAIN	NO.3	CLOSED	PCM 1
14	ZSL183	1.ON	XXX	RCVR	DRAIN	NO.4	CLOSED	PCM 1
15	ZSL184	1.ON	XXX	RCVR	DRAIN	NO.5	CLOSED	PCM 1
16	ZSL185	1.ON	XXX	RCVR	DRAIN	NO.6	CLOSED	PCM 1
17	ZSL186	1.ON	XXX	RCVR	DRAIN	NO.7	CLOSED	PCM 1
18	ZSL187	1.ON	XXX	RCVR	DRAIN	NO.8	CLOSED	PCM 1
19	ZSL188	1.ON	XXX	RCVR	DRAIN	NO.9	CLOSED	PCM 1
20	ZSL189	1.ON	XXX	RCVR	DRAIN	NO.10	CLOSED	PCM 1

COPY

GROUP 08

01	ZSH190	0.OFF	[illegible]	RCVR	PURGE	NO.1	OPEN	PCM 1
02	ZSH191	0.OFF	XXX	RCVR	PURGE	NO.2	OPEN	PCM 1
03	ZSH192	0.OFF	XXX	RCVR	PURGE	NO.3	OPEN	PCM 1
04	ZSH193	0.OFF	XXX	RCVR	PURGE	NO.4	OPEN	PCM 1
05	ZSH194	0.OFF	XXX	RCVR	PURGE	NO.5	OPEN	PCM 1
06	ZSH195	0.OFF	XXX	RCVR	PURGE	NO.6	OPEN	PCM 1
07	ZSH196	0.OFF	XXX	RCVR	PURGE	NO.7	OPEN	PCM 1
08	ZSH197	0.OFF	XXX	RCVR	PURGE	NO.8	OPEN	PCM 1
09	ZSH198	0.OFF	XXX	RCVR	PURGE	NO.9	OPEN	PCM 1
10	ZSL190	1.ON	XXX	RCVR	PURGE	NO.1	CLOSED	PCM 1
11	ZSL191	1.ON	XXX	RCVR	PURGE	NO.2	CLOSED	PCM 1
12	ZSL192	1.ON	XXX	RCVR	PURGE	NO.3	CLOSED	PCM 1
13	ZSL193	1.ON	XXX	RCVR	PURGE	NO.4	CLOSED	PCM 1
14	ZSL194	1.ON	XXX	RCVR	PURGE	NO.5	CLOSED	PCM 1
15	ZSL195	1.ON	XXX	RCVR	PURGE	NO.6	CLOSED	PCM 1
16	ZSL196	1.ON	XXX	RCVR	PURGE	NO.7	CLOSED	PCM 1
17	ZSL197	1.ON	XXX	RCVR	PURGE	NO.8	CLOSED	PCM 1
18	ZSL198	1.ON	XXX	RCVR	PURGE	NO.9	CLOSED	PCM 1

COPY

GROUP 09

01	TE101	522.F		RCVR	INLET	HEADER		H	650.	L	500.	PCM 1
02	TE103	214.F	XXX	RCVR	PASS01	OUTLET	TEMP	H	640.	L	500.	PCM 1
03	TE104	203.F	XXX	RCVR	PASS02	OUTLET	TEMP	H	665.	L	500.	PCM 1
04	TE105	208.F	XXX	RCVR	PASS03	OUTLET	TEMP	H	690.	L	500.	PCM 1
05	TE106	228.F	XXX	RCVR	PASS04	OUTLET	TEMP	H	720.	L	500.	PCM 1
06	TE107	235.F	XXX	RCVR	PASS05	OUTLET	TEMP	H	750.	L	500.	PCM 1
07	TE108	255.F	XXX	RCVR	PASS06	OUTLET	TEMP	H	780.	L	500.	PCM 1
08	TE109	233.F	XXX	RCVR	PASS07	OUTLET	TEMP	H	810.	L	500.	PCM 1
09	TE110	176.F	XXX	RCVR	PASS08	OUTLET	TEMP	H	835.	L	500.	PCM 1
10	TE111	231.F	XXX	RCVR	PASS09	OUTLET	TEMP	H	865.	L	500.	PCM 1
11	TE112	204.F	XXX	RCVR	PASS10	OUTLET	TEMP	H	890.	L	500.	PCM 1
12	TE113	251.F	XXX	RCVR	PASS11	OUTLET	TEMP	H	920.	L	500.	PCM 1
13	TE114	188.F	XXX	RCVR	PASS12	OUTLET	TEMP	H	950.	L	500.	PCM 1
14	TE115	246.F	XXX	RCVR	PASS13	OUTLET	TEMP	H	975.	L	500.	PCM 1
15	TE116	200.F	XXX	RCVR	PASS14	OUTLET	TEMP	H	990.	L	500.	PCM 1
16	TE117	191.F	XXX	RCVR	PASS15	OUTLET	TEMP	H	1010.	L	500.	PCM 1
17	TE118	261.F	XXX	RCVR	PASS16	OUTLET	TEMP	H	1030.	L	500.	PCM 1
18	TE119	282.F	XXX	RCVR	PASS17	OUTLET	TEMP	H	1050.	L	500.	PCM 1
19	TE120	242.F	XXX	RCVR	PASS18	OUTLET	TEMP	H	1070.	L	500.	PCM 1
20	TE102	515.F	XXX	RCVR	OUTLET	HEADER		H	1060.	L	500.	PCM 1

COPY

GROUP 10
27-JUL-84 16:04:52

01	PT180	0.PSI		RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
02	PS281	1.ON		TSS	SGS	AIR	SUPPLY					PCM	3
03	ZSHDR	0.OFF	XXX	RCVR	CAVITY	DOOR	OPEN					PCM	1
04	ZSLDR	1.ON	XXX	RCVR	CAVITY	DOOR	CLOSED					PCM	1
05	TE286	158.F	XXX	TSS	COLD	PUMP	BEARNG	H	190.	L	-99.	PCM	3
06	TE180	95.F	XXX	BOOST	PUMP	BEARNG	TEMP	H	190.	L	-99.	PCM	3
07	TE101	517.F	XXX	RCVR	INLET	HEADER		H	650.	L	500.	PCM	1
08	TE102	513.F	XXX	RCVR	OUTLET	HEADER		H	1060.	L	500.	PCM	1
09	RMAXT	249.F	XXX	RCVR	PANEL	MAX	TEMP	H	1080.	L	500.	PCM	1
10	RMINT	89.F	XXX	RCVR	PANEL	MIN	TEMP	H	1080.	L	500.	PCM	1
11	TE140	90.F	XXX	RCVR	PANEL	BACK	MIDDLE	H	905.	L	500.	PCM	1
12	PT181	0.PSI	XXX	RCVR	INLET	PRESS		H	125.	L	10.	PCM	1
13	TE211	205.F	XXX	TSS	COLD	SUMP	VENT	H	400.	L	-99.	PCM	3
14	TE181	147.F	XXX	BOOST	PUMP	SUMP	VENT	H	350.	L	-99.	PCM	3
15	TE184	263.F	XXX	RCVR	HOT	SURGE	VENT	H	400.	L	-99.	PCM	1
16	ZSHBP	0.OFF	XXX	RCVR	SALT	BOOST	PUMP					PCM	3
17	ZSHCSP	0.OFF	XXX	TSS	COLD	SALT	PUMP					PCM	3
18	ZSHCLP	0.OFF	XXX	TSS	COOLNT	PUMP						PCM	3
19	LV181	1.ON	XXX	24VDC	CONTRL	POWER	SUPPLY					PCM	1
20	LV281	1.ON	XXX	24VDC	CONTRL	POWER	SUPPLY					PCM	3
21	FT101	.0KLB	XXX	RCVR	SALT	FLOW		H	100.0	L	20.0	PCM	1
22	TE161	417.F	XXX	TSS	DWNCMR	OUTLET	TEMP	H	1070.	L	500.	PCM	3

COPY

GROUP 11
27-JUL-84 16:07:36

01	FCV201	23.9IN	XXX	TSS	COLD	SUMP	LEVEL	H	80.0	L	15.0	PCM	3
02	ZSHCSP	0.OFF	XXX	TSS	COLD	SALT	PUMP					PCM	3
03	ZSHBP	0.OFF	XXX	RCVR	SALT	BOOST	PUMP					PCM	3
04	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
05	FCV151	.0PCT	XXX	RCVR	COLD	SURGE	TANK	H	100.0	L	.0	PCM	1
06	FCV162	.0IN	XXX	RCVR	DWNCMR	COLD	TANK	H	70.0	L	15.0	PCM	3
07	FCV161	.0IN	XXX	RCVR	DWNCMR	HOT	TANK	H	70.0	L	15.0	PCM	3
08	FCV199	0.OFF		RCVR	DRAIN	FILL	ISOLAT					PCM	3
09	DRCLSD	1.ON	XXX	RS	DRAIN	VALVES	CLOSED					PCM	1
10	PUCLSD	1.ON	XXX	RS	PURGE	VALVES	CLOSED					PCM	1
11	PT182	0.PSI	XXX	RCVR	COLD	SURGE	TANK	H	180.	L	10.	PCM	1
12	LT151	.0IN	XXX	RCVR	COLD	SURGE	TANK	H	90.0	L	10.0	PCM	1
13	PT181	0.PSI	XXX	RCVR	INLET	PRESS		H	125.	L	10.	PCM	1
14	FT101	.0KLB	XXX	RCVR	SALT	FLOW		H	100.0	L	20.0	PCM	1
15	FCV171	0.OFF		RCVR	CTANK	AIR	SUPPLY					PCM	1
16	RS.DRAIN	0.OFF	XXX	RCVR	DRAIN							PCM	3
17	RS.FILL	0.OFF	XXX	RCVR	FILL							PCM	3
18	RS.MAN	0.OFF	XXX	RCVR	UNDER	MANUAL	CONTRL					PCM	3
19	SP.SALT	750.F	XXX	RCVR	SALT	TEMP	SETPT	H	1060.	L	700.	PCM	1

