14.4-KV SYSTEM

A. GULF STATES CONNECTION

General

From startup in 1958 until June 30, 1972, our plant was connected to Gulf States Utilities through a 138-KV transformer and line to the GSU Addis Substation. The high voltage side of the transformer was connected to the 138-KV line. The low voltage side of the main transformer was connected to the 14.4-KV synchronizing bus through a 3000-ampere, 1000-MVA air circuit breaker (252-211) and to the main ground bus through a grounding transformer.

A capacity potential device is connected to the high side of the main transformer for voltage indication on the Electric Control Board. One set of three 600/5-ampere current transformers is located in the high side of the main transformer and one 600/5-current transformer located in the neutral leg at the main transformer is connected to GSU pilot wire relaying and Dow main transformer relaying. A 1200/5-ampere current transformer on the ground connection of the grounding transformer connects to the main transformer relaying. One set of 14.4 KV/120V potential transformers on the low side of the main transformer is connected to the Electric Control Board for voltage indication, the synchroscope, synchronizing switches, and metering and relaying.

All the above facilities are still intact and ready for service if we decide to tie back in to GSU or to any other source of outside power.

B. MAIN POWER TRANSFORMER (Now out of service)

The main power transformer is an outdoor power transformer, 30/40/50 MVA, OA-(straight self-cooled) 30,000 KVA FOA-(first-stage fan and pump equipment in operation) 40,000 KVA, FOA-(second-stage fan and pump equipment in operation) 50,000 KVA. The first and second stages of forced cooling are obtained by operation of either part and then all of the fans and oil circulating equipment which are actuated by winding temperature control.

The winding temperature control relay is actuated in part by the temperature of the top oil and in part by the current proportional to the high voltage line current. A separate bushing type current transformer provides current for this relay. The relay actuates three switches which:

1. Start first-stage forced cooling.
2. Start second-stage forced cooling.
3. Actuate an alarm.

The fans, pumps and associated contactors are operated from two sources of 440-volt, 3-phase, 60-cycle power. (Breaker 52-1316A

B. MAIN POWER TRANSFORMER (cont'd)

MCC 1-3 and Breaker 52-1433 MCC 1-4). The preferred source is selected by means of a selector switch. An automatic throw-over contactor will cause transfer of the control circuit to the alternate source upon loss of power to the preferred source. Loss of power on the preferred source, loss of control power, and low oil pressure for either pump will be annunciated on the Electrical Control Board. "Main Transformer Trouble".

With the transformer de-energized, two 2-1/2 percent fixed taps above and below rated voltage are operated by a hand-operated tap changer to permit changing connections in the windings.

A three-phase load tap changer permits varying the low side voltage from + 10% of normal voltage in 16 raise and 16 lower steps while the transformer is energized and carrying rated load. Below normal voltage, the taps permit operation at rated current while above normal voltage, the taps permit operation at rated KVA. An operation counter indicates the number of load tap changes. Hand operation by a hand crank is possible and is interlocked so that when operating the hand crank the motor circuit is opened. There are several types of operation of the Load Tap Changer:

1. Local - controlled at the transformer.
2. Remote - controlled at the Electrical Control Board.
3. Manual - operation by turning a control switch either at the transformer or Electrical Control Board.
4. Automatic - this circuit is purposely disabled.
5. Hand - operation by a hand crank at the transformer.

Selector switches at the transformer permit selection of:

1. Local manual.
2. Local automatic.
3. Remote operation.

When the transformer selector switch is in the remote position, operation is possible from the Electrical Control Board. Manual operation is performed by a momentary flip of the manual control switch either in the raise or lower direction. One flip of this control switch will move the tap one complete tap change. A white light on the transformer control indicates that the tap mechanism is "off-position".

The transformer is also provided with:

1. Dial type thermometer for hot oil - measures temperature of hottest oil, has reset pointer that shows highest temperature attained, and alarms at preset temperature.

2. Dial type thermometer for hot spot - indicates approximate hot spot temperature, alarms at preset temperature.

B. MAIN POWER TRANSFORMER (cont'd)

3. Liquid level gauges - indicate level of insulating oil in transformer-alarms on low level.

4. Nitrogen pressure equipment - nitrogen bottle for supply of inert gas to fill spaces above insulating oil - regulator for maintaining pressure on transformer-alarms for transformer high and low pressure and bottle low pressure.

All main transformer alarms except "sudden pressure relay" will indicate on the Electrical Control Board annunciator - "Main Transformer Trouble". Operation of "sudden pressure relay" causes annunciator operation entitled "Main Transformer Differential or Pressure Relay".

C. GROUNDING TRANSFORMER (presently out of service)

The main transformer low side grounding connection is made through the grounding transformer which is an outdoor type 12,230-KVA, 14.2-KV, 1490-ampere fault current, 10-second time rating, interconnected star (zig-zag) transformer.

The high side connection to the grounding transformer is through a crank type disconnect switch. The low side or ground lead connects to the main ground bus through a knife type disconnect switch.

The grounding transformer is equipped with:

1. Combination oil drain, filter pressure connection and sampling device.

2. Magnetic liquid level gauge with two sets of alarm contacts.

3. Dial type thermometer with two sets of alarm contacts.

4. Upper filter pressure connection.

5. Mechanical relief device with alarm mounted on the cover.

The purpose of this transformer is to provide a neutral ground for the 14.4-KV system when the generator is not operating. When the generator is placed in operation, it is permissible to leave transformer neutral disconnect closed, but the high side ground transformer disconnect must be opened after generator neutral is closed and generator is on the line. All ground transformer alarms will indicate on the electrical control board alarm - "Grounding Transformer Trouble".

D. SYNCHRONIZING BUS

The synchronizing bus is connected to:

1. The main transformer through a 3000 ampere, 1000 MVA air circuit breaker (352-211).

2. 14.4 KV Generator bus No. 1 through a 3000 ampere, 1000 MVA air circuit breaker (252-103).

3. 14.4 KV Generator bus No. 2 through a 3000 mapere, 1000 MVA air circuit breaker (252-206).

4. 14.4 KV Generator bus No. 3 through a 4000 ampere 1500 MVA air circuit breaker (252-303).

5. 14.4 KV Generator bus No. 4 through a 4000 ampere 1500 MVA air circuit breaker (252-405).

6. H-102 tie line to H-100.
   H-202 tie line to H-200.

Reactors are provided for all generator buses. The 14.4 switchgear and reactors are the indoor type located on ground elevation inside the 14.4 KV switchgear buildings. The H-15 feeder reactor is an outdoor type mounted at ground elevation.

The 14.4 KV/120 volt potential transformers on the synchronizing bus provide:

1. Potential for synchronizing the five generator and tie line breakers that connect the synchronizing bus.

2. Potential for metering the ties between synchronizing bus and 14.4 KV generator buses.

The synchronizing bus lock-out relay will trip the five breakers that connect to the synchronizing bus. Unbalance of the synchronizing bus differential relay will trip the synchronizing bus lock-out relay.

F. 14.4-KV GENERATOR BUS NO. 1

The following air circuit breakers connect to 14.4 KV Generator Bus No. 1:

252-101 Generator No. 1
252-102 H10-23 Poly A & CA-2
252-103 Synchronizing bus tie No. 1
252-104 Station service transformer No. 1
252-105 14.4 KV feeder H4-6-13 Substations & Return Sta.

E. 14.4 KV GENERATOR BUS NO. 1 (CONT'D.)

252-106 14.4-KV feeders H-18 & H-19 Substation, Intake & Return Stations.

The 14.4 KV switchgear 1-1 lockout relay will trip all six breakers that connect to the bus. Unbalance of the 14.4 KV switchgear 1-1 differential relay will trip the lockout relay.

Feeder backup relay (286FB) will trip:

1. The generator breaker (252-101).
2. Synchronizing bus tie No. 1 (252-103).
3. Generator neutral breaker (252-101).
4. Main exciter field breaker (41-101).
5. Spare exciter field breaker (41-102).
6. The turbine solenoid trip.

F. NO. 1 GENERATOR

The main generating equipment and auxiliaries consist of:

1. One 58824 KVA (at 30 psig hydrogen pressure), 0.85 P-f, two pole, three phase, 60 cycle, 14,400 volt, 3600 rpm hydrogen-cooled synchronous generator with four vertical corner-mounted coolers designed for 95 F. cooling water.

