INTERMOUNTAIN GENERATING STATION

INTERMOUNTAIN POWER PROJECT
INTERMOUNTAIN GENERATING STATION

AUXILIARY ELECTRIC SYSTEM
EXPANSION STUDY PM 86

FILE NO. 15119.42.0412

IPP
INTERMOUNTAIN POWER PROJECT

BLACK & VEATCH/consulting engineers

IP12_005213

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Black & Veatch
Engineers-Architects

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	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Registered Professional Engineer under the laws of the State of Utah.

Lloyd Wade Sherrill

Date Oct 23, 1989 Reg. No. 5546

REGISTERED PROFESSIONAL ENGINEER
No. 5546
LLOYD
WADE
SHERRILL
STATE OF UTAH

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1.0 INTRODUCTION

The Intermountain Power Project is considering expanding each unit's auxiliary electric system from a generator breaker with two main auxiliary transformers to a configuration which includes a reserve transformer source for the purpose of supplying safe shutdown power after a unit trip which includes loss of the main auxiliary source.

This study determines the reserve auxiliary transformer ratings and load transfer methods necessary to achieve this result, and the changes necessary to prevent a loss of the dc substation auxiliary electric system due to voltage excursion at the 46 kV substation source bus.

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2.0 SUMMARY

2.1 SUMMARY OF IMPORTANT INFORMATION

A transfer of unit auxiliary load from the main auxiliary transformer source to a new reserve auxiliary source is required to provide safe shutdown of a unit if an electrical fault occurs in the protective relay zone that includes the generator step-up transformer, main auxiliary transformer, and the 345 kV overhead conductors to the 345 kV substation. The reserve source will be the 46 kV substation. The voltage transients which occur during transfer must not adversely affect the dc substation auxiliary electric system. In addition, adherence to other operating and design criteria is required to ensure normal and safe system operation.

This study examined three methods of automatic transfer commonly used in the power industry: fast transfer, in-phase transfer, and residual bus voltage transfer. The fast transfer scheme was determined to be the required method in order to transfer the load and maintain system operation for a safe shutdown. The remaining methods will not meet the criteria established for the study.

A single new three-winding reserve transformer rated 36/48/60 OA/FA/FOA for each generating unit was determined to be adequate to supply the normal post-trip 6,900 volt bus load. Each secondary will be connected to a small and large motor bus.

The new reserve transformer size and impedances were determined in conjunction with the 46 kV substation source capacity by utilizing commercially available personal computer based software for calculating power flows and fault currents. Two methods were utilized to calculate voltage drops during the transfer. One method approximated power flows and the other method used expected bus residual voltages. Fault studies were made for three-phase bolted faults and the results were compared to existing equipment ratings.

Results of the calculations indicated that the impedance of the existing 46 kV substation transformers is too high to provide adequate voltage

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regulation during transfer of plant auxiliaries. Transformer capacity of 100 MVA at 5.5 percent nominal impedance is required if both units transfer simultaneously to this reserve source. Since the initial criteria required only one 46 kV substation transformer to be in service during load transfer, each transformer should be rated 100 MVA OA at 5.5 percent nominal impedance. An alternative criteria in which both transformers are in service and operated in parallel during the two-unit load transfer would require each 46 kV substation transformer to be rated 50 MVA OA at 5.5 percent nominal impedance.

The studies also considered the addition of two future 8,000 hp boiler feed pumps in each generating unit to replace the existing simple 7,000 hp boiler feed pump. This future contingency required a slight increase in the reserve transformer impedance to limit bus fault currents. Reserve transformer impedances of 8.0 percent nominal for the 100 MVA 46 kV transformer configuration and 7.6 percent nominal for the alternate 50 MVA 46 kV transformer configuration are required.

The induced draft fan variable frequency drive control system was reviewed, and it appears that the successful transfer of the drive is possible; however, the manufacturer, Westinghouse Electric Corporation, has recommended that transfer tests be made to ensure proper operation.

Motor starting capability of the new reserve source was also studied. With the final expected post-trip load of 20 MW connected, an 8,000 hp motor can be started utilizing the 100 MVA 345/46 kV transformer configuration.

The effect of a fast transfer on the safe shutdown analysis was also examined. No adverse effects are expected.

Due to the increase in fault MVA available at the 46 kV substation, the existing breaker interrupting ratings will be exceeded. For the 100 MVA 46 kV transformer configuration, the existing breakers must be replaced with breakers having a 63 kA interrupting rating and for the 50 MVA 46 kV transformer configuration the existing breakers must be

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replaced with breakers having a 40 kA interrupting rating; however, it is anticipated that the 46 kV bus will be rebuilt and the new design must incorporate the expected new fault currents. The rebuilt 46 kV switchrack will be a breaker and one-half arrangement. The existing 46 kV switchrack is in a ring bus configuration. The new breakers and one-half arrangement may offer some maintenance advantages as well as better operational flexibility and reliability. The existing 46 kV breakers will need to be changed out to a higher interrupting rating to accomodate the new 345/46 kV transformers; therefore, the reconfigured breaker and one-half arrangement can be constructed before the existing bus is removed from service. This construction can be accomplished with the 46 kV switchrack out of service for a very short time.

Costs for the auxiliary electric system modifications expansion were estimated for both the 100 MVA 46 kV configuration and the 50 MVA 46 kV configuration. These estimates include the substation reconfiguration costs. The costs were estimated at $10,206,216.00 and $8,391,261.00, respectively.

2.2 CONCLUSION

The transfer of auxiliary electric system unit loads to a new reserve transformer by the fast transfer method is an acceptable method of providing power to critical loads during a unit trip which involves the generator transformer Lockout Relay 86 GT.

The inrush currents will not be harmful to the motors and excessive voltage drops at the substation dc auxiliary system bus will not occur under normal bus loading conditions.

The existing 345/46 kV substation transformers will require replacement by either two 100 MVA transformers or two 50 MVA transformers. The criteria for two 100 MVA 46 kV transformers versus two 50 MVA 46 kV transformers are influenced by the probability of one transformer being out of service due to forced or scheduled outages at the same time as a two-unit simultaneous transfer due to a trip initiation within each unit's generator and main auxiliary transformer protective zone.

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Using industry average data for auxiliary transformers for large fossil fired units shows an average unavailability of such transformers of 12.4 hours per year (one failure every 6.7 years with an average downtime of 83 hours). The probability of either transformer being out of service is about 0.003.

The probability of simultaneous unit trips is not determinable because all known causes for common mode failures resulting from causes within each unit's transformer protection zone have been considered in the design. The expected occurrence rate of any such common mode failure should be multiplied by 0.003 (the probability of one of two transformers being out of service). Thus, if the expected occurrence rate for simultaneous trips is estimated at 1 in 10 years, the probability of two transformers being required is 0.003 * 1/10 years = 3 per 10,000 years.

The transfer of each bus should be by the fast transfer method and should be supervised by individual bus high-speed synch-check relays. Prior to revising the auxiliary electric system configuration, bus transfer tests should be performed with Westinghouse participation to determine that proper induced draft fan variable frequency drive operation will occur during a transfer.

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3.0 STUDY

3.1 OBJECTIVES

The objective of this study is to determine a unit reserve auxiliary transformer rating and impedance parameters necessary to achieve a safe shutdown without disturbing the dc substation operation when transferring loads from the unit main auxiliary transformers during a unit trip. The reserve transformer source will be the 46 kV substation. If necessary, the 46 kV substation transformer ratings will be revised as required.

The study will also review the types of load transfer and consider the operation of the variable frequency induced draft (ID) fans, the reserve system motor starting capabilities, and the relation to the safe shutdown analysis.

3.2 CRITERIA

Criteria for this study include the following.

- The new reserve auxiliary transformer arrangement is to be provided only for the purpose of safe shutdown of a generating unit in the event of a unit trip which involves a fault in a generator transformer, or a main auxiliary transformer which would otherwise result in a black trip of the generating unit. Routine shutdown and startup of the generating units will normally be done using the generator transformer and main auxiliary transformers.
- The power source for the reserve transformer is the 46 kV substation presently supplied by two bank transformers, designated K and L.
- As an initial criteria, only one 46 kV transformer is to be considered in service. In that the transfer of loads typically affects only a single unit, an alternate criteria of having both 46 kV transformers in service when a two-unit transfer occurs will be considered.
- Both generating units' auxiliary loads will transfer to the reserve sources simultaneously.

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- The post trip continuous load must be supplied without exceeding transformer capacity ratings.
- Operating voltage range of the 6.9 kV and 46 kV buses should be greater than 0.95 per unit when supplying post trip loads and less than 1.05 per unit at no load.
- Voltage at the 46 kV substation should not dip below 0.85 per unit (0.9 preferred) during transfer inrushes.
- Voltage at the 6.9 kV buses should not dip below 0.7 per unit during the bus disconnect time or during the transfer inrush. This is to ensure against control relay dropout, starter contactor dropout, or other control device misoperation.
- Existing equipment nameplate or latest shop drawing data will be utilized as necessary in the studies.
- Future transformer impedance data will consider manufacturing tolerances of ±7.5 percent of nominal design impedance, and the X/R ratio will be 40.
- The startup boiler feed pump may be revised from one 7,000-horsepower (hp) motor to two 8,000-hp motors. The fault and transfer surge studies will include this potential change.
- Switchgear fault interrupting ratings shall not be exceeded during the transfer. All loads shall be considered connected during the transfer.
- The draft fan drives shall remain in normal operation after transfer.

3.3 ANALYSIS

3.3.1 Auxiliary Electric System Design and Bus Transfer Methods

Large unit-connected generating systems utilizing reserve auxiliary transformers as startup and backup power source are generally designed so that the maximum unit auxiliary load can be supported by the reserve auxiliary transformer at its maximum rating. The criteria for selecting

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transformer impedance include auxiliary bus normal operating voltages, voltages during motor starting, and fault currents. Generally, normal operating bus voltages should not exceed 110 percent of motor rated voltage and should not be less than 95 percent of bus nominal voltage. When starting the largest motor of a bus with all other loads running, voltage at the motor should not decay to a value less than the motor starting design voltage. The bus fault currents must not exceed the switchgear ratings when the reserve auxiliary transformer fault source is a maximum and all loads are connected.

To meet the criteria, the final design usually utilizes two 3-winding reserve auxiliary transformers and four main buses, each connected to one secondary winding and rated for 500 MVA fault duty. The reserve auxiliary transformer source is usually high fault capacity and through fault contribution to each switchgear bus is limited to less than 300 MVA. This design basis combined with the fact that the motor loads include high inertia drives and time delay constants that support bus voltage during a source disconnect, and the use of fast closing stored energy breakers have led to use of fast bus transfer of loads from the main auxiliary transformers to the reserve auxiliary transformers during unit trips. Table 3-1 indicates some of the plants that incorporate fast transfer schemes, including the Northern States Power SHERCO 3 plant which has variable frequency ID fan drives. All fast transfers at SHERCO 3 have been successful and there has been no loss of the ID fan drives due to the fast transfer.

There are three types of automatic load transfers in general use: fast transfer, in-phase transfer, and residual bus voltage transfer. For the fast transfer, the main auxiliary transformer bus breaker is commanded open with a simultaneous close command to the reserve auxiliary transformer breaker. The main breaker will open prior to the reserve breaker closing and, during this disconnect period (three to four cycles), the bus voltage will decay and its phase angle relation to the source voltage will increase as the motor speeds decrease. When the reserve breaker closes, the phasor difference in bus voltage and source voltage will appear as a

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TABLE 3-1. SELECTED PLANTS THAT INCORPORATE FAST TRANSFER SCHEMES

Plant	Transfer Scheme	Auxiliary Electric System Size MVA	Variable Speed Drives	Initiation From
OUC	Fast	30	N	86G
PSO-NE3	Fast*	35	N	86G
IIGE-Louisa	Fast**	40	N	86G
Coal Creek	Fast	40	N	86G, 286G
SHERCO 3	Fast	40	Y (IDF)	86G, 286G W/25B, Fast Synch Check***
Sherco 1 and 2	Fast	46	N	86G
Jeffrey	Fast	50	N	86G

*If fast transfer is not successful, slow transfer is attempted. Fast is supervised by a synchro-verifier. Reserve source is separate from generator substation and can be out-of-phase. If fast transfer is missed, fans are tripped and a voltage controlled transfer to keep circulating water pumps on is made.

**Same as PSO-NE, but a fast/slow selector switch is provided to lock out fast transfer scheme. Supervised by GE solid-state high-speed synch check; if transfer is missed, then a voltage controlled transfer is initiated.

***Synch check was GE SLJ, Model 12SLJ21A1A, under volts 96.

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transient voltage across the system impedances causing high inrush currents. These currents may exceed normal motor starting values and overstress the motors. In order for the fast transfer to be successful, the differential or resultant voltage should be kept below 1.33 per unit volts per Hz. Fast transfers generally result in less than 1.0 per unit volts per Hz and surge currents from two to four times motor full load amperes. Normal motor starting currents are approximately 4 to 6 times the motor full load amperes. Due to the high MVA source capability and relatively low transformer impedance compared to the total system impedance, the auxiliary bus voltage dip is not excessive, and the fast transfer is accomplished without loss of auxiliaries or motor excessive torques.

For the in-phase transfer, the bus residual voltage is monitored after the main breaker opens. The reserve breaker is then closed when the phase angle of the bus voltage is in phase with the reserve source. This method requires a high-speed synchro-closing device which also anticipates breaker closing time, and must wait until the bus voltage angle has increased due to the motor speed decay to a point nearly in phase with the source voltage. The time duration will be generally greater than 30 cycles and voltage will be less than 60 percent. The inrush currents will tend to be less than a fast transfer, but will last longer due to reacceleration of the motor load from a lower speed. A potential problem with in-phase transfer is the low voltage level reached and possible loss of control devices, motor stalling, or loss of motor synchronization to the system. For this method to be successful, the bus residual voltage must remain at high levels necessary to maintain motor synchronization and control device operation.

For the residual bus voltage transfer, the bus voltage magnitude is monitored and, when it reaches 25 percent, the reserve breaker is closed. With this transfer, the motors will be protected against excessive currents and torques, but the system must reaccelerate the motors from a relatively low speed. This procedure is similar to starting all motors at once. Inrush currents in the reserve auxiliary transformer will be very

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large with resulting high voltage drop. The system voltage will then be quite low for a long period of time and may cause excessively long acceleration periods and subsequent motor overheating. In addition, some control devices will drop out due to the low voltage. For this transfer to be successful, voltage controlled load shedding must precede the reserve breaker closing.

A manual transfer scheme is used for normal load transfers. The reserve breaker is manually closed and then the main breaker is manually opened. The closing is supervised by a synch-check relay. A warning alarm sounds during the time both breakers are closed to alert the operator to open the main or reserve breaker. The alarm is necessary because the bus fault MVA will be significantly exceeded by the combination of the two power sources. In addition, high circulating currents will occur between the parallel windings of the two transformers.

The residual voltage and in-phase transfer methods will not meet the criteria for this study because, in each case, the voltage will decay to such low values that the draft fans cannot continue to operate and provide a gas path in the steam generators. This conclusion is evident by inspection of the bus residual voltage fault recorder graphs after the main breakers were tripped by an 86GT. In the case of the large motor buses the voltage reaches approximately 20 percent prior to an in-phase condition. Thus, the transfer will be a voltage controlled transfer, which requires load shedding, and therefore, little certainty of maintaining plant auxiliary operation.

Since the in-phase and low residual voltage transfers cannot meet the study criteria, the fast transfer method is recommended. The reserve transformer system should be designed to be similar to a normal configuration, as discussed above, in order to ensure successful fast transfers and normal operations. This consideration would include a system with two 3-winding reserve transformers per unit connected to a high capacity source; however, the study criteria requires only the successful transfer of normal running loads and not the capacity to supply the total maximum

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plant load. Therefore, a reduced capacity system is considered to decrease costs. A single 2-winding transformer was considered, but the combined motor contribution to a fault would then require an excessively high transformer impedance. For this reason, a single 3-winding reserve transformer is selected as the minimum reserve source configuration. Studies are then made to determine its impedance in conjunction with the 46 kV source capacity.

3.3.2 Reserve Auxiliary Transformer Loading

The auxiliary electric nontransient load prior to and after a unit trip is plotted on Figure 3-1. The data were derived from the isochronous operation tests performed on April 9, 1987. The load is approximately 40 MW during normal operation; after the unit trip, the load cycles from 35 MW to 22 MW before stabilizing at 22 MW. The cyclic nature of the load is due to the ID fans responding to the unit trip and is shown by the fan speed plotted on the same figure. Since the 40 MW load is approximately half the original estimated unit auxiliary load, the reserve auxiliary transformer primary winding capacity rating was selected to be the same as half the total main auxiliary transformer capacity or 36/48/60 OA/FA/FOA MVA. Throughout this study, all transformer impedances are based upon the 18 MVA OA rating of one of the two equal capacity secondary windings.

The ac transient loads occurring during a fast transfer were estimated in two ways.

The first iteration of load flow calculations was made utilizing two and four times running MVA for approximation of the transient loading. Subsequently, a more detailed calculation was made to verify the selected transformer impedances by estimating the auxiliary bus residual voltages, modeling the motors and SUS loads as a lumped impedance, and using the load flow program to calculate system resultant voltages and power flows. The motors that remain on the bus after a trip were determined by review of the 86G and 86GT trip outputs. Table 3-2 is a list of breakers tripped.

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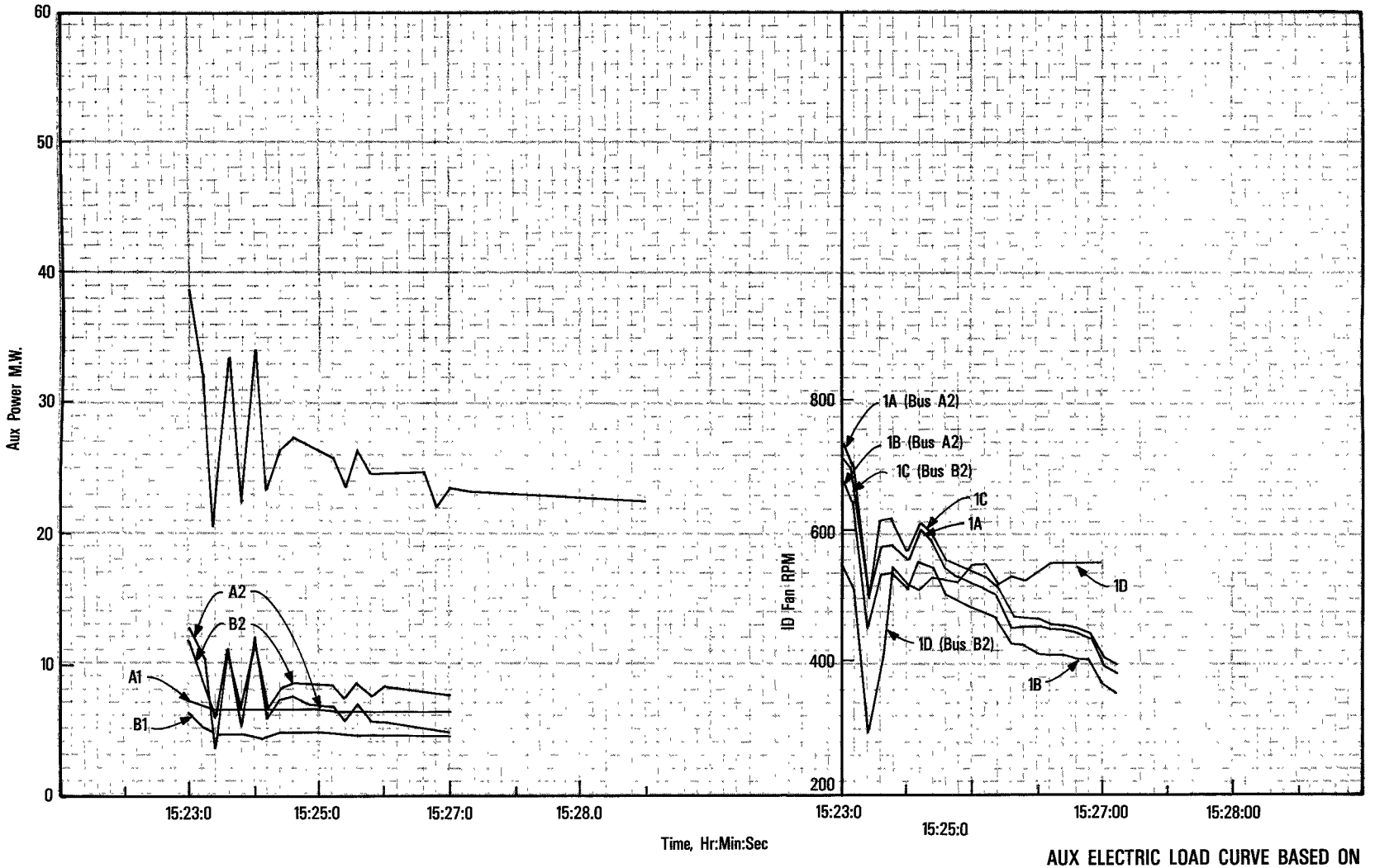

AUX ELECTRIC LOAD CURVE BASED ON
ISOCHRONOUS OPERATION TEST
LOAD CURVE FOLLOWING UTR TRIP

Figure 3-1

AUXILIARY ELECTRIC SYSTEM	EXPANSION STUDY	FILE NO. 15119.42.0412
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TABLE 3-2. LIST OF BREAKERS TRIPPED

Equipment Name	Horsepower	Tripped By 86G	Tripped By 86GT	Undervoltage Trip
Closed Cycle Cooling Water Pump	500	N		Y*
Air Compressor	700	N		Y*
Pulverizer	800	Y**		Y*
Circulating Water Pump	2,000	N		Y (8 SEC TD)
Condensate Pump	1,750	N		N
Primary Air Fan	2,100/4,000	Y**		N
Forced Draft Fan	2,750/6,500	N***		N
Induced Draft Fan	7,500	N		Y (Internal to IDF)
Standby Boiler Feed Pump	7,000	N		N
Conveyor 18A (18B Unit 2)	400	N		N
Fly Ash Compressor	700	N		N
Turbine Lube Oil Flush Pump	400	N		N
Booster Boiler Feed Pump	600	N		N
Scrubber High-Pressure Spray Pump	500	N		Y* (Bus Feeder Breaker is Tripped.)
Scrubber Low-Pressure Spray Pump	500	N		Y* (Bus Feeder Breaker is Tripped.)
Limestone Pulverizer	600	N		Y* (Bus Feeder Breaker is Tripped.)
Coal Handling Bus		N		Y* (Bus Feeder Breaker is Tripped.)
345 kV Generator Breaker			Y	
26 kV Generator Breaker			Y	
86G			Y	
Switchgear Main Breakers			Y	

*Trip occurs when both Bus 1A1 and 1B1 undervoltage relays (27A and 27B) are dropped out and both Bus 1A1 and 1B1 main breakers are open. Bus undervoltage relays drop out after 28 cycles at 55 volts or less.

**Via unit trip relay.

***Via unit trip relay plus furnace pressure high.

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3.3.3 Load Flow and Fault Calculations

The Electrocon International, Inc., Power Flow Program, Version 3.02, for personal computers was used to make calculations for the estimation of system voltages during normal power flow conditions, during the fast transfer of loads, and during motor starting. The calculated cases are listed in Table 3-3.

The program was used to calculate voltages during the fast transfer in two ways as described in Subsection 3.3.2. This subsection discusses the MVA approximation cases and Subsection 3.3.5 will discuss the bus residual voltage calculations. The motor starting calculations are discussed in Subsection 3.3.6.

The Electrocon International, Inc., Short-Circuit Program, Version 3.10, for personal computers was used to calculate fault currents for various transformer impedances selected to ensure that fault capacity of the 6.9 kV switchgear was not exceeded. The calculated cases are listed in Table 3-4.

The results of selected cases are shown on the system one-line diagram figures in Appendix A.

Equipment impedances used in the load flow and fault studies are listed in Appendix B.

Initial load flow calculations were made based upon utilizing the existing 46 kV transformers as the source to the new reserve auxiliary transformers. Figure A-1 shows the voltages for a single unit's load of 20 and 40 MW when both 46 kV transformers are in service, while Figure A-2 shows the voltages for a two-unit load when each is loaded at 20 and 40 MW. When larger megawatt loads (60 and 80 MW) were used to approximate transfer surges, the program would not converge on a solution due to excessive system voltage drops. At this point, the system was considered unsuitable for supporting adequate bus voltage at the 46 kV bus during a transfer or a potential 40 MW post trip load.

In Figure A-2, the 46 kV bus voltage at 40 MW load per unit is below 0.90 per unit and does not meet the criteria for a 0.95 per unit voltage.

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TABLE 3-3. LOAD FLOW CALCULATIONS

Case	Source MVA	46 kV Transformer MVA/Z_{NOM}	46 kV Transformer Connection	Substation and Yard Load MW	Reserve Transformer MVA/Z_{NOM}	Unit Load, MW or Fast Transfer or Motor Start	Units Connection	Comments
IGSPF5B	Infinite	30/10.5/11.0	0	0	18/6.8	81	1	Base Case
IGSPF9A	Infinite	30/10.8	2	0	18/6.8	20	1	Figure A-1
IGSPF7A	Infinite	30/10.8	2	0	18/6.8	20	2	Figure A-2
IGSPF9E	Infinite	30/10.8	2	0	18/6.8	40	1	Figure A-1
IGSPF8D	Infinite	30/10.8	2	0	18/6.8	40	2	Figure A-2
IGSPF9F	Infinite	30/10.8	2	0	18/6.8	0	2	Figure A-2
IGSPF19E	6,000	30/10.8	2	16	18/6.8	FT	2	
IGSPF19F	12,000	30/10.8	2	16	18/6.8	FT	2	
IGSPF19I	6,000	30/10.8	2	16	18/6.8	FT	1	
IGSPF19J	12,000	30/10.8	2	16	18/6.8	FT	1	
IGSPF11A	Infinite	30/10.8	3	0	18/6.4	0	2	
IGSPF11B	Infinite	30/10.8	3	0	18/6.4	20	2	
IGSPF11C	Infinite	30/10.8	3	0	18/6.4	40	2	
IGSPF11D	Infinite	30/10.8	3	0	18/6.4	60	2	
IGSPF8J	Infinite	40/6.0	2	0	18/6.8	0	1	
IGSPF8K	Infinite	40/6.0	2	0	18/6.8	20	1	Figure A-3
IGSPF8L	Infinite	40/6.0	2	0	18/6.8	40	1	Figure A-3
IGSPF8M	Infinite	40/6.0	2	0	18/6.8	60	1	Figure A-3
IGSPF8N	Infinite	40/6.0	2	0	18/6.8	80	1	Figure A-3
IGSPF8K2	Infinite	40/6.0	2	0	18/6.8	20	2	Figure A-4
IGSPF8L2	Infinite	40/6.0	2	0	18/6.8	40	2	Figure A-4
IGSPF8M2	Infinite	40/6.0	2	0	18/6.8	60	2	Figure A-4
IGSPF8N2	Infinite	40/6.0	2	0	18/6.8	80	2	Figure A-4 Did Not Converge
IGSPF10A	Infinite	None	--	0	18/8.2	40	2	
IGSPF13A	Infinite	50/5.5	2	11	18/7.1	20	2	Figure A-5
IGSPF13B	Infinite	50/5.5	2	11	18/7.1	40	2	Figure A-5
IGSPF13C	Infinite	50/5.5	2	11	18/7.1	60	2	Figure A-5
IGSPF13D	Infinite	50/5.5	2	11	18/7.1	80	2	Figure A-5
IGSPF12A	Infinite	50/5.5	2	11	18/7.1	80	1	

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TABLE 3-3 (Continued). LOAD FLOW CALCULATIONS

Case	Source MVA	46 kV Transformer MVA/Z_{NOM}	46 kV Transformer Connection	Substation and Yard Load MW	Reserve Transformer MVA/Z_{NOM}	Unit Load, MW or Fast Transfer or Motor Start	Units Connection	Comments
IGSPF14A	Infinite	50/5.5	1	16	18/7.1	20	2	Figure A-6
IGSPF14B	Infinite	50/5.5	1	16	18/7.1	40	2	Figure A-6
IGSPF14C	Infinite	50/5.5	1	16	18/7.1	60	2	Figure A-6 Did Not Converge
IGSPF19G	6,000	50/5.5	2	16	18/7.1	FT	2	
IGSPF19H	12,000	50/5.5	2	16	18/7.1	FT	2	
IGSPF19K	6,000	50/5.5	2	16	18/7.1	FT	1	
IGSPF19L	12,000	50/5.5	2	16	18/7.1	FT	1	
IGSPF19M	6,000	50/5.5	1	16	18/7.1	FT	1	
IGSPF19N	12,000	50/5.5	1	16	18/7.1	FT	1	
IGSPF19O	6,000	50/5.5	1	16	18/7.1	FT	2	
IGSPF21A	6,000	50/5.5	1	16	18/7.1	MS/8,000 HP	2	
IGSPF21B	12,000	50/5.5	1	16	18/7.1	MS/8,000 HP	2	
IGSPF21C	6,000	50/5.5	2	16	18/7.1	MS/8,000 HP	2	
IGSPF21D	12,000	50/5.5	2	16	18/7.1	MS/8,000 HP	2	
IGSPF22A	6,000	50/5.5	1	16	18/7.1	MS/6,500 HP	2	
IGSPF22B	12,000	50/5.5	1	16	18/7.1	MS/6,500 HP	2	
IGSPF22C	6,000	50/5.5	2	16	18/7.1	MS/6,500 HP	2	
IGSPF22D	12,000	50/5.5	2	16	18/7.1	MS/6.500 HP	2	
IGSPF23A	6,000	50/5.5	1	16	18/7.1	20	2	
IGSPF23B	12,000	50/5.5	1	16	18/7.1	20	2	
IGSPF23C	6,000	50/5.5	2	16	18/7.1	20	2	
IGSPF23D	12,000	50/5.5	2	16	18/7.1	20	2	
IGSPF15A	Infinite	100/5.5	1	16	18/7.6	20	2	Figure A-7
IGSPF15B	Infinite	100/5.5	1	16	18/7.6	40	2	Figure A-7
IGSPF15C	Infinite	100/5.5	1	16	18/7.6	60	2	Figure A-7
IGSPF15D	Infinite	100/5.5	1	16	18/7.6	80	2	Figure A-7 Did Not Converge
IGSPF16A	Infinite	100/5.5	2	16	18/7.6	20	2	Figure A-8
IGSPF16B	Infinite	100/5.5	2	16	18/7.6	40	2	Figure A-8

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TABLE 3-3 (Continued). LOAD FLOW CALCULATIONS

Case	Source MVA	46 kV Transformer MVA/Z_{NOM}	46 kV Transformer Connection	Substation and Yard Load MW	Reserve Transformer MVA/Z_{NOM}	Unit Load, MW or Fast Transfer or Motor Start	Units Connection	Comments
IGSPF16C	Infinite	100/5.5	2	16	18/7.6	60	2	Figure A-8
IGSPF16D	Infinite	100/5.5	2	16	18/7.6	80	2	Figure A-8
IGSPF19C	6,000	100/5.5	1	16	18/7.6	FT	2	Figure A-11
1ISPF19D	12,000	100/5.5	1	16	18/7.6	FT	2	Figure A-11
IGSPF15E	6,000	100/5.5	1	16	18/7.6	MS/8,000 HP	2	Figure A-13
IGSPF15F	12,000	100/5.5	1	16	18/7.6	MS/8,000 HP	2	Figure A-13
IGSPF15G	6,000	100/5.5	1	16	18/7.6	MS/6,500 HP	2	Figure A-14
IGSPF15H	12,000	100/5.5	1	16	18/7.6	MS/6,500 HP	2	Figure A-14
IGSPF20A	6,000	100/5.5	1	16	18/7.6	20	2	Figure A-12
IGSPF20B	12,000	100/5.5	1	16	18/7.6	20	2	Figure A-12
IGSPF19Q	6,000	50/5.5	1	16	18/7.6	FT	2	Figure A-19 Includes STUBFP
IGSPF14A2	Infinite	50/5.5	1	16	18/7.6	20	2	Figure A-17
IGSPF14B2	Infinite	50/5.5	1	16	18/7.6	40	2	Figure A-17
IGSPF19P	6,000	100/5.5	1	16	18/8.0	FT	2	Figure A-20 Includes STUBFP
IGSPF15A2	Infinite	100/5.5	1	16	18/8.0	20	2	Figure A-18
IGSPF15B2	Infinite	100/5.5	1	16	18/8.0	40	2	Figure A-18
IGSPF21G	6,000	50/5.5	1	16	18/7.6	MS/2,000 HP	2	
IGSPF21H	12,000	50/5.5	1	16	18/7.6	MS/2,000 HP	2	

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TABLE 3-4. FAULT CALCULATIONS

Case	Source MVA	46 kV Transformer MVA/Z_{NOM}	46 kV Transformer Connection	Reserve Transformer MVA/Z_{NOM}	Units Connection	Comments
IPPIGS8	27,209	--	--	--	--	Base Data
IPPIGS7	27,209	--	--	--	--	Unit 1 and 2, Main Auxiliary Transformers in Service
IPPIGS6	27,209	30/10.8	2	18/6.8	2	
IPPIGS9	27,209	30/10.8	2	18/6.8	2	Simplified Model
IPPIGS10	27,209	40/6.0	2	18/6.8	2	
IPPIGS5	27,209	--	0	18/8	2	345 kV Reserve Transformer
IPPIGS15	27,209	30/10.8	3	18/6.4	2	
IPPIGS14	27,209	50/5.5	2	18/7.1	2	Figure 9
IPPIGS13	27,209	100/5.5	2	18/7.6	2	Figure 10
IPPIGS17	27,209	100/5.5	2	18/7.6	2	All SUSs Updated to Nameplate
IPPIGS18	27,209	100/5.5	2	18/7.6	2	Future 8,000-hp SBFPs Added
IPPIGS19	27,209	50/5.5	2	10/7.1	2	Future 8,000-hp SBFPs Added
IPPIGS20	27,209	100/5.5	2	18/8.0	2	Future 8,000-hp SBFPs Added Figure 15
IPPIGS21	27,209	50/5.5	2	18/7.6	2	Future 8,000-hp SBFPs Added Figure 16

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In addition, the criteria require only one 46 kV transformer in service and the transformer taps were set low to offset the expected large voltage drops which then gives an excessive no load voltage of 1.09 P.U. at the 6.9 kV buses.

These results indicate that a larger capacity (larger fault MVA available) 46 kV bus is required to support the 46 kV bus voltage during a two-unit load transfer and post trip loading of up to 40 MVA.

The next calculation was made utilizing a third 30 MVA transformer in parallel with the existing units in order to increase the bus capacity. This transformer would require 10.8 percent impedance to operate in parallel with the existing transformers without excessive circulating currents. However, initial calculations indicated that the source capacity was still too low and the potential problems of operating three transformers in parallel eliminated this configuration.

Because the use of the existing transformers is not practical, the 46 kV source capacity should be increased by providing two new identical transformers of larger MVA capacity and lower impedance. A configuration of two 40 MVA transformers at 6.0 percent nominal impedance was studied. Figure A-3 shows the results of two 40 MVA transformers connected to one unit at various loads, while Figure A-4 shows the results when two units are connected. The results are improved, but still not acceptable even with both 46 kV transformers connected. In addition, the 46 kV tap is still set too low to give acceptable no load voltage at the 6.9 kV buses.

The 46 kV transformer capacity was increased to 50 MVA and the impedance was reduced to a 5.5 nominal percent, which is a minimum practical value, to further increase the 46 kV bus capacity. This configuration exceeds the fault capacity of the existing substation equipment. This capacity increase required that the reserve auxiliary transformer impedance be increased from 6.8 percent to 7.1 percent nominal to limit total fault current at the 6.9 kV buses. The 46 kV transformer taps were also revised so that no load voltages at the 6.9 kV buses would be acceptable.

Figure A-5 shows the results for the two 50 MVA transformers connected to two units at 20, 40, 60, and 80 MW loads, while serving a 46 kV

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bus load of 11 MW for the coal unloading thaw shed and miscellaneous yard loads. For this calculation, the two transformers were modeled as one 100 MVA transformer.

Figure A-6 shows the results for one 50 MVA transformer connected to two units at 20 and 40 MW loads. The 46 kV bus load was revised from 11 MW to 16 MW to include the converter stations and substation relay house bus loads.

These results indicate that 100 MVA of capacity will meet the criteria for supporting post trip loads and would support the estimated 80 MW surge during the fast transfer. Although the 6.9 kV buses reach 0.65 per unit voltage minimum, the actual bus voltage is not expected to drop below 0.7 per unit as discussed later. This low voltage is a result of the use of an 80 MW load model to estimate the surge voltages.

When only one 46 kV 50 MVA transformer is placed in service, the system will not support the expected surge load, and will not support voltages during 40 MW post trip loading.

Because a 100 MVA transformer capacity will meet the criteria, the next configuration utilizes two 100 MVA transformers at 5.5 percent nominal impedance. Figure A-7 shows the results for one 100 MVA 46 kV transformer connected to two units at 20, 40, and 60 MW loadings. At 80 MW load, the program would not converge due to the increase in the reserve auxiliary transformer impedance from 7.1 to 7.6 percent nominal. However, the voltage at the 46 kV bus is expected to be the same as calculated on Figure A-5. The increase in the reserve transformer impedance was required to limit fault currents at the 6.9 kV buses. The 6.9 kV bus voltages are slightly lower than those on Figure A-5 but are adequate.

Figure A-7 shows the results for the case when the two 100 MVA transformers are paralleled and indicates that all voltage criteria are met.

The fast transfer method of calculation, discussed later, also indicates good results for this configuration as shown on Figure A-11.

This configuration will meet the criteria; therefore, a modified load flow was run to check voltages during a two-unit post trip condition after

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the load has stabilized. The loading is approximately 20 MW per unit and the source MVA is at minimum and probable values of 6,000 MVA and 12,000 MVA, respectively. The results are shown on Figure A-12 and indicate all voltages near nominal when a single 100 MVA transformer is connected to both units.

Due to the possible addition of two new 8,000-hp startup boiler feed pumps, fault calculations required that the reserve transformer nominal impedance be raised from 7.6 percent to 8.0 percent if 100 MVA 46 kV transformers are used. This increase in impedance will not affect voltages at the 46 kV bus appreciably but will change the 6.9 kV bus voltage during normal loading. Figure A-18 shows the results of 20 and 40 MW loadings with this increased impedance. When compared to Figure A-7, the results show the 6.9 kV bus voltages are essentially unchanged.

Because the 100 MVA transformer at 5.5 percent nominal impedance will meet the study criteria for voltage drops during expected transients and post trip loading, the case of two 50 MVA transformers at 5.5 percent nominal impedance is an alternative configuration for the criteria of only one unit tripping when only one 50 MVA transformer is in service. If the two parallel 50 MVA transformers configuration is utilized, the reserve auxiliary transformer impedance must be increased from previous study values of 7.1 percent to 7.6 percent to account for the possible startup boiler feed pump revision.

The voltages for this case at 20 and 40 MW loadings with one 50 MVA transformer in service are shown on Figure A-17. At 20 MW loading, the criteria for voltages are met and the 46 kV transformer capacity would not be exceeded. If loading is increased to 40 MW per unit, then voltage criteria are not met and thermal capacity of the transformer is exceeded. As discussed later, a fast transfer calculation for this configuration was also made and the voltages did not meet the criteria.

In conjunction with the load flow calculations, fault calculations are required to determine fault currents at the 46 kV and 6.9 kV buses to ensure that equipment ratings are not exceeded and, if they are exceeded, corrective action recommended.

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Based upon the existing 6.9 kV bus equipment ratings, X/R ratios calculated in accordance with ANSI C37.010, and X/R multiplying factors derived from ANSI, the maximum allowable interrupting current is 33,081 amperes RMS. The close and latch rating of 70,000 amperes also must not be exceeded. Initial calculations show that in order to not exceed 70,000 amperes, the motor contribution to the 6.9 kV faulted bus must not exceed approximately 16,500 amperes when calculated for interrupting rating. It was not expected that 16,500 amperes motor contribution would be exceeded and, therefore, total fault currents at 33,081 amperes would be considered acceptable.

The 46 kV bus fault currents are also calculated and are expected to exceed the existing equipment ratings for certain cases; however, it is anticipated that the 46 kV bus will be rebuilt and the new design must incorporate the expected new fault currents.

Figure A-9 shows the results of fault studies for the case of two 50 MVA transformers connected to both units, prior to inclusion of the possible 8,000-hp startup boiler feed pumps. Figure A-10 shows the results for the case of two 100 MVA transformers. Figure A-9 indicates that Buses 1A1 and 2A1 exceed the criteria by a half percent but this is not considered significant enough to revise the transformer impedance.

The case for Figure A-10 was calculated with secondary unit substation transformer impedances revised to nameplate conditions and the fault currents were recalculated at all secondary unit substations (SUSs) as a check. The fault currents at the SUSs were slightly less than original design values due to the nameplate impedance being greater than the design allowance impedance. The result for SUS C21 is shown as typical.

Additional calculations were made to include the possible new startup boiler feed pumps. The results indicated that the 6.9 kV bus fault criteria would be exceeded significantly; therefore, calculations were made to determine an appropriate reserve transformer impedance.

Figures A-15 and A-16 show the results for the case of two 100 MVA and two 50 MVA transformers, respectively. There is a 0.9 percent higher

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fault current than the criteria value, but this is not considered significant enough to revise the impedances.

Although not included in this study, the fault currents at the dc substation, relay house, ash recycle pumphouse, and thaw shed service entrance equipment must not exceed the equipment's interrupting ratings. A review of the equipment ratings indicated that the ratings are not exceeded.

3.3.4 Auxiliary Electric System Bus Residual Voltage

As indicated in Subsection 3.3.1, the bus residual voltage is the primary factor in determining the suitability of the fast transfer scheme and the resultant voltages across the system impedances. The bus residual voltage is the voltage measured at the 6.9 kV bus after the main auxiliary source is disconnected and is determined by the characteristics of the connected motors and their mechanical load. When disconnection occurs, those motors that have larger time constants tend to support the bus voltage and supply excitation current to those motors that have smaller time constants. The net effect is that the voltage measured at the bus will decay at some intermediate rate and the system is held in synchronization until voltage reaches about 20 percent. The system frequency will decay as the motors slow down. The frequency decay is determined by the energy stored in the rotating masses and its transfer to the connected loads. The motors with larger inertias will supply the majority of energy to the smaller inertia motor loads and the resultant decay in speed and frequency is primarily dependent upon the larger inertia loads.

Calculation of individual motor voltages, motor speeds, and resultant residual bus voltage and frequency is not possible by any but the most complex digital computer programs. Such programs are not commercially available at this time. Papers indicating the results of fast transfer tests and of those of calculations made by proprietary programs are available for comparison and generalization as to expected voltages. EPRI

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report EL 4286 VII, Improved Motors for Utility Applications, Bus Transfer Studies presents the fast transfer technique in detail including the effects of variable frequency drives. In comparing the results of the EPRI report for bus load data similar to the bus load data in Tables 3-5 through 3-8, residual voltages characteristics can be generalized.

It would be expected for Buses 1A1 and 1B1 that the voltage decay would be gradual since the open circuit time constants are of a typical value, but due to relative low inertia constant, the frequency decay would be faster than average. Buses 1A2 and 1B2 would have voltage decay similar to Buses 1A1 and 1B1. Because the ID fan drive is a variable frequency drive and does not contribute energy to the bus during a transfer and the other major source of inertia (the primary air (PA) fans) is tripped under the bus transfer condition, the frequency decay would also be faster than average and similar to the low inertia Buses 1A1 and 1B1.

Nevertheless, the residual voltage is expected to be of a value and phase angle that will allow a fast transfer without producing excessive motor currents and torques. Fortunately, bus voltage plots are available which show the actual bus voltages after a unit trip. Bus main breaker trip times are also shown on these plots. These plots allow determination of the bus residual voltage and phase angle for typical bus loadings which support the generalization made above. The referenced plots are from the plant RIS TR-1620 digital fault recorder and are for events on April 27 and November 24, 1988, and January 2, 1989.

The voltage plots are nearly identical for the bus disconnect time under consideration. The April 27 plot (Figure 3-2) was analyzed to determine voltage, phase angle, and frequency at the moment of closing the new reserve source breaker following the main breaker trip.

The new circuit breaker rated closing time is expected to be a maximum of nine cycles, while the opening time of the existing main breakers as shown by chart traces is approximately five cycles (cycles are on 60 Hz basis); therefore, the bus disconnect time is four cycles. The residual voltage and angle for Buses 1A1 and 1B1 are 0.73 per unit at -55 degrees

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TABLE 3-5. SWITCHGEAR 1A1 MOTOR AND LOAD DATA

Application	Quantity	HP	KVA	RPM	FLA	LRA	WK^2	H	Load Torque	TOC	TSC	Xd"
Pulverizer	4	800	793	900	69	391			4,748			0.178
Air Compressor	1	700	683		57	343						0.167
Closed Cycle Cooling Water Pump	1	500	448	900	40	237	1,675	0.70	2,936	1.13		0.167
480 Volt SUS	12		489		41	245						0.167
Switchgear 1A3												
Scrubber Spray Pump	9	500	431	1,800	37	235	625	1.08	4,735	2.73		0.157
Limestone Pulverizer	1	600	534	1,200	47	336	2,765	1.72	2,643	1.35		0.140
480 Volt SUS	4		489		41	245						0.167

NOTES:

(1) No detailed data available on air compressor motor, pulverizer motors, or 480 volt SUS.

(2) $H = (2.31 \times 10^{-7})\ (WK^2)\ (RPM)^2/kVA$.

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TABLE 3-6. SWITCHGEAR 1A2 MOTOR AND LOAD DATA

Application	Quantity	HP	KVA	RPM	FLA	LRA	WK^2	H	Load Torque	TOC	TSC	Xd"
Forced Draft Fan	1	6,500	5,921	900	508	3,043	61,436	1.94	20,123	1.55	0.1	0.17
Primary Air Fan	1	4,000	3,459	1,200	302	1,945	161,595	15.5	17,582	2.29	0.113	0.168
Circulating Water Pump	1	2,000	1,961	450	179	1,002	6,500	0.155	24,131	0.87		0.179
Condensate Pump	2	1,750	1,535	1,200	132	858	2,461	0.533	7,726	1.29	0.06	0.154
Boiler Feed Pump (Existing)	1	7,000	5,853	1,800	512	3,246	3,892	0.498	20,516	3.49	0.11	0.17
Boiler Feed Pump (Future)	1	8,000	6,693	1,800	585	3,709	4,000	0.510	23,446	3.49	0.11	0.17
Booster Boiler Feed Pump	1	600	532	1,800	46	279	460	0.647	3,838	1.8		0.165
Fly Ash Compressor	1	700	585	3,600	51	336	852	0.435	1,027	2.05		0.152
Belt Conveyor	1	400	323	1,800	27	162				0.55		0.167
Induced Draft Fan	2	7,500			538	538						
480 Volt SUS	1		1,785		149	896				0.5		0.167

NOTES:

(1) The circulating water pump motor is rated at 2,050 hp in the motor data.

(2) No detailed data available on belt conveyor motor or 480 volt SUS.

(3) $H = (2.31 \times 10^{-7})\ (WK^2)\ (RPM)^2/kVA$.

(4) The induced draft fan is a variable frequency drive.

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TABLE 3-7. SWITCHGEAR 1B1 MOTOR AND LOAD DATA

Application	Quantity	HP	KVA	RPM	FLA	LRA	WK^2	H	Load Torque	TOC	TSC	Xd"
Pulverizer	1	800	793	900	69	391			4,748			0.178
Air Compressor	1	700	683		57	343						0.167
Closed Cycle Cooling Water Pump	4	500	448	900	40	237	1,675	0.70	2,936	1.13		0.167
480 Volt SUS	10		489		41	245						0.167
Switchgear 1B3												
Scrubber Spray Pump	9	500	431	1,800	37	235	625	1.08	4,735	2.73		0.157
Limestone Pulverizer	1	600	534	1,200	47	336	2,765	1.72	2,643	1.35		0.140
480 Volt SUS	3		489		41	245						0.167

NOTES:

(1) No detailed data available on air compressor motor, pulverizer motor, or 480 volt SUS.

(2) $H = (2.31 \times 10^{-7})\ (WK^2)\ (RPM)^2/kVA$.

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TABLE 3-8. SWITCHGEAR 1B2 MOTOR AND LOAD DATA

Application	Quantity	HP	KVA	RPM	FLA	LRA	WK^2	H	Load Torque	TOC	TSC	Xd"
Forced Draft Fan	1	6,500	5,921	900	508	3,043	61,436	1.94	20,123	1.55	0.1	0.17
Primary Air Fan	1	4,000	3,459	1,200	302	1,945	161,595	15.5	17,582	2.29	0.113	0.168
Circulating Water Pump	2	2,000	1,961	450	179	1,002	6,500	0.155	24,131	0.87		0.179
Condensate Pump	1	1,750	1,535	1,200	132	858	2,461	0.533	7,726	1.29	0.06	0.154
Boiler Feed Pump (Future)	1	8,000	6,693	1,800	585	3,709	4,000	0.510	23,446	3.49	0.11	0.17
Booster Boiler Feed Pump	2	600	532	1,800	46	279	460	0.647	3,838	1.8		0.165
Fly Ash Compressor	2	700	585	3,600	51	336	852	0.435	1,027	2.05		0.152
Induced Draft Fan	2	7,500			538	538						
480 Volt SUS	1		1,785		149	896				0.5		0.167

NOTES:

(1) The circulating water pump motors are rated at 2,050 hp in the motor data.

(2) No detailed data available on belt conveyor motor or 480 volt SUS.

(3) $H = (2.31 \times 10^{-7})\ (WK^2)\ (RPM)^2/kVA$.

(4) The induced draft fan is a variable frequency drive.

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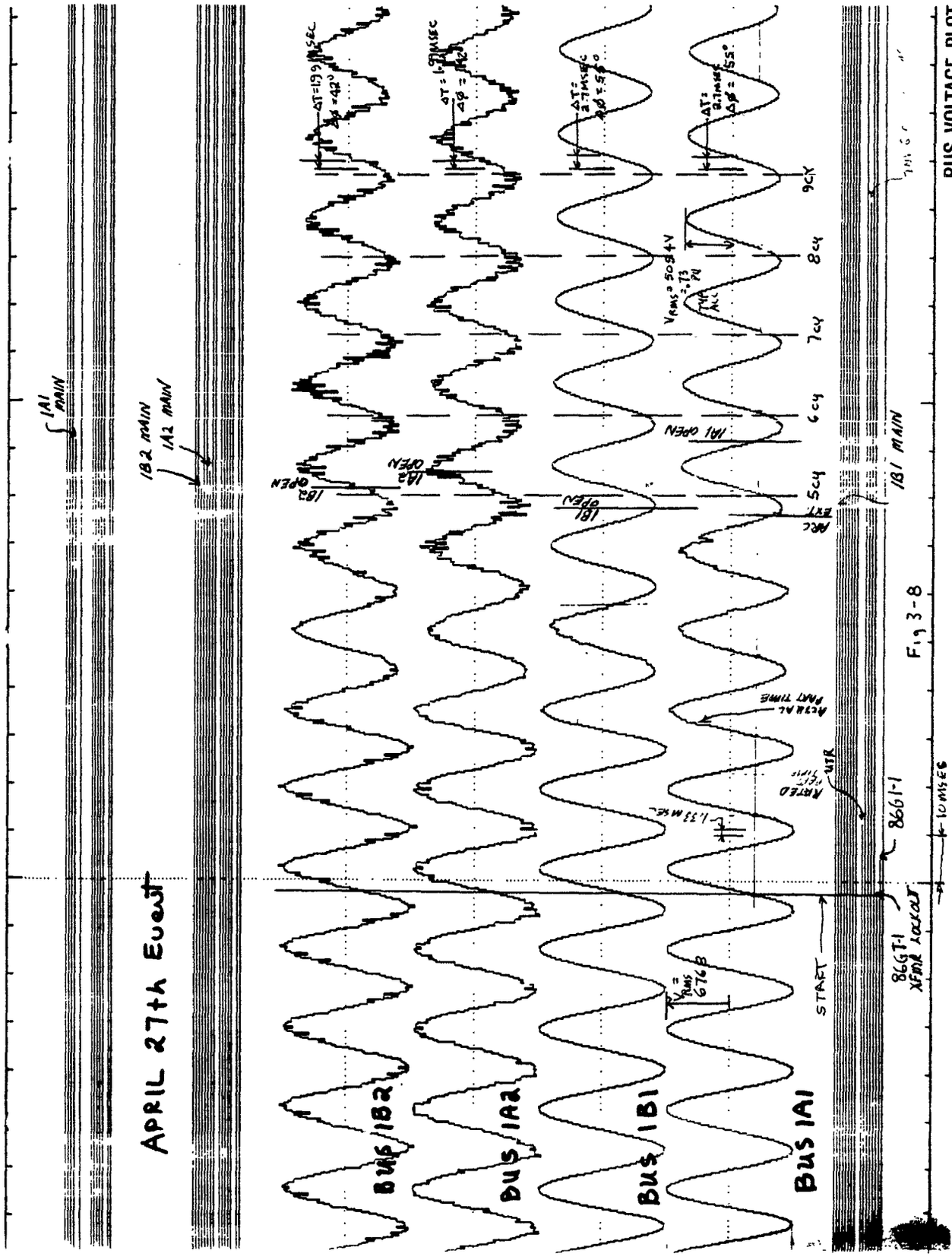

BUS VOLTAGE PLOT
APRIL 27 EVENT

Figure 3-2

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and 57.6 Hz while Buses 1A2 and 1B2 are 0.73 per unit at -42 degrees and 58.6 Hz. These values when converted to a volts per Hz basis on the motor rated kV base and subtracted from the reserve source on the same basis give resultant voltages of 0.90 V/Hz per unit for Buses 1A1 and 1B1 and 0.73 V/Hz per unit for Buses 1A2 and 1B2. These values are less than the ANSI standard C50.41-77 recommended 1.33 V/Hz per unit maximum resultant voltage limit.

Although the resultant voltage for this condition is within acceptable limits, bus loading could be such that the voltage would not be acceptable for a fast transfer and it is recommended that a high-speed synch-check relay designed for this purpose be installed at each 6.9 kV reserve bus. This relay would monitor the reserve source voltage and bus voltage and inhibit reserve breaker closing if the resultant voltage exceeded 1.33 V/Hz.

3.3.5 Auxiliary Electric System Fast Transfer Voltages and Power Flows

As indicated in Subsections 3.3.2 and 3.3.3, the Electrocon load flow program was utilized to calculate system voltages and power flows during a fast transfer using the bus residual voltage and system impedances. Of primary importance is the voltage at the 46 kV substation since a large voltage drop could lead to a dc substation trip. When the reserve breaker is closed onto the bus, the resultant voltage, i.e., the difference between the reserve source voltage and each motors residual voltage, appears across the system impedances which include the source impedance, 46 kV transformer impedance, reserve auxiliary transformer impedance, and the motors locked-rotor impedance. Since individual motor voltages are unknown, an approximation is made by equating the bus residual voltage to the motor residual voltage and then lumping all motor and SUS impedances together to simulate a single motor and voltage at each bus. This bus is then modeled in the Electrocon program as a source (swing) bus connected to the 6.9 kV auxiliary bus through a branch connection of impedances

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equal to the lumped load impedance. The reference bus is assigned a voltage and angle equal to the bus residual voltage and angle as determined by the graph analysis discussed in Subsection 3.3.4.

Since the substation is not connected to either unit during a two-unit trip, the substation source (swing) bus was remodeled to a source bus connected to the substation through an impedance in order to model the substation source as a 6,000 or 12,000 MVA source during the fast transfer calculation.

Motor and SUS impedances are listed in Tables 3-5 through 3-8. All motors except the pulverizers and PA fans, which are tripped when the unit trips, are connected. In addition, the impedances for the new 8,000-hp boiler feed pumps were used in lieu of the existing 7,000-hp pump.

Figure A-11 indicates the voltages for a two unit transfer with one 46 kV 100 MVA transformer in service. The voltage at the 46 kV bus meets the study criteria. The voltage at the converter station dips to 0.897 per unit which is less than the preferred 0.9 per unit but is acceptable. The 6.9 kV buses recover to 0.81 per unit which is also acceptable. As the motors accelerate, the bus currents will decrease and the system power factor will improve until the voltage reaches post trip values as previously calculated in the power flow calculations.

Figures A-19 and A-20 indicate the voltages for the case of one 46 kV 50 MVA transformer and one 46 kV 100 MVA transformer and also include revised reserve auxiliary transformer impedances due to the 8,000-hp startup boiler feed pumps. For the 100 MVA transformer case, the 6.9 kV bus voltages decreased slightly; however, all results are acceptable.

For the 50 MVA transformer case, the 46 kV substation voltages have dipped below the 0.85 per unit criteria.

During the fast transfer, there will be dc transient currents imposed on the ac currents which have the effect of increasing the total RMS value of inrush current and subsequently lowering the voltage. The effect will last for three to five cycles and will increase the first half cycle RMS

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current value by 20 to 40 percent and, therefore, increase the voltage drops causing slightly less voltage at the buses than calculated. Since this is an extremely short duration event, no adverse effects on the operation of the 46 kV substation are predicted.

3.3.6 Induced Draft Fan Consideration

As discussed in the EPRI EL-4286 report, variable frequency drives normally will not contribute energy to the bus during the disconnect period, but will keep driving the load and tend to decrease the bus voltage and frequency more than if the motors were directly connected to the power source. Two methods of enhancing the bus residual voltage by control of the variable frequency drives are presented: one is to direct the drive to coast and the other is to direct the drive to regenerate.

The induced fan drives for this project are built by Westinghouse Electric Corporation and are designed to regenerate when the speed signal is decreased. During a unit trip, regeneration will occur due to a temporary combustion control system runback bias to prevent high negative furnace pressures. This runback is evident by power decrease and ID fan rpm decrease shown on Figure 3-1. Although this regeneration occurs, the time at which it begins will be after the fast transfer is complete. Westinghouse has been contacted to determine if the system can be modified for instant regeneration or coast modes. Westinghouse has indicated that reprogramming will be required and may not achieve acceptable results.

The induced draft fan drives must remain in operation during the fast transfer so that the boiler draft is not disturbed. Therefore, the drive must not trip due to low voltage at the bus. The control system is powered from the essential services power and is not affected. Loss of drive cooling fans will trip the fan drives but due to the quick transfer time this is not expected to cause an ID fan drive trip. The only other trip that could be determined to affect the successful transfer is the 6.9 kV bus low voltage trip. When voltage decreases to 0.7 per unit or less, the ID fan drive will trip.

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Westinghouse was requested to verify the above assumptions; however, they responded with uncertainty and recommended that tests be performed to determine the actual response characteristics of the fan drives during a load transfer.

3.3.7 Motor Starting Capabilities

Although motor starting is not a requirement of this study, it is desirable to know what would be the largest motor that could be started without an unacceptable voltage drop. The large motor Buses 1A2 and 1B2 motors are designed to start with 5.28 kV voltage at the motor terminals and, allowing for cable voltage drop, about 5.41 kV (0.78 per unit) at the 6.9 kV switchgear bus.

The small motor buses were designed to limit minimum voltage to 5.86 kV (0.85 per unit) when starting the largest motor on these buses. These buses also have the majority of SUS loads.

Since Buses 1A1 and 1A2 are connected together, large motor starting on Bus 1A2 will reduce the voltage on Bus 1A1. However, providing that voltage does not dip below 0.78 per unit while starting any motor on Bus 1A2 or 0.85 when starting any motor on Bus 1A1, the motor will start successfully without disturbing running loads.

The load flow program was used to solve for voltages by assuming 20 MW running motor load per unit and modeling starting motors as a reactive shunt of fixed impedance based on starting motor locked-rotor impedance. The substation source was modeled at its minimum and probable minimum MVA fault capacities of 6,000 and 12,000 MVA since both generating units are tripped.

Figure A-13 shows the results of starting one of the future 8,000-hp startup boiler feed pumps with the 46 kV 100 MVA transformer. Substation and plant voltages are acceptable.

Figure A-14 shows the results of starting one 6,500-hp FD fan motor for the same conditions of Figure A-13. Again all voltages are acceptable.

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The cases on Figures A-13 and A-14 are based on the reserve transformer impedance at 7.6 percent, not the final 8.0 percent. Since the results would not be appreciably changed, additional the calculations were not made.

Motor starting cases were also run for the single 46 kV, 50 MVA, 7.1 percent impedance transformer configuration. A 6,500-hp motor could be started in this case.

3.4 SAFE SHUTDOWN ANALYSIS CONSIDERATIONS

Previous studies have analyzed the various control systems during a loss of the associated programmable controller or a loss of plant auxiliary power. As a supplement to these analyses, the effects of the momentary reduction in voltage that will be experienced during a fast transfer have been considered. The components most likely to be affected by this momentary reduction in voltage are motor starters, control relays, and programmable controller processors and I/O. In addition, the bus undervoltage tripping scheme was reviewed to determine if it would operate during the fast transfer.

The coil data for motor starters and control relays were reviewed to determine if the coils of these devices would drop out during the fast transfer. In addition, the power specifications for programmable controller processors, I/O interfaces, and 115 VAC input cards were reviewed to determine if these components would remain operational. The following is a summary of the findings.

- The motor starters for this project were specified to have a dropout voltage of 90 volts or less. Furthermore, they were specified to be unaffected by a complete loss of power for three cycles. Testing performed on a recent project has shown that the actual dropout voltage for motor starters is approximately 60 volts or 50 percent of nominal voltage.
- The control relays for this project were specified to have a dropout of voltage of 75 volts or less. Furthermore, they were

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specified to be unaffected by a complete loss of power for three cycles. Manufacturer's information on the control relay coils indicates that dropout will actually occur at voltages much lower than that specified (7 volts for the Struthers-Dunn relays). Field testing has shown that an Allen Bradley relay, with no load, will drop out at approximately 60 volts. A heavily loaded relay will probably hold in to a lower voltage, due to inductance of the circuits.