when this is on, the two valves FCV161 & FCV162 are not temperature controlled

COPY

GROUP 12
27-JUL-84 16:09:01

01	SP.EST	850.F		EVAP	SALT	TEMP	SETPT	H	870.	L	780.	PCM 3
02	SP.DL	.0IN	XXX	SGS	DRUM	LEVEL	SETPT	H	4.0	L	-4.0	PCM 3
03	SP.SP	1100.PSI	XXX	SGS	STEAM	PRESS	SETPT	H	1130.	L	1070.	PCM 3
04	SP.ST	950.F	XXX	SGS	STEAM	TEMP	SETPT	H	980.	L	920.	PCM 3
05	MAN.301	0.OFF		REQEST	MANUAL	CONTRL	FCV301					PCM 3
06	SP.301	.0PCT	XXX	SGS	FCV301	MANUAL	SETPT	H	100.0	L	.0	PCM 3
07	MAN.321	0.OFF		REQEST	MANUAL	CONTRL	FCV321					PCM 3
08	SP.321	99.7PCT	XXX	SGS	FCV321	MANUAL	SETPT	H	100.0	L	.0	PCM 3
09	MAN.331	0.OFF		REQEST	MANUAL	CONTRL	FCV331					PCM 3
10	SP.331	9.9PCT	XXX	SGS	FCV331	MANUAL	SETPT	H	100.0	L	.0	PCM 3
11	MAN.341	0.OFF		REQEST	MANUAL	CONTRL	FCV341					PCM 3
12	SP.341	.0PCT	XXX	SGS	FCV341	MANUAL	SETPT	H	100.0	L	.0	PCM 3
13	MAN.351	0.OFF		REQEST	MANUAL	CONTRL	FCV351					PCM 3
14	SP.351	.0PCT	XXX	SGS	FCV351	MANUAL	SETPT	H	100.0	L	.0	PCM 3
15	MAN.411	0.OFF		REQEST	MANUAL	CONTRL	FCV411					PCM 3
16	SP.411	.0PCT	XXX	SGS	FCV411	MANUAL	SETPT	H	100.0	L	.0	PCM 3
17	MAN.38182	0.OFF		SGS	EVAP	SUPHTR	DRAIN					PCM 3
18	FCV38182	0.OFF		SGS	EVAP	SUPHTR	DRAIN					PCM 3
19	MAN.383	0.OFF		SGS	ELECT	HEATER	BYPASS					PCM 3
20	FCV383	0.OFF		SGS	ELECT	HEATER	BYPASS					PCM 3
21	MAN.384	0.OFF		SGS	ELECT	HEATER	STRTUP					PCM 3
22	FCV384	0.OFF		SGS	ELECT	HEATER	STRTUP					PCM 3

COPY

GROUP 13
27-JUL-84 16:10:25

01	[redacted]													
02	TE483	105.F	XXX	HRFS	HIGH	PRESS	STEAM	H	990.	L	850.	PCM	2
03	PT383	62.PSI	XXX	SGS	STEAM	DRUM	PRESS	H	1250.	L	950.	PCM	3
04	FT411	.00KLB	XXX	HRFS	FEED	WATER	FLOW	H	16.00	L	.00	PCM	3
05	FT311	.01KLB	XXX	SGS	MAIN	STEAM	FLOW	H	12.60	L	3.20	PCM	3
06	FT381	0.LB	XXX	SGS	ATTEMP	STEAM	FLOW	H	2500.	L	0.	PCM	3
07	TE332	102.F	XXX	SGS	TURBIN	THROTL	TEMP	H	990.	L	910.	PCM	3
08	TE331	302.F	XXX	SGS	SPRHTR	STEAM	OUTLET	H	1200.	L	910.	PCM	3
09	PT321	63.PSI	XXX	SGS	STEAM	DLIVRY	PRESS	H	1150.	L	950.	PCM	2
10	PT386	0.PSI	XXX	SGS	FEED	WATER	PRESS	H	1500.	L	0.	PCM	3
11	TE386	97.F	XXX	HRS	FEED	WATER	TEMP	H	575.	L	500.	PCM	3
12	TE388	304.F	XXX	SGS	EVAPTR	WATER	TEMP	H	1100.	L	500.	PCM	3
13	ZT411	.0PCT	XXX	HRS	FCV411	VALVE	POS	H	100.0	L	.0	PCM	3
14	ZT331	.0PCT	XXX	SGS	FCV331	VALVE	POS	H	100.0	L	.0	PCM	3
15	ZSH384	1.ON	XXX	SGS	ELECT	HEATER	STRTUP					PCM	3
16	ZSL384	0.OFF	XXX	SGS	ELECT	HEATER	STRTUP					PCM	3
17	FCV401	18.PSI	XXX	HRFS	FDWATR	PUMP	PRESS	H	1500.	L	0.	PCM	2
18	FCV421	140.F	XXX	HRFS	FDWATR	TEMP	CONTRL	H	2500.	L	-99.	PCM	2
19	FCV431	.0PCT	XXX	HRFS	STEAM	CONTRL		H	100.0	L	.0	PCM	2
20	FCV432	1.PSI	XXX	DEATOR	OPRTNG	PRESS	CONTRL	H	400.	L	0.	PCM	2
21	FCV491	63.PSI	XXX	SGS	STEAM	DLIVRY	PRESS	H	1150.	L	950.	PCM	2
22	LT471	14.7IN	XXX	HRFS	DEATOR	LEVEL	CONTRL	H	30.0	L	10.0	PCM	2

COPY

GROUP 14
27-JUL-84 16:11:54

01	PT382	0.PSI	[illegible]	SGS	SPRHTR	SALT	INLET	H	200.	L	0.	PCM	3
02	TE382	457.F	XXX	SGS	SPRHTR	SALT	INLET	H	1070.	L	500.	PCM	3
03	TE301	521.F	XXX	SGS	EVAPTR	SALT	INLET	H	880.	L	500.	PCM	3
04	TE384	511.F	XXX	SGS	EVAPTR	SALT	OUTLET	H	640.	L	500.	PCM	3
05	PT384	3.PSI	XXX	SGS	EVAPTR	SALT	OUTLET	H	200.	L	0.	PCM	3
06	FT382	3.13KLB	XXX	SGS	COLD	BYPASS	FLOW	H	16.00	L	.00	PCM	3
07	FT321	4.5KLB	XXX	SGS	TOTAL	SALT	FLOW	H	100.0	L	.0	PCM	3
08	ZT301	62.6PCT	XXX	SGS	FCV301	VALVE	POS	H	100.0	L	.0	PCM	3
09	ZT321	100.0PCT	XXX	SGS	FCV321	VALVE	POS	H	100.0	L	.0	PCM	3
10	ZT341	.0PCT	XXX	SGS	FCV341	VALVE	POS	H	100.0	L	.0	PCM	3
11	ZT351	.0PCT	XXX	SGS	FCV351	VALVE	POS	H	100.0	L	.0	PCM	3
12	FCV221	39.9IN	XXX	TSS	HOT	SUMP	LEVEL	H	100.0	L	.0	PCM	3
13	FCV201	29.9IN	XXX	TSS	COLD	SUMP	LEVEL	H	60.0	L	15.0	PCM	3
14	PT180	0.PSI	XXX	RCVR	BOOST	PUMP	DSCHGE	H	400.	L	275.	PCM	3
15	LT281	49.9IN	XXX	TSS	COLD	TANK	LEVEL	H	134.0	L	15.0	PCM	3
16	LT291	108.5IN	XXX	TSS	HOT	TANK	LEVEL	H	190.0	L	10.0	PCM	3
17	PT383	58.PSI	XXX	SGS	STEAM	DRUM	PRESS	H	1250.	L	950.	PCM	3
18	FT311	.01KLB	XXX	SGS	MAIN	STEAM	FLOW	H	12.60	L	3.20	PCM	3
19	FT411	.00KLB	XXX	HRFS	FEED	WATER	FLOW	H	16.00	L	.00	PCM	3
20	LT311	-14.2IN	XXX	SGS	STEAM	DRUM	WATER	H	4.0	L	-4.0	PCM	3
21	TE387	103.F	XXX	HOT	SALT	PUMP	BEARNG	H	190.	L	-99.	PCM	3
22	TE286	154.F	XXX	TSS	COLD	PUMP	BEARNG	H	190.	L	-99.	PCM	3

COPY

GROUP 15
27-JUL-84 16:13:13

01	ESH1	0.OFF		SGS	ELECT	HEATER	NO.1	PCM 3
02	ESH2	0.OFF		SGS	ELECT	HEATER	NO.2	PCM 3
03	ESH3	0.OFF		SGS	ELECT	HEATER	NO.3	PCM 3
04	ESH4	0.OFF		SGS	ELECT	HEATER	NO.4	PCM 3
05	ESH5	0.OFF		SGS	ELECT	HEATER	NO.5	PCM 3
06	MAN.ESH1	0.OFF		SGS	ELECT	HEATER	NO.1	PCM 3
07	MAN.ESH2	0.OFF		SGS	ELECT	HEATER	NO.2	PCM 3
08	MAN.ESH3	0.OFF		SGS	ELECT	HEATER	NO.3	PCM 3
09	MAN.ESH4	0.OFF		SGS	ELECT	HEATER	NO.4	PCM 3
10	MAN.ESH5	0.OFF		SGS	ELECT	HEATER	NO.5	PCM 3
11	EH1.ON	0.OFF	XXX	SGS	ELECT	HEATER	NO.1	PCM 3
12	EH2.ON	0.OFF	XXX	SGS	ELECT	HEATER	NO.2	PCM 3
13	EH3.ON	0.OFF	XXX	SGS	ELECT	HEATER	NO.3	PCM 3
14	EH4.ON	0.OFF	XXX	SGS	ELECT	HEATER	NO.4	PCM 3
15	EH5.ON	0.OFF	XXX	SGS	ELECT	HEATER	NO.5	PCM 3
16	MAN.BWCP	0.OFF		SGS	WATER	CIRC	PUMP	PCM 3
17	BWCP	0.OFF		SGS	WATER	CIRC	PUMP	PCM 3
18	ZSHBCP	1.ON	XXX	SGS	BOILER	CIRC	PUMP	PCM 3
19	MAN.383	0.OFF		SGS	ELECT	HEATER	BYPASS	PCM 3
20	MAN.384	0.OFF		SGS	ELECT	HEATER	STRTUP	PCM 3
21	FCV383	0.OFF		SGS	ELECT	HEATER	BYPASS	PCM 3
22	FCV384	0.OFF		SGS	ELECT	HEATER	STRTUP	PCM 3

(Rows 02–05:) Manuals must be turned on first

(Row 06:) – manual control for electric startup heater

(Rows 11–15:) High & Low Micro, tells which heaters are on or off

COPY

GROUP 16

01	ZSH381	1.ON		SGS	EVAP	DRAIN						PCM 3
02	ZSL381	0.OFF	XXX	SGS	EVAP	DRAIN						PCM 3
03	ZSH382	1.ON	XXX	SGS	SUPER	HEATER	DRAIN					PCM 3
04	ZSL382	0.OFF	XXX	SGS	SUPER	HEATER	DRAIN					PCM 3
05	ZSH383	0.OFF	XXX	SGS	ELECT	HEATER	BYPASS					PCM 3
06	ZSL383	1.ON	XXX	SGS	ELECT	HEATER	BYPASS					PCM 3
07	ZSH384	1.ON	XXX	SGS	ELECT	HEATER	STRTUP					PCM 3
08	ZSL384	0.OFF	XXX	SGS	ELECT	HEATER	STRTUP					PCM 3
09	ZSL491	1.ON	XXX	HRFS	STEAM	SHUT	OFF					PCM 3
10	ZT301	62.7PCT	XXX	SGS	FCV301	VALVE	POS	H	100.0	L	.0	PCM 3
11	ZT321	100.0PCT	XXX	SGS	FCV321	VALVE	POS	H	100.0	L	.0	PCM 3
12	ZT341	.0PCT	XXX	SGS	FCV341	VALVE	POS	H	100.0	L	.0	PCM 3
13	ZT351	.0PCT	XXX	SGS	FCV351	VALVE	POS	H	100.0	L	.0	PCM 3