2. One indoor type, filtered air-cooled, main exciter. motor-generator set, 200 KW at 250 volts DC exciter and 300-hp, 2300-volt, three-phase, 60-cycle motor.

3. One indoor type, filtered air-cooled, spare exciter motor generator set, 200 KW at 250 volts DC exciter and 300-hp, 2300 volt, three-phase, 60-cycle motor. Spare exciter is identical to main exciter.

4. One electrically operated air circuit breaker, 800 amperes, 250 volts DC, drawout type for the main exciter, 125-volt DC control.

5. One electrically operated air circuit breaker, 800-mapere, 250 volts DC, drawout type for the spare exciter, 125-volt, DC control.

6. One generator field discharge resistor.

7. One main generator amplidyne type voltage regulator including one amplidyne motor-generator set with a 480-volt, three-phase, 60-cycle motor.

F. NO. 1 GENERATOR (cont'd)

8. One motor-operated field rheostat for the main exciter, 125-volt DC control.

9. One motor-operated field rheostat for the spare exciter, 125-volt DC control.

The hydrogen cooling, bearing lubricating, and seal oil supply equipment will be covered under another section of this manual.

The generator is connected to the 14.4-KV switchgear 1-1 through air circuit breaker 252-101 (3000A-1000MVA). Three 14.4-KV/120 volt potential transformers connected to the generator bus provide potential for generator metering and synchronizing breaker 252-101.

Number 1 generator metering consists of: (All located on the electrical control board except where noted otherwise.)

1. Voltmeter with transfer switch for three phases.

2. Frequency indicating meter.

3. Three ammeters.

4. An indicating wattmeter for the turbine startup control panel.

5. Indicating wattmeter.

6. Watt hour meter.

7. VAR recording meter.

8. Watt recording meter.

9. Thermal converter unit for Leeds & Northrup load control equipment.

10. Field temperature recorder.

Number 1 generator relaying consists of:

1. Generator lockout relay (286G1) which trips:

   a. Generator breaker 252-101.
   b. Generator neutral ACB 252-110.
   c. Main exciter field breaker 41-101.
   d. Spare exciter field breaker 41-102
   e. Turbine stop valve.
   f. Alarm annunciated on the electrical control board.

2. Generator differential (287G1) - trips generator lockout relay.

3. Generator loss of field (240) trips generator lockout relay.

F. NO. 1 GENERATOR (cont'd)

4. Generator ground overcurrent - timing relay - trips generator lockout relay.

5. 14.4-KV switchgear No. 1 differential relay - trips generator breaker 252-101.

6. Feeder backup relay - trips generator breaker (252-101), generator neutral breaker (252-110), main exciter field breaker (41-101), spare exciter field breaker (41-102), and the turbine solenoid trip.

The generator field is provided with:

1. An 800-amp, 100-MV shunt which is used for field temperature indication on the mechanical vertical board.

2. An 800-amp, 100-MV shunt which is used for field current indication on the electrical control board.

3. A ground alarm relay which annunciates on the electrical control board.

4. A generator field discharge resistor which is connected across the generator field when both exciter breakers are open.

Excitation for the main generator is obtained from either the main or spare exciters. The main exciter is connected to the generator field breaker 41-101 and the spare exciter by breaker 41-102. The main exciter motor is fed by breaker 152-111 at the 2400-volt switchgear 1-1 and the spare exciter motor by breaker 152-208 at 2400-volt switchgear 1-2. Both of the exciters are equipped with field rheostats for varying their output voltage, voltmeters and ammeters.

The generator is provided with an amplidyne type voltage regulator which may be used with either exciter. The amplidyne motor is fed from breaker 52-1315 at MCC 1-3. The regulator equipment is located in the excitation switchgear and consists of (1) a voltage regulator panel, (2) a reactive-ampere limit panel, (3) an auxiliary panel including an equalizing reactor, (4) a stabilizer relay panel, and (5) an amplidyne M-G set for use with the above panels.

The main regulator controls are located on the electric control board and consist of (1) a regulator control switch with OFF-TEST-ON positions, and (2) a manual voltage adjuster. A zero-center DC voltmeter is also furnished on the electric control board to indicate the amplidyne output voltage.

The voltage regulator receives its voltage input signal from three generator potential transformers. The current input

F. NO. 1 GENERATOR (CONT'D.)

signal for the reactive-ampere limit control is obtained from one generator bushing type current transformer.

Essentially the operation of the voltage regulator is as follows:

1. The voltage signal is applied to a comparison circuit which senses any change in generator terminal voltage.

2. The output of the comparison circuit is fed to the control field of the amplidyne generator.

3. The output of the amplidyne generator is applied to the field of the exciter.

4. The exciter output is applied to the generator field which in turn tends to raise or lower the generator terminal voltage back to normal depending on the change in load which causes the generator voltage to vary.

The under-excited reactive ampere limit circuit prevents the regulator from reducing the generator excitation to a point where the heating of the end turns or pulling out of step might occur. An equalizing reactor is used to divide the reactive current and to restrict the flow of crosscurrents between the four generators.

G. 14.4 KV GENERATOR BUS NO. 2

The following air circuit breakers connect to 14.4 KV generator bus No. 2:

252-201 Generator No. 2
252-202 H-7 Chlorine
252-203 14.4 KV feeder H-1-2 Substations, Intake and Return Stations.
252-204 Station service transformer
252-205 Chlorine feeder H-8
252-206 Synchronizing bus tie No. 2

The 14.4 KV switchgear 2-1 lockout relay (286B2) will trip breakers that connect to this bus. Unbalance of the 14.4 KV switchgear 2-1 differential relay (287B2) will trip the lockout relay.

H. NO. 2 GENERATOR

The main generating equipment and auxiliaries consist of:

1. One 88235-KVA (at 30-psig hydrogen pressure), 0.85 P-F, 75,000-KW two-pole, three-phase, 60-cycle, 14,400-volt, 3600-rpm hydrogen-cooled synchronous generator with f ur vertical corner-mounted coolers designed for 95° F. cooling water.

2. One indoor type, filtered air-cooled, main exciter motor-generator set, 250-KW at 250 volts DC exciter and 300 hp, 2300-volt, three-phase, 60-cycle motor.

3. One indoor type, filtered air-cooled, spare exciter motor-generator set, 200-KW at 250 volts DC exciter and 300-hp 2300-volt, three-phase, 60-cycle motor. Spare exciter is common to Generators 1 and 2.

4. One electrically operated air circuit breaker, 800-amperes, 250 volts DC, drawout type for the main exciter, 125-volt DC control.

5. One electrically operated air circuit breaker, 800-ampere 250 volts DC, drawout type for the spare exciter, 125-volt, DC control.

6. One generator field discharge resistor.

7. One main generator amplidyne type voltage regulator including one amplidyne motor-generator set with a 480-volt, three-phase, 60-cycle motor.

8. One motor-operated field rheostat for the main exciter, 125-volt DC control.

9. One motor-operated field rheostat for the spare exciter, 125-volt DC control.

The hydrogen cooling, bearing lubricating, and seal oil supply equipment will be covered under another section of this manual.

The generator is connected to the 14.4-KV switchgear 1-2 thr ugh air circuit breaker 252-201 (4000A-1500MVA). Three 14.4-KV/120-volt potential transformers connected to the generator bus provide potential for generator metering and synchronizing breaker 252-103.

Number 2 generator metering consists of: (All located on the electrical control board except where noted otherwise.)

H. No. 2 GENERATOR (Contd.)

2. An 800 AMP 100 MV shunt which is used for field current indication on the electrical control board.

3. A ground alarm relay which annunciates on the electrical control board.

4. A generator field discharge resistor which is connected across the generator field when both exciter breakers are open.

Excitation for the main generator is obtained from either the main or spare exciters. The main exciter is connected to the generator field breaker 41-201 and the spare exciter by breaker 41-202. The main exciter motor is fed by breaker 152-211 at the 2400 volt switchgear 1-2 and the spare exciter motor by breaker 152-208 at 2400 volt switch-gear 1-2. Both of the exciters are equipped with field rheostats for varying their output voltage, voltmeters, and ammeters.

