Enclosure 2 to AECM-82/152

TEST REPORT

GRAND GULF NUCLEAR STATION

HPCS POWER SUPPLY UNIT

I. Klepper

A. Sheel

Approved: A. Koslow for

G. B. Stramback, Manager
Reactor Instrumentation and Protection Design
Nuclear Control & Instrumentation Department
General Electric Company
San Jose, California

8204260266

TABLE OF CONTENTS

1. Introduction 2

2. Test Plan 3

3. Tests 4

4. Test Results 8

5. Design Margin 15

6. Acceptability 17

7. Conclusion 20

8. References 21

9. Figures and Tables 22

Appendix 23

1. INTRODUCTION

The HPCS Power Supply was developed to power the high pressure core spray (HPCS) system for BWR/5 and BWR/6 plants.

The HPCS Power Supply concept was originally provided in a licensing topical report, NEDO-10905, May 1973. The NRC staff reviewed the topical report and Amendments 1 and 2, NEDO-10905-1, August 1974, and NEDO-10905-2, April 1976, respectively, and concluded that "the analysis and simulated tests provide reasonable assurance that the concept, though unique for diesel generator loading is workable, however, due to the marginal nature of the design concept, and partial testing performed, the staff will require that an actual test be performed which simulates as close as practicable the actual HPCS system configuration."[1]

The staff also reviewed and accepted Amendment 3, NEDO-10905-3, August 1979, and concluded that the acceptance is only for a particular design diesel generator unit (Diesel Engine GM-EMD Model 20-645E4; Generator Ideal Electric Company, Type-SAB, Frame-M636PB) and "Each of the other diesel generators listed in NEDO-10905 (Table 3-1) must undergo similar prototype qualification testing to be acceptable."[4]

The remainder of this report presents results of prototype qualification testing on a particular design diesel generator unit depicted in NEDO-10905 Table 3-1 as Diesel Engine GM-EMD Model 12-645E4-Tandem.

2. TEST PLAN

In accordance with the staff's requirement,[1] a test program was arranged. The test program was presented for the staff's review[2] and the staff provided comments on the test program.[3] NEDO-10905-3 presented a revised test procedure, incorporating the staff's comments, to be used as guidance for additional testing in accordance with the staff's requirement.[1] Based on the staff's acceptance and requirement for additional testing,[4] a prototype qualification test for a second engine type, tandem-12 cylinder, (as referenced in Table 3-1, NEDO-10905) was arranged.

3. TESTS

3.1 TEST SITE

The test was conducted during preoperational tests on the HPCS equipment at the Grand Gulf Nuclear Station, Unit 1, presently under construction by Mississippi Power & Light Company.

3.2 TEST REQUIREMENT

A test program specific to Grand Gulf was prepared and discussed with the staff in a meeting on July 23, 1981. Based on the July 1981 meeting discussion and the NRC's question 40.29, detailed Grand Gulf test instructions were prepared and incorporated into preoperational test procedures 1P81PT01, 1P81PT04, and 1E22-PT01. The test instructions were reviewed by the NRC site representative.

3.3 DOCUMENTATION

All the test data wer‹ logged and signed off by the preoperational test supervisor. The completed test instruction containing all test results is filed in the General Electric Document Control System, San Jose, California, at Grand Gulf under the control of the GGNS Records Coordinator, and is available for review.

3.4 TEST ARRANGEMENT

3.4.1 Process Arrangement

The piping and instrumentation diagram is shown in Figure 3-1 and the process diagram for the HPCS system is presented in Figure 3-2. In a loss of coolant accident (LOCA) mode of operation, the HPCS pump (E22-C001-C) operates with suction from either the condensate storage tank with suction valve (E22-F001-C) open, or the suppression pool with suction valve (E22-F015-C) open. The injection valve (E22-F004-C) is automatically opened during this mode. However, because of lack of reactor pressure, in this prototype test, mode H of operation (see Figure 3-2) was selected.

By opening the motor operated valves E22-F010-C and E22-F011-C, a flow path from condensate storage tank to condensate storage tank was established. In this way the HPCS system operation was checked over the entire flow range and respective pump discharge pressures.

3.4.2 Power Supply Arrangement

The main one line diagram, Figure 3-3, shows the electrical distribution network for Grand Gulf Units 1 & 2. The HPCS one line diagram, Figure 3-4a through 3-4c shows the electrical configuration of the HPCS power supply system (bus 4.16KV-17AC, bus 480VAC, and bus 125VDC).

In the normal condition, the system is operated from one of the offsite sources, and the DG is not running (breaker #1 open). Extra heaters were added for test purposes to load the system to some margin in excess of the normal design load. Loss of offsite power (LOP) was simulated by tripping breaker #5 (152-1705 Figure 3-3).

3.4.3 Equipment Descrption

3.4.3.1 Diesel Engine

The test was conducted on a tandem 12 cylinder, turbocharged GM EMD engine Model R12-654E4. The governor is Woodward EG series, electric type hydraulic actuator.

3.4.3.2 Generator

The AC synchronous generator, manufactured by Portec, Inc., Electric Products Division is rated at 4125 KVA (3300 KW) continuously, 900 RPM, 60 Hz, 4160/2400 V, WYE connected.

The generator is equipped with a static exciter and static voltage regulator, type SVS. The generator data are tabulated in Table 4-3.

3.4.3.3 Motor

The motor is an induction type K manufactured by General Electric Company rated 3500 HP, 4000 V, 60 Hz, 1800 RPM, and 436A.

The motor characteristics may be found in NEDO-10905, May 1973, Table 3-4.

3.4.3.4 Pump

The HPCS pump (Figure 3-6) manufactured by Borg Warner Corporation, Byron Jackson Pump Division is rated 3500 HP, 7275 GPM. The pump calculated performance and factory test curves are shown in Figure 3-5 and 3-5a.

3.4.3.5 Test Setup and Instrumentation

An additional forced cooling system was added to the engine lube oil and jacket water cooling system to cool the engine after shutdown. The cooling system was used only to cool the engine when required after a test run to bring the temperature down to the prewarmed condition. Before each test run, the engine was brought back to normal configuration by valving off the additional forced cooling system. Normal system instrumentation was used during the test. Additional Brush oscillographic recorders were used for recording all major parameters, such as speed, voltage, KW, KVAR, frequency, flow, and pressure. All instruments were calibrated. A detailed instrument list and calibration records are available for review from GE's Document Control System and are maintained at Grand Gulf under the control of the GGNS Records Coordinator.

4. TEST RESULTS

4.1 FUNCTIONAL TEST

Prior to actual test, all control and protection circuits and systems including excitation systems, voltage regulator, and governor were checked for operability.

The alarms and protective relays were set and tested to meet the design requirements, preparing the entire system for the actual test.

No adjustment except that recommended by the normal maintenance procedure, were allowed during test runs.

4.2 DIESEL GENERATOR STARTING TIME

This is an exclusive start test without loading of DG to determine the starting time for the DG. The DG start signal was manually initiated from the local panel and the transient events were recorded on an oscillographic chart.

Five (5) such consecutive starting tests were performed: three from the engine at cold, prewarmed standby condition (lube oil temperature at 85°F-140°F or 29.4°C-60°F and jacket water temperature at 95°F-155°F or 35°C-68.3°C) and two from the engine at hot equilibrium condition

(jacket water temperature at 165°F-175°F or 74°C-79.5°C and lube oil temperature at 170°F-190°F or 76.7°C-87.8°C). The following results were obtained:

Rated Speed (900±5% RPM)	in	7.1-7.6 secs.
Rated Frequency (60±.3 Hz)	in	7.4-7.8 secs.
Rated Voltage (4160±1% VAC)	in	7.9-8.3 secs.

The test data from start no. 3 (cold) are tabulated in Tables 4-1a and 4-1b.

The oscillographic chart recordings are shown in Figure 4-1.

4.3 HPCS SYSTEM OPERATION FROM NORMAL POWER SOURCE

This test was performed to determine the performance of the HPCS system. This test was performed with the HPCS bus (17AC) being powered from the offsite (normal) power source.

An automatic HPCS start signal was initiated with automatic opening of the injection valve F004-C and water suction from the suppression pool with valve F015-C open; an injection in the reactor vessel was achieved in 4.0 secs. at rated flow of 7115 GPM. This result was well within the design requirement of 27 secs. maximum.

Note: This above test was performed with the actual injection valve used for HPCS; a fast opening valve with 12 secs. maximum opening time.

4.4 HPCS SYSTEM OPERATION FROM DIESEL GENERATOR SOURCE

4.4.1 Rated Flow

This test was run to determine the performance of the HPCS system

operating at rated flow (7115 GPM) with the diesel generator as the only source of power.

The system was aligned to inject water into the reactor vessel with an automatic opening of the injection valve E22-F004-C and suction from the suppression pool with valve E22-F015-C open. The HPCS power supply (bus 17AC) was in its normal condition, i.e., DG in standby condition with bus 17AC (4.16 KV) being fed from normal offsite source.

A loss of offsite power (LOP) and a LOCA were simultaneously initiated by manually tripping the offsite power breaker (to provide for DG start) and manually initiating the HPCS system (to provide HPCS pump start as soon as the HPCS DG is available for loading). This test was repeated five times following the same test sequence.

A rated flow of 7115 GPM was achieved in 14.6-17.8 secs from the time initiation signal was applied. This is well within the design requirement of 27 secs. maximum.

At rated flow the HPCS pump motor drew 1800 KW (2413 HP) which is less than the nominal 3500 HP and DG load was 2000 KW. The DG satisfactorily started and accepted all system loads and none of the low voltage motor starters dropped out after bus 17AC was reenergized during HPCS pump start.

4.4.2 Maximum BHP Flow

This test was run to determine the performance of HPCS system at maximum BHP of HPCS pump motor, with only DG supplying the 4.16 KV bus, without being paralleled to offsite power. All the normal HPCS loads were operational and the HPCS pump was manually started. The test valves E22-F010C and E22-F011C were manually positioned to obtain the maximum load on HPCS pump motor, i.e., maximum BHP of HPCS pump motor. Therefore, the system was set in condensate storage tank to condensate storage tank (CST) mode, and operated for one hour.

The total water flow was 4700 GPM. The initial voltage dip at the start of the pump went to 60% and recovered to 70% within 3.3 secs. In the first 2.5 secs. after start, the frequency dropped to 98.3% of its rated value and recovered to the rated value in another 1.7 secs.

The same test was run with the system set in suppression pool to suppression pool mode; valve E22-F023-C open to obtain the flow corresponding to the maximum BHP on HPCS pump motor. The voltage dip at start of the pump was 63.63% and recovered after approximately 3.6 secs. to 72.72%.

In the first 3.6 secs, the frequency dropped to 95.6% and recovered to its rated value after another 2.5 secs.

No equipment failed to operate due to low voltage during pump motor start, in both tests.

The transient events for test 4.3 and 4.4 were recorded and the charts are available for review from GE document Control System and are maint ined at Grand Gulf under the control of the GGNS Records Coordinator.

4.5 STARTING AND LOAD RELIABILITY TEST

The HPCS System was aligned for a flowpath from CST to CST, by positioning the test valves E22-F010C and E22-F011C to load the HPCS pump motor at its maximum BHP.

The bus 17AC (4.16KV) was fed from the offsite power transformer 21; breaker 152-1705 (Figure 3-3) closed. The DG was ready for auto start. Extra heaters (480 V) were connected to the HPCS 480V MCC to load the DG in excess of the design load of HPCS System (HPCS pump motor at BHP and HPCS MCC loads of 270 KW±10%).

A signal from undervoltage relay of bus 17AC (4.16KV) provided a DG start signal after the offsite breaker (152-1705) was tripped. The HPCS system was manually initiated to provide a start signal for the HPCS pump. The test was run for one hour, during which time the lube oil and jacket water temperature reached their equilibrium point (jacket water temperature 165°F-175°F or 74°C-79.5°C and lube oil temperature 170°F-190°F or 76.7°C-87.8°C). The load was maintained at maximum design load of HPCS system.

At the end of one hour run the DG was shutdown. An external forced cooling system was employed to cool the engine to its standby condition

(lube oil temperature 85°F-140°F or 29.4°C-60°C and jacket water temperature 95°F-155°F or 35°C-68.3°C).

The test was repeated 69 times, of which 63 times were from engine in warm standby condition and 6 times were from the hot equilibrium condition of engine.

For hot equilibrium condition the test was immediately initiated after the shutdown of DG without using the forced cooling system. All variable readings were taken at 15 minute intervals and chart recordings monitored the transient events for each of 69 starts. There was no failure (as defined by Reg. Guide 1.108) in starting or carrying the HPCS design load (HPCS pump motor at BHP and normal and resistive 480V MCC loads).

The results of the 69 tests are as follows:

Time from the start signal till DG tied to bus	8.46-9.2 sec.
Time till HPCS system attained the rated flow (7115 GPM)	21-26.25 sec.
Minimum voltage on Bus 17AC (4.16KV)	2800-2975V or 67.3%-71.5% of rated 4160V
Time for Bus 17AC voltage to return to 80% of rated voltage	4.1-4.6 sec.
Time for Bus 17AC voltage to return to 90% of rated voltage	4.23-5 sec.
Minimum frequency on Bus 17AC (after DG on Bus)	59-59.6 Hz or 98.33%-99.33% of rated Hz

During the one hour test of each of 69 starts, the DG load was maintained at the maximum design load of HPCS system 2700-2850 KW and water flow at 4650-6000 GPM to attain the BHP of pump motor.

Due to similarity of the tests, one typical group of strip charts (Figures 4-2a through 4-2d) and data sheets (Tables 4-2a through 4-2d) for the test #23 are included in this report. All other test run data and charts are available from GE Document Control System and are maintained at Grand Gulf under the control of the GGNS Records Coordinator.