COPY

GROUP 17
27-JUL-84 16:16:12

01	FY472	14.6IN	XXX	HRFS	MAKEUP	PUMP	STROKE	H	30.0	L	10.0	PCM	2
02	DTC451	198.F	XXX	HRFS	DEATOR	HEATER	CONTRL	H	750.	L	-300.	PCM	2
03	DTC452	198.F	XXX	HRFS	DEATOR	HEATER	CONTRL	H	750.	L	-300.	PCM	2
04	FCV401	18.PSI	XXX	HRFS	FDWATR	PUMP	PRESS	H	1500.	L	0.	PCM	2
05	TE421	140.F	XXX	HRFS	FDWATR	TEMP	CONTRL	H	600.	L	400.	PCM	2
06	FCV421	140.F	XXX	HRFS	FDWATR	TEMP	CONTRL	H	2000.	L	-55.	PCM	2
07	PT431	8.PSI	XXX	HRFS	HIGH	PRESS	STEAM	H	1200.	L	900.	PCM	2
08	FCV431	.0PCT	XXX	HRFS	STEAM	CONTRL		H	100.0	L	.0	PCM	2
09	FCV432	1.PSI	XXX	DEATOR	OPRTNG	PRESS	CONTRL	H	400.	L	0.	PCM	2
10	FCV483	0.OFF		HRFS	DEATOR	VENT	NO.1					PCM	2
11	FCV484	0.OFF		HRFS	DEATOR	VENT	NO.2					PCM	2
12	PT401	18.PSI	XXX	HRFS	FDWATR	PUMP	PRESS	H	1400.	L	900.	PCM	2
13	PT432	1.PSI	XXX	HRFS	DEATOR	PRESS	CONTRL	H	250.	L	200.	PCM	2
14	PT482	4.PSI	XXX	HRFS	SPRAY	WATER	PRESS	H	300.	L	200.	PCM	2
15	PT483	0.PSI	XXX	HRFS	FDWATR	PRESS		H	1230.	L	1180.	PCM	2
16	PT481	16.PSI	XXX	HRFS	FDWATR	PUMP	SUPPLY	H	400.	L	170.	PCM	2
17	TE481	197.F	XXX	HRFS	DEATOR	STEAM	TEMP	H	400.	L	300.	PCM	2
18	TE483	105.F	XXX	HRFS	HIGH	PRESS	STEAM	H	990.	L	850.	PCM	2
19	TE482	196.F	XXX	HRFS	SPRAY	WATER	TEMP	H	445.	L	-300.	PCM	2
20	FT482	1.KLB	XXX	HRFS	SPRAY	WATER	FLOW	H	160.	L	0.	PCM	2
21	FT481	0.KLB	XXX	HRFS	FEED	SPRAY	WATER	H	160.	L	0.	PCM	2
22	FCV471	14.6IN	XXX	HRFS	DEATOR	LEVEL	CONTRL	H	30.0	L	10.0	PCM	2

COPY

GROUP 18
[illegible] 16:18:45

01	FWP	0.OFF		HRFS	FEED	WATER	PUMP					PCM 2
02	FWP.EN	0.OFF		HRFS	FWP	ENABLE						PCM 2
03	SWP	0.OFF		HRFS	SPRAY	WATER	PUMP					PCM 2
04	SWP.EN	0.OFF		HRFS	SWP	ENABLE						PCM 2
05	CWP	0.OFF		HRFS	COOLNG	WATER	PUMP					PCM 2
06	CWP.EN	0.OFF		HRFS	CWP	ENABLE						PCM 2
07	CMP	0.OFF		HRFS	COND	MAKEUP	PUMP					PCM 2
08	CMP.EN	0.OFF		HRFS	CMP	ENABLE						PCM 2
09	CFP	1.ON		HRFS	CYCLE	FILL	PUMP					PCM 2
10	CFP.EN	1.ON		HRFS	CFP	ENABLE						PCM 2
11	CTP	0.OFF		EPGS	COOLNG	TOWER	PUMP					PCM 2
12	CTP.EN	1.ON		EPGS	CTP	ENABLE						PCM 2
13	ZSHFWP	0.OFF	XXX	HRFS	FEED	WATER	PUMP					PCM 2
14	ZSHSWP	0.OFF	XXX	HRFS	SPRAY	WATER	PUMP					PCM 2
15	ZSHCWP	0.OFF	XXX	HRFS	COOLNG	WATER	PUMP					PCM 2
16	ZSHCMP	0.OFF	XXX	HRFS	COND	MAKEUP	PUMP					PCM 2
17	ZSHCFP	0.OFF	XXX	HRFS	CYCLE	FILL	PUMP					PCM 2
18	ZSHCTP	0.OFF	XXX	EPGS	COOLNG	TOWER	PUMP					PCM 2
19	LT471	14.6IN	XXX	HRFS	DEATOR	LEVEL	CONTRL	H	30.0	L	10.0	PCM 2
20	TE582	75.F	XXX	EPGS	COOLNG	TOWER	DSCHGE	H	100.	L	40.	PCM 2

COPY

GROUP 19

01	CF1	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
02	CF2	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
03	CF3	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
04	CF4	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
05	CF5	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
06	CF6	0.OFF		HRFS	COOLNG	TOWER	FANS					PCM	2
07	CF1.EN	0.OFF		HRFS	CF1	ENABLE						PCM	2
08	CF2.EN	0.OFF		HRFS	CF2	ENABLE						PCM	2
09	CF3.EN	0.OFF		HRFS	CF3	ENABLE						PCM	2
10	CF4.EN	0.OFF		HRFS	CF4	ENABLE						PCM	2
11	CF5.EN	0.OFF		HRFS	CF5	ENABLE						PCM	2
12	CF6.EN	0.OFF		HRFS	CF6	ENABLE						PCM	2
13	TE484	76.F	XXX	HRFS	COOLNG	WATER	TEMP	H	130.	L	-300.	PCM	2
14	TE486	79.F	XXX	HRFS	COOLNG	TOWER	OUTLET	H	110.	L	32.	PCM	2
15	FT482	1.KLB	XXX	HRFS	SPRAY	WATER	FLOW	H	160.	L	0.	PCM	2
16	LT471	14.6IN	XXX	HRFS	DEATOR	LEVEL	CONTRL	H	30.0	L	10.0	PCM	2
17	TE451	198.F	XXX	HRFS	DEATOR	HEATER	CONTRL	H	400.	L	300.	PCM	2
18	TE482	196.F	XXX	HRFS	SPRAY	WATER	TEMP	H	445.	L	-300.	PCM	2
19	CTF	0.OFF		EPGS	COOLNG	TOWER	FANS					PCM	2
20	CTF.EN	0.OFF		EPGS	CTF	ENABLE						PCM	2
21	ZSHCTF	0.OFF	COS	EPGS	COOLNG	TOWER	FANS					PCM	2

COPY

GROUP 20
27 JUL 84 16:22:46

01	TCPMS	0.OFF		EPGS	REMOTE	MODE	SELECT					PCM	2
02	FCV471	11.9IN	XXX	HRFS	DEATOR	LEVEL	CONTRL	H	30.0	L	10.0	PCM	2
03	FCV521	77.F	XXX	EPGS	OIL	COOLER	TEMP	H	500.	L	0.	PCM	2
04	OH.ON	0.OFF		EPGS	OIL	HEATER						PCM	2
05	EOP	1.ON		EPGS	ELECT	OIL	PUMP					PCM	2
06	EOP.EN	1.ON		EPGS	EOP	ENABLE						PCM	2
07	ZSHEOP	0.OFF	XXX	EPGS	ELECT	OIL	PUMP					PCM	2
08	PT501	0.PSI	XXX	EPGS	OIL	SUPPLY	PRESS	H	40.	L	10.	PCM	2
09	PT531	0.PSI	XXX	EPGS	HYDRO	OIL	PRESS	H	100.	L	55.	PCM	2
10	TT521	77.F	XXX	EPGS	OIL	COOLER	TEMP	H	140.	L	100.	PCM	2
11	TE582	75.F	XXX	EPGS	COOLNG	TOWER	DSCHGE	H	100.	L	40.	PCM	2
12	AEP	1.ON		EPGS	AIR	XHAUST	PUMP					PCM	2
13	AEP.EN	1.ON		EPGS	AEP	ENABLE						PCM	2
14	ZSHAEP	0.OFF	XXX	EPGS	AIR	XHAUST	PUMP					PCM	2
15	PT502	23.9IN	XXX	EPGS	CONDSR	PRESS		H	15.0	L	.0	PCM	2
16	CNP	1.ON		EPGS	COND	PUMP						PCM	2
17	CNP.EN	1.ON		EPGS	CNP	ENABLE						PCM	2
18	ZSHCNP	0.OFF	XXX	EPGS	COND	PUMP	ON					PCM	2
19	PT583	0.PSI	XXX	HRFS	COND	PUMP	OUTPUT	H	300.	L	240.	PCM	2
20	FCV551	0.OFF		EPGS	COND	RECIRC						PCM	2
21	LT511	18.4IN	XXX	EPGS	HOT	WELL	LEVEL	H	16.0	L	8.0	PCM	2
22	EPS2.RST	0.OFF		EPS	RESET	FROM	PCM2					PCM	2

COPY

GROUP 21
6-AUG-84 07:25:43

01	ET	0.OFF		EPGS	EMER	TRIP						PCM 2
02	ETR	0.OFF		EPGS	EMER	TRIP	RESET					PCM 2
03	PT581	0.PSI	XXX	EPGS	TURBIN	STEAM	PRESS	H	1500.	L	800.	PCM 2
04	TT583	92.F	XXX	EPGS	TURBIN	STEAM		H	990.	L	800.	PCM 2
05	ST582	0.RPM	XXX	EPGS	GEN	SPEED		H	1270.	L	0.	PCM 2
06	FCV501	0.OFF		EPGS	TURBIN	STOP						PCM 2
07	ZSH501	0.OFF	XXX	EPGS	TURBIN	STOP	VALVE					PCM 2
08	ZSL501	1.ON	XXX	EPGS	TURBIN	STOP	VALVE					PCM 2
09	TVM.OPN	0.OFF		EPGS	THROTL	VALVE	MOTOR					PCM 2
10	TVM.CLS	0.OFF		EPGS	THROTL	VALVE	MOTOR					PCM 2
11	ZT581	.0PCT	XXX	EPGS	THROTL	VALVE	POS	H	100.0	L	.0	PCM 2
12	PT582	2.PSI	XXX	EPGS	STEAM	SEAL	PRESS	H	4.	L	0.	PCM 2
13	PT502	23.9IN	XXX	EPGS	CONDSR	PRESS		H	15.0	L	.0	PCM 2
14	LT511	13.9IN	XXX	EPGS	HOT	WELL	LEVEL	H	16.0	L	8.0	PCM 2
15	PT501	0.PSI	XXX	EPGS	OIL	SUPPLY	PRESS	H	40.	L	10.	PCM 2
16	PT531	1.PSI	XXX	EPGS	HYDRO	OIL	PRESS	H	100.	L	55.	PCM 2
17	TT501	78.F	XXX	EPGS	TURBIN	OUTBD	BEARNG	H	170.	L	110.	PCM 2
18	TT502	78.F	XXX	EPGS	TURBIN	INBD	BEARNG	H	170.	L	110.	PCM 2
19	TE503	77.F	XXX	EPGS	TURBIN	OUTBD	GEAR	H	170.	L	110.	PCM 2
20	TE505	78.F	XXX	EPGS	GEN	OUTBD	GEAR	H	170.	L	110.	PCM 2
21	TE506	78.F	XXX	EPGS	GEN	INBD	GEAR	H	170.	L	110.	PCM 2
22	AZT581	.1PCT	XXX	EPGS	TURBIN	VIBRAT	0...5G	H	100.0	L	.0	PCM 2