- All of the Plant Motor Control System programmable controllers and the majority of the remaining programmable controllers are served from a dedicated uninterruptible power supply. However, the programmable controllers are designed to operate at 80 volts for up to 10 seconds and to withstand a complete loss of power for 17 milliseconds. The programmable controller 115 volt ac inputs are designed to indicate an off state at 0 volt to 48 volts.

Based on these findings, malfunctions of the various control systems during a fast transfer are not expected.

The bus undervoltage tripping scheme is designed to operate when the switchgear bus voltage drops to approximately 45 percent of the nominal rated voltage (55 volts at the potential transformer secondary) for 28 cycles and the switchgear main breakers are open. Even if the switchgear bus voltage does drop to this level, it should not remain there for the 28 cycles necessary to initiate the trip.

3.5 46 KV SUBSTATION MODIFICATIONS AND ESTIMATED OVERALL COSTS

The fault study for the 100 MVA 46 kV transformer configuration requires breakers which are suitable for interrupting 49,354 amperes at an X/R ratio of 36. The existing 46 kV breakers are rated at 20,000 amperes interrupting capacity and must be replaced with new 115 kV breakers rated at 63,000 amperes RMS interrupting capacity.

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For the 50 MVA 46 kV transformer configuration, the fault current is 28,442 amperes at an X/R ratio of 37. New 69 kV breakers rated 40,000 amperes RMS interrupting capacity are then required.

In addition to the replacement of the existing breakers, it is anticipated that the existing substation ring bus configuration will be replaced with a breaker-and-one-half configuration including 11 breakers. Costs were estimated for breaker-and-one-half configuration utilizing the 100 MVA transformers and utilizing the 50 MVA transformers, as shown respectively on Tables 3-9 and 3-10.

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TABLE 3-9. 100 MVA TRANSFORMER CONFIGURATION

Item	Material $	Labor $	Total $
100 MVA Transformers	2,718,000	100,800	
36 MVA Reserve Auxiliary Transformers	990,000	28,000	
Cable, Bus Duct Conduit, Duct Bank	1,215,600	738,800	
115 kV, 63 kAIC Breakers	990,000	61,600	
Substation Bus, Stands, Foundations and Grounding	350,180	74,600	
7,200 Volt Circuit Breakers	240,000	10,800	
Plant Control and Wiring	30,000	30,000	
Substation Control and Wiring	60,000	30,000	
	6,593,780	1,074,600	7,668,380
Contractor Mobilization and Demobilization			70,000
Administrative and Engineering Costs			766,800
Subtotal			8,505,180
Contingency (20 percent)			1,701,036
Total			10,206,216

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TABLE 3-10. 50 MVA TRANSFORMER CONFIGURATION

Item	Material $	Labor $	Total $
50 MVA Transformers	1,974,000	100,800	
36 MVA Reserve Auxiliary Transformers	990,000	28,000	
Cable, Bus Duct Conduit, Duct Bank	1,215,600	738,800	
69 kV, 40 kAIC Breakers	440,000	39,000	
Substation Bus, Stands, Foundations and Grounding	300,180	66,200	
7,200 Volt Circuit Breakers	240,000	10,800	
Plant Control and Wiring	30,000	30,000	
Substation Control and Wiring	60,000	30,000	
	5,249,780	1,043,600	6,293,380
Contractor Mobilization and Demobilization			70,000
Administrative and Engineering Costs			629,338
Subtotal			6,992,718
Contingency (20 percent)			1,398,543
Total			8,391,261

IP12_005256

APPENDIX A

SYSTEM ONE-LINE DIAGRAMS

IP12_005257

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]^{XX} NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF9A	20MW-UNIT 1 RESERVE AUX
IGSPF9E	40MW-UNIT 1 RESERVE AUX

UNIT 1 ON RESERVE TRANSFORMER, WITH RATINGS AT 18 MVA, A NOMINAL IMPEDANCE OF 6.8% AT A TAP OF 1.0. THE 46 KV TRANSFORMERS ARE RATED AT 30 MVA WITH A NOMINAL IMPEDANCE OF 10.9% AT A .95 TAP.

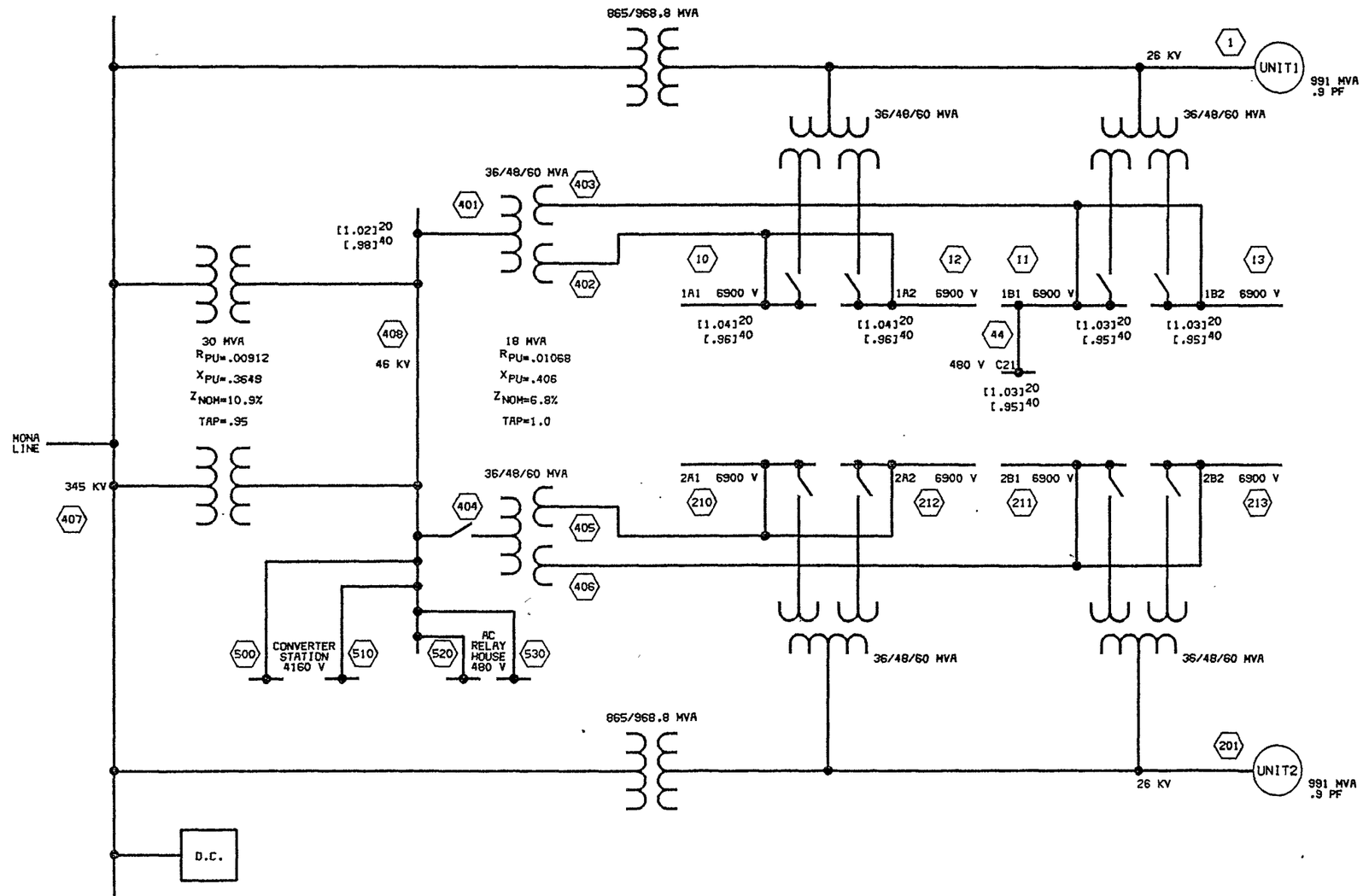

Figure A-1

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF9F	NO LOAD VOLTAGES
IGSPF7A	20MW BOTH UNITS
IGSPF8D	40MW BOTH UNITS

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 30 MVA WITH A NOMINAL IMPEDANCE OF 10.9%, AT A .95 TAP. THE RESERVE AUXILIARY TRANSFORMERS ARE RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 6.8% AT A 1.0 TAP.

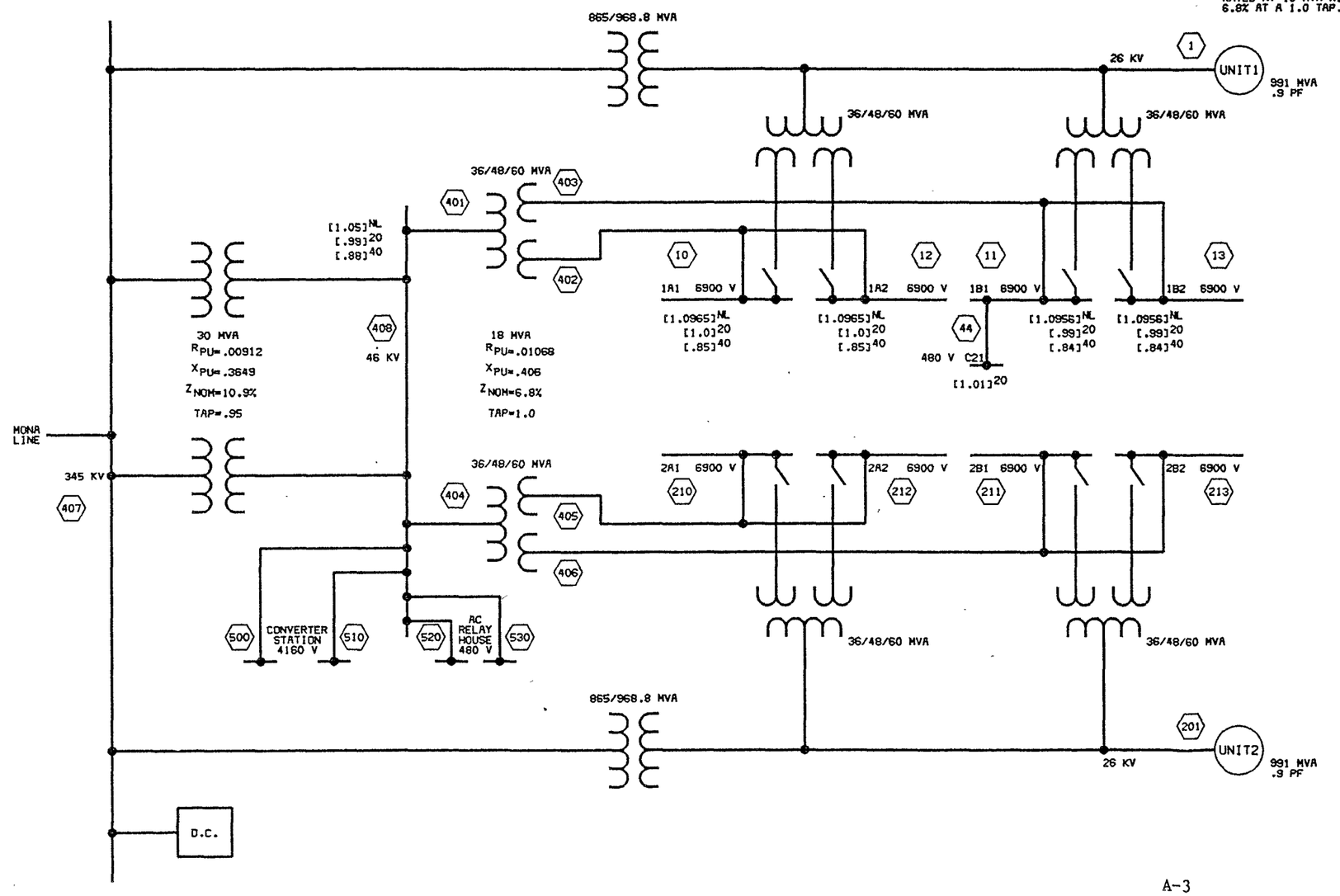

Figure A-2

IP12_005259

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
ICSPF8J	NO LOAD
ISGPF8K	20MW-UNIT 1
ICSPF8L	40MW-UNIT 1
ICSPF8M	60MW-UNIT 1
ICSPF8N	80MW-UNIT 1

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 40 MVA WITH A NOMINAL IMPEDANCE OF 6.0%, AT A .95 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 6.8% AT A 1.0 TAP.

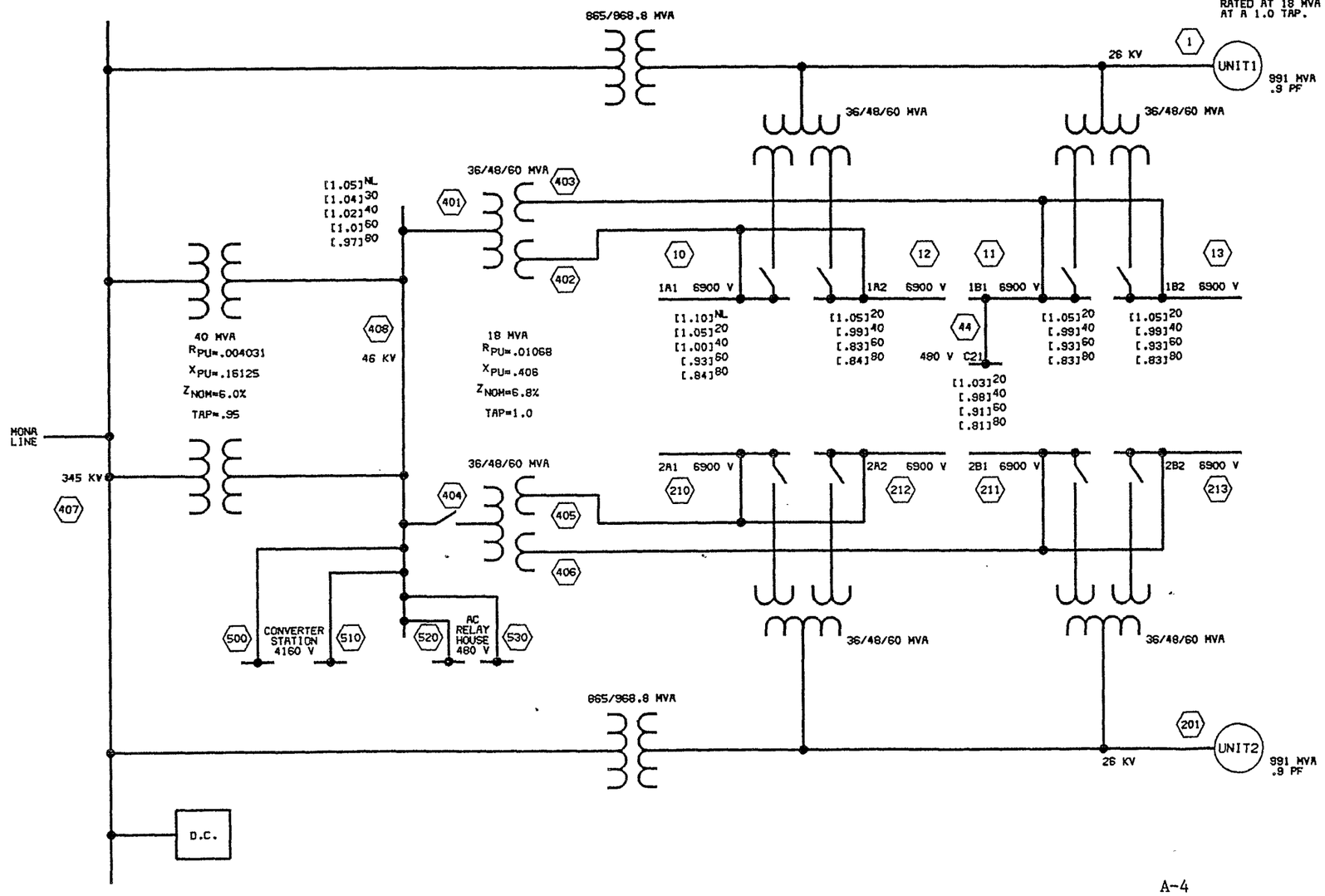

Figure A-3

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
ICSPF8K2	20MW BOTH UNITS
ISCPF8L2	40MW BOTH UNITS
ICSPF8M2	60MW BOTH UNITS
ICSPF8N2	80MW BOTH UNITS

NOTE: CASE ICSPF8N2 DID NOT CONVERGE.

TWO 46KV TRANSFORMERS IN SERVICE. EACH RATED AT 40 MVA WITH A NOMINAL IMPEDANCE OF 6.0%, AT A .95 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 6.8% AT A 1.0 TAP.

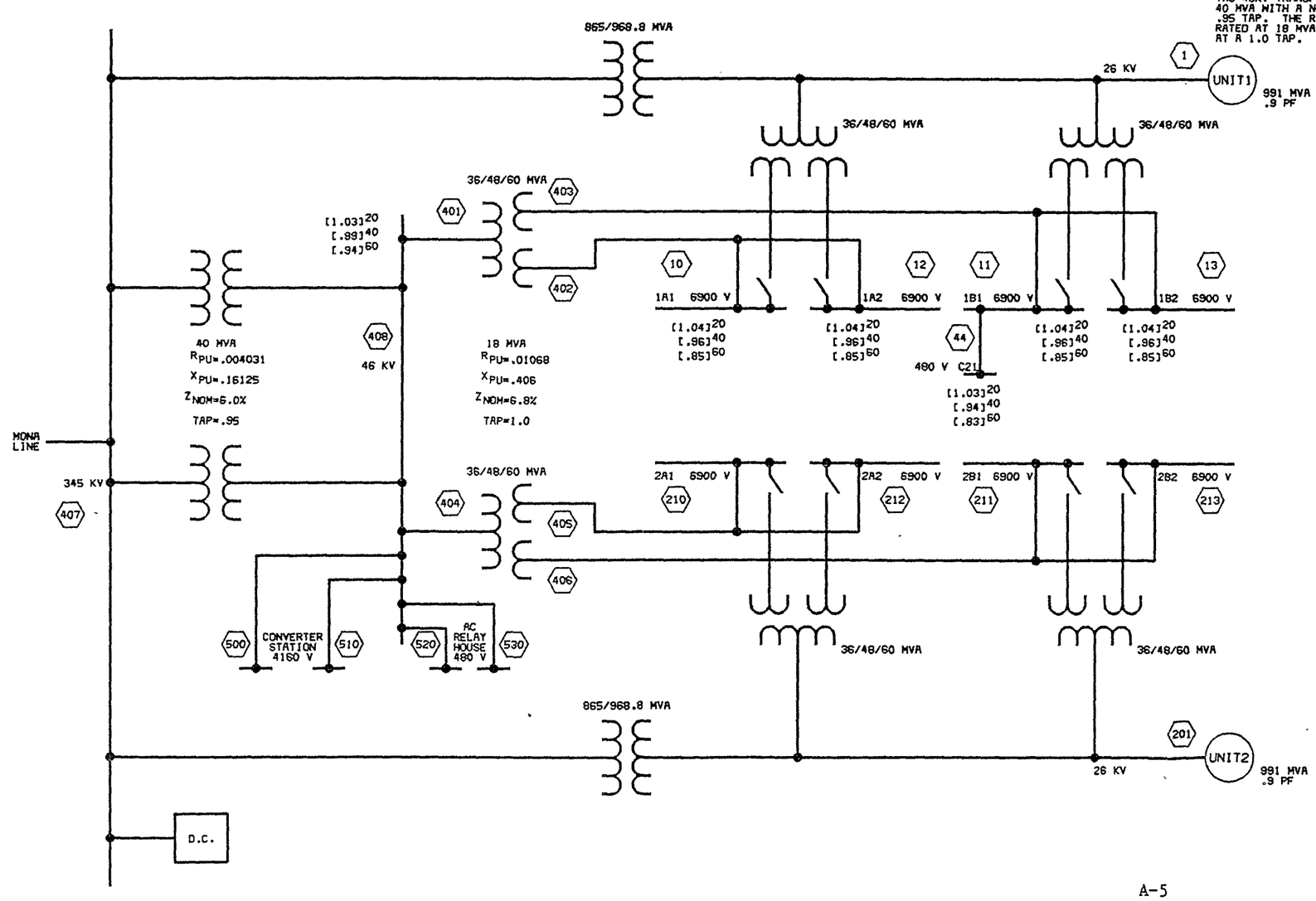

Figure A-4

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF13A	20MW EACH UNIT
IGSPF13B	40MW EACH UNIT
IGSPF13C	60MW EACH UNIT
IGSPF13D	80MW EACH UNIT

ONE 46 KV TRANSFORMER OUT OF SERVICE. THE OTHER RATED AT 100 MVA WITH A NOMINAL IMPEDANCE OF 5.5%, AT A .975 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 7.1% AT A 1.0 TAP.
DC SUBSTATION, THAW SHED AND YARD LOAD EQUAL TO 11 + j3.61 MVA

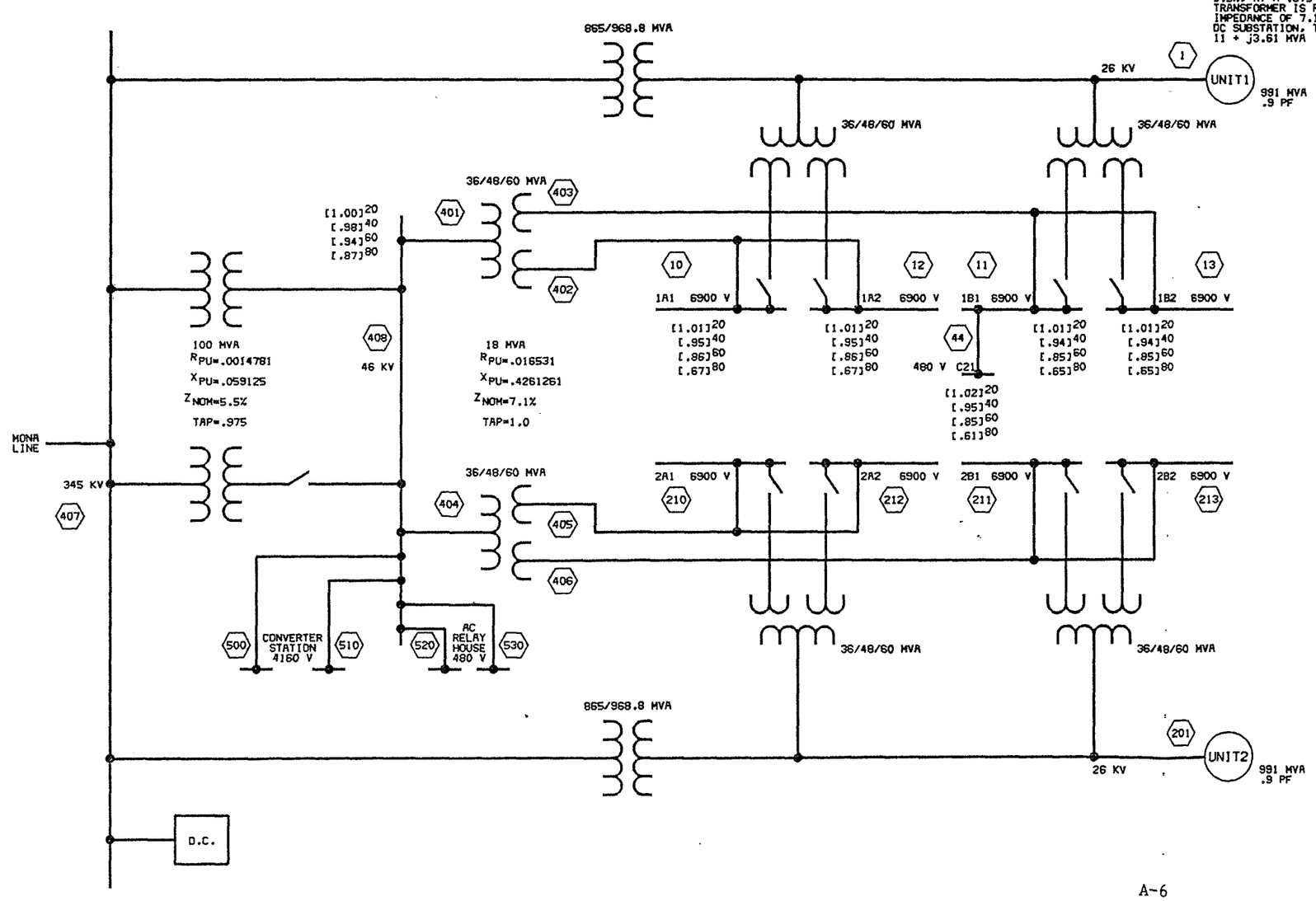

Figure A-5

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF14A	20MW PER UNIT
ISGPF14B	40MW PER UNIT
IGSPF14C	60MW PER UNIT

NOTE: CASE IGSPF14C DID NOT CONVERGE.

ONE 46KV TRANSFORMER OUT OF SERVICE. THE OTHER RATED AT 50 MVA WITH A NOMINAL IMPEDANCE OF 5.5%, AT A .975 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 7.1% AT A 1.0 TAP.

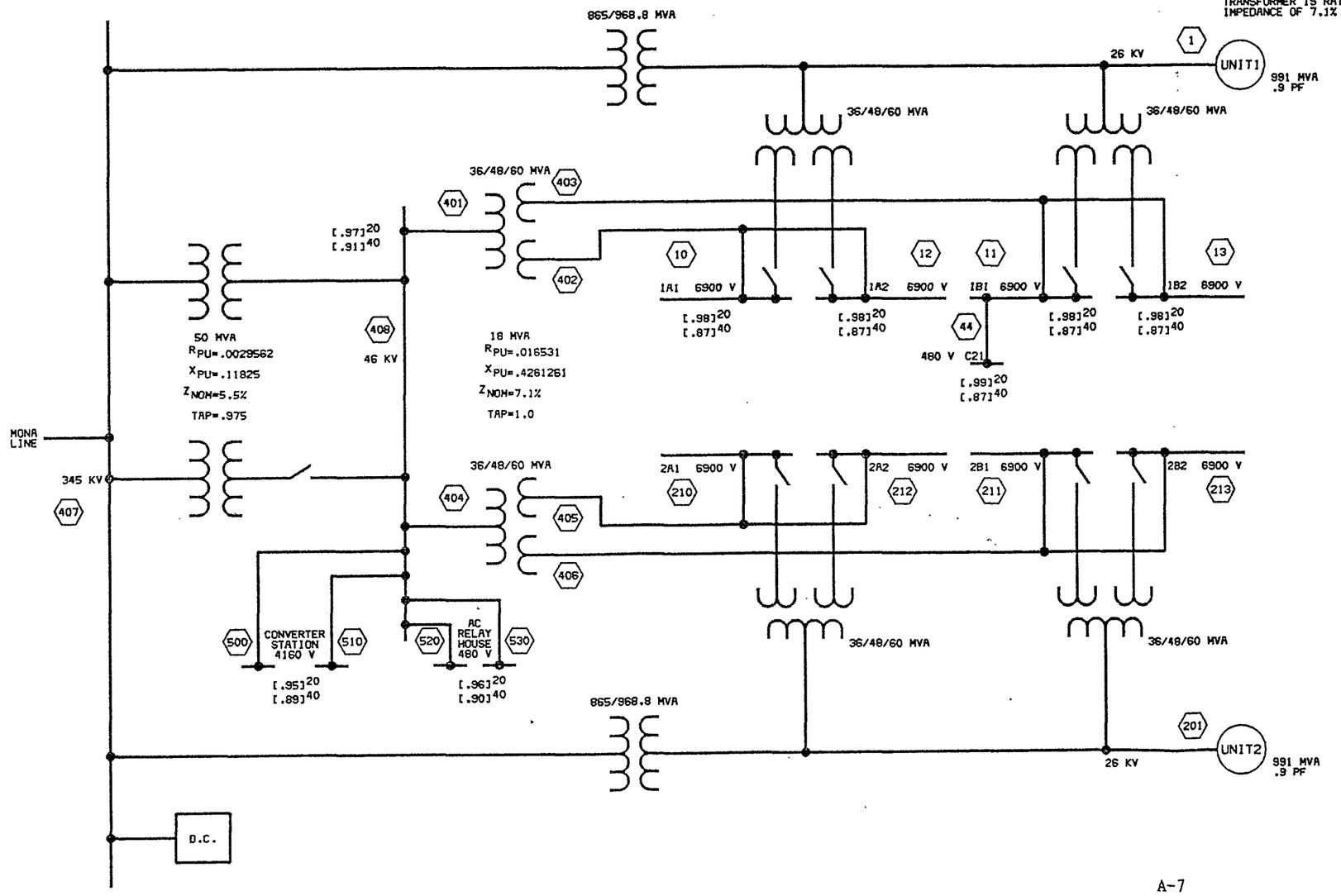

Figure A-6

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF15A	20MW EACH UNIT
ISGPF15B	40MW EACH UNIT
IGSPF15C	60MW EACH UNIT
IGSPF15D	80MW EACH UNIT

NOTE: CASE IGSPF15D DID NOT CONVERGE.

ONE 46KV TRANSFORMER OUT OF SERVICE. THE OTHER RATED AT 100 MVA WITH A NOMINAL IMPEDANCE OF 5.5% AT A .975 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 7.6% AT A 1.0 TAP.

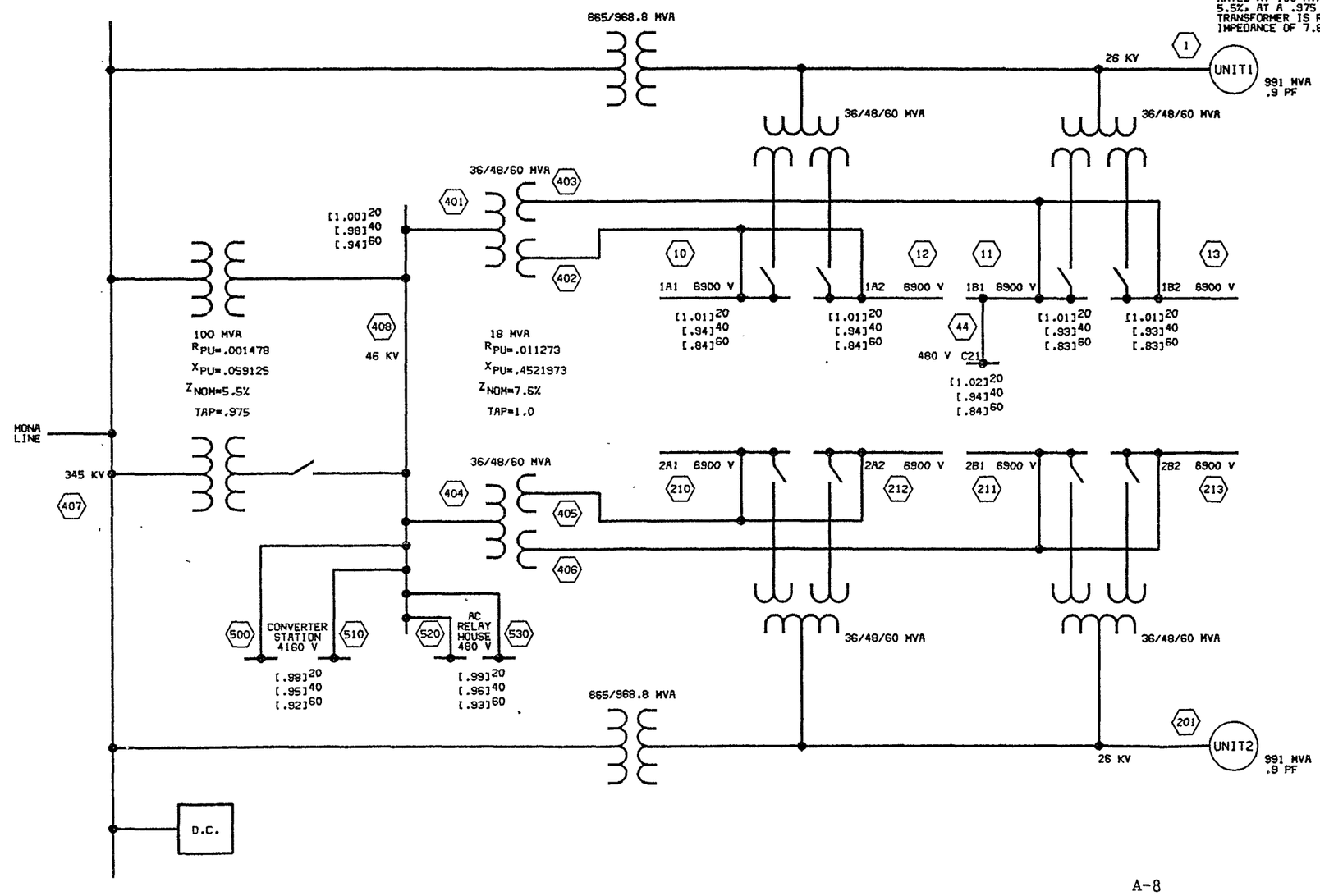

Figure A-7

IP12_005264

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
IGSPF16A	20MW EACH UNIT
IGSPF16B	40MW EACH UNIT
IGSPF16C	60MW EACH UNIT
IGSPF16D	80MW EACH UNIT

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 100 MVA WITH A NOMINAL IMPEDANCE OF 75.5%, AT A .95 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 7.6% AT A 1.0 TAP.

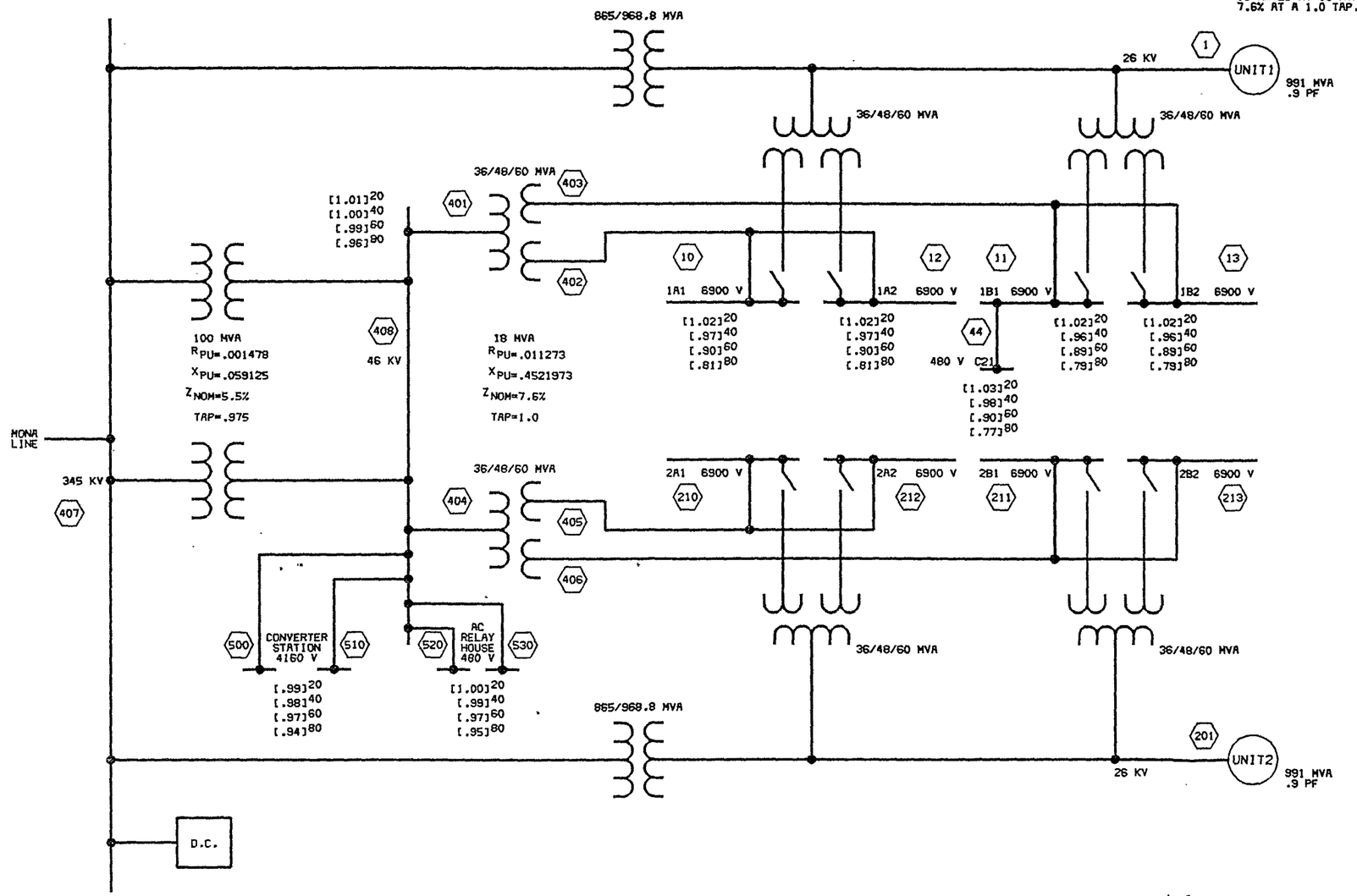

Figure A-8

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN FAULT CALCULATION PROGRAM.

[ ] NUMBER IN BRACKETS REFERS TO THE MAXIMUM FAULT CURRENT SEEN AT THAT PARTICULAR BUS IN AMPS.

FAULT CALCULATION

INPUT DATA CASE

IPPIGS14

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 50 MVA WITH NOMINAL IMPEDANCE OF 5.5% AT A .975 TAP. BOTH RESERVE AUXILIARY TRANSFORMERS RATED AT 18 MVA WITH NOMINAL IMPEDANCE 7.1% AT A TAP 1.0

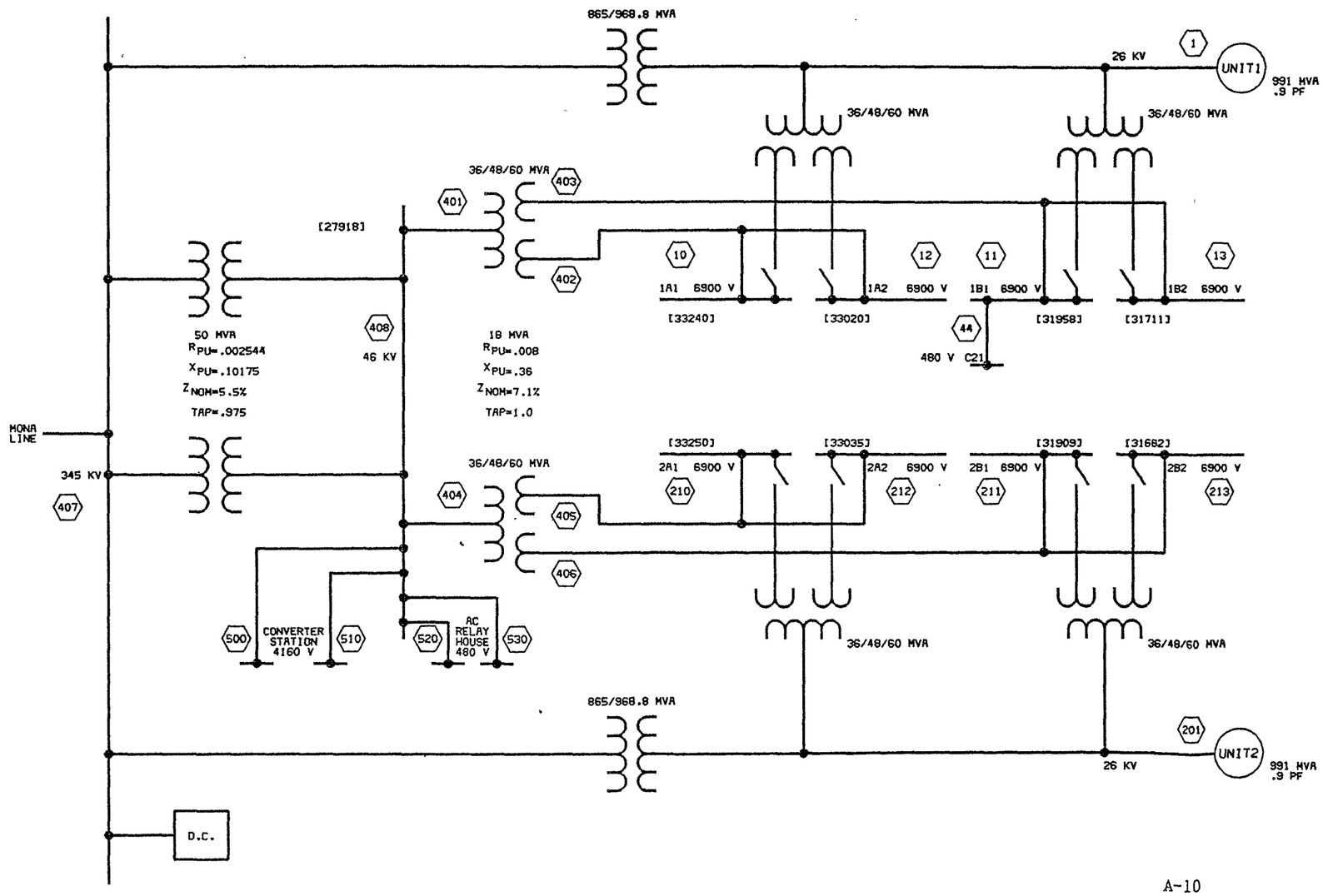

Figure A-9

IP12_005266

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN FAULT CALCULATION PROGRAM.

[ ] MAXIMUM FAULT CURRENT SEEN AT THAT PARTICULAR BUS IN AMPS.

FAULT CALCULATION

INPUT DATA CASE

IPPICS17

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 100 MVA WITH NOMINAL IMPEDANCE OF 5.5% AT A .975 TAP. RESERVE AUXILIARY TRANSFORMERS RATED AT 18 MVA WITH NOMINAL IMPEDANCE 7.1% AT A TAP 1.0

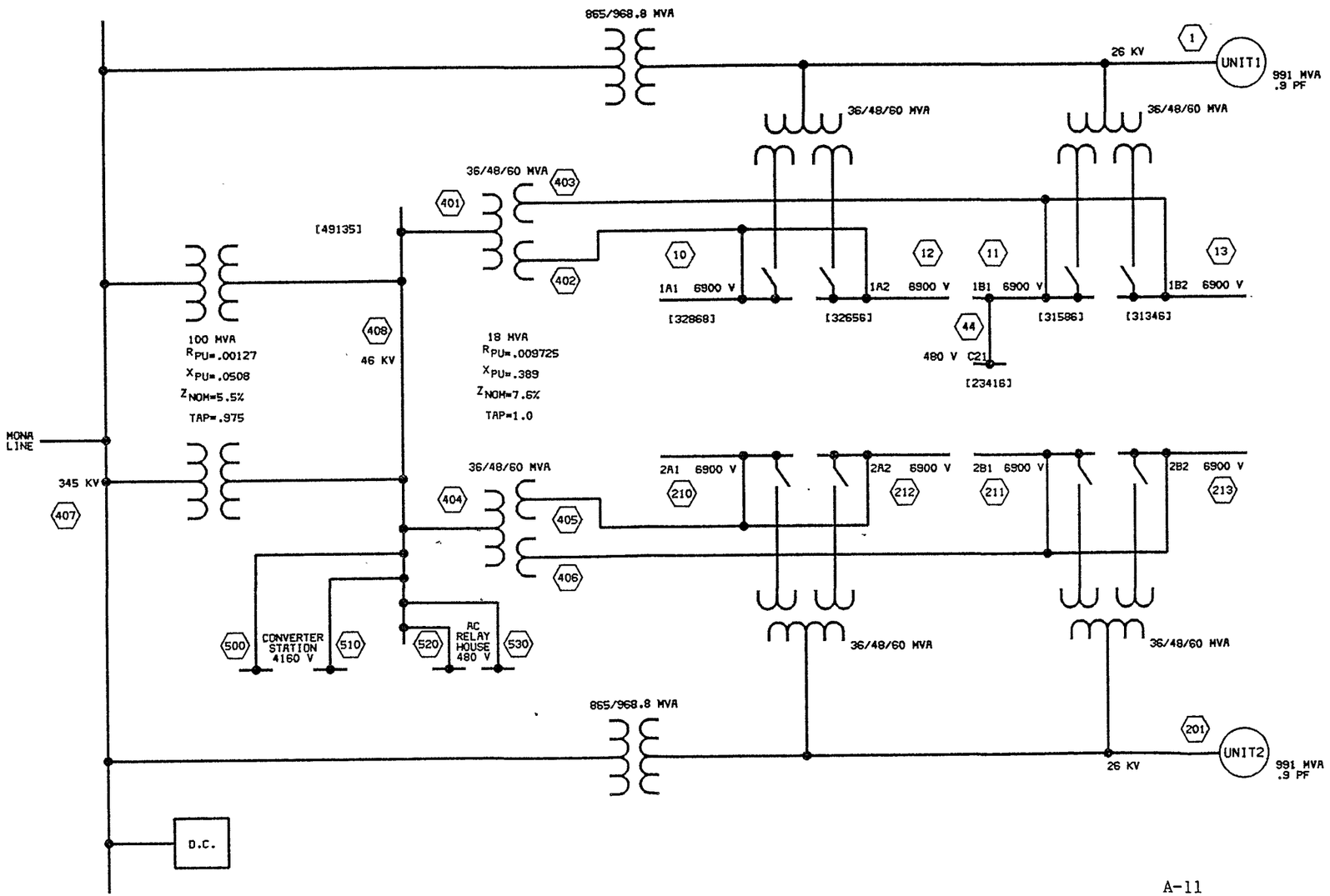

Figure A-10

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

TRANSFER

INPUT DATA CASE	DESCRIPTION
IGSPF19C	6000 MVA MONA LINE SOURCE
IGSPF19D	12000 MVA MONA LINE SOURCE

TWO UNIT TRANSFER. ONE 46 KV TRANSFORMER OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DISCONNECTED. BUS VOLTAGES HAVE BEEN CALCULATED WITH MOTOR RESIDUAL VOLTAGES LUMPED ONTO EACH SWITCHGEAR DURING TRANSFER.

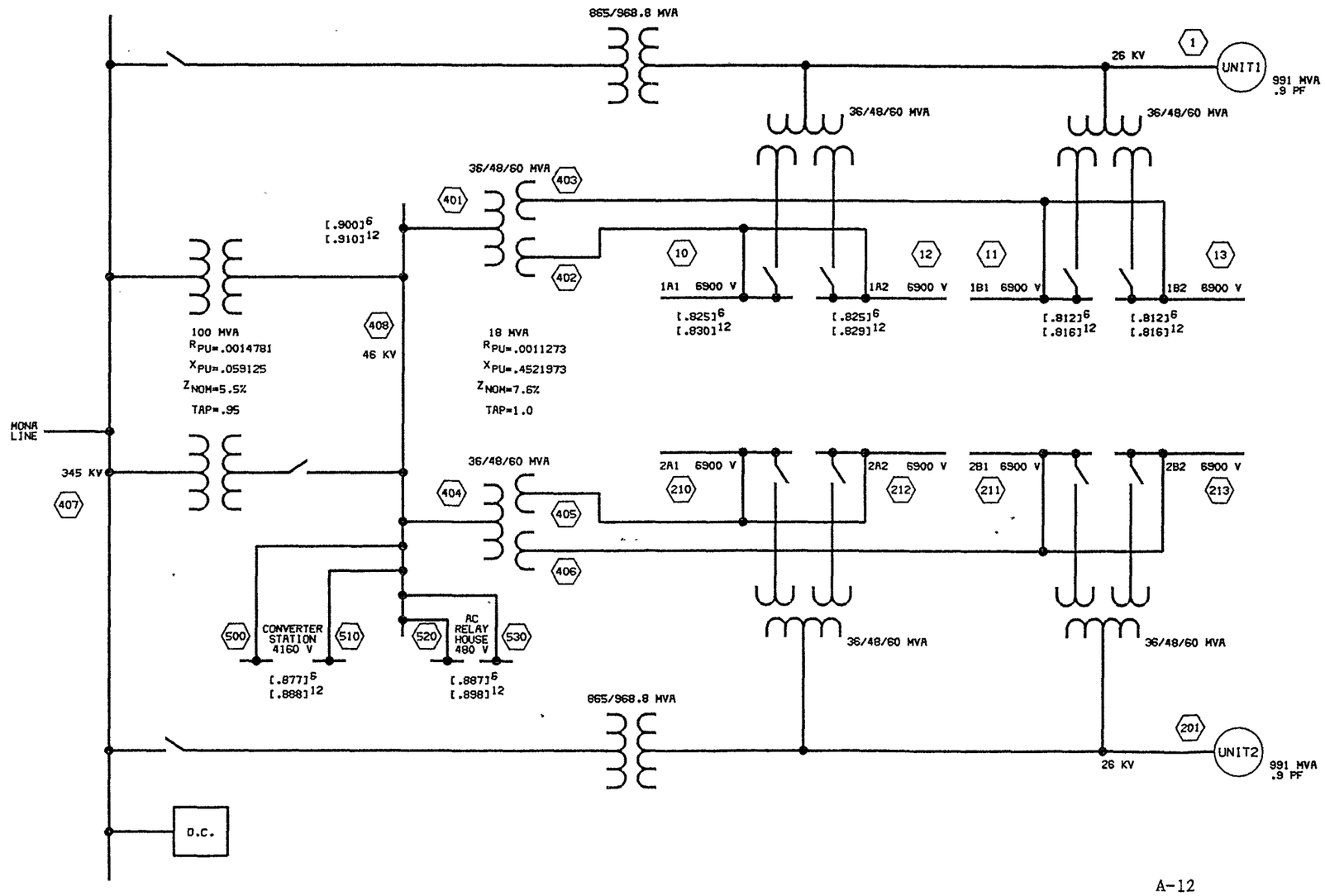

Figure A-11

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

POST TRIP LOAD FLOW

INPUT DATA CASE	DESCRIPTION
1GSPF20B	6000 MVA MONA LINE SOURCE
1GSPF20R	12000 MVA MONA LINE SOURCE

BOTH UNITS ON RESERVE POWER. ONE 46 KV TRANSFORMER IS OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DISCONNECTED.

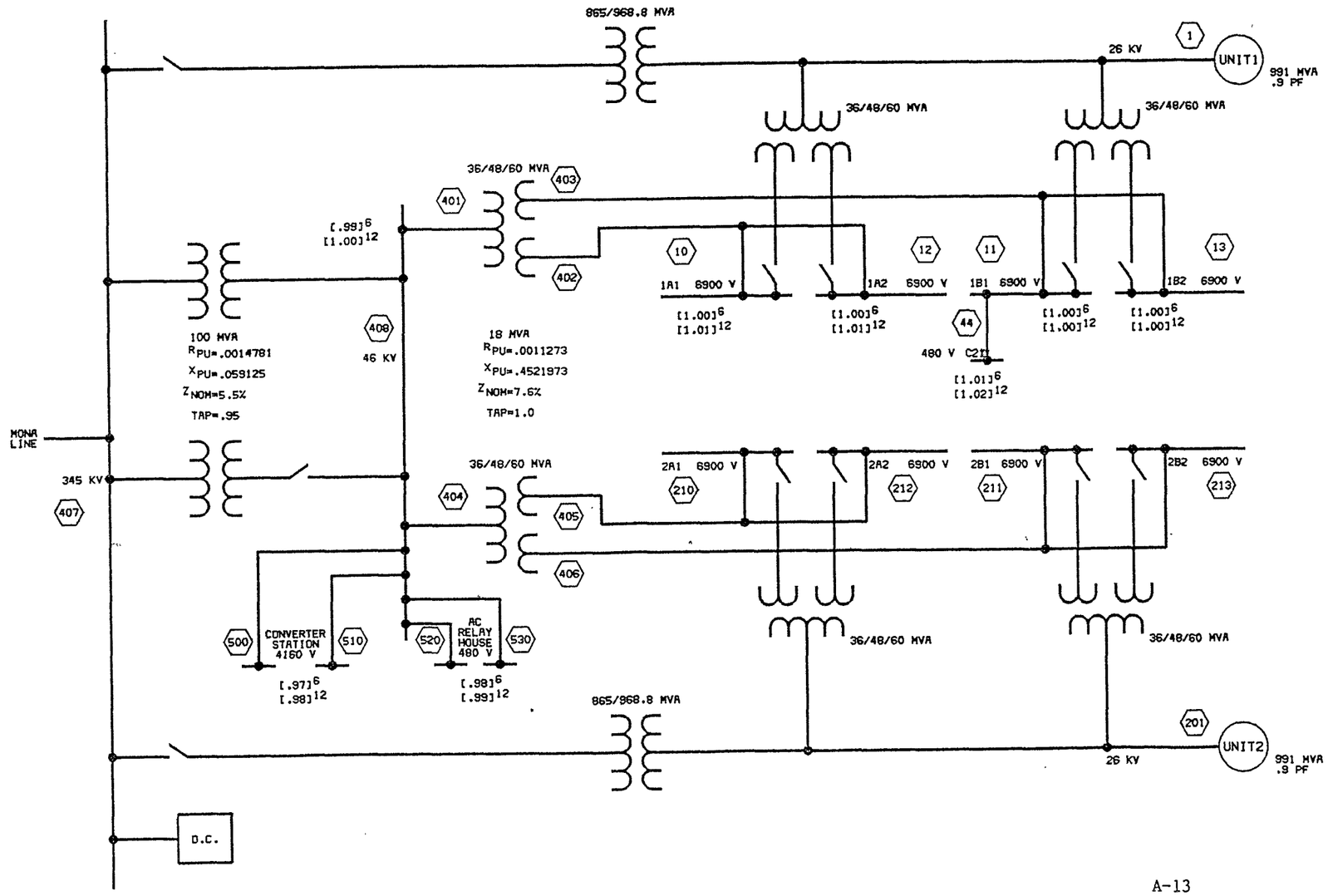

Figure A-12

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

8000HP
MOTOR STARTING

INPUT DATA CASE	DESCRIPTION
IGSPF15E	6000 MVA MONA LINE SOURCE
IGSPF15F	12000 MVA MONA LINE SOURCE

BOTH UNITS ON RESERVE POWER. ONE 46 KV TRANSFORMER IS OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DICONNECTED. BUS VOLTAGES CALCULATED DURING THE START OF A 8000 HP BOILER FEED PUMP MOTOR ON SWITCHGEAR 1A2.

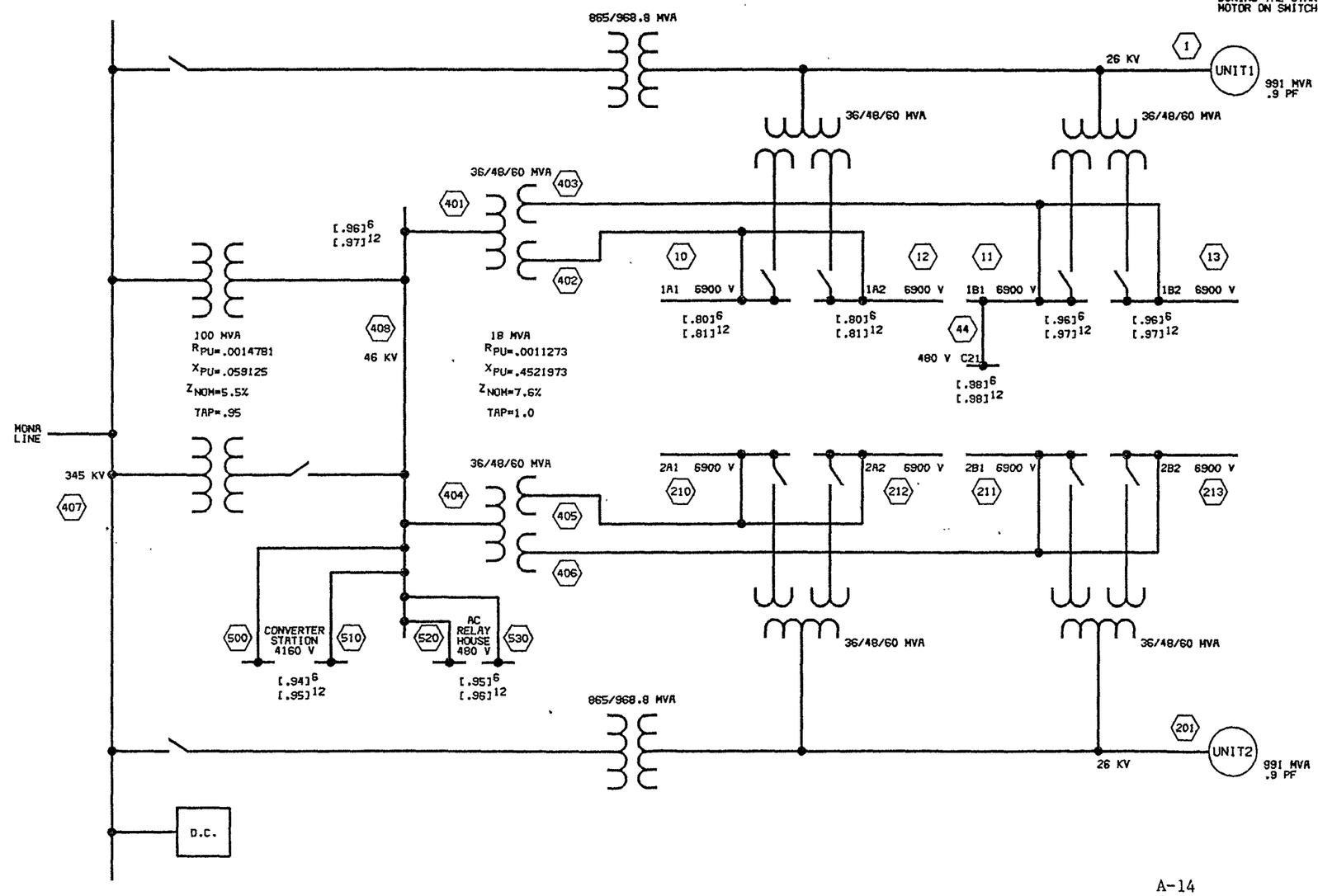

Figure A-13

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

6500HP
MOTOR STARTING

INPUT DATA CASE	DESCRIPTION
IGSPF15G	6000 MVA MONA LINE SOURCE
IGSPF15H	12000 MVA MONA LINE SOURCE

BOTH UNITS ON RESERVE POWER. ONE 46 KV TRANSFORMER IS OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DICONNECTED. BUS VOLTAGES CALCULATED DURING THE START OF A 6500 HP FORCED DRAFT FAN MOTOR ON SWITCHGEAR 1A2.

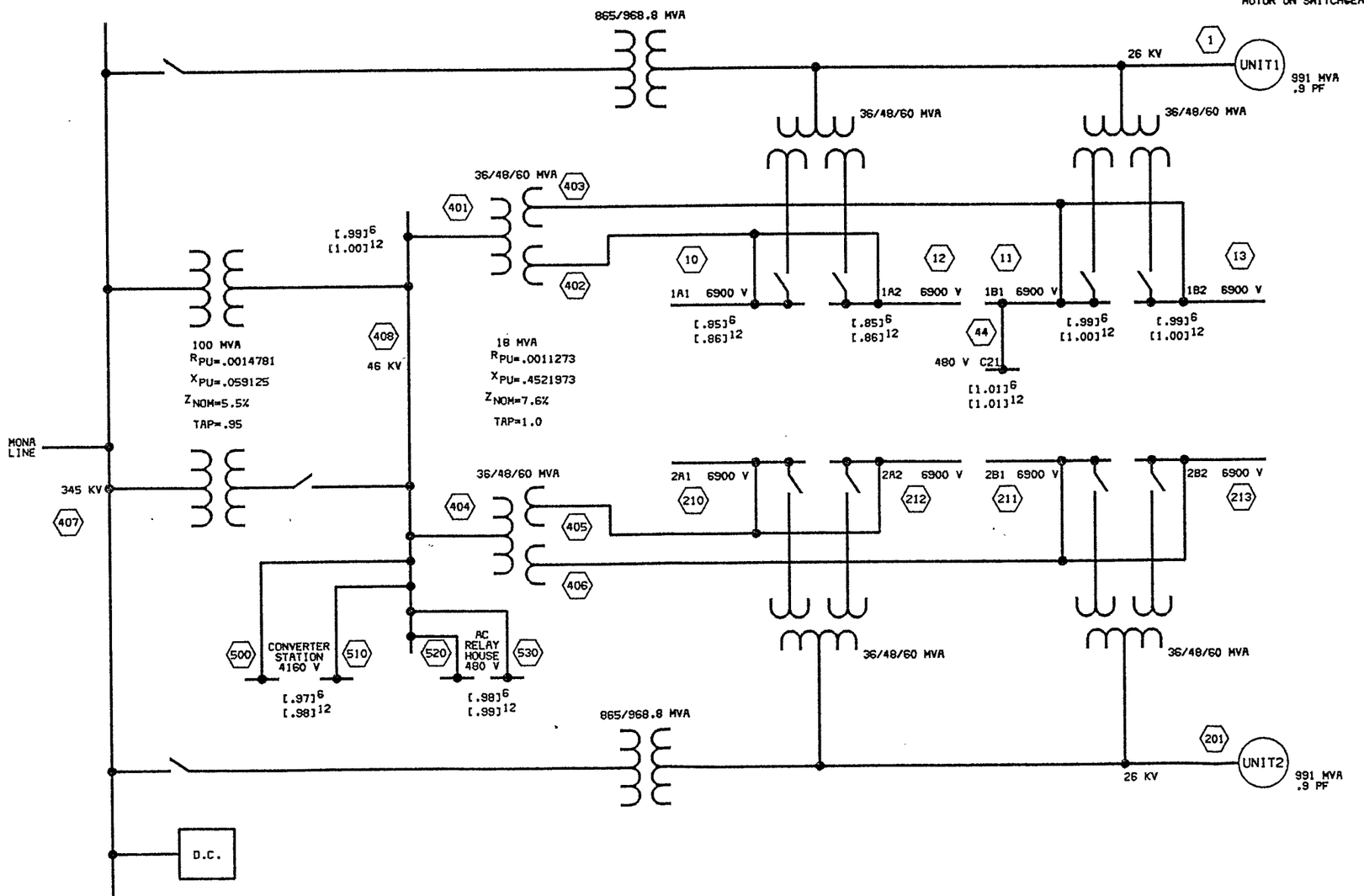

Figure A-14

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN FAULT CALCULATION PROGRAM.