The generator is provided with an amplidyne type voltage regulat r which may be used with either exciter. The amplidyne motor is fed from breaker 52-2317 at MCC 2-3. The regulator equipment is located in the excitation switchgear and consists of (1) a voltage regulator panel, (2) a reactive-ampere limit panel, (3) an auxiliary panel including an equalizing reactor, (4) a stabilizer relay panel, and (5) an amplidyne M-G set for use with the above panels.

The main regulator controls are located on the Electric Control Board and consists of (1) a regulator control switch with OFF-TEST-ON positions, and (2) a manual voltage adjuster. A zero-center d-c voltmeter is also furnished on the Electrical Control Board to indicate the amplidyne output voltage.

The voltage regulator receives its voltage input signal from three generator potential transformers. The current input signal for the reactive-ampere limit control is obtained from one generator bushing-type current transformer.

Essentially the operation of the voltage regulator is as follows:

1. The voltage signal is applied to a comparison circuit which senses any change in generator terminal voltage.

2. The output of the comparison circuit is fed to the control field of the amplidyne generator.

3. The output of the amplidyne generator is applied to the field of the exciter.

4. The exciter output is applied to the generator field which in turn tends to raise or lower the generator terminal voltag back to normal depending on the change in load which causes the generator voltage to vary.

H. NO. 2 GENERATOR (cont'd)

1. Voltmeter with transfer switch for three phases.

2. Frequency-indicating meter.

3. Three ammeters.

4. An indicating wattmeter for the turbine startup control panel.

5. Indicating wattmeter.

6. Watt hour meter.

7. VAR recording meter.

8. Watt recording meter.

9. Thermal converter unit for Leeds & Northrup load control equipment.

10. Field temperature recorder.

Number 2 generator relaying consists of:

1. Generator lockout relay which trips:

   a. Generator breaker 252-110
   b. Generator neutral ACB 252-210.
   c. Main exciter field breaker 41-201.
   d. Spare exciter field breaker 41-202.
   e. Turbine stop valve.
   f. Alarm annunciated on the electrical control board.

2. Generator differential - trips generator lockout relay.

3. Generator loss of field trips generator lockout relay.

4. Generator ground overcurrent - timing relay - trips generator lockout relay.

5. 14.4-KV switchgear No. 2 differential relay - trips generator breaker 252-210.

6. Feeder backup relay - trips generator breaker (252-201), generator neutral breaker (252-210), main exciter field breaker (41-201), spare exciter field breaker (41-202), and the turbine solenoid trip.

The generator field is provided with:

1. An 800-amp, 100-MV shunt which is used for field temperature indication on the mechanical vertical board.

H. No. 2 GENERATOR (Contd.)

2. An 800 AMP 100 MV shunt which is used for field current indication on the electrical control board.

3. A ground alarm relay which annunciates on the electrical control board.

4. A generator field discharge resistor which is connected across the generator field when both exciter breakers are open.

Excitation for the main generator is obtained from either the main or spare exciters. The main exciter is connected to the generator field breaker 41-201 and the spare exciter by breaker 41-202. The main exciter motor is fed by breaker 152-211 at the 2400 volt switchgear 1-2 and the spare exciter motor by breaker 152-208 at 2400 volt switch-gear 1-2. Both of the exciters are equipped with field rheostats for varying their output voltage, voltmeters, and ammeters.

The generator is provided with an amplidyne type voltage regulator which may be used with either exciter. The amplidyne motor is fed from breaker 52-2317 at MCC 2-3. The regulator equipment is located in the excitation switchgear and consists of (1) a voltage regulator panel, (2) a reactive-ampere limit panel, (3) an auxiliary panel including an equalizing reactor, (4) a stabilizer relay panel, and (5) an amplidyne M-G set for use with the above panels.

The main regulator controls are located on the Electric Control Board and consists of (1) a regulator control switch with OFF-TEST-ON positions, and (2) a manual voltage adjuster. A zero-center d-c voltmeter is also furnished on the Electrical Control Board to indicate the amplidyne output voltage.

The voltage regulator receives its voltage input signal from three generator potential transformers. The current input signal for the reactive-ampere limit control is obtained from one generator bushing-type current transformer.

Essentially the operation of the voltage regulator is as follows:

1. The voltage signal is applied to a comparison circuit which senses any change in generator terminal voltage.

2. The output of the comparison circuit is fed to the control field of the amplidyne generator.

3. The output of the amplidyne generator is applied to the field of the exciter.

4. The exciter output is applied to the generator field which in turn tends to raise or lower the generator terminal voltage back to normal depending on the change in load which causes the generator voltage to vary.

M. 14.4 KV SWITCHGEAR AIR COMPRESSORS

The 14.4 KV switchgear is pneumatically operated both on closing and opening. Each breaker is equipped with:

1. Solenoid operated closing and tripping valves.
2. A compressed air tank with pressure alarm relay - "14.4-KV Switchgear Air Pressure Low" annunciated on the Electrical Control Board.
3. Automatic check valve.
4. Drain valve.
5. Safety valve.
6. Shut-off valve.
7. A pressure relay which prevents operation of the breaker when the tank pressure is too low for safe operation.

One set of three single-pole, 15 KV disconnect switches is located electrically on each side of the circuit breaker for maintenance and testing. All switches are opened simultaneously and are either all open or all closed. The circuit breaker and disconnecting switches are interlocked to insure safe operation.

Compressed air is supplied to the Westinghouse 14.4 KV switchgear on generator buses 1, 2 and 3 from three Westinghouse type CA-9 air compressor units at 150 psi. The compressors operate at 300 psi and discharge into separate storage reservoirs which are equipped with 315 psi safety valves and drain valves to remove accumulated moisture from the reservoir.

High-pressure air from the reservoir passes through a strainer and a non-return check valve to a reducing valve which is set to reduce the air pressure from 300 psi to 150 psi. Low-pressure air from the reducing valves then passes through the protection valve which is designed to safeguard against the complete loss of storage reservoir air in the event of a pipe breakage between the compressor unit and the circuit breaker equipment. This valve is set to close at between 105 psi and 90 psi. Once the protection valve closes, no air can be drawn from the storage reservoir unless the handle of the protection valve is depressed manually. Air from the protection valve then passes to a globe cut-off valve and thence into a line leading to the switchgear.

The compressors are designed for fully automatic operation. When the reservoir pressure drops to 260 psi, the pressure switch starts the compressor and pumps up to 300 psi. An elapsed time indicator records the hours of compressor operation.

Compressed air is supplied to the General Electric 14.4 KV switchgear on generator bus No. 4 from two GE type NA5 air compressors at 250 psig. The compressors operate at 375 psig. Air is stored in two receivers at the compressore and is reduced to 250 psig as needed for the individual breaker air receivers.

N. AUXILIARY POWER SYSTEM

A. General Description

Electrical power for the Steam Plant Auxiliary Equipment and Lighting is supplied by two 7500/8300-KVA and two 7500/9375-KVA, 13.8-2.4-KV transformers connected to each 14.4-KV switchgear bus. The station service transformers furnish power to the 2400-volt switchgear assemblies which distribute power to and provides control of the boiler feed pump motors, fan motors, exciter motors, 2400-480-volt auxiliary transformers and a 2400-volt feeder to Water Treating. If any station service transformer is out of service, power for its associated 2400-volt switchgear can be furnished from other 2400-volt switchgear through the bus tie circuit breakers.

Each 2400-480 volt auxiliary transformer is connected to 480-volt switchgear assembly. The 480-volt switchgear supplies power and control for condensate pump motors, lighting transformers, circulating water pump motors, condensate make-up pump motors and motor control centers.

B. 2400-Volt System

Connections

The primaries of the station service transformers are connected to the 14.4-KV switchgear bus 1-1, 2-1, 3-1 and 4-1 by overhead cables and circuit breakers 252-104 (No. 1 S.S. Transformer) 252-204 (No. 2 Transformer) 252-305 (No. 3. Transformer), and 252-407 (No. 4 Transformer). The secondaries are connected to the 2400-volt buses by underground cables and circuit breakers (152-110, 152-210, 152-301, and 152-401) in the associated 2400-volt switchgear. The 2400-volt switchgear is connected together by overhead buses and the tie circuit breakers.