COPY

GROUP 22

01	JT581	0.KW		EPGS	POWER	0..960	KWATTS	H	960.	L	0.	PCM	2
02	ET581	0.VAC	XXX	EPGS	VOLTS			H	480.	L	450.	PCM	2
03	ST582	0.RPM	XXX	EPGS	GEN	SPEED		H	1270.	L	0.	PCM	2
04	ST581	.0PCT	XXX	EPGS	FREQ	55..65	HERTZ	H	60.0	L	40.0	PCM	2
05	IT581	0.AMP	XXX	EPGS	CURRNT			H	1200.	L	0.	PCM	2
06	PFT581	1.00LAG	XXX	EPGS	POWER	FACTOR		H	1.00	L	.85	PCM	2
07	VT581	0.VAR	XXX	EPGS	VARS	0..960	KVARS	H	960.	L	0.	PCM	2
08	TT507	79.F	XXX	EPGS	GEN	OUTBD	BEARNG	H	170.	L	110.	PCM	2
09	TE508	78.F	XXX	EPGS	GEN	AIR	TEMP	H	100.	L	-300.	PCM	2
10	TT510	96.F	XXX	EPGS	STATOR	WINDNG	1	H	260.	L	0.	PCM	2
11	TT511	93.F	XXX	EPGS	STATOR	WINDNG	2	H	260.	L	0.	PCM	2
12	TT512	90.F	XXX	EPGS	STATOR	WINDNG	3	H	260.	L	0.	PCM	2
13	TT513	92.F	XXX	EPGS	STATOR	WINDNG	4	H	260.	L	0.	PCM	2
14	TT514	94.F	XXX	EPGS	STATOR	WINDNG	5	H	260.	L	0.	PCM	2
15	TT515	93.F	XXX	EPGS	STATOR	WINDNG	6	H	260.	L	0.	PCM	2

COPY

GROUP 23
27-JUL-84 16:25:31

01	EPS1.RST	0.OFF		EPS	RESET	FROM	PCM1	PCM 1
02	EPS2.RST	0.OFF		EPS	RESET	FROM	PCM2	PCM 2
03	EPS3.RST	0.OFF		EPS	RESET	FROM	PCM3	PCM 3
04	TR181	0.OFF	XXX	RCVR	SALT	HIGH	TEMP	PCM 1
05	TR183	0.OFF	XXX	RCVR	INLET	PRESS	LOW	PCM 1
06	TR184	0.OFF	XXX	RCVR	TUBE	HIGH	TEMP	PCM 1
07	TR185	0.OFF	XXX	RCVR	HTANK	HIGH	LEVEL	PCM 1
08	TR182	0.OFF	XXX	BOOST	PUMP	LOW	PRESS	PCM 3
09	TR186	0.OFF	XXX	BOOST	PUMP	SUMP	LEVEL	PCM 3
10	TR281	0.OFF	XXX	HOT	SUMP	HIGH	LEVEL	PCM 3
11	TR282	0.OFF	XXX	COLD	SUMP	HIGH	LEVEL	PCM 3
12	TR381	0.OFF	XXX	SGS	DRUM	LEVEL	LO.LO	PCM 3
13	TR382	0.OFF	XXX	SGS	WATER	RECIRC	PUMP	PCM 3
14	TR383	0.OFF	XXX	SGS	DRUM	LEVEL	HI.HI	PCM 3
15	TR582	0.OFF	COS	EPGS	MANUAL	TRBGEN	TRIP	PCM 2
16	TR583	0.OFF	XXX	EPGS	OIL	PRESS	LOW	PCM 2
17	TR584	0.OFF	XXX	EPGS	GEN	BEARNG	TEMP	PCM 2
18	TR585	0.OFF	XXX	EPGS	GEN	AIR	TEMP	PCM 2
19	TR586	0.OFF	XXX	EPGS	GEN	BRKR	TRIP	PCM 2
20	TR587	0.OFF	XXX	EPGS	VIBRAT	HIGH		PCM 2
21	TR588	0.OFF	XXX	EPGS	STEAM	ENERGY	LOW	PCM 2

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GROUP 26
27-JUL-84 16:27:28

01	TR181	0.OFF		RCVR	SALT	HIGH	TEMP	PCM 1
02	TR182	0.OFF	XXX	BOOST	PUMP	LOW	PRESS	PCM 3
03	TR183	0.OFF	XXX	RCVR	INLET	PRESS	LOW	PCM 1
04	TR184	0.OFF	XXX	RCVR	TUBE	HIGH	TEMP	PCM 1
05	TR185	0.OFF	XXX	RCVR	HTANK	HIGH	LEVEL	PCM 1
06	TR186	0.OFF	XXX	BOOST	PUMP	SUMP	LEVEL	PCM 3
07	LV181	1.ON	XXX	24VDC	CONTRL	POWER	SUPPLY	PCM 1
08	TR281	0.OFF	XXX	HOT	SUMP	HIGH	LEVEL	PCM 3
09	TR282	0.OFF	XXX	COLD	SUMP	HIGH	LEVEL	PCM 3
10	LV281	1.ON	XXX	24VDC	CONTRL	POWER	SUPPLY	PCM 3
11	TR381	0.OFF	XXX	SGS	DRUM	LEVEL	LO.LO	PCM 3
12	TR382	0.OFF	XXX	SGS	WATER	RECIRC	PUMP	PCM 3
13	N90.PS	1.OK	XXX	NETWRK	90	POWER	SUPPLY	PCM 3
14	N90.ALM	0.ALM	XXX	NETWRK	90	ALARM		PCM 3
15	LV481	1.ON	XXX	24VDC	CONTRL	POWER	SUPPLY	PCM 2
16	VIB.OVR	1.ON		EPGS	VIBRAT	OVRIDE		PCM 2
17	TR583	0.OFF	XXX	EPGS	OIL	PRESS	LOW	PCM 2
18	TR584	0.OFF	XXX	EPGS	GEN	BEARNG	TEMP	PCM 2
19	TR585	0.OFF	XXX	EPGS	GEN	AIR	TEMP	PCM 2
20	TR586	0.OFF	XXX	EPGS	GEN	BRKR	TRIP	PCM 2
21	TR587	0.OFF	XXX	EPGS	VIBRAT	HIGH		PCM 2
22	TR588	0.OFF	XXX	EPGS	STEAM	ENERGY	LOW	PCM 2

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GROUP 27
27-JUL-84 16:28:49

COP #1 CONTROL ROOM PRETEST CHECKLIST

TEST DATE
10/04/84

This Console operating procedure will be utilized to verify process control integrity prior to all tests. It is unnecessary to verify control integrity of subsystems not used (not applicable). This checklist shall be completed by the control room process console operator.

I. Test Description ____________________

Start Time

II. Responsible operating personnel

	Primary	Backup
Test Conductor (MDAC)	Stan Saloff	
Heliostat Operator	Arleen Vance	
Console Operator	Evans/Nelson	
Operation/Safety Engineer	John Holmes	
Subsystem Technicians		
RS	Jerome Griego	
TSS	Matt Matthews	
SGS	Matt Matthews	
HRFS	Jay Holton	
EPGS	Jay Holton	

III. Safety Checklist — O/S

Complete this checklist for all operations.

1. Site occupants

   A. Verify that all test personnel have been briefed on the scheduled test description, objectives, individual responsibilities, and expected response to emergencies ____________

   B. Communications established to all manned control points ____________

   C. Safety equipment in place:

      1. OSHA protective gloves ____________

      2. Fire retardant coveralls ____________

      3. Hard hats/Face shields ____________

      4. Approved fire extinguishers ____________

2. Solar only

   A. "Test In Progress" lights on in the tower ____________

   B. Non-Test personnel informed and in secure location ____________

   C. Diesel-Generator on and frequency OK ____________

   D. Field monitor on call after solar start-up ____________

   E. Communications established ____________

   F. Tower top barricade up ____________

   G. Gates closed and posted with red lights or signs ____________

   H. Field clear and ready for start-up ____________

3. Control Room locked ____________

4. Beam up command shall be given only after above checklist is completed by O/S Engineer ____________

STEP	DESCRIPTION	VERIFICATION

Notice

Four items that impact system start-up significantly and should be verified and/or corrected first are:

a. Emcon operation
b. Acurex temperatures
c. D/D level and temp.
d. Steam drum level and temp.