[ ] MAXIMUM FAULT CURRENT SEEN AT THAT PARTICULAR BUS IN AMPS.

FAULT CALCULATION

INPUT DATA CASE

IPPICS20

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 100 MVA WITH NOMINAL IMPEDANCE OF 5.5% AT A .975 TAP. RESERVE AUXILIARY TRANSFORMERS RATED AT 18 MVA WITH NOMINAL IMPEDANCE 8.0% AT A TAP 1.0

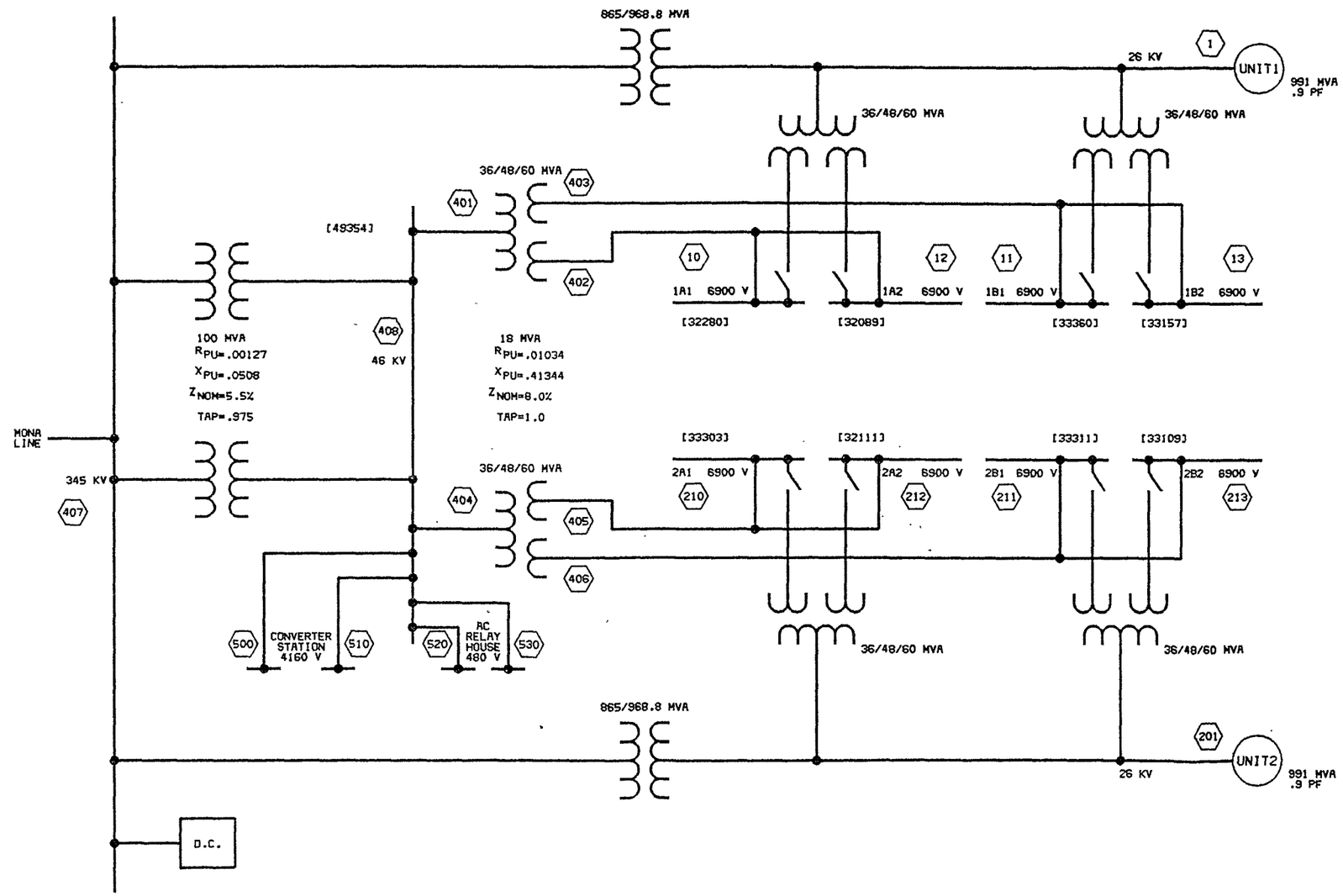

Figure A-15

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN FAULT CALCULATION PROGRAM.

[ ] MAXIMUM FAULT CURRENT SEEN AT THAT PARTICULAR BUS IN AMPS.

FAULT CALCULATION

INPUT DATA CASE

IPPIGS21

TWO 46 KV TRANSFORMERS IN SERVICE. EACH RATED AT 50 MVA WITH NOMINAL IMPEDANCE OF 5.5% AT A .975 TAP. RESERVE AUXILIARY TRANSFORMERS RATED AT 18 MVA WITH NOMINAL IMPEDANCE 7.6% AT A TAP 1.0

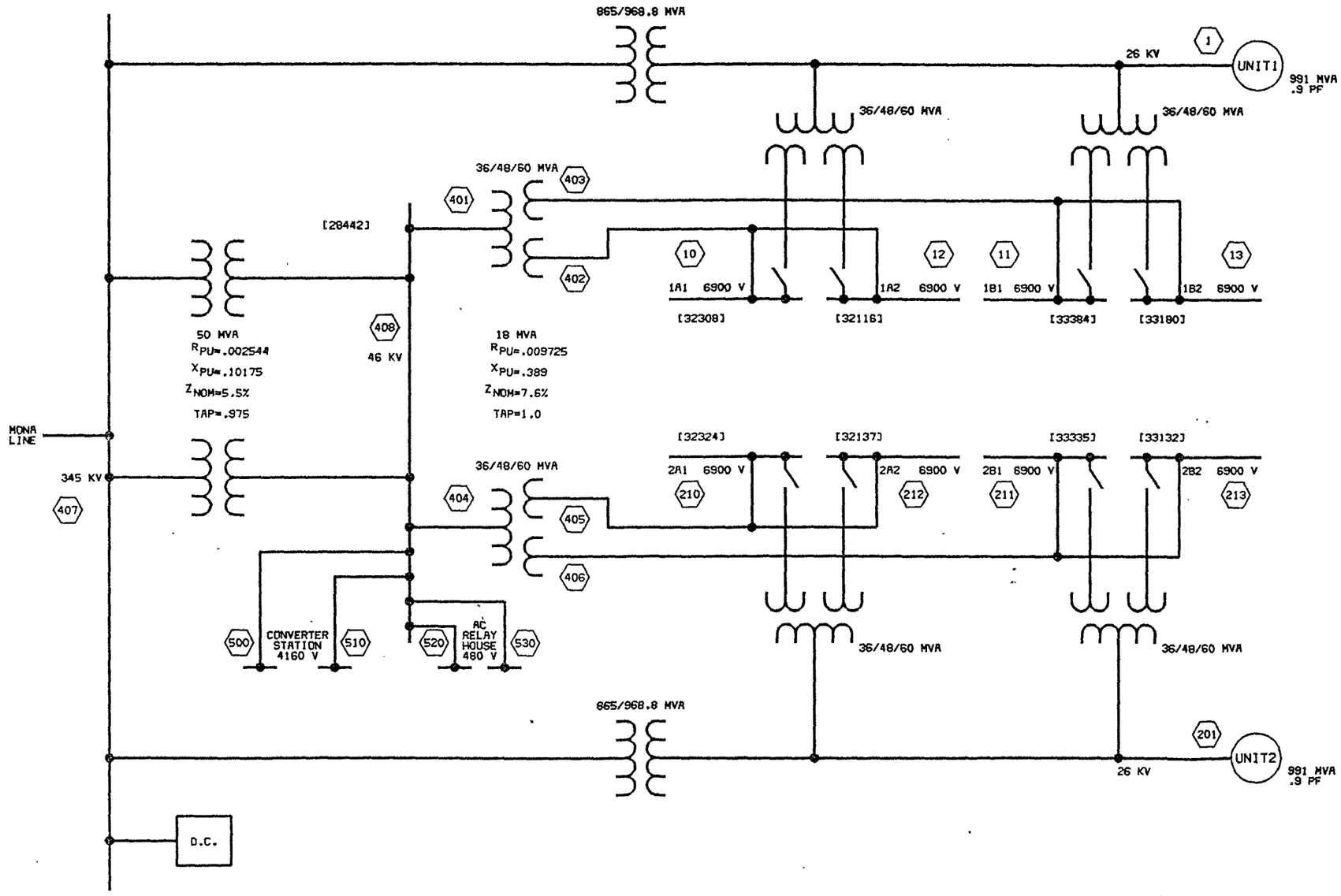

Figure A-16

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
1GSPF14A2	20MW PER UNIT
1SGPF14B2	40MW PER UNIT

ONE 46KV TRANSFORMER OUT OF SERVICE. THE OTHER RATED AT 50 MVA WITH A NOMINAL IMPEDANCE OF 5.5%, AT A .975 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 7.6% AT A 1.0 TAP.

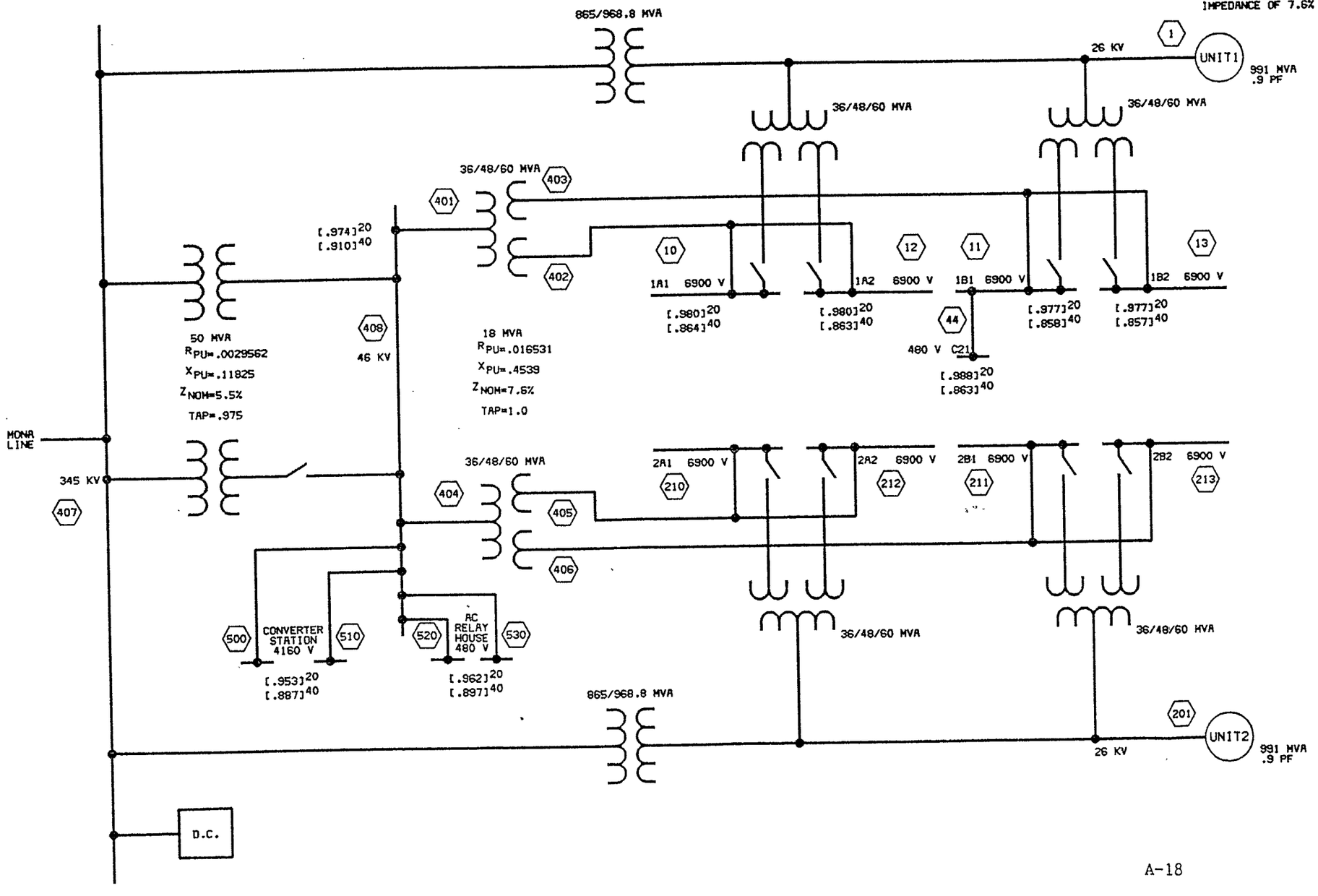

Figure A-17

IP12_005274

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MW LOAD PER UNIT EQUALS THE VALUE OF THE SUPERSCRIPT.

FLOW PROGRAM

INPUT DATA CASE	DESCRIPTION
1GSPF15A2	20MW EACH UNIT
1SGPF15B2	40MW EACH UNIT

ONE 46KV TRANSFORMER OUT OF SERVICE. THE OTHER RATED AT 100 MVA WITH A NOMINAL IMPEDANCE OF 5.5%, AT A .975 TAP. THE RESERVE AUXILIARY TRANSFORMER IS RATED AT 18 MVA WITH A NOMINAL IMPEDANCE OF 8.0% AT A 1.0 TAP.

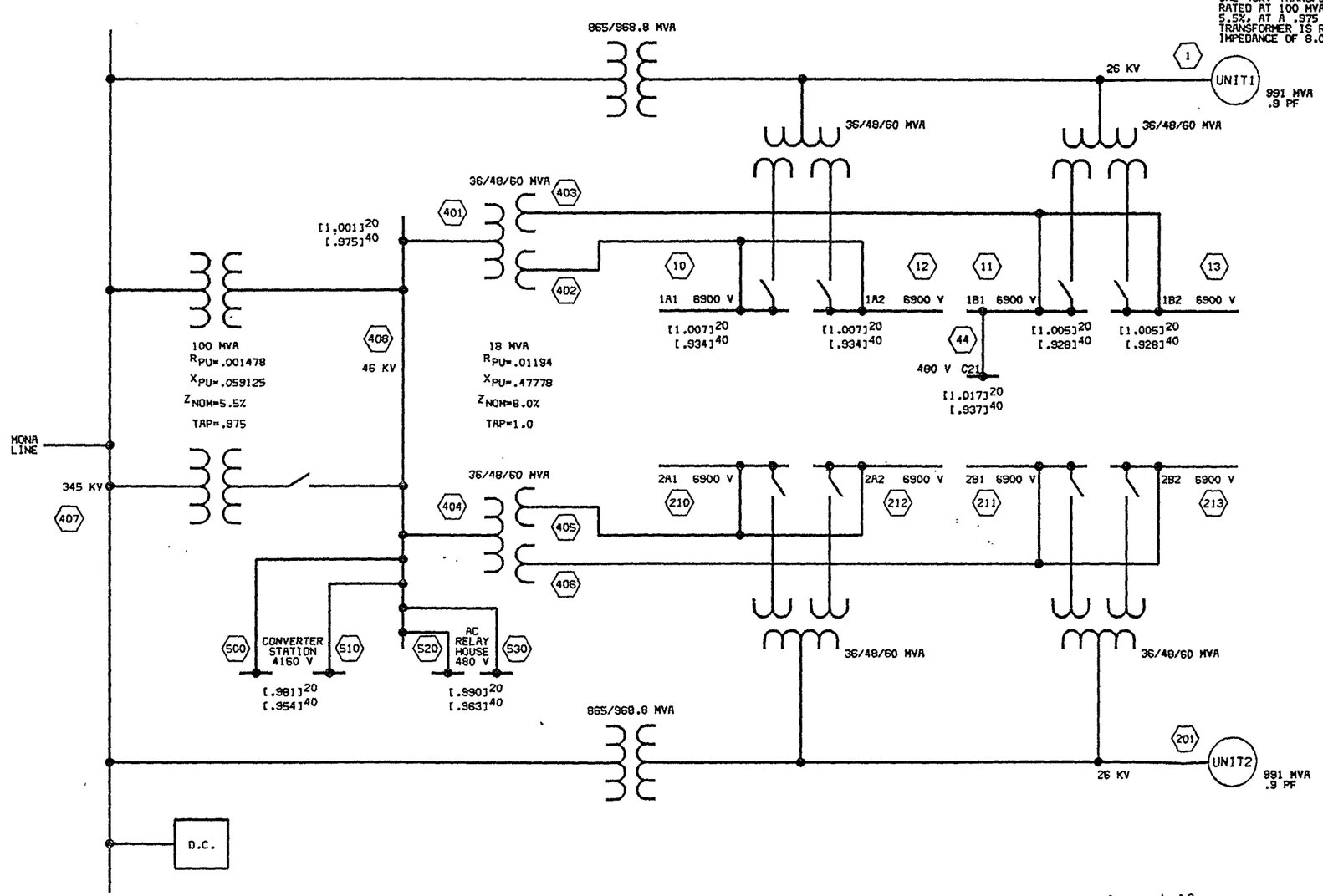

Figure A-18

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

TRANSFER

INPUT DATA CASE	DESCRIPTION
IGSPF19Q	6000 MVA MONA LINE SOURCE

TWO UNIT TRANSFER. ONE 46 KV TRANSFORMER OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DISCONNECTED. BUS VOLTAGES HAVE BEEN CALCULATED WITH MOTOR RESIDUAL VOLTAGES LUMPED ONTO EACH SWITCHGEAR DURING TRANSFER.

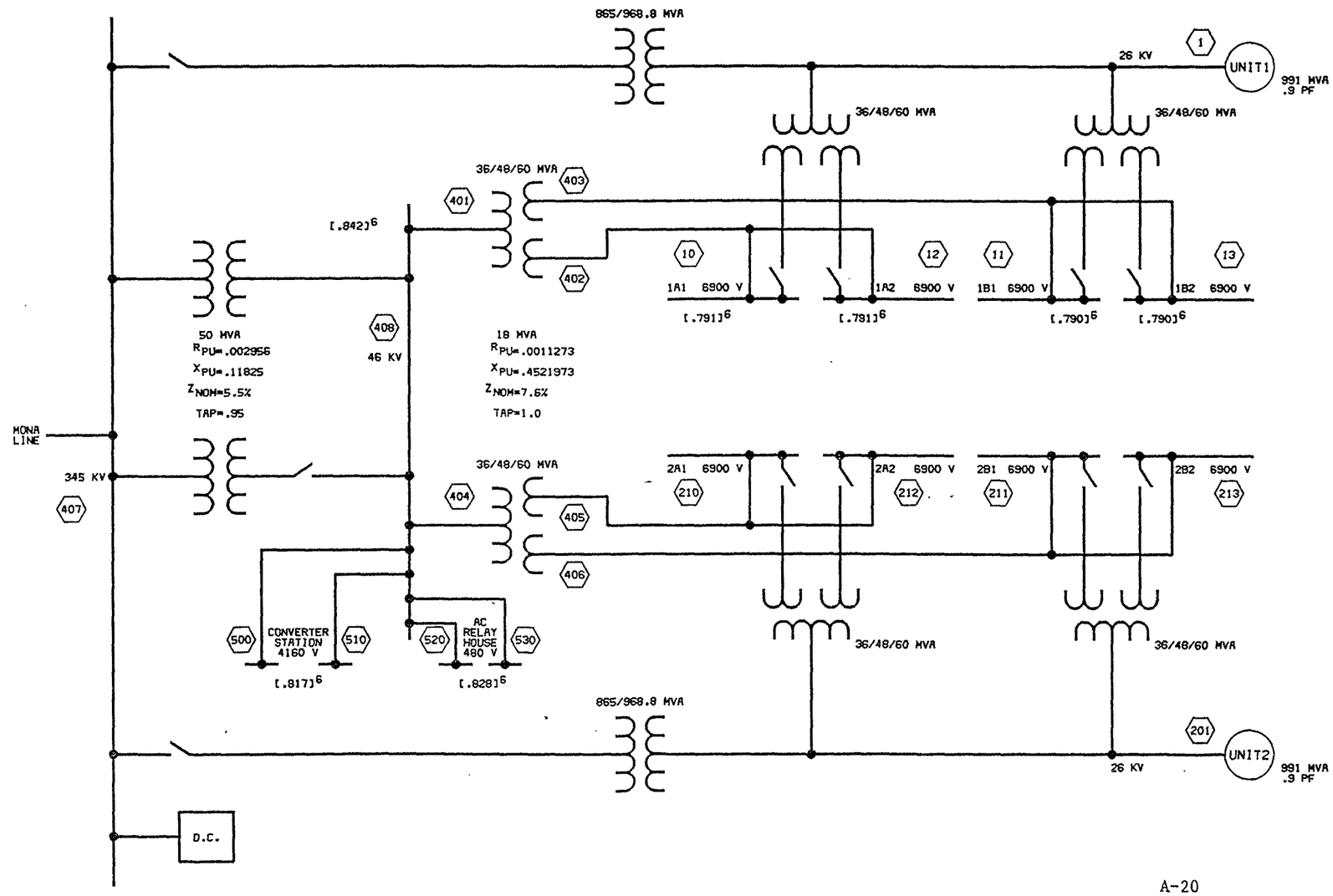

Figure A-19

	EXPANSION STUDY	FILE NO. 15119.42.0412
	AUXILIARY ELECTRIC SYSTEM	IPP 092789-0

LEGEND:

⬡ REFERS TO BUS NUMBER AS USED IN LOAD FLOW PROGRAM

[ ]XX NUMBER IN BRACKETS REFERS TO THE BUS VOLTAGE WHEN THE MONA LINE MVA CAPABILITY EQUALS 1000 THE VALUE OF THE SUPERSCRIPT.

TRANSFER

INPUT DATA CASE	DESCRIPTION
IGSPF19P	6000 MVA MONA LINE SOURCE

TWO UNIT TRANSFER. ONE 46 KV TRANSFORMER OUT OF SERVICE. THE GENERATORS FOR UNITS 1 AND 2 HAVE BEEN DISCONNECTED. BUS VOLTAGES HAVE BEEN CALCULATED WITH MOTOR RESIDUAL VOLTAGES LUMPED ONTO EACH SWITCHGEAR DURING TRANSFER.

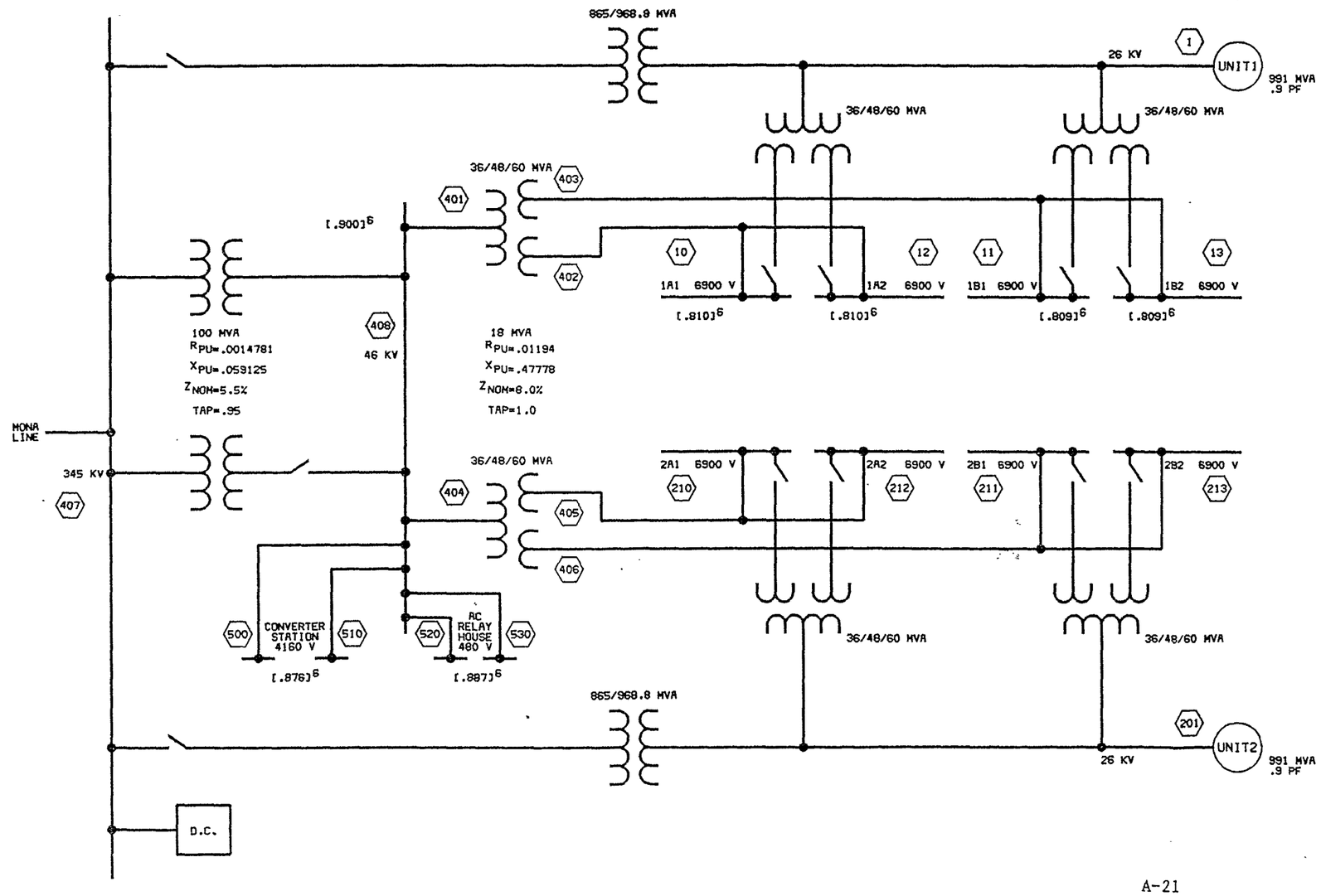

Figure A-20

APPENDIX B

EQUIPMENT IMPEDANCES

IP12_005278

EQUIPMENT IMPEDANCES

B.1 Generator, Generator Transformer, and Unit Auxiliary Transformer Impedances.

B.2 Segregated and Nonsegregated Phase Bus Duct Impedances for Auxiliary System.

B.3 46 kV Cable and Nonsegregated Bus Duct Impedances for Reserve Auxiliary System.

B.4 6.6 kV Motor Impedances.

B.5 6.6 kV Motor Cable Impedances.

B.6 SUS Cable Impedances.

B.7 SUS Transformer Impedances.

Data listed under the original column were derived from the original project load flow and fault studies dated July 9, 1987, Project 9255, B&V File 52.0401.

Data listed under the current column were derived from the latest available source (shop drawing, test data, or nameplates).

IP12_005279

B.1 GENERATOR, GENERATOR TRANSFORMER, AND UNIT AUXILIARY TRANSFORMER IMPEDANCES

Generator Impedance

Name	kVA	Current Impedance Value (X"d) R	Current Impedance Value (X"d) X	Original Impedance Value (X"d) R	Original Impedance Value (X"d) X
Generator 1	991,000	0.000191308	0.105731584	0.000191308	0.105731584

Transformer Impedances

Name	Winding	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
Unit Auxiliary Transformer 1A	H-X	18,000	6.62	38	6.43	40
	H-Y	18,000	6.65	38	6.43	40
	X-Y	18,000	12.52	47.5	12.86	40
Unit Auxiliary Transformer 1B	H-X	18,000	6.69	38	6.43	40
	H-Y	18,000	6.76	38	6.43	40
	X-Y	18,000	12.66	47.5	12.86	40
Generator Transformer		968,800	9.20	88	9.22	40

NOTE: Impedances are in percent on the transformer kVA rating.

IP12_005280

B.2 SEGREGATED AND NONSEGREGATED PHASE BUS DUCT IMPEDANCES FOR AUXILIARY SYSTEM

Segregated Phase Bus Impedance	Current Impedance Value		Original Impedance Value	
	R	X	R	X
Generator 1 to Generator Transformer 1	0.0000656	0.002010	0.0000656	0.002010
to Unit Auxiliary Transformer 1A	0.0004017	0.005386	0.0004017	0.005386
to Unit Auxiliary Transfomer 1B	0.0005690	0.007611	0.0005690	0.007611
Generator Transformer 1 to Substation	0.002062	0.002062	0.002062	0.002062

Nonsegregated Phase Bus Impedances	Current Impedance Value		Original Impedance Value	
	R	X	R	X
Unit Auxiliary Transformer 1A to Switchgear 1A1	0.0004915	0.006762	0	0.006638
Unit Auxiliary Transformer 1B to Switchgear 1B1	0.0004984	0.006853	0	0.006729
Unit Transformer 1A to Switchgear 1A2	0.0004709	0.006476	0	0.006358
Unit Auxiliary Transformer 1B to Switchgear 1B2	0.0004709	0.006476	0	0.006358

NOTE: Impedance values are in OHMS.

IP12_005281

B.3 46 kV CABLE AND NONSEGREGATED BUS DUCT IMPEDANCES FOR RESERVE AUXILIARY SYSTEM

46 kV Cable	Current Impedance Value		Original Impedance Value	
	R	X	R	X
46 kV Substation to Reserve Auxiliary Transformer 1	0.042074	0.119516	--	--
46 kV Substation to Reserve Auxiliary Transformer 2	0.035844	0.101851	--	--

Nonsegregated Phase Bus Duct	Current Impedance Value		Original Impedance Value	
	R	X	R	X
Reserve Auxiliary Transformer 1 to Switchgear 1A1	0.000872	0.011998	--	--
Reserve Auxiliary Transformer 1 to Switchgear 1B1	0.000863	0.011810	--	--
Switchgear 1A1 to Switchgear 1A2	0.000208	0.002857	--	--
Switchgear 1B1 to Switchgear 1B2	0.000208	0.002857	--	--
Switchgear 1A1 to Switchgear 1A3	0.012122	0.019791	--	--
Switchgear 1B1 to Switchgear 1B3	0.012534	0.020368	--	--

NOTE: Impedance values are in OHMS.

IP12_005282

B.4 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1A1

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1ECB-MP-1A-Closed Cycle Cooling Water Pump 1A	445	1.86	105.9	462	1.69	96.0
9CAA-CMP-1A Air Compressor 1A	647	0.95	31.3	647	0.95	31.3
1SGA-PLV-1A Pulverizer 1A	793	0.93	64.3	793	0.89	61.5
1SGA-PLV-1B Pulverizer 1B	793	0.93	64.3	793	0.89	61.5
1SGA-PLV-1C Pulverizer-1C	793	0.93	64.3	793	0.89	61.5
1SGA-PLV-1D Pulverizer 1D	793	0.93	64.3	793	0.89	61.5

NOTE: Impedance values are in OHMS.

IP12_005283

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1B1

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1ECB-MP-1B-Closed Cycle COoling Water Pump 1A	445	1.86	105.9	462	1.69	96.0
9CAA-CMP-1B Air Compressor 1B	647	0.95	31.3	647	0.95	31.3
1SGA-PLV-1E Pulverizer 1E	793	0.93	64.3	793	0.89	61.5
1GSA-PLV-1F Pulverizer 1F	793	0.93	64.3	793	0.89	61.5
1SGA-PLV-1G Pulverizer 1G	793	0.93	64.3	793	0.89	61.5
1GSA-PLV-1H Pulverizer 1H	793	0.93	64.3	793	0.89	61.5

NOTE: Impedance values are in OHMS.

IP12_005284

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1A2

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1HRC-MP-1B Circulating Water Pump 1B	1,961	0.27	12.5	1,848	0.26	12.0
1HRA-MP-1C Condensate Pump 1C	1,535	0.32	14.6	1,617	0.31	14.0
1HRA-MP-1A Condensate Pump 1A	1,535	0.32	14.6	1,617	0.31	14.0
1SGB-FAN-2A Primary Air Fan 2A	3,459	0.11	6.45	3,695	0.11	6.20
1GSB-MFAN-1A Forced Draft Fan 1A	5,921	0.07	4.12	6,005	0.06	3.70
1FWA-MP-1C Boiler Feed Pump 1C	6,693	0.07	3.87	6,467	0.06	3.50
1FWA-MP-2B Booster Boiler Feed Pump 2B	532	1.43	90.0	554	1.36	85.8
9CHD-CVY-18A Belt Conveyor 18A	370	2.40	120.7	370	2.40	120.7
1ASB-CMP 1A Fly Ash Compressor 1A	580	2.06	39.0	414	5.66	107.5
17QD-XF-1 LO Flush Pump	350	192	1,920	350	192	1,920

NOTE: Impedance values are in OHMS.

IP12_005285

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1B2

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1HRC-MP-1A Circulating Water Pump 1A	1,961	0.27	12.5	1,848	0.26	12.0
1HRA-MP-1B Condensate Pump 1B	1,535	0.32	14.6	1,617	0.31	14.0
1SGB-FAN-2B Primary Air Fan 2B	3,459	0.11	6.45	3,695	0.11	6.20
1SGB-MFAN-1B Forced Draft Fan 1B	5,921	0.07	4.12	6,005	0.06	3.70
1FWA-MP-2C Booster Boiler Feed Pump 2C	532	1.43	90.0	554	1.36	85.8
1FWA-MP-2A Booster Boiler Feed Pump 2A	532	1.43	90.0	554	1.36	85.8
1ASB-CMP-1C Fly Ash Compressor 1C	585	1.13	37.4	647	1.09	35.9
1ASB-CMP-1B Fly Ash Compressor 1B	585	1.13	37.4	647	1.09	35.9
1HRC-MP-1C Circulating Water Pump 1C	1,961	0.27	12.5	1,848	0.26	12.0

NOTE: Impedance values are in OHMS.

IP12_005286

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1A3

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1CCC-MP-1D Scrubber HP Spray Pump 1D	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2D Scrubber IP Spray Pump 2D	431	1.88	106.8	462	1.69	96.0
1CCC-MP-3E Scrubber LP Spray Pump 3E	431	1.88	106.8	462	1.69	96.0
1CCC-MP-1F Scrubber HP Spray Pump 1F	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2F Scrubber IP Spray Pump 2F	431	1.88	106.8	462	1.69	96.0
1CCC-MP-3C Scrubber LP Spray Pump 3C	431	1.88	106.8	462	1.69	96.0
9BMC-PLV-1A Limestone Pulverizer 1A	534	1.19	74.7	554	1.23	77.5
1CCC-MP-3A Scrubber LP Spray Pump 3A	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2B Scrubber IP Spray Pump 2B	431	1.88	106.8	462	1.69	96.0
1CCC-MP-1B Scrubber HP Spray Pump 1B	431	1.88	106.8	462	1.69	96.0

NOTE: Impedance values are in OHMS.

IP12_005287

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear 1B3

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
1CCC-MP-3D Scrubber LP Spray Pump 3D	431	1.88	106.8	462	1.69	96.0
1CCC-MP-1E Scrubber HP Spray Pump 1E	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2A Scrubber IP Spray Pump 2A	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2E Scrubber IP Spray Pump 2E	431	1.88	106.8	462	1.69	96.0
1CCC-MP-1A Scrubber HP Spray Pump 1A	431	1.88	106.8	462	1.69	96.0
1CCC-MP-3B Scrubber LP Spray Pump 3B	431	1.88	106.8	462	1.69	96.0
9BMC-PLV-1B Limestone Pulverizer 1B	534	1.19	74.7	554	1.23	77.5
1CCC-MP-3F Scrubber HP Spray Pump 3F	431	1.88	106.8	462	1.69	96.0
1CCC-MP-2C Scrubber IP Spray Pump 2C	431	1.88	106.8	462	1.69	96.0
1CCC-MP-1C Scrubber LP Spray Pump 1C	431	1.88	106.8	462	1.69	96.0

NOTE: Impedance values are in OHMS.

IP12_005288

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear C1

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
9CHB-CVY-4 Conveyor 4	323	2.89	138	323	2.89	138
9CHB-CVY-3 Conveyor 3	554	1.36	85.8	554	1.36	85.8
9CHB-CVY-8 Conveyor 8	370	2.40	123	370	2.40	123
9CHB-CVY-5A Conveyor 5A	462	1.67	95.3	462	1.67	95.3
9CHD-CRH-1A Crusher 1A	370	2.40	123	370	2.40	123
9CHB-CVY-2A Conveyor 2A	831	0.76	55.1	831	0.76	55.1

NOTE: Impedance values are in OHMS.

IP12_005289

B.4 (Continued) 6.6 kV MOTOR IMPEDANCES

6.6 kV Motor Impedances on Switchgear C2

Name	Current kVA	Current Impedance Value R	Current Impedance Value X	Original kVA	Original Impedance Value R	Original Impedance Value X
9CHB-CVY-2B Conveyor 2B	831	0.76	55.1	831	0.76	55.1
9CHD-CRH-1B Crusher 1B	370	2.43	124	370	2.43	124
9CHB-CVY-6 Conveyor 6	831	0.76	55.1	831	0.76	55.1
9CHB-CVY-5B Conveyor 5B	831	0.76	55.1	831	0.76	55.1

NOTE: Impedance values are in OHMS.

IP12_005290

B.5 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear 1A1

To	Original and Current Impedance Value R	X
1ECB-MP-1A-Closed Cycle Cooling Water Pump 1A	0.024757	0.014759
9CAA-CMP-1A Air Compressor 1A	0.006198	0.003809
1SGA-PLV-1A Pulverizer 1A	0.023805	0.014283
1SGA-PLV-1B Pulverizer 1B	0.024281	0.014283
1SGA-PLV-1C Pulverizer 1C	0.024757	0.014759
1SGA-PLV-1D Pulverizer 1D	0.025233	0.015235

NOTE: Impedance values are in OHMS.

IP12_005291

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 Motor Cable Impedances from Switchgear 1B1

To	Original and Current Impedance Value R	X
1ECB-MP-1B-Closed Cycle Cooling Water Pump 1B	0.022377	0.013331
9CAA-CMP-1B Air Compressor 1B	0.005237	0.002857
1SGA-PLV-1E Pulverizer 1E	0.017616	0.010950
1SGA-PLV-1F Pulverizer 1F	0.019520	0.011426
1SGA-PLV-1G Pulverizer 1G	0.020948	0.012379
1SGA-PLV-1H Pulverizer 1H	0.023853	0.013807

NOTE: Impedance values are in OHMS.

IP12_005292

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear 1A2

To	Original and Current Impedance Value R	X
1HRC-MP-1B Circulating Water Pump 1B	0.18849	0.16802
1HRA-MP-1C Condensate Pump 1C	0.008022	0.007151
1HRA-MP-1A Condensate Pump 1A	0.008684	0.007741
1SGB-Fan-2A Primary Air Fan 2A	0.015143	0.018339
1GSB-MFAN-1A Forced Draft Fan 1A	0.009003	0.016351
1FWA-MP-1C Boiler Feed Pump 1C	0.009365	0.017006
IFWA-MP-2B Booster Boiler Feed Pump 2B	0.018166	0.016187
9CHD-CVY-18A Belt Conveyor 18A	0.059073	0.052657
1CCE-MFAN-1A Induced Draft Fan 1A	0.009793	0.023905
1CCE-MFAN-1B Induced Draft Fan 1B	0.009793	0.023905
1ASB-CMP-1A Fly Ash Compressor 1A	0.043325	0.025709
17QD-XF-1 LO Flush Pump 1A	0.0556	0.0496

NOTE: Impedance values are in OHMS.

IP12_005293

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear 1B2

To	Original and Current Impedance Value R	X
1HRC-MP-1A Circulating Water Pump 1A	0.191806	0.170977
1HRA-MP-1B Condensate Pump 1B	0.009998	0.008922
1SGB-Fan-2B Primary Air Fan 2B	0.014569	0.026471
1SGB-MFAN-1B Forced Draft Fan 1B	0.009017	0.016378
1FWA-MP-2C Booster Boiler Feed Pump 2C	0.027780	0.024757
1FWA-MP-2A Booster Boiler Feed Pump 2A	0.025457	0.022696
1ASB-CMP-1C Fly Ash Compressor 1C	0.042235	0.037660
1ASB-CMP-1B Fly Ash Compressor 1B	0.043892	0.039126
1HRC-MP-1C Circulating Water Pump	0.188536	0.168016
1CCE-MFAN-1C Induced Draft Fan 1C	0.010455	0.025524
1CCE-MFAN-1D Induced Draft Fan 1D	0.010200	0.024900

NOTE: Impedance values are in OHMS.

IP12_005294

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear 1A3

To	Original and Current Impedance Value R	X
1CCC-MP-1D Scrubber HP Spray Pump 1D	0.005966	0.005318
1CCC-MP-2D Scrubber 1P Spray Pump 2D	0.006961	0.006204
1CCC-MP-3E Scrubber LP Spray Pump 3E	0.012598	0.011226
1CCC-MP-1F Scrubber HP Spray Pump 1F	0.015249	0.013593
1CCC-MP-2F Scrubber IP Spray Pump 2F	0.015911	0.014188
1CCC-MP-3C Scrubber LP Spray Pump 3C	0.014916	0.013283
9BMC-PLV-1A Limestone Pulverizer 1A	0.065835	0.058684
1CCC-MP-3A Scrubber LP Spray Pump 3A	0.004970	0.004432
1CCC-MP-2B Scrubber 1P Spray Pump 2B	0.011269	0.010046
1CCC-MP-1B Scrubber HP Spray Pump 1B	0.012264	0.010931

NOTE: Impedance values are in OHMS.

IP12_005295

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear 1B3

To	Original and Current Impedance Value R	X
1CCC-MP-3D Scrubber LP Spray Pump 3D	0.008617	0.007684
1CCC-MP-1E Scrubber HP Spray Pump 1E	0.010936	0.009760
1CCC-MP-2A Scrubber IP Spray Pump 2A	0.006630	0.005908
1CCC-MP-2E Scrubber IP Spray Pump 2E	0.012264	0.010934
1CCC-MP-1A Scrubber HP Spray Pump 1A	0.008289	0.007389
1CCC-MP-3B Scrubber LP Spray Pump 3B	0.010274	0.009160
9BMC-PLV-1B Limestone Pulverizer 1B	0.065845	0.058684
1CCC-MP-3F Scrubber HP Spray Pump 3F	0.018563	0.016549
1CCC-MP-2C Scrubber IP Spray Pump 2C	0.016906	0.015069
1CCC-MP-1C Scrubber LP Spray Pump 1C	0.018901	0.016844

NOTE: Impedance values are in OHMS.

IP12_005296

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear C1

To	Original and Current Impedance Value R	X
9CHB-CVY-4 Conveyor 4	0.042563	0.037945
9CHB-CVY-3 Conveyor 3	0.039583	0.035284
9CHB-CVY-8 Conveyor 8	0.011331	0.010108
9CHB-CVY-5A Conveyor 5A	0.016664	0.014835
9CHD-CRH-1A Crusher 1A	0.106875	0.095220
9CHB-CVY-2A Conveyor 2A	0.044220	0.039421

NOTE: Impedance values are in OHMS.

IP12_005297

B.5 (Continued) 6.6 kV MOTOR CABLE IMPEDANCES

6.6 kV Motor Cable Impedances from Switchgear C2

To	Original and Current Impedance Value R	X
9CHB-CVY-2B Conveyor 2B	0.047867	0.042659
9CHB-CRH-1B Crusher 1B	0.104885	0.093506
9CHB-CVY-6 Conveyor 6	0.051895	0.046229
9CHB-CVY-5B Conveyor 5B	0.013188	0.011760

NOTE: Impedance values are in OHMS.

IP12_005298

B.6 SUS CABLE IMPEDANCES

SUS Cable Impedances from Switchgear 1A1

To	Original and Current Impedance Value R	X
SUS 1A1 Turbine Area Primary	0.003315	0.002955
SUS 1A2 Boiler Area Primary	0.022996	0.020525
SUS 1A3 Plant	0.002321	0.002069
SUS 1A4 Plant	0.004310	0.003841
SUS 1A5 Plant	0.002652	0.002364
SUS 1A6 Plant	0.004970	0.004432
SUS 1A8 Plant	0.003315	0.002955
SUS 1A9 Upper Boiler	0.024265	0.021631
SUS 1A10 Upper Boiler	0.023603	0.021039
SUS C12 Sludge Treatment	0.208294	0.185679
SUS C14 Water Treatment	0.062509	0.113536
SUS C16 Water Treatment	0.004972	0.004432
CPT 37 Warehouses	0.343887	0.306551
CPT 34 Construction Materials Secyrutt Office	0.156468	0.139473
CPT 35 Welding Services Building	0.149109	0.132832

NOTE: Impedance values are in OHMS.

IP12_005299

B.6 (Continued) SUS CABLE IMPEDANCES

SUS Cable Impedances from Switchgear 1B1

To	Original and Current Impedance Value R	X
SUS 1B1 Turbine Area Primary	0.004641	0.004137
SUS 1B2 Boiler Area Primary	0.022542	0.020091
SUS 1B3 Plant	0.002652	0.002364
SUS 1B4 Plant	0.003646	0.003250
SUS 1B5 Plant	0.001657	0.001476
SUS 1B6 Plant	0.005304	0.004713
SUS 1B8 Plant	0.002983	0.002657
SUS 1B9 Upper Boiler	0.026454	0.023581
SUS 1B10 Upper Boiler	0.025790	0.022996
SUS C21 Onsite Reservoir	0.283280	0.252523
CPT 33 Site Service Building	0.241569	0.215197
CPT 17 Management Office Building	0.063655	0.056656
CPT 6 Administration Building	0.195201	0.174048
CPT 29 Well Pump 2	0.062845	0.056085

NOTE: Impedance values are in OHMS.

IP12_005300

B.6 (Continuted) SUS CABLE IMPEDANCES

SUS Cable Impedances from Switchgear 1A2

To	Original and Current Impedance Value R	X
ITGD-XF-1 Turbine LO Flush Pump	0.026471	0.023615
SUS 1A11 Cooling Tower	0.083606	0.51852

NOTE: Impedance values are in OHMS.

SUS Cable Impedances from Switchgear 1B2

To	Original and Current Impedance Value R	X
SUS 1B11 Cooling Tower	0.084474	0.153428

NOTE: Impedance values are in OHMS.

IP12_005301

B.6 (Continued) SUS CABLE IMPEDANCES

SUS Cable Impedances from Switchgear 1A3

To	Original and Current Impedance Value R	X
SUS 1A12 AQCS Control Building	0.008094	0.007387
SUS 1A13 AQCS Control Building	0.004310	0.003841
SUS C10 Limestone Preparation	0.069273	0.061750
SUS 1A14 Fabric Filter Building	0.028090	0.025376

NOTE: Impedance values are in OHMS.

SUS Cable Impedances from Switchgear 1B3

To	Original and Current Impedance Value R	X
SUS B12 AQCS Control Building	0.006298	0.005613
SUS B13 AQCS Control Building	0.001989	0.001773
SUS B4 Fabric Filter Building	0.027138	0.024229

NOTE: Impedance values are in OHMS.

IP12_005302

B.7 SUS TRANSFORMER IMPEDANCES

SUS Transformer Impedances From Switchgear 1A1

SUS	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
SUS 1A1 Turbine Area Primary	1,500	7.87	8.94	8	10
SUS 1A2 Boiler Area Primary	1,500	7.9	8.94	8	10
SUS 1A3 Plant	1,500	7.9	8.94	8	10
SUS 1A4 Plant	1,500	7.67	8.94	8	10
SUS 1A5 Plant	1,500	7.97	8.94	8	10
SUS 1A6 Plant	1,500	7.92	8.94	8	10
SUS 1A8 Plant	1,500	7.8	8.94	8	10
SUS 1A9 Upper Boiler	1,500	7.9	8.94	8	10
SUS 1A10 Upper Boiler	1,500	7.7	8.94	8	10
SUS C12 Sludge Treatment	1,500	7.9	8.94	8	10
SUS C14 Water Treatment	1,500	7.92	8.94	8	10
SUS C16 Water Treatment	1,500	7.9	8.94	8	10

NOTE: Impedance values are in percent on transformer kVA rating.

IP12_005303

B.7 (Continued) SUS TRANSFORMER IMPEDANCES

SUS Transformer Impedances From Switchgear 1B1

SUS	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
SUS 1B1 Turbine Area Primary	1,500	7.92	8.94	8	10
SUS 1B2 Boiler Area Primary	1,500	7.9	8.94	8	10
SUS 1B3 Plant	1,500	8.0	8.94	8	10
SUS 1B4 Plant	1,500	7.92	8.94	8	10
SUS 1B5 Plant	1,500	7.95	8.94	8	10
SUS 1B6 Plant	1,500	7.99	8.94	8	10
SUS 1B8 Plant	1,500	8.0	8.94	8	10
SUS 1B9 Upper Boiler	1,500	7.8	8.94	8	10
SUS 1B10 Upper Boiler	1,500	7.9	8.94	8	10
SUS C21 Onsite Reservoir	1,500	7.9	8.94	8	10

NOTE: Impedances are in percent on transformer kVA rating.

IP12_005304

B.7 (Continued) SUS TRANSFORMER IMPEDANCES

SUS Transformer Impedances From Switchgear 1A2

SUS	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
ITGD-XF-1 Turbine LO Flush Pump	750	5	10	5	10
SUS 1A11 Cooling Tower	2,500	7.9	9.704	8	10

NOTE: Impedances are in percent on transformer kVA rating.

SUS Transformer Impedances From Switchgear 1B2

To	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
SUS 1B11 Cooling Tower	2,500	7.8	9.704	8	10

NOTE: Impedances are in percent on transformer kVA rating.

IP12_005305

B.7 (Continued) SUS TRANSFORMER IMPEDANCES

SUS Transformer Impedances From Switchgear 1A3

SUS	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
SUS 1A12 AQCS Control Building	1,500	7.94	8.94	8	10
SUS 1A13 AQCS Control Building	1,500	7.7	8.94	8	10
SUS C10 Limestone Preparation	1,500	7.9	8.94	8	10
SUS 1A14 Fabric Filter Building	1,500	8.0	8.94	8	10

NOTE: Impedance values are in percent on transformer kVA rating.

SUS Transformer Impedances From Switchgear 1B3

SUS	kVA	Current Impedance Value percent	Current X/R	Original Impedance Value percent	Original X/R
SUS 1B12 AQCS Building	1,500	7.92	8.94	8	10
SUS 1B13 AQCS Building	1,500	7.94	8.94	8	10
SUS 1B14 Fabric Filter Building	1,500	7.86	8.94	8	10

NOTE: Impedance values are in percent on transformer kVA rating.

IP12_005306

INTERMOUNTAIN GENERATING STATION

INTERMOUNTAIN POWER PROJECT
INTERMOUNTAIN GENERATING STATION

AUXILIARY ELECTRIC SYSTEM
FAST TRANSFER TEST

PROJECT NO. 15119.320

IPP

INTERMOUNTAIN POWER PROJECT

BLACK & VEATCH/consulting engineers

INTERMOUNTAIN POWER PROJECT
INTERMOUNTAIN GENERATING STATION

AUXILIARY ELECTRIC SYSTEM
FAST TRANSFER TEST

PROJECT NO. 15119.320

Black & Veatch
Engineers-Architects

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APPENDIX B FAST TRANSFER TEST DATA RECORDING

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1.0 INTRODUCTION

This report presents the results of the fast transfer tests conducted at the Intermountain Generating Station on November 11, 1989.

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2.0 SUMMARY

2.1 SUMMARY OF IMPORTANT INFORMATION

Four fast transfer tests were made to verify that the variable frequency induced draft fan drives would remain operating during a fast transfer of the 6.9 kV switchgear power source bus from one source to another. In addition, various auxiliary electric system data were recorded for comparison to the previous Auxiliary Electric Expansion Study.

The induced draft drives remained in operation during each test with no significant change in operation. Westinghouse was present and supervised the recording of data during the test.

The 6.9 kV auxiliary electric system data were analyzed and the alternate source breaker closure was quicker than estimated by the study, resulting in higher recovery voltage and lower inrush currents. It is expected that the proposed reserve auxiliary electric system will exhibit more conservative recovery voltages than estimated by the study.

2.2 CONCLUSION

The tests support the viability of an auxiliary electric system fast transfer scheme using the proposed reserve power source. The system performance should be similar to that estimated by the previous study, but recovery voltages are expected to be more conservative.

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3.0 TEST

3.1 OBJECTIVES

The Intermountain Power Project intends to expand the auxiliary electric system by the addition of a reserve power source. A previous study, Auxiliary Electric System Expansion Study, File No. 15119.42.0412, was made to determine the feasibility and configurations of a reserve power source which would allow a safe fast transfer of the auxiliary system load. The study determined that a safe fast transfer is feasible, but recommended that tests be performed to verify the response of the induced draft fan variable frequency drives to a fast transfer.

Based on the study recommendations, the fast transfer tests were performed to verify induced draft fan drive response. In addition, data were collected to verify the auxiliary electric system response to the fast transfer.

The test procedure was drafted by Black & Veatch and transmitted to Intermountain Power Project by letter of October 6, 1989, File 15119.320. The test procedure was reviewed and issued by Intermountain Power Project as Fast Transfer Test, Rev 0, October 1989. The test procedure is included in Appendix A.

The test included four fast transfers. The first test was to determine the effect of a fast transfer on only one ID fan drive power source. The second test was to determine the effect of a fast transfer on the ID fan drive exciter power source as well as the power source. The third test was the same as the first except both ID fan drives were transferred. The fourth test was the same as test three, except the primary air fan was running. This was done to determine if the voltage and frequency of the bus would be enhanced by the primary air fan's contribution.

3.2 DATA

Data were recorded at the variable frequency drives and at the 6,900 volt switchgear with recorders. The manufacturer of the drives, Westinghouse, determined the drive parameters to be recorded, and a service

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representative was present during the test. The drive data were recorded on an ASTRO-MED recorder and are included in Appendix B.

The data recorded at the 6,900 volt switchgear were recorded on an ASTRO-MED recorder and a GOULD recorder. Two recorders were used for redundancy. The recorder channel settings and recorded variables are listed in Tables 3-1 and 3-2. The ASTRO-MED and GOULD recordings are included in Appendix B.

In addition to the recorder data, the switchgear electric loads were recorded prior to and after each test. These data are listed in Table 3-3.

3.3 ANALYSIS

The induced draft fan variable frequency drives did not open the drive output contactor or trip the incoming power supply breakers during any of the tests.

The lowest recorded 6.9 kV switchgear bus residual voltage was approximately 4,700 volts (0.68 per unit [PU]). This is slightly less than the 0.7 PU value that was indicated by Westinghouse to be the pickup setting for tripping the drive. Westinghouse has indicated that this is a delayed trip, and, in this case, it was demonstrated that the unit did not trip during the four-cycle transfer.

Test 2 included transfer of the exciter power supply. The voltage at the 6.9 kV switchgear Bus 1A1 which supplies power to the exciter dropped to 5,091 volts (0.73 PU). The drive graph recorded during this test indicates a change in gate firing angles which did not occur in any of the other tests. In addition, the fan drive trouble alarms actuated, but cleared. Westinghouse will provide a report on the test results which should address these items.

Table 3-4 lists selected results derived from the recordings taken at the 6.9 kV switchgear during each transfer test. The results for Test 1 indicate that the differential voltage between the bus residual voltage and the incoming source voltage is 0.40 PU. This value is less than the 1.33 PU requirement generally recognized as a safe motor transfer voltage differential and the 0.73 PU estimated by the auxiliary electric system study.

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TABLE 3-1. FAST TRANSFER TEST ASTRO-MED RECORDER CHANNEL SETTINGS AND INPUTS

Channel	Channel Scale and Range	Input Variable Units and Range	Variable			
			Test 1	Test 2	Test 3	Test 4
1	10 V/Div ±250 V Inst	Volts ±250 V Inst	Generator 1 Bus Voltage (Note 1)	6,900 V Swgr 1A1 Main Volts	Generator 1 Bus Voltage	Generator 1 Bus Voltage
2	10 V/Div ±250 V Inst	Volts ±250 V Inst	6,900 V Swgr 1A2 Volts	6,900 V Swgr 1A1 Volts	6,900 V Swgr 1A2 Volts	6,900 V Swgr 1A2 Volts
3	2 V/Div ±50 V Inst	Volts ±50 V Inst	Generator 1 - Swgr 1A2 Volts	6,900 V Swgr 1A1 Main - Bus Volts	Generator 1 - Swgr 1A2 Volts	Generator 1 - Swgr 1A2 Volts
4	20 MV/Div +1 V Inst	Degrees 0-18 Deg	Generator 1 - Swgr 1A2 Volt. Phase Angle	6,900 V Swgr 1A1 Main - Bus Phase Angle	Generator 1 - Swgr 1A2 Volt. Phase Angle	Generator 1 - Swgr 1A2 Volt. Phase Angle
5	1 MV/Div ±25 MV Inst	Amps (0.01 ohm shunt) ±2.5 A Inst	6,900 V Swgr 1A2 Main Amps	6,900 V Swgr 1A2 Main Amps	6,900 V Swgr 1A2 Main Amps	6,900 V Swgr 1A2 Main Amps
6	50 MV/Div ±1,250 MV Inst	Amps (0.1 ohm shunt) ±12.5 A Inst	Condensate Pump 1A Amps	6,900 V Swgr 1A1 Main Amps	Belt Conv 18A Amps	Primary Air Fan 2A Amps
7	5 MV/Div ±125 MV Inst	Amps (0.01 ohm shunt) ±12.5 A Inst	Circ Water Pump 1B Amps	Circ Water Pump 1B Amps	Circ Water Pump 1B Amps	Circ Water Pump 1B Amps
8	1 MV/Div ±25 MV Inst	Amps (0.01 ohm shunt) ±2.5 A Inst	Forced Draft Fan 1A Amps	Forced Draft Fan 1A Amps	Forced Draft Fan 1A Amps	Forced Draft Fan 1A Amps

NOTE 1: Generator 1 bus voltage is equivalent to Swgr 1A2 main source voltage (equivalent PT ratio 7200:120).

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TABLE 3-2. FAST TRANSFER TEST GOULD RECORDER CHANNEL SETTINGS AND INPUTS

Channel	Channel Scale and Range	Input Variable Units and Range	Variable
1	10 V/Div ±250 V Inst	Volts ±250 V Inst	Same as for Astro-Med
2	10 V/Div ±250 V Inst	Volts ±250 V Inst	Same as for Astro-Med
3	10 V/Div ±250 V Inst	Volts ±250 V Inst	Same as for Astro-Med
4	0.2 V/Div 10 V Inst	Volts 0-180 Deg	Same as for Astro-Med
5	2 MV/Div ±50 MV Inst	Amps (0.01 ohm shunt) ±5 A Inst	Same as for Astro-Med
6	50 MV/Div ±1,250 MV Inst	Amps (0.1 ohm shunt) ±12.5 A Inst	Same as for Astro-Med
7	5 MV/Div ±125 MV Inst	Amps (0.01 ohm shunt) ±12.5 A Inst	Same as for Astro-Med
8	5 MV/Div ±125 MV Inst	Amps (0.01 ohm shunt) ±12.5 A Inst	Same as for Astro-Med

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TABLE 3-3. FAST TRANSFER TEST SWITCHGEAR LOADING

Test		Switchgear 1A2			Switchgear 1A1		
		MW	MVARS	AMPS RMS	MW	MVARS	AMPS RMS
1	Before Transfer	6	9	900	--	--	--
	After Transfer	6	9	900	--	--	--
2	Before Transfer	5	8	800	7	4	700
	After Transfer	5	8	800	6	4	600
3	Before Transfer	5	10	1,000	--	--	--
	After Transfer	5	10	1,000	--	--	--
4	Before Transfer	6	12	1,100	--	--	--
	After Transfer	6	12	1,100	--	--	--

NOTES:

1. During Test 2, Condenser Vacuum Pump 1A and 1B tripped, limestone conveyors tripped, and ID Fans 1A1 and 1A2 had trouble alarms which cleared.

2. Data are from auxiliary electric panel meters.

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TABLE 3-4. FAST TRANSFER TEST RESULTS DERIVED FROM RECORDER TRACES[1]

				At Reconnect, T=0-			After Reconnect											
													Channel 6		C. W. Pump		F. D. Fan	
Test	Tie Bkr Open Time Hz	Main Bkr Close Time Hz	Bus Disconnect Time Hz	ΔV V Rms[2] kV	Phase Angle, Degrees[3]	ΔV, P.U. 6.6 kV Base	Bus Volts Min Rms	Bus Volts Run Rms	Time to V Run, Hz (Recovery Time)	Main Amps Max[4] Rms	Main Amps Run[4] Rms	Main Amps Max/Min[4]	Amps Max Rms	Amps, Max Amps, L.R.	Amps Max Rms	Amps, Max Amps, L.R.	Amps Max Rms	Amps, Max Amps, L.R.
1 Swgr 1A2	2.25	6.25	4	2.7	22	0.40	6.6	6.8	26	1,800	900	2	Cond Pump 1A 282	0.33	435	0.43	537	0.23
2 Swgr 1A1	2.5	6.25	3.75	2.8	22	0.42	6.6	6.9	26	2,863	636	4.5	Swgr 1A1 Main Amps 2,863	--	403	0.40	510	0.22
3 Swgr 1A2	2.25	6.5	4.25	2.9	22	0.43	6.5	6.9	26	2,250	1,000	2.25	Belt Cnv 18A 172	1.06	424	0.42	537	0.23
4 Swgr 1A2	2.5	6.5	4	2.7	15	0.40	6.5	6.7	34	2,062	1,100	1.87	PA Fan 2A 601	0.31	413	0.41	480	0.20

NOTE:

[1]All voltages and current are converted from measured peak-to-peak value to actual rms value at switchgear voltage level.