5. DESIGN MARGIN

This test was performed for the first time to the largest combination of DG (4610 HP Tandem type 3300 KW) and pump (3500 HP) ever used in HPCS system of a BWR plant (see NEDO-10905, May 1973, Table 3-1). The results of the test demonstrated the following margins.

5.1 STARTING TIME MARGIN

The HPCS system attained a rated flow (7115 GPM) in a maximum time of 17.8 seconds (test 4.4.1). When compared to the design requirement of 27 seconds the system demonstrated a starting time margin of 9.2 seconds.

The starting time achieved during the CST to CST test configuration (test 4.5) was somewhat longer due to test conditions which required operator actions to manually position the two slower operating (much slower than the HPCS injection valve F004-C) test valves F010-C and F011-C to a position that yielded the maximum BHP of the HPCS pump motor.

Further margin in starting time is anticipated in case of an actual LOCA condition because of high reactor pressure which requires a very low initial HPCS flow.

5.2 LONG TERM LOAD CARRYING CAPABILITY

The DG supplied successfully the maximum design load of HPCS system (maximum BHP of HPCS pump motor and HPCS-MCC). This condition represented the maximum load to be ever supplied by DG in an accident condition. The load margin was 13.64%. At all other points, the power demand by the pump is much less, i.e., at rated flow and especially during an accident condition when reactor pressure is high. On a long term basis, the DG would be loaded to less than 70% of its continuous rating.

The DG also successfully passed the 24 hour full load carrying capability test (R.G. 1.108 requirement) of which for 22 hours, it was loaded at 100% of its continuous rating (3300 KW) and for 2 hours it was loaded to 110% of its continuous rating (3630 KW).

6. ACCEPTABILITY

6.1 PERFORMANCE

The performance of the DG was satisfactorily demonstrated. It fully demonstrated the capability of the DG to perform its intended function for HPCS application. The following performance was particularly verified during the test.

a. Fast and reliable starting of the engine in 8.3 seconds or less was demonstrated repeatedly from both cold and hot engine conditions.

b. The DG could successfully start and accelerate a large motor almost equal to its size (3300 KW generator and 3500 HP motor) well within the required time.

c. During the loading sequence of the DG, the frequency and voltage decreased to 98.33% and 67.3% of nominal, respectively. The voltage returned to 80% in 4.1 secs and 90% in 4.23 secs of rated value. Regulatory Guide 1.9, position C.4 requires that the DG unit design should be such that at no time during the loading sequence, should the frequency and voltage decrease to less than 95% of nominal and 75% of nominal, respectively. The test met this requirement for frequency but not for voltage. However, the DG carries a single large load (HPCS pump motor) which represents more than 90% of the design load on the HPCS bus 17AC, and therefore a larger decrease in voltage is acceptable. The HPCS system

operation was entirely successful in meeting the design requirement of establishing rated flow condition in far less than 27 secs. The voltage recovery and the speed of DG during transient events also meet the Regulatory Guide 1.9 requirement.

d. Because of the excellent performance in terms of volts/cycle, which is a true measure in determining the performance of an electrical system, the voltage and frequency variation did not have any adverse effect on the design load. The system fully utilized the benefit of low voltage starting.

e. No adverse effect of load sequencing was encountered during the test, which simulated as close as possible the actual load of HPCS system.

f. The DG successfully carried additional 480V loads in order to assure a maximum design load of HPCS. This will satisfy minor variation of load without jeopardizing the performance of the system. The voltage and frequency variation had no adverse effect on the battery charger and its load.

g. The voltage and frequency overshoot during 100% rated-load rejection had no adverse effect on the diesel engine's operation.

h. The DG carried 100% and 110% rated load without exceeding the diesel engine manufacturer's design limits.

i. The reliability of starting and accepting design load in the required time was fully demonstrated by starting and carrying design load 69 times without failure from both hot and cold engine starting conditions. This met the objective of establishing a 0.99 reliability for the particular DG design.

j. Long-term load carrying capability was demonstrated by running the system for a period of almost 70 hours during starting and load reliability test.

k. The system has adequate margin in all respects, such as starting time, accelerating time, and long-term carrying capability.

l. The pump performance proved that it closely corresponds to manufacturer's data (see Figure 3-5).

7. CONCLUSION

The test fully demonstrated that the HPCS power supply can fully meet its design intent. This series of actual pump loop tests provided full assurance of the workability of the HPCS power supply concept and confirmed that the analytical studies and factory prototype tests could conservatively predict the engine generator performance.

It also further confirmed the results of LaSalle test. Even though the DG size and configuration were different at Grand Gulf, compared to LaSalle, the results of both tests are remarkably similar.

8. REFERENCES

The below listed references are presented in Appendix A:

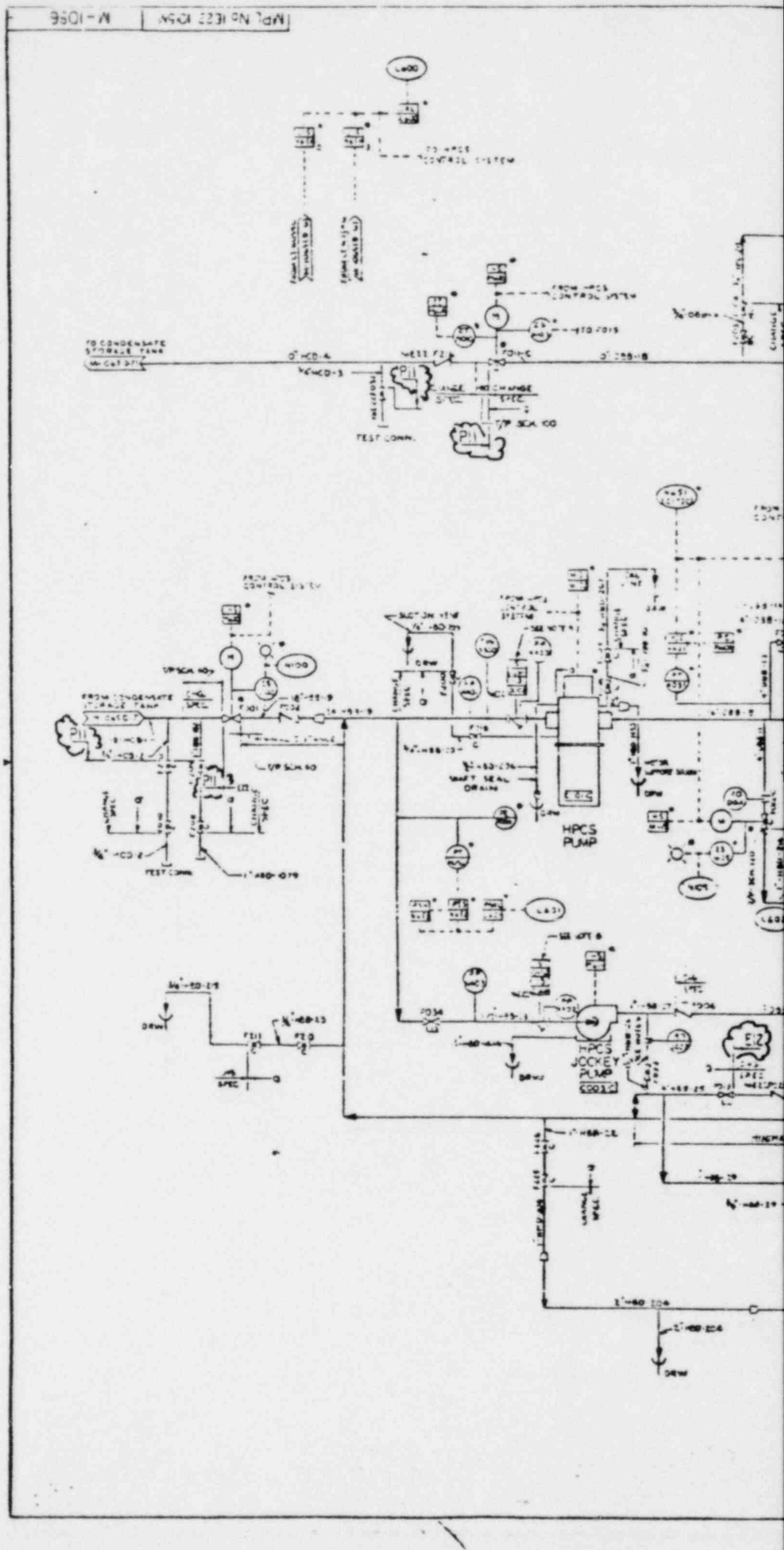
1. Letter from Olan D. Parr to G. G. Sherwood, December 17, 1976, on General Electric topical report NEDO-10905.

2. General Electric letter No. 781-106-77, November 17, 1977, from J. F. Quirk to Olan D. Parr on GE HPCS Power Supply Unit, Qualification Testing.

3. Letter from Olan D. Parr to G. G. Sherwood, March 31, 1978, on GE HPCS Power Supply Unit, Qualification Testing.

4. Letter from Olan D. Parr to G. G. Sherwood, April 7, 1980, accepting results of GE prototype testing of a specific DG unit (2600 KW) identified in NEDO-10905 (Table 3-1).

9. FIGURES AND TABLES


TO CONDENSATE STORAGE TANK
FROM CONDENSATE STORAGE TANK
TEST CONN.
SUCTION VENT
SHAFT SEAL DRAIN
HPCS PUMP
HPCS JOCKEY PUMP
DRW