Station Service Transformers

The station service transformers are 7500-KVA, oil immersed, self-cooled, three-phase, 60-cycle, 13800-volt. The tap changers are designed for de-energized operation.

Transformer Accessories Include:

1. Dial type thermometer with high-temp alarm contacts.
2. Magnetic oil level gauge with low-level alarm contacts.
3. Sudden pressure relay with alarm contacts.
4. Pressure relief device with alarm contacts.

2400-Volt Switchgear

The 2400-volt switchgear consist of Westinghouse metalclad switchgear cubicles equipped with Westinghouse-type "Deion"

N. Auxiliary Power System (Contd.)

B. 2400 Volt System (Contd.)

air circuit breakers. Overhead buses and a tie circuit breaker connect the switchgear. Indicating lamps, relays, and breaker control switches are mounted on Hinged front panels of the various switchgear sections. The local breaker control switches are arranged to operate the circuit breakers in the test position. All circuit breakers are operated from remote points by control switches. The location of which are tabulated below.

Location

Electrical Control Board

152-109	Aux. Trans. No. 1
152-110	Sta. Ser. Trans. No. 1
152-111	Main Exciter No. 1
152-207	Aux. Trans. No. 2
152-208	Spare Exciter
152-209	Bus Tie
152-210	Station Ser. Trans. No. 2
152-211	Exciter No. 2
152-303	Aux. Trans. No. 3
152-301	Sta. Ser. Trans. No. 3
152-401	Sta. Ser. No. 4
152-402	Bus Tie
152-403	Aux. Trans. No. 4

Mechanical Console Board

152-101	F.D. Fan 3A	152-206	I.D..Fan 2B
152-102	Boiler Feed Pump No. 1	152-211	Boiler Feed Pump No. 4
152-103	Boiler Feed Pump No. 2	152-213	F.D. Fan 3B
152-104	F.D. Fan No. 1A	152-304	F.D. Fan 4A
152-105	F.D. Fan No. 2A	152-305	F.D. Fan 5A
152-106	I.D. Fan No. 1A	152-306	Boiler Feed Pump No. 5
152-107	I.D. Fan No. 2A	152-307	Boiler Feed Pump No. 7
152-202	Boiler Feed Pump No. 3	152-404	F.D. Fan 4B
152-203	F.D. Fan 1B	152-405	F.D. Fan 5B
152-204	F.D. Fan 2B	152-406	Boiler Feed Pump No. 6
152-205	I.D. Fan 1B	152-408	Boiler Feed Pump No. 8

Boiler Feed Pump Boards

152-102	Boiler Feed Pump No. 1	I52-306	Boiler Feed Pump No. 5
152-103	Boiler Feed Pump No. 2	152-307	Boiler Feed Pump No. 7
152-202	Boiler Feed Pump No. 3	152-406	Boiler Feed Pump No. 6
152-211	Boiler Feed Pump No. 4	152-408	Boiler Feed Pump No. 8

Watt hour meters are located on the 2400 volt switchgear for the following equipment.

No. 1 Exciter
No. 2 Exciter
Spare Exciter
Aux. Transformer No. 1
Aux. Transformer No. 2
Aux. Transformer No. 3
Aux. Transf rmer No. 4
Water Treating Feeder

N. Auxiliary Power System (Contd.)

B. 2400-Volt System (Contd.)

2400 Volt Bus Automatic Transfer

Under normal operating conditions the 2400 volt switchgear is fed through its associated station service transformer (low side breaker No. 152-110 for Bus 1-1, low side breaker No. 152-210 for Bus 1-2 low side breaker 152-301 for Bus 1-3 and low side breaker 152-401 for Bus 1-4.) Bus tie breakers No. 152-209 and 152-403 are open under normal conditions.

A manual-automatic selector switch on the electrical control board allows operation of these breakers either manually or automatically.

With the selector switch set on Automatic:

1. Loss of potential on either 2400 volt bus 1-1 or 1-2 will cause bus tie ACB 152-209 to close and the affected station service transformer ACB to trip. Loss of potential on either 2400 volt bus 1-3 or 1-4 will cause the bus tie ACB 152-402 to close and the affected station service transformer ACB to trip.

2. Opening of any station service transformer ACB will cause the bus tie ACB to close on its associated bus.

3. A 2400 volt bus fault will block the Auto Transfer Scheme.

C. 480 Volt System

Connection

The high voltage side of the auxiliary transformers No. 1 and No. 2 are connected to their associated 2400 volt buses by underground cables and circuit breaker in the 2400 volt switchgear. The high voltage side of Auxiliary Transformers No. 3 and No. 4 are connected by overhead cables to their associated 2400 volt buses and a circuit breaker in the 2400 volt switchgear. The low voltage side of each transformer is connected to its associated 480 volt bus by underground cables on No. 1 and 2 transformers and overhead cables on No. 3 and 4 transformers and a circuit breaker in the related 480 volt switchgear. 480 volt buses 1-1 and 1-2 may be connected together through a tie circuit breaker and 480 volt buses 3 and 4 may be connected together through a tie breaker.

Auxiliary Transformer

The auxiliary transformers are Westinghouse type, OA, 750 KVA (No. 1 and No. 2) 1000 KVA (No. 3 and No. 4) oil immersed, self cooled, outdoor, 3 phase, 60 cycle, 2400 volts Delta connected primary to 480 volts Delta connected secondary.

Accessories Include:

Dial typ thermometer with alarm contacts
Magentic liquid level gauge with alarm contacts
Press relief device with alarm contacts

N. AUXILIARY POWER SYSTEM (CONT'D.)

C. 480 Volt System (Contd.)

480 Volt Switchgear

The 480 volt switchgear, indoor type metal enclosed structures containing four main buses and two tie breakers are equipped with Westinghouse and ITE electrically operated circuit breaker units for the control of the auxiliary transformer low voltage circuits, bus transfer circuits, and feeder circuits as tabulated below:

Bus 1	Bus 2
Condensate Pump 2A	Circulator 3A
Lighting Transformer 1	Condensate Pump 3A
MCC-1	Make-Up Pump 4
Circulator 2A	Make-Up Pump 5
Make-Up Pump 1	Lighting Transformer 3
Condensate Pump 1A	MCC-5
Make-Up Pump 3	MCC-6
Circulator 1A	Aux. Transformer 3
Aux. Transformer 1	Bus 3-4 Tie
Bus 1-2 Tie	

Bus 2	Bus 4
Circulator 2B	MCC-7
Lightining Transformer 2	MCC-8
MCC-2	Condensate Pump 3B
MCC-3	Make-Up Pump 6
MCC-4	Make-Up Pump 7
Condensate Pump 2B	CO_2 Blower
Condensate Pump 1B	Circulator 3B
Circulator 1B	Lighting Transformer 4
Aux. Transformer 2	Aux. Transformer 4
Make-Up Pump 2	

Indicating lamps, relays and control switches are located on the front panel of each section.

Potential transformers connected to each main bus provide voltage for ground detector lights and a ground detector relay used for annunciation. A second set of potential transformers is used with the automatic bus transfer arrangement. Each bus has a voltmeter and transfer switch for potential indication.

480 Volt Bus Automatic Transfer

Under normal conditions each 480 volt bus is fed from its associated auxiliary transformer. If the 480 volt bus under-voltage relays operate, an automatic throwover scheme is used to isolate the de-energized bus from its transformer and connect the bus by a tie breaker to the other energized 480 volt bus. Upon restoration of

N. AUXILIARY POWER SYSTEM (CONT'D.)

C. 480 Volt System (Contd.)

480 Volt Bus Automatic Transfer (Contd.)

voltage to the de-energized circuit, the system can be returned to normal, manually, by control switches on the front of the 480 volt switchgear. Short time overcurrent relays on the low side of each auxiliary transformer block automatic transfer if the low voltage condition is caused by a fault or overload on the 480 volt buses is already de-energized, thereby preventing a transfer to a "dead" bus. When placed in the Manual position, a Manual-Automatic selector switch on the Electrical Control Board makes the automatic transfer scheme inoperative. This automatic transfer scheme describes the set-up between Bus 1 and 2, and between Bus 3 and 4, respectively.