[2]From Channel 3, checked against Channel 1 versus Channel 2.

[3]Determined from Channel 1 versus Channel 2. Channel 4 trace is not valid.

[4]Channel 5 trace not valid. Table data from switchgear loading chart and Channel 5 max/min trace ratio, for Switchgear 1A2 only.

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The low differential is primarily due to the alternate source breaker closing time of 6.25 cycles resulting in 22-degree phase differential versus the studies' estimate of a 9 cycle breaker closing time and 42 degrees.

The main breaker inrush current, 1,800 amps, was only two times the running current and less than system rated current. The condensate pump, circulating water pump, and forced draft fan motor inrush amperes were all less than locked-rotor amperes by a considerable margin. These currents are below levels required to prevent excessive motor torques.

The low inrush currents also account for the high recovery voltage of 6.6 kV. The system voltage stabilized at 6.8 kV after 26 cycles without any sign of instability.

Test 2 showed similar results for the fast transfer of Bus 1A1 except the inrush current is higher, but not excessive. This could be due to the larger secondary unit substation loading which tends not to support voltage and frequency of the system and, therefore, exhibits higher inrush currents on re-energization.

Test 3 is similar to Test 1, but shows the effect of the additional ID fan drive reactive loading. The voltage differential increased, while the phase angle remained the same. This loading caused a slightly higher main breaker inrush amperes, but it is still acceptable. The belt Conveyer 18A motor inrush current to rated lock rotor current ratio was 1:06. If the 1:33 volt/Hz guideline is utilized, the maximum ratio would be 1.33; therefore, this is acceptable.

Test 4 demonstates the effect of the bus increased inertia due to the addition of the primary air fans to the running load of Test 3. The result was a decreased phase angle difference and, consequently, a reduced voltage differential and current inrushes. The main breaker current inrush decreased eight percent from that of Test 3 as a result of the decreased motor inrush currents.

During Test 2, the Condenser Vacuum Pumps 1A and 1B tripped. Review of the schematics indicate seven trip actions possible: Seal Water Temperature High, Seal Water Flow Low, Relay CR-1A dropped out, Relay A01 dropped out, the motor contactor dropped out, the motor overload relay

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actuated, or the motor inrush current exceeded the breaker magnetic pickup setting. Of these, the only potential trips under the fast transfer conditions are Relays CR-1A or Relay A01 dropping out or a breaker magnetic trip. It is doubtful that the relays would drop out due to the short duration of low voltage and the fact that many other relays would have dropped out. The inrush could last long enough and contain a dc offset not normally seen by the breaker to cause a magnetic trip. The breaker settings should be increased as a precaution against future tripping.

These test results cannot be compared directly to the study because the proposed reserve auxiliary electric system and transferred loads are not identical to the test system and loads. Generalizations, though, can be made. The test differential voltages and phase angles are less than assumed in the study and the test inrushes were therefore less than in the studies. Since the test system impedances are less than the proposed reserve auxiliary system impedances, recovery voltages proved to be greater than estimated by the study. When a transfer to the new reserve system occurs, the higher system impedance should result in a lower recovery voltage and inrush currents than recorded in the tests. As a result, the time to full voltage will increase since initial recovery voltage will be less, causing a decrease in motor torque.

Overall, the proposed reserve system should result in recovery voltages greater than the study estimates because the actual transfer time is less than the estimated transfer time.

APPENDIX A

FAST TRANSFER TEST SETUP AND PROCEDURES

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EQUIPMENT BID AND RECORD

Requested by JON P CHRISTENSEN Div. TECH Sec. SERVICE Submitted by _____ (Operator) _____ (Time) AM PM _____ (Date)

Out of Service Clearance O.K TO — TO JON P CHRISTENSEN (Responsible Party) Div. Sec. TECH SERVICES

EQUIPMENT REQUESTED: 6.9 SWGR 1A1, 1A2 AND ID FAN 1A VARIABLE SPEED DRIVES

NATURE OF WORK: FAST TRANSFER TEST PER ATTACHED DESCRIPTION

Bid from 0100* (Time) AM ~~PM~~ 11/11/89 (Date) To 0500 (Time) AM ~~PM~~ 11/11/89 (Date)

Work Time from 0115 (Time) AM ~~PM~~ 11/11/89 (Date) To 0445 (Time) AM ~~PM~~ 11/11/89 (Date)

PREPARATION REQUIRED:

* AS SOON AS ~~THE~~ UNIT 1 COMES OFF LINE, IS STABILIZED AND THE ~~AUXILIARY POWER EQUIPMENT~~ 6.9 SWGR AND ASSOCIATED EQUIPMENT BECOMES AVAILABLE

BID APPROVED:

Shift Supv. _____ Time _____ AM PM Date _____ Removed by _____ Time _____ AM PM Date _____

Supt. _____ Time _____ AM PM Date _____ Issued to _____ Time _____ AM PM Date _____

Dispatcher _____ Time _____ PM Date _____ Returned by _____ Time _____ PM Date _____

EQUIPMENT NORMAL: Time _____ AM PM Date _____ By _____ (Operator) _____ (Foreman)

Remarks: _____

IP12_005321

FAST TRANSFER TEST

The primary purpose of the fast transfer test is to insure that the variable frequency induced draft fan drives will remain in operation during a 6.9 kV power source transfer. During testing, additional data will be gathered to verify conclusions of the Auxiliary Electric System Expansion Study prepared by Black and Veatch. The procedure for this test was developed by Black & Veatch under the direction of LADWP PD&C. Westinghouse was retained to provide consulting service on the operation of the variable frequency drives.

TEST SET UP

1. Connect monitoring equipment for voltage and current signals to the recorder in the 6.9 kV Switchgear Room.
   A. Connect a temporary cable to synchronizing circuit in 1GTC-JBX-35 (Reference Sketch 15119.320-1). Work to be performed by IPSC relay technicians.
   B. Connect to potential transformer circuit in switchgear 1A1 cubicle 1 (main circuit breaker). Connection to be made to existing terminal block. Work to be performed by IPSC relay technicians.
   C. Connect to current transformer circuit in Switchgear 1A2 cubicle 1 (main circuit breaker). Connection to be made to existing terminal block. Work to be performed by IPSC relay technicians.
   D. Connect to current transformer circuits in Switchgear 1A2 cubicles 6,7,10,12,and 15 (FD Fan 1A,PA Fan 2A,Condensate Pump 1A, Circulating Water Pump 1B, and Belt Conveyor 18A). Connections to be made on existing terminal blocks. Work to be performed by IPSC relay technicians.
   E. Connect ID Fan recording equipment to ID Fan 1A variable frequency drives. Requires a Clearance on drive links 1A1 and 1A2 (links to be cleared one at a time to keep the ID Fan in service). Clearance must include associated 6.9 kV circuit breakers in Switchgear 1A2.(Cubicles 2 and 3). Work to be performed on 11/09 and 11/10/89 by IPSC electricians.
   F. Perform test transfers of the Auxiliary Power as detailed in the test procedure. Test to be performed from 1:00 AM to 5:00 AM on 11/11/89. Start of test depends upon when the Unit 1 equipment becomes available for test.

TEST PROCEDURE

Test #1

Reference: Single line diagram (Sketch 1)

1. Verify with Operations that the 6.9 kV Bus is available for Fast Transfer Test after the Unit comes off line. Pick up OK TO TEST.

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2. Connect test panel lockout relay to Bus 1A2 main and tie circuit breakers.

3. Verify the inputs to the recorder are correct as indicated on the CT and PT connection diagram.

4. Verify motor loads as indicated on the 1A2 Bus loading chart.

5. Close Bus 1A2 tie circuit breaker and open the 1A2 main circuit breaker. Verify the control switch is in "After trip position" and not "Pull to Lock".

6. Verify that Westinghouse is ready to record test at ID Fan 1A.

7. Count down to Westinghouse and then turn fast transfer test switch to "ON".Verify recorders are running. There is a two second delay allowing time to stop the test if necessary. Fast transfer test panel trips Bus 1A2 maintenance tie breaker and closes the main circuit breaker simultaneously.

8. After bus transfer, watch recorder traces stabilize and turn test transfer switch to "OFF". Reset lockout relay, clear tie breaker alarms, collect and label test recorder data, collect fault recorder data and reset fault recorder.

<u>Test #2</u>

References: Single line Diagram (Sketch 2)

1. Verify with operations that they are ready for test.

2. Connect test panel lockout relay to Bus 1A1 tie circuit breaker and main circuit breaker.

3. Verify inputs to the recorders are correct.

4. Verify with Operations that the motor loads are correct with the loading schedule.

5. Close 1A2 tie circuit breaker and then open the main circuit breaker. Verify that the control switches are in the "After trip" and not "Pull to Lock" position.

6. Close the 1A1 tie circuit breaker and than open the main circuit breaker. Verify the control switches are in the "After trip" and not in the "Pull to lock" position.

7. Verify that Westinghouse is ready to record test at ID fan 1A.

8. Count down to Westinghouse and then turn the fast transfer switch to "ON". Verify recorder is running. Two seconds are allowed to stop the test if necessary. Test panel simultaneously trips the maintenance tie circuit breakers for bus 1A1 and 1A2 and closes the main circuit breakers.

9. After bus transfer watch recorder traces until they stabilize and turn fast transfer switch "OFF".

10. Reset lockout relay,clear circuit breaker alarms,collect and label data, collect fault recorder data and reset fault recorder.

11. Remove connections to the Bus 1A1 tie circuit breaker trip circuit and main circuit breaker close circuit.

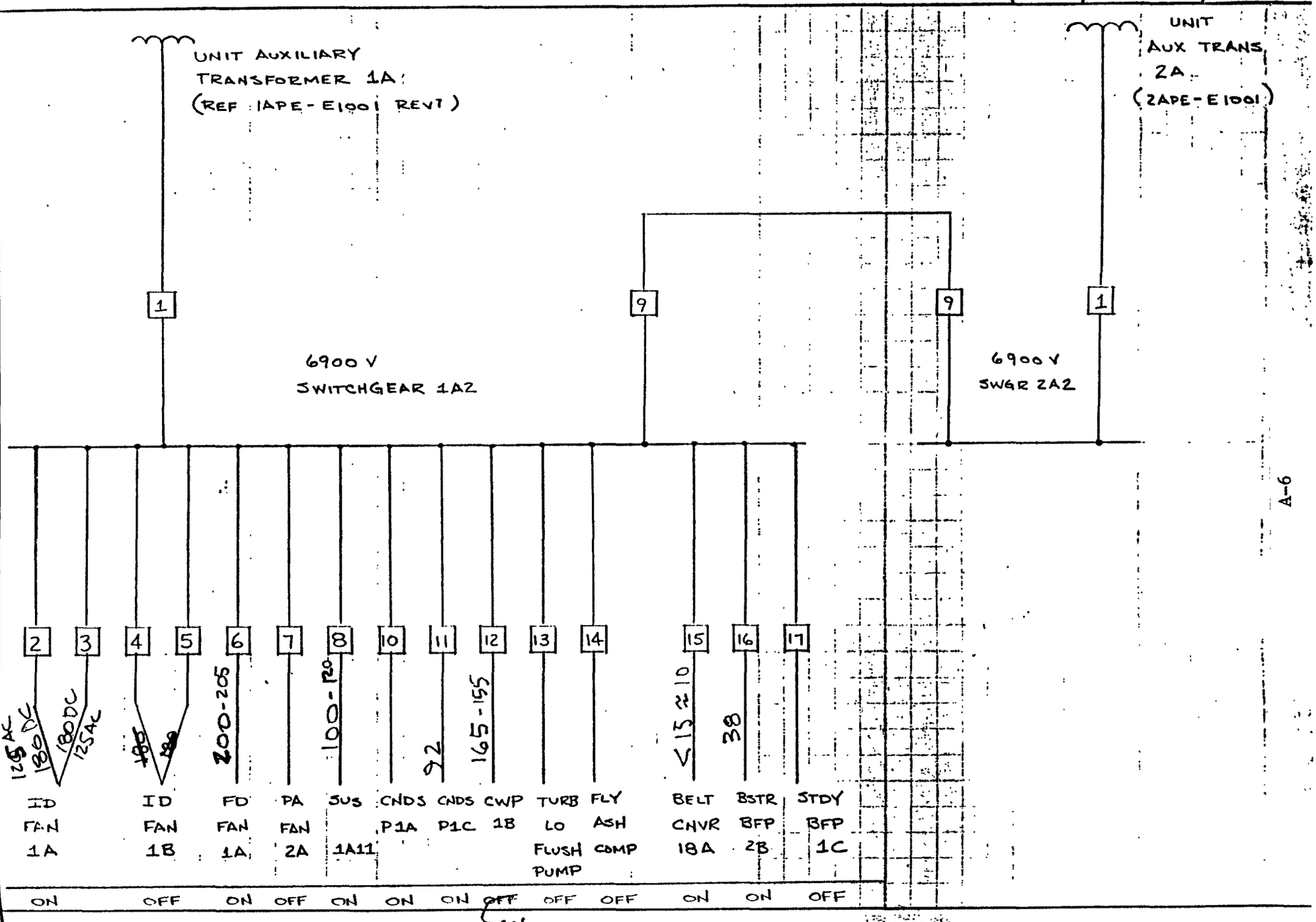
Test #3 and 4

Single line diagrams (Sketches 3 and 4)

1. Follow the same procedure for test 1. Pay particular attention to the bus loading. Test #3 adds ID fan 1B to the load on the bus and Test #4 adds both ID fan 1B and PA fan 2A.

FAST TRANSFER TEST 1

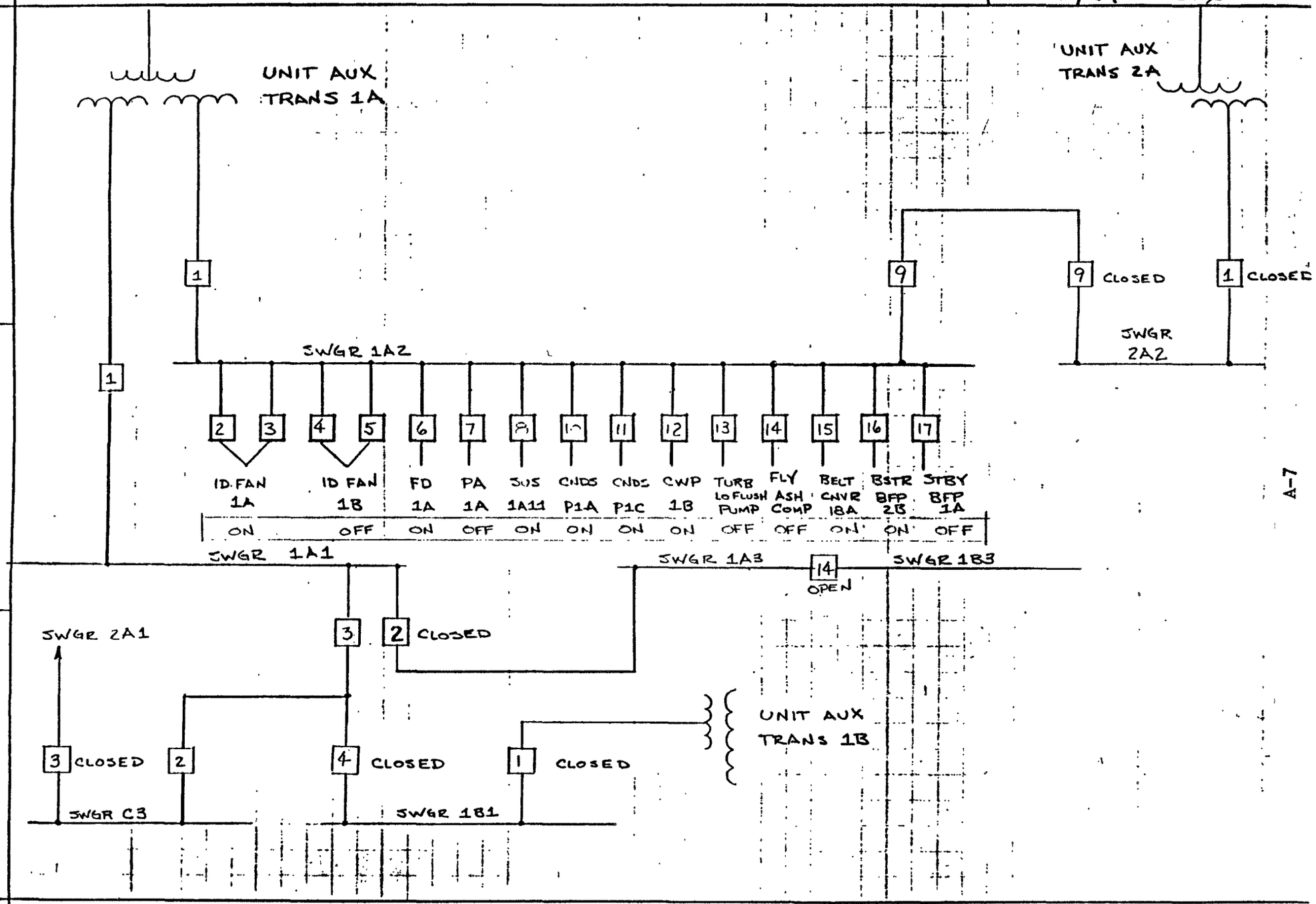
SKETCH 1 4PC 10/89 REV Ø



A-6

IP12_005325

FAST TRANSFER TEST 2 SKETCH 2 4PC 10/89 REV Ø

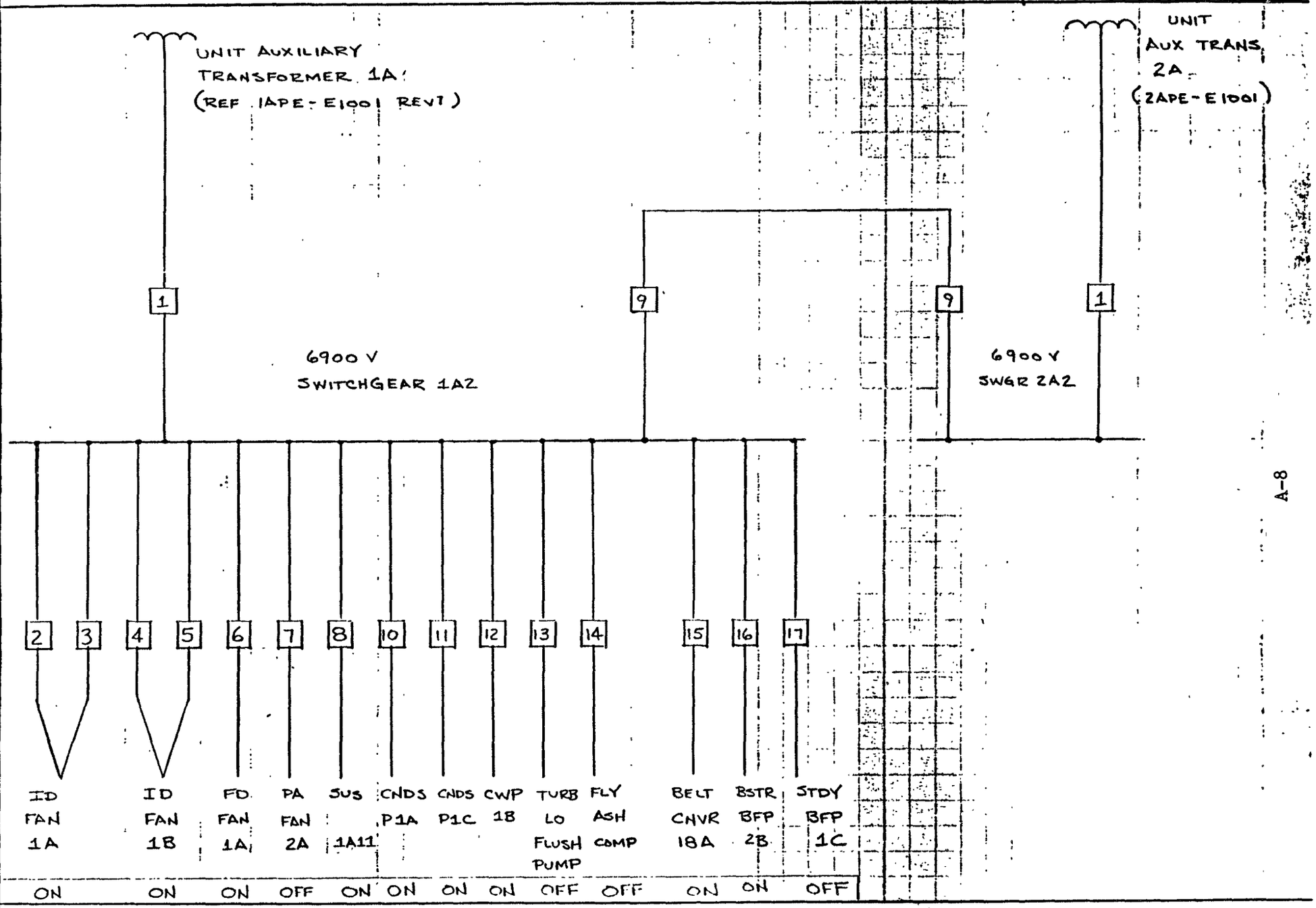


A-7

IP12_005326

FAST TRANSFER TEST 3

SKETCH 3 APC 10/89 REV Ø

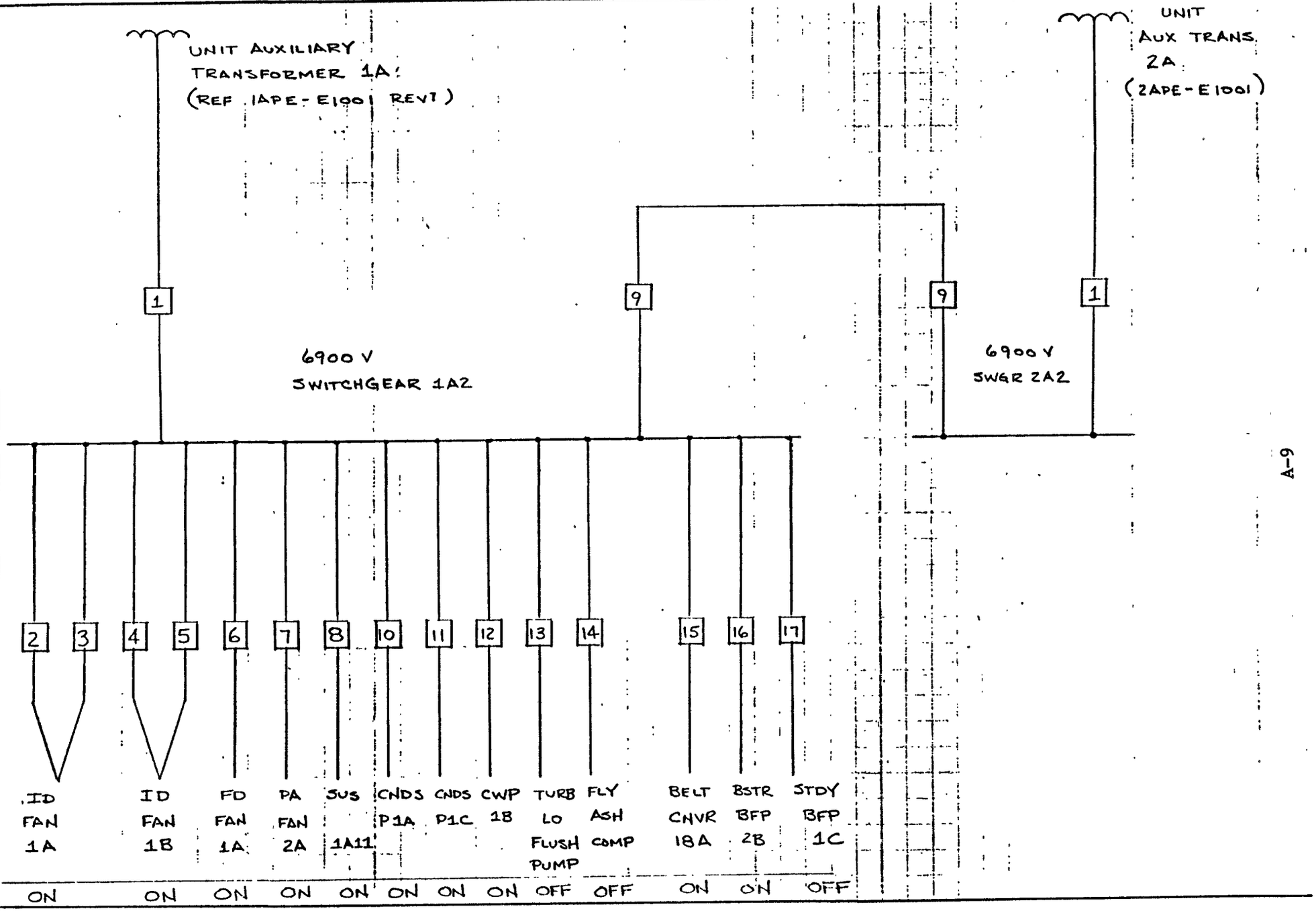


A-8

IP12_005327

FAST TRANSFER TEST 4

SKETCH 4 4PC 10/89 REV Ø



A-9

IP12_005328

BLACK & VEATCH ENGINEERS-ARCHITECTS

Owner LADWP
Plant IPP Unit
Project No. 15119.320 File No.
Title FAST TRANSFER TEST-BUS 1A2

Computed By Walthall
Date 10/15 19 89
Checked By
Date 19
Page 1 of 2

DO NOT WRITE IN THIS SPACE

BUS 1A2 LOADING

LOAD	QTY	TEST 1 STATUS	TEST 1 LOAD	TEST 2 STATUS	TEST 2 LOAD	TEST 3 STATUS	TEST 3 LOAD	TEST 4 STATUS	TEST 4 LOAD
FORCED DRAFT FAN	1	ON	2083 KVA (2296)	ON	2083 KVA	ON	2083 KVA	ON	2083 KVA
PRIMARY AIR FAN	1	OFF	—	OFF	—	OFF	—	ON	1037 KVA (2296)
CIRCULATING WTR PP	1	ON	980 KVA (1886)	ON	980 KVA	ON	980 KVA	ON	980 KVA
CONDENSATE PUMP	2	ON	767 KVA (1257)	ON	767 KVA	ON	767 KVA	ON	767 KVA
BOILER FEED PUMP	1	OFF	—	OFF	—	OFF	—	OFF	—
BOILER FEED BOOSTER PUMP	1	ON	174 KVA (457)	ON	174 KVA	ON	174 KVA	ON	174 KVA
FLY ASH COMPRESSOR	1	OFF	—	OFF	—	OFF	—	OFF	—
BELT CONVEYOR	1	ON	129 KVA	ON	129 KVA	ON	129 KVA	ON	129 KVA
480 VOLT SUS	1	ON	400 KVA (1143)	ON	400 KVA	ON	400 KVA	ON	400 KVA
ID FAN 1A	1	ON	2463 KVA (2154)	ON	2463 KVA	ON	2198 KVA	ON	2198 KVA
ID FAN 1B	1	OFF	—	OFF	—	ON	2198 KVA	ON	2198 KVA
TOTAL KVA			6996 KVA		6996 KVA		8929 KVA		9966 KVA
TOTAL KW			4200 KW		4200 KW		4212		4834 KW

LOADS ARE ESTIMATED BASED ON UNIT OFF LINE AND ARE NOT SPECIFICALLY REQUIRED FOR TEST. ACTUAL LOADING WILL BE DETERMINED BY CONDITIONS AT TIME OF TEST. HIGHER KW LOADS ARE DESIRABLE.

P-GN-172A

REVISED, SUPERSEDE LATIONS MUST BE CLEARLY IDENTIFIED, INITIALED, AND DATED BY THE ... DUAL

IP12_005329

BLACK & VEATCH ENGINEERS-ARCHITECTS

Owner: LADWP
Plant: IPP Unit: 1
Project No. 15119.320 File No.
Title: FAST TRANSFER TEST - BUS 1A1/1A3 TRANSFERED DURING TEST 2 ONLY

Computed By: Walt Collins
Date: 10/5 19 89
Checked By:
Date: 19
Page 2 of 2

BUS 1A1 / 1A3 LOADING TEST 2

LOAD	QTY	TEST 1	TEST 2	TEST 3	TEST 4
PULVERIZERS	4	OFF	OFF	OFF	OFF
AIR COMPRESSOR	1	AUTO	AUTO	AUTO	AUTO
CLOSED CYCLE CLG WTR PUMP	1	AUTO	ON	AUTO	AUTO
SCRUBBER SPRAY PUMP	9	OFF	ON	OFF	OFF
LIMESTONE PULV	1	OFF	ON	OFF	OFF
480 VOLT SUS	16	ON	ON	ON	ON

ESTIMATED LOAD DURING TEST 2

CLOSED CYCLE CLG WTR PUMP	268 KVA	1 = .8
SCRUBBER SPRAY PUMPS	1274 KVA	1 = .65
LIMESTONE PULV	175 KVA	= .65
480 VOLT SUS'S	3228 KVA	
TOTAL KVA	4945 KVA	
TOTAL KW	3922 KW	

DO NOT WRITE IN THIS SPACE

PGN-172A

REVISED, SUPERSEDED AND DATED BY THE RESPONSIBLE INDIVIDUAL. TIONS MUST BE CLEARLY IDENTIFIED, INITIALED,

IP12_005330

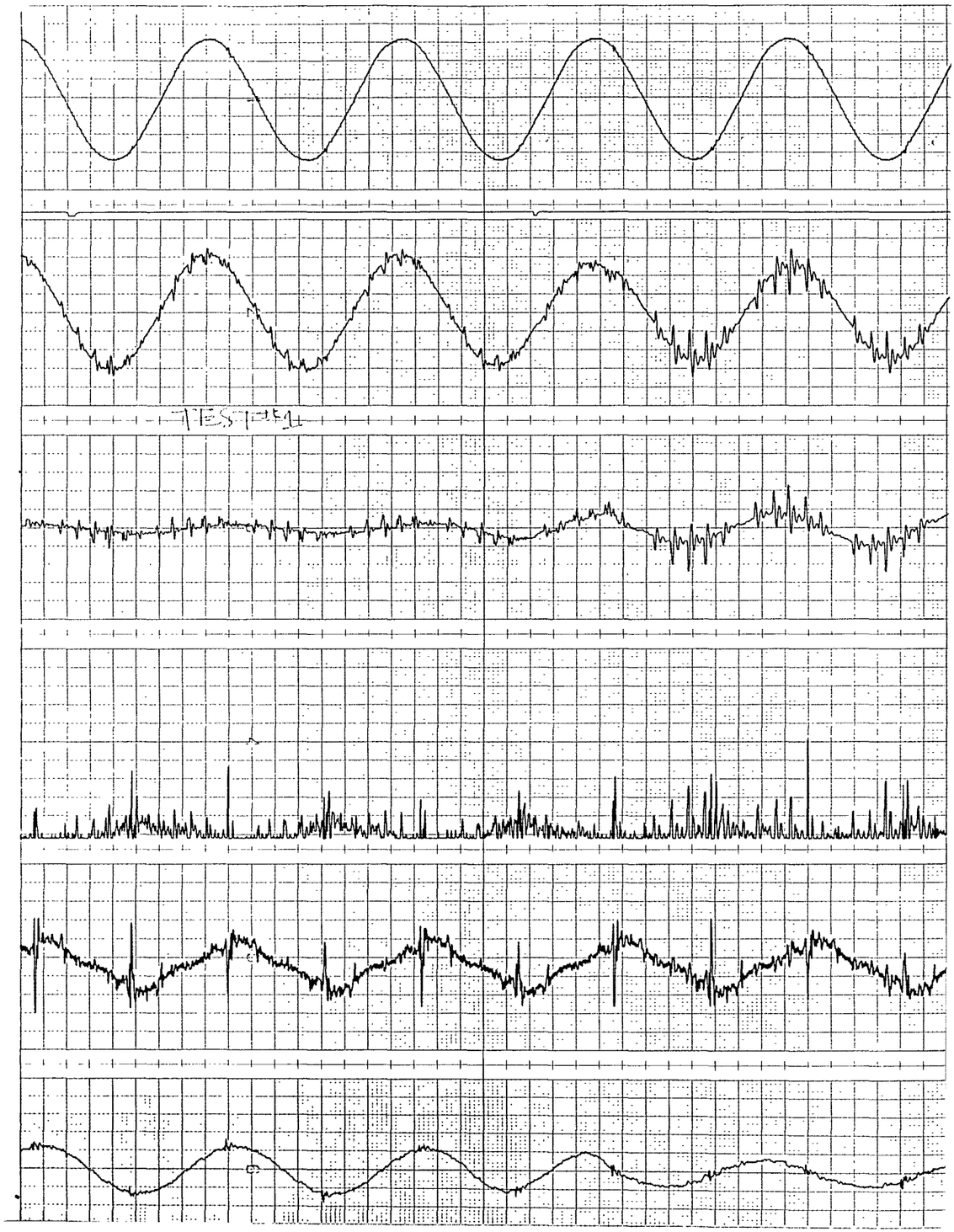
APPENDIX B

FAST TRANSFER TEST

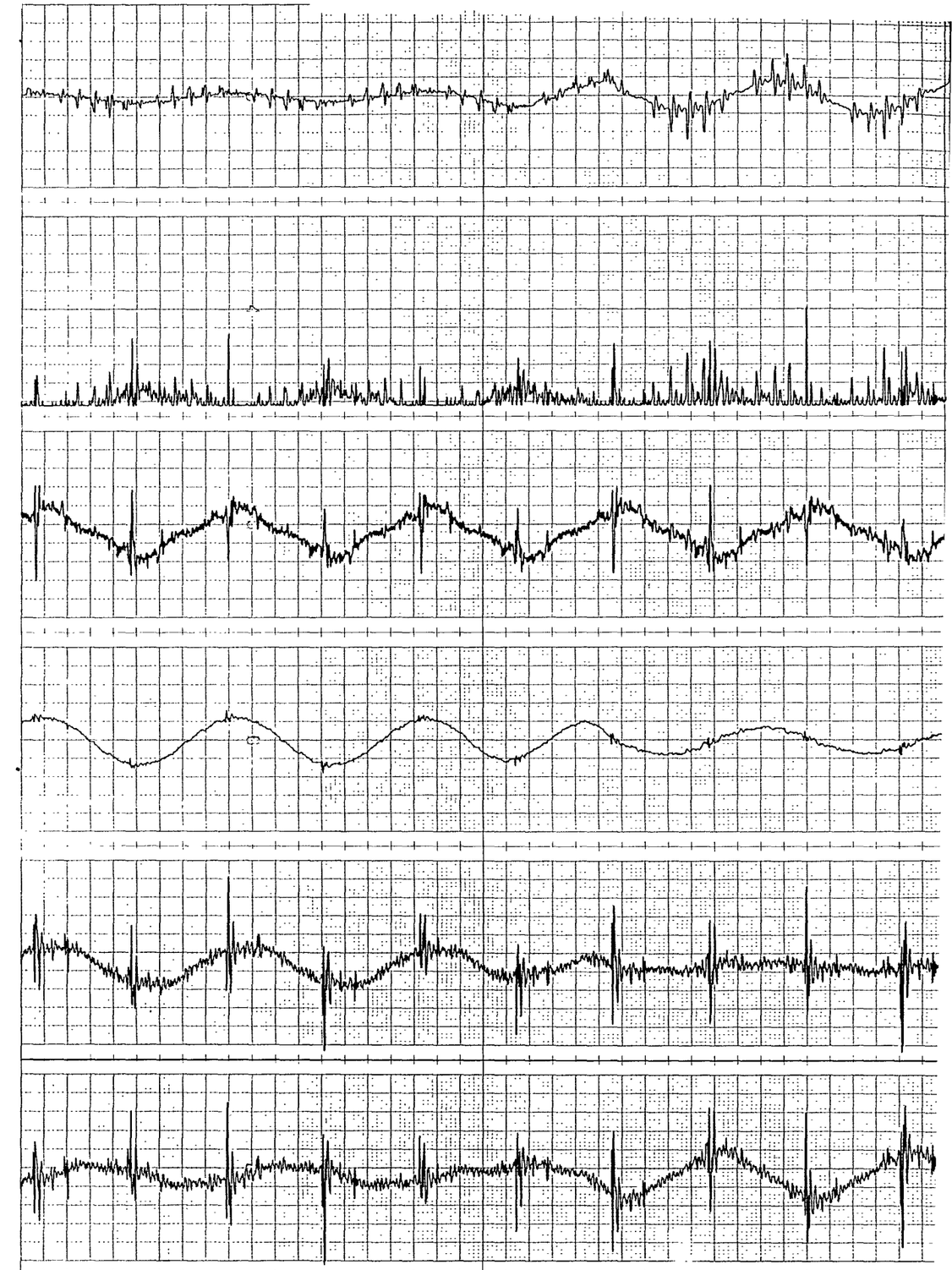
DATA RECORDING

IPP 022890

IP12_005331

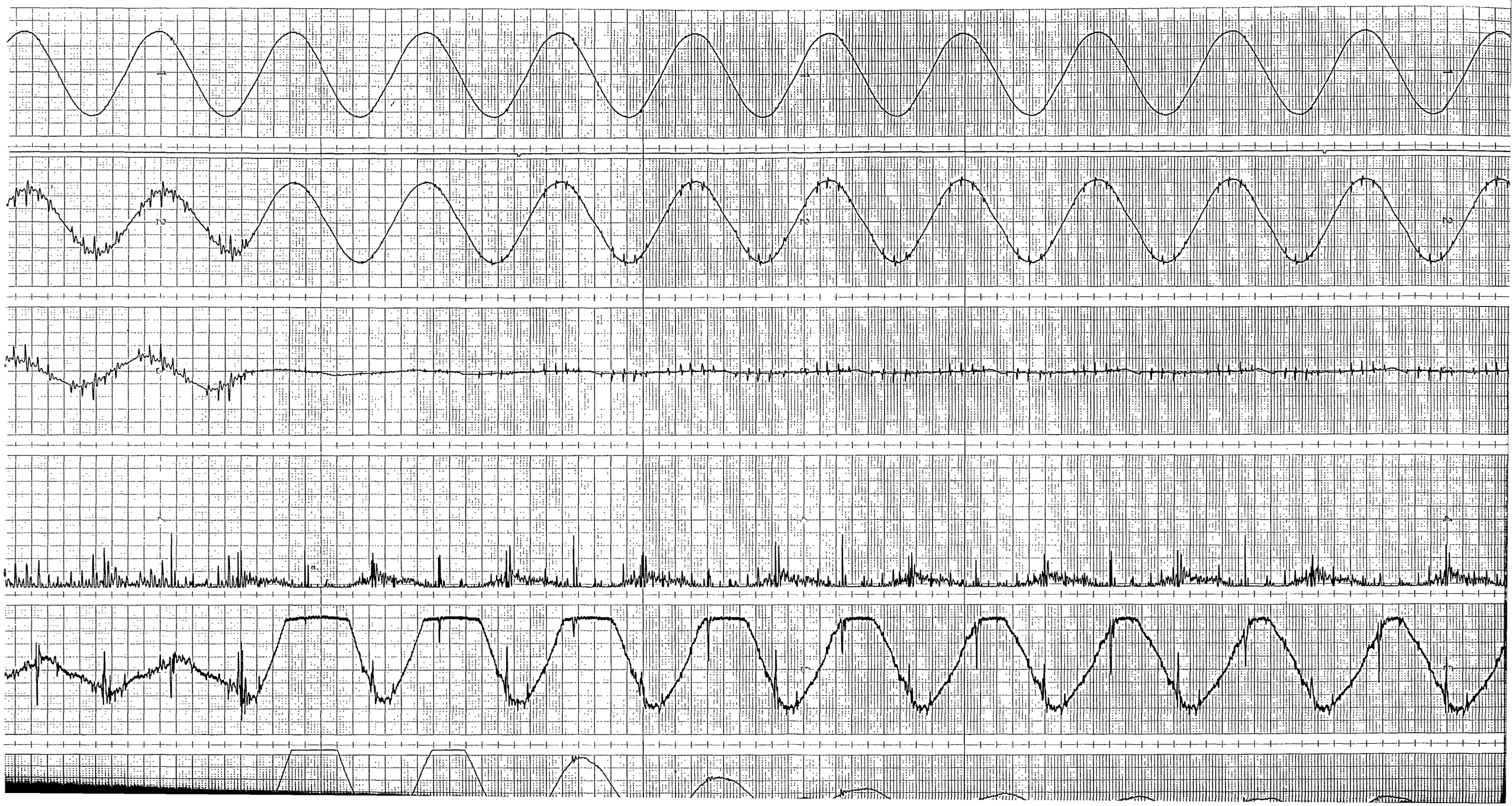


IP12_005332



IP12_005333

8.5 /DIV



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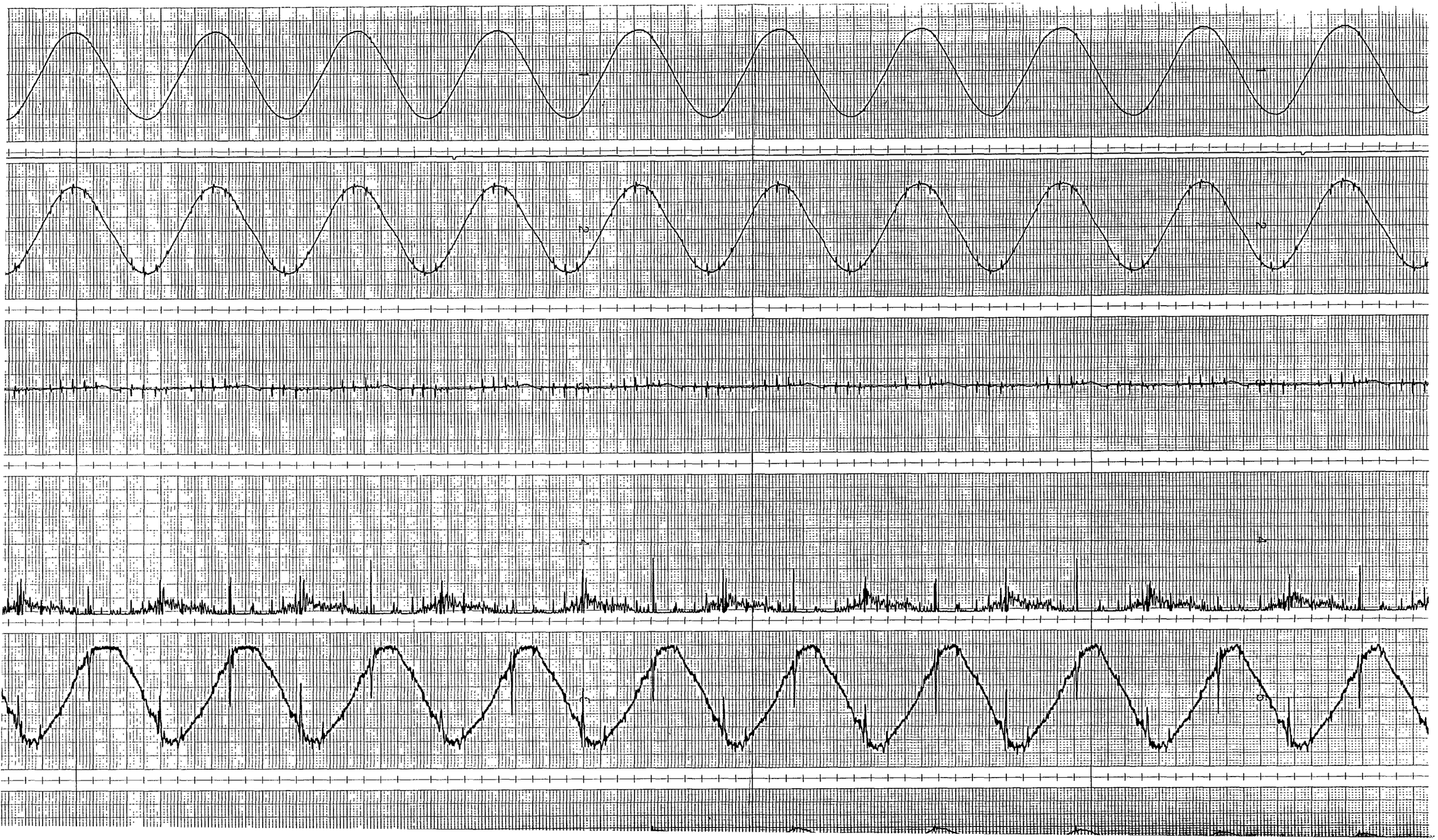
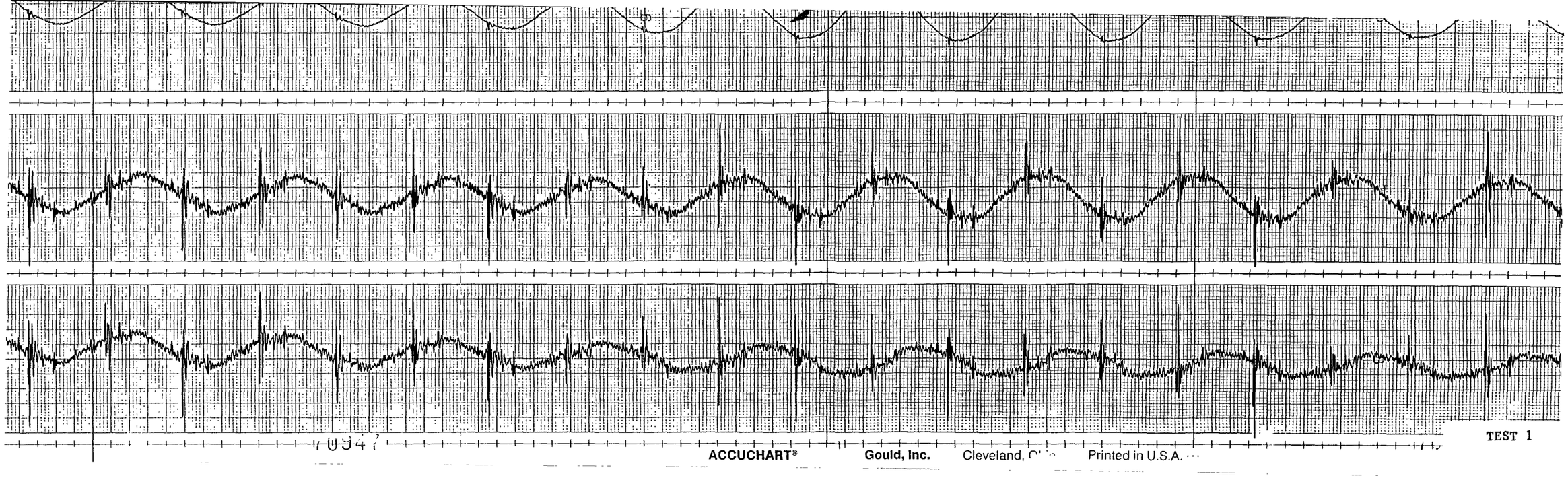
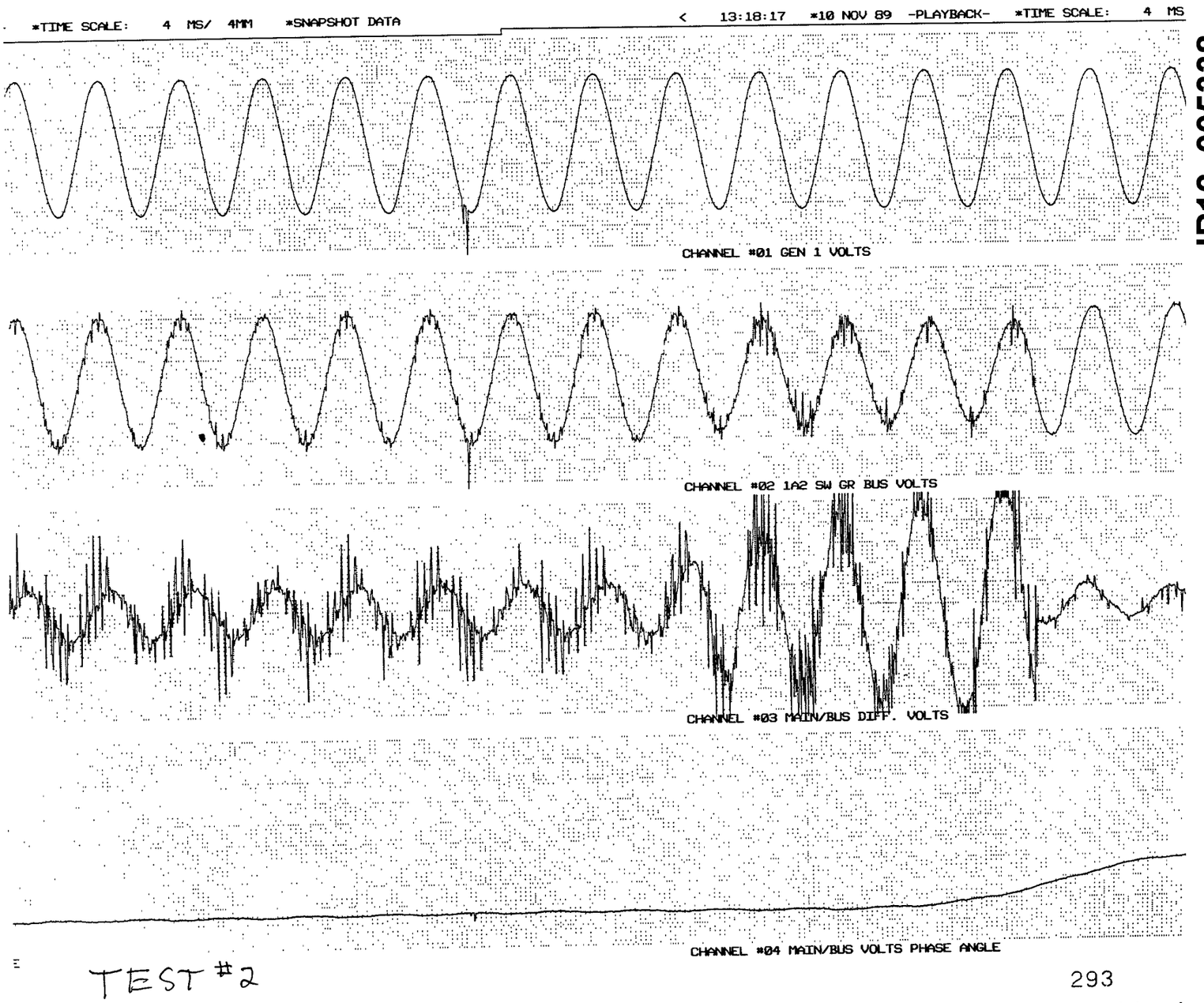


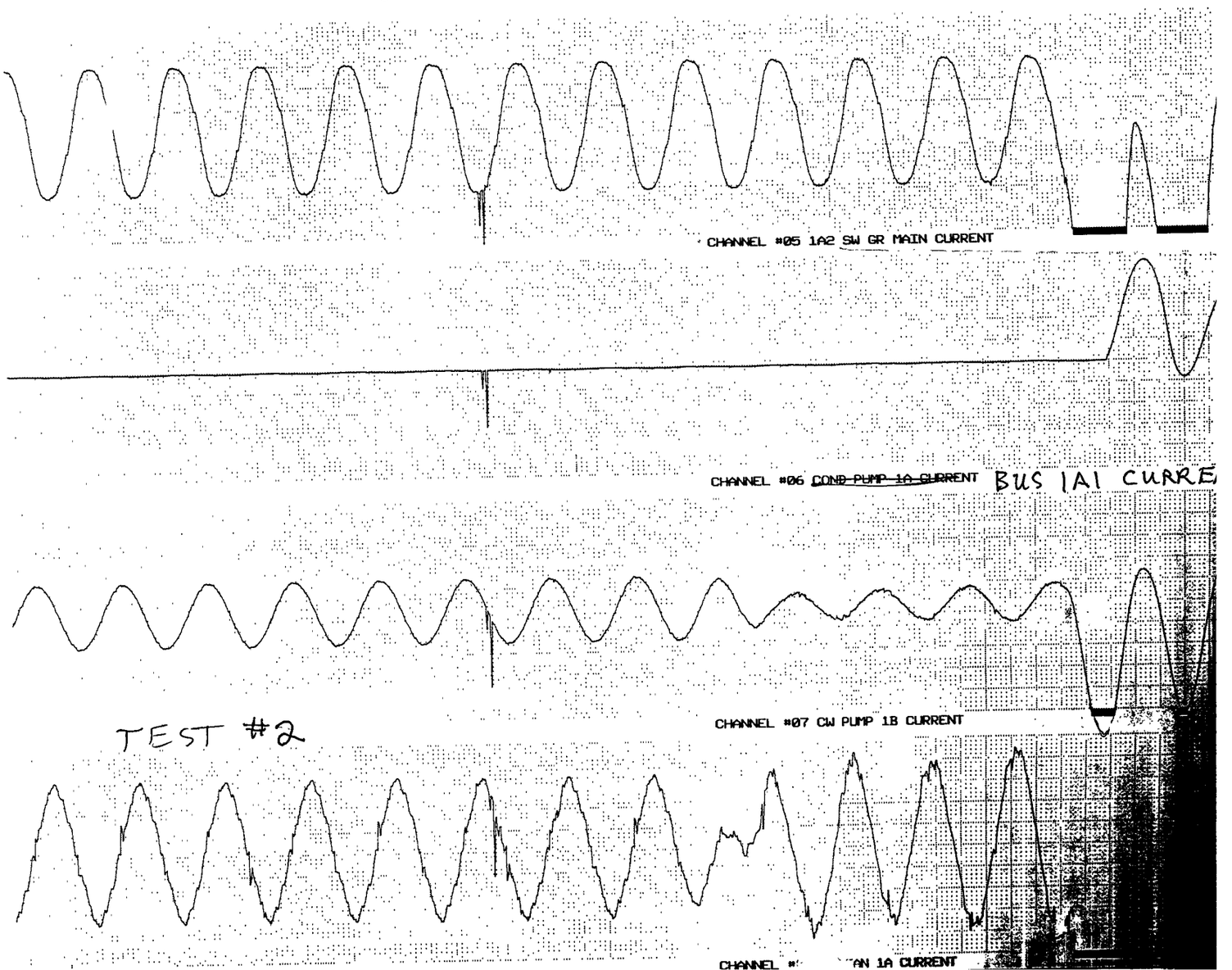
IP12_005336


TEST 1
ACCUCHART®
Gould, Inc.
Cleveland,
Printed in U.S.A.