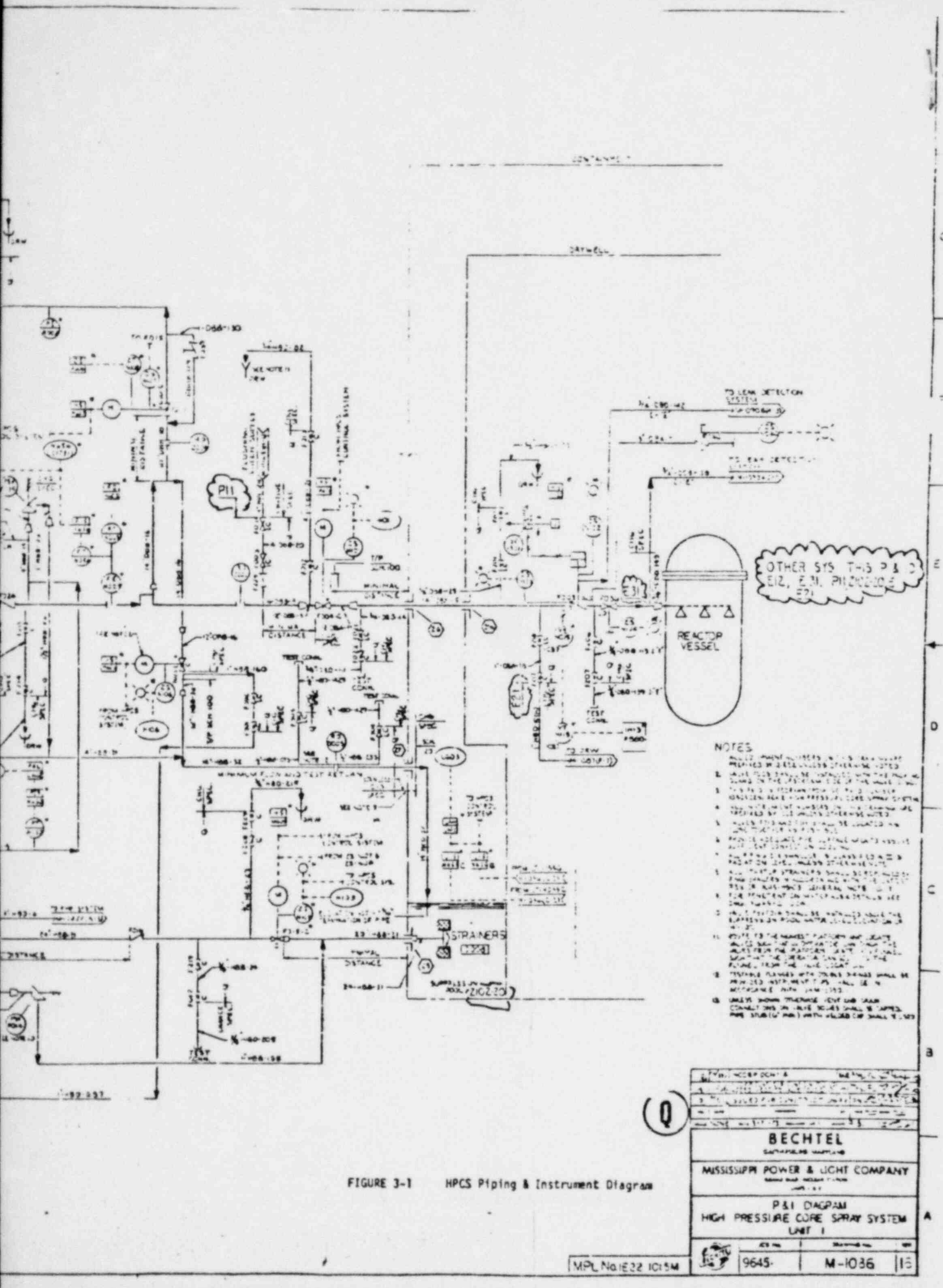


FIGURE 3-1 HPCS Piping & Instrument Diagram

18. FO[illegible]

19. TH[illegible]

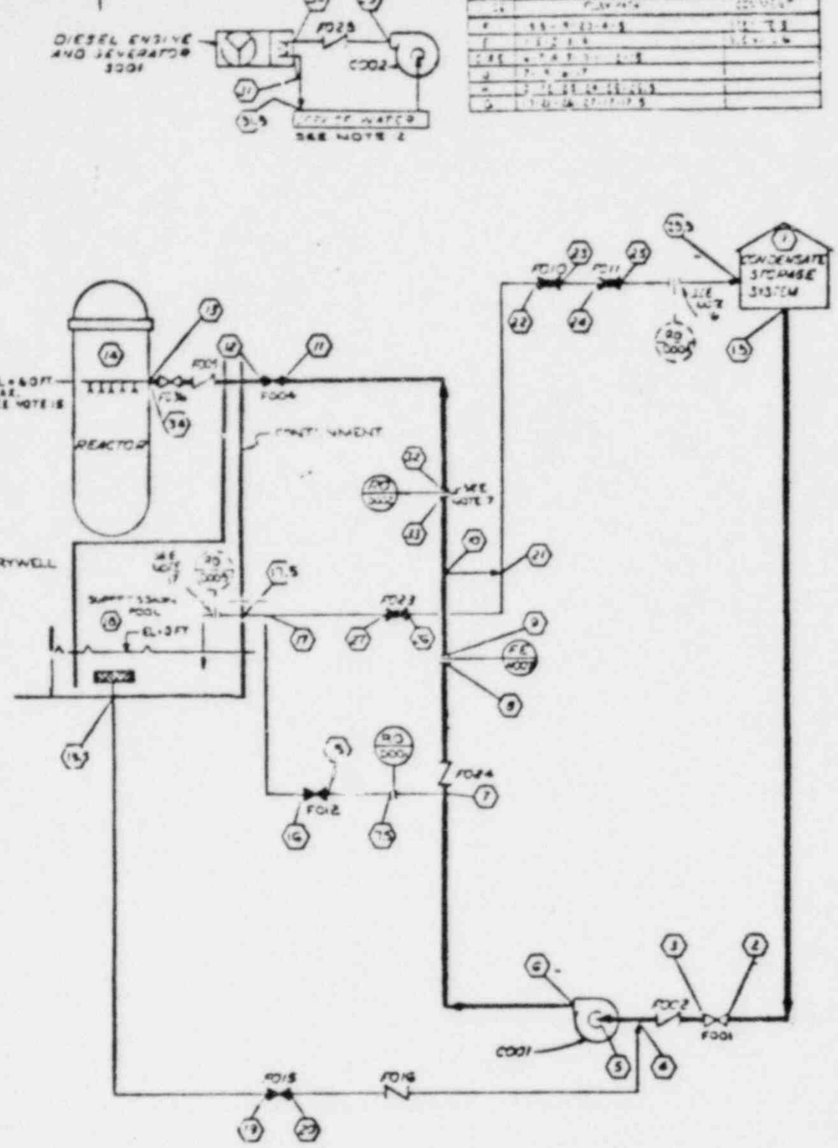


TABLE II

[illegible]	[illegible]	[illegible]

TABLE I
VALVE POSITION TABLE

VALVE	F001	F004	F010	F011	F012	F015	F023	F036
MODE A	O	O	C	C	C	C	C	O
MODE B	C	O	C	C	C	O	C	
MODE C	C	O	C	C	C	O	C	
MODE CC	C	O	C	C	O	O	C	
MODE E	O	O	C	C	C	C	C	
MODE F	C	O	C	C	C	O	C	
MODE G	C	C	C	C	C	O	O	
MODE H	O	C	O	O	C	C	C	
MODE J	O	C	C	C	O	C	C	
MODE S	O	C	C	C	C	C	C	O

O - VALVE OPEN
C - VALVE CLOSED

MODE J PUMP OPERATING ON BYPASS, SUCTION FROM CONDENSATE STORAGE

POSITION			4					6	17	18
FLOW GPM	N/A	700 ←					NOTE 9 →		700	N/A
PRESS. PSIA	14.7	X	X	X	X	X	X	X	X	14.7
TEMP °F	AMB	125/40 ←						→	125/40	AMB
MAX. PRESS. DIFFERENCE FT.				← 3430 →			← 2.8 →			

MODE S SYSTEM ON STANDBY DUTY

POSITION ◯	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FLOW GPM	N/A	0	←									→	0	N/A
PRESS. PSIA	14.7	X	X	X		X	X	X	X	X	X	X	X	[illegible]
TEMP °F	AMB	120/40	←						→	120/40	AMB	←		→ AMB
MAX. PRESS. DIFFERENCE FT.					← 0 →									

MODE A ACCIDENT OR RCIC BACKUP[illegible]

POSITION ◯	1	2	3	4	5
FLOW GPM	N/A	650	←		
PRESS. PSIA	14.7				
TEMP °F	AMB	120/40	←		
MAX. PRESS. DIFFERENCE FT.				← 2815	

SEE NOTE 8

MODE B ACCIDENT, REACTOR AT H[illegible]

POSITION ◯	4	5	6	7	8
FLOW GPM	650	←			
PRESS. PSIA					
TEMP °F	120/40				
MAX. PRESS. DIFFERENCE FT.		← 2815 →			

SEE NOTE 8

MODE C ACCIDENT, SYSTEM INJECTION[illegible]

POSITION ◯	4	5	6	7	8
FLOW GPM SEE NOTE 7	743	←			
PRESS. PSIA					
TEMP °F	120/40	←			
MAX. PRESS. DIFFERENCE FT.		← 910 →			← 21

MODE CC ACCIDENT OR RCIC BACKUP, REACTOR[illegible]

POSITION ◯	18	19	20	4	5
FLOW GPM	98	650	←		
PRESS. PSIA	14.7				
TEMP °F	AMB	120/40			
MAX. PRESS. DIFFERENCE FT.					← 294

SEE NOTE 17

MODE E ACCIDENT, SYSTEM INJECTION[illegible]

POSITION ◯	1	2	3	4	5
FLOW GPM SEE NOTE 8&7	N/A	743	←		
PRESS. PSIA	14.7				NOTE 6
TEMP °F	AMB	120/40	←		
MAX. PRESS. DIFFERENCE FT.		← 3 →			← 910

MODE F ACCIDENT, SYSTEM OPERATI[illegible]

POSITION ◯	4	5	6	7	8
FLOW GPM SEE NOTE 7	400	←			
PRESS. PSIA		SEE NOTE 5			
TEMP °F	120/40	←			
MAX. PRESS. DIFFERENCE FT.		← 582 →			

MODE G SYSTEM TEST, SUCTION F[illegible]

POSITION	[illegible]				
FLOW GPM	[illegible]				
PRESS. PSIA	X	X	X	X	
TEMP °F					
MAX. PRESS. DIFFERENCE FT.		← 582 →			

MODE H SYSTEM TEST, SUCTION F[illegible]

POSITION ◯	1	2	3	4	5
FLOW GPM	N/A	743	←		
PRESS. PSIA	14.7	X	X	X	
TEMP °F	AMB	120/40			
MAX. PRESS. DIFFERENCE FT.					← 9[illegible]

...MODES AND ONE THIRD OF THE FLOW SPECIFIED SHALL BE ...EVERED TO THE REACTOR VESSEL WITH THE REACTOR VESSEL ...SSURE AT 1192 PSIA AND THE LOW FLOW BYPASS VALVE ...2-F012) OPEN.

... FLOW SPECIFIED FOR MODE CC MUST BE EQUALED OR ...EEDED WITH SUCTION FROM THE CONDENSATE STORAGE ...TEM AND WITH THE REACTOR PRESSURE EQUAL TO 1192 PSIA.

HIGH PRESSURE CORE SPRAY

MPL NO E22-1010

NOTES:

1. ALL EMPTY PRESSURE DATA BLANKS CAN BE FILLED IN BY OTHERS (BASED ON ACTUAL ARRANGEMENT) OR EQUIVALENT HYDRAULIC DATA SUBMITTED TO GE. ▭ INDICATES DATA IS NOT SIGNIFICANT.
2. ▭ INDICATES MAXIMUM & MINIMUM VALUE OF PARAMETER FOR THE MODE SPECIFIED.
3. ELEVATIONS ARE NOT INCLUDED IN ΔP VALUES GIVEN. ELEVATIONS SHALL BE INCLUDED WHEN DETERMINING FINAL VALUES FOR EMPTY PRESSURE DATA BLANKS.
4. THE PUMP MAXIMUM SHUTOFF HEAD WILL NOT EXCEED 1900 FT.
5. IN MODE F, THE NET POSITIVE SUCTION HEAD (NPSH) AVAILABLE AT A REFERENCE LOCATION 2 FEET ABOVE THE PUMP MOUNTING FLANGE MUST EQUAL OR EXCEED 5 FT. THE NPSH AVAILABLE AT THE PUMP SUCTION NOZZLE MUST EQUAL THIS VALUE PLUS THE DIFFERENCE IN ELEVATION BETWEEN THE REFERENCE LOCATION AND THE CENTERLINE OF THE PUMP SUCTION NOZZLE.
6. IN MODE E AND AT FLOW RATE OF 9100 GPM, THE AVAILABLE NPSH MUST EQUAL OR EXCEED THE VALUE SPECIFIED IN NOTE 5 FOR MODE F.
7. THE ΔP BETWEEN LOCATIONS 12 AND 13 WILL BE DETERMINED IN PRE-OPERATIONAL TEST. THE ΔP WILL BE ADJUSTED SUCH THAT:
   A. THE FLOW SPECIFIED FOR MODES C, AND E ARE EQUALED OR EXCEEDED AT THE REACTOR PRESSURE SPECIFIED.
   B. THE FLOW IN MODE F IS LESS THAN OR EQUAL TO THE FLOW SPECIFIED WITH REACTOR PRESSURE OF 14.7 PSIA.
   C. THE FLOW IN MODE E IS EQUAL TO OR LESS THAN 9100 GPM WITH A VESSEL PRESSURE OF 14.7 PSIA AND A PUMP TDH OF 582 FT.
   D. THE FLOW IN MODES E & F WITH A VESSEL PRESSURE OF 14.7 PSIA IS LESS THAN OR EQUAL TO THE MAXIMUM FLOW THAT THE PUMP HAS BEEN TESTED TO BY THE PUMP SUPPLIER.
   E. THE FLOW IS LESS THAN OR EQUAL TO A VALUE THAT ASSURES ADEQUATE NPSH TO THE PUMP FOR MODES E AND F AT A VESSEL PRESSURE OF 14.7 PSIA AS DETERMINED FROM THE PUMP NPSH PERFORMANCE TEST DATA.
   F. THE FLOW IN MODES E AND F WITH A VESSEL PRESSURE OF 14.7 PSIA IS LESS THAN OR EQUAL TO THE MAXIMUM ALLOWABLE PUMP FLOW RATE SPECIFIED IN THE PUMP INSTRUCTION MANUAL (IF ANY UPPER LIMIT IS SPECIFIED.)
8. THE ΔP GIVEN FOR THE VALVES IN MODES G AND H IS THE MINIMUM POSSIBLE AND MAY BE INCREASED BY PIPING DESIGNER (THROTTLING) TO ACCOMMODATE PIPING ARRANGEMENT.
9. THE BYPASS FLOW SPECIFIED IN MODE J IS APPROXIMATE AND WILL BE SPECIFIED BY THE PUMP VENDOR.
10. PIPING SYSTEM DESIGN PRESSURE AND TEMPERATURE AND THE ESTIMATED LINE SIZES ARE FOR INFORMATION ONLY. ACTUAL DESIGN TEMPERATURE AND PRESSURE AND LINE SIZES AS DETERMINED BY PIPING DESIGN SHALL MEET THE PROCESS DIAGRAM HYDRAULIC REQUIREMENTS.
11. THE TEMPERATURE RANGE AT LOCATIONS (23) AND (?) IS EQUAL TO THE TEMPERATURE RANGE OF THE SERVICE WATER AVAILABLE TO THE HPCS DIESEL GENERATOR. THE TEMPERATURE AT LOCATION (?) CAN BE AS HIGH AS 10°F GREATER THAN THE MAXIMUM SERVICE WATER TEMPERATURE AND AS LOW AS THE LOWEST SERVICE WATER TEMPERATURE.
12. THE DIESEL SERVICE WATER FLOW RATE IS A FUNCTION OF MAXIMUM SITE SERVICE WATER TEMPERATURE AS SPECIFIED IN THE DATA SHEETS OF HPCS SYS.
13. ΔP VALUES FOR EQUIPMENT WITHIN GE SCOPE ARE AS NOTED.
14. TABLE I INDICATES VALVE POSITION DURING VARIOUS OPERATING MODES.
15. THE DIFFERENCE IN ELEVATION BETWEEN THE MINIMUM WATER LEVEL OF THE SUPPRESSION POOL AFTER LOCA FOLLOWING POOL PUMP DOWN AND THE CORE SPRAY SPARGER SHALL NOT EXCEED 60 FT.
16. IT IS RECOMMENDED THAT THIS ORIFICE BE INSTALLED IF IT IS REQUIRED TO LIMIT FLOW TO 7115 GPM IN MODE H WHEN VALVES F010 AND F011 ARE FULLY OPEN.
17. IT IS RECOMMENDED THAT THIS ORIFICE BE INSTALLED IF IT IS REQUIRED TO LIMIT FLOW IN MODE G TO THE VALUE SPECIFIED OR TO THE MAXIMUM FLOW PERMITTED BY NOTE 7(D), 7(E) OR 7(F) WHEN VALVE F023 IS FULL OPEN.