D. 480 Volt Motor Control Centers

General

The General Electric motor control centers, designated as Motor Control Centers No. 1, 2, 3, 4, 5, 6, 7, and 8, provide 3-phase, 480 volt power and single phase 120/240 volt power to auxiliary equipment in the vicinity of each motor control center. The centers consist of various numbers of vertical sections arranged to form rigid, free standing, dead front, control assembly. Generally, each motor control center contains plug-in type combination magnetic motor starters, feeder circuit breakers, a 480-240 control power transformer, a 2-pole solid neutral distribution panel board and contactors for the outside lighting and space heaters.

The plug-in-starter units employ molded case air circuit breakers in combination with magnetic contactors. The contactors are equipped with bi-metallic thermal relays for motor overload protection. The circuit breakers provide short circuit protection for feeders. External breaker operating handles, lockable in the OFF position, provides a safe disconnecting means during maintenance periods. Each starter is equipped with a 480/volt control power transformer with fused secondary circuits.

Essential 440 volt motors are held "on the line" during an automatic bus transfer by maintained contacts in the starter control switch or undervoltage relays with time delay.

MOTOR CONTROL CENTER 1 (West side) - 480V Bus 1-1

1301 POTENTIAL IND. & CONTROL STA.	1307 14KV SwGr. Cont. Air Comp.	1310 Out-door Lgt. Trans. 25KVA 1	Spare	1316A Main Trans. Auxs.	AUXILLARY PANEL (Heater Breakers)	1349 KW Hrs SPARE
1302 Bowser Centrifuge	1309 Outdoor Lgt. Trans. 15KVA 1	1308 No. 1 Eleva-tor	1316 Battery Charger 1A	1315 Amp. Motor Volt. Reg. #1		
1304 Vent Fan 14.4KV SwGr. Room	1311 Instrument Air Compressor No. 1		1317 15KVA Trans. (Power to Intake Level Trans. and Probes)		240KV Heaters	1350 West H.P. Heater Pump
1305 Vent Fan 14.4KV SwGr. Room	East Soot Blower Support Cooling Water Pump					
1306 Welding Recept.	Welding Recept.	Boilers 1 & 2 Scanner Cooling Air Blower #1				

MOTOR CONTROL CENTER 1 (East Side) - 480V Bux 1-1

			☒ Relay	
	1333 Main Exciter Motor Htr.	1337 Cooling Water Pump 1A	1342 Lube Oil Transfer Pump	1346 Spare
	1334 Main Exciter Gen. Heater		1343 Lube Oil Heater - Clean Bowser Sect. (East)	
	1335 Spare Exciter Motor Htr.		1344 Lube Oil Heater - Reserve Bowser Sect. (Center)	
	1336 Spare Exciter Gen. Heater	#3 Blr. APH Auxiliary Drive	1345 Lube Oil Heater - Dirty Oil Section (West)	1347 #2B Servo Pump Amps
	1332 Intake Structure Welding Receptacle & Hoist Motor	1340 Sump Pump No. 1 (East) A D H	1341 Welding Receptacle	1348 #1 L. P. Htr. Pump

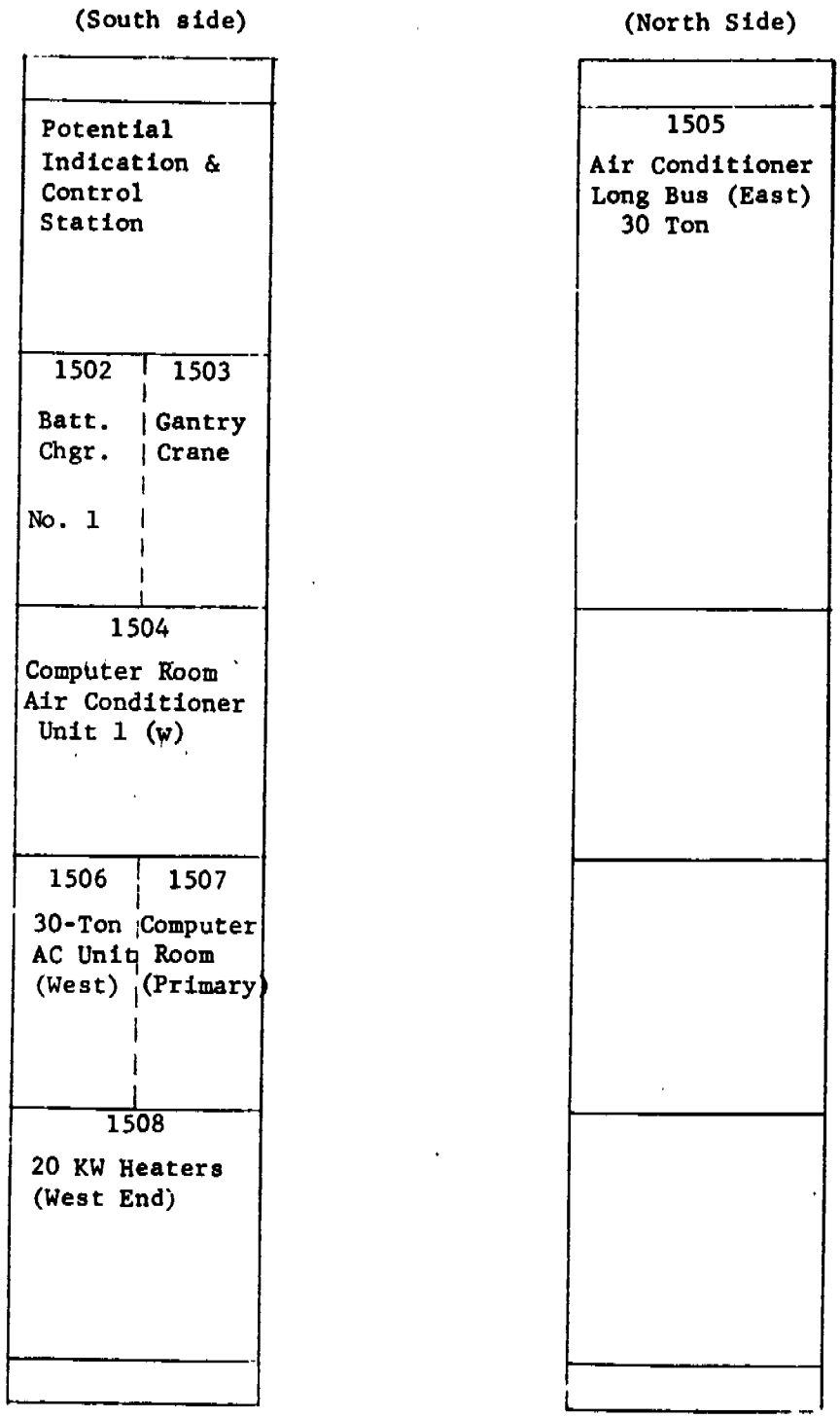
Motor Control Center 2 (South Side) - 480V Bus 1-2

<table>
<tr><td>#3 Phosphate Pump</td><td rowspan="4">1421
Cooling Water Pump 1B (2)</td><td>1428
.1 & 2 Boilers Scanner Cooling Air Blower #2</td><td>1429
7.5KVA Trans. T.S. U.P. #1</td><td>1432
14.4KV SwGr. Control Air Comp.</td><td>1433
Main Trans. Auxs.</td><td rowspan="2">Auxiliary Panel (Heater Breakers)</td></tr>
<tr><td>#2 Phosphate Pump</td><td colspan="2">1430
Vapor Extractor #1</td><td colspan="2" rowspan="2">1435
15KVA Transformer</td></tr>
<tr><td>#1 Phosphate Pump</td><td colspan="2">1420
#2 Sulfite Pump</td><td rowspan="2">240V Heaters</td></tr>
<tr><td>Boiler 3 Soot Blower</td><td>Boiler 1 Soot Blower</td><td>#1 Sulfite Pump</td><td colspan="2">#3 Sulfite Pump</td></tr>
<tr><td colspan="2">Welding Receptacle</td><td>1424
Lube Oil Return Pump #1</td><td>1425
Welding Receptacle</td><td>1431
#1 L.O. Reservoir Heaters</td><td colspan="2"></td></tr>
</table>