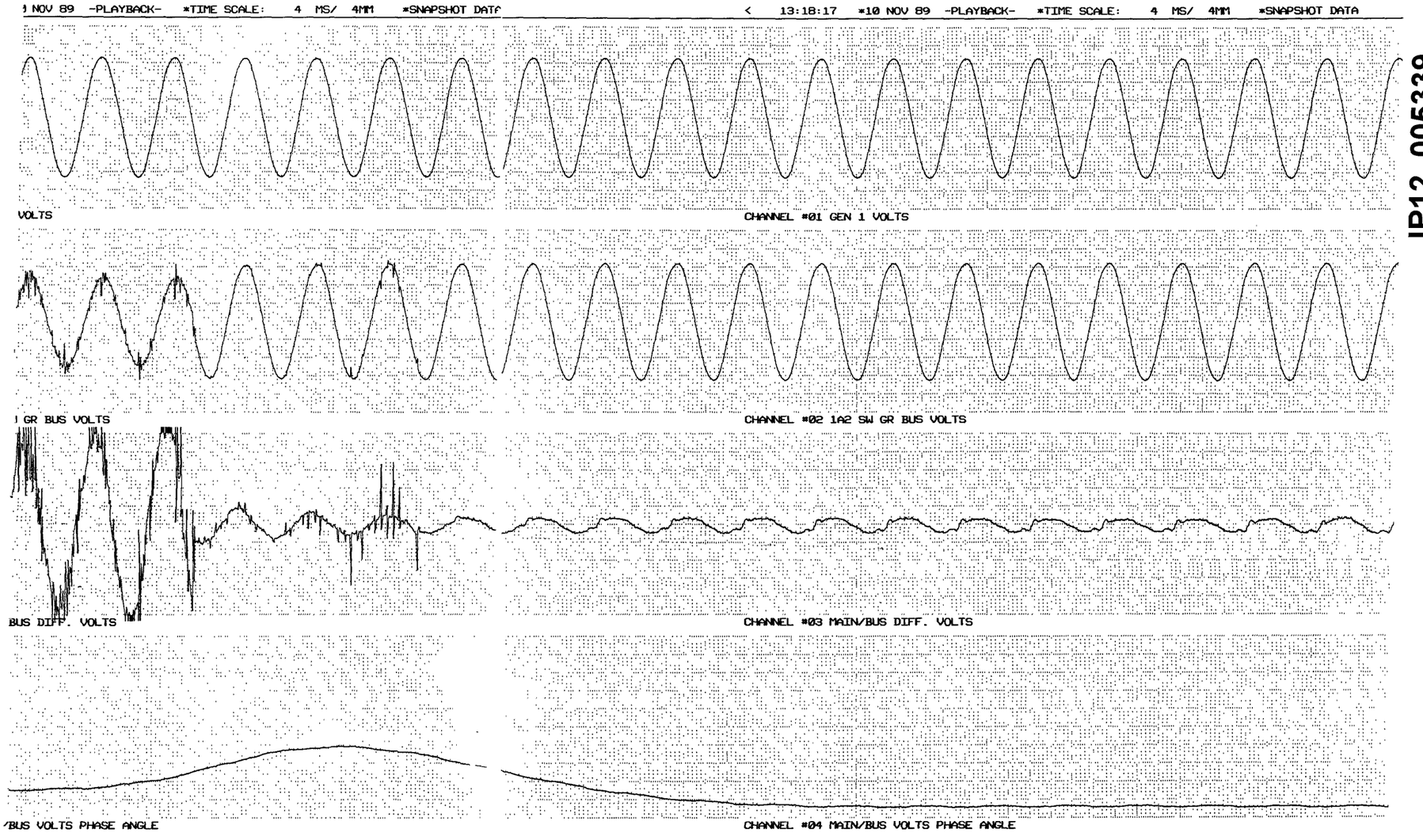
TEST #2

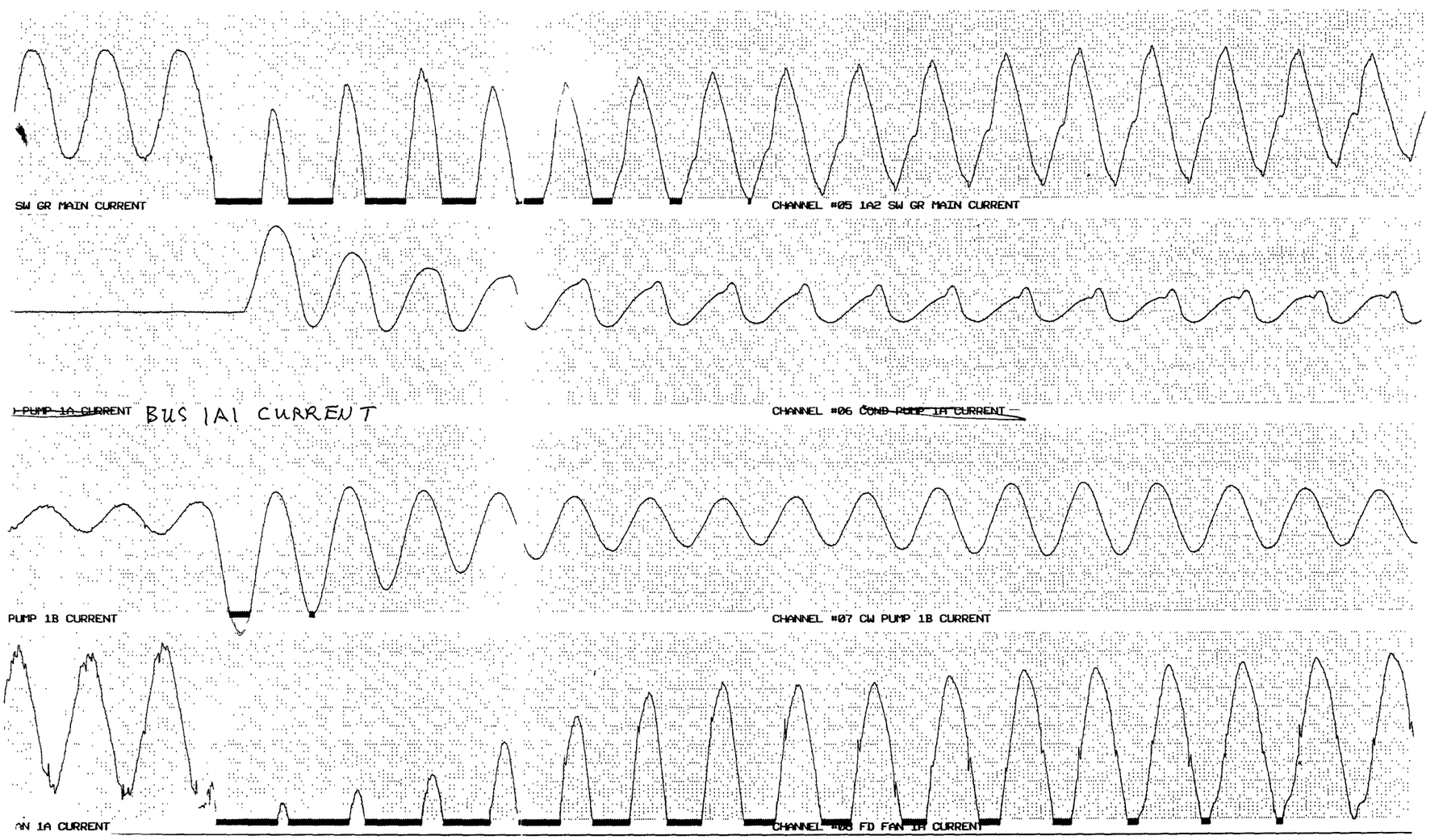
Astro-Med, Inc. MT-95000 MULTI-TASK RECORDER

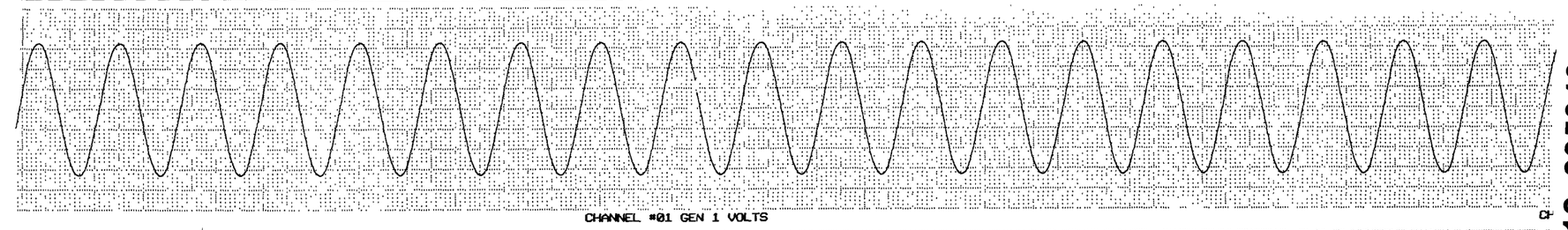


IP12_005338

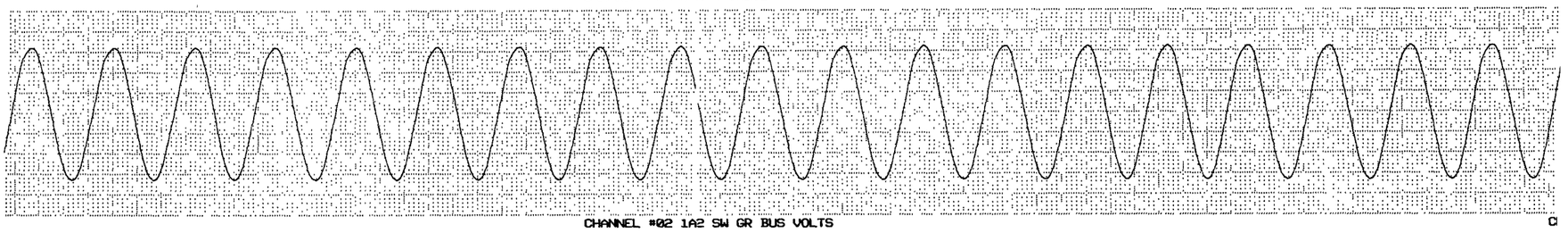
IP12_005339


VOLTS
CHANNEL #01 GEN 1 VOLTS
GR BUS VOLTS
CHANNEL #02 1A2 SW GR BUS VOLTS
BUS DIFF. VOLTS
CHANNEL #03 MAIN/BUS DIFF. VOLTS
/BUS VOLTS PHASE ANGLE
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE

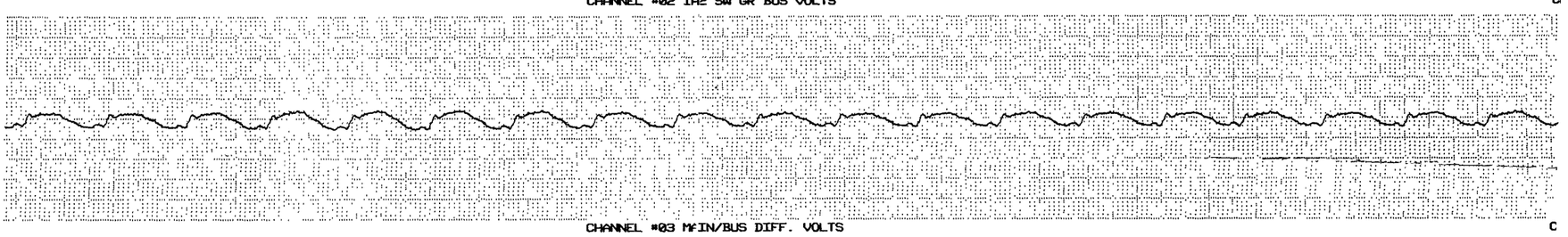

SW GR MAIN CURRENT
CHANNEL #05 1A2 SW GR MAIN CURRENT
~~PUMP 1A CURRENT~~ BUS 1A1 CURRENT
CHANNEL #06 ~~COND PUMP 1A CURRENT~~
PUMP 1B CURRENT
CHANNEL #07 CW PUMP 1B CURRENT
AN 1A CURRENT
CHANNEL #08 FD FAN 1A CURRENT



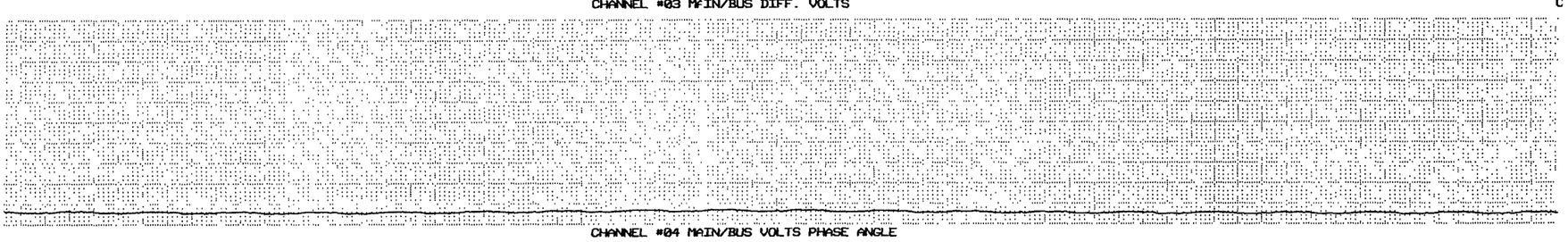
CHANNEL #01 GEN 1 VOLTS



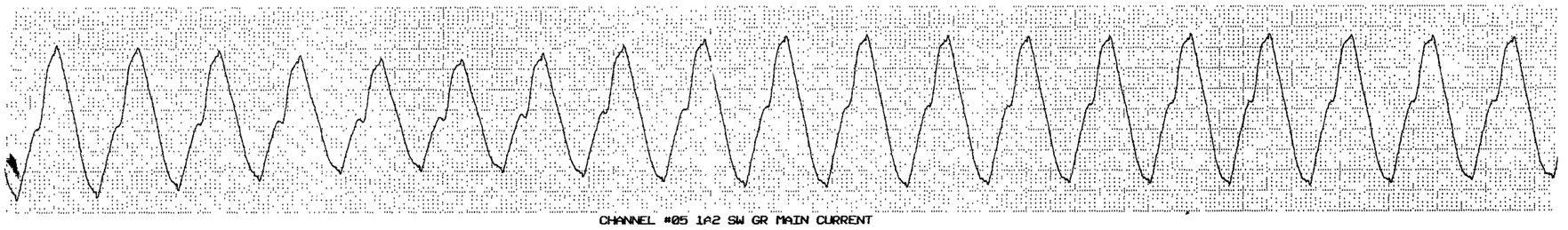
CHANNEL #02 1A2 SW GR BUS VOLTS



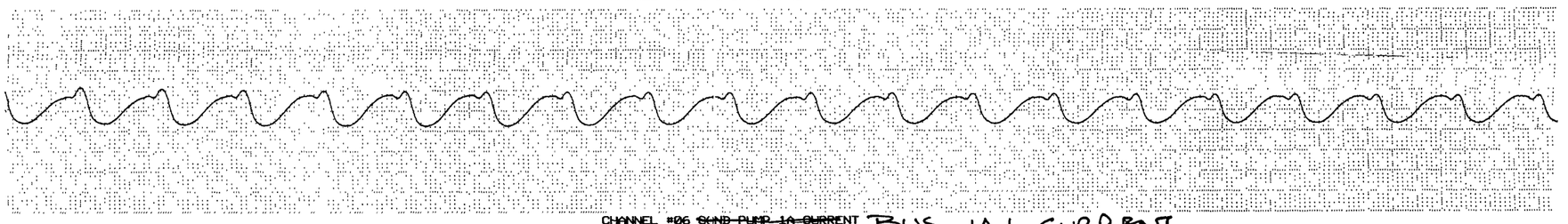
CHANNEL #03 MAIN/BUS DIFF. VOLTS



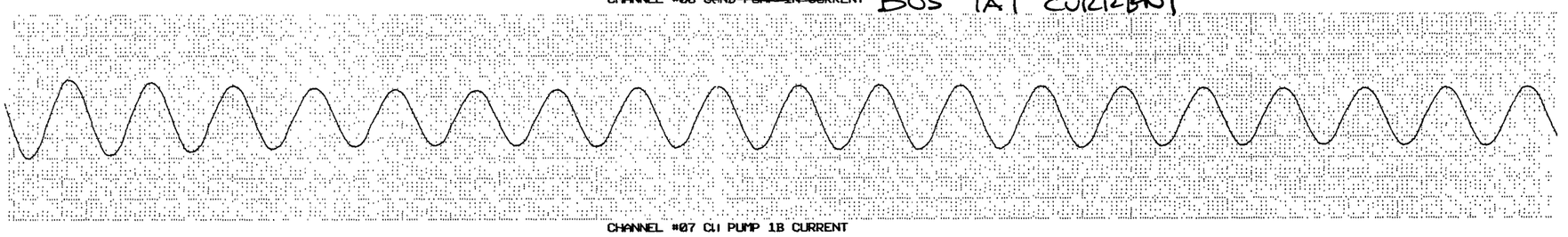
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE



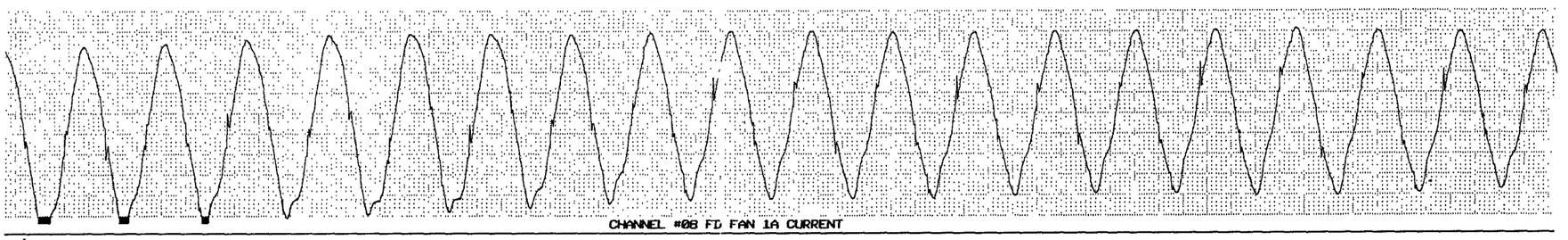
CHANNEL #05 1A2 SW GR MAIN CURRENT



CHANNEL #06 ~~SCND PUMP 1A CURRENT~~ BUS 1A1 CURRENT



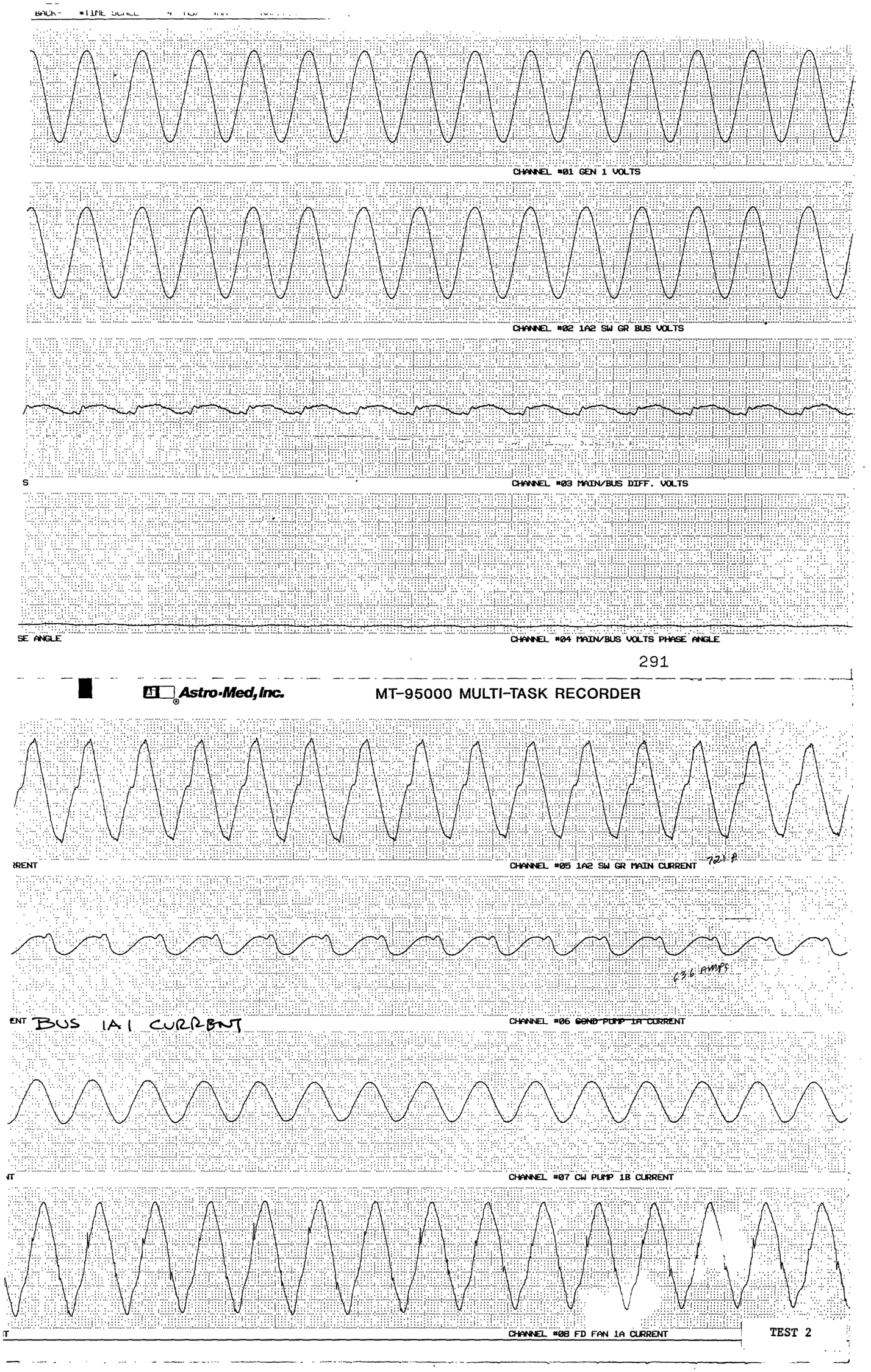
CHANNEL #07 CLI PUMP 1B CURRENT



CHANNEL #08 FD FAN 1A CURRENT

IP12_005340

Astro-Med, Inc. MT-95000 MULTI-TASK RECORDER



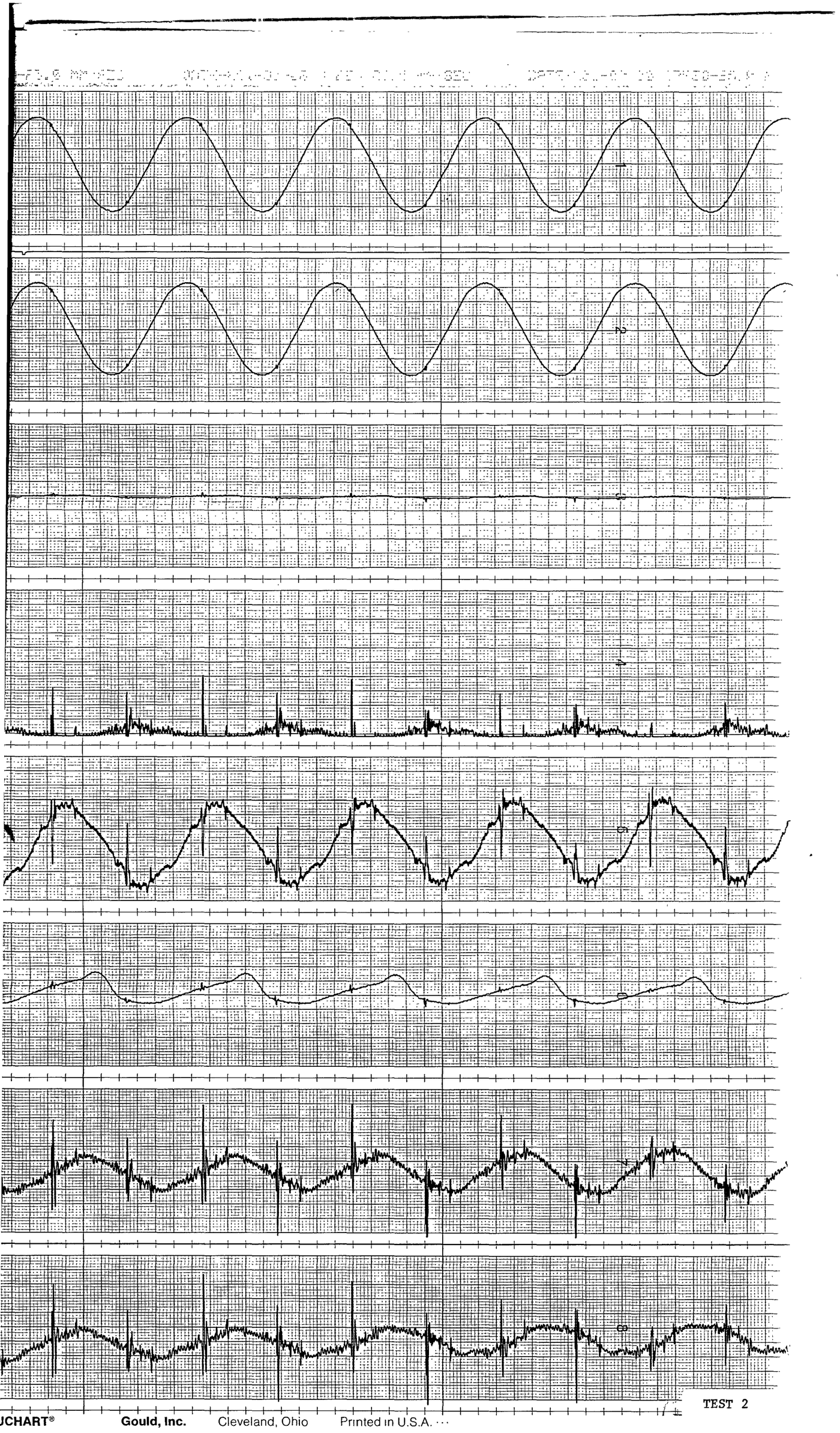
IP12_005341

IP12_005342

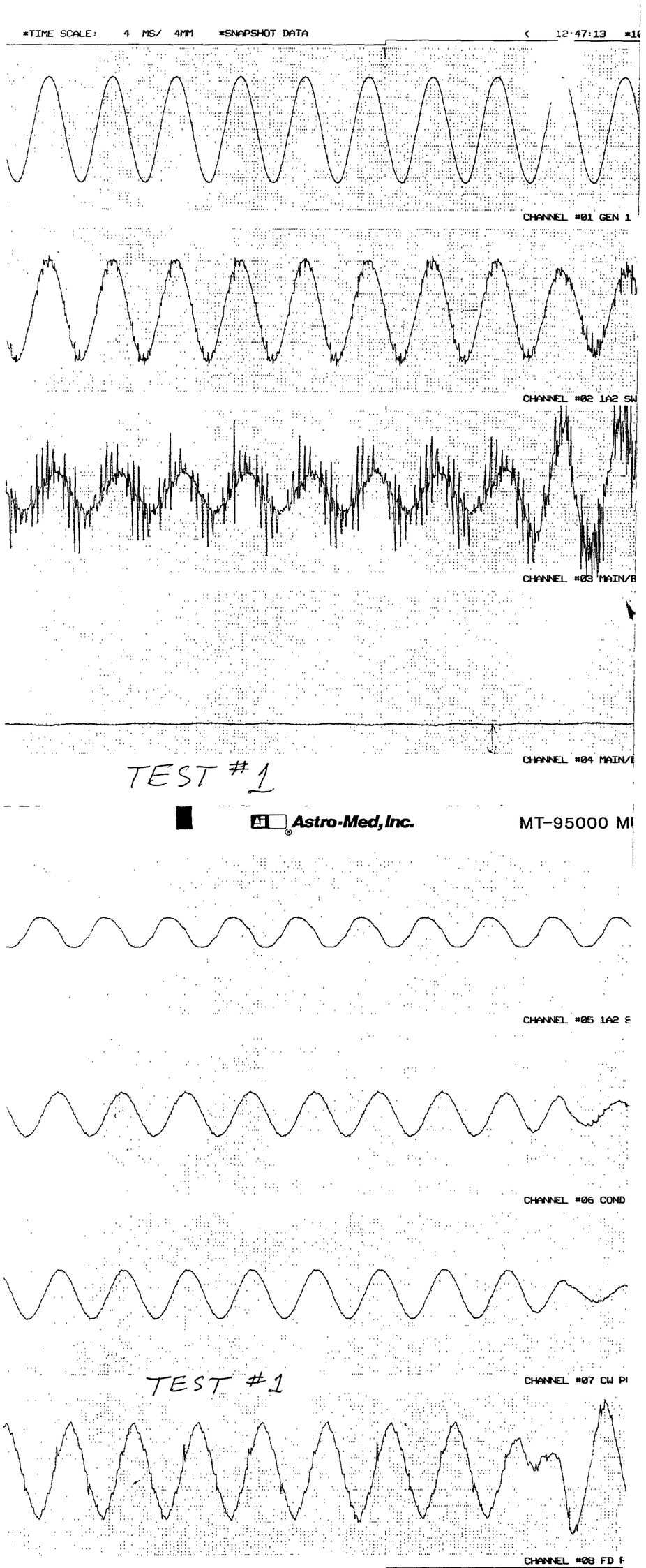
ACCUCHART® Gould, Inc. Cleveland, Ohio Printed in U.S.A.

IP12_005343

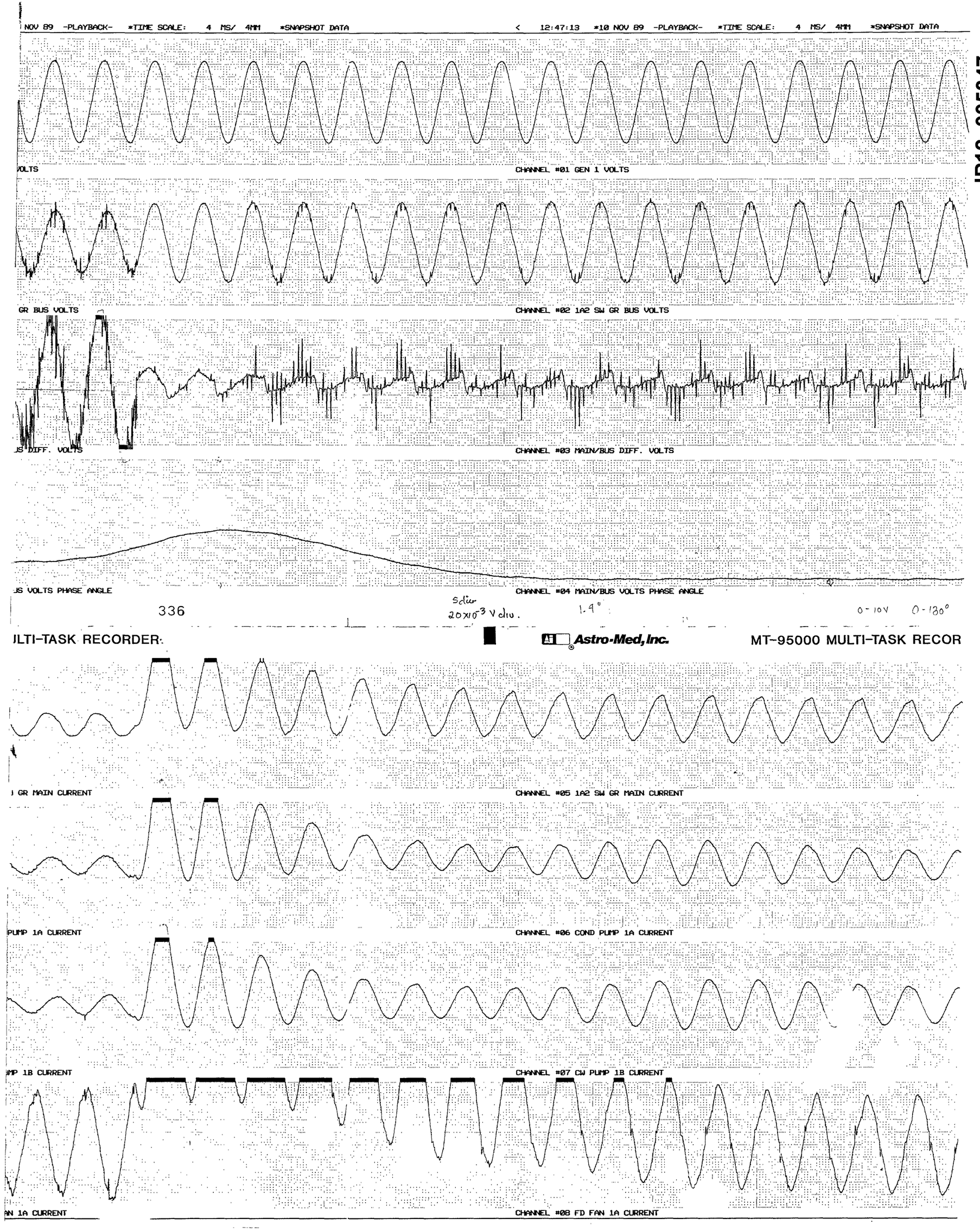
IP12_005344



IP12_005345

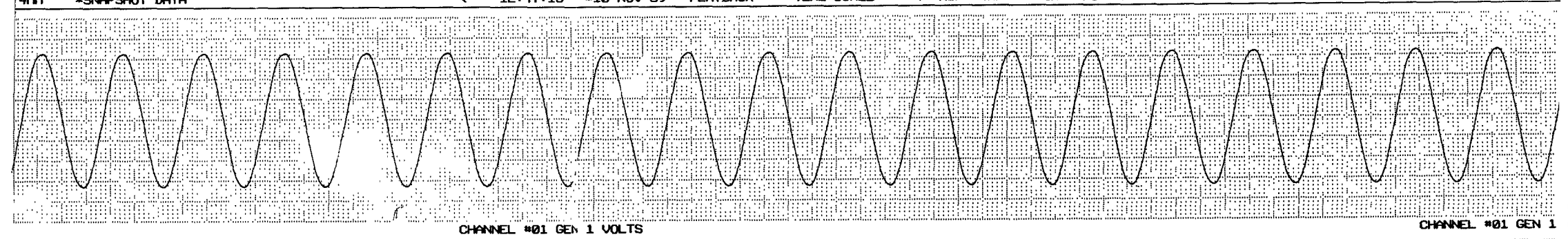

*TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
12:47:13
CHANNEL #01 GEN 1
CHANNEL #02 1A2 SW
CHANNEL #03 MAIN/E
CHANNEL #04 MAIN/E
TEST #1
Astro-Med, Inc.
MT-95000 MI
CHANNEL #05 1A2 S
CHANNEL #06 COND
TEST #1
CHANNEL #07 CW PI
CHANNEL #08 FD F

IP12_005346

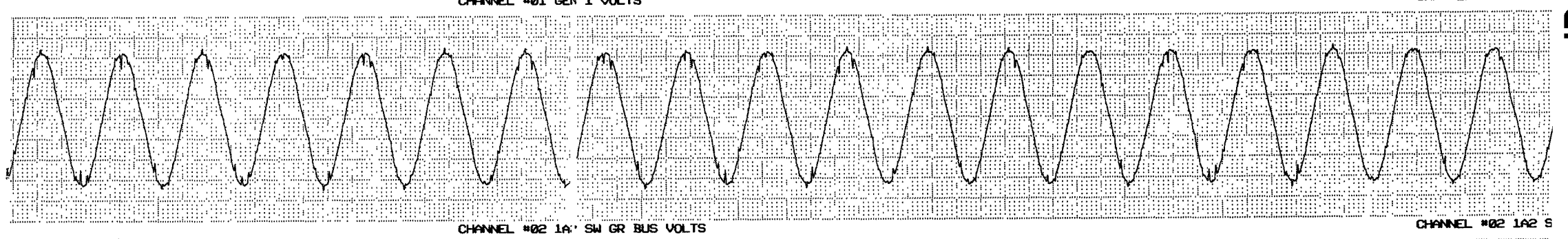

NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
< 12:47:13 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
VOLTS
CHANNEL #01 GEN 1 VOLTS
GR BUS VOLTS
CHANNEL #02 1A2 SW GR BUS VOLTS
JS DIFF. VOLTS
CHANNEL #03 MAIN/BUS DIFF. VOLTS
JS VOLTS PHASE ANGLE
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE
336
Sdiv
20x10^-3 V div.
1.4°
0-10V
0-180°
ILTI-TASK RECORDER
Astro-Med, Inc.
MT-95000 MULTI-TASK RECOR
J GR MAIN CURRENT
CHANNEL #05 1A2 SW GR MAIN CURRENT
PUMP 1A CURRENT
CHANNEL #06 COND PUMP 1A CURRENT
MP 1B CURRENT
CHANNEL #07 CW PUMP 1B CURRENT
AN 1A CURRENT
CHANNEL #08 FD FAN 1A CURRENT

IP12_005347

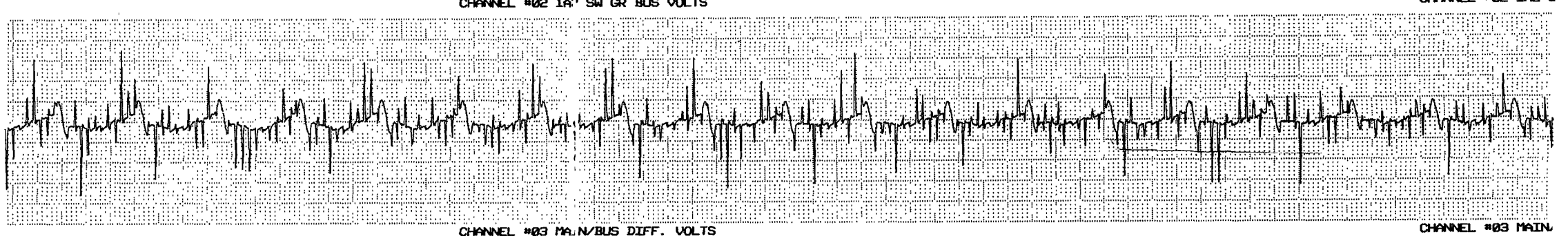
4MM *SNAPSHOT DATA < 12:47:13 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA



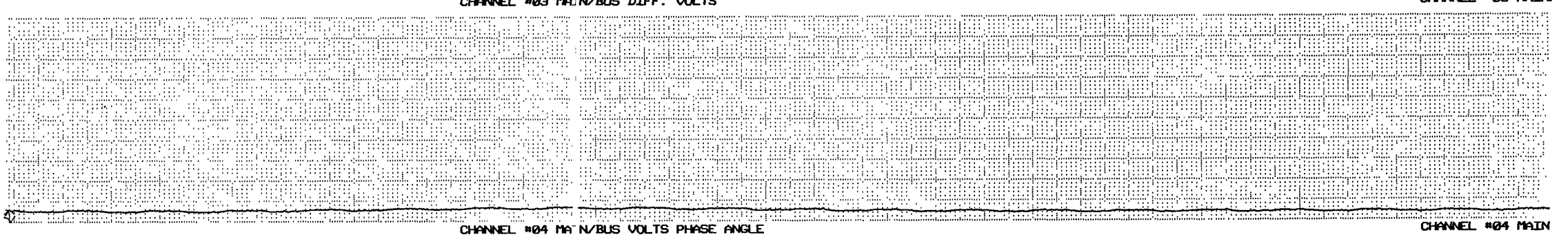
CHANNEL #01 GEN 1 VOLTS CHANNEL #01 GEN 1



CHANNEL #02 1A' SW GR BUS VOLTS CHANNEL #02 1A2 S



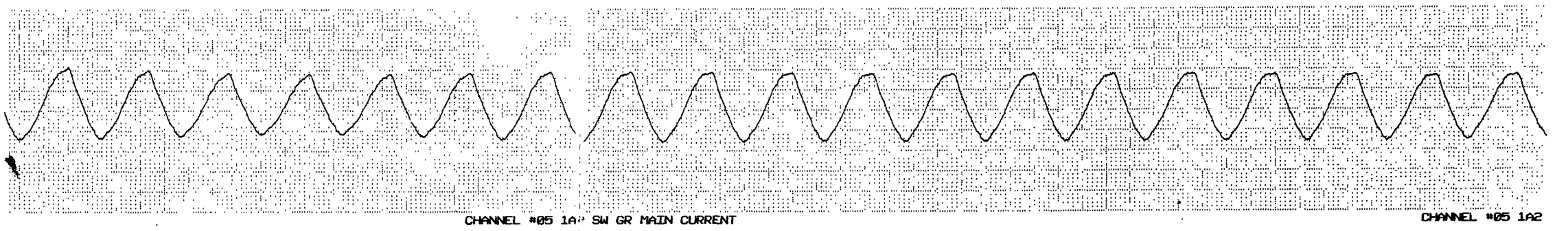
CHANNEL #03 MA N/BUS DIFF. VOLTS CHANNEL #03 MAIN



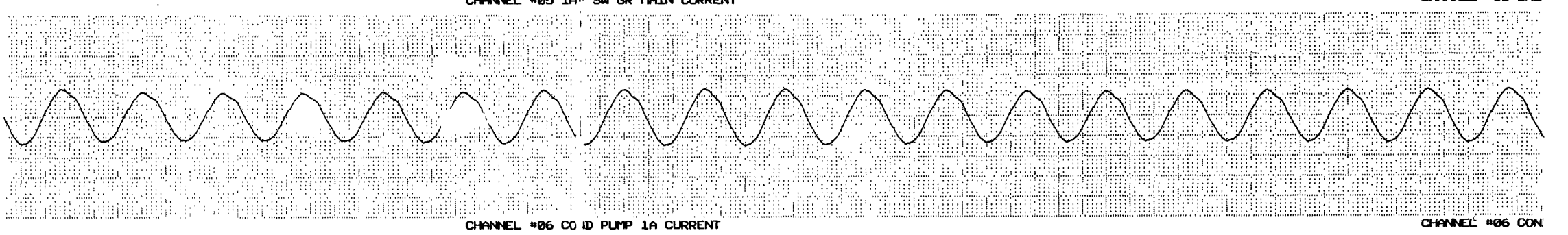
CHANNEL #04 MA N/BUS VOLTS PHASE ANGLE CHANNEL #04 MAIN

0-10V 0-180° 335

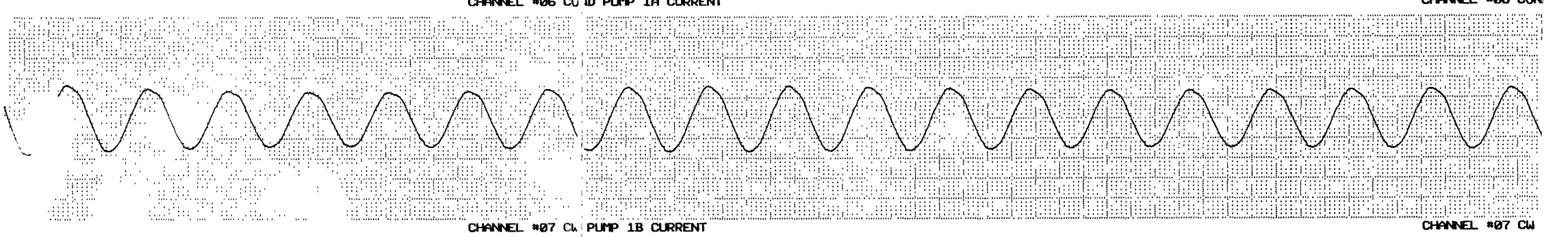
MULTI-TASK RECORDER Astro-Med, Inc. MT-95000 MULTI-TASK RECC



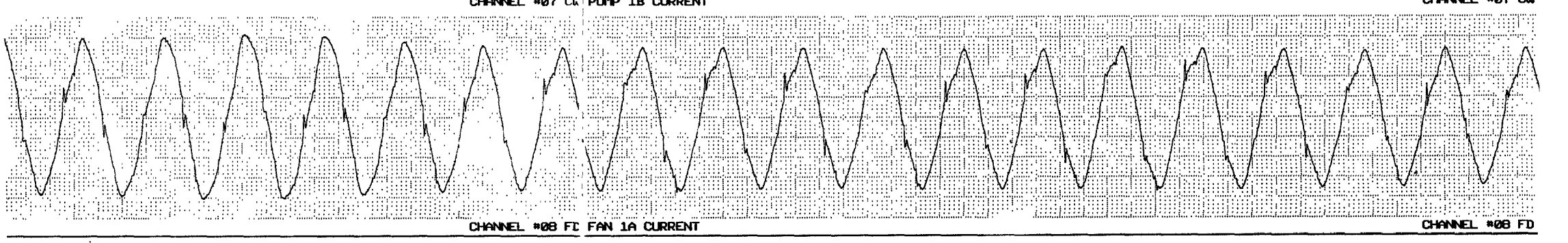
CHANNEL #05 1A' SW GR MAIN CURRENT CHANNEL #05 1A2



CHANNEL #06 CO ID PUMP 1A CURRENT CHANNEL #06 CON



CHANNEL #07 CW PUMP 1B CURRENT CHANNEL #07 CW



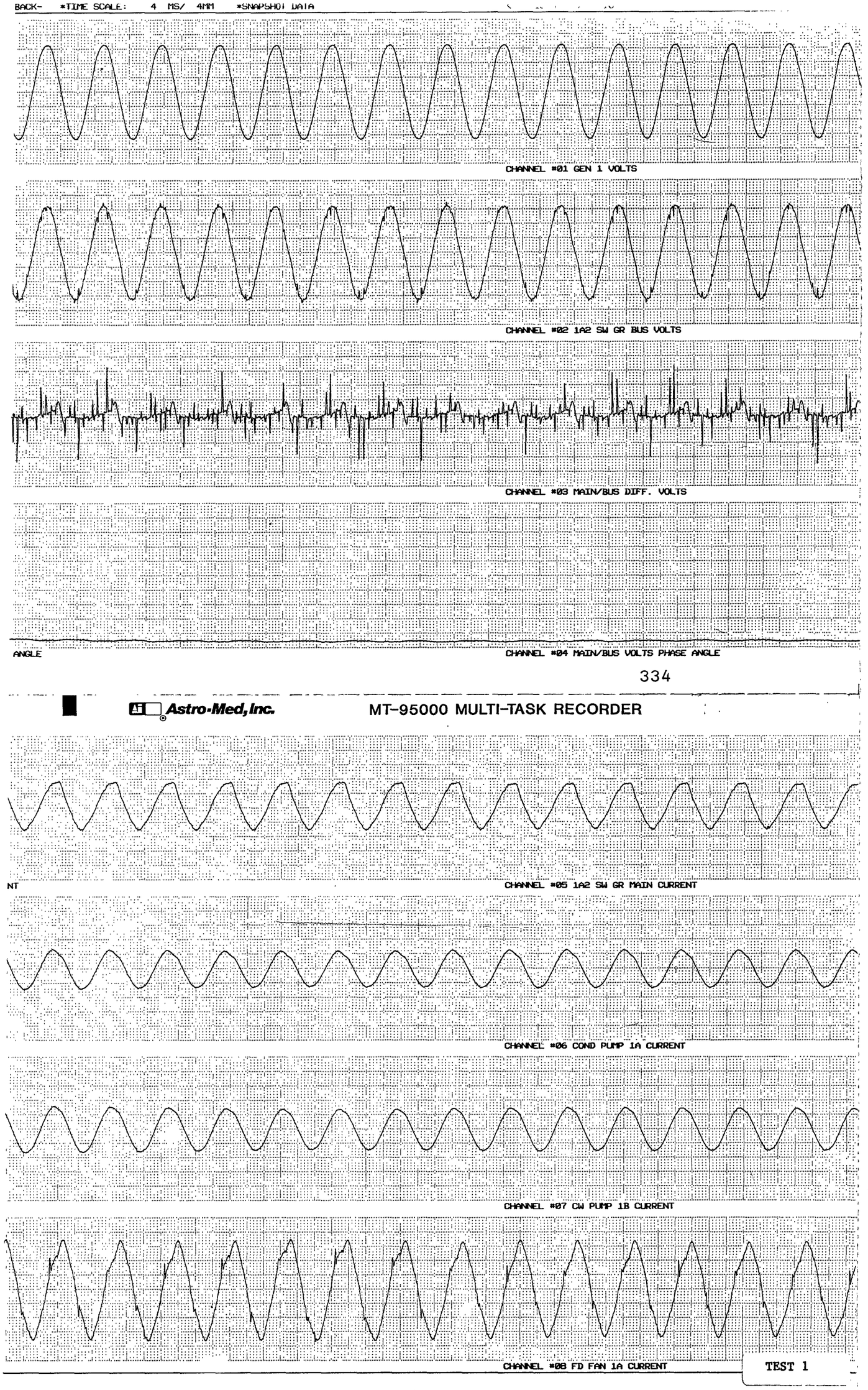
CHANNEL #08 FD FAN 1A CURRENT CHANNEL #08 FD

IP12_005348

Astro-Med, Inc.

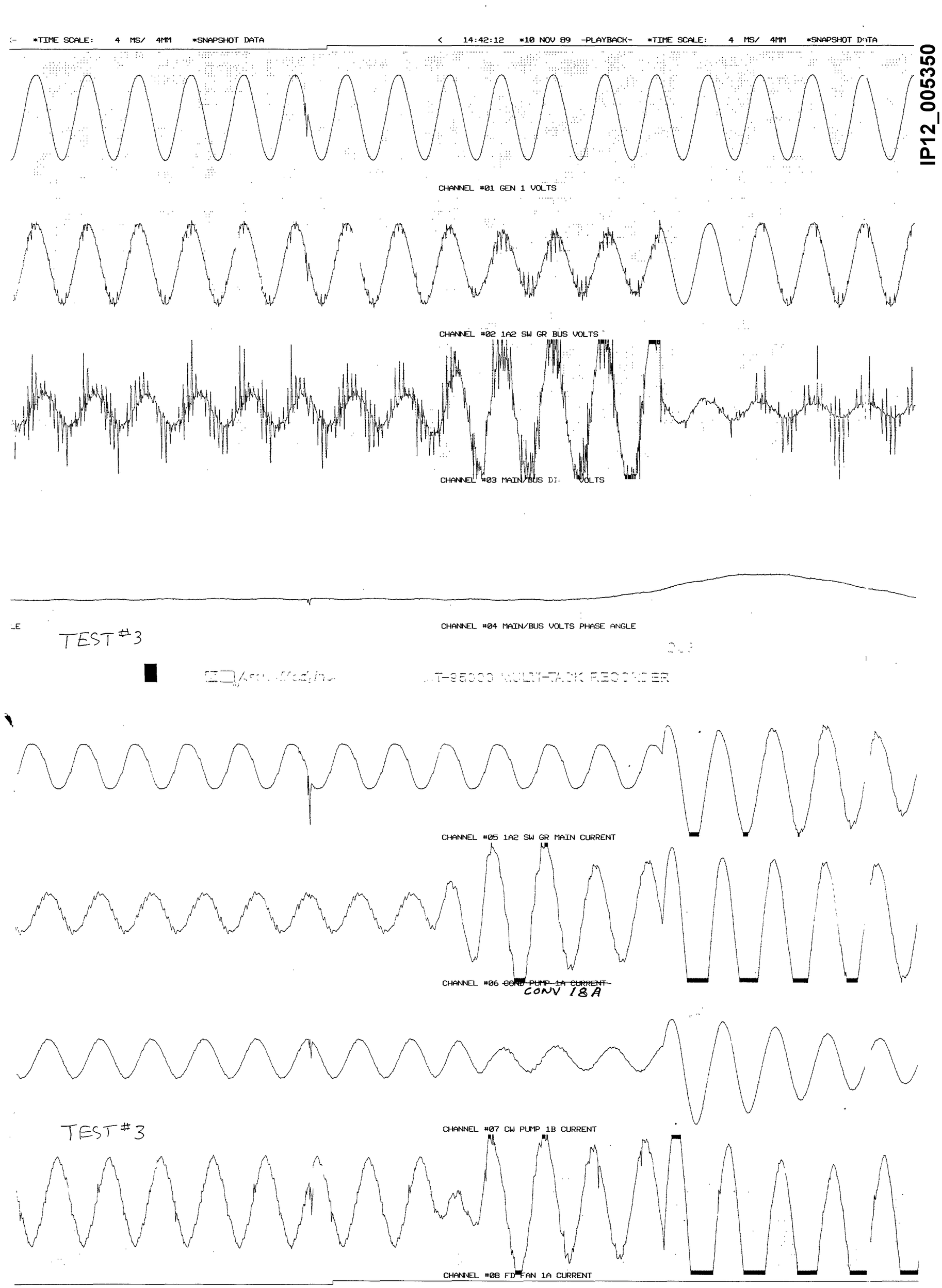
MT-95000 MULTI-TASK RECORDER

BACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA

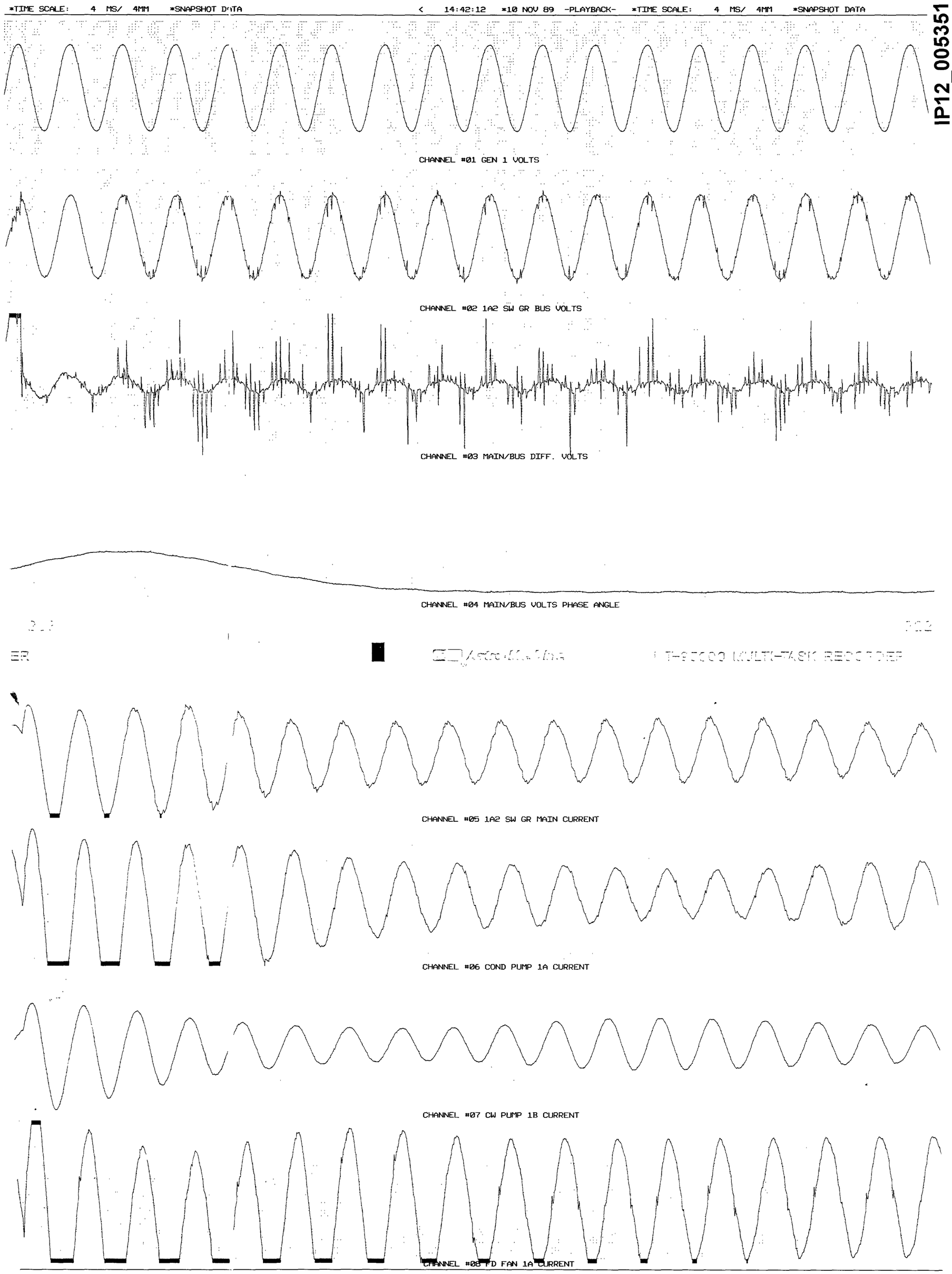


TEST 1

IP12_005349


*TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
14:42:12 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
CHANNEL #01 GEN 1 VOLTS
CHANNEL #02 1A2 SW GR BUS VOLTS
CHANNEL #03 MAIN/BUS DI VOLTS
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE
TEST #3
CHANNEL #05 1A2 SW GR MAIN CURRENT
CHANNEL #06 ~~COND PUMP 1A CURRENT~~ CONV 18A
TEST #3
CHANNEL #07 CW PUMP 1B CURRENT
CHANNEL #08 FD FAN 1A CURRENT

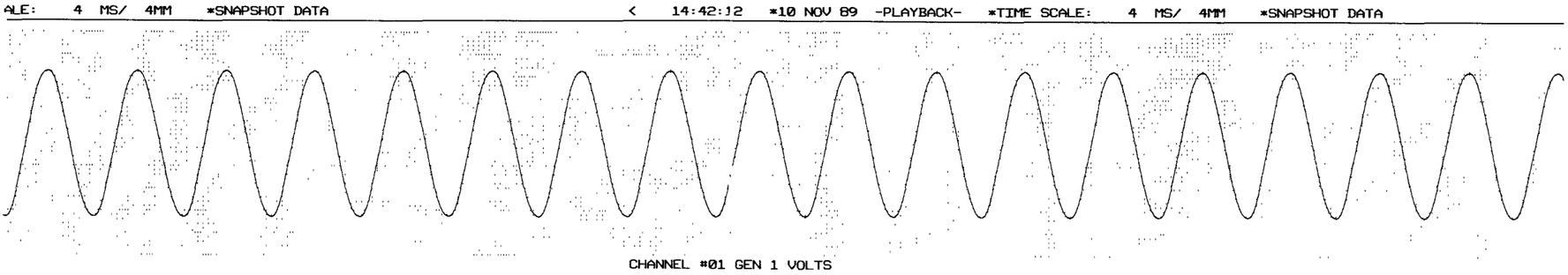
IP12_005350


*TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
< 14:42:12 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
CHANNEL #01 GEN 1 VOLTS
CHANNEL #02 1A2 SW GR BUS VOLTS
CHANNEL #03 MAIN/BUS DIFF. VOLTS
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE
CHANNEL #05 1A2 SW GR MAIN CURRENT
CHANNEL #06 COND PUMP 1A CURRENT
CHANNEL #07 CW PUMP 1B CURRENT
CHANNEL #08 FD FAN 1A CURRENT

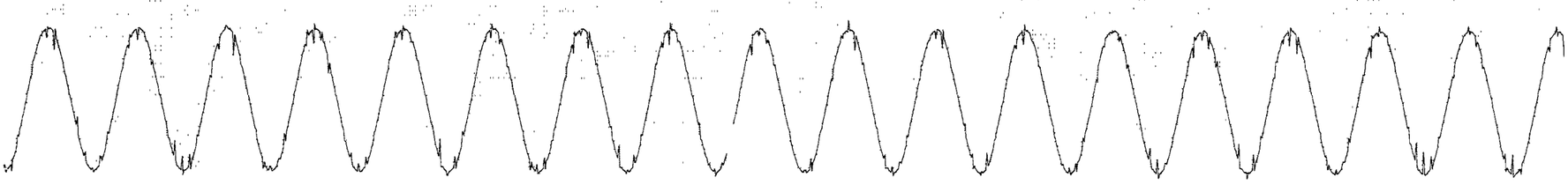
IP12_005351

ALE: 4 MS/ 4MM *SNAPSHOT DATA < 14:42:12 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA

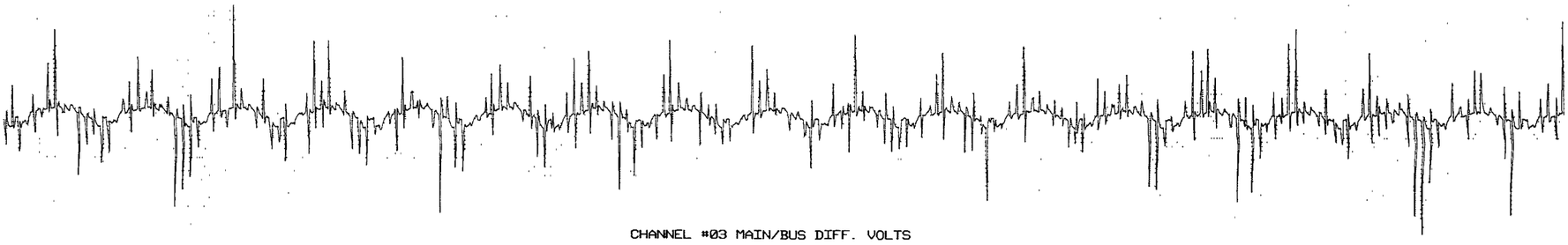
IP12_005352



CHANNEL #01 GEN 1 VOLTS

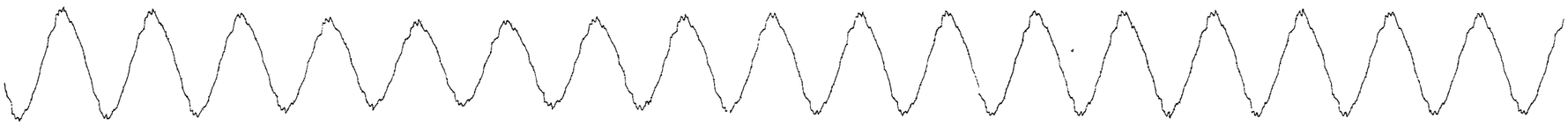


CHANNEL #02 1A2 SW GR BUS VOLTS

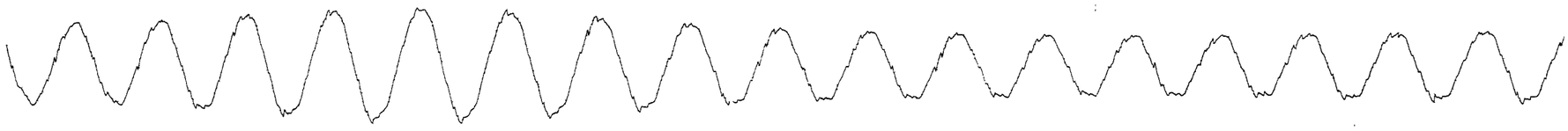


CHANNEL #03 MAIN/BUS DIFF. VOLTS

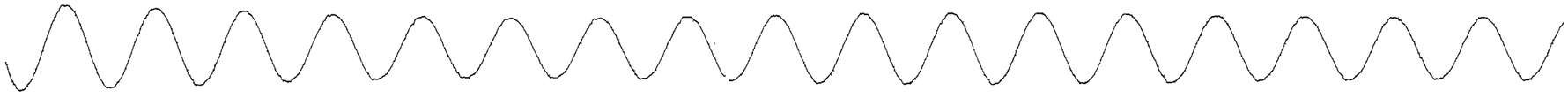
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE



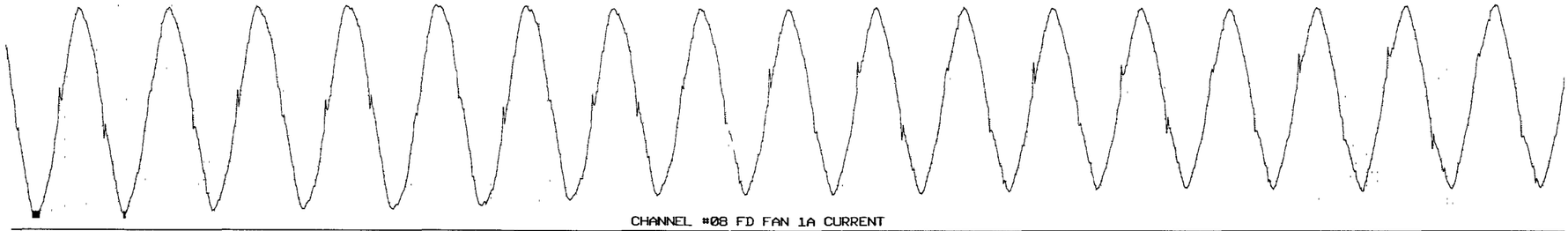
CHANNEL #05 1A2 SW GR MAIN CURRENT



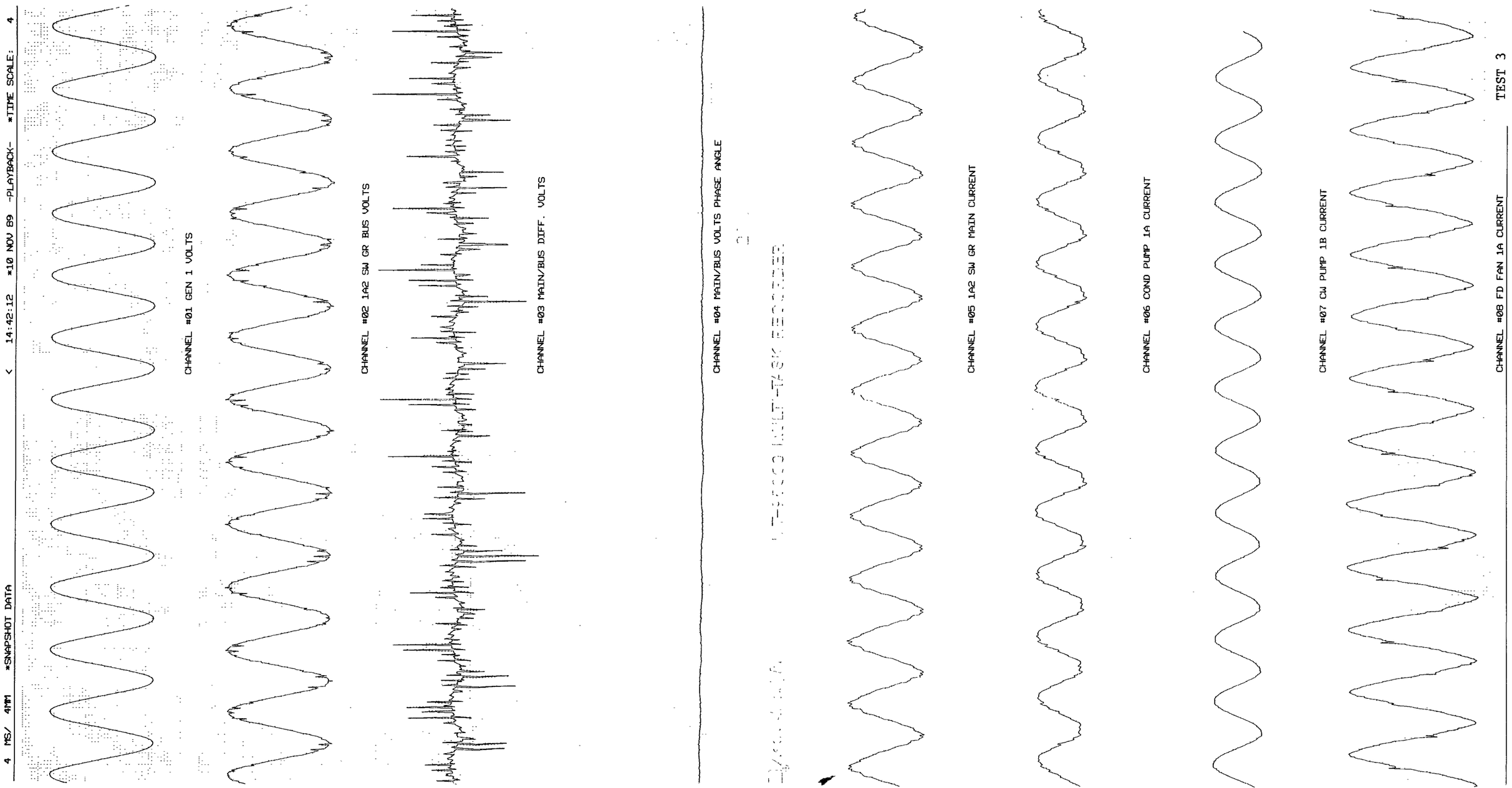
CHANNEL #06 COND PUMP 1A CURRENT



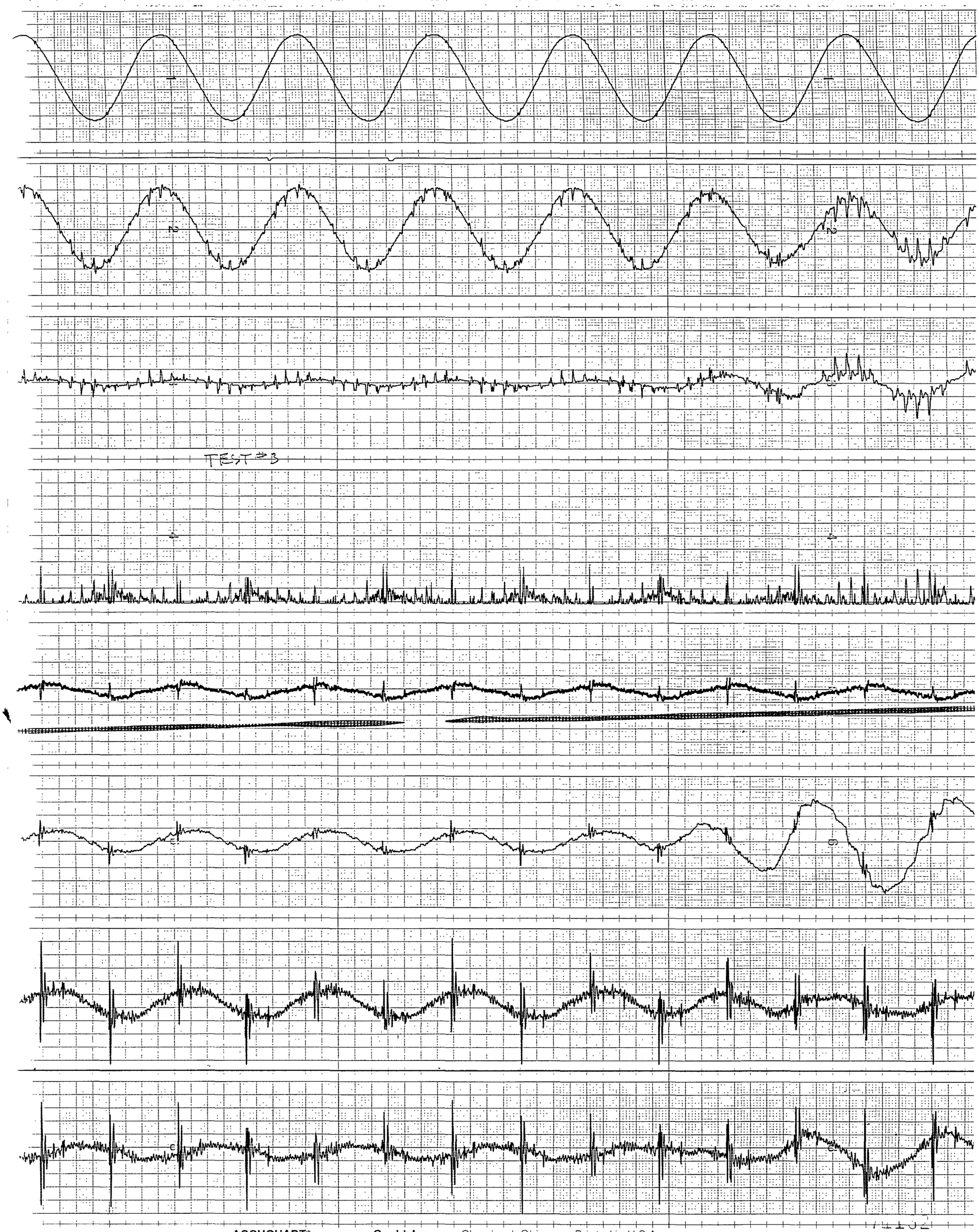
CHANNEL #07 CW PUMP 1B CURRENT



CHANNEL #08 FD FAN 1A CURRENT


4 MS/ 4MM *SNAPSHOT DATA < 14:42:12 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4
CHANNEL #01 GEN 1 VOLTS
CHANNEL #02 1A2 SW GR BUS VOLTS
CHANNEL #03 MAIN/BUS DIFF. VOLTS
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE
CHANNEL #05 1A2 SW GR MAIN CURRENT
CHANNEL #06 COND PUMP 1A CURRENT
CHANNEL #07 CW PUMP 1B CURRENT
CHANNEL #08 FD FAN 1A CURRENT