MISCELLANEOUS INFORMATION
(SEE NOTE 10)

LOCATION															
DESIGN TEMP (°F)	140	212	212	212	575	*	575	212		212		212	140	100	150
DESIGN PRESSURE	100		100	1575	1575	*	1250	1575	100	1575	100	1575	100	100	100
EST. RATED LINE SIZE (IN)	18		24	16	12	12	12	4		12		10		4	3
	SUPPRESSION POOL SUCTION LINE		CONDENSATE STORAGE SUCTION LINE	MAIN HPCS LINE TO REACTOR				BYPASS LINE		SUPPRESSION POOL TEST LINE		CONDENSATE STORAGE TEST RETURN LINE		[illegible] WATER LINE	

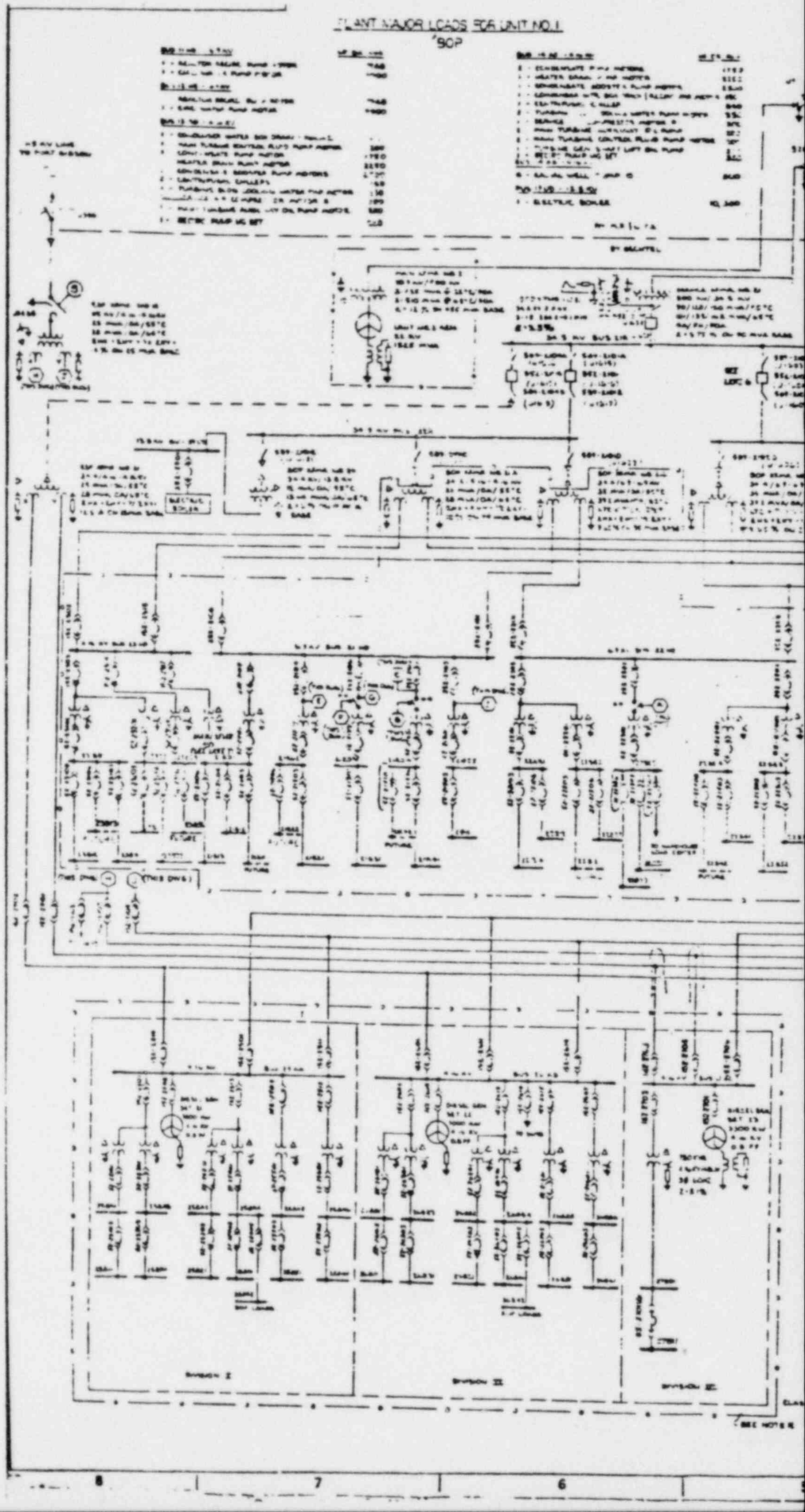
* DUAL DESIGN CONDITION: 1250 PSIG 575°F AND 1575 PSI @ 140°F

SUPPORTING DOCUMENTS: MPL ITEM NO.

1. PIPING & INSTRUMENT SYMBOLS DWG - - - - - AN2-1010

FIGURE 3-2. HPCS System Process Diagram.

762E445


PLANT MAJOR LOADS FOR UNIT NO. 1
BOP
8
7
6

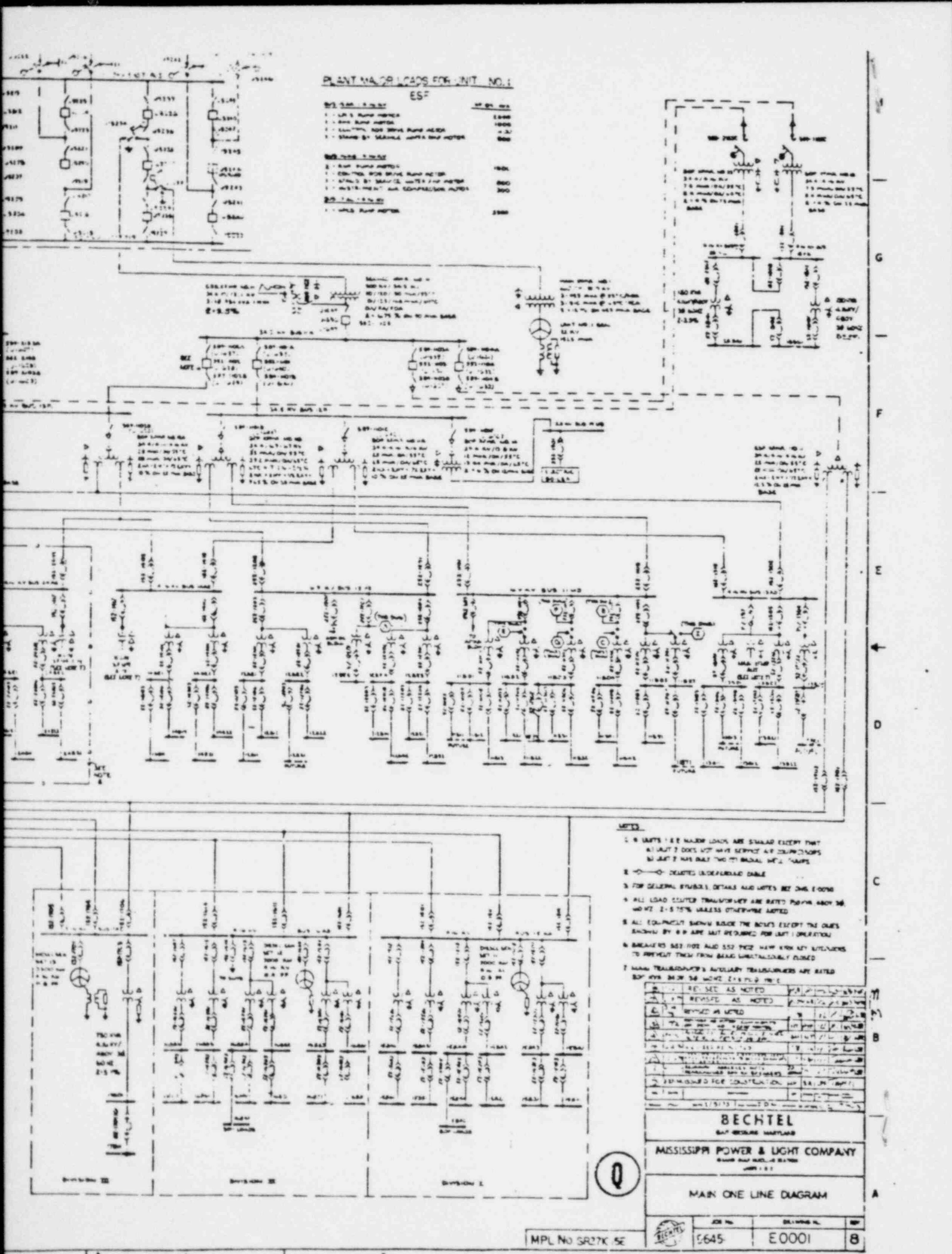
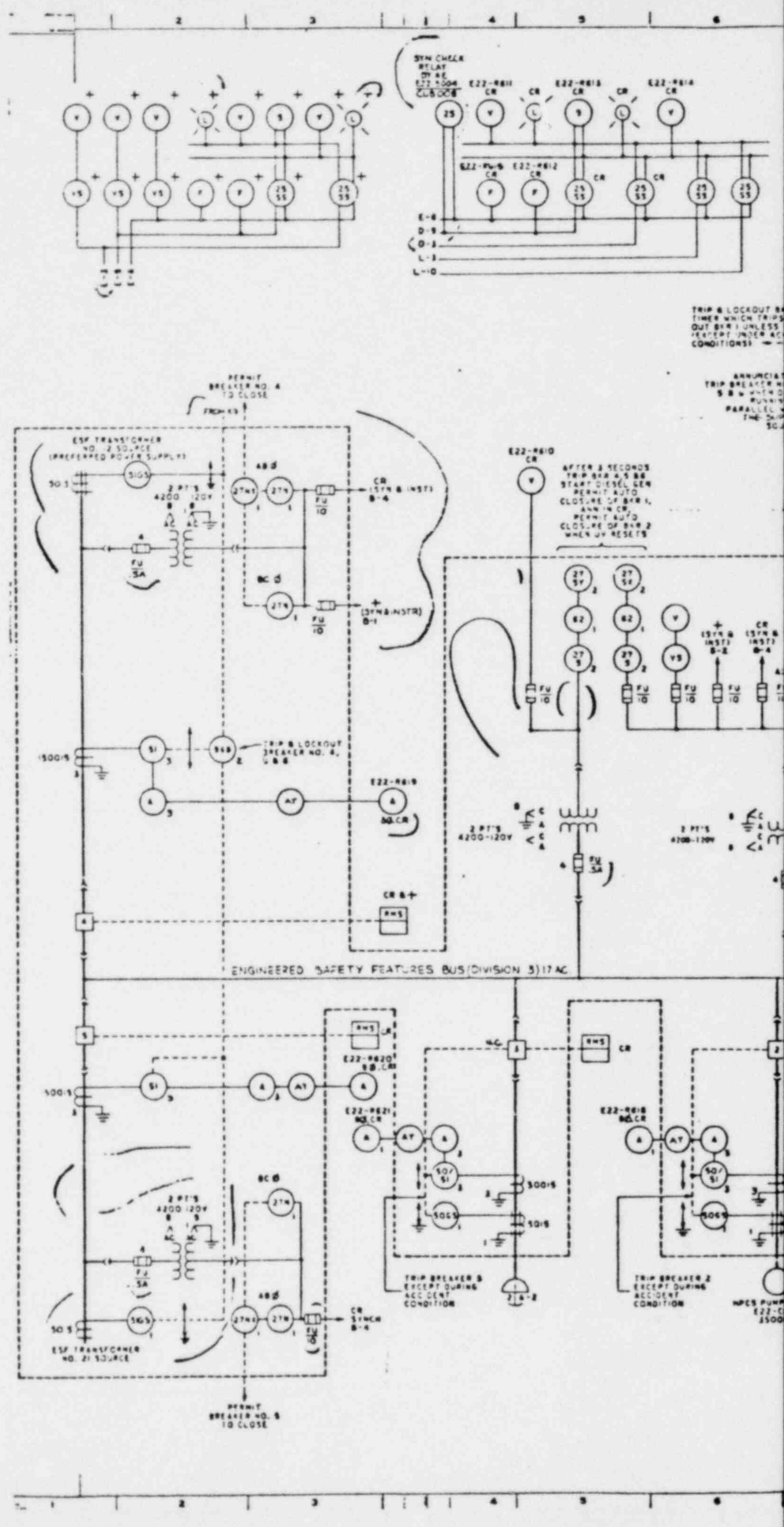


FIGURE 3-3. Grand Gulf Main One Line Diagram.