Motor Control Center 2 (North Side) - 480V Bux 1-2

1401 Potential Indication & Control Station	1406 Instrument Air Compressor #2	1412 Vent Blower Motor Front Standard	1416 Sump Pump #1B (West) A C H	KW Hrs. SPARE
1402 Lube Oil Centrifuge #1	1407 Hydrogen Seal Oil Pump #1 Gen.	1413 Vent Blower Motor H.P. Valve Gear	1417 Gland Exh. 1A (North)	East H.P. Heater Pump
1403 BFP #1 Auxiliary Oil Pump	1408 Turning Gear Motor #1 Turbine	1414 Vent Blower Motor H.P. Extraction Valve	1418 Gland Exh. 1B (South)	
1404 BFP #2 Auxiliary Oil Pump	1409 Turning Gear Lube Oil Pump #1 Turbine	1411 Vent Blower Motor H.P. Extraction Valve	1415 Vent Blower Motor L.P. Extract. Valve	
1405 BFP #3 Auxiliary Oil Pump	1410 Vent Blower Motor Turning Gear Compt.	1426 Welding Receptacle	1427 Welding Receptacle	

Motor Control Center 3 - 480V Bus 1-2



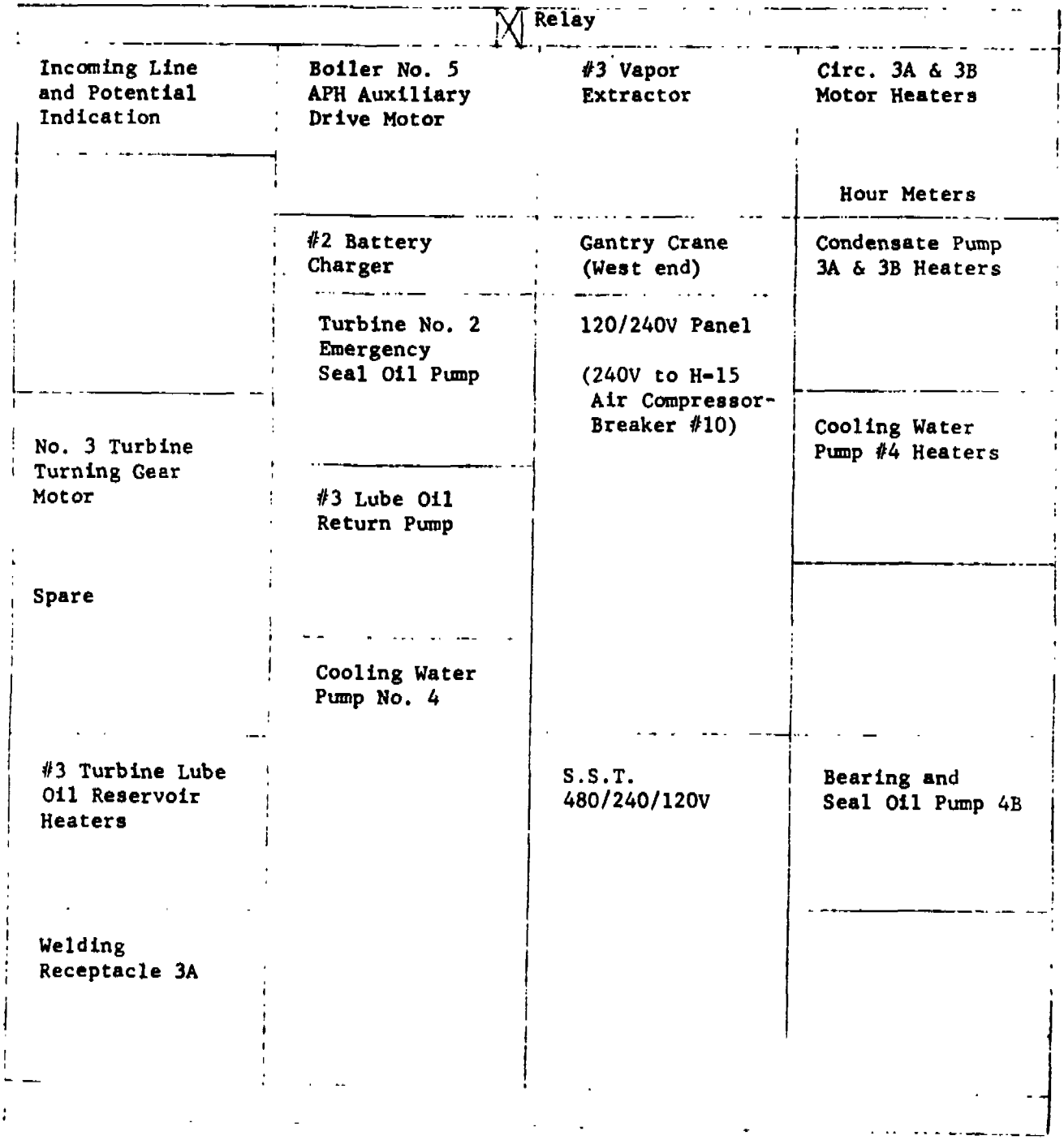
Motor Control Center 4 - 480V Bus 1-2 (West side)

Lagging Vent Fan VBM-1	Boilers 1 & 2 Scanner Cooling Air Blower #3	Vapor Extractor #2	Ampli-dyne MG Set #2	East 5-Ton AC Unit
Lagging Vent Fan VBM-2	#2 Turning Gear Motor	#2 Bearing Drain Exhauster	Servo Tank #2 Heater	
Lagging Vent Fan VBM-3	Lube Oil Return Pump #2	Gland Exhauster 2A (#1)	Low Pressure Heater Pump #2	
Lagging Vent Fan VBM-4	Spare	Gland Exhauster 2B (#2)	Lube Oil Centrifuge #2	
Lagging Vent Fan VBM-5		Bearing & Seal Oil Pump - #2 Turbine	#2 Exciter H ater Circuits	
West 5-Ton Air Cond.	Servo Pump 2A (#1)		Lube Oil Storage Tank #2 Heaters	
	Amps			

Motor Control Center 4 - 480V Bus 1-2 (East Side)

	Blr. #3 APH Lube Oil Pump	FD-3A & 3B Htrs.		Circulators 2A & 2B Heaters
BFP #4 Aux. Lube Oil Pump				
	100 Amp Exide Battery Charger	BFP #4 & Cooling Water Pump #3 Heaters		Condensate Pumps 2A & 2B Heaters
#2 Condenser Sump Pump				
	Blr. #3 APH Main Drive Motor	Weld. Recept.	Weld. Recept	Lighting Panel
Instrument Air Compressor #3				
	Cooling Water Pump #3	Weld. Recept.	Lgt. Transf. Cir. Brkr.	
		Spray Water Pump Motor Heaters & Lube Oil Pump		Lighting Transf. 15KVA 480/240/120
West Soot Blower Support Cooling Water Pump				

Motor Control Center 5 - 480V Bus 1-3 (West Side)