IV. MASTER CONTROL SUBSYSTEM

A. EMCON D/2 HOST START UP CHECKLIST
Complete this checklist for all operations.

1. Equipment powered up:

a) Host cabinet
b) Operator Console 1
c) Operator Console 2
d) (2) LA-120 Terminals
e) VT-100 Terminal
f) Tri-log printer ____________

2. Disk Packs (2) installed in drives, disk drives running with "READY" lamp lit. ____________

3. EMCON system booted and "START-UP" command file executed:

a) Correct date and time
b) Disk unit DLI mounted
c) CCM, PCMs loaded (optional)
d) EMCON host programs running

1. SPNCOL	5. CONSL2
2. POWER	6. CONSL1
3. ALRMMX	7. SYSMON
4. ALARMS	8. TRACKR

____

4. MSSND program executing when data logging display is required on the Auxiliary Data Logging/Display System. ____________

5. Unlock Console to allow activation of operational alarms and Receiver Control Algorithm. ____________

6. Enable general alarms by turning GAL on. ____________

STEP	DESCRIPTION	VERIFICATION

B. ACUREX START-UP CHECKLIST
Complete this checklist for all operations using salt.

1. Equipment powered up:

   a) Host chassis - Autodate Ten/50
   b) Electrohome monitor
   c) GT-100 Terminal
   d) Texas Instruments 820 RO Terminal ____________

2. Tape Cassette loaded in host drive. ____________

3. Recent (within 60 minutes) logout of temperatures available on TI printer. ____________ Last Print Time

4. Set scan rate to every 60 minutes. ____________

C. AUXILIARY DATA LOGGING/DISPLAY SYSTEM
Data acquisition checklist completion optional as required.

1. Equipment powered up:

   a) H-P 1000 Cabinet
   b) H-P 2645 Terminal
   c) H-P 2621 Terminal
   d) Tektronix 4014 Terminal
   e) Tektronix 463 hard-copy unit
   f) (6) Display CRTs
   g) Versatec Video Copier
   h) Versatec Printer
   i) H-P 7925 Disc Drive ____________

2. Disk pack installed in drive, disc drive running with "READY" lamp lit. ____________

3. System booted:

   a) Correct date and time
   b) Transfer file IMSRP executed ____________

4. MSPAS program executing when data logging/display is required and MSSN2 has been started on the EMCON host. ____________

5. Following support programs available for execut:

   a) MSRTP
   b) MSPSU
   c) MSDSD
   d) MSSL1 through MSSL6
   e) MSCDT ____________

6. Label file used:__________ ____________

7. Data file used:__________ ____________

STEP	DESCRIPTION	VERIFICATION

D. NETWORK 90 SETUP CHECKLIST
Complete this checklist for operation with SGS.

1. Verify equipment powered up and operational.

   a) Bailey PCU
   b) Operator Interface Drive Unit
   *c) Keyboard Console
   *d) Printer

*These components may be turned off when not in use. ________

V. RS - RECEIVER SUBSYSTEM
Complete this checklist for operation with Receiver.

1. Verify acceptable limits on winds (less than 30 MPH), solar insolation (above 600 W/m^2) and cloud condition (partly cloudy or clear). ________

2. Verify TV cameras are on and operational. ________

3. Verify the Control Room SCRAM and EPS power supplies behind Weather Monitor Panel are On and set at 24VDC. ________

02 4. Open the Receiver cavity door upon the request of the RS technician for the RS pretest check. Reclose or leave open as required. (DR.OPN/CLS). ________

07 5. Verify Emcon RS header temperatures are above 480°F. (TE-188 inoperable). ________

6. Verify the Acurex RS trace heaters are operating and the temperatures are above 480°F (Table A). NOTE EXCEPTIONS. If required, heat tracing control can be taken over locally at the module control room. ________ ________ Time

7. Align/verify the following valve alignment; confirm valve temps are acceptable before moving. (to avoid bellows damage) Coordinate with Receiver technician. RCK 'ON' may be used to auto align these, turning itself off when complete. ________

	Valve	Description	Position		
	FCV-101	Salt flow control	Man/Open/N		
01	FCV-102	Salt flow control	Man/Open/N		
	FCV-180-189	Drain valves	On/Open/N	(ZSH180-189 On)	08
	FCV-190-198	Purge valves	On/Open/N	(ZSH190-198 On)	09
04	CSP.EN	Enable CSP control	On		
	BP.EN	Enable BP control	ON		

STEP	DESCRIPTION	VERIFICATION

VI. **TSS - THERMAL STORAGE SUBSYSTEM**

Complete this checklist for all operations using salt.

1. Verify that the Acurex TSS trace heaters are operating and the temperatures are above 480°F (Table B). NOTE EXCEPTIONS. If req'd, heat tracing control can be controlled locally at salt storage control building. ✓ 8:55 Time

2. If operating Propane Heater without SGS, verify that these Acurex SGS inlet trace heaters are above 480°F (Ref. Table C): ✓

Channel	Channel	Local Temp. Verific.
204	255	FCV-241
205	256	Hot Tank inlet line
206	257	
	258	

3. Verify salt levels in storage tanks and sumps are commensurate with test requirements ✓

LT-201 Cold Sump 29.5 in. (60" max)**@ 606 °F (Acurex Chan 124,125)

03 LT-281 Cold Tank 39.8 in. (40" min)* @ 580 °F (Acurex Chan 110-112)

LT-221 Hot Sump 25.8 in. (43" max)**@ 925 °F (Acurex Chan 126,127)

LT-291 Hot Tank 22.9 in. @ 867 °F (Acurex Chan 134-136)

*Minimum level req'd to maintain cold sump level during fill operations
**Maximum levels automatically close FCV-211 and 231 thru Emcon and lockout may overridden by turning OVR3 on. Maximum levels require vent checks; advise technician.

4. Align/verify the following valves for operation with RS, with SGS, & without Propane Heater. Confirm valve temps are accept. before moving. Coordinate with thermal storage technician. TCK 'ON" may be used to auto align these, turning itself off when complete. ✓

	Valve	Description	Position	
	*FCV-151	CST Level Control	Man/Closed/N Locked	
02	FCV-161	HST Level Control(Hot)	Man/Closed/N Locked	
	FCV-162	HST Level Control(Cold)	Man/Closed/N Open	
	FCV-199	Bypass valve	Off/Open /N	(ZSH199 on)
	FCV-201	Cold Sump Level Control	Auto/Closed/N SP 23"	
04	FCV-211	Cold Sump Isol. (OPN/CLS.211)	Closed/Locked	(ZSL211 on)
	FCV-221	Hot Sump Level Control	Auto/Closed/N SP 20"	
	FCV-231	Hot Sump Isol. (OPN/CLS.231)	Closed/Locked	(ZSL231 on)
05	FCV-241	Propane Heater Inlet	Man/Closed/Locked	
	FCV-242	Propane Heater Isolation	Off/Closed/~~Locked~~ N	(ZSL242 on)
	FCV-301	Bypass Salt Flow	Closed/N	(MAN on, SP Auto 0
13	FCV-341	Cold Salt Isol.	Closed/N	(MAN on, SP Auto 0
	FCV-351	Hot Salt Isol.	Closed/N	(MAN on, SP Auto 0
04	CSP.EN	Enable CSP Control	On	

*Bad signal (blue) can indicate EPS closure. Clear trips and reset EPS1 & EPS3 to regain control.

STEP	DESCRIPTION	VERIFICATION

5. For operation with Propane Heater instead of Receiver OR for SGS alone, Modify the valve alignment of step 4 as follows:

	Valve	Position
—	FCV-151	Locked
02	FCV-161	Locked
	FCV-162	Man/Open/N
05	FCV-242	Nuetral

6. For operation without SGS, Modify the valve alignment of step 4 as follows: N/A

	Valve	Position
13	FCV-301	Locked
	FCV-341	Locked

04 7. Verify pump bearing temp's are less than 190°F (TE 180, 286, & 387 on EMCON) and alarms on.

VII. SGS - STEAM GENERATION SUBSYSTEM
Complete this checklist for operation with SGS.

1. Verify that the Acurex SGS trace heaters are operating and the temperatures are above 480°F (Table C). NOTE EXCEPTIONS. If required, heat tracing control can be taken over locally at the salt storage control building Acurex cabinet back. 9:30 Time

2. Align/verify the following valve positions. Confirm valve temps are accept. before moving. Coordinate with thermal storage technician. All SGS control valve MAN signals should be On. (Emcon commands not applicable from Net 90) SCK 'ON' may be used to auto align these, turning itself off when complete.

	Emcon Command	Valve Description	Position
—	MAN.321 On/ SP-321 Auto 100%	Main Salt Flow	Open
	MAN.331 On/ SP-331 Auto 10%	Steam Attemp.	10% Open
13	MAN.38182 On/FCV-38182 On	Salt Drain	Open
	*MAN.384 On/ FCV-384 On	Circ Htr Supply	Open
	*MAN.383 On/ FCV-383 Off	Circ Htr Bypass	Closed
04	HSP.EN	Enable HSP Control	On

*Open FCV-384 before closing FCV-383 to avoid SGS Pump and Heater Shut-off

STEP	DESCRIPTION	VERIFICATION

Complete the following steps after completing HRFS startup. (Presuming SGS is in Diurnal Shutdown).

3. If SGS F.W. inlet pipe temp. (Acurex Channel 132) is below 200°F, increase bridge pipe feedwater temperature:

   a) Verify D/D TE-451 is above 250°F ✓

   b) Advise the SGS technician to open the bridge feedwater drain HV-370, then open FCV-411 to 20% (Emcon MAN.411 on/SP Auto 20%) ✓

   c) Verify Acurex channel 132 increases above 200°F (Approx 5 min after opening FCV-411) ✓

   d. Reclose HV-370 and FCV-411 ✓

4. Verify drum level LT-311 is at 0.0 inches. If drum level is below 0.0 inches; open HV-488, then open FCV-411 to 20% and fill to 0.0". Close FCV-411 and HV-488 to avoid FW leakage into drum. ______

5. Verify that the boiler water circulation pump (BWCP) <u>is</u> running (ZSHBCP). If it is <u>not</u> running:

   a) Review overnight data to determine reason and correct.

   b) Start BWCP

   c) Start circulation heater (pulse EHAC.ON) ______

6. If freezing ambient temperatures have been experienced, resolve any suspicious instr. transmitter readings with the SGS technician. Be skeptical of all readings until proven. ______

COP #1 CONTROL ROOM PRETEST CHECKLIST

STEP	DESCRIPTION	VERIFICATION

VIII. HRFS - HEAT REJECTION AND FEEDWATER SUBSYSTEM
Complete this checklist for all water system operations.

1. Set/Verify the following control devices in the listed positions: HCK 'ON' may be used to auto align these, turning itself off when complete. ____________

Step	Identifier	Description	Command	Position
call up	GSTAT	D/D Press Enable	Off (PT-431 control)	N/A
	EN.DTC451	D/D Heater 1 Enable	Off	N/A
	EN.DTC452	D/D Heater 2 Enable	Off	N/A
18	DTC-451	D/D Heater 1	Auto SP 390 or 400°F	Not Enabled
	DTC-452	D/D Heater 2	Auto SP 390 or 400°F	Not Enabled
	FCV-401	FWP Press Recirc	Auto SP 1250 psi	Closed
	FCV-411	Feedwater Delivery	MAN.411 On/SP-411 AUTO 0%	Closed
	FCV-421	FWH Steam Supply	Man	Closed
	FCV-431	D/D Steam Inlet	Auto/Casc to PT-431	Closed
	PT-431	Steam Line Press	Auto SP 1080 psi	N/A
	PT-432	D/D Press	Auto SP 225 psi	N/A
	FCV-432	SWHX Divert	Auto SP 233 psi	Open to Bypass
	FCV-471	T-G Condensate Return	Auto SP 0%	Closed
	FY-472	CMUP Stroke Positioner	Auto SP 0%	Closed
21	FCV-491	SGS Steam Delivery	Auto SP 900 psi	Closed
	ZSL-501	Main Steam Stop micro	On	Closed
	TCPMS	EPGS Control Mode	Off (local)	N/A
20	CF1.EN	Cooling Fan 1 Enable	On	N/A
	CF2.EN	2	On	N/A
	CF3.EN	3	On	N/A
	CF4.EN	4	On	N/A
	CF5.EN	5	On	N/A
	CF6.EN	6	On	N/A
19	CFP.EN	Cycle Fill Pump Enable	On	N/A
	CMP.EN	Cond. Make-up Pump	On	N/A
	CWP.EN	Cooling Water Pump	On	N/A
	SWP.EN	Spray Water Pump	On	N/A
	FWP.EN	Feed Water Pump	On	N/A