TEST 3



IP12_005354

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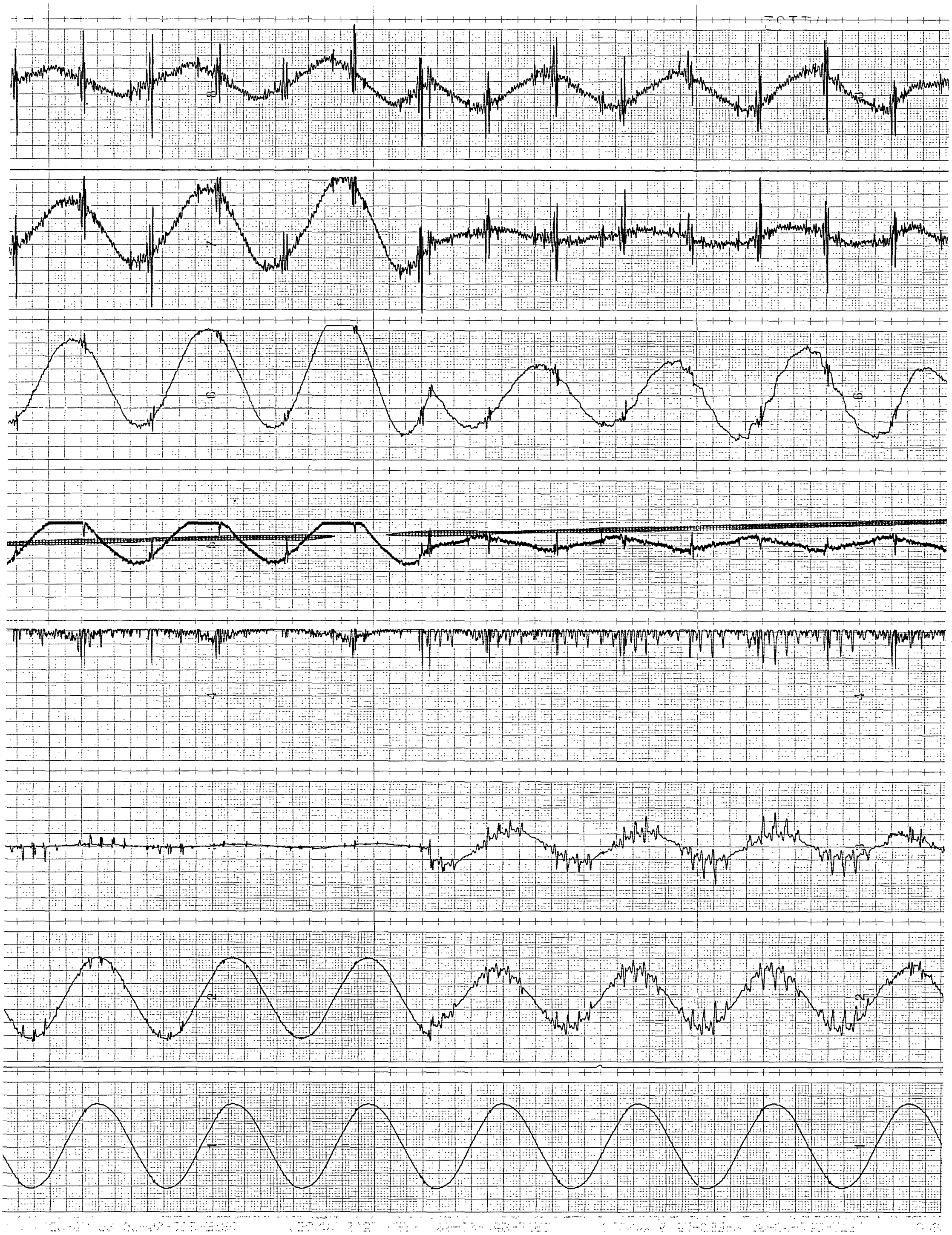
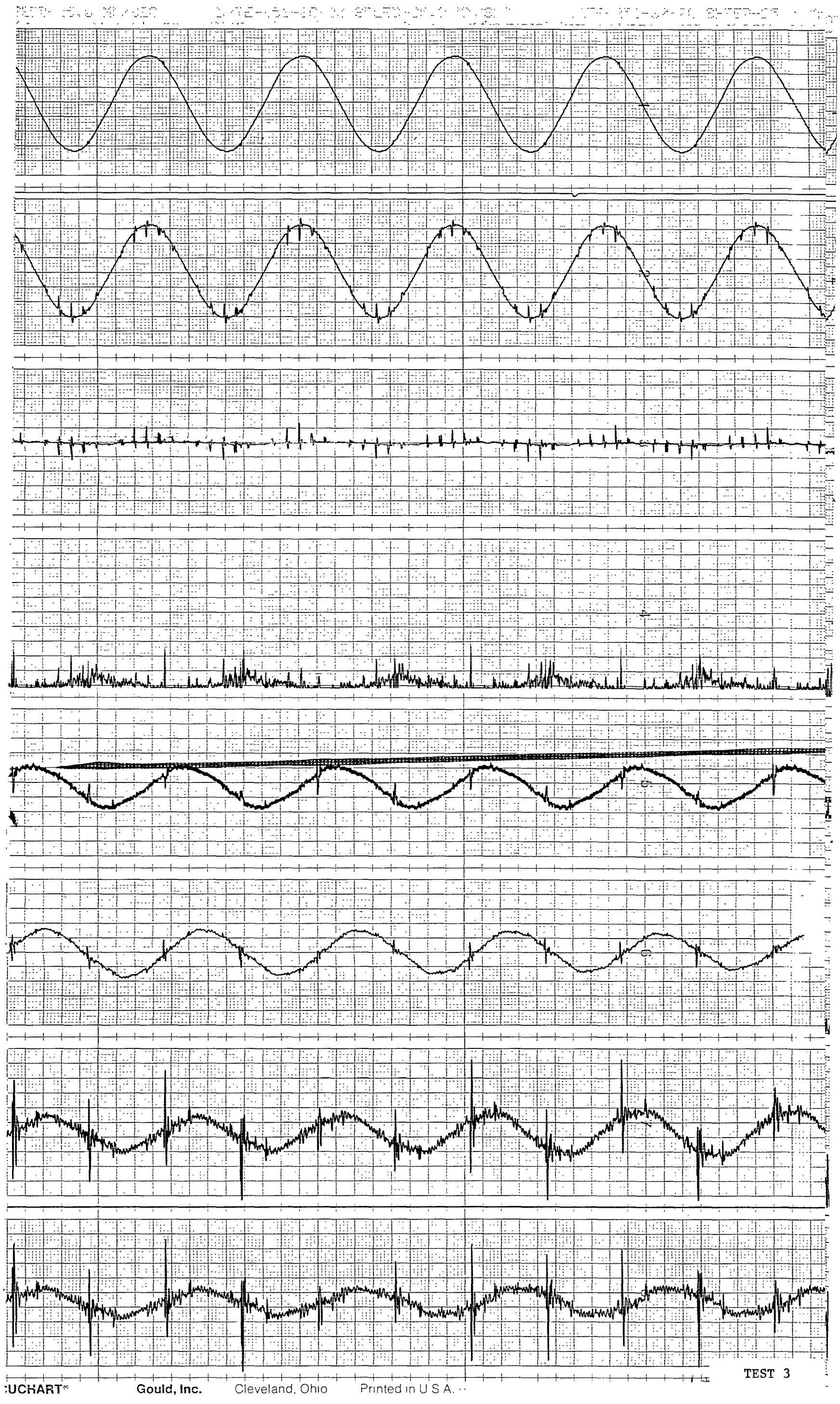


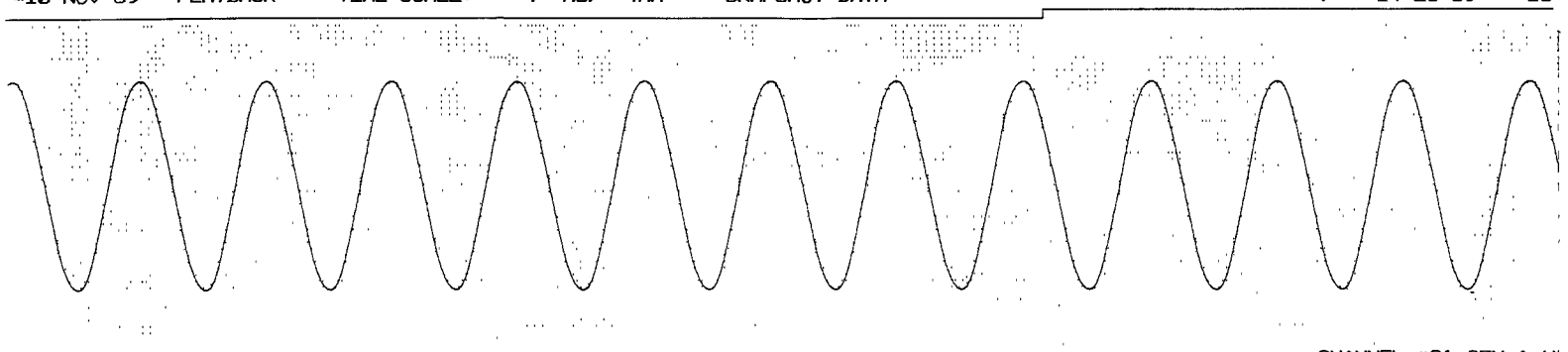
IP12_005355

IP12_005356
ACCUCHART®
Gould, Inc.
Clev

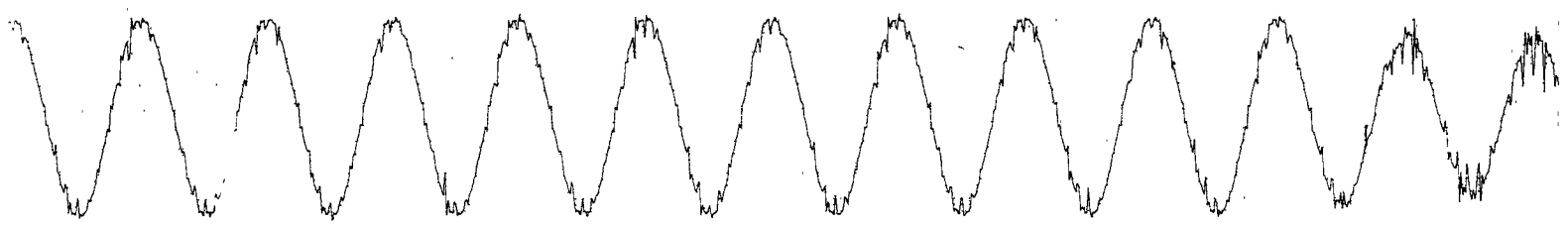


IP12_005357

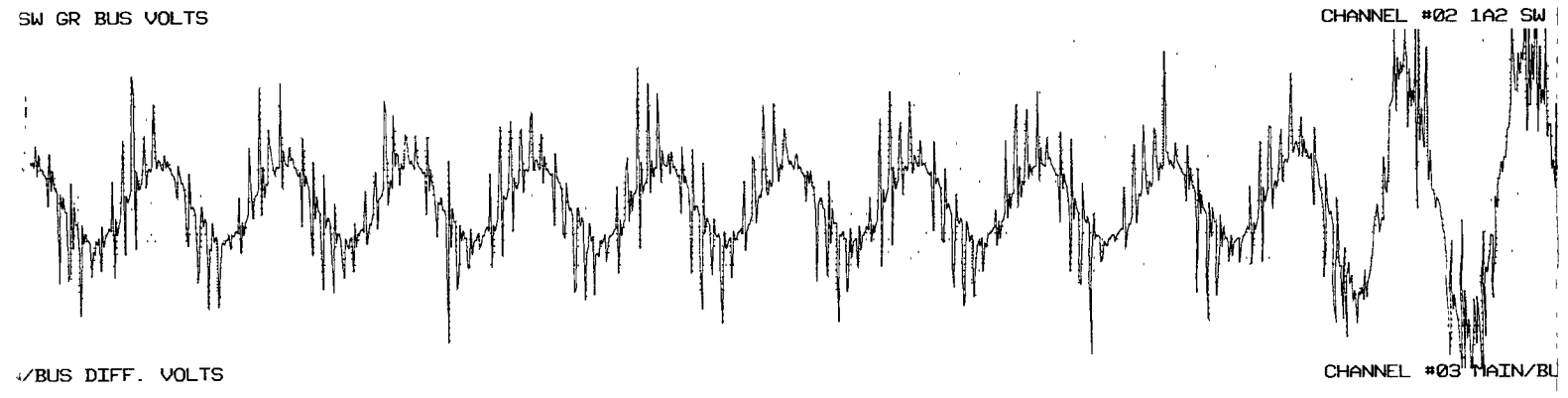
*10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA < 14:26:59 *10



1 VOLTS CHANNEL #01 GEN 1 V(

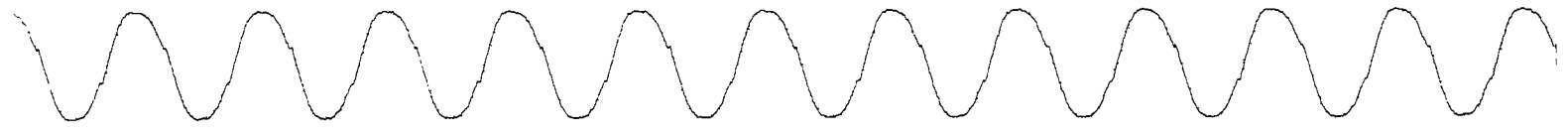


SW GR BUS VOLTS CHANNEL #02 1A2 SW

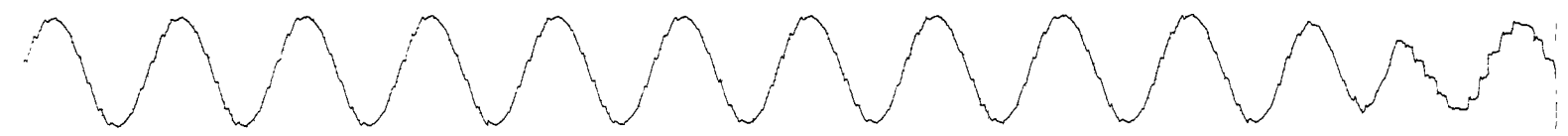


/BUS DIFF. VOLTS CHANNEL #03 MAIN/BU

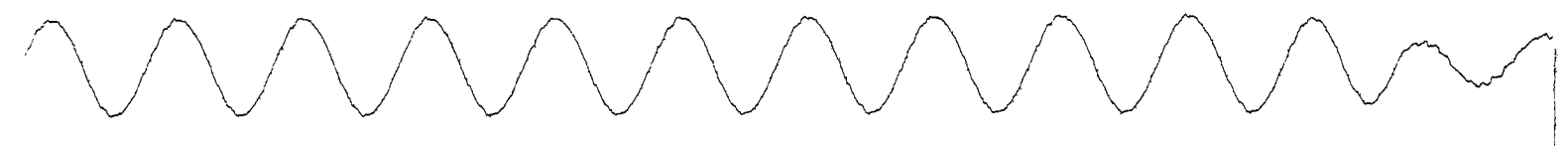
N/BUS VOLTS PHASE ANGLE TEST #4 CHANNEL #04 MAIN/BU



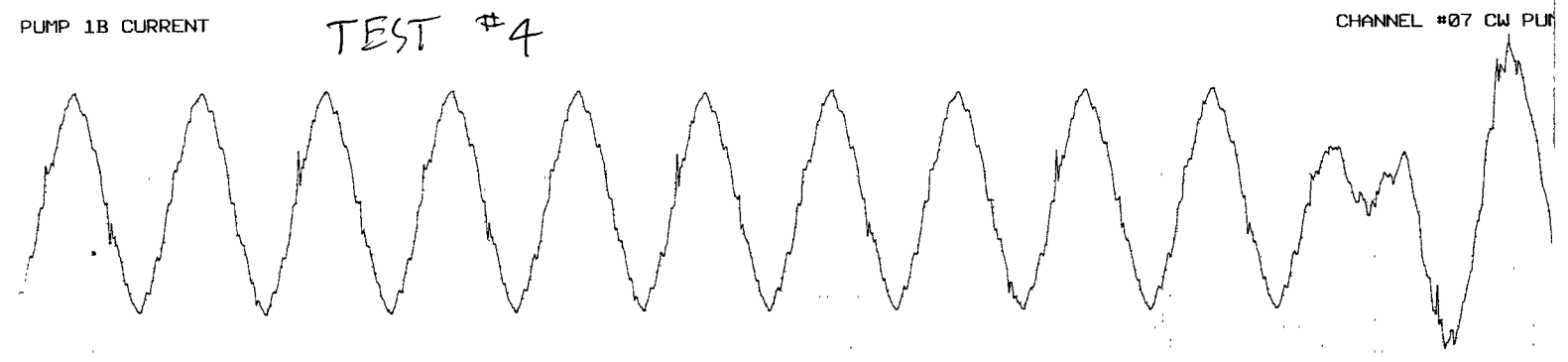
SW GR MAIN CURRENT CHANNEL #05 1A2 SW



D PUMP 1A CURRENT CHANNEL #06 PR

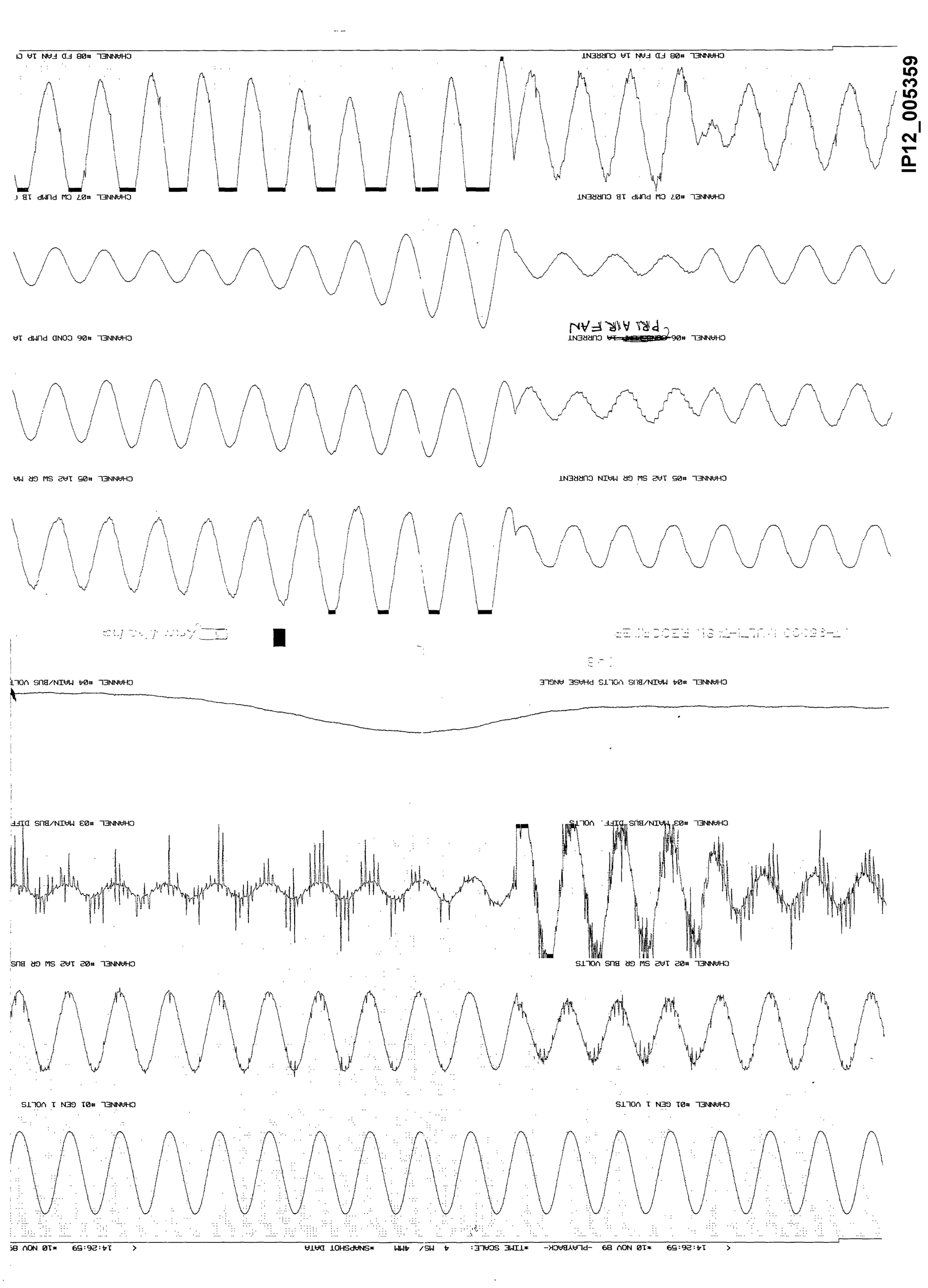


PUMP 1B CURRENT TEST #4 CHANNEL #07 CW PU



AN 1A CURRENT CHANNEL #08 FD FA

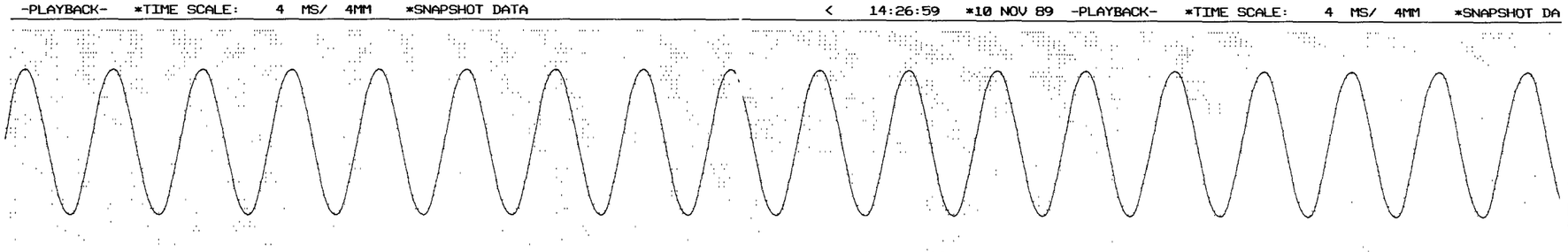
IP12_005358


CHANNEL #08 FD FAN 1A CURRENT
CHANNEL #08 FD FAN 1A CU
CHANNEL #07 CW PUMP 1B CURRENT
CHANNEL #07 CW PUMP 1B C
CHANNEL #06 ~~COND PUMP 1A~~ CURRENT
PRI AIR FAN
CHANNEL #06 COND PUMP 1A
CHANNEL #05 1A2 SW GR MAIN CURRENT
CHANNEL #05 1A2 SW GR MA
CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE
CHANNEL #04 MAIN/BUS VOLT
CHANNEL #03 MAIN/BUS DIFF. VOLTS
CHANNEL #03 MAIN/BUS DIFF
CHANNEL #02 1A2 SW GR BUS VOLTS
CHANNEL #02 1A2 SW GR BUS
CHANNEL #01 GEN 1 VOLTS
CHANNEL #01 GEN 1 VOLTS
< 14:26:59 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA
< 14:26:59 *10 NOV 89

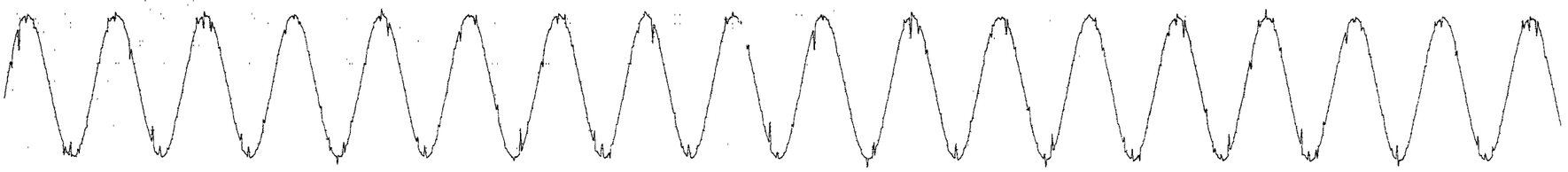
IP12_005359

-PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA < 14:26:59 *10 NOV 89 -PLAYBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DA

IP12_005360

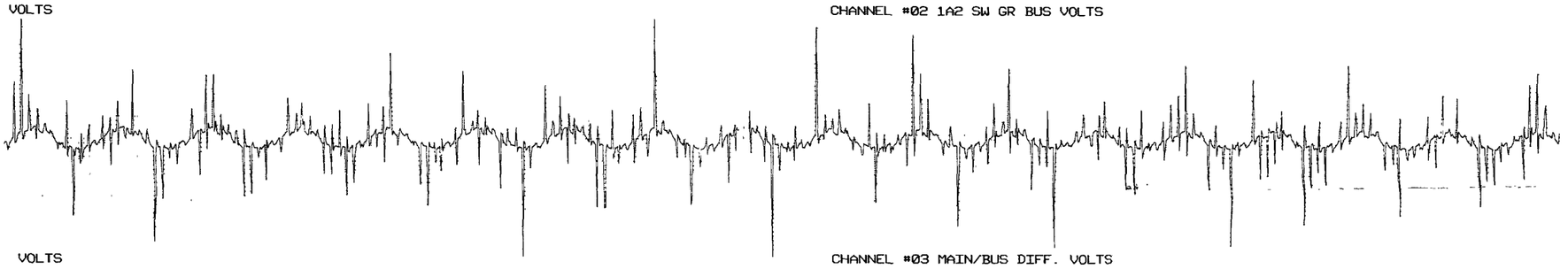


CHANNEL #01 GEN 1 VOLTS



VOLTS

CHANNEL #02 1A2 SW GR BUS VOLTS

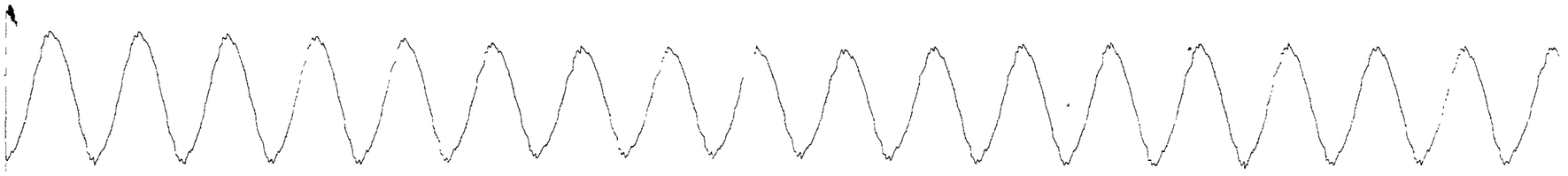


VOLTS

CHANNEL #03 MAIN/BUS DIFF. VOLTS

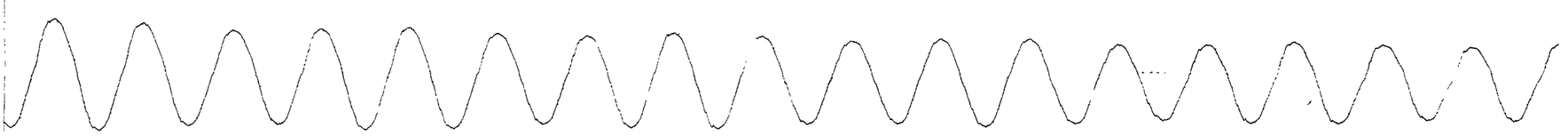
3 PHASE ANGLE

CHANNEL #04 MAIN/BUS VOLTS PHASE ANGLE



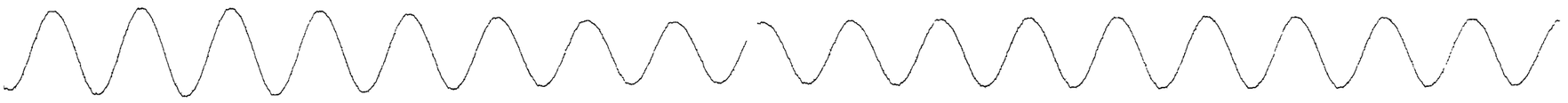
N CURRENT

CHANNEL #05 1A2 SW GR MAIN CURRENT



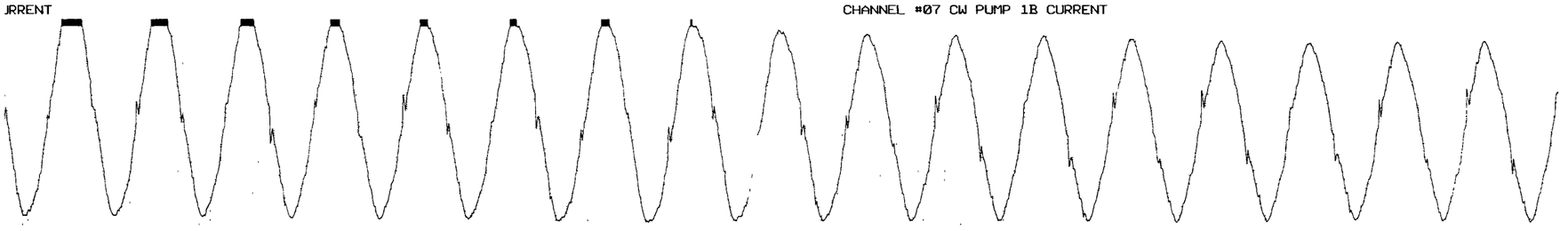
CURRENT

CHANNEL #06 COND PUMP 1A CURRENT



URRENT

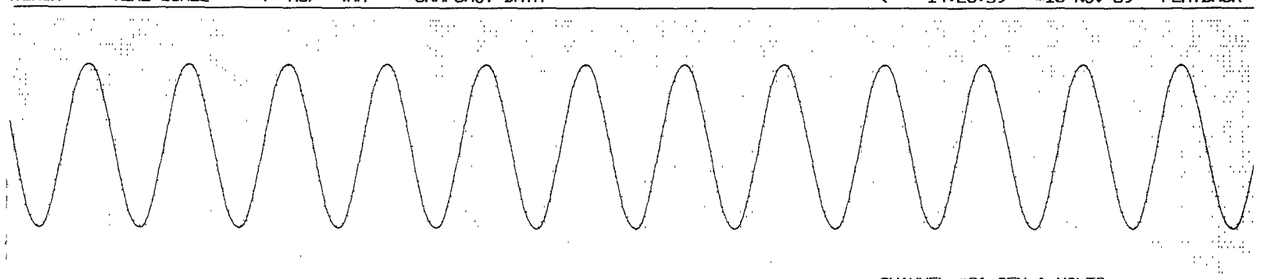
CHANNEL #07 CW PUMP 1B CURRENT



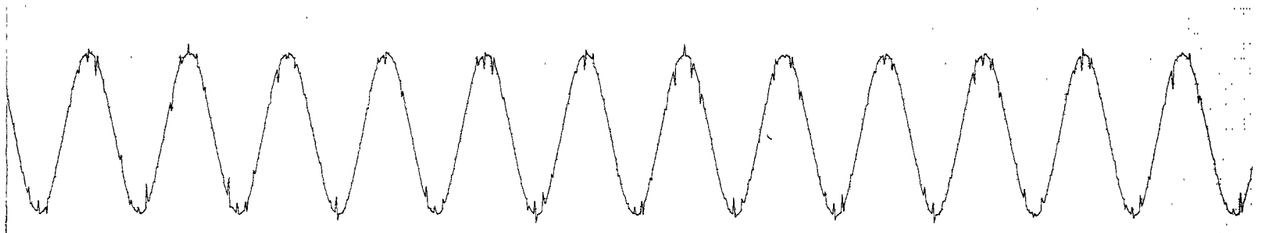
RRENT

CHANNEL #08 FD FAN 1A CURRENT

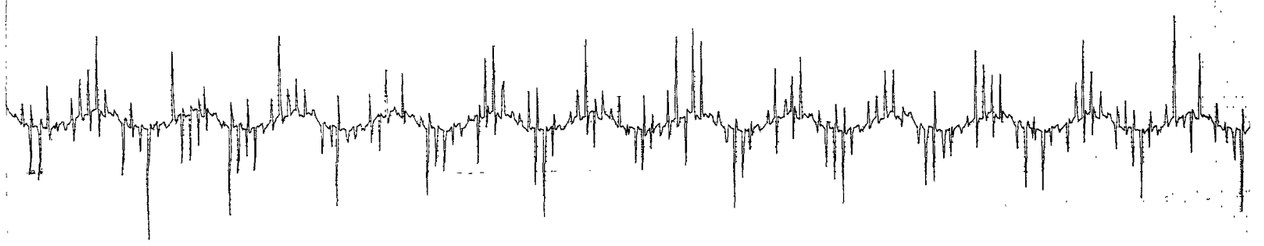
:YBACK- *TIME SCALE: 4 MS/ 4MM *SNAPSHOT DATA < 14:26:59 *10 NOV 89 -PLAYBACK-



CHANNEL #01 GEN 1 VOLTS



CHANNEL #02 1A2 SW GR BUS VOLTS

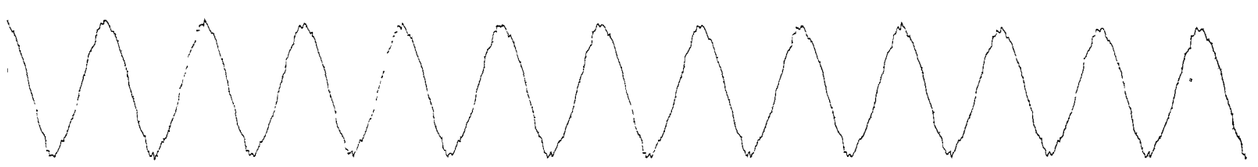


5

CHANNEL #03 MAIN/BUS DIFF. VOLTS

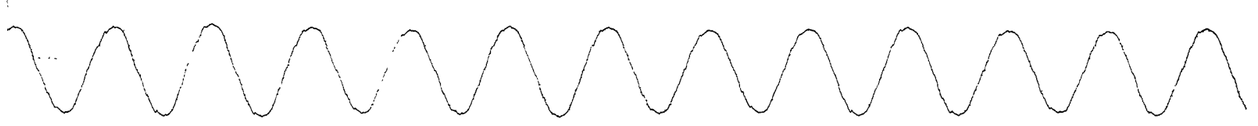
E ANGLE

CHANNEL #04 MAIN/BUS VOLTS PHASE ANGL



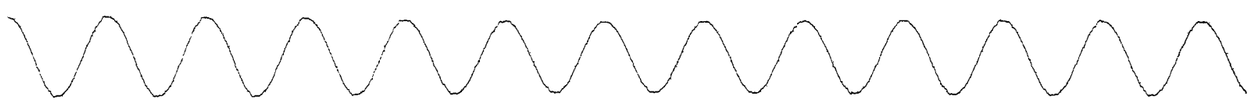
ENT

CHANNEL #05 1A2 SW GR MAIN CURRENT

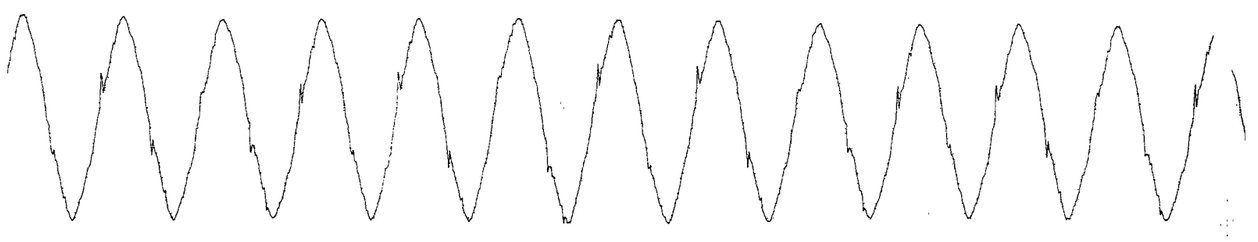


T

CHANNEL #06 COND PUMP 1A CURRENT



CHANNEL #07 CW PUMP 1B CURRENT



CHANNEL #08 FD FAN

TEST 4

IP12_005361

IP12_005362

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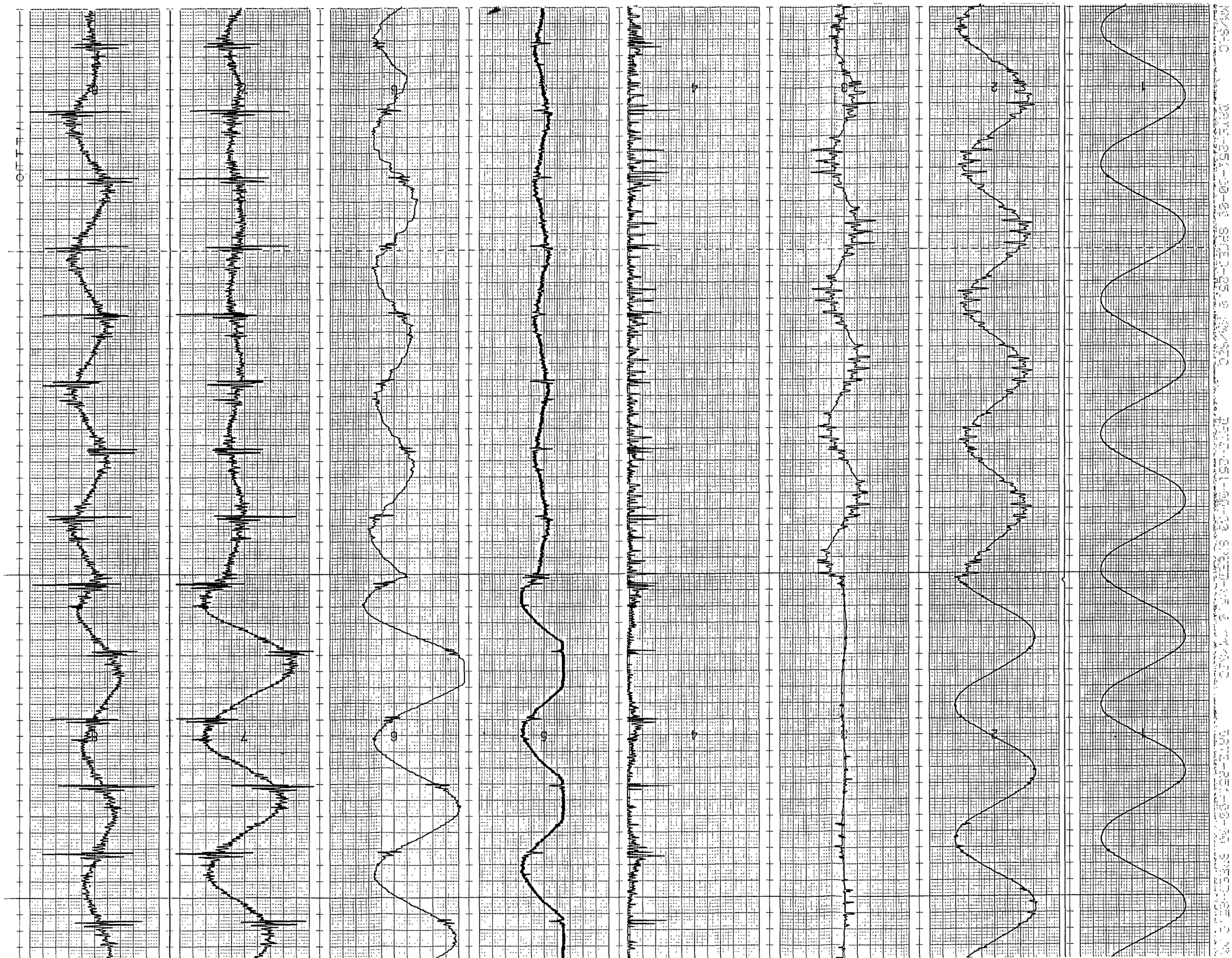
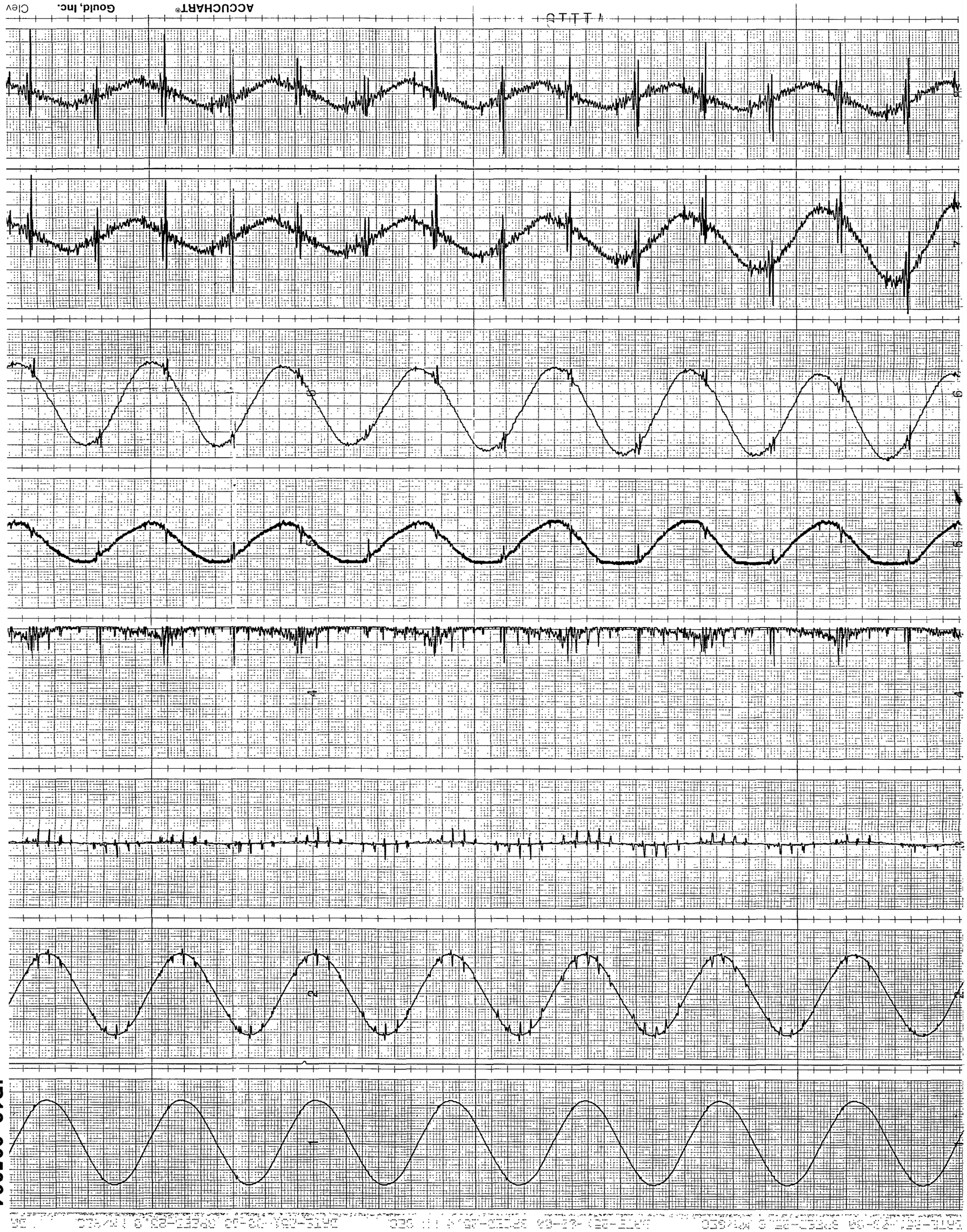
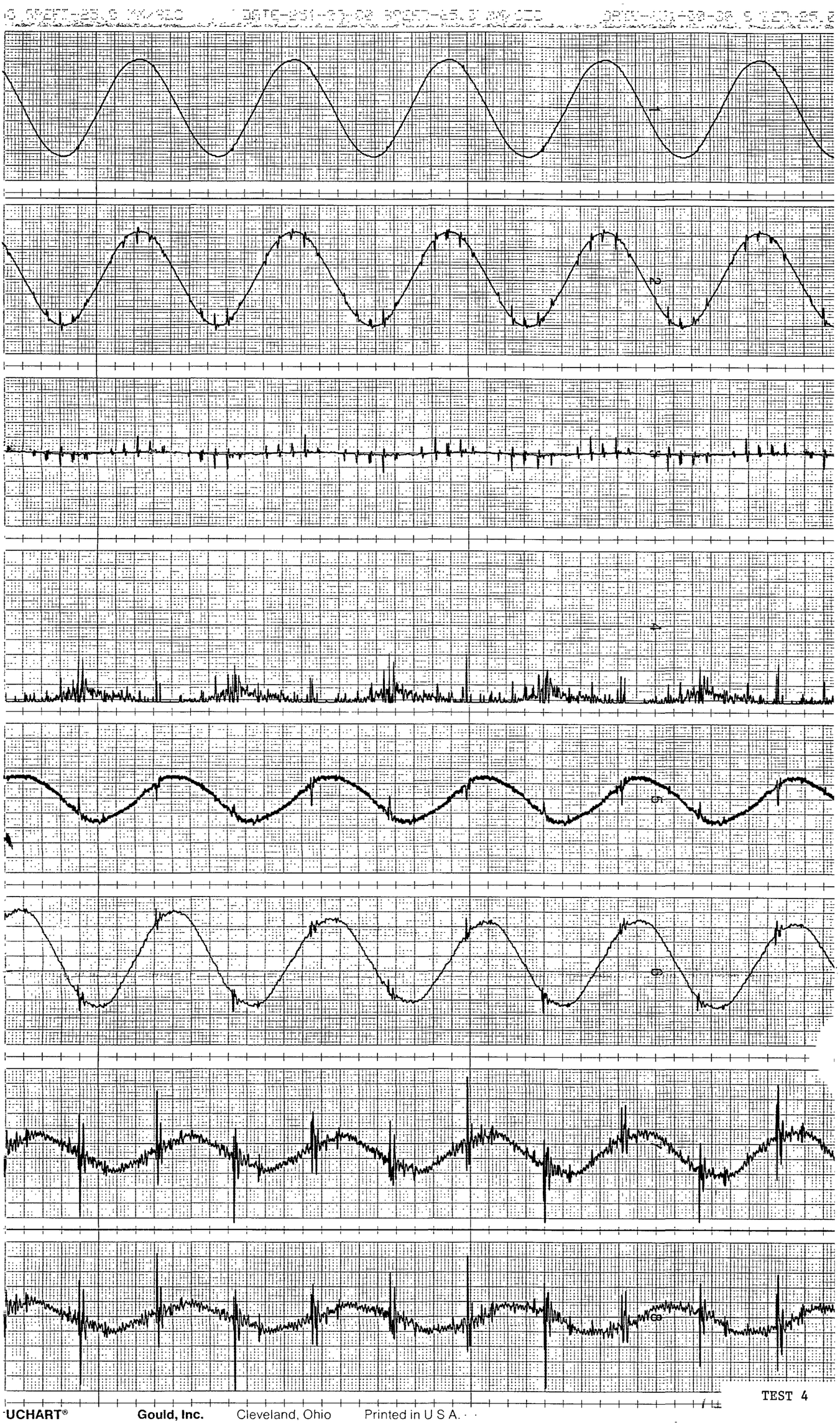




IP12_005364

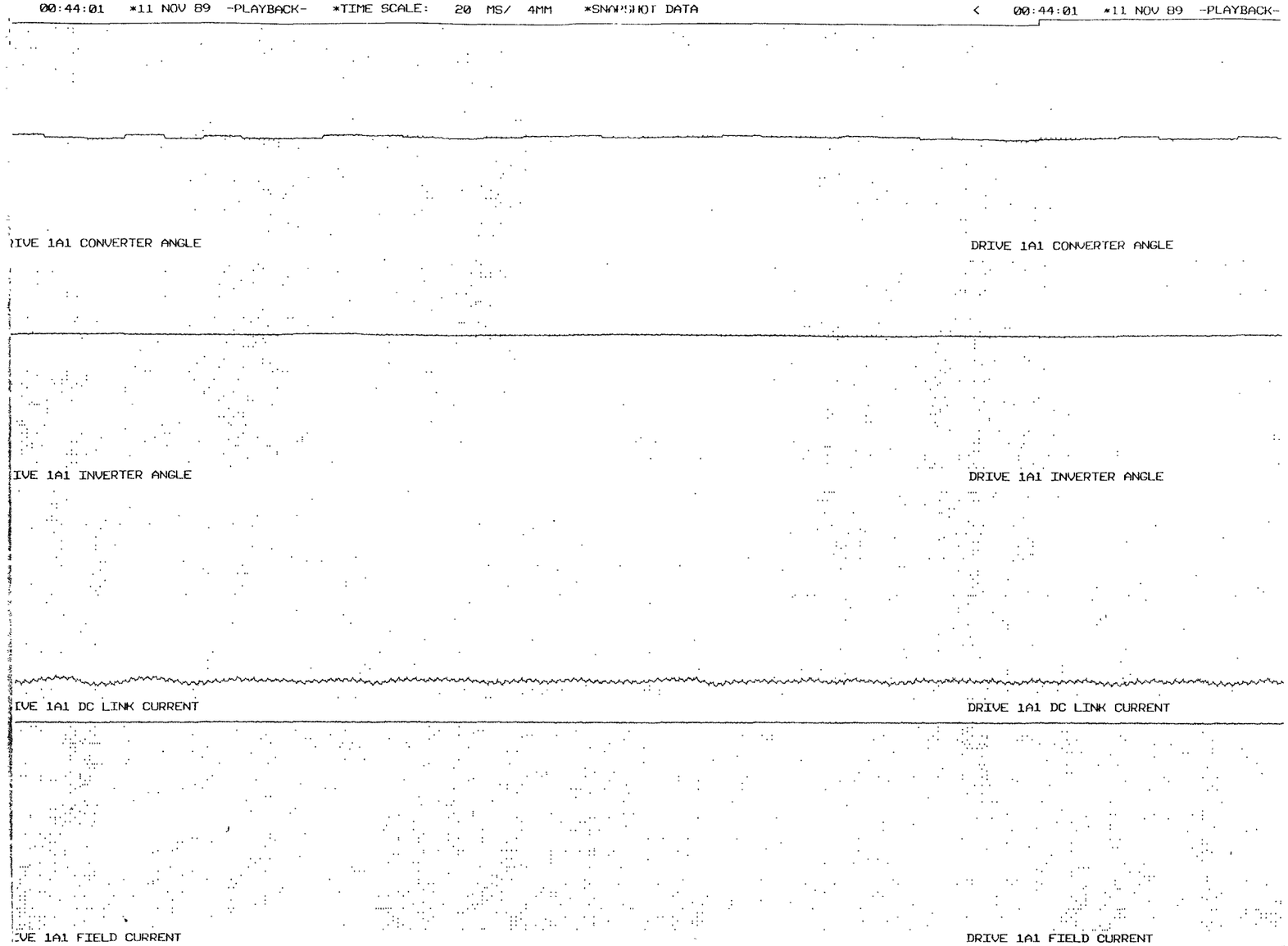


TEST 4

UCHART® Gould, Inc. Cleveland, Ohio Printed in U S A.