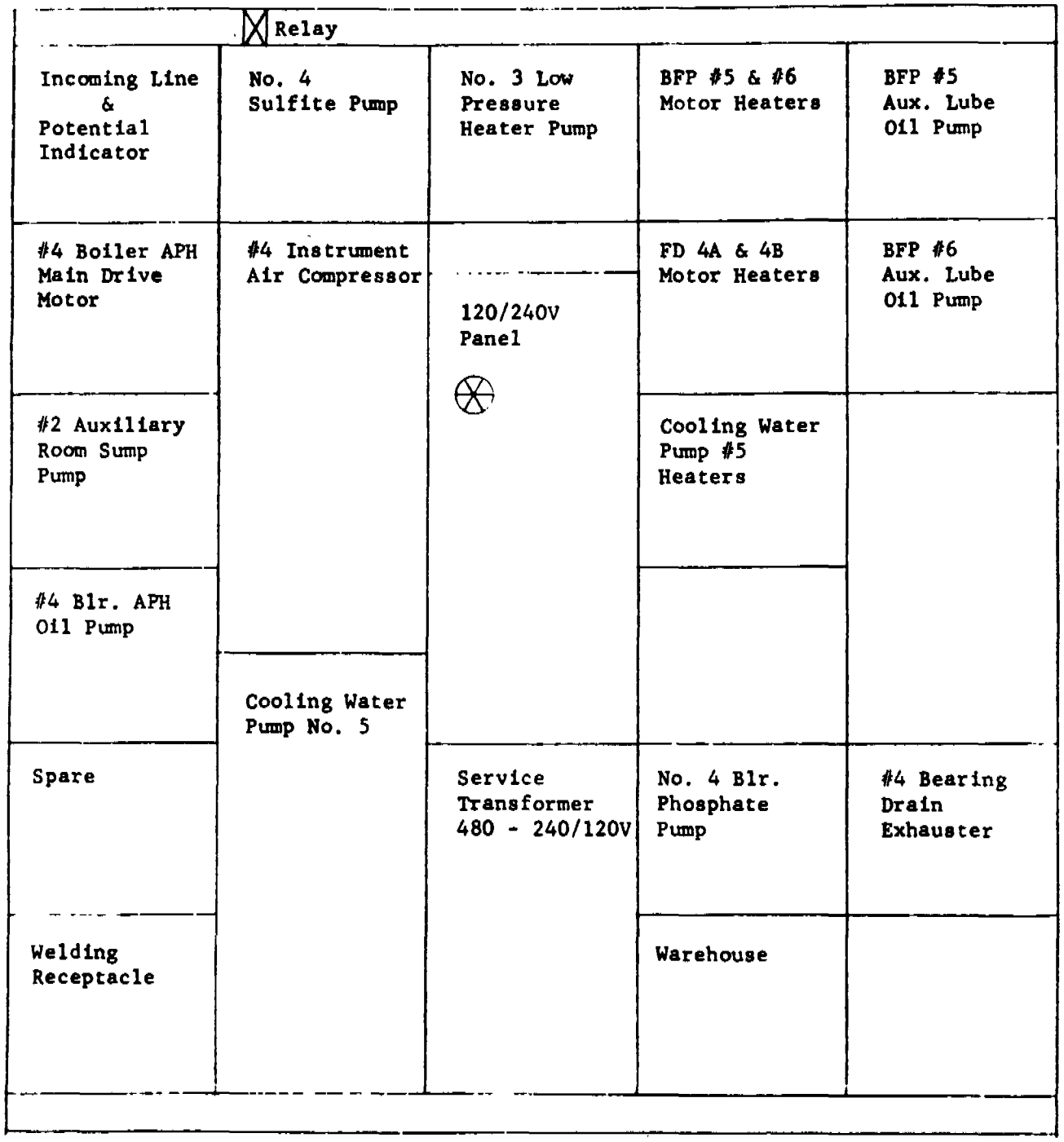


Motor Control Center 5 - 480V Bus 1-3 (East Side)

S. S. #3	S. S. #4	Servo Pump 3A (#1)	
14.4KV SwGr. Air Compressor 4B	14.4KV SwGr. Air Compressor #3	AMPS	
Lagging Vent Blower VBM-1	#3 B Gland Exhauster	Bearing and Seal Oil Pump 3B	
Lagging Vent Blower VBM-2	#3 A Gland Exhauster	Bearing Drain Enlargement Exhauster #3	Lube Oil Centrifuge #3
Lagging Vent Blower VBM-3	Welding Receptacle		Servo Oil Pump 4B AMPS
Lagging Vent Blower VBM-4	Intake Crib Lighting Transformer	Condenser Pit Sump Pump 3B	14.4KV SwGr. 3-1 Vent 3A
Lagging Vent Blower VBM-5		Condenser Pit Sump Pump 3A	14.4KV SwGr. 3-1 Vent 3B

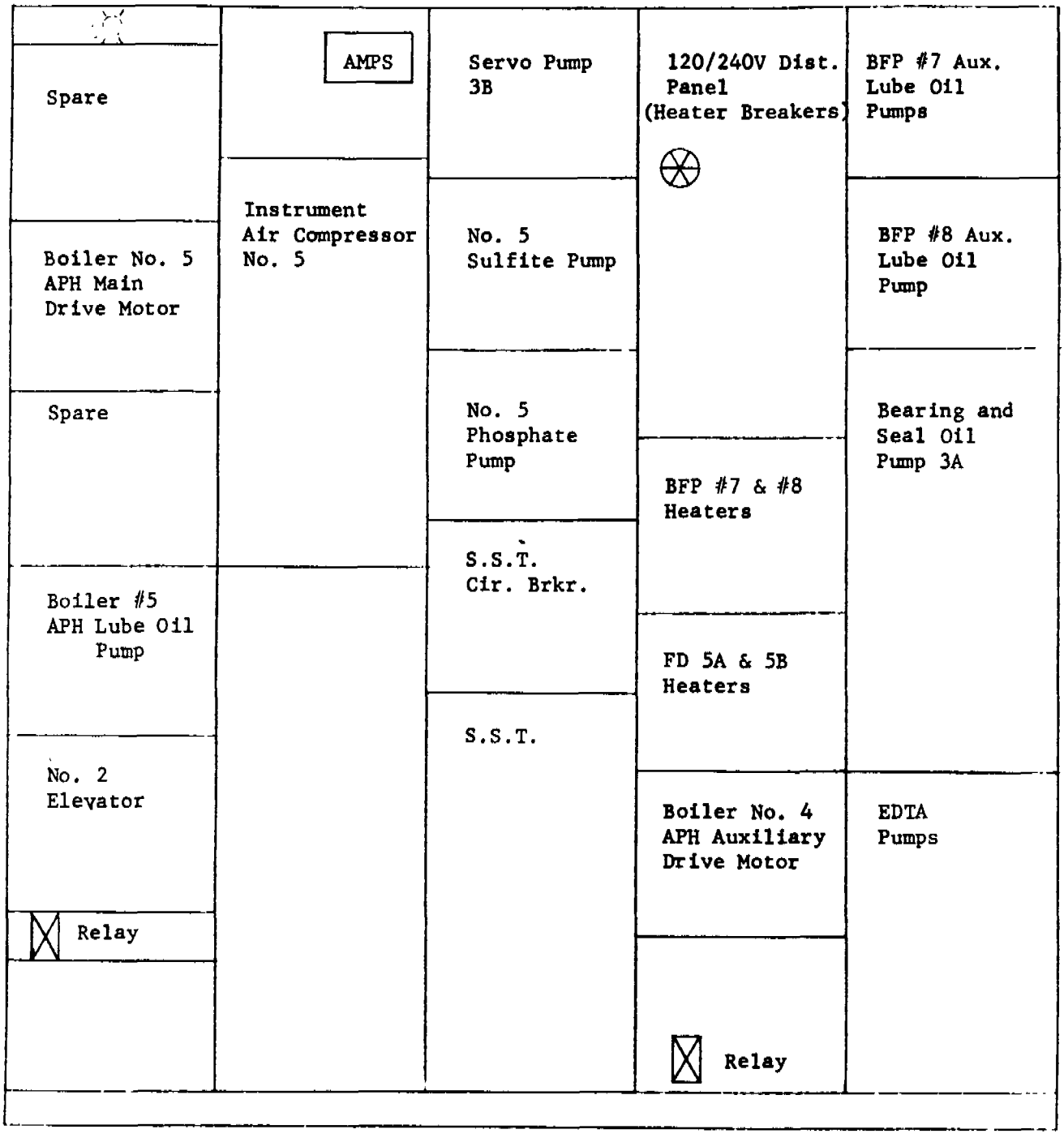
DO 124615
CONFIDENTIAL

Motor Control Center 6 - 480V Bus 1-3



3 - Blr. No. 4 APH Cleaner
5 - Space Htrs. MCC 3-3
11 - BFP No. 5 Htrs.
12 - BFP No. 6 Htrs.
13 - FD 4A Heaters
14 - FD 4B Heaters
15 - Cooling Water Pump No. 5 Htrs.
(All others spares)