IX. EPGS ELECTRIC POWER GENERATION SUBSYSTEM
Complete this checklist for all turbine-generator operations.

1. Verify RGP Gen Breaker green (open) light is on. ____________

2. Verify that the Sync switch handle has been procured from the MSEE key box if synch is to be completed or observed from the control room. ____________

T/C	DESCRIPTION	ACUREX CHANNEL	T/C	DESCRIPTION	ACUREX CHANNEL
TEH-190	Purge Valve #1	000	TEH-157	Receiver Outlet-Heater R	027
TEH-191	Purge Valve #2	001	TEH-158	Receiver Outlet-Heater R	028
TEH-192	Purge Valve #3	002	TEH-153	Hot Surge Tank Inlet-Heater N	029
TEH-193	Purge Valve #4	003	TEH-159	Hot Surge Tank Outlet-Heater N	030
TEH-194	Purge Valve #5	004	TEH-152	Cold Surge Tank Inlet-Heater O	031
TEH-195	Purge Valve #6	005	TEH-156	Cold Surge Tank-Heater O	032
TEH-196	Purge Valve #7	006	TEH-150	Receiver Inlet-Heater P	033
TEH-197	Purge Valve #8	007	TEH-151	Receiver Inlet-Heater P	034
TEH-198	Purge Valve #9	008	TEH-162	FCV-101-Heater Q	035
TEH-180	Drain Valve #1	009	TEH-163	FCV-102-Heater Q	036
TEH-181	Drain Valve #2	010	TEH-154	Drain Line-Heater T	037
TEH-182	Drain Valve #3	011	TEH-155	Drain Line-Heater T	038
TEH-183	Drain Valve #4	012	TEH-166	Hot Surge-Heater U	039
TEH-184	Drain Valve #5	013	TEH-167	Hot Surge-Heater U	040
TEH-185	Drain Valve #6	014	TEH-164	Cold Surge-Heaster V	041
TEH-186	Drain Valve #7	015 (Bad)	TEH-165	Cold Surge-Heater V	042
TEH-187	Drain Valve #8	016	TEH-131	Riser-Heater H	300
TEH-188	Drain Valve #9	017	TEH-133	Riser-Heater I	301
TEH-189	Drain Valve #10	018	TEH-134	Riser-Heater I	302
TEH-160	Purge Line-Heater S	019	TEH-135	Riser-Heater J	303
TEH-161	Purge Line-Heater S	020	TEH-136	Riser-Heater J	304
TEH-176	Drain Line	021	TEH-130	Downcomer-Heater K	305
TEH-177	Drain Line	022	TEH-132	Downcomer-Heater L	306
TEH-172	Outlet of Pass #1 (Header)	023	TEH-137	Downcomer-Heater M	307
TEH-173	Pass #10	024	TEH-138	Downcomer-Heater M	308
TEH-174	Pass #11	025	TEH-139	Downcomer-Heater L	(Skip) 309
TEH-175	Pass #18	026			

TABLE A RS HEAT TRACE INSTRUMENTATION

T/C	DESCRIPTION	ACUREX CHANNEL	T/C	DESCRIPTION	ACURE CHANN
TEH-218	Hot Tank Outlet	(B)100	TEH-207	Boost Pump Outlet - Heater A	122
TEH-216	FCV-211, Line X	(B)101	TEH-208	Boost Pump Outlet - Heater A	123
TEH-219	Hot Sump Outlet	(B)102	TEH-227	Cold Sump	*124
TEH-222	Hot Sump	(B)103	TEH-228	Cold Sump	*125
TEH-225	Cold Sump Outlet	104	TEH-220	Hot Sump	(B)*126
TEH-230	Cold Tank Inlet	105	TEH-221	Hot Sump	(B)*127
TEH-201	Boost Sump Drain - Heater D	106	TEH-211	Riser - Storage End - Heater H	128
TEH-202	Cold Pump Outlet - Heater C	107	TEH-241	FCV-151, Heater H	(A)129
TEH-265	Cold Sump Outlet	108	TEH-212	Downcomer - Storage - Heater K	130
TEH-229	Cold Sump Inlet	109	TEH-240	FCV-161, Heaters A-Y, K	131
TEH-233	Cold Tank #1, CT-1 thru 7	*110	TEH-213	Hot Tank #1	*134
TEH-234	Cold Tank #2, CT--1 thru 7	*111	TEH-214	Hot Tank #2	*135
TEH-235	Cold Tank #3, CT-1 thru 7	*112	TEH-215	Hot Tank #3	*136
TEH-231	FCV-201	113	TEH-217	Cold/Hot Tank Bypass-Heater AA	(A,B)137
TEH-232	Cold Tank Outlet	114	TEH-223	Propane Heater	(A)138
TEH-205	Boost Suump - Heater W	115	TEH-224	Propane Heater	(A)139
TEH-206	Boost Sump - Herater W	116	TEH-236	Cold/Hot Tank Bypass, Heater AA	(A,B)140
TEH-203	Boost Pump Bypass - Heater E	117	TEH-238	FCV-242	141
TEH-204	Boost Pump Outlet - Heater B	118	TEH-239	Propane Heater Outlet	(A)142
TEH-209	Cold Tank Inlet - Heater F	(B)119			
TEH-210	Cold Tank Bypass - Heater G	120			
TEH-237	FCV-162, Heater F	(B)121			

* Record for TSS Step 2, stored salt temp's

(A) Normally not operating during system operation

(B) Not required for Propane Heater operation

TABLE B TSS HEAT TRACE INSTRUMENTATION

T/C	DESCRIPTION	ACUREX CHANNEL	
TEH-305, 306	Hot Salt Inlet Lines	200, 201	
TEH-307, 308	Salt Piping Between SH and EV	202, 203	
TEH-309 thru 311	Cold Salt Inlet Lines	204 thru 206	
TEH-312 thru 314	EV Salt Outlet	207 thru 209	
TEH-315 thru 317	Salt Drain Lines	210 thru 212	
TEH-318, 319	SH and EV Outlet Overpressure	**213, 214	
TEH-320, 321	Superheater	215, 216	
TEH-322. 323	Evaporator	217, 218	
6005 thru 6009	Misc. Salt Lines (info.)	230 thru 234	233 (Skip) 234 (O.R.)
6011 thru 6016	Superheater (info.)	##236 thru 241	
----	FCV-351 Body, Bonnet	242,/243	
6020 thru 6025	Evaporator (info.)	##245 thru 250	
6026 thru 6029	Hot Salt Inlet (info.)	251 thru 254	
6030, 6031	FCV-341 Body, Bonnet	255,/256	
6032, 6033	FCV-301 Body, Bonnet	257, 258	
6034, 6035	FCV-321 Body, Bonnet	259, 260	
6036, 6037	FCV-381 Body, Bonnet	261, 262	
6038, 6039	FCV-382 Body, Bonnet	263, 264	
6040 thru 6042	Salt Drain Lines (info.)	##265 thru 267	
6043	SH Drain (info.)	**268	
6044 thru 6053	Misc. Lines (info.)	269 thru 278	275 (Skip) 277 (O.R.)

**These will normally be below salt freezing temperature (no problem).

##These may be below 480°F - But they should be above 400°F prior to salt flow.

TABLE C SGS HEAT TRACE INSTRUMENTATION

TABLE D GROUP ALARM LIST

GAL GENERAL ALARMS

LT-201	TE-180	TE-383	TE-508	LS-541	LV-28
LT-221	TE-181	387	-509	PS-281	LV-481
LT-281	TE-184	388	-581	PS-485	LV-N9(
LT-291	TE-211	TE-481		TS-501	N90-AL!
LT-311	TE-231	484		TS-502	
LT-471	TE-281	486			
LT-511	TE-286				

RAL RECENER OPERATIONAL ALARMS

FT-101	LT-151	TE-101	PT-181	RMINT
	LT-161	TE-102	PT-182	RMAXT
		TE-161		
		[illegible]		

SAL STEAM GENERATOR OPERATIONAL ALARMS

TE-301	TE-384	PT-321	PT-431
TE-331	386	382	432
332	421	383	483
TE-382	483	384	
		386	

PAL ELECT. POWER OPERATIONAL ALARMS

ET-581	TT-501	TE-505	TT-521	PT-501	PT-531
ST-581	TT-502	TE-506	TT-583	502	581
ZSH-AEP	TE-503	TT-507			583

TABLE E MSEE REMOTE OPERATED VALVE ALIGNMENT

VALVE	FUNCTION	PRETEST: BASIC FULL SYSTEM	PRETEST: MODIFICATION TO OPERATE 1. W/O RECVR 2. W/ OR W/O PROPANE HTR	PRETEST: MODIFICATION TO OPERATE 1. RECVR ONLY -OR- 2. PROPANE HTR ONLY	OPERATION: BASIC FULL SYSTEM	OPERATION: MODIFICATION TO OPERATE 1. W/O RECVR -AND- 2. W/PROPANE HTR	POST TEST	
FCV-101	RECVR FLOW CTRL	○ MAN			© CASC SP, SALT SP 1000 °F	○ MAN	○ MAN	
FCV-102	RECVR FLOW CTRL	○ MAN			© CASC SP, SALT SP 1000 °F	○ MAN	○ MAN	
FCV-151	CST LEVEL CTRL	● MAN	● L MAN	● L MAN (W/ HTR)	© CASC LT-151 SP 87"	● L MAN	○ MAN	
FCV-161	HST LEVEL CTRL	● MAN	● L MAN	● L MAN (W/ HTR)	© AUTO SP 20"	● L MAN	○ MAN	
FCV-162	HST LEVEL CTRL	● MAN	○ MAN	○ MAN (W/ HTR)	● AUTO SP 20"	○ MAN	○ MAN	
FCV-180-189	RECVR DRAIN	○			●		●	
FCV-190-198	RECVR PURGE	○			●		●	
FCV-501	TURBINE STOP	●			○		●	
FCV-511	HOT WELL OVERFLOW	● EN, HLC OFF			© EN, HLC ON		●	
FCV-512	HOTWELL MAKE-UP	● (LOCAL CNTRL)			© (AUTO CNTRL)		● (LOCAL CNTRL)	
FCV-521	OIL COOLANT FLOW CTRL	● AUTO SP 120° F			© AUTO SP 120° F		● MAN	
FCV-541	CNST MAKE-UP	● LOCAL CNTRL			LOCAL CNTRL		● LOCAL CNTRL	
FCV-551	CONDENSATE RECIRC	●			●		●	
FCV-561	TURBINE TRIP	● ET OFF			● ET OFF		● ET OFF	
TVM	TURBINE THROTTLE	●			©		●	

● L — ● CLOSED, L LOCKED
○ — OPEN
© — CONTROLLING

COP #2 CONTROL ROOM POST-TEST CHECKLIST | Test Date ______ 9/22/84

This Console operating procedure will be utilized to secure the process controls following all tests. This checklist shall be completed by the Control Room process console operator.