SYN CHECK RELAY
ESF TRANSFORMER NO. 2 SOURCE (PREFERRED POWER SUPPLY)
PERMIT BREAKER NO. 4 TO CLOSE
TRIP & LOCKOUT BREAKER NO. 4, 5 & 6
AFTER 3 SECONDS TRIP BKR 4,5 & 6 START DIESEL GEN PERMIT AUTO CLOSURE OF BKR 1, ANN IN CR, PERMIT AUTO CLOSURE OF BKR 2 WHEN UV RESETS
ENGINEERED SAFETY FEATURES BUS (DIVISION 3) 17 AC
TRIP BREAKER 3 EXCEPT DURING ACCIDENT CONDITION
TRIP BREAKER 2 EXCEPT DURING ACCIDENT CONDITION
ESF TRANSFORMER NO. 21 SOURCE
PERMIT BREAKER NO. 5 TO CLOSE

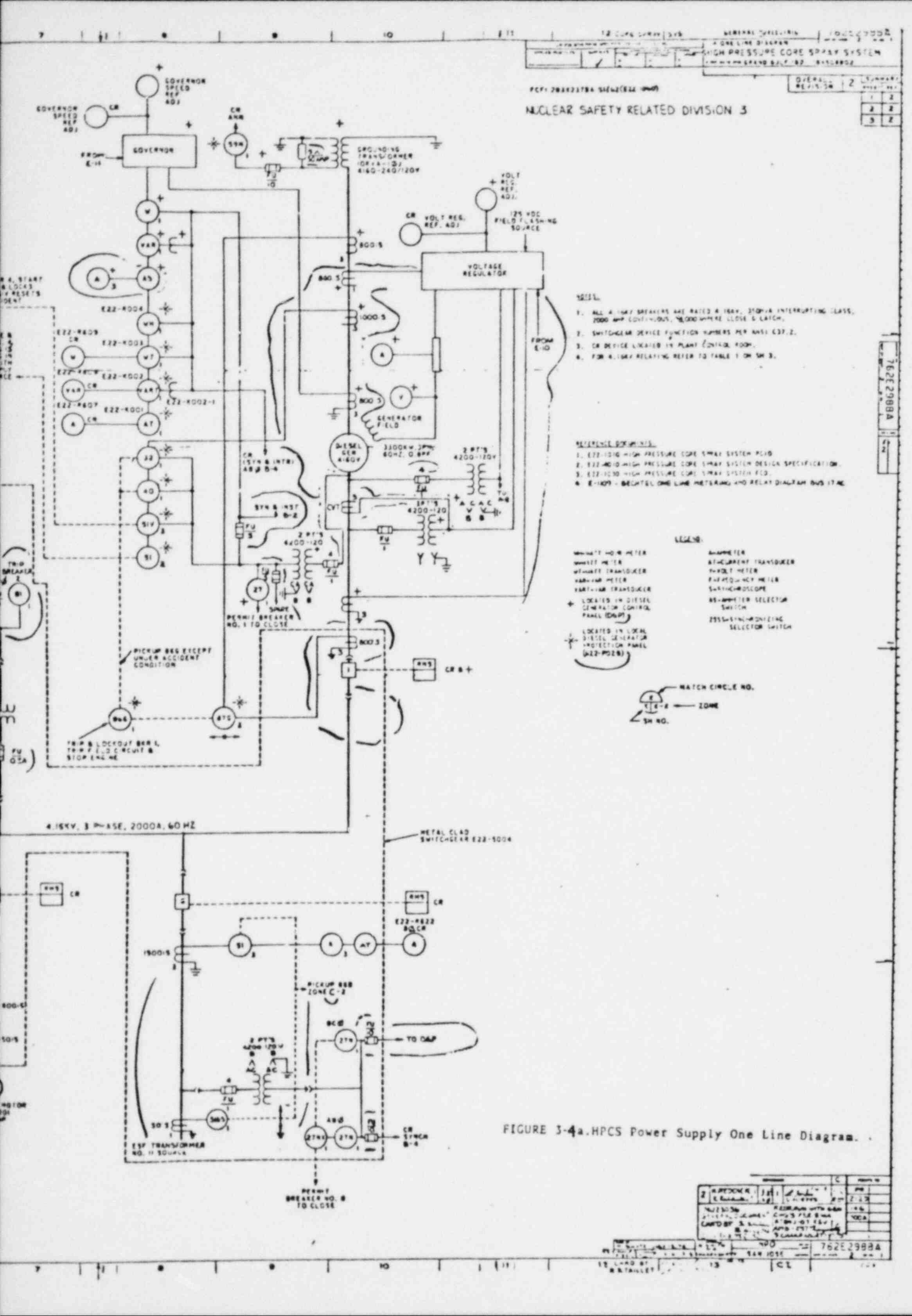
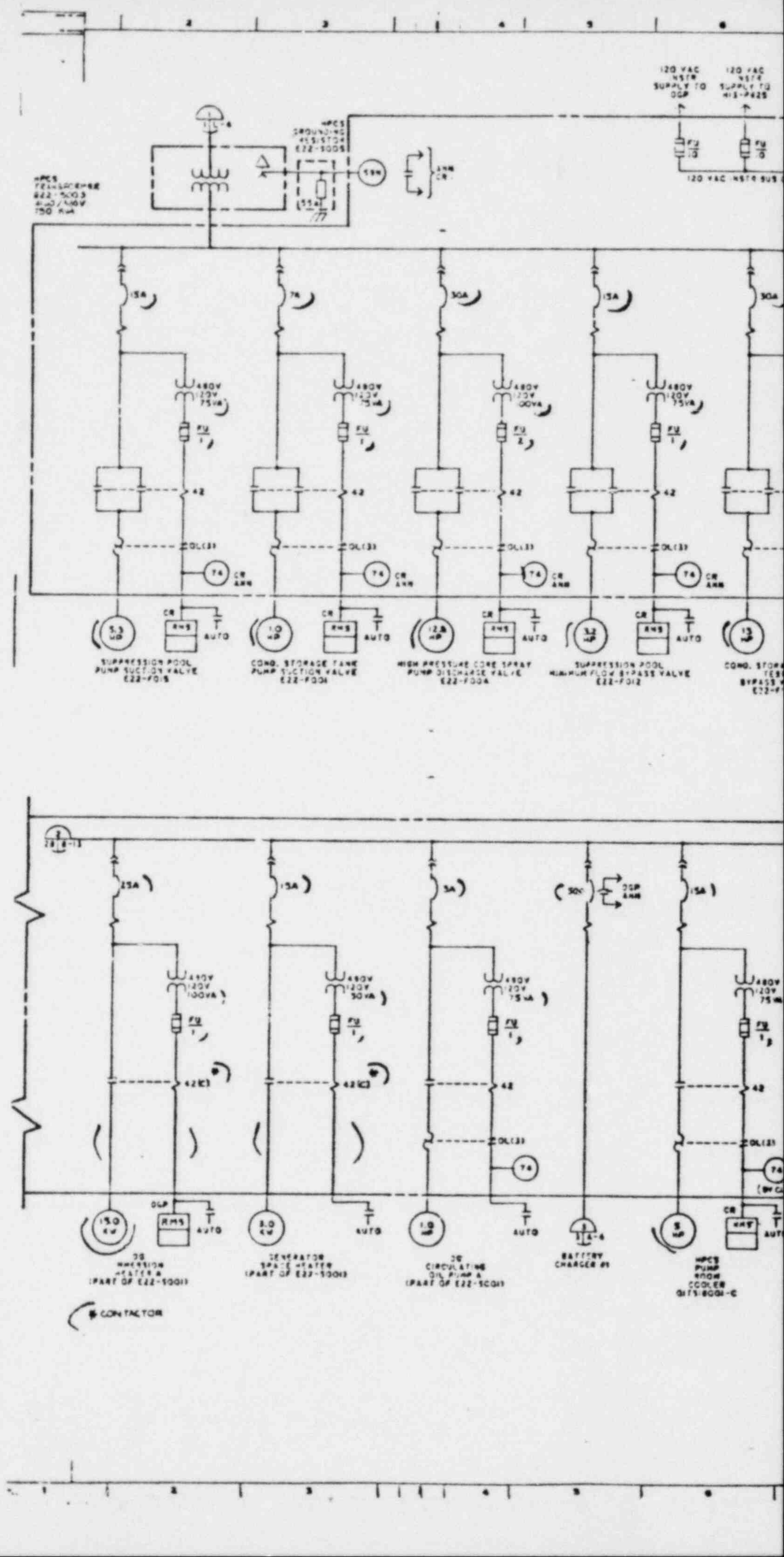


FIGURE 3-4a. HPCS Power Supply One Line Diagram.



SUPPRESSION POOL PUMP SUCTION VALVE E22-F015
COND. STORAGE TANK PUMP SUCTION VALVE E22-F001
HIGH PRESSURE CORE SPRAY PUMP DISCHARGE VALVE E22-F004
SUPPRESSION POOL MINIMUM FLOW BYPASS VALVE E22-F012
GENERATOR SPACE HEATER (PART OF E22-S001)
BATTERY CHARGER #1
CONTACTOR

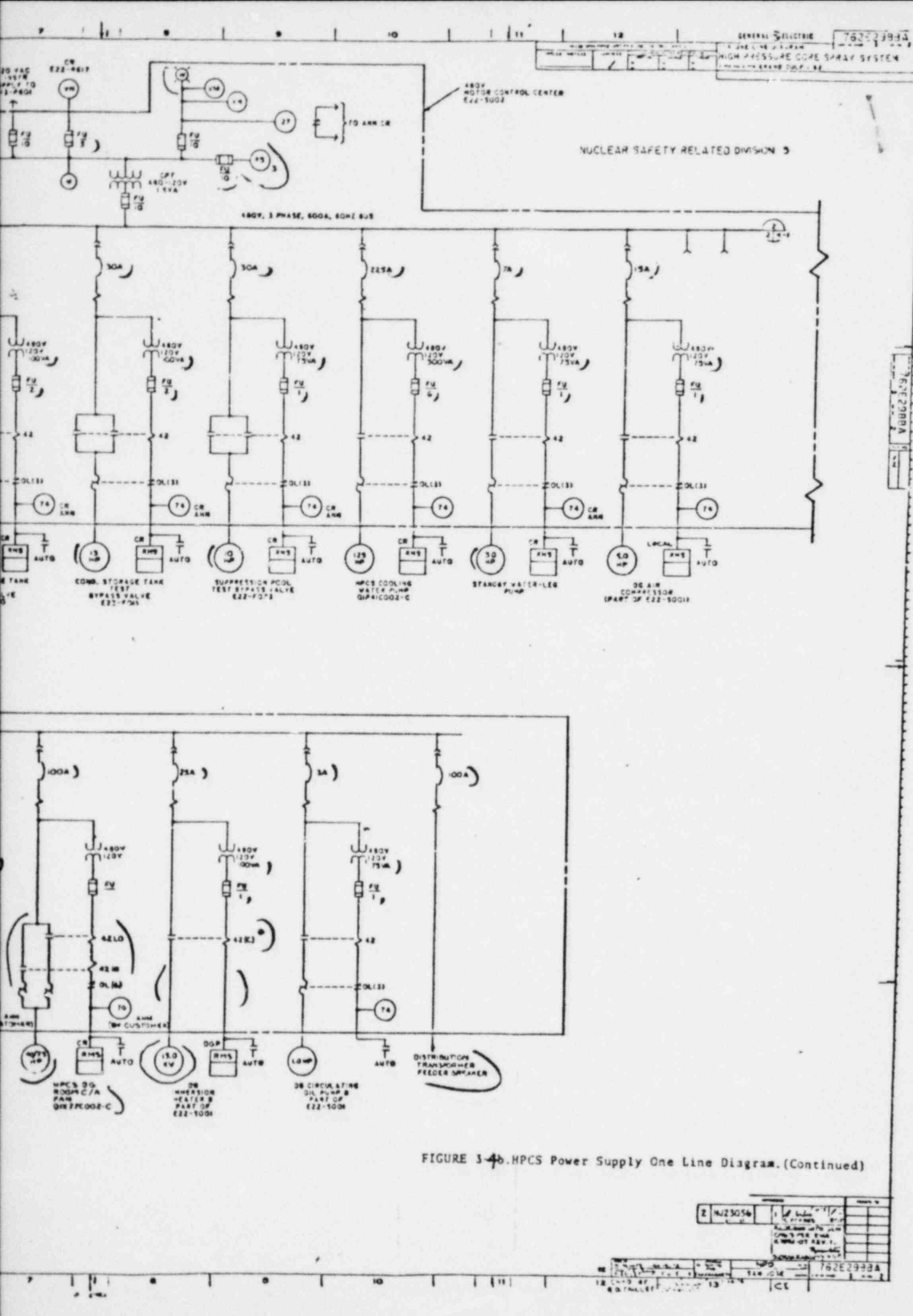
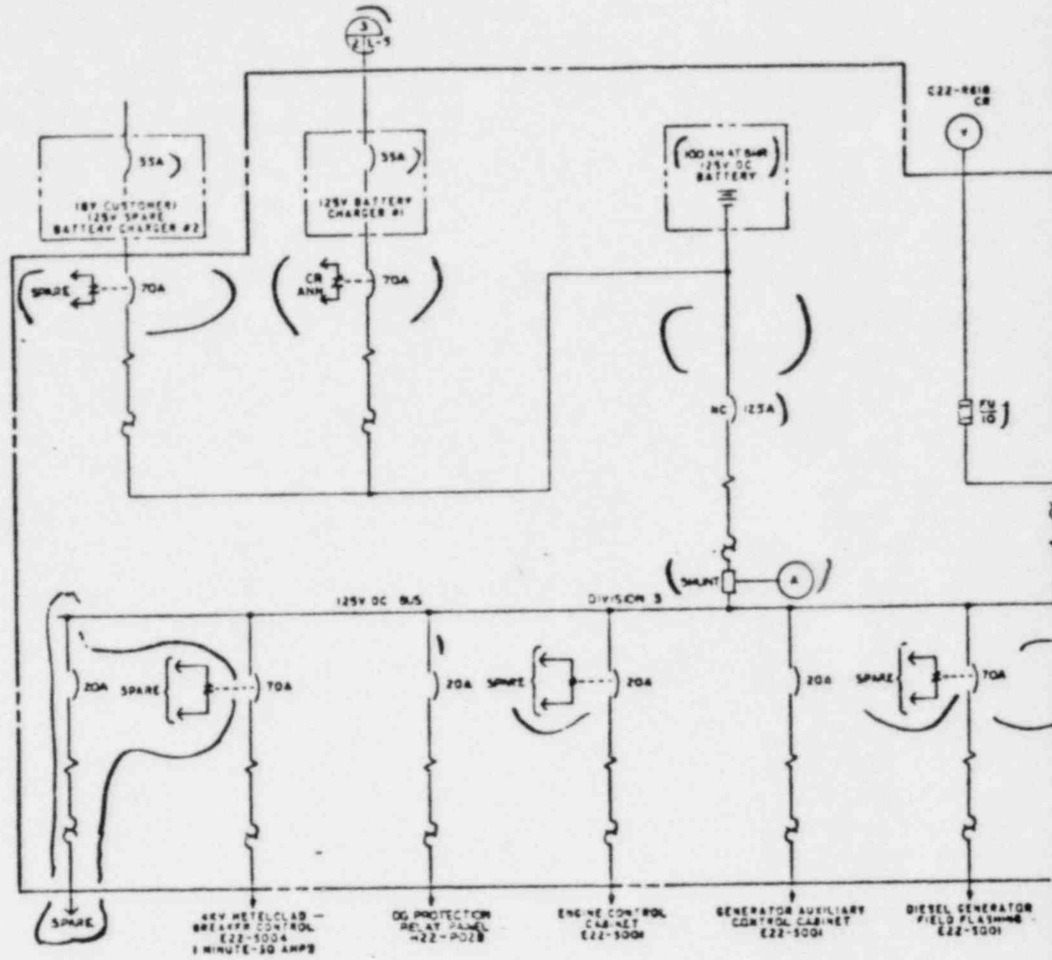