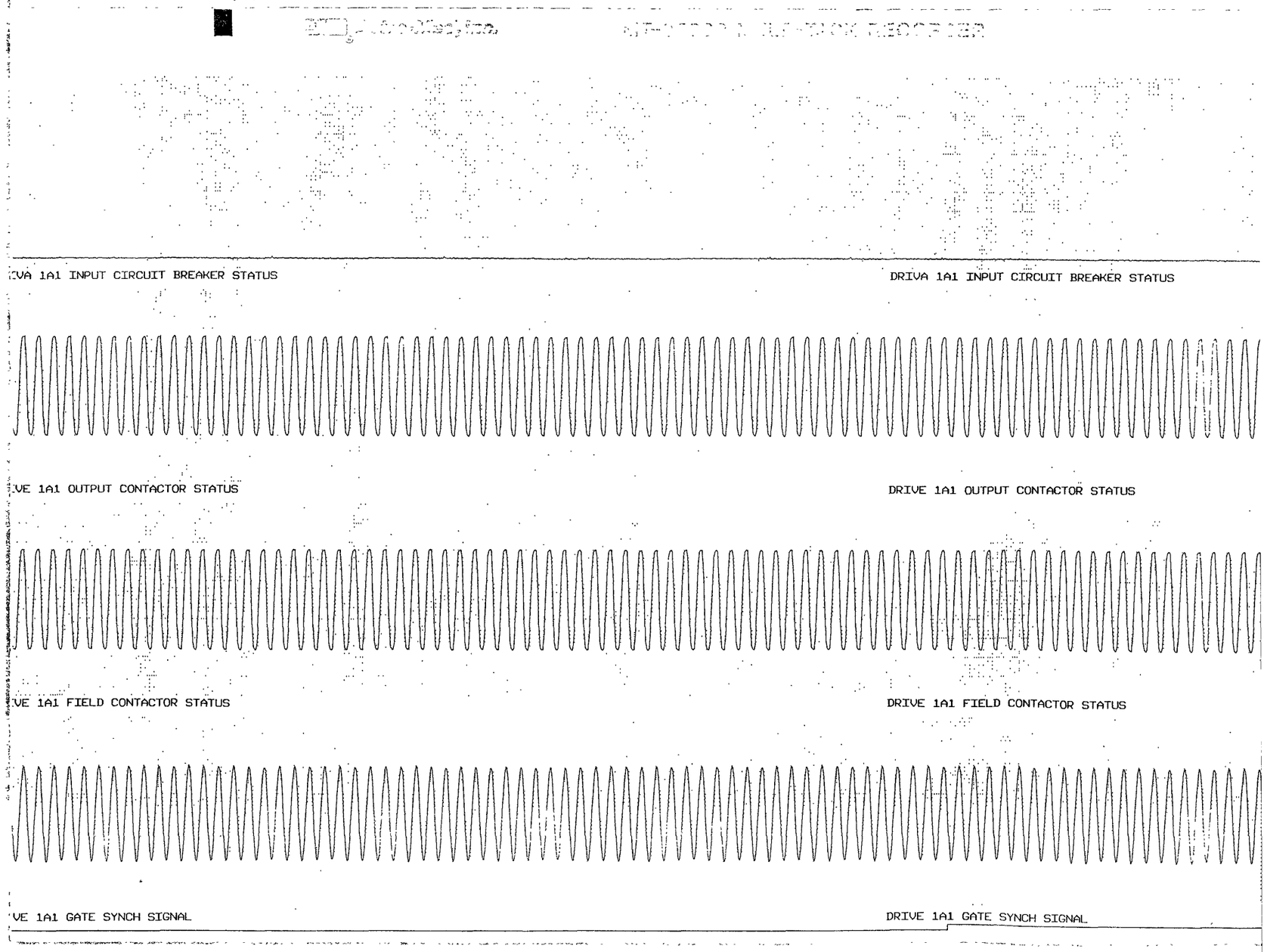
IP12_005365

00:44:01 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA < 00:44:01 *11 NOV 89 -PLAYBACK-

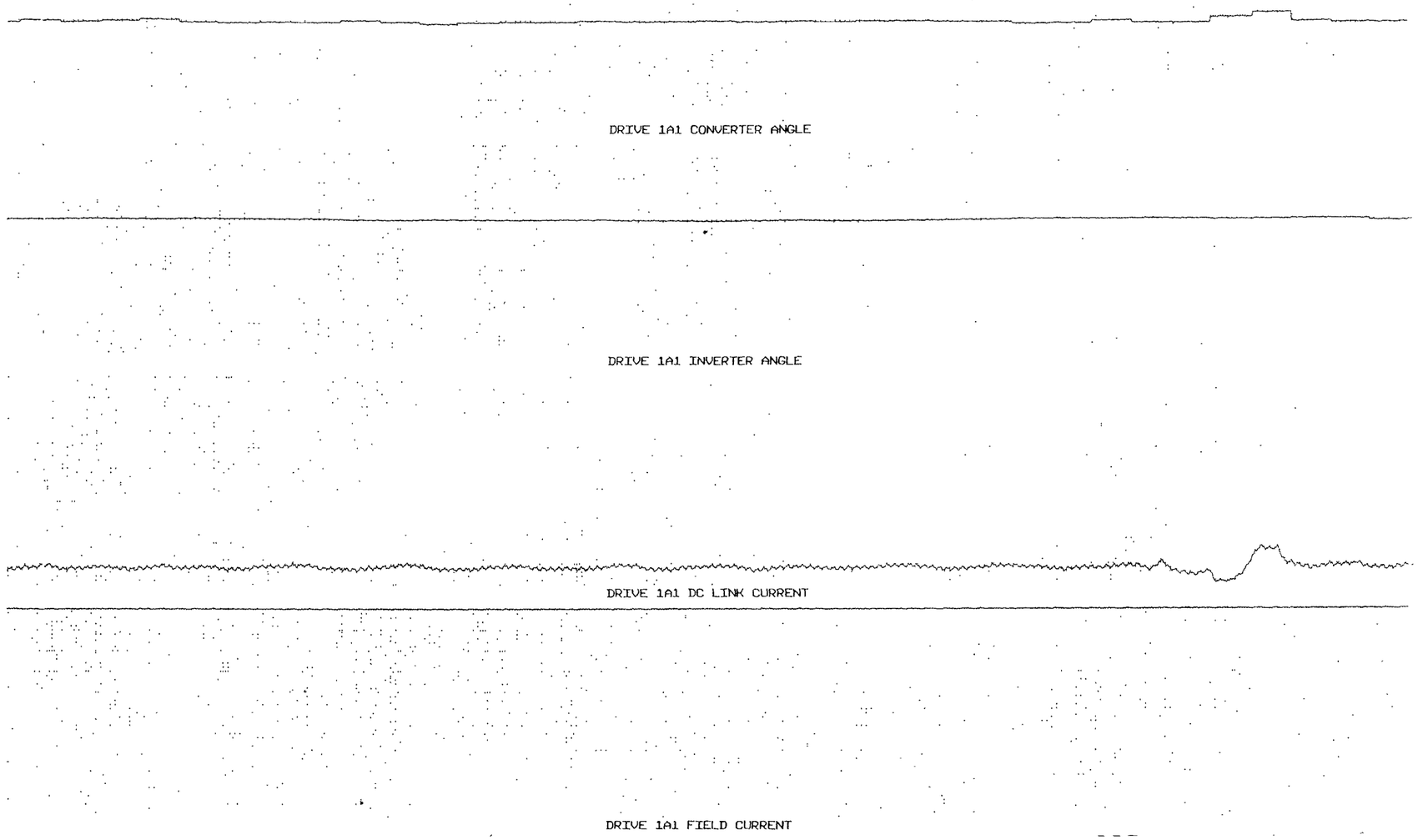


IP12_005366

TEST # 1

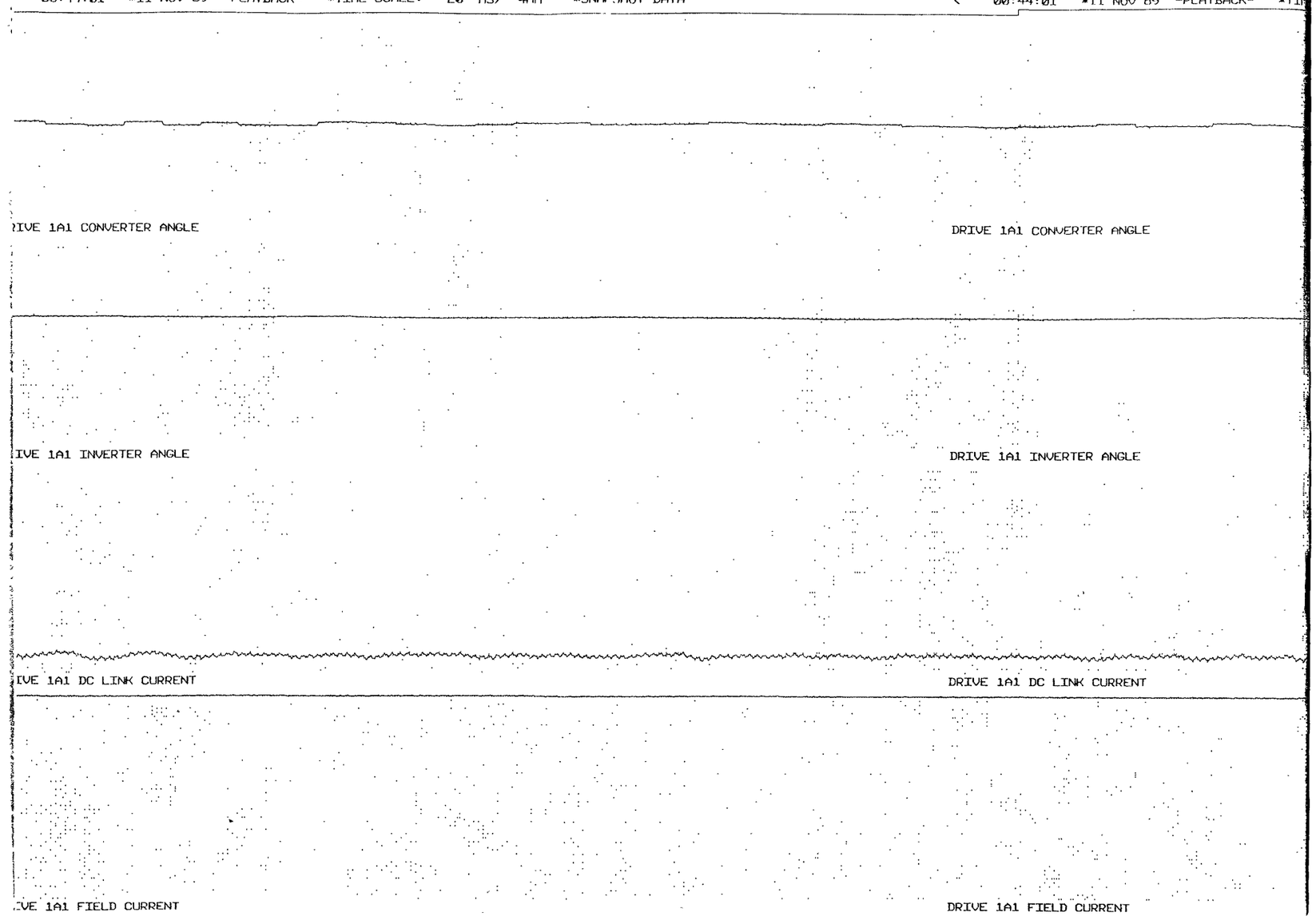

:VA 1A1 INPUT CIRCUIT BREAKER STATUS
DRIVA 1A1 INPUT CIRCUIT BREAKER STATUS
:VE 1A1 OUTPUT CONTACTOR STATUS
DRIVE 1A1 OUTPUT CONTACTOR STATUS
VE 1A1 FIELD CONTACTOR STATUS
DRIVE 1A1 FIELD CONTACTOR STATUS
VE 1A1 GATE SYNCH SIGNAL
DRIVE 1A1 GATE SYNCH SIGNAL

SCALE: 20 MS/ 4MM *SNAPSHOT DATA < 00:44:01 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA



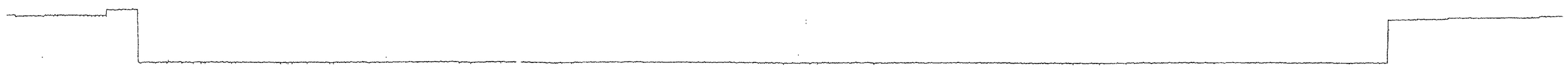
IP12_005368

00:44:01 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA

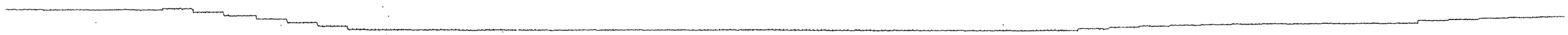


< 00:44:01 *11 NOV 89 -PLAYBACK- *TI
DRIVE 1A1 CONVERTER ANGLE
DRIVE 1A1 INVERTER ANGLE
DRIVE 1A1 DC LINK CURRENT
DRIVE 1A1 FIELD CURRENT

5:06 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA < 01:15:06 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA < 01:15:06 *11

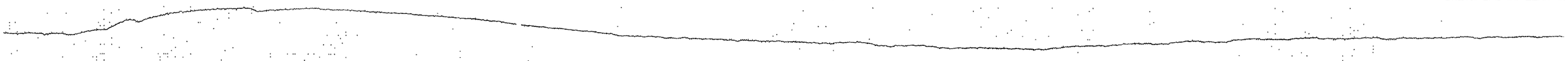


CONVERTER GATE ANGLE DRIVE 1A2 CONVERTER GATE ANGLE DRIVE 1A2 CONVERTER



INVERTER GATE ANGLE DRIVE 1A2 INVERTER GATE ANGLE DRIVE 1A2 INVERTER

DC LINK CURRENT DRIVE 1A2 DC LINK CURRENT DRIVE 1A2 DC LINK C

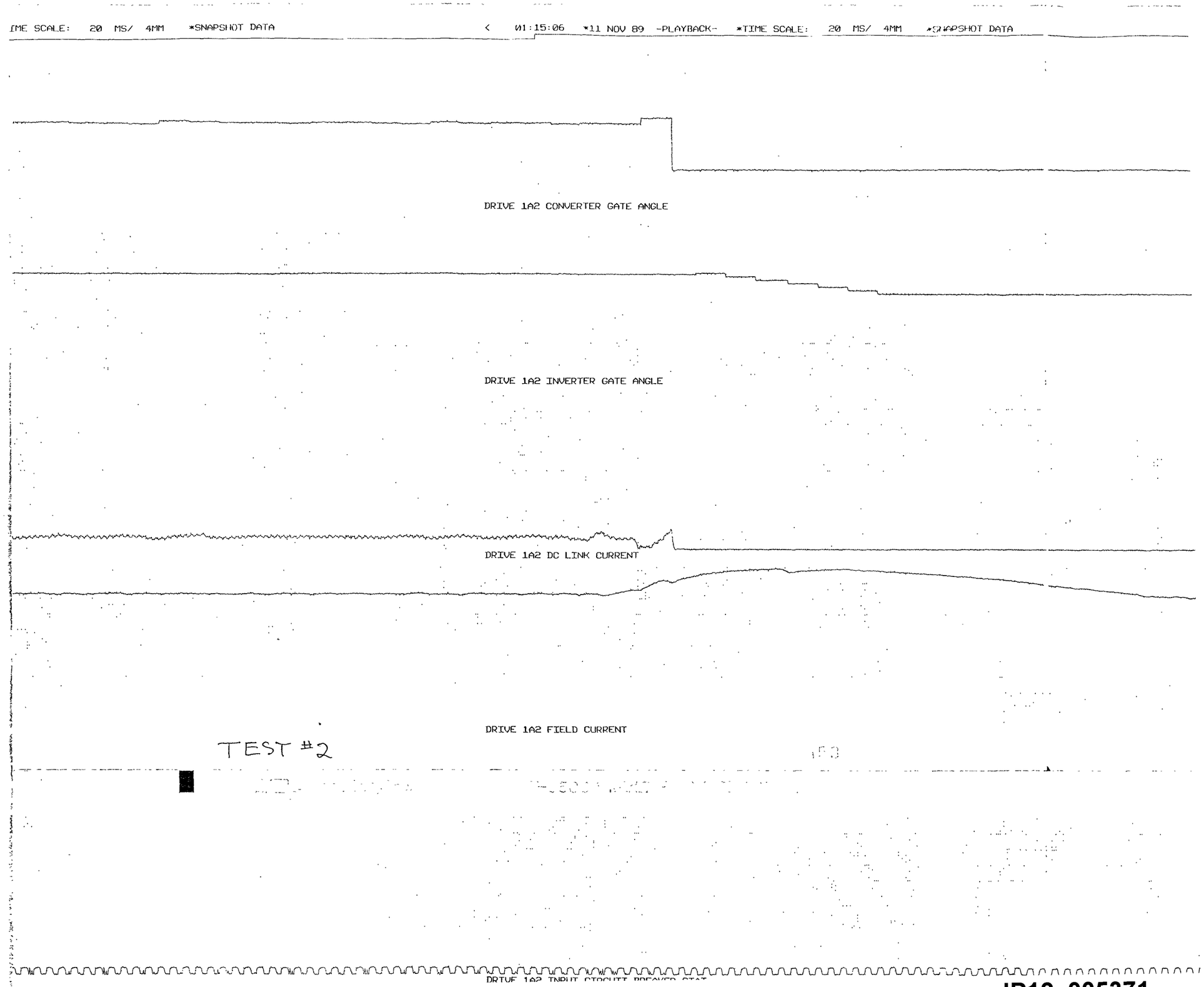


2 FIELD CURRENT DRIVE 1A2 FIELD CURRENT DRIVE 1A2 FIELD CUR

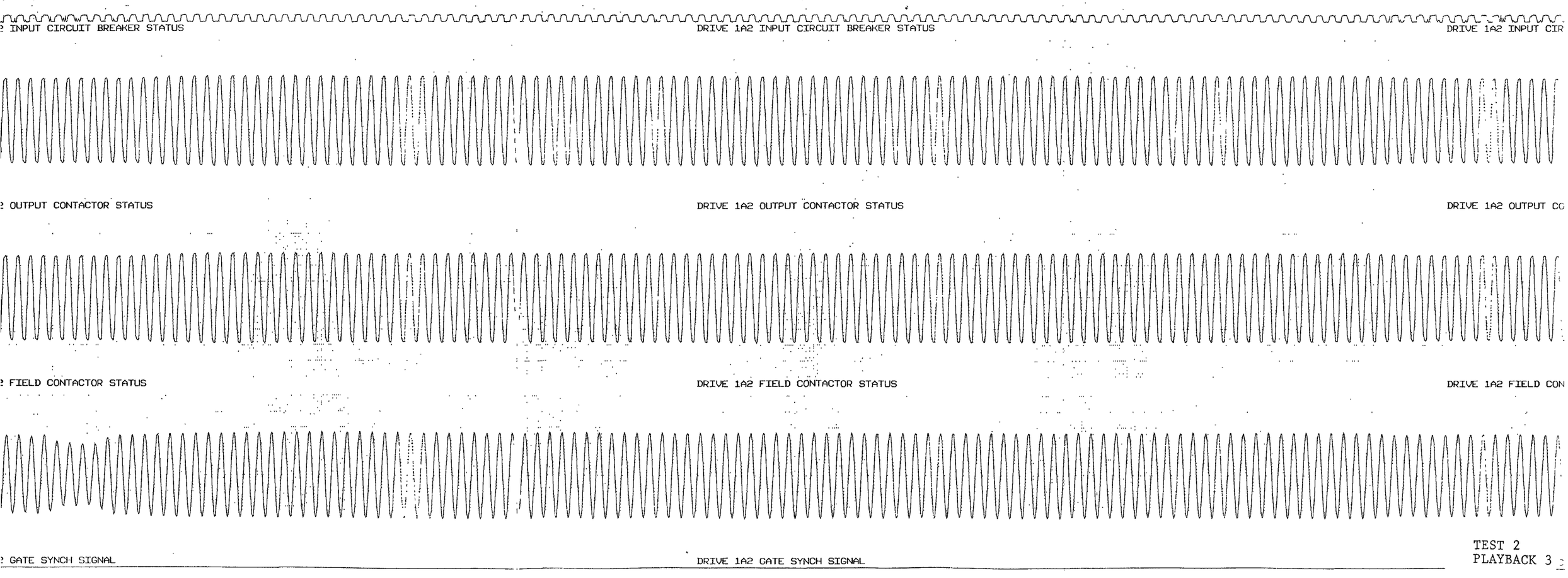
453 452

2 INPUT CIRCUIT BREAKER STATUS DRIVE 1A2 INPUT CIRCUIT BREAKER STATUS DRIVE 1A2 INPUT CIR

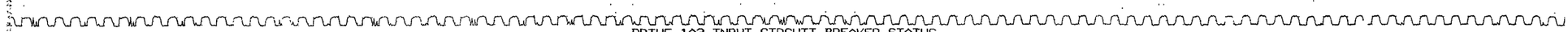
IP12_005370


IME SCALE: 20 MS/ 4MM *SNAPSHOT DATA
< 01:15:06 *11 NOV 89 -PLAYBACK- *TIME SCALE: 20 MS/ 4MM *SNAPSHOT DATA
DRIVE 1A2 CONVERTER GATE ANGLE
DRIVE 1A2 INVERTER GATE ANGLE
DRIVE 1A2 DC LINK CURRENT
DRIVE 1A2 FIELD CURRENT
TEST #2

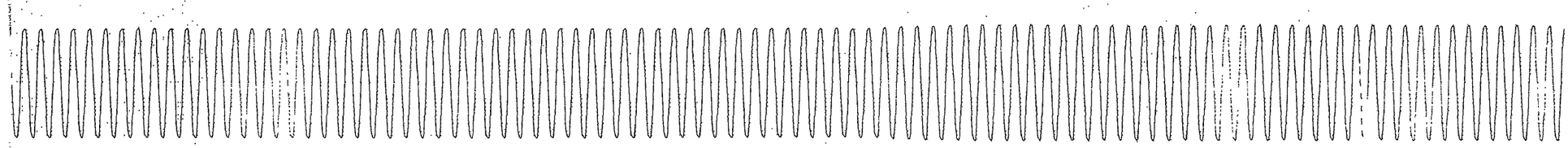
IP12_005371



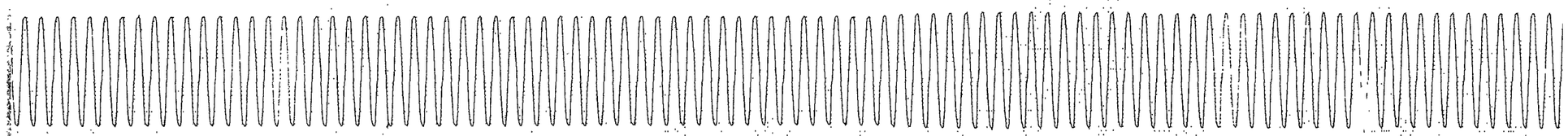
TEST 2
PLAYBACK 3



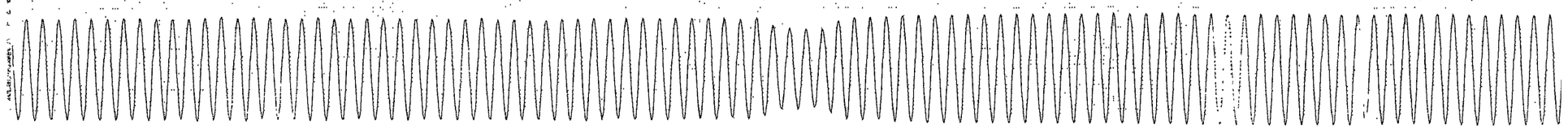
DRIVE 1A2 INPUT CIRCUIT BREAKER STATUS



DRIVE 1A2 OUTPUT CONTACTOR STATUS



DRIVE 1A2 FIELD CONTACTOR STATUS



DRIVE 1A2 GATE SYNCH SIGNAL

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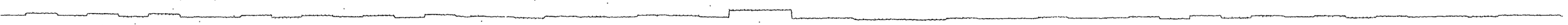

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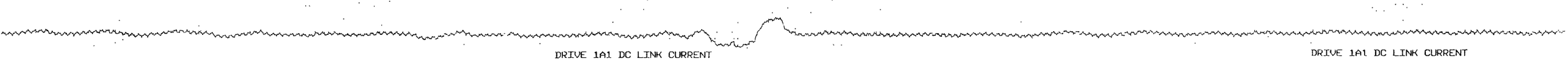

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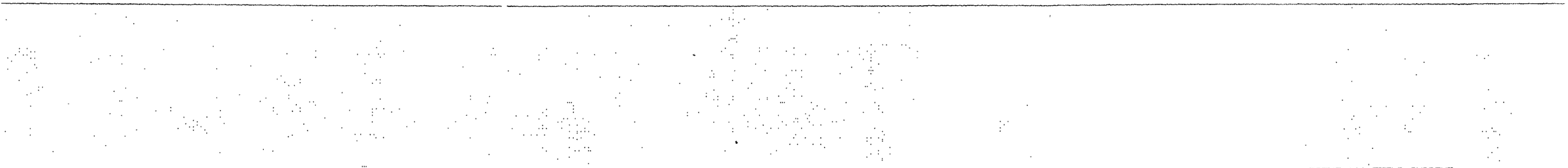

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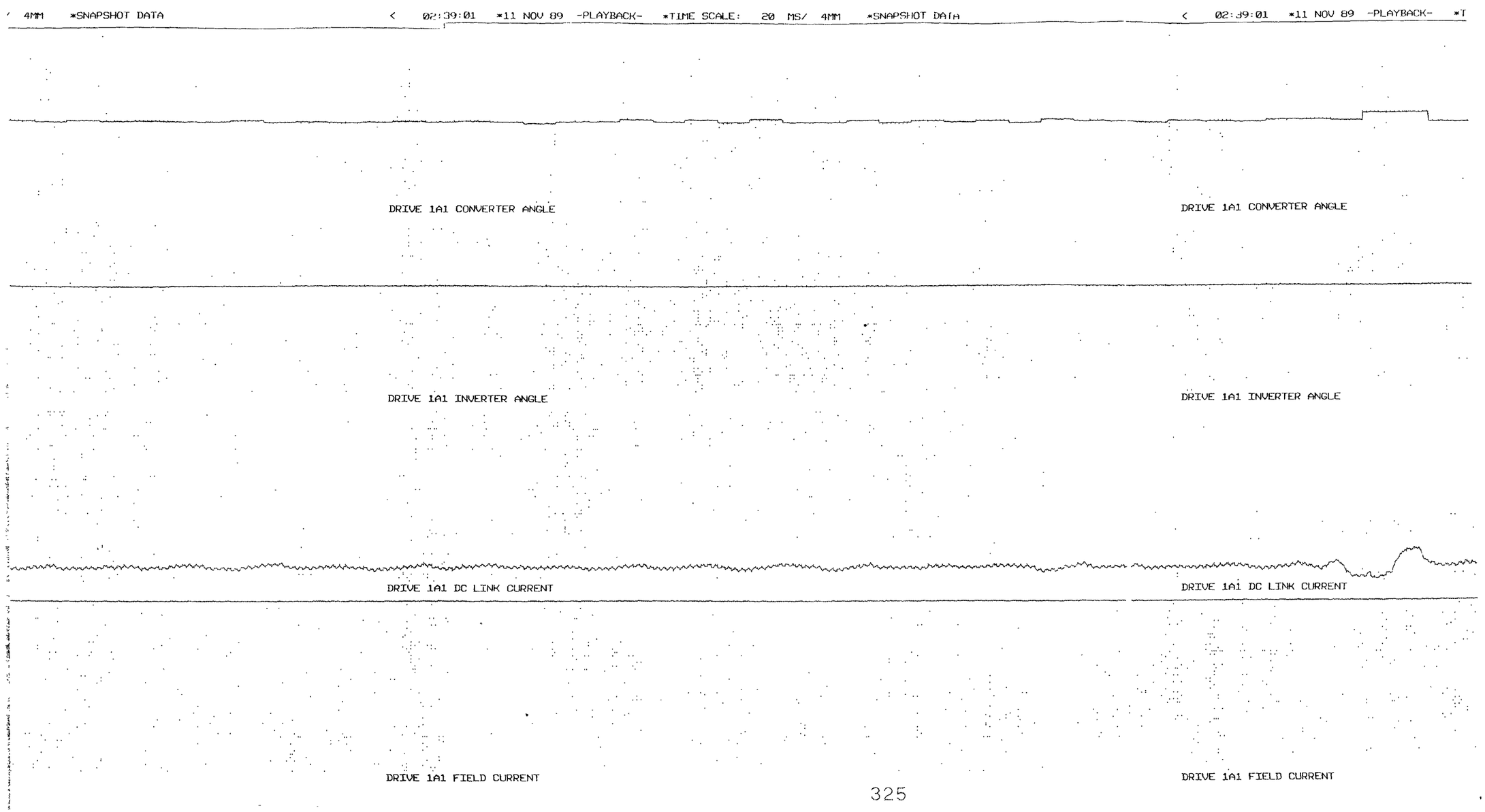
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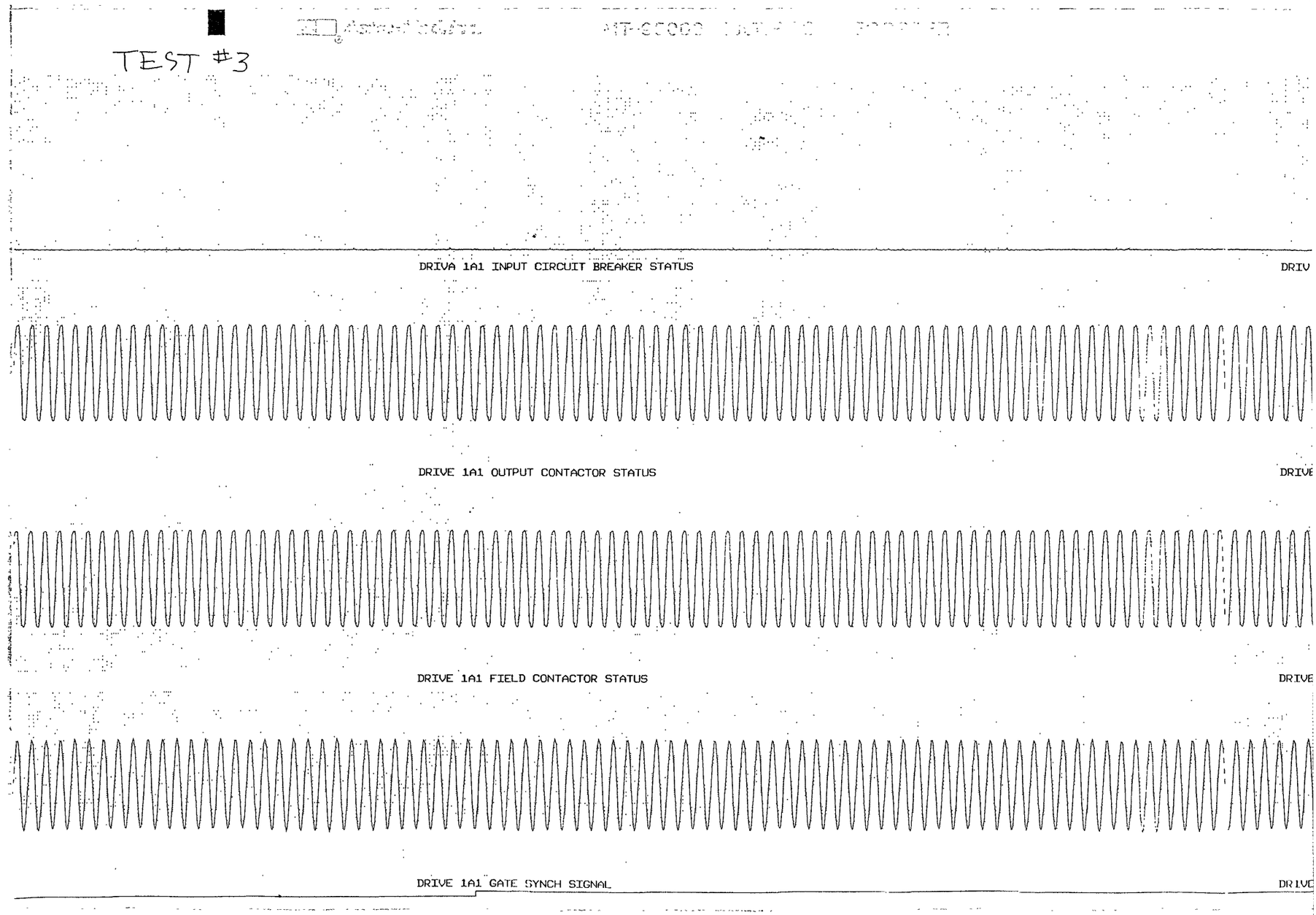
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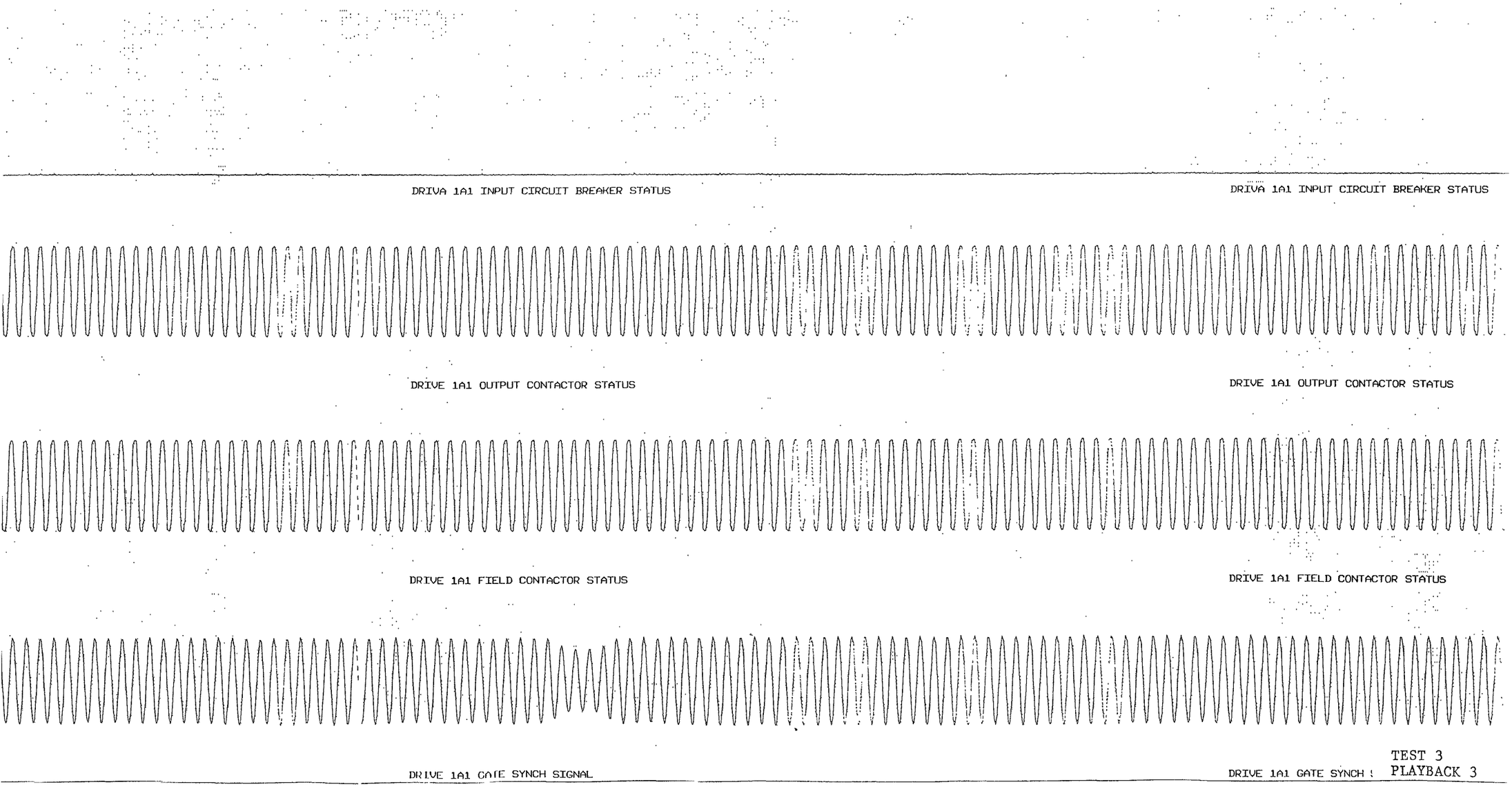

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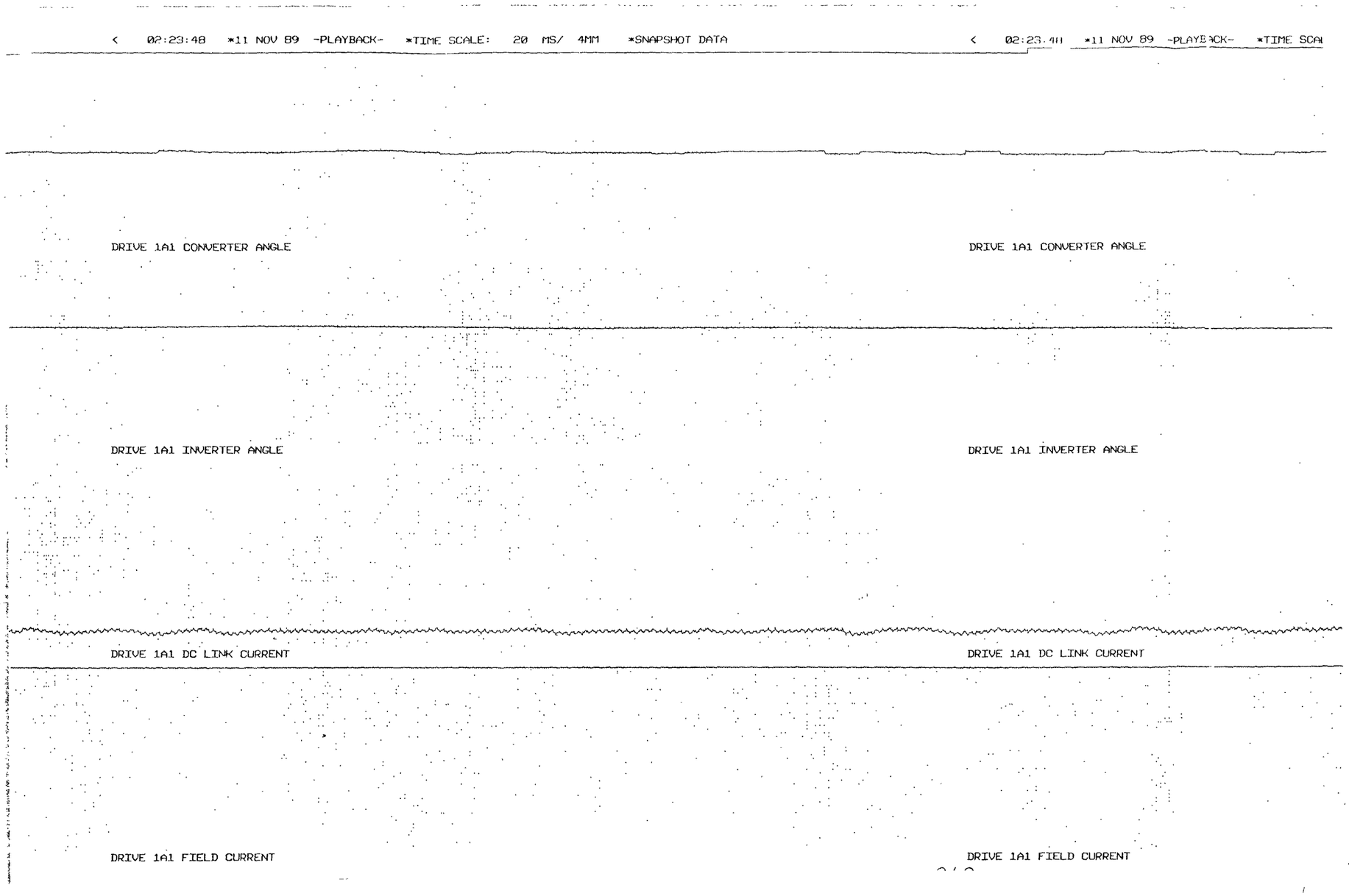
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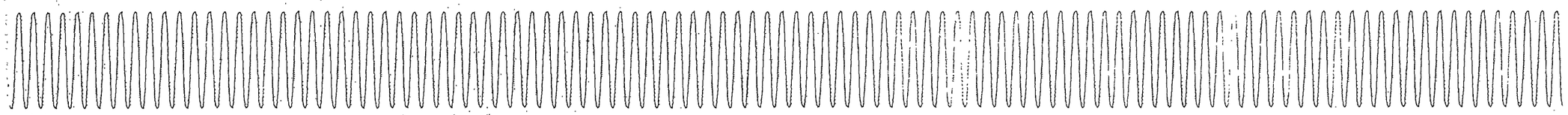

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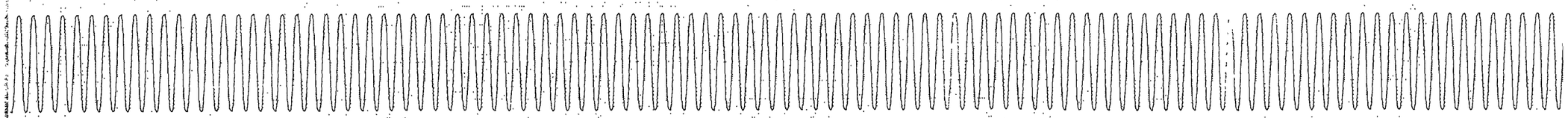

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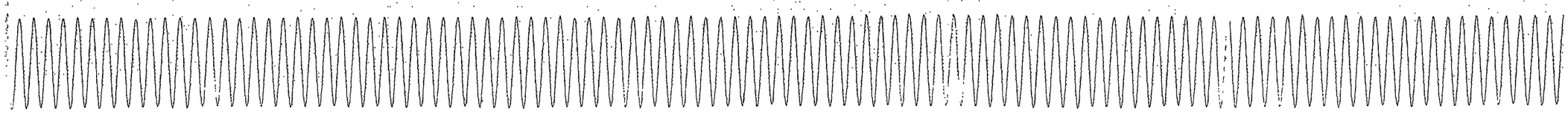

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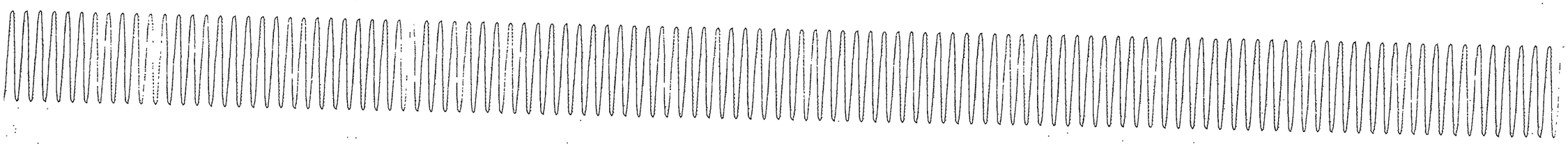

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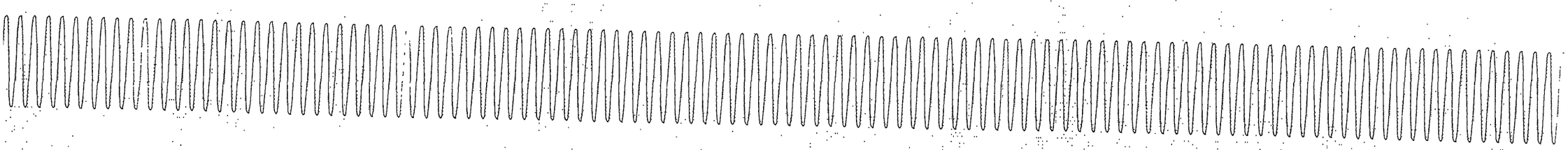

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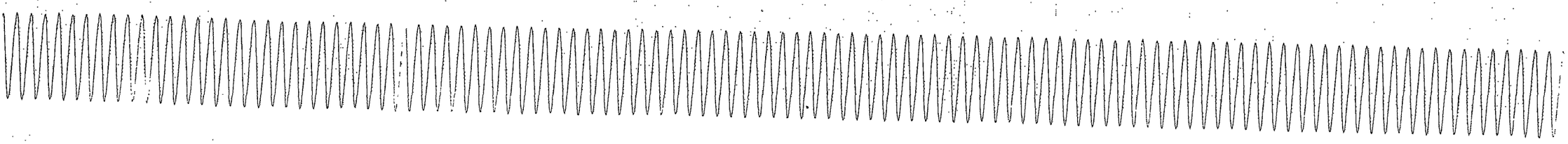

DRIVE 1A1 GATE SYNCH SIGNAL

DRIVE 1A1 GATE SYNCH SIGNAL

TEST 4
PLAYBACK 1360

Intermountain Power Project
Torsional Fatigue Study

Performed by
GE Power Systems Engineering Department
One River Road
Schenectady, New York 12345

Principal Contributors

Colin E.J. Bowler
Dr. Henry Mosteller

Consultants

Dr. Daniel Baker
Richard J. Piwko

December, 1992

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AC6 Two Units, 2ϕ Fault at Adelanto Plus CFC

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EXECUTIVE SUMMARY

This report quantifies the IPP plant turbine-generator torsional duty due to ac and dc faults. The torsional duty is caused by system faults, and subsequent unit and ac tie line trips, in the presence of dc power controls that require constant dc power over short periods following disturbances.

The objective of the study is to show the degree of improvement, in fault caused torsional fatigue, resulting from three HVDC control approaches:

1. Bypass Pair Order (BPPO)
2. Converter Firing Control (CFC)
3. Fast DC Power Schedule Calculator (DC PSC)

The CFC and BPPO controls are designed to minimize generator transient power reversal, at the rectifier, due to inverter commutation failure, caused by inverter ac bus faults. The DCPSC control provides a dc power demand signal which follows the available ac power from the IPP generators power plus the tie line power. This available ac power changes if a unit or the tie lines are tripped.

The investigation of mitigation methods to eliminate transient reverse power on the IPP generators showed CFC to be ineffective, and BPPO to be quite effective in reducing torsional response.

The investigation of the fast ramp DC PSC proved that this technique is effective in reducing fatigue for two unit operation where one unit is tripped following a fault. The effectiveness of this method is limited, however, by the time delay in communication with the inverter to initiate power reduction. On balance, the DC PSC is important and should be instituted as it is simple and effective. **The fast DCPSC application reduced the torsional duty on the order of 2:1.**

For this study, the ac and dc faults simulated were chosen to produce maximum torsional response at the turbine-generator. These cases are unlikely and may not represent real plant operating conditions, but do represent potentially severe events. As a result of studying worst case dc faults, it was found that **modification of the DC**

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restart time to delay restart, an additional 100 to 200 msec, is beneficial and **reduces the potential torsional duty from approximately 5% to 2%.**

The DCPSC modifications, and the BPPO Control respond to different precursors of transient torsional response of the IPP units. To be effective, both controls need to be implemented.

Fatigue effects are cummulative, and the elements of the system and controls that conspire to produce high torsional response are probabilistic in nature. There is nothing in this report to help guide a decision for application of the controls based on probability. High torsional response, however, can lead to coupling slip which may lead to high vibrations and cause unit outage for rebalancing. The event severity is deterministic and can be effectively controlled by the application of the DCPSC modification and BPPO controls. **To date, monitoring activity of the IPP units has not indicated any actual events of the severity reported here.**

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Section 1

INTRODUCTION

This report provides information and conclusions on the impact of power system faults and dc system operations on the torsional duty of the IPP turbine-generator units.

This study work was prompted by the measurement of high torsional response and high frequency of occurrence of events as recorded by the torsional vibration monitor (TVMS) equipment installed on the IPP turbine-generators. These observations were coupled with some projections that indicated very high level response possibilities for certain kinds of two-unit operation. These projections raised the question of the impact of other system events for which there was no previous experience, such as dc faults and restart operations, especially when the restart is unsuccessful, and repeated.

The expectation of high torsional response for turbine-generators when closely coupled to dc transmission equipment is based on the high bandwidth of response of dc controls to input errors, allowing fast changes of dc power demand, and the consequence of maintaining quasi constant dc power operation under changing ac supply system configurations.

Turbine-generator electromagnetic response allows an almost instantaneous change of electrical torque to changes in system reactance. Turbine-generator torsional dynamics will respond dramatically to such applied torque changes as a consequence of their resonant and poorly damped mechanical characteristics. These characteristics result from the distribution of inertia and stiffness of the turbine and generator rotors and shafts, that produce very low natural frequency resonance's, with a high degree of coupling to the power system through the generator.

The above mechanical and electrical characteristics combine to produce severe torsional response and stress for multiple disturbances closely spaced in time. This is because the response to an initial disturbance may not decay before a second

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disturbance is initiated. That is, a second or subsequent disturbance may double the response of the first disturbance. The timing and direction of subsequent disturbances is critical in the production of response doubling, more generally described as response compounding.

One multiple disturbance that may be achieved, which produces high torsional response, is the effect of an ac fault on the Mona or IPP ac bus. The subsequent tripping of the ac ties, and an inadvertent sequential load rejection of both units conspire to produce very high torsional response. This event is somewhat unlikely because of the system design which includes a breaker and one half scheme at Intermountain Generating Plant, and a double bus configuration for the Mona lines. However, such an event serves to describe the potential effect of response compounding, and the reason for, and value of instituting the Fast Ramp feature of the DC Power Scheduling Calculator. In Figure 1-1, Unit one power and shaft torque is plotted assuming worst case timing of events. The initial fault reduces the unit power output almost to zero as a consequence of the loss of terminal voltage. The power returns to near pre-fault values on fault removal. The fault is removed at a time when the initial torsional response is a maximum and turning in the direction that it would naturally move under the action of an external decelerating force. This timing has the effect of doubling the response of shaft torque and stress. The third event of additional decelerating force occurs on loss of the ac tie to Mona. If this occurs when the natural response direction from previous events is in phase with the direction caused by the new deceleration step, compounding will again occur. This procedure may be continued for the timing of the unit two trip, another deceleration, and finally for an acceleration on the trip of unit one. The above scenario assumes that the DC power, after unit trip, quickly returns to prefault values. The fast DC power scheduling controls change this to a reducing power order on unit trip and beneficially reduces the potential for response compounding in the post trip period. In actual simulations of this effect, Fast DCPSC application reduced the torsional duty on the order of 2:1.

Similar response compounding effects are attributable to DC faults with multiple unsuccessful restarts. These effects have been investigated and new longer delay restart times have been established that reduce this torsional duty by a factor on the

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order of 2:1. These longer delays will also have the beneficial effect of reducing the probability of unsuccessful restart.

While the effect of faults and DC power controls has been studied under selected scenarios on a reduced order model of the plant and system, we expect that the same beneficial effects of reducing torsional duty will appear in the actual performance of the turbine-generators at the Intermountain Generating Station.

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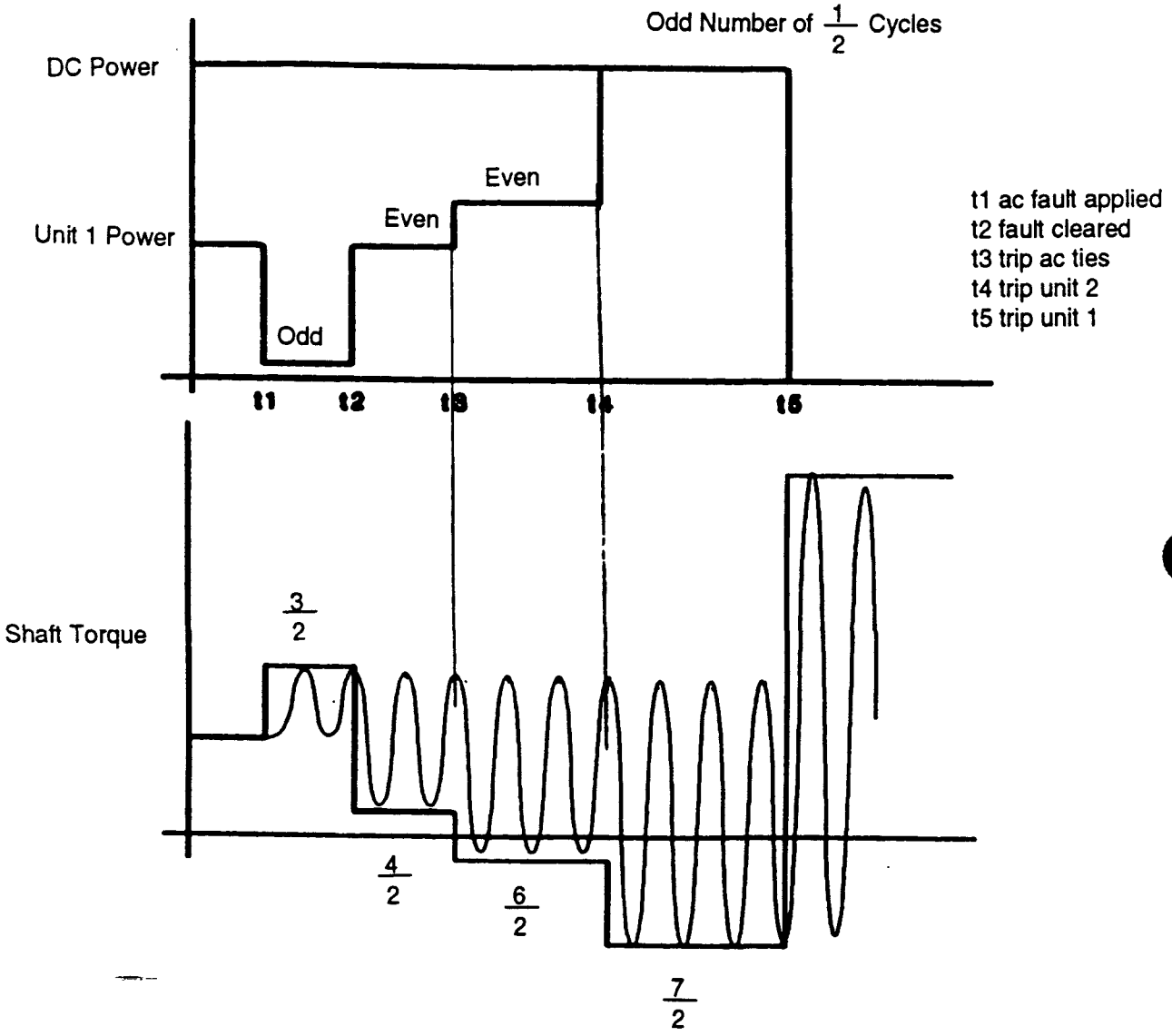

Figure 1-1. Idealized Response. (IPP Unit, Mode 1 Torsional Frequency 14 Hz Assumed Dominant.)

IP12_005391

Section 2
SUMMARY

2.1 SUMMARY OF RESULTS

The investigation of torsional duty was carried out by selection of a number of known precursors of high torsional response, followed by an evaluation of these, as single and multiple disturbances. The work was performed in a time simulation environment that modeled the cycle-by-cycle performance of the dc converters and direct phase simulation of the synchronous machine interface. This modeling detail is required to provide an accurate assessment of the unit torsional duty. The following precursors were evaluated:

- Three-phase ac faults at IPP
- Three- and two-phase ac faults at Adelanto
- DC faults with initial bipole operation
- Converter pole blocking
- Trip AC tie
- Trip one or two units

We have shown in Section 1.0 that the timing of events is important to subsequent torsional duty. Thus, initial work concerned the evaluation of the time period between events (such as fault application and removal, and pole block and restore) to find those times that would produce the maximum torsional response. This work was carried out with a series of short simulations just to the point where the prospective response could be evaluated, to provide sensitivity data concerning response to event duration. Sensitivity investigations were performed for the following events:

- AC fault duration at IPP (three-phase)
- AC fault duration at Adelanto (three- and two-phase)
- DC fault/block and remove/unblock timing
- AC tie trip timing
- AC Unit 1 and 2 trip timing

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The above events were evaluated as single and multiple disturbances such as multiple faults followed by cascading ac tie and unit trips.

For the multiple events a build-up of cases was required, optimizing each event serially. A generic example of this is shown in Figure 2-1, showing the shaft torque sensitivity to dc fault and restart duration. This example is illustrative only and is not keyed to any specific dc fault case.

A summary of case results is shown in Tables 2-1 and 2-2, giving information on torsional response as a function of the disturbances defined above. The limiting shaft torque zero to peak oscillatory response, and the corresponding fatigue loss of life is indicated. The loss of life reported is a prospective value based on the peak torque level, and expected damping, rather than the calculated value. This is because the dc controls are not tuned to model damping contribution at the torsional frequency. The DC controls in this simulation model were not tuned to adequately model the effects on torsional damping, and as modeled, appear to overstate the damping. Also, for this same reason, the SSDC was not modeled, as it must be tuned to the HVDC model itself. The HVDC model is, however, appropriate for returning the peak torsional responses which are unaffected by expected damping levels. This allows the evaluation of prospective fatigue based on expected damping, eliminating the need for a more exact HVDC model, which was not generally available, or held proprietary by the HVDC equipment manufacturer.

Each Table starts out with the worst case disturbance. We report the results for both single and two unit operation as initial conditions.

The ac fault cases are divided into two and three phase faults as initiating events, followed by pole blocking action for remote ac faults at Adelanto and loss of the Mona ac tie. The case of unit trips following the disturbances is also investigated. The remaining cases study the effect of additional controls which were added to minimize transient power reversal, at the rectifier, due to inverter commutation failure, caused by inverter ac bus faults. These additional controls are the rectifier Bypass Pair Order (BPPO) and the Converter Firing Control (CFC) (see reference [5]). In addition, a DC Power Scheduling Control (DCPSC) was studied which provides a dc power demand signal which follows the available ac generator power plus ac tie power.

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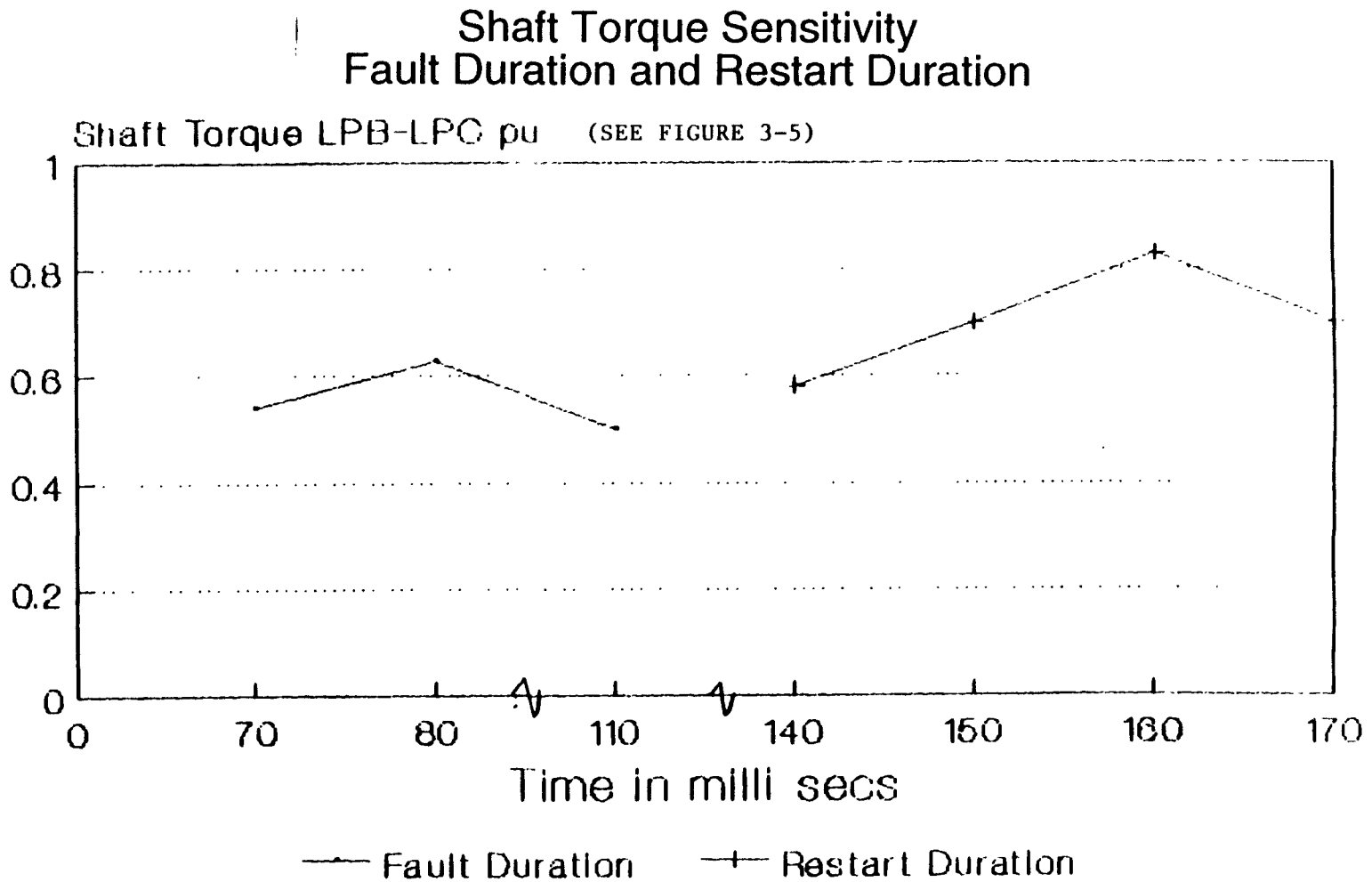

Figure 2-1. DC Fault and Restart Timing Sensitivity

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Table 2-1

AC Faults

Case No.	DC Line MW No. of Units	Fault Duration Cycles Fault Type and Location	Trip	Additional Controls	Worst Case Shaft § pu Torque Z-P	% Damage
AC1	1760 2	2.14 3ϕ, IPP	AC, * 2 GEN		2.12	1.6
AC2	1760 2	2.5 3ϕ, IPP	AC, 2 GEN		2.03	1.3
AC3	1760 2	2.5 3ϕ, IPP	AC, 2 GEN	DCPSC	1.83	.8
AC4	1760 2	4.0 3ϕ, ADE	AC		.934	.03
AC5	1760 2	3.0 2ϕ, ADE			1.13	.08
AC6	1760 2	3.0 2ϕ, ADE		CFC	1.14	.08
AC7	1760 2	3.0 2ϕ, ADE		BPPO	.879	.02
AC8	1760 2	3.0 2ϕ, ADE	AC, 2 GEN		1.46	.32
AC9	1760 2	3.0 2ϕ, ADE	AC, 2 GEN	DCPSC	1.41	.25
AC10	1760 2	3.0 2ϕ, ADE	AC, 2 GEN	DCPSC, CFC	1.33	.2
AC11	1760 2	3.0 2ϕ, ADE	AC, 2 GEN	DCPSC, BPPO	.877	.02

* AC = Both Mona Lines

§ Worst Case Shaft is 4 (LPB-LPC), see Figure 3-5.

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Table 2-2

DC Faults

Case No.	DC Lines MW No. of Units	Poles Faulted and Location	No. of Restarts & Duration in Millisec.	Trip	Additional Controls	Worst Case Shaft § pu Torque Z-P	% Damage
DC1	1100 1	Poles 1,2 IPP	2 107, 107	AC* 1 GEN		2.85	5.0
DC2	1100 1	Poles 1, 2 IPP	2 107, 107	AC 1 GEN	DCPSC	2.91	5.0
DC3	1100 1	Poles 1,2 IPP	3 † 250, 300, 350	AC 1 GEN		2.19	2.0
DC4	1100 1	Poles 1,2 IPP	1 225	AC, 1 GEN		1.07	.08
DC5	1760 2	Poles 1,2 IPP	3 † 250, 300, 350	AC, 2 GEN		1.18	.10

* AC = Both Mona Lines.

§ Worst Case Shaft is 4 (LPB-LPC), see Figure 3-5.

† Current restart Timings are 225, 325 and 425 ms.

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The dc fault cases apply the fault near the IPP plant, with the dc line in bipolar operation. The effect of monopolar operation is studied by initiating the simulation in bipolar mode and tripping one pole. The event severity in monopolar operation was increased by tripping one or two units in addition to tripping the ac tie.

The dc faults are not particularly severe torsionally provided the dc stays in bipolar operation. This is because the other pole will rapidly pick up the load rejected by the faulted pole. However, in monopolar operation the dc fault causes sudden power reduction from the unit. The amount of the reduction is a function of the ac system strength. Subsequent loss of the ac tie, increases the response and amplifies subsequent disturbance effects such as additional dc faults, and unit tripping.

2.2 WORST CASE AC FAULT (AC1)

The worst case ac event, case AC1, is caused by an initial three-phase fault near IPP with the sequential loss of the ac tie and both IPP units. The sequence of events is important to the resulting torsional response. First, unit 1 responds to the fault, and due to the ac trip and unit 2 trip, unit 1 is left on line transiently supplying all of the dc power, as scheduled prior to the disturbance. Unit 1 trip from this condition raises the fatigue loss of life to about 1.6% if the sequence of events is precisely timed as shown in Figure 2-2. The shaft numbering scheme is shown in Figure 3-5.

The timing requirements for maximizing response, for operations occurring in the first half second of an initiating disturbance, are dominated by the IPP unit mode one torsional natural frequency. For a single mode response, that mode's response is maximized due to reversing disturbances, such as a fault, by a duration equal to an odd number of half cycles of the torsional response. The corresponding modal response, for non-reversing disturbances, such as fault clearing followed by ac tie or unit trip, is maximized by a duration equal to an even number of half-cycles of the torsional response modal frequency.

Because unit responses are multi-modal, rather than a single mode, timing for response maxima is difficult to determine apriori especially since the disturbance torques contain sinusoidal as well as unidirectional torque. Therefore, worst case

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Case AC1

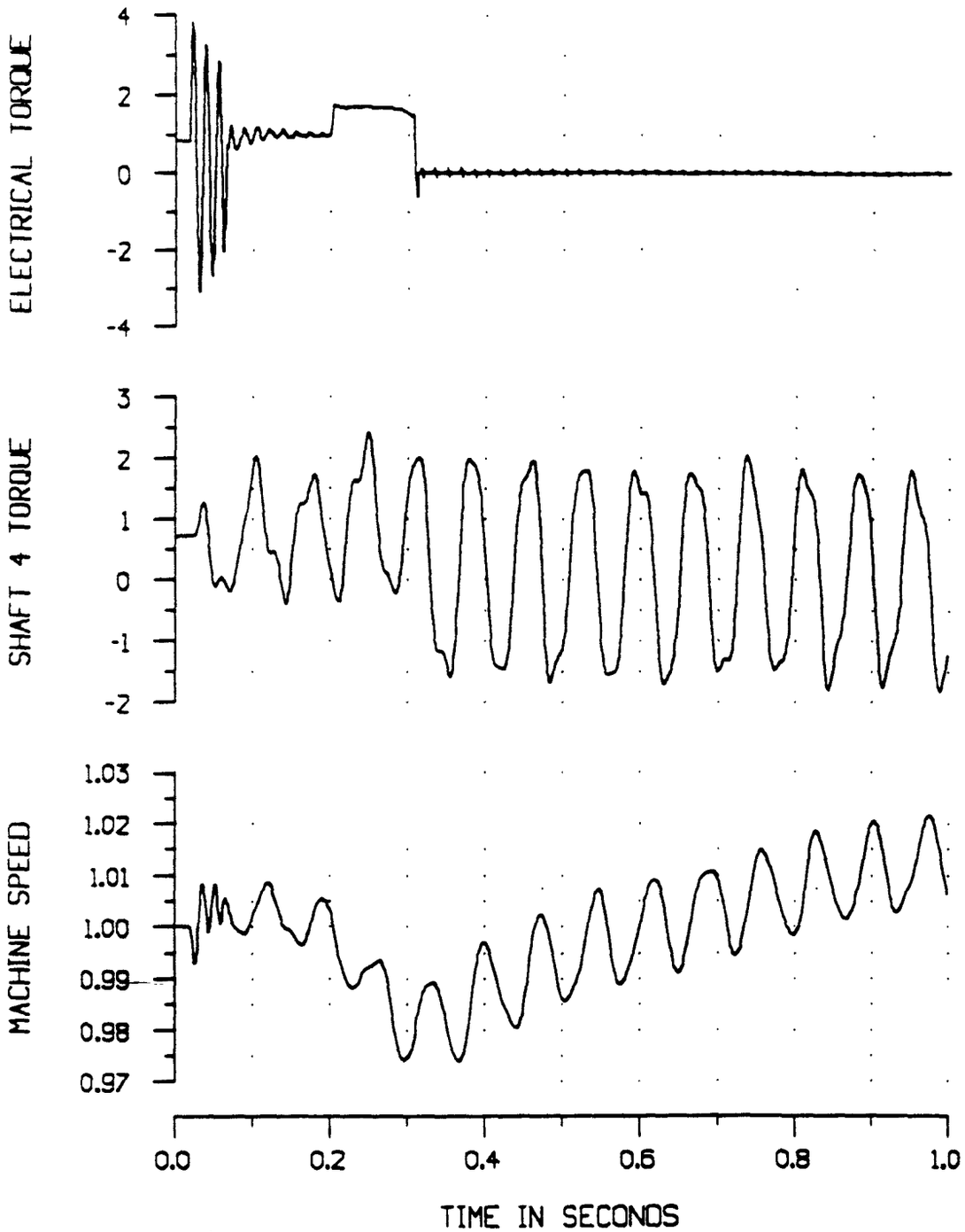

Figure 2-2. Case ACF2GT

timing for torsional response can only be found by simulation and iteration on the duration between disturbances.