STEP	DESCRIPTION	VERIFICATION

I. HELIOSTAT SUBSYSTEM

1. Verify system returned to a safe condition; (Helioststs, salt, steam, water) ______

II. RS RECEIVER SUBSYSTEM

1. Verify the following valve alignment: ______

01	FCV-101	Man/Open		
	FCV-102	Man/Open		
	FCV-180 thru 189	Off/Closed	(ZSL's on)	08
	FCV-190 thru 198	Off/Closed	(ZSL's on)	09

02 2. Verify the receiver cavity door is fully closed (ZSLDR on). ______

3. Verify RS secured from technician - post test checklist completed (ROP #4). ______

III. TSS THERMAL STORAGE SUBSYSTEM

1. Verify the following valve alignment in MAN:

02	FCV-151 Open	04	FCV-211 Closed/Locked✓
	FCV-161 Open	04	FCV-221 Closed
	FCV-162 Open	04	FCV-231 Closed/Locked✓
	FCV-199 Open	05	FCV-241 Closed
04	FCV-201 Closed	05	FCV-242 Closed
	CSP.EN Off, BP.EN Off, HSP.EN Off		______

2. Record the following salt levels & temp's:

03
LT-201 Cold sump ______ in. @ ______ °F (Acurex Chan 124,125)

LT-281 Cold tank ______ in. @ ______ °F (Acurex Chan 110-112)

LT-221 Hot sump ______ in. @ ______ °F (Acurex Chan 126,127)

LT-291 Hot tank ______ in. @ ______ °F (Acurex Chan 134-136)

3. Verify TSS secured from technician - post test checklist completed (TOP #4). ______

COP #2 CONTROL ROOM POST-TEST CHECKLIST

STEP | DESCRIPTION | VERIFICATION

IV. SGS STEAM GENERATION SUBSYSTEM

1. Verify the following valve alignment: __________

STEP			
	*FCV-301	Closed	MAN.384 On
	*FCV-321	Open	FCV.384 On (open)
13	*FCV-331	10% Open	MAN.38182 On
	*FCV-341	Closed	FCV.38182 Off (closed)
	*FCV-351	Closed	

*Emcon commands - MAN signals on with SP in Auto to the positions noted.

2. Verify SGS secured from technician - post test checklist completed (SOP #4). __________

V. HRFS HEAT REJECTION AND FEEDWATER SUBSYSTEM

1. Verify the following device alignment:

STEP				VERIFICATION
	EN.DTC451	--	Off	
	EN.DTC452	--	Off	
	GSTAT	--	Off	
	FCV-431	Closed	Casc	
18	FCV-432	Open	Auto SP 233	
	FCV-471	Closed	Auto SP 0%	
	FY-472	Closed	Auto SP 0%	
	FCV-411	Closed	MAN.411 On/SP.411 Auto 0%	
	FCV-491	Closed	Auto Closed	
	FCV-501	Closed	Off/ZSL-501 On	__________
19	Pump EN Signals		Off	
20				

2. Verify HRFS secured from technician - post test checklist completed (HOP #4). __________

VI. EPGS ELECTRIC POWER GENERATION SUBSYSTEM

21 1. Verify TCRMS is off. __________

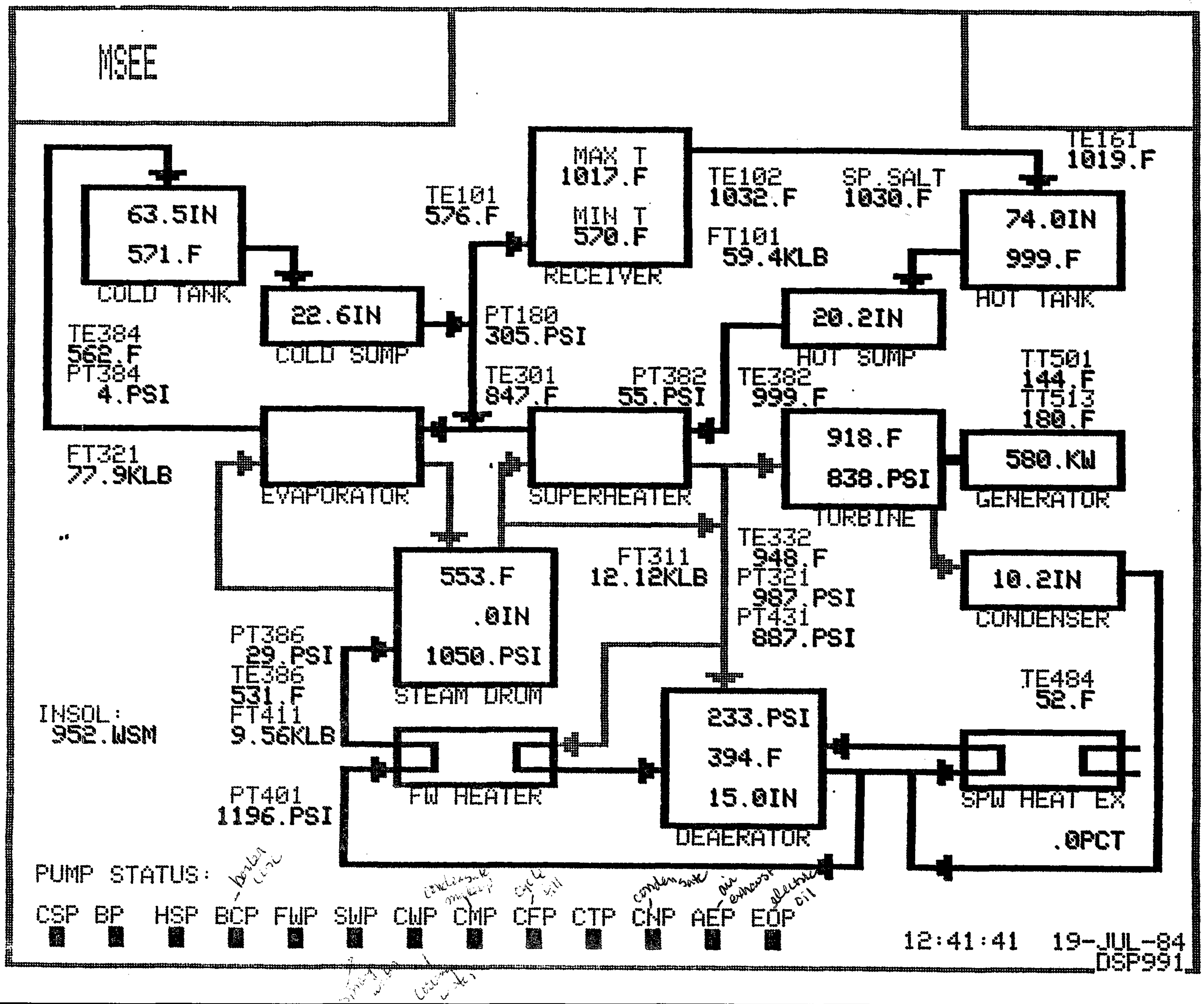
2. If used, reset bkr control switch to green flag, remove the RGP Sync switch handle and return it to the MSEE key box. Set Run Volt and Speed controls down. __________

3. Verify EPGS secured from technician - post test checklist completed (POP #4). __________

VII. MCS MASTER CONTROL SUBSYSTEM

1. Disable general alarms by turning GAL off. __________

2. Safe the Emcon and Net. 90 control consoles to eliminate any inadvertant control inputs. (Lock-up) __________


MSEE
MAX T
1017.F
MIN T
570.F
RECEIVER
TE161
1019.F
TE102
1032.F
SP.SALT
1030.F
FT101
59.4KLB
TE101
576.F
63.5IN
571.F
COLD TANK
22.6IN
COLD SUMP
74.0IN
999.F
HOT TANK
20.2IN
HOT SUMP
PT180
305.PSI
TE384
562.F
PT384
4.PSI
TE301
847.F
PT382
55.PSI
TE382
999.F
TT501
144.F
TT513
180.F
EVAPORATOR
SUPERHEATER
918.F
838.PSI
TURBINE
580.KW
GENERATOR
FT321
77.9KLB
TE332
948.F
PT321
987.PSI
PT431
887.PSI
FT311
12.12KLB
553.F
.0IN
1050.PSI
STEAM DRUM
10.2IN
CONDENSER
PT386
29.PSI
TE386
531.F
FT411
9.56KLB
TE484
52.F
INSOL:
952.WSM
FW HEATER
233.PSI
394.F
15.0IN
DEAERATOR
SPW HEAT EX
.0PCT
PT401
1196.PSI
PUMP STATUS:
CSP BP HSP BCP FWP SWP CWP CMP CFP CTP CNP AEP EOP
12:41:41 19-JUL-84
DSP991

	TEST DATE
COP #1 CONTROL ROOM PRETEST CHECKLIST	10/04/84

This Console operating procedure will be utilized to verify process control integrity prior to all tests. It is unnecessary to verify control integrity of subsystems not used (not applicable). This checklist shall be completed by the control room process console operator.

I. Test Description ______________________________

Start Time

II. Responsible operating personnel

	Primary	Backup
Test Conductor (MDAC)	Stan Saloff	
Heliostat Operator	Arleen Vance	
Console Operator	Evans/Nelson	
Operation/Safety Engineer	John Holmes	
Subsystem Technicians		
RS	Jerome Griego	
TSS	Matt Matthews	
SGS	Matt Matthews	
HRFS	Jay Holton	
EPGS	Jay Holton	

STEP	DESCRIPTION	VERIFICATION

VIII. HRFS - HEAT REJECTION AND FEEDWATER SUBSYSTEM
Complete this checklist for all water system operations.

1. Set/Verify the following control devices in the listed positions: HCK 'ON' may be used to auto align these, turning itself off when complete. ____________