FIGURE 3-4b.HPCS Power Supply One Line Diagram.(Continued)



55A
(BY CUSTOMER) 125V SPARE BATTERY CHARGER #2
55A
125V BATTERY CHARGER #1
100 AH AT 8HR 125V DC BATTERY
C22-R618 CR
SPARE
70A
CR ANN
70A
NC
125A
FU 10
SHUNT
A
125V DC BUS
DIVISION 3
20A
SPARE
70A
20A
SPARE
20A
20A
SPARE
70A
SPARE
4KV METELCLAD — BREAKER CONTROL E22-S004 1 MINUTE-50 AMPS
DG PROTECTION RELAY PANEL H22-P028
ENGINE CONTROL CABINET E22-S001
GENERATOR AUXILIARY CONTROL CABINET E22-S001
DIESEL GENERATOR FIELD FLASHING E22-S001

ONE LINE DIAGRAM
HIGH PRESSURE CORE SPRAY SYSTEM

NUCLEAR SAFETY RELATED DIVISION 3

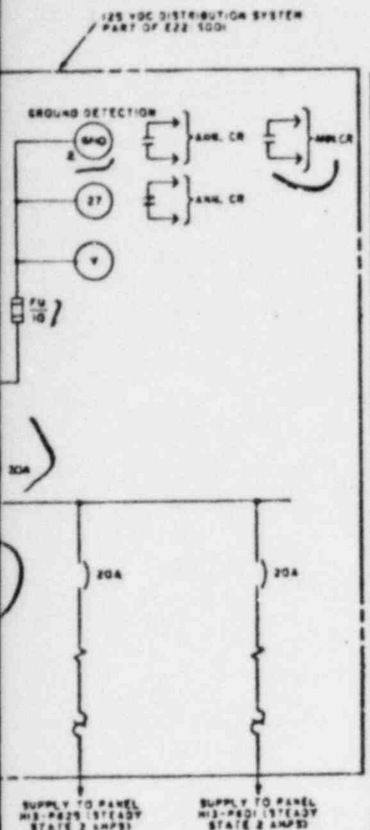


TABLE I

4.16 KV RELAY LIST

SERVICE	DEVICE NO.	DESCRIPTION	RELAY TYPE (GE)	QUANTITY	CLASSIFICATION	REMARKS
DIESEL GEN FEEDER BREAKER 1	40	DIESEL GEN LOSS OF EXCITATION	CEH 51A1A	1	A	
	32	DIESEL GEN REVERSE POWER	GGP 53A	1	A	
	51V	DIESEL GEN TIME OVER CURRENT WITH VOLTAGE RESTRAINT	IJCV 51B	3	A	
	51	DIESEL GEN TIME OVER CURRENT	IAC57	1	A	
	87G	DIESEL GEN DIFFERENTIAL	PVD 21B	3	A	
	86G	DIESEL GEN LOCKOUT	HEA 61B	1	A	TRIPPING OF THE DG BREAKER BY THE PROTECTIVE RELAY ON THE GENERATOR, ACTUATE A SINGLE GENERATOR TRIP ANNUNCIATOR IN THE CONTROL ROOM
	27	DIESEL GEN VOLTAGE BUILDUP	*	1	A	
	59N	DIESEL GEN GRD OVER VOLTAGE	IAV 51K1A	1	N	ANNUNCIATE ONLY
HPCS PUMP MOTOR FEEDER BREAKER 2	50/51	HPCS PUMP MOTOR INSTR & TIME OVER-CURRENT	IAC66K 8B	3	A	THE INDUCTION DISC ELEMENTS ENERGIZE AN ANNUNCIATOR IN THE CONTROL ROOM. A HIGH DROPOUT INSTANTANEOUS UNIT WITH ITS CONTACT IN SERIES WITH THE INDUCTION DISC CONTACT TRIPS MOTOR AT THE POINT OF INCIPIENT STALL. A NORMAL DROPOUT INSTANTANEOUS UNIT TRIPS THE MOTOR INSTANTANEOUSLY UNDER SYSTEM FAULT CONDITIONS
	50GS	HPCS PUMP MOTOR FEEDER GROUND INSTR OVER CURRENT	PJC11 AAA	1	A	TRIPPING OF THIS BREAKER BY THE PROTECTIVE RELAYS CAUSES A CONTROL ROOM ANNUNCIATOR TO BE ENERGIZED.
480V TRANSFORMER FEEDER BREAKER 3	50/51	TRANSFORMER FEEDER INSTR. & TIME OVER CURRENT	IAC66 T7A	3	A	
	50GS	FEEDER GROUND INST OVER CURRENT	PJC11 AAA	1	N	TRIPPING OF THIS BREAKER BY THE PROTECTIVE RELAYS CAUSES THE CONTROL ROOM ANNUNCIATOR TO BE ENERGIZED
ESF TRANSFORMER SOURCES, FEEDERS, BREAKERS 4, 5 & 6	51	FEEDER TIME OVER-CURRENT	IAC51 A802A	9	A	WITHOUT INSTANTANEOUS UNIT
	51GS	FEEDER GROUND TIME OVER-CURRENT	IAC53 A20A	3	A	
	27A	FEEDER VOLTAGE AVAILABLE	NGV25 AAA	6	N	
	27AX	AUX RELAY	HMA 8 B6	3	N	
	86B	FEEDER LOCK-OUT	HEA 61B	2	A	TRIPPING OF THESE BREAKERS BY THE PROTECTIVE RELAYS CAUSES A CONTROL ROOM ANNUNCIATOR TO BE ENERGIZED.
4.16KV BUS MONITORING	27S	BUS UNDER VOLTAGE	NGV25 AAA	4	A	
	62	BUS UNDER-VOLTAGE TIMER	SAM11 A22A	2	A	
	27SX	AUX RELAY	HFA51A42F HMA 8 B6	1 1	A A	
	27SY	AUX RELAY	HFA51A42F HMA 8 B6	1 1	A A	
	81	HPCS BUS OVER FREQUENCY	IJF 51A	1	A	

A= ESSENTIAL

N= NON ESSENTIAL

*- ZENITH CONTROLS, INC. RELAY TYPE AM-1

FIGURE 3-4c HPCS Power Supply One Line Diagram. (Continued)