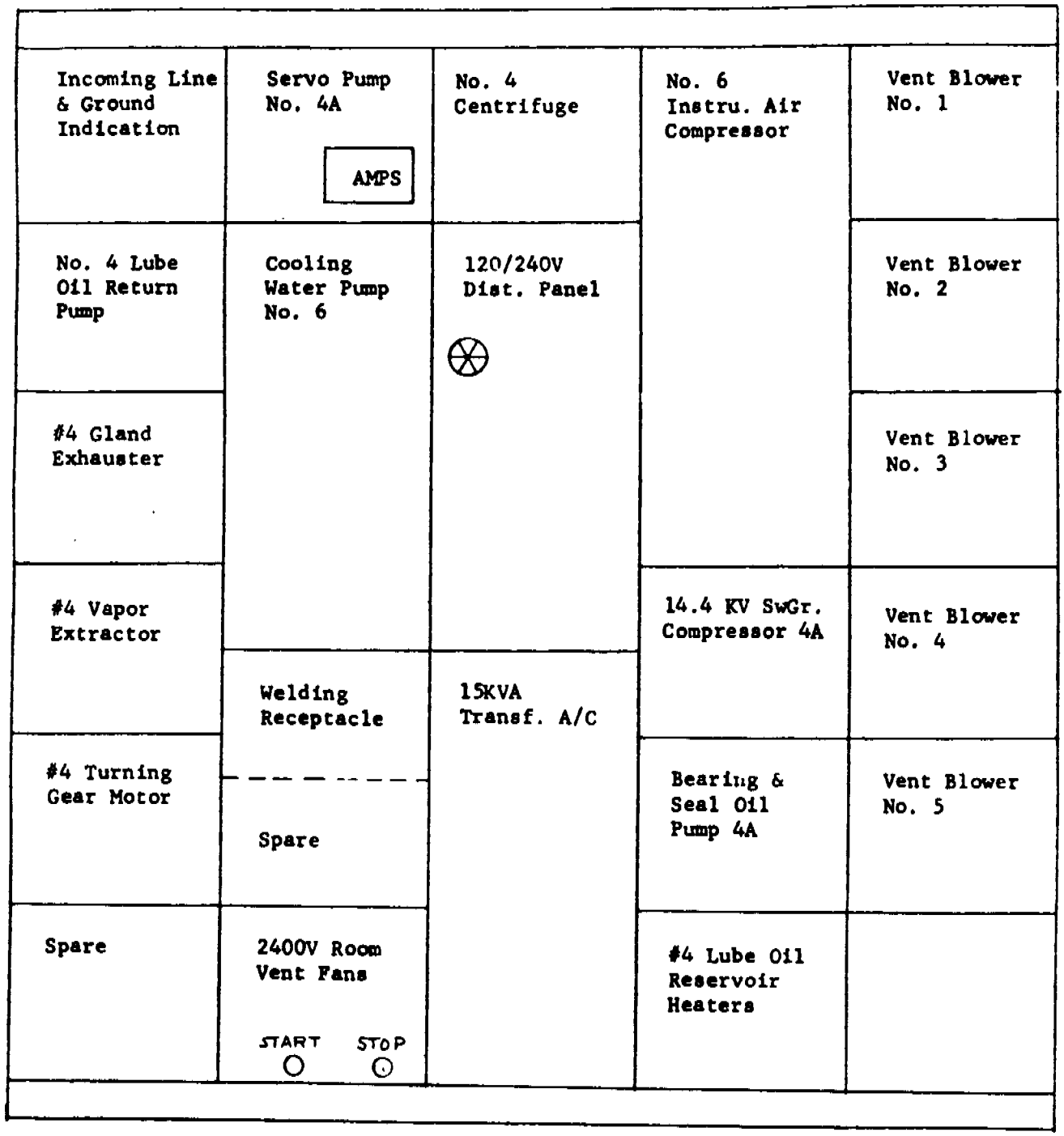
Motor Control Center 7 - 480V Bus 1-4



1 - Dissolved O^2 & H^2 Anal.
2, 3, & 4 - Spares
5 - APH Clean. Motor
6 - Spare
7 - #7 BFP Heater
8 - #8 BFP Heater
9 - FD 5A Heater
10 - FD 5B Heater
11, 12, & 13 - Spares
14 - Gas Flow Recorders - Blrs. 4 & 5
(All others spares)

Rev. 1/80/jml

Motor Control Center 8 - Bus 4



1 - #4 Gen. housing lights & recept.
2 -
3 - Gen. Neutral Brkr. Htrs.
4 - MCC space htr.
5 - Main Oil Tank Console
6 - Spare
7 - Spare
8 - Electrical Console - No. 4 Unit
(All others spares)

O. 125-VOLT SYSTEM

General Description

DC power for control, annunciation, emergency lighting, motor-operated valves, standby seal oil pumps and fuel gas solenoid-operated valves is distributed via the DC switchboards from the two 125-volt (Nominal) station battery banks. Silicon diode type rectifiers furnish the normal continuous DC requirements of the system and maintain the station batteries in a fully charged condition.

Station Battery No. 1

A 60-cell Exide lead acid battery provides the 125-volt DC system with the reliability necessary for essential power and control circuits. The battery has an eight-hour rating of 1200 ampere hours down to 1.75 volts per cell.

Station Battery No. 2

A 60-cell Gould Kathonode type, lead acid battery provides 125-volt DC power for Turbines 3 and 4 and Boilers 4 and 5 needs. The battery has an eight-hour rating of 840 amperes.

Battery Charger No. 1

A 100-ampere silicon diode rectifier type battery charger with a magnetic amplifier regulator is provided for charging the station battery and supplies the continuous DC load at a maximum continuous rate of 100 amperes DC, with a 480-volt, three-phase, 60-cycle power input. The output voltage is adjustable from 120 to 150 volts DC. The output voltage regulation is plus or minus 1% with a 10% variation of the AC supply voltage. A magnetic amplifier current limiter is set to allow a maximum output current of 120 amperes. The battery charger is floor mounted with the controls located on the front panel and is located in a room at west end of control room building.

Battery Chargers No. 1A and No. 2

Both are full wave silicon diode rectifier type battery chargers with a magnetic amplifier regulator, provided for charging station battery and supplying the continuous DC load at a maximum continuous rate of 200 amperes at 129 volts DC. The output voltage is adjustable from 120 to 150 volts. An automatic load-limiting feature limits output current beyond 120%. Chargers are enclosed in floor-mounted cabinets with controls on the front panel. No. 1A is located in #1 battery room in the east auxiliary bay. No. 2 is located in #2 14.4-KV switchgear room adjacent to the DC distribution panels.

125-Volt DC Distribution Switchboard No. 1

The switchboard consists of three metal-enclosed vertical sections and is located in the communication room. Section 2 mounts the metering and alarm devices for the DC system. Section 2 also houses the main station battery breaker. Section 3 contains the Unit 1 DC distribution panelboard, made up of 36 two-pole, F-frame air circuit breakers and the

main two-pole, L-frame breaker. Each circuit breaker is equipped with bell alarm contacts which close only when the breaker is tripped by overcurrent. The alarm switch and breaker are reset by moving the breaker handle first to the OPEN position and then to the CLOSE position. The tie breaker which connects to #2 battery is also mounted on the side of Section 3.

125-Volt DC Distribution Switchboard #2

The switchboard consists of three metal-enclosed vertical sections and is located in No. 2 14.4-KV switchgear room. Section 1 contains a voltmeter and DC ampmeter which monitor the output of the charger. Section 1 also contains the main battery breaker and the tie breaker to No. 1 battery. Sections 2 and 3 contain 36 two-pole air circuit breakers each and main two-pole breakers. Each circuit breaker is equipped with bell alarm contacts which close only when the breaker is tripped by overcurrent. The alarm switch and breaker are reset by moving the breaker handle first to the OPEN position and then to the CLOSE position.

Protection

In addition to the overcurrent protection afforded by the various circuit breakers, the DC system is also equipped with a DC undervoltage relay and a ground detector relay which cause an alarm to operate. A time delay AC undervoltage relay in the rectifier input supply warns the operator of prolonged loss of AC voltage but will not sound an alarm for an automatic bus transfer or minor load variations.

Metering

Two DC-indicating ampmeters on the front of the 125-volt DC distribution switchboards measure the battery charger output current and the total DC system load current. A voltmeter and a voltmeter switch are also provided to indicate the battery voltage, the battery charger output voltage, and the positive and negative bus-to-ground voltages.

Annunciation

Visual and audible alarms are obtained for the following conditions:

Battery Charger (AC Failure) (DC Trip)	Common Window
Battery Breaker Trip) Distribution Breaker Trip)	Common Window
DC Low Voltage) DC Bus Ground)	Common Window

O. 125-VOLT DC SYSTEM (cont'd)

Control Room Indication

Voltage and ampere loads on each battery are indicated in control room. Each battery voltmeter has high- and low-voltage alarm contacts connected to annunciators.