	Identifier	Description	Command	Position
call up	GSTAT	D/D Press Enable	Off (PT-431 control)	N/A
	EN.DTC451	D/D Heater 1 Enable	Off	N/A
	EN.DTC452	D/D Heater 2 Enable	Off	N/A
	DTC-451	D/D Heater 1	Auto SP 390 or 400°F	Not Enabled
	DTC-452	D/D Heater 2	Auto SP 390 or 400°F	Not Enabled
	FCV-401	FWP Press Recirc	Auto SP 1250 psi	Closed
	FCV-411	Feedwater Delivery	MAN.411 On/SP-411 AUTO 0%	Closed
	FCV-421	FWH Steam Supply	Man	Closed
18	FCV-431	D/D Steam Inlet	Auto/Casc to PT-431	Closed
	PT-431	Steam Line Press	Auto SP 1080 psi	N/A
	PT-432	D/D Press	Auto SP 225 psi	N/A
	FCV-432	SWHX Divert	Auto SP 233 psi	Open to Bypass
	FCV-471	T-G Condensate Return	Auto SP 0%	Closed
	FY-472	CMUP Stroke Positioner	Auto SP 0%	Closed
	FCV-491	SGS Steam Delivery	Auto SP 900 psi	Closed
21	ZSL-501	Main Steam Stop micro	On	Closed
	TCPMS	EPGS Control Mode	Off (local)	N/A
	CF1.EN	Cooling Fan 1 Enable	On	N/A
	CF2.EN	2	On	N/A
20	CF3.EN	3	On	N/A
	CF4.EN	4	On	N/A
	CF5.EN	5	On	N/A
	CF6.EN	6	On	N/A
	CFP.EN	Cycle Fill Pump Enable	On	N/A
	CMP.EN	Cond. Make-up Pump	On	N/A
19	CWP.EN	Cooling Water Pump	On	N/A
	SWP.EN	Spray Water Pump	On	N/A
	FWP.EN	Feed Water Pump	On	N/A

IX. EPGS ELECTRIC POWER GENERATION SUBSYSTEM
Complete this checklist for all turbine-generator operations.

1. Verify RGP Gen Breaker green (open) light is on. ____________

2. Verify that the Sync switch handle has been procured from the MSEE key box if synch is to be completed or observed from the control room. ____________

June 28, 1984

Telephone Numbers for maintenance calls:

MODCOMP	1-800-327-8928	give site number found on sticker on cabinet front panel.
HEWLETT-PACKARD	9-842-1283	give model, serial, and ADP information on attached sheet.
RAMTEK		look for on-site spares first. no existing maintenance contract.
DIGITAL (DEC)	9-345-4471	give following information: CPU 11/34A, Serial No. AG 25174, identify faulty item.
EMC (EMCON)	8-713-665-9911	give nature of problem to Bob Marian or Jerry Kulbeck
BAILEY (N90)	8-303-757-5408	give nature of problem to Denver office. Bill Mahoney
VERSATEC PRINTER VERSATEC VIDEO COPIER	292-1212 (BFA)	give P.O. number 47-4080 and nature of problem.
TECKTRONIX 4014 TEXAS INST TERMINALS	4-3091 (Org. 2617)	give nature of problem, terminal type, S #, serial number.

Ar Hden: 842-1283

The ADP numbers for the equipment that you requested is to put on maintenance are:

Model		Serial number	ADP No.	Prop. No.
2113B	DSP	2015A06179	288-45	S263101
2112A	MCS	1611A00666	284-54A	S24497
2113B	DEV	1737A00225	284-69	S24861
2113B	L. CYCLE	2020A06523	288-53	S2729
2117F	BCS	1810A00132	284-78	S2540
2117F	FCS	2012A01467	288-45	S2631

DSP and MCS are covered for 4 hour response, all others are covered for next day response. Systems not listed will be covered via T & M contracts.

TE161	(3)	-99. → 2500.
TE281	(3)	-99. → 2500.
TE291	(3)	-99. → 2500.
TE101	(1)	-99. → 2500.
TE102	(1)	-99. → 2500.
SP.SALT	(1)	-99. → 2500.

Bob Marcon or Jerry

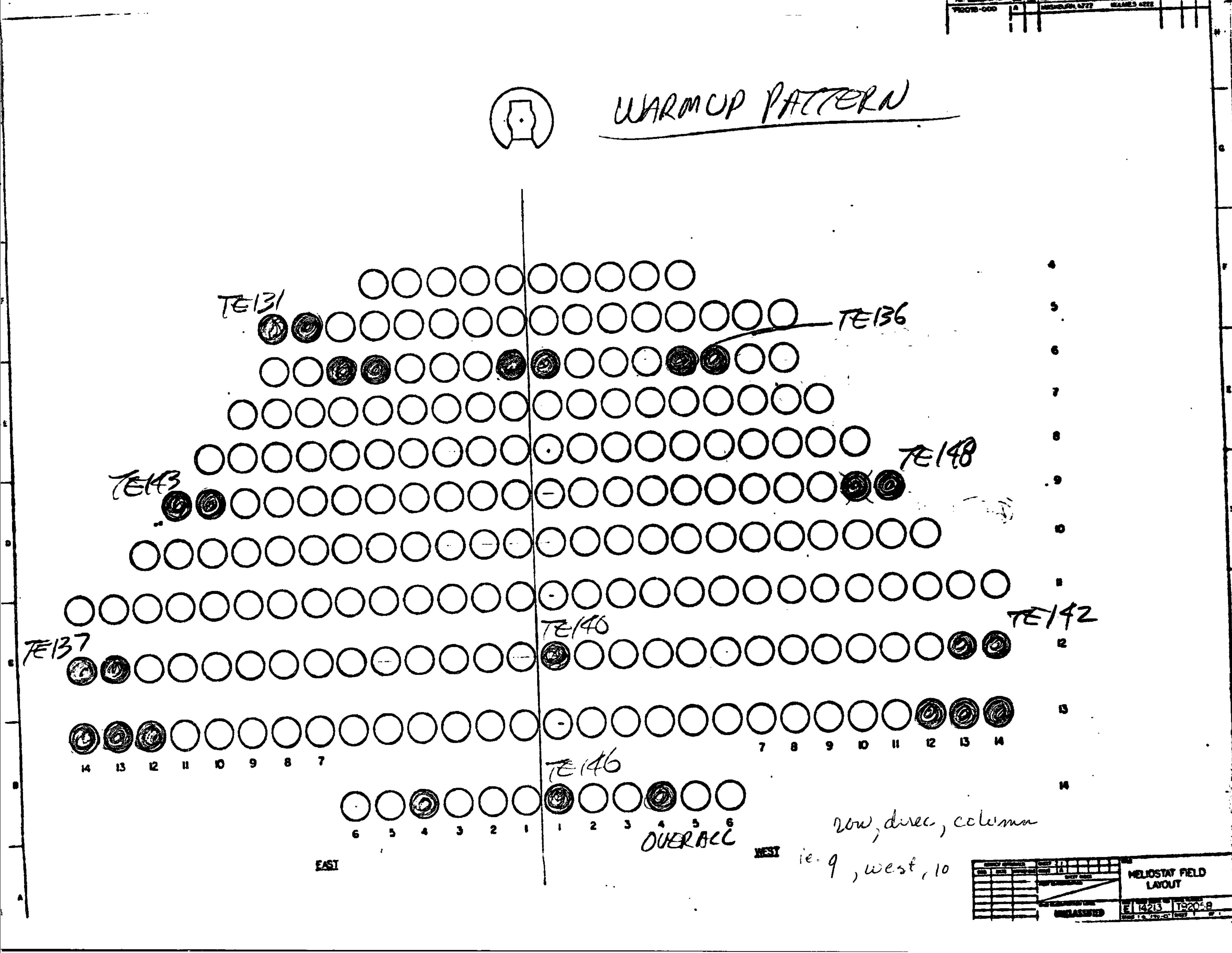
A/D converter card into PCM 1]

if it has to be calibrated in place they have to come & do it

4-6360 & leave message

[Exchange cards 15 in PCM 1 & PCM 2]

[



WARMUP PATTERN
TE131
TE136
TE143
TE148
TE140
TE142
TE137
TE146
4
5
6
7
8
9
10
11
12
13
14
14 13 12 11 10 9 8 7
7 8 9 10 11 12 13 14
6 5 4 3 2 1
1 2 3 4 5 6
OVERALL
EAST
WEST
row, direc, column
ie. 9, west, 10
HELIOSTAT FIELD LAYOUT
E 14213 T920-8
UNCLASSIFIED

Follow this sequence when you get to step #10 of ROP #2

RECEIVER AUTO FILL SEQUENCE CHECKLIST

Step	Description	Verification
1.	Cold Salt Pump ON	✓
2.	Boost Pump ON	✓
3.	Boost Pump Discharge Pressure PT-180 to 310 PSI	✓
4.	FCV-151 OPEN 50%	✓
5.	TE-161 Responds to Salt	✓
6.	Salt in Cold Surge Tank	✓
7.	TE-101 Responds to Salt FT-101 Starts Indicating Flow	✓
8.	Salt in Hot Surge Tank (when cold surge tank level LT-151 reaches 40-50 inches).	
9.	FCV-199 CLOSED (when hot surge tank level LT-161 reaches 10"	
10.	Drain Valves CLOSED (when hot surge tank level LT-161 reaches 56"	
11.	Purge Valves Sequentially Close (EMCON Group 09)	
12.	Hot Surge Tank Level LT-161 Decrease to 20" With FCV-162 Controlling	
13.	Cold Sump Level Controlling at 20"	
14.	FCV-101/102 Controlling Receiver Salt Flow at 30 Klb/hr	
15.	FCV-151 100% OPEN Increasing Cold Surge Tank Level LT-151 to 80-85"	
16.	Return to Step 26 of Receiver Startup Procedure ROP #2	

Procedure	Completed

3. Confirm receiver technician is completing receiver pretest checklist (ROP #1)

4. Confirm thermal storage technician is completing TSS pretest checklist (TOP #1) ✓

5. Complete control room pretest checklist (COP ~~#0~~ #1) Sections I - VI ________

6. Fill receiver, establish serpentine flow, and transition to extended warm standby mode (ROP #2 Sections 1 - ~~35~~ 27) ________

group 01

7. Increase salt flow to 45 KLB/hr, stabilize and confirm level controls of hot and cold surge tanks and cold sump. & Look at FCV162 ________

8. Increase salt flow to 60 KLB/hr, restabilize and reconfirm level controls. (as in #7) ________

9. Increase salt flow to 85 KLB/hr, monitor cold sump level and compare to low alarm level. Reduce flow if necessary and restabilize at a flow rate which allows the sump level to be maintained. Determine the maximum steady state flow rate as limited by the sump supply line.

FT-101	Max steady state flow	________
LT-281	Cold storage tank level	________

10. Reduce flow demand to 30 KLB/hr ________

11. Shut down receiver (ROP#3) ________

5.2 OPERATIONAL EXERCISES

5.2.1 Receiver Cold Flow

Description

- o Fill receiver
- o Circulate the cold salt through the receiver and back to the cold storage tank
- o Drain receiver

Objectives

- o Introduce the operator to receiver start-up and shutdown operations
- o Familiarize the operator with the receiver loop equipment and controls

Initial System Conditions

- o RS2 - Receiver drained with trace heat on
- o TSS2- Hot and cold salt tanks warm and ready for operation
- o SGS not applicable
- o EPGS not applicable

Procedure	Completed
1. Advise data system operator to load system data package.	✓
2. Advise data system operator to display the following on the data display screens:	✓

LT-281	Cold storage tank level
FT-101	Receiver salt flow rate
TE-101	Receiver inlet salt temp
TE-102	Receiver outlet salt temp
LT-151	Cold salt surge tank level
LT-161	Hot salt surge tank level

MCDONNELL DOUGLAS
CORPORATION