762E298BA

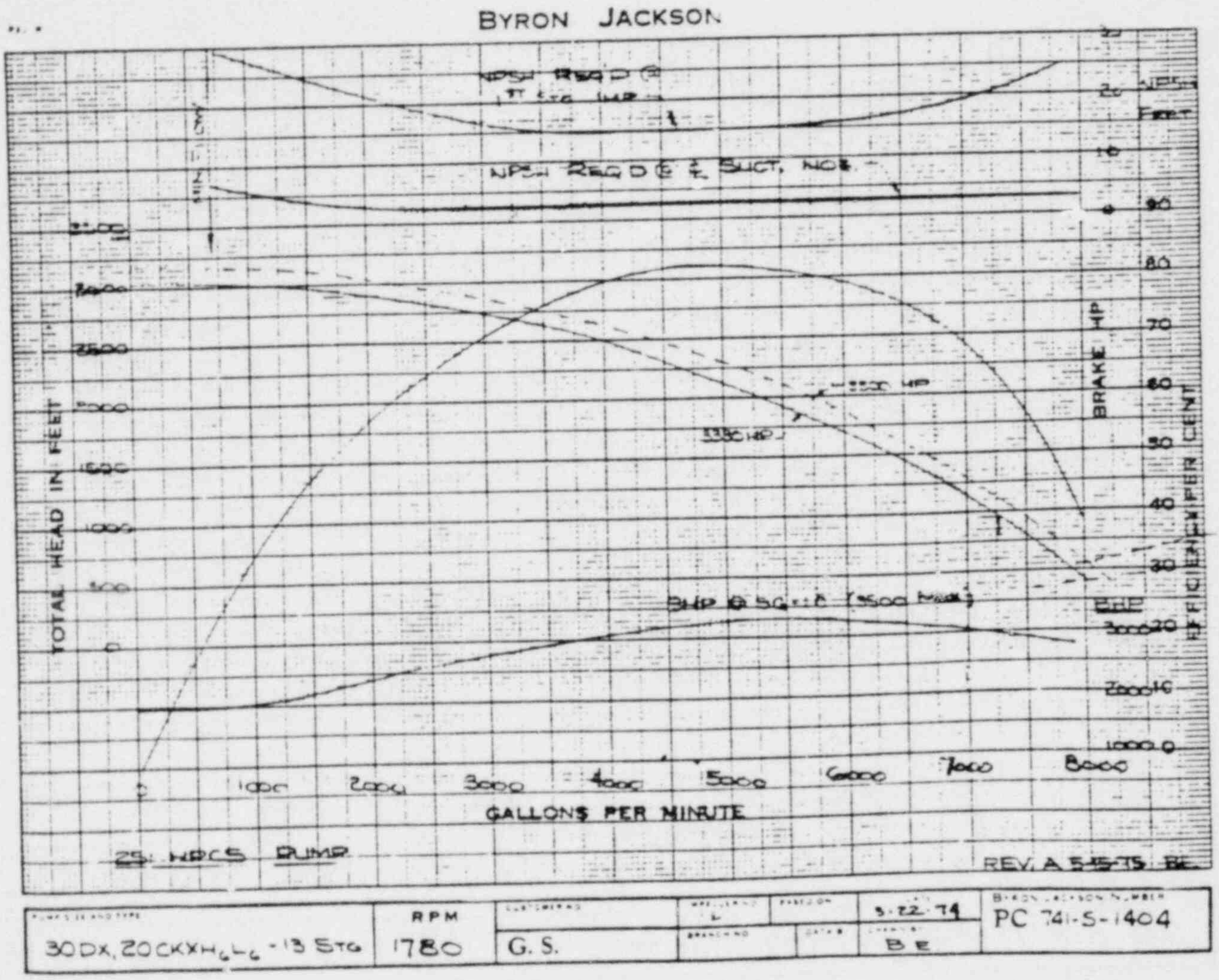


Figure 3-5
MANUFACTURER'S CALCULATED
PERFORMANCE CURVE FOR HPCS PUMP

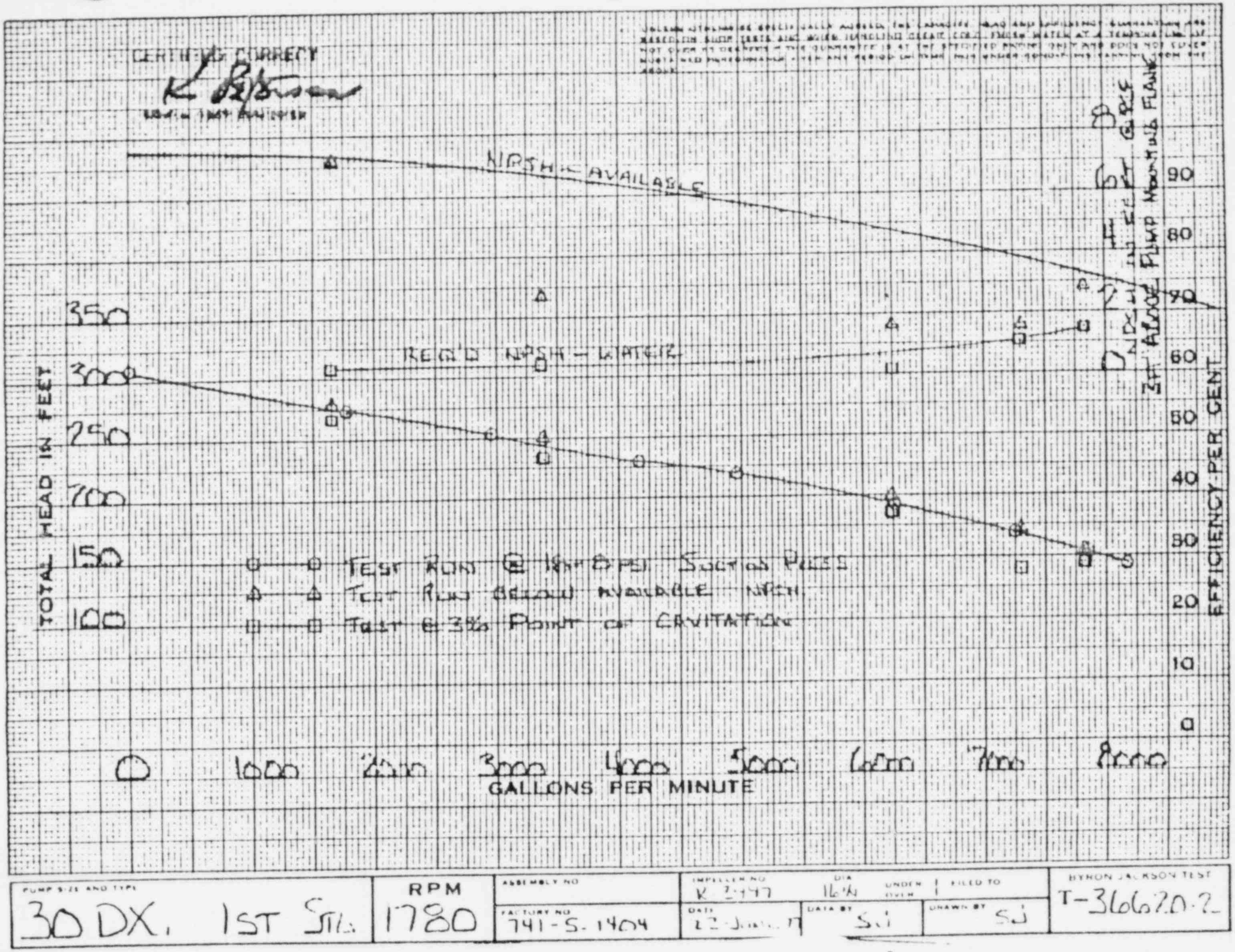
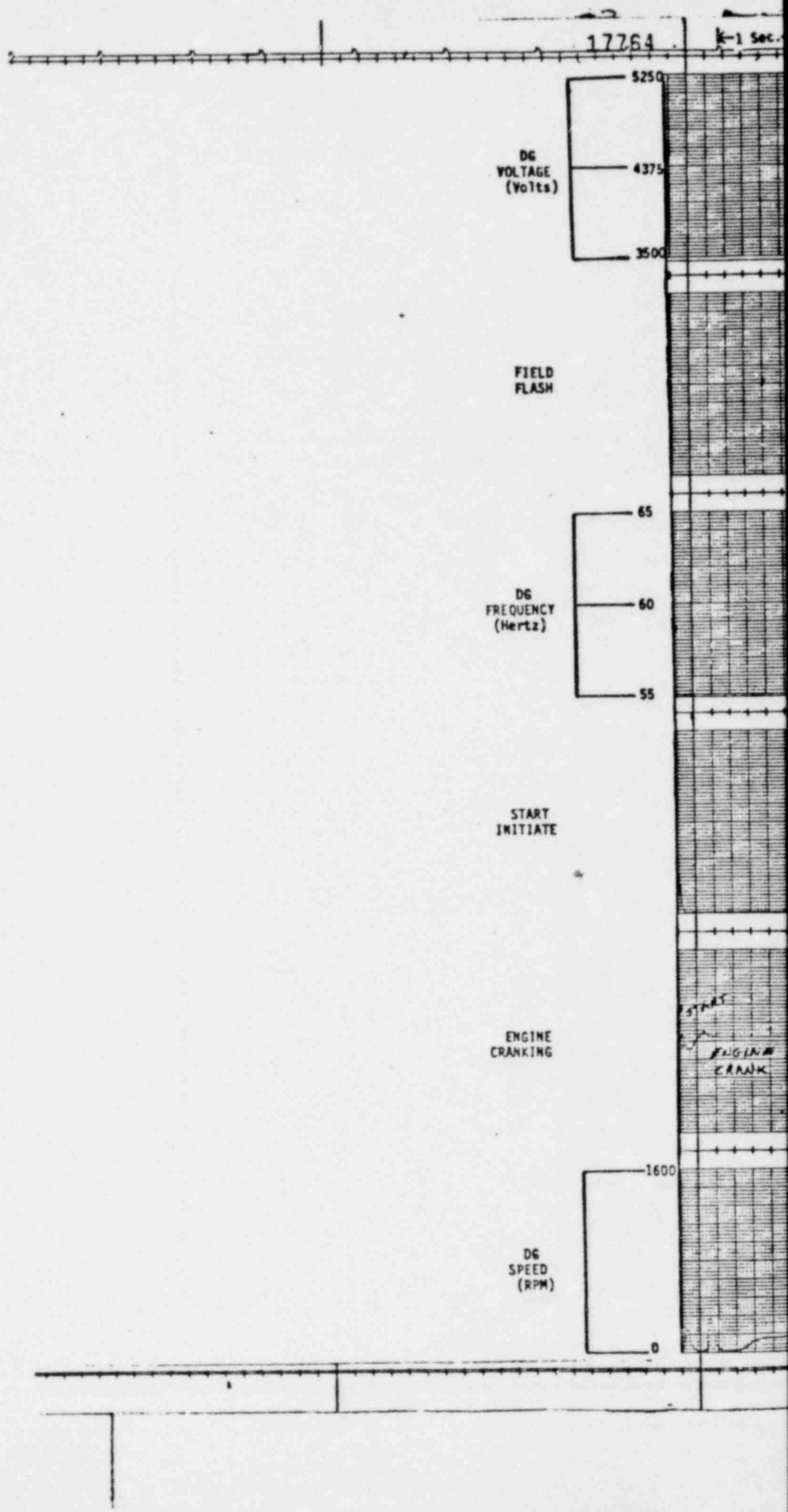


FIGURE 3-5a Manufacturer's Performance Test Curve for


17764
1 Sec.
5250
DG
VOLTAGE
(Volts)
4375
3500
FIELD
FLASH
65
DG
FREQUENCY
(Hertz)
60
55
START
INITIATE
ENGINE
CRANKING
START
ENGINE
CRANK
1600
DG
SPEED
(RPM)
0

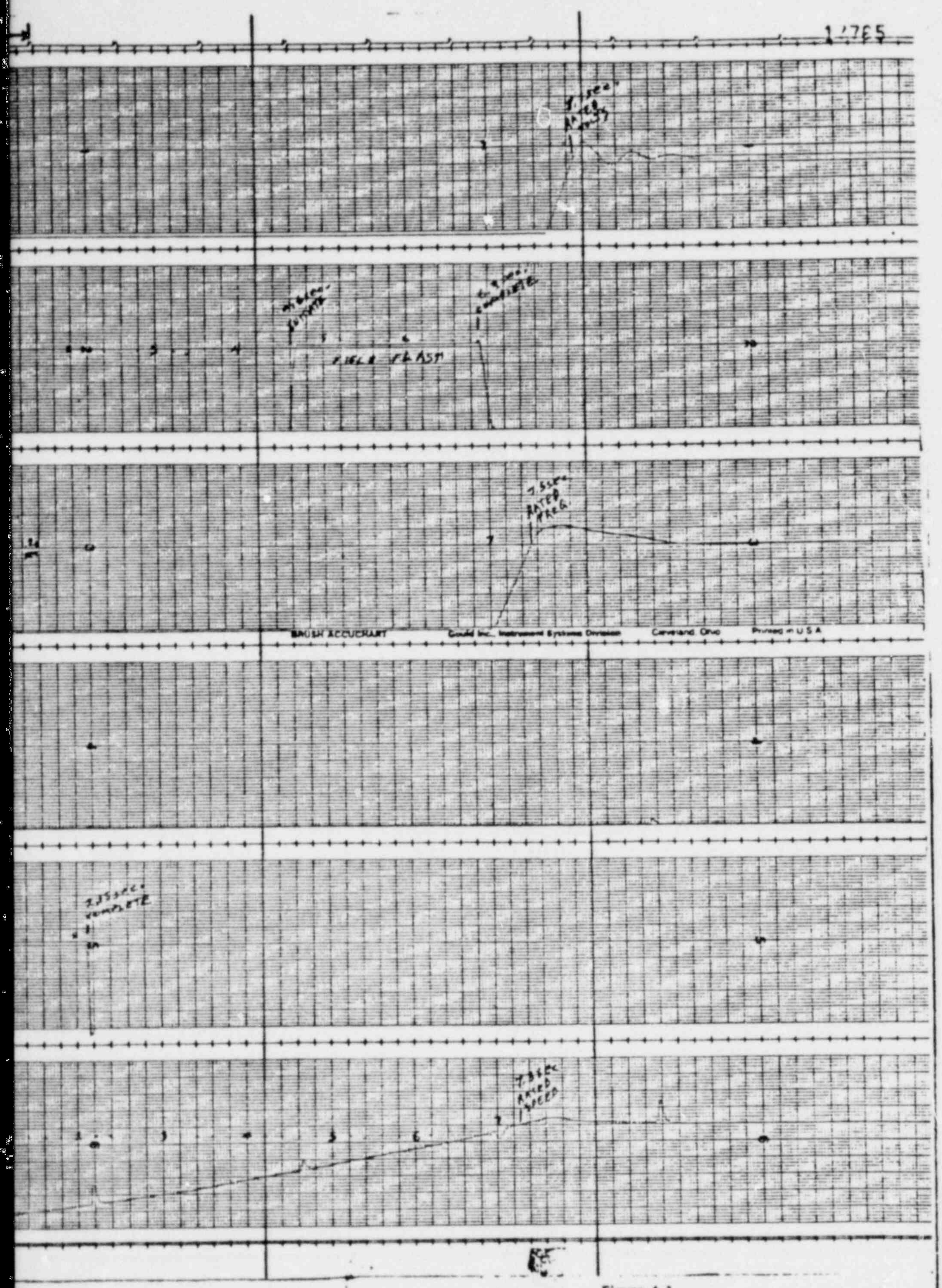


Figure 4-1
HPCS-D.G. STARTING TEST
START NO. 3 (COLD)

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DATA SHEET 8.7

Diesel Generator Starting Test-Start No.3 (Cold)

Part 1: System Data
Time of start 1652

Instrument MPL	LOCATION	Service Description	Eng Units	Step 7.1.4.2 Initial Data	Step 7.1.4.4 After Start Data
Test Inst.	1351	Outside Ambient Temperature	°F	68.8	62.7 * (changed location)
Test Inst.	1352	D/G Room Temperature	°F	73.6	72.1 *
PI-R107A	*	Eng A Start Air A003A Press.	Psig	243	218 *
PI-R108A	*	Eng A Start Air A004A Press.	Psig	242	220 *
PI-R107B	*	Eng B Start Air A003B Press.	Psig	242	220 *
PI-R108B	*	Eng B Start Air A004B Press.	Psig	240	217 *
TI-R003A	**	JW CLR SSW INL	°C	14	15
Inst.# 0790 (TI-R004A)	**	JW Outlet	°C	(50) 137F	✓(60) 143°F
TI-R005A	**	JW INL To OIL CLR	°C	67	71 ✓
TI-R006A	**	JW Out FM OIL CLR	°C	65	72
TI-R009A	**	LO FLTR INL	°C	56	57
TI-R010A	**	LO CLR OUTL	°C	55	64 ✓
PI-R016A	**	LO PRESSURE	Psig	0	106
PI-R017A	**	LO FILTER INL	Psig	0	0
PI-R018A	**	LO FILTER OUTL	Psig	0	0
TI-R003B	**	JW CLR SSW INL	°C	13	12 ✓
I.# 2796 (TI-R004B)	**	JW OUTLET	°C	(46) 133F	(54) ✓ 135°F
TI-R005B	**	JW INL TO OIL CLR	°C	61	67
TI-R006B	**	JW OUT FM OIL CLR	°C	58	64 ✓
TI-R009B	**	LO FLTR INL	°C	~~58~~ 48	51 ✓
TI-R010B	**	LO CLR OUTL	°C	54	65
PI-R016B	**	LO PRESSURE	Psig	0	106 ✓
PI-R017B	**	LO FILTER INL	Psig	0	0
PI-R018B	**	LO FILTER OUTL	Psig	0	0
					[illegible] 3/25/82

RSL 3/28/82 ✓ [illegible] 3/28/82 * FbC 3/28/82

* At E22-S001 Engine Start Air Receivers
** At E22-S001 Engine Skid

TABLE 4-1a
D/G STARTING TIME TEST,COLD,DATA SHEET

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DATA SHEET 8.7

Diesel Generator Starting Test-Start No. 3 (Cold)

Part 2: Recorded data

Field flashing initiation time 4.6 sec
Field flashing completion time 6.9 sec
Engine cranking initiation time 0 sec
Engine cranking completion time 2.15 sec
Acceleration time to attain rated speed (900 + 4.5 rpm or 60.0 + .3 HZ) (900) 7.3 / (60HZ) 7.5 sec.
and rated voltage (4160 ± 41 VAC) 8.1 sec.

Part 3: Acceptance criteria

All data taken on this data sheet is baseline except for the following:

Air pressure (PI-R107A, B; PI-R108A, B) > 160 psig
SEE TCN NO. 2 ... °C < Lube oil temperature (TI-R010A,B) < 115°C
35 46°C ≤ Jacket water temperature (TI-R004 A,B) < 90°C OR INSTALLED PYROMETER AT TSHL-N044A,B)
SEE TCN NO. 7 Acceleration time to rated speed and voltage ≤ 10 seconds

DATA SHEET 8.7 COMPLETED BY:

TEST SUPERVISOR SIGNATURE	DATE
JABurris	3/30/82

TABLE 4-1b
D/G STARTING TIME TEST, COLD, DATA SHEET

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DATA SHEET 8.33

HPCS Diesel Generator Operating Parameters For D/G Load And Reliability Test No. 23

DATE: 3/14/82 SHEET 1 OF 4

Instrument MPL Number	LOCATION	Service Description	Eng Units	Step 7.3.23.2 Initial Data	Step 7.3.23.10 After Engine Start 15 min	30min	45 min	60 min
E22-JI-R609	1	Wattmeter	KW	0	3000	3000	3000	2850
E22-JI-R608	1	Varmeter	KVAR	0	1200	1200	1200	1200
E22-EI-R610	1	Bus Voltmeter	KV	4.10	4.200	4.200	4.200	4.200
E22-II-R607	1	D/G Ammeter	AMP	0	420	420	420	410
E22-SI-R612	1	D/G Frequency	HZ	60	60	60	60	60
E22-SI-R615	1	Bus Frequency	HZ	60	60	60	60	60
LIS-N600	4	FO Storage Tk	IN	6.8'	6.8'	6.8'	6.8'	6.8
LIS-N602	4	FO Day Tk	IN	13.5"	34"	31"	26"	20"
LI-R600	5	FO Stor Tk	IN	6.8'	6.8'	6.8'	6.8'	6.8
LI-R601	5	FO Day Tk	IN	13.5"	34"	31"	26"	20
JI-R031	6	Wattmeter	KW	0	2790	2786	2790	2790
JI-R032	6	Varmeter	KVAR	0	1100	1100	1100	1100
EI-R034	6	Bus VM Ø1-Ø2	KV	4.100	4200	4200	4200	4200
EI-R034	6	Bus VM Ø2-Ø3	KV	4.140	4200	4200	4200	4200
EI-R034	6	Bus VM Ø3-Ø1	KV	4.200	4200	4200	4200	4200
EI-R033	6	D/G VM Ø1-Ø2	KV	0	4200	4200	4200	4200
EI-R033	6	D/G VM Ø2-Ø3	KV	0	4200	4200	4200	4200
EI-R033	6	D/G VM Ø3-Ø1	KV	0	4200	4200	4200	4200
II-R051	6	D/G AM Ø1	AMP	0	415	415	415	415
II-R051	6	D/G AM Ø2	AMP	0	415	415	415	415
II-R051	6	D/G AM Ø3	AMP	0	415	415	415	415
SI-R024	6	D/G Frequency	HZ	0	60	60	60	60
SI-R050	6	Bus Frequency	HZ	60	60	60	60	60
EI-R046	6	Exciter VM	VOLT	0	87	89	90	[illegible]
II-R047	6	Exciter AM	AMP	0	99	100	100	[illegible]
EI-R029	6	DC Supply VM	VOLT	131	131	131	131	131
II-R030	6	DC Supply AM	AMP	4	11	11	11	11
KI-R006	6	Running Time	HR	183.0	183.3	183.5	183.7	184.0
SI-R002	6	D/G Tachometer	RPM	0	900	900	900	900
E22-FI-R603	1	HPCS Pump Flow	GPM	0	5200 SF	5300	5300	5300
E22-PI-R601	1	HPCS Pump Dis Press	Psig	0	845	850	850	850
E22-PIS-N652	2	HPCS Pump Suc Press	Psig	20	20	20	20	20
				KNHR0371X... RB 3/14/82	MZM 3-14-82	MZM 3-14-82	MZM 3-14-82	DS 3-14-82
					SE 3/14/82	SE 3/14/82	SE 3/14/82	

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SHarris	3/14/82

TABLE 4-2a

HPCS D/G LOAD AND RELIABILITY TEST DATA

DATA SHEET 8.33

HPCS Diesel Generator Operating Parameters For D/G Load And Reliability Test No. 23

Instrument MPL Number	LOCATION	Service Description	Eng Units	Step 7.3.23.2 Initial Data	Step 7.3.23.10 After Engine Start 15 min	30min	45 min	60 min
TI-R049-1A	3	A CYL 1 EXH	°C	54	470	472	470	470
TI-R049-2A	3	A CYL 2 EXH	°C	60	480	483	480	480
TI-R049-3A	3	A CYL 3 EXH	°C	55	477	479	479	475
TI-R049-4A	3	A CYL 4 EXH	°C	51	455	458	460	460
TI-R049-5A	3	A CYL 5 EXH	°C	59	433	434	436	[illegible]
TI-R049-6A	3	A CYL 6 EXH	°C	55	418	419	423	420
TI-R049-7A	3	A CYL 7 EXH	°C	58	463	463	463	465
TI-R049-8A	3	A CYL 8 EXH	°C	55	478	479	480	480
TI-R049-9A	3	A CYL 9 EXH	°C	56	478	480	480	480
TI-R049-10A	3	A CYL 10 EXH	°C	52	442	445	447	447
TI-R049-11A	3	A CYL 11 EXH	°C	30	—	—	—	—
TI-R049-12A	3	A CYL 12 EXH	°C	55	438	440	440	[illegible]
TI-R049-CEA	3	ENG A EXHAUST	°C	54	424	425	428	425
TI-R049-1B	3	B CYL 1 EXH	°C	59	456	460	460	460
TI-R049-2B	3	B CYL 2 EXH	°C	53	463	465	467	465
TI-R049-3B	3	B CYL 3 EXH	°C	51	467	468	470	470
TI-R049-4B	3	B CYL 4 EXH	°C	52	466	462	462	465
TI-R049-5B	3	B CYL 5 EXH	°C	54	443	445	449	[illegible]
TI-R049-6B	3	B CYL 6 EXH	°C	61	439	441	442	[illegible]
TI-R049-7B	3	B CYL 7 EXH	°C	53	452	455	457	460
TI-R049-8B	3	B CYL 8 EXH	°C	60	465	468	469	470
TI-R049-9B	3	B CYL 9 EXH	°C	52	450	450	452	455
TI-R049-10B	3	B CYL 10 EXH	°C	51	454	454	458	460
TI-R049-11B	3	B CYL 11 EXH	°C	51	435	436	438	[illegible]
TI-R049-12B	3	B CYL 12 EXH	°C	58	435	436	439	[illegible]
TI-R049-CEB	3	Eng B EXHAUST	°C	55	429	430	431	435
TIS-N045	3	Stator Temp PT 1	°F	121	170	173	176	180
TIS-N045	3	Stator Temp PT 2	°F	136	197	194	196	200
TIS-N045	3	Stator Temp PT 3	°F	120	169	173	175	180
TIS-N045	3	Stator Temp PT 4	°F	120	165	170	171	175
TIS-N045	3	Stator Temp PT 5	°F	122	169	172	174	[illegible]
TIS-N045	3	Stator Temp PT 6	°F	119	167	173	174	[illegible]
				MZM 3-14-82	MZM 3-14-82	MZM 3-14-82	MZM 3-14-82	[illegible]

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TABLE 4-2b

HPCS D/G LOAD AND RELIABILITY TEST DATA

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DATA SHEET 8.33

HPCS Diesel Generator Operating Parameters For D/G Load And Reliability Test No. 23

SHEET 3 OF 4

Instrument MPL Number	LOCATION	Servive Description	Eng Units	Step 7.3.23.2 Initial Data	Step 7.3.23.10 15 min	30 min	45 min	60 min
					<---After Engine Start--->			
TI-R003A	3	JW CLR SSW INL	°C	15	15	15	15	15
TI-R004A	3	JW OUTLET	°C	38	68	68	68	68
TI-R005A	3	JW INL TO OIL CLR	°C	58	72	72	72	72
TI-R006A	3	JW OUT FM OIL CLR	°C	72	70	70	70	70
TI-R009A	3	LO FLTR INL	°C	55	82	84	84	84
TI-R010A	3	LO CLR OUTL	°C	44	68	70	70	70
PI-R016A	3	LO PRESSURE	Psig	0	97	96	96	96
PI-R017A	3	LO FILTER INL	Psig	0	0	0	0	0
PI-R018A	3	LO FILTER OUTL	Psig	0	0	0	0	0
PI-R065A	3	FO INL PRESS	Psig	0	38	38	38	38
TI-R003B	3	JW CLR SSW INL	°C	10	10	10	10	10
TI-R004B	3	JW OUTLET	°C	42	74	74	74	74
TI-R005B	3	JW INL TO OIL CLR	°C	70	70	70	70	70
TI-R006B	3	JW OUT FM OIL CLR	°C	70	70	70	70	70
TI-R009B	3	LO FLTR INL	°C	52	80	83	83	83
TI-R010B	3	LO CLR OUTL	°C	56	80	82	82	82
PI-R016B	3	LO PRESSURE	Psig	0	98	96	96	96
PI-R017B	3	LO FILTER INL	Psig	0	0	0	0	0
PI-R018B	3	LO FILTER OUTL	Psig	0	0	0	0	0
PI-R065B	3	FO INL PRESS	Psig	0	38	38	38	38
					4.0 SA*	4.0		
Test Inst.	3	CRANKCASE PRESS A	In H20	.3	~~2.6~~	~~2.6~~	4.0	4.0
Test Inst.	3	CRANKCASE PRESS B	In H20	.3	~~2.1~~	~~2.1~~	3.6	3.6
					3.6 *	3.6		
Test Inst.	3352	Outside Ambt. Temp	°F	76	79.6	80.1	79	75
Test Inst.	3356	D/G Room Temp	°F	87.5	90.4	93.9	94.4	94.6
		Clock Time	HR-MIN	2230	2255	2310	2325	2340
				CHW 3-14-82	CHW 3-14-82	CHW 3-14-82	CHW 3-14-82	CHW 3-14-82

* reading error total water column not added up.
SA 3/14/82

DATA SHEET 8.33 COMPLETED BY:

TEST SUPERVISOR SIGNATURE	DATE
SBurris	3/14/82

TABLE 4-2c
HPCS D/G LOAD AND RELIABILITY TEST DATA

DATA SHEET 8.33

HPCS Diesel Generator Operating Parameters For D/G Load And Reliability Test No. 23

Location 1 — 1H13-P601-16B
Location 2 — 1H13-P625
Location 3 — 1E22-S001 Engine Skid
Location 4 — 1H13-P877
Location 5 — 1H13-P870
Location 6 — 1H22-P118

Data From Recordings:

Time from undervoltage signal till D/G tied to bus 8.6 sec
Time till HPCS at rated flow (from U.V. signal) 23.5 sec
SEE TCN#3 ~~Time till valve E22-F004 G full open (from U.V. signal) ______ sec~~ Deleted
D/G steady-state load 2200 KW 950 KVAR
Minimum Voltage on Bus 17AC 2810 Volt (after D/G on Bus)
Minimum Freq on Bus 17AC 59.3 HZ (after D/G on Bus)
SEE TCN#3 Time after D/G tie for frequency to return to 98% (58.8 HZ) 0 sec
Time after D/G tie for Bus 17AC voltage to return to 80% (3328 VAC) 4.5 sec
Time after D/G tie for Bus 17AC voltage to return to 90% (3744 VAC) 4.6 sec

Comments: Freq. never below 59.3

Test Equipment used: Bell & Howell #2651 GOULD 2600 #1634
GOULD 2600 #1632 Hewlett Packard REC #636 AMP+ SC
GOULD 2200 #878 GOULD 2200 # 875

Acceptance Criteria: All data is baseline except for the following: D/G load (E22-R609) is maintained at design loads for at least one hour.

DATA SHEET 8.33 COMPLETED BY:

TEST SUPERVISOR SIGNATURE	DATE
S Gurrie	3/18/82

TABLE 4-2d

HPCS D/G LOAD AND RELIABILTY TEST DATA

SERIAL NO. 17312216/217	200	A. C. SYNCHRONOUS GENERATOR DATA	SALES ORDER NO. 17312216/217	DATE 3/7/74	REV. 2
TYPE L-11022	KVA 4125	VOLTS 4160/2400	AMPS 572.5/992.3	PHASE 3(6 Wire)	HERTZ 60
FRAME 150	INSUL CLASS F	P.F. .8	POLES 8	DUTY Continuous	RPM 900

1	Direct Axis Synchronous Reactance (Unsaturated)	Xd	.732	P.U.
2	Quadrature Axis Synchronous Reactance (")	Xq	.386	P.U.
3	Direct Axis Transient Reactance (Rated Voltage)	X'd	.135	P.U.
4	Direct Axis Subtransient Reactance (" ")	X"d	.072	P.U.
5	Quadrature Axis Subtransient Reactance (" ")	X"q	.088	P.U.
6	Zero Sequence Reactance (" ")	Xo	.058	P.U.
7	Negative Sequence Reactance (" ")	X2	.080	P.U.
8	Direct Axis Transient Open Circuit Time Constant	T'do	5.291	Sec.
9	Direct Axis Short Circuit Transient Time Constant	T'd	.977	Sec.
10	Direct Axis Short Circuit Subtransient Time Const	T"d	.04	Sec.
11	Synchronous Impedance Unit on Rated KVA Base		4.192	Ohms
12	Short Circuit Ratio	SCR	1.436	P.U.
13	Field Resistance at 25 Deg. C		.722	Ohms
14	Field Current at Full Load, Rated Voltage and Power Factor		109.6	Amps
15	Field Current at No Load, Rated Voltage		69.2	Amps
16	Field Current at No.Load, 60% Volts		40.2	Amps
17	Continuous Duty Field Voltage		105.1	Volts
18	Inherent Regulation		27.5	%
19	Recommended Field Discharge Resistor:		2. Ohms	50. Amps
20	Synchronizing Power Coefficient at No Load	PrNL	10680	KW/E.Rad
21	Synchronizing Power Coefficient at Full Load	PrFL	13990	KW/E.Rad
22	Unbalanced Magnetic Pull with Rotor Displaced:	Pd0/32	6280	Lbs.
23	Magnetization Characteristics	Curve No. 2503		

*Rating - above P.U. values are based upon 4125 KVA, 3300 KW base rating. Generator 2000 Hr. (continuous)rating at 50 degrees C:3474 KW at 0.8 P.F. capable of 10 percent O.L. for 2 hr. in any 24 hr. period. 1/2 hr. rating: 3688 KW at 0.8 P.F.

STATIC EXCITER

SERIAL NO.	600	N.A. D.C. EXCITER DATA	TYPE L-	SATURATION CURVE NO:

1	KW	VOLTS	AMP	RPM	INSUL. CLASS	
2	Field Resistance at 25 Deg. C					Ohms
3	Recommended Rheostat:			Plate(s)	Ohms	Amps

TABLE 4-3
HPCS POWER SUPPLY GENERATOR
DATA

APPENDIX

CORRESPONDENCE RELATED TO HPCS POWER
SUPPLY PROTOTYPE TESTING