It is possible to conceive of even more difficult cases than described above by consideration of transient initial conditions where the ac powerflow is higher than normal due to power swing, and initiating the disturbances at the peak of such a swing. However, this was not done in the present study. The simulated performance of case AC1 is plotted in Figure 2-2, indicating response of generator electrical torque, shaft torque in the limiting shaft, and generator speed. It can be seen that conditions for maximization are only approximated by comparison with the idealized response in Figure 1-1. The remaining plots for case AC1 are shown in Section 5.1. Note that the responses for the IPP beta and the Adelanto beta and gamma are essentially random after .3 second. This occurs because the IPP plant is floating after .3 second. It is floating because the ac tie lines to Mona have been tripped and both IPP generators have been tripped.

2.3 WORST CASE DC FAULT (DC1)

DC faults are reduced in impact because of blocking on the faulted pole and take over by the unfaulted pole. These actions take place very quickly, generally faster than the half period of a typical low frequency torsional mode. Thus, torsional response does not build up appreciably. Another factor that controls torsional duty, is the ac interconnection to Utah, which provides a power outlet path for the units when the dc path is unavailable or reduced because of a dc fault.

Based on the above reasoning, we expect that torsional response will be higher for dc faults during monopolar operation, and increased further still as the ac short circuit reactance to Utah is increased. Thus, the probability of a worst case dc fault may be very small as it requires simultaneous outages of a dc pole, failure of the Contingency Arming Scheme, and an initial ac tie trip.

Figure 2-3 presents the response of generator electrical and shaft torque, and speed for single unit operation, resulting from dc faults with unsuccessful restart and worst case timing. Figure 2-3 is a simulation with the ac ties tripped as a consequence of the first dc fault during monopolar operation. Here we see that the electrical torque averages zero during the fault providing maximum impetus to the

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unit. At the third fault the generator is tripped. The unit prospective fatigue is about 5% for this case.

Cases DC1 and DC2 are hypothetical and may not represent real plant operating conditions. These cases were selected to give maximum torsional response at the turbine-generator. Inspection of Table 2-2 shows that the DC PSC inclusion in case DC2 offers no improvement compared to case DC1 (see Section 2.4). Case DC3 is closer to realistic operation. After the DC3 simulation was made, the restart timings were changed to 225, 325 and 425 ms from the previous values of 250, 300 and 350 ms. The response for the new timings will be different but should be similar to case DC3.

2.4 ADDITIONAL CONTROLS

Additional controls were investigated to minimize generator transient power reversal, at the rectifier, due to inverter commutation failure, caused by inverter ac bus faults. These additional controls are the rectifier Bypass Pair Order (BPPO) and the Converter Firing Control (CFC) (see Reference [5]). In addition, a DC Power Scheduling Control (DCPSC) was studied which provides a dc power demand signal which follows the available ac generator power plus ac tie line power.

BPPO -The bypass pair order is achieved by continuously gating a pair of thyristors at the rectifier, essentially short circuiting or bypassing the dc poles, on sensing a commutation failure at the inverter. The rectifier and inverter controls are modified to hold certain alpha and gamma conditions. The control changes are shown below:

Rectifier

- Set bypass thyristor firing on sensing simultaneous low dc pole voltages, i.e, when $V_{dc} \leq .2$ pu . Set α max = 90°. Set α min = 85°.

- Reset bypass and α max, α min if $I_{dc} \leq .05$ pu for more than .05-seconds.

- Reset bypass and α max, α min if time since set is greater than .25-seconds.

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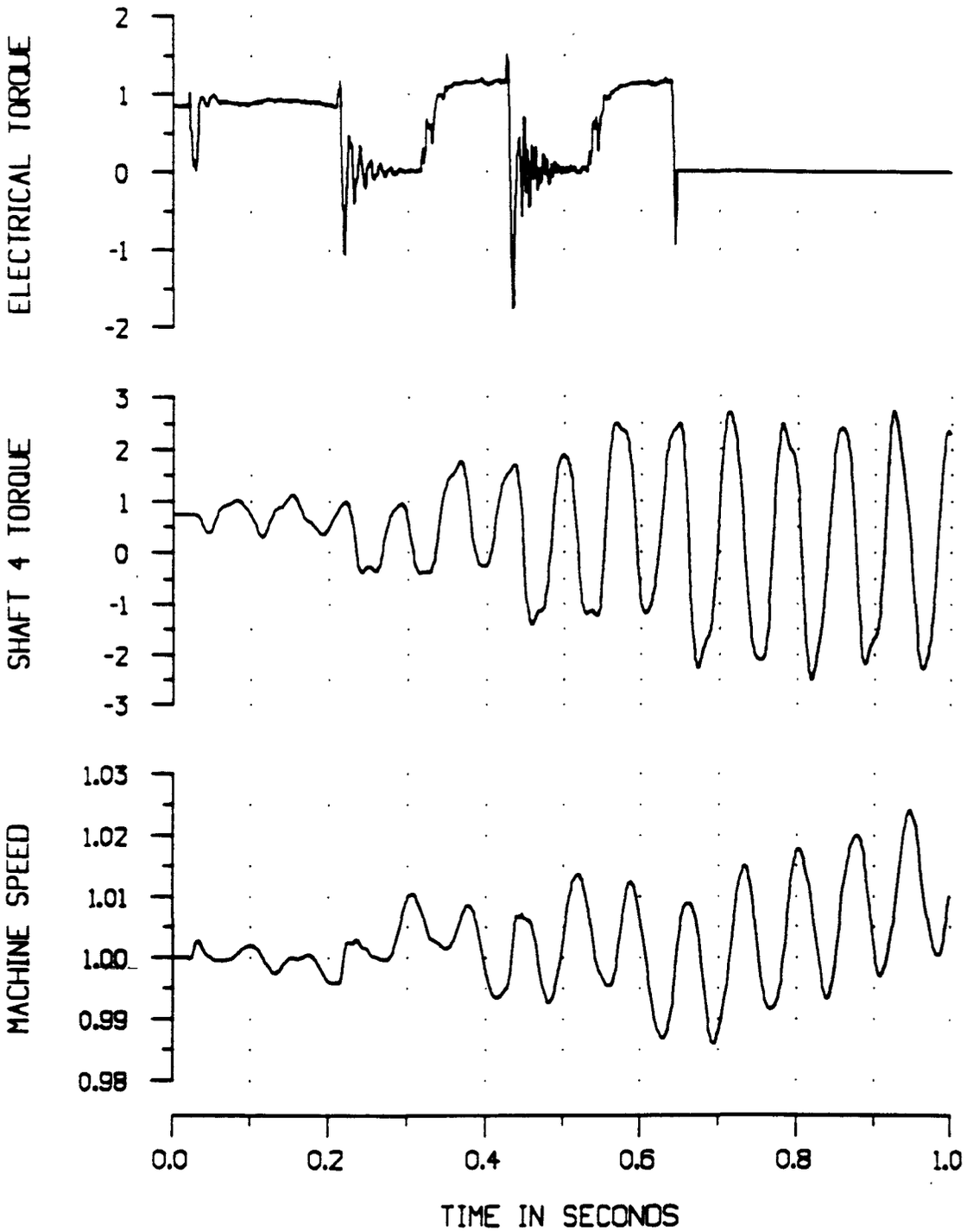
Case DC1



HWM 02/18/88 17.59.28 [IPPTORIDCF1GB12T.PL4]1 Page 1

Figure 2-3. Case DCF1GB12T

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Inverter

- Set $\gamma = 17°$, when $V_{dc} \leq .5$ pu
- Reset γ when $V_{dc} > .5$ pu

CFC – The converter firing control approach is an alternate to BPPO. However, it is less effective. The CFC attempts to keep $\alpha \equiv 90°$ during a transient. The changes are:

- If simultaneous low dc pole voltages are sensed, i.e., when $V_{dc} \leq .2$ pu then set α min = 65° for .022 seconds. Following this, ramp α min to 100° over .04 seconds and hold until reset.
- Reset α min if $I_{dc} < .5$ pu.

DCPSC – The dc Power Schedule Calculator provides a dc power demand signal which follows the available ac generator power plus ac tie line power. A block diagram of the control is shown in Figure 2-4.

At the left side of the diagram, the inputs are the electrical power of units 1 and 2 in per unit and the ac tie power in MW. These are summed together and passed through a filter with a 10 second time constant. This filter smoothes the electrical power fluctuations and eliminates the instability of inter-area oscillations caused by fast dc power controls.

The filter output is combined with two ramp generator outputs to create DC Power Demand. When a unit is tripped, the ramp generator creates a ramp starting at 0 MW and increasing to a saturated value equal to the unit's load level in MW. The ramp time is 85 ms. Thus, when a unit is tripped (or the ac tie is tripped), the dc power demand is reduced to reflect the actual available power. The actual logic used is more complex and involves the use of "fast ramps" and "slow ramps", etc. This will not be discussed here.

The fast balancing of dc power demand and available ac power is ultimately limited by the actual speed of dc power reduction. There is a delay of .045 seconds on dc current order reduction, due to communication channel delay with the inverter. This delay is simulated in the current order control, Figure 3-6.

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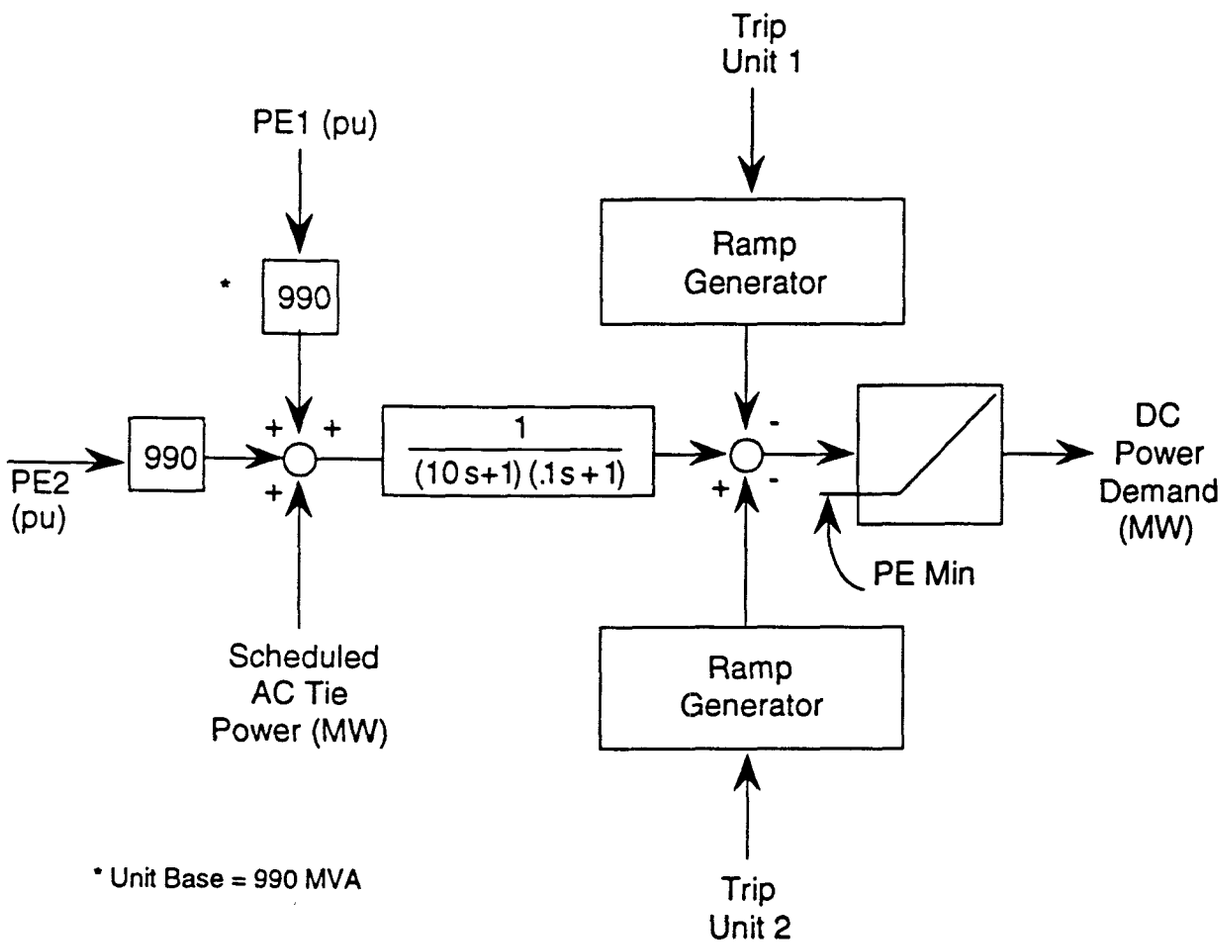

Figure 2-4. Fast DC Power Schedule Calculator. (Simplified Diagram – Actual Logic is more Complex.)

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AC Fault Cases (DCPSC) – The DCPSC was investigated in two different scenarios: a 3ϕ fault at IPP and a 2ϕ fault at Adelanto. The 3ϕ fault cases are AC2 (without DCPSC) and AC3 (with DCPSC). It is seen from Table 2-1, that the worst case zero to peak shaft torque and damage are reduced by using the DCPSC. Thus, the DCPSC is a beneficial improvement. The improvement is due to the reduction in electrical torque and dc line MW after generator 2 is tripped at .1986 seconds.

The 2ϕ fault cases are AC8 (without DCPSC) and AC9 (with DCPSC). Table 2-1 again shows that the worst case zero to peak shaft torque and damage are reduced by using the DCPSC. The reduction is smaller in this case. The improvement is due to the reduction in electrical torque and dc line MW after generator 2 and the ac tie are tripped at .1929 seconds.

DC Fault Cases (DCPSC) – Two dc cases were investigated: Case DC1 (without DCPSC) and Case DC2 (with DCPSC). Case DC1 was chosen to investigate the effect of DCPSC, because it was the worst case of previously simulated dc fault cases. It is seen from Table 2-2, that the worst case zero-to-peak shaft torque and fatigue are unchanged by using the DCPSC. The reason for no improvement by DCPSC action is because it is really only effective for two unit operation. The AC tie line trip at .21 seconds could have had some effect; but the 10 second filter time constant blocked the delta MW from appearing in the dc power demand output. Obviously the DCPSC will not affect the result for single unit operation because it takes effect only after unit trip. With no units left on line it can have no further effect on unit acceleration power and torsional response. Other dc fault cases, especially with two unit operation would show value in the use of DCPSC. Unfortunately, there were no event simulations of this type in any of the previous work.

Inverter AC Fault Cases (BPPO) – BPPO was investigated in two different scenarios: a 2ϕ fault at Adelanto without DCPSC and with DCPSC. The cases without DCPSC are AC5 (without BPPO) and AC7 (with BPPO). Table 2-1 shows that the worst case zero to peak shaft torque and damage are significantly reduced by using the BPPO. Thus, the BPPO is a beneficial improvement. The improvement is due to the smoother response of electrical torque and dc line MW during the 2ϕ fault interval from .02 to .07 seconds. Note from the plots shown in section AC7 that the IPP α=90° (β=90°) during the fault interval. The plots in section AC5 show that the IPP α=130° (β=50°) during the fault interval.

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The cases with DCPSC are AC9 (without BPPO) and AC11 (with BPPO). Table 2-1 shows that the worst case zero to peak shaft torque and damage are reduced by using the BPPO. The improvement is due to the smoother response of electrical torque and dc line MW during the 2ϕ fault interval from .02 to .07 seconds. Note from the plots shown in section AC11 that α=90° (β=90°) during the fault interval. The plots in section AC9 show that α=130° (β=50°) during the fault interval.

The differences between the two cases is largely due to the action of BPPO, and only slightly affected by DCPSC. This is expected because of the short period, between tripping unit 1 and 2, where half of this time was taken by the 0.045 sec inverter communication delay for current order reduction.

AC Fault Cases (CFC) – CFC was investigated in two different scenarios: a 2ϕ fault at Adelanto without DCPSC and with DCPSC. The cases without DCPSC are AC5 (without CFC) and AC6 (with CFC). Table 2-1 shows that the worst case zero to peak shaft torque and damage are essentially unchanged by using the CFC. This indicates that the CFC is ineffective. Inspection of the plots in sections AC5 and AC6 indicates no improvement in the electrical torque and dc line MW responses during the 2ϕ fault interval from .02 to .07 seconds. We also see that α=130° (β=50°) during the fault interval.

The cases with DCPSC are AC9 (without CFC) and AC10 (with CFC). Table 2-1 shows that the worst case zero to peak shaft torque and damage are reduced only slightly by using the CFC. Again, this indicates that the CFC is ineffective. Inspection of the plots in sections AC9 and AC10 indicates no improvement in the electrical torque and dc line MW response during the 2ϕ fault interval from .02 to .07 seconds. We also see that α=130° (β=50°) during the fault interval.

2.5 CONCLUSIONS

The findings of this investigation show that system operation using hypothetical worst case disturbances may produce approximately 2% fatigue loss-of-life for ac fault cases and approximately 2% for realistic dc fault cases. The torsional responses are a function of the dc power scheduling controls that allow constant power operation of the dc line over short periods of time following disturbances, such as ac and dc faults, ac tie trips and unit load rejections.

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Generally, single unit operation is worst for fault events, while two unit operation is worse for events involving unit trip of both units. 3ϕ faults at IPP produce a higher worst case zero-to-peak shaft torque and fatigue than 2ϕ faults at Adelanto. The Adelanto faults are moderated by the ac tie at IPP.

Although the worst case torsional duty is significant, the probability of experiencing these hypothetical disturbances is relatively low. These events require an initiating fault, followed by some unfortunately timed subsequent events of ac tie trip or unit trip action. These timings are, however, not unique and there are many opportunities during multiple events, to experience torsional response compounding.

Prospective worst case torsional duty prior to instituting control modifications represents onerous duty. At these levels the responses are close to coupling slip levels, while at higher levels, stress conditions are no longer linear with response; and fatigue predictions are no longer accurate. Occurrence of either, may induce high lateral vibrations due to coupling slip and/or shaft kinking which may be sufficient to require unit realignment in order to return the unit to service. The DCPSC modification and/or restart timing reduce the prospective fatigue by about 2:1, a beneficial effect.

The DCPSC allows the dc power demand to approximately follow the available ac power. DCPSC was found to be effective at reducing the torsional response and could usefully be implemented. Similarly, the BPPO was found to be effective at reducing the torsional response and transient power reversal. It should also be implemented. The effectiveness of DCPSC modification in reducing torsional response is limited to events during two unit operation. Because of communication delays, in inverter controls, the DCPSC modification effectiveness is limited to events that evolve from a single unit trip to a subsequent event in time periods of the order of 0.1 seconds and longer. Opportunities for response compounding for subsequent events in this time period are many, and no controls investigated here are effective in these cases. However, there appear to be many situations that would be helped by the DCPSC modification including IPP and Adelanto ac faults, or dc faults. This modification should be implemented. The transient power reversal at the rectifier during inverter ac and dc faults is not affected by the DCPSC. Transient power reversal acting alone is not an onerous duty torsionally, however, it can add

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significantly to an event that involves unit tripping from two unit operation. BPPO, however, was found to effectively reduce overall response for these cases, especially for those events where timing prevents DCPSC from being effective.

The worst fault cases for IPP units are dc faults, especially when there are multiple unsuccessful restarts. Each unsuccessful restart produces a new torque pulsation with transient power reversal, which increases the torsional response dramatically. These cases will obviously be moderated significantly if the transient power reversal is eliminated.

The CFC was found to be ineffective and should not be studied further.

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Section 3

DESCRIPTION OF TORSIONAL ANALYSIS MODELING

The torsional analysis consists of the time simulations plus the torsional fatigue calculations for each case. The modeling of the time simulations is described in this section, while the fatigue calculation is discussed in Section 4.

3.1 TRANSMISSION SYSTEM AND LOAD FLOW

The time simulations were made using GE's MANTRAP Program (Machine And Network TRAnsients Program) [1]. This program is based upon the Electro-Magnetics Transients Program (EMTP) where GE has added its own synchronous machine modeling. In particular, MANTRAP uses excitation system, power system stabilizer, and governor controls coded in FORTRAN. The torsional response data is interfaced to the fatigue program through a file of shaft torque maximums and minimums which is read by the fatigue program and used to calculate stress and strain. Following an electrical system disturbance, the torsional system alone is modeled for an extended time period to simulate the decay of oscillations after the electrical torque stimulus has disappeared.

The system modeled in detail is shown in Figure 3-1. The model consisted of the machines in the Intermountain, Huntington Canyon, Emery, and Bonanza stations, along with the 345 kV interconnecting ac transmission system. The dc line from Intermountain to Adelanto was also modeled. The model of this area was chosen to be large enough to maintain the critical power flow and dynamic system characteristics in the vicinity of Intermountain, while also being small enough to permit simulation with the MANTRAP program. This detailed network was connected to an equivalent of the surrounding power system as shown by the dotted line network in Figure 3-1.

The system model was derived from a 1750 bus, 2800 line, and 411 machine data set provided by the Western Systems Coordinating Council. The model reduction process involved retaining the integrity of the transmission system in the vicinity of the Intermountain station, and aggregating the surrounding system into a series of

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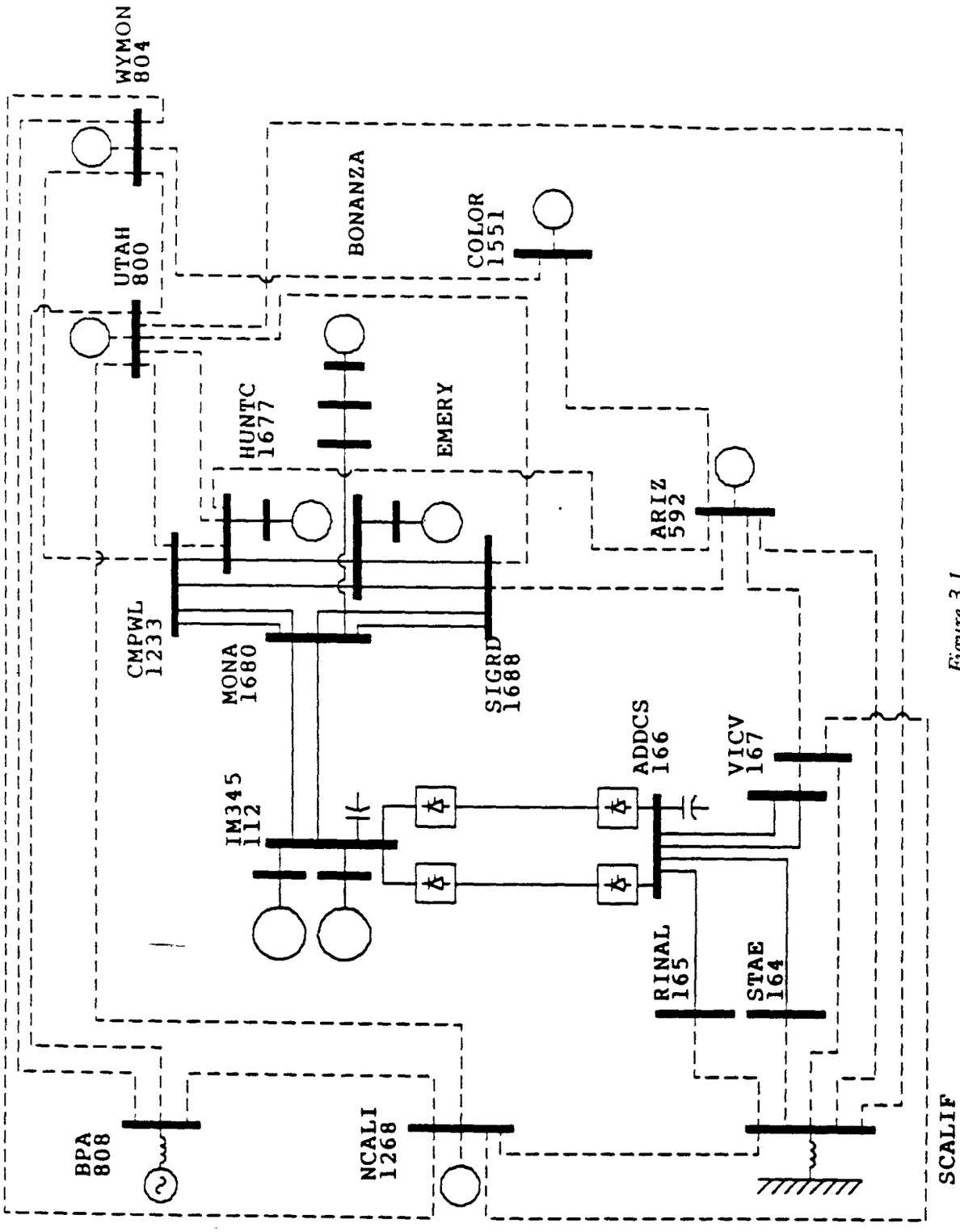

Figure 3-1.

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interconnected dynamic equivalents. This reduction was performed using the dynamic equivalencing program, developed partially by GE and partially by the Electric Power Research Institute (EPRI). The resulting system model, shown in Figure 3-1, has seven dynamic equivalent machines and loads representing:

Southern California

Northern California

Bonneville Power Administration

Utah

Wyoming and Montana

Colorado

Arizona

In the actual system, transformers exist at some of the 345 kV buses with connections to transmission lines at lower voltage levels. The system model used for the study included equivalent impedance representation of the lower voltage transmission, but, for clarity on the diagram, these are not shown in detail. Loads were represented as positive sequence, constant impedance load models. The Gonder-Mona line was not modeled.

3.2 INTERMOUNTAIN UNITS 1 AND 2

The Intermountain turbine-generators were the study units. The generator electrical circuits, rotor torsional systems, and excitation systems were represented on these units.

The Intermountain generator electrical modeling was based on data (rated current) provided by GE's Steam Turbine-Generator Department. The generator was simulated using the detailed MANTRAP (Jackson-Winchester) model shown in Figures 3-2 and 3-3. A simpler model based on stability data is also shown for comparison. Saturation was also modeled on these units. The GENERREX excitation system for these units was modeled as shown in Figure 3-4.

The torsional model and mode shapes for the Intermountain unit are shown in Figure 3-5. The torsional spring and mass data is given in Table 3-1.

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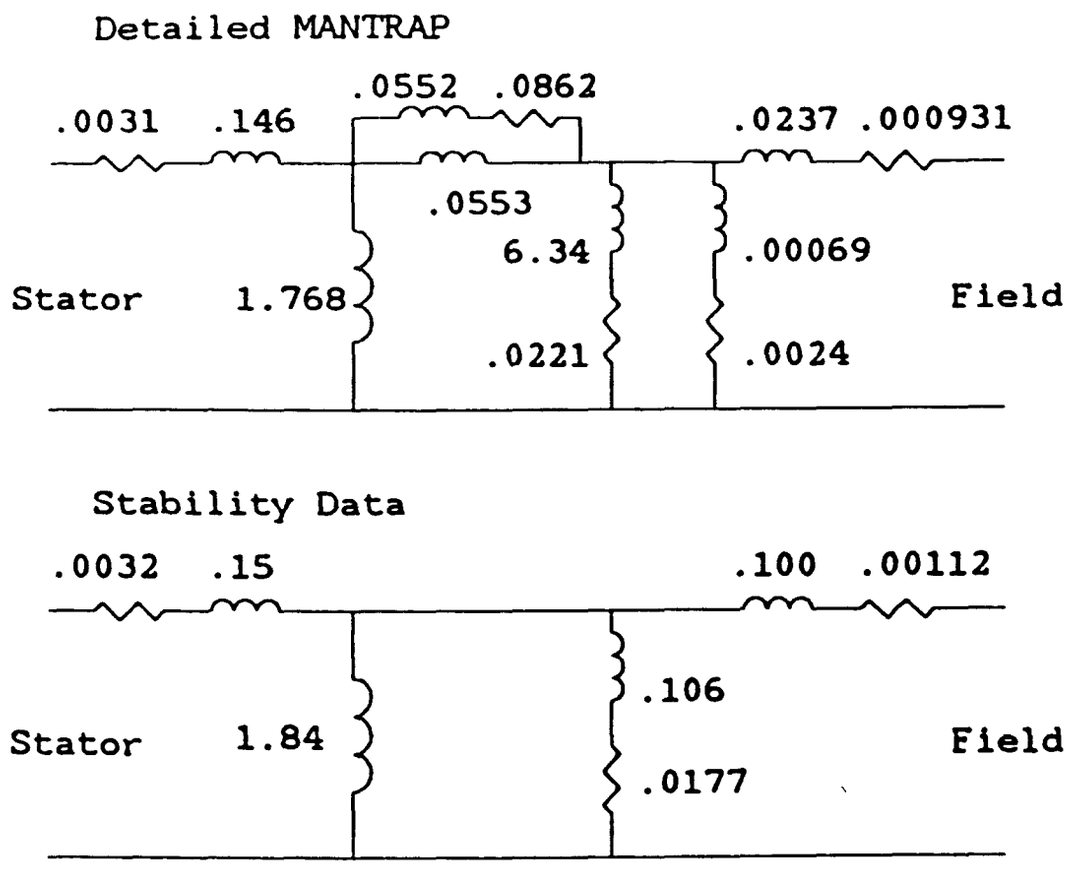

Figure 3-2. Direct Axis Equivalent Circuits and Data.

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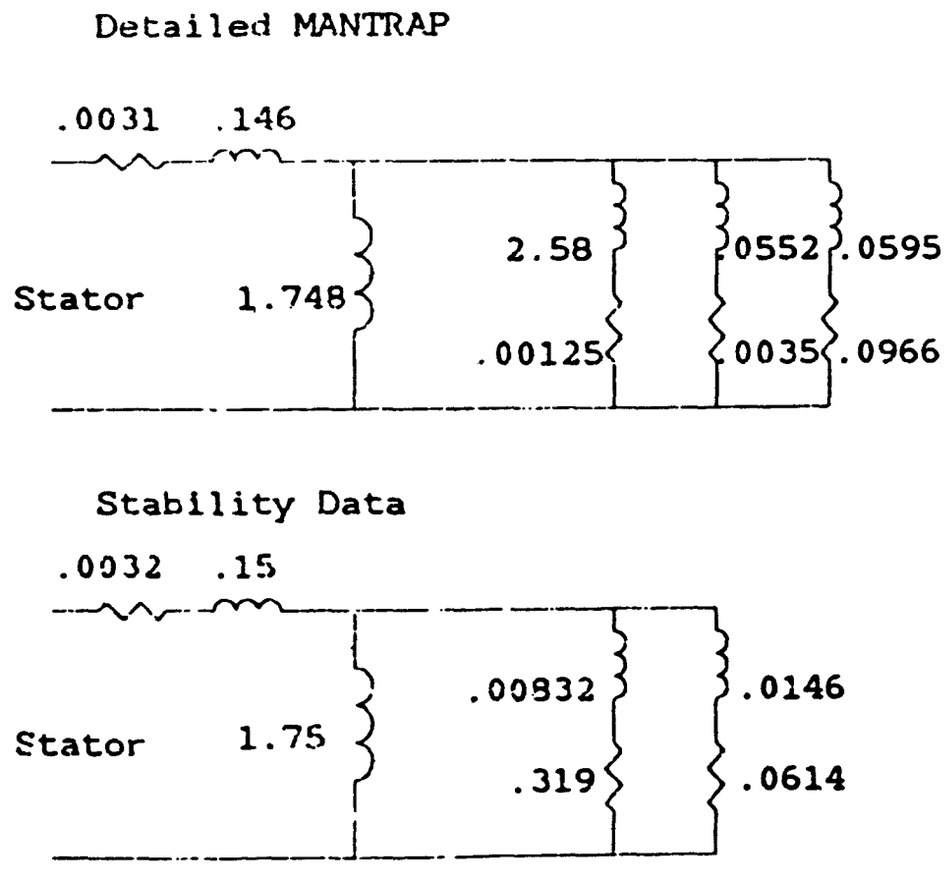

Figure 3-3. Quadrature Axis Equivalent Circuits and Data.

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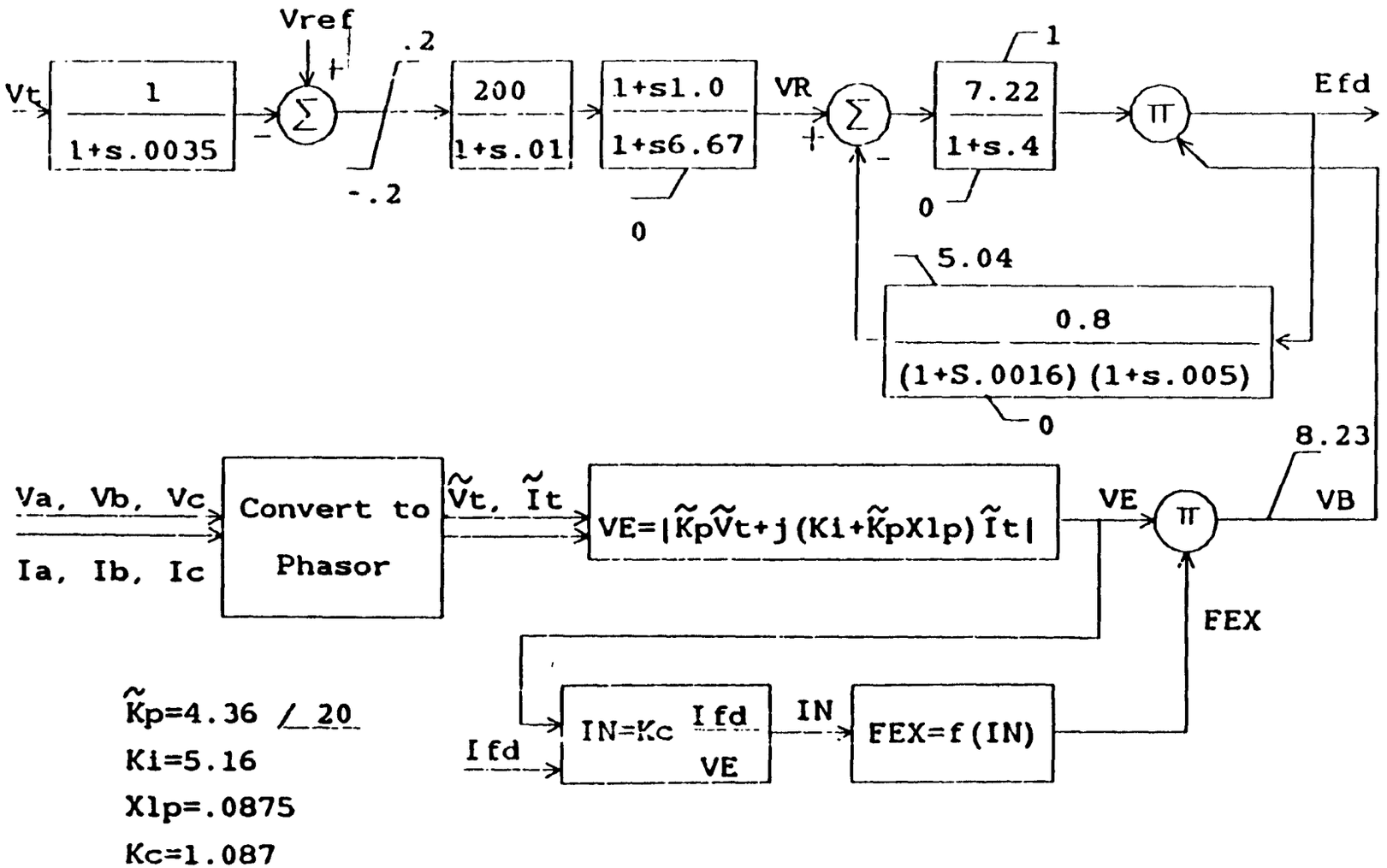

Figure 3-4. Model of Excitation System ST3 for GENERREX.

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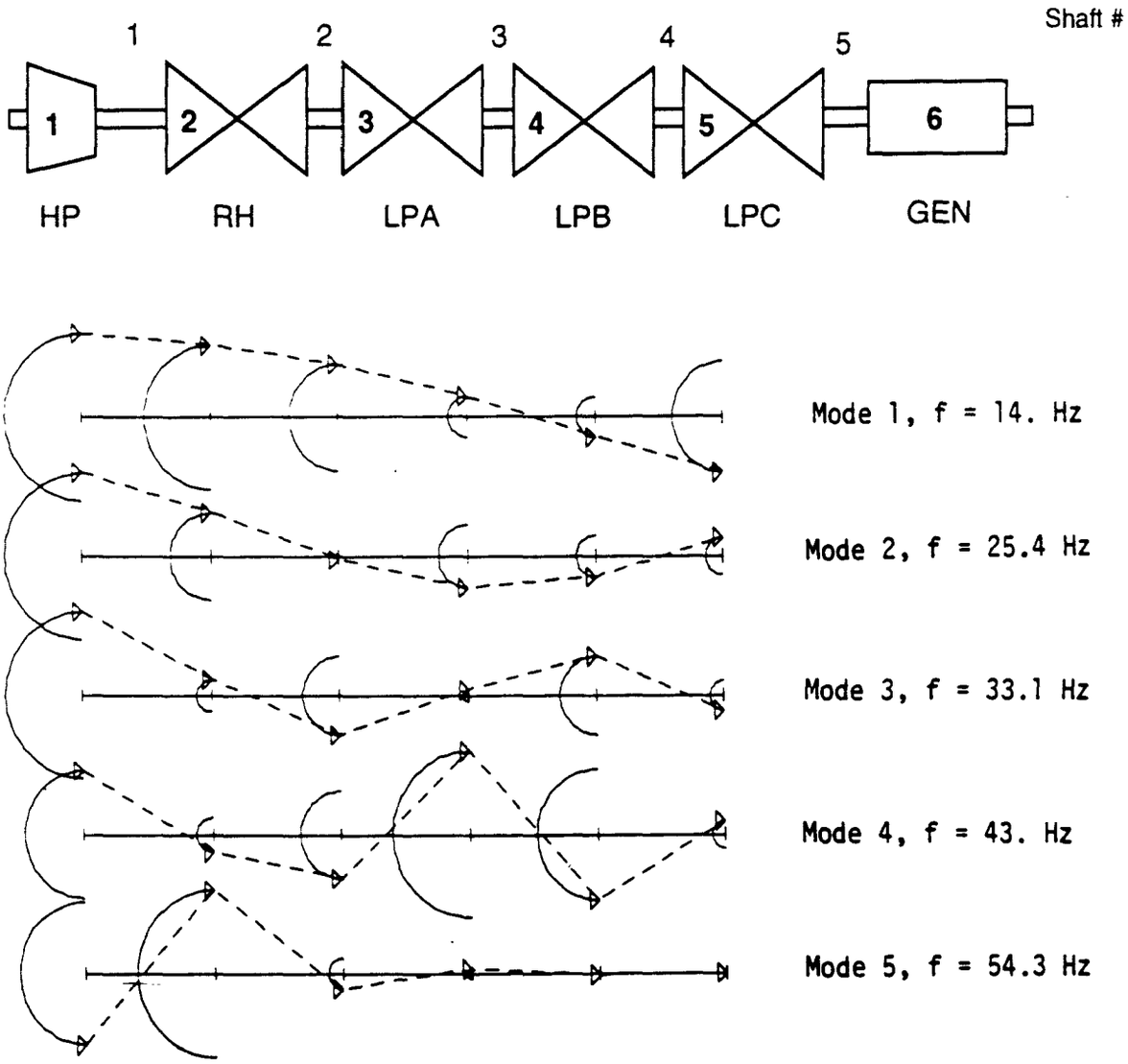

Figure 3-5. Intermountain.

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Table 3-1

Intermountain Torsional System Data

	Polar Moment of Inertia (LBM IN^2)	Turbine Power Fractions		Stiffness (LBF IN / RAD)
J_1	4.457 E6	.29	K_{12}	618.4 E6
J_2	7.741 E6	.29	K_{23}	999.6 E6
J_3	27.17 E6	.14	K_{34}	1451. E6
J_4	27.17 E6	.14	K_{45}	1446. E6
J_5	27.76 E6	.14	K_{56}	1341. E6
J_6	42.74 E6			

The Intermountain unit is rated at 991 MVA, 3600 RPM (two poles).

The values of mechanical torsional damping used in the simulations were determined by experience and knowledge of measured torsional damping during tests on units of similar design and construction. The machines at Huntington Canyon, Emery, and Bonanza were represented electrically by using stability data for these machines. The inertia effects were included with a single mass representation of the rotor system. Torsional dynamics were not modeled.

3.3 DC LINE MODEL

The dc line from IPP to Adelanto was modeled and included in the GE MANTRAP simulation. The HVDC converter model simulates a 12-pulse thyristor bridge with snubbers and valve arrester, three-phase converter transformer including saturation, and a smoothing reactor. GE HVDC controls were used. The controls were modified to match the ASEA data supplied by LADWP. For example, a block diagram of the modified frequency controller is shown in Figure 3-6. In this diagram, the processor time delays T_1 to T_4 were added. The upper path (FC) which

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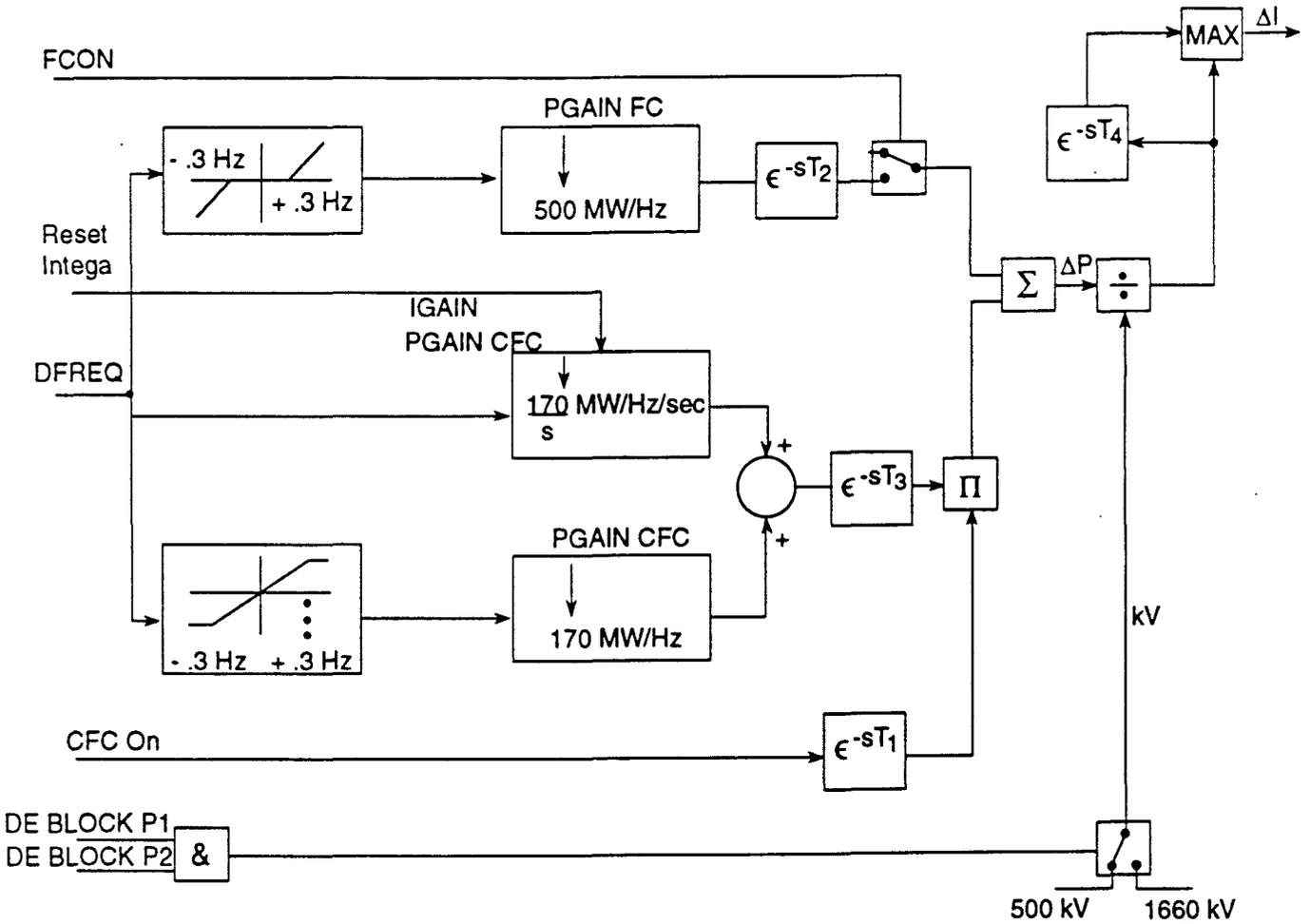

T_1 = .11 sec.

T_2 = .08 sec.

T_3 = .20 sec.

T_4 = .045 sec.

Deadband: FC ±0.30 Hz
CFC ±0.30 Hz

Gain: FC PGAIN = 500 MW/Hz
CFC PGAIN = 170 MW/Hz
CFC IGAIN = 170 MW/HZ/sec

Figure 3-6. Block Diagram of Frequency Controller, Revised to Include Processor Time Delays.

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calculates delta power Δp from delta frequency Δf is always present. The lower path (CFC), which includes a proportional plus integral control, is used only when the plant is in islanded operation (i.e., no ac tie lines). The maximum operation and time delay of T_4 seconds in the current order (ΔI) path allows instantaneous transmission of current order increases but delays current order decreases by T_4 seconds.

3.4 UNMODELED SYSTEM FEATURES

The simulation model used for this study of torsional duty is not faithful to all features of equipment and controls present at the Intermountain Generating Plant and HVDC switching station. This has been indicated elsewhere in this report concering the HVDC Subsynchronous Damping Control (SSDC), because of the lack of a suitable model to represent the long-term high frequency dynamics of the HVDC equipment. Similarly, the details of the Contingency Arming Scheme for the effect of power surges on the status of the Utah lines was not modeled explicitly. Instead, the fault scenarios studied, assumed that it may have operated. The SMF torsional relays were also not modeled. These relays are mostly tuned to detect unstable torsional oscillations, and to trip for exceptionally severe torsional transient events. Where unit tripping was a factor in torsional response, trip times were chosem to maximize response. The actual trip could be from almost any cause, and the timing of such an event cannot be established on a deterministic basis. Hence, the use of worst cases for trip timing.

We believe the study model to be adequate for the intended purpose, namely, to establish the peak transient torsional duty following a disturbance with worst case timing, and to evaluate the prospective torsional fatigue improvement of HVDC control modifications, and restart timing.

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Section 4

DESCRIPTION OF TORSIONAL FATIGUE CALCULATIONS

4.1 FACTORS AFFECTING TORSIONAL RESPONSE AND FATIGUE

With the switching of transmission lines in the vicinity of a power plant, the turbine-generator is exposed to a torsional disturbance which is related to the magnitude of the angle difference across the switched line, the change in power transfer impedance to other generators, the loading of the study unit, and the level of power flow in the transmission system. The disturbance may cause either a sudden increase or decrease in the power output of the generator and therefore a sudden change in the average electrical torque, causing it to either accelerate or decelerate. This stimulates the torsional modes of oscillation, causing oscillating shaft torques as the accelerating energy is converted back and forth from kinetic energy of the inertias to potential energy of the shaft springs.

The elements of importance to evaluation of fatigue of turbine- generator shafts are: (1) an adequate representation of generator electromagnetic torque response to disturbances in the power system, (2) the translation of these applied torques to the torsional mechanical system to calculate shaft torques, and (3) evaluating shaft torque reversals to calculate fatigue loss of life for each shaft for each case.

The torsional response and fatigue of the turbine-generator to electrical disturbances is dependent upon several factors. These factors include:

1. Unit load
2. System strength
3. Generator and power system electrical parameters
4. Torsional system mechanical parameters and damping
5. Shaft diameters
6. Stress concentration factors
7. Shaft material characteristics.

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The unit load prior to the disturbance affects the initial magnitude of the acceleration of the unit after the disturbance. The worst torsional fatigue is normally when the unit is operating at full power.

The system strength in terms of voltage support defines the unit decelerating power after the disturbance. The torsional mechanical parameters of inertia and stiffness affect the shaft torque response. The unit torsional damping affects the rate of decay of the torsional oscillations and hence the number of cycles of shaft torque that contribute to fatigue. Shaft diameters, stress concentration factors, and shaft material properties are involved in the translation of the shaft torque history to stress and strain responses for determining the shaft fatigue.

4.2 FATIGUE CALCULATION METHODOLOGY

For this study, some of the above parameters were varied (within reasonable limits) to determine the worst case fatigue for the cases considered. A wide variety of cases were studied. The range of these cases is indicated below:

- Three-phase ac faults at IPP.
- One or two IPP generators on-line.
- DC faults on Pole 1 at IPP. Pole 2 was allowed to operate normally.
- Two-phase ac faults at Adelanto.
- Trip ac tie lines to IPP plant. Trip IPP generators 1 and 2.
- Loss of dc Pole 2 followed by dc faults on Pole 1 at IPP.

These cases are more fully described in Section 5.

In general, the entire electrical and mechanical system was simulated for 1.0 second. At this time, the electrical torque stimulus to the torsional system is well defined. The torsional system solution was then extended to 10 seconds to allow the torsional oscillations to decay with the mechanical torsional damping. The electrical torque stimulus for the extended time solution is "filled in" to approximate the power swing oscillation, with the average value returning to the prime mover torque level.

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As a result of the initial full simulation and the extended torsional simulation, a history of the shaft torques for a 10 second window has been developed. The next step is to convert the shaft torques to fatigue loss of life for each case.

The fatigue evaluations provided in this report are based generally on the analytical procedures of Reference [2]. The material data used has been developed by extensive testing upon small diameter shafts as described in Reference [3]. The actual data used included size effects for larger diameter shafts. The strain versus cycles to failure data for the -2σ point (at -2 standard deviations from the mean) of the fatigue probability curve was used for the case evaluations.

There are two fatigue procedures that have generally been used by GE for the analysis of torsional fatigue. They are the "nominal method" and the "local method." For each method the name reflects the means by which concentrated stress conditions are estimated from the applied shaft torques.

In the nominal method, the concentrated stress conditions are inferred from the relationship between the "smooth bar" and the "notched bar" fatigue results. In the local method, a modified Neuber's rule is applied to estimate the concentrated strain conditions from the applied shaft torques. For the work presented in this report, the local method was used, as it reflects the data available for the Intermountain unit and is the preferred method of analysis.

The Intermountain torsional system data was analyzed using GE's TORsional ANalysis (TORAN) program. Refer to the torsional system diagram, Figure 3-5. Note that there are six masses and five shafts. All five shaft fatigues are calculated by the fatigue program. However, one or two shafts will have higher damage levels than the others, and these represent the worst case. In this case, TORAN analysis indicated that Mode 1 with f = 14 Hz had Shaft 4 as the limiting shaft. The shafts are numbered from left to right, so Shaft 4 is between LPB and LPC. TORAN also produces a fault duration resonance indicator analysis which indicates the shaft torque sensitivity to torque pulses of varying lengths (in cycles of 60 Hz). The shaft torque is per unitized on its endurance torque and plotted versus cycles (see Figure 4-1). On a curve of shaft torque versus cycles to failure, the torque at 10^7 cycles to failure is the endurance torque. It is the smallest torque level where shaft fatigue damage starts to occur. Figure 4-1 indicates that Shaft 4 is the worst case shaft with

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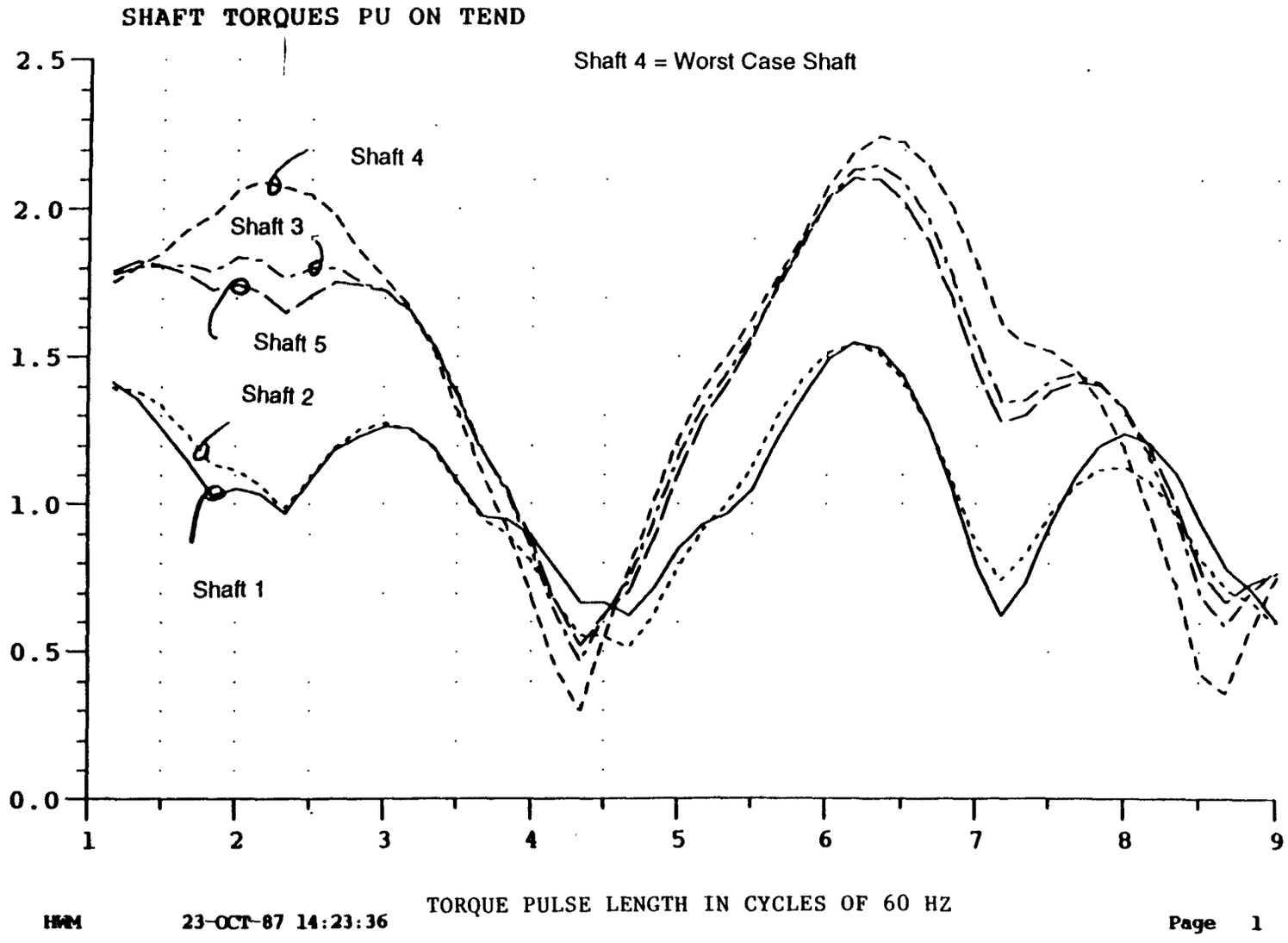

Figure 4-1. Intermountain Fault Duration Resonance Indicator.

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response maxima at 2.17~ and 6.33~. Both of these times were used in the MANTRAP simulations. The maximum fatigue damage occurred for a fault length of 2.17~. This time corresponds to one-half cycle of 14 Hz = .0357 seconds.

The fatigue procedure as described relates only to the estimate of fatigue for a single loading cycle in terms of percent loss of life. The estimate of life loss due to fatigue for a complex loading history includes a linear damage summation law for individual loading cycles to arrive at the total estimate for the case. The loss of life for a complex loading cycle history is based on the procedure of "range pair cycle counting" [4]. This cycle counting procedure pairs reversals of shaft torque loading on the basis that the resulting stress-strain trajectory in the concentrated region form closed loops. For the complex loading history of Figure 4-2, the pairing sequence of reversals would be as indicated in Figure 4-3 using the range pair cycle counting method. In this method, the fatigue is history dependent since the highest reversal pair must be found before any other pairs can be determined. This history dependence is not generally a problem for the damped periodic torques of the turbine-generator shaft caused by shock loading.

For the reversal sequence depicted in Figure 4-3, each cycle defined by a closed loop has an associated mean stress and strain as well as a cyclic or alternating stress and strain. The effect of mean stress and strain on cyclic fatigue for local uniaxial analysis has been accounted for by modifying the alternating stress range via Smith's equation in Reference [4]. The effect of mean stress and strain were not included here since the local torsion analysis method was used in this study.

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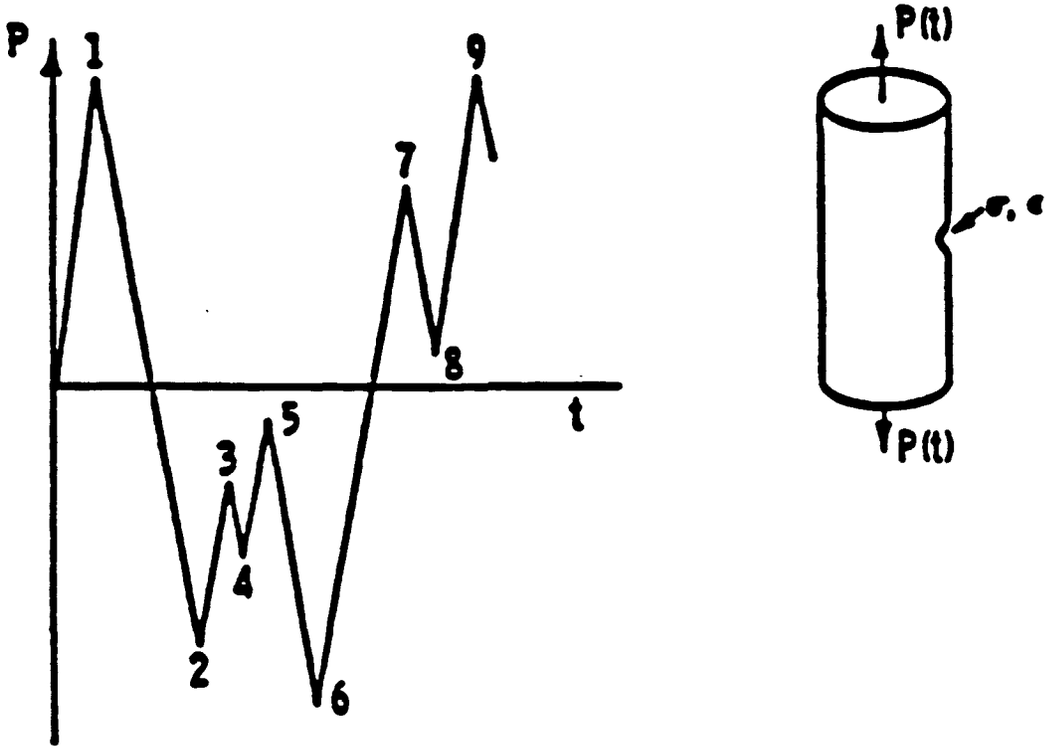


Figure 4.2.

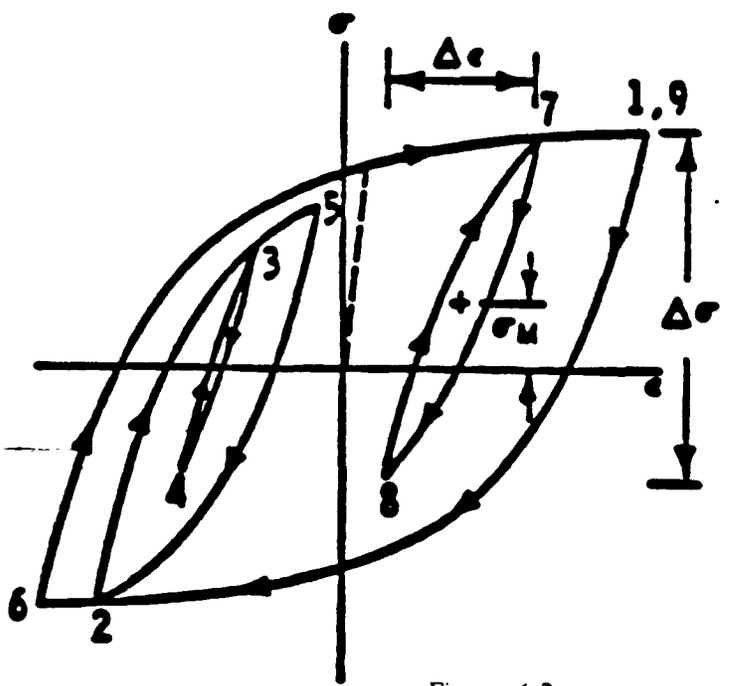


Figure 4-3

Stress Strain Response During an Irregular Load History.

IP12_005423

4.3 SHAFT FATIGUE ENDURANCE LIMIT

The p.u. shaft torque versus cycles to failure (NF) curve for the worst case Shaft 4 is presented in Figure 4-4. The pu torque versus NF curves for the other shaft sections have similar shapes. Failure means the point of crack initiation in the shaft. The endurance limit torque for Shaft 4 is the torque value at NF = 10^7 cycles. From Figure 4-4, this is seen to be 0.5949. Table 4-1 shows the endurance torques for all five shafts.

Table 4-1

Shaft No.	PU Endurance Torque (0 to Peak)
1	.2376
2	.4579
3	.5949
4	.5949
5	.6299

The torque level shown represents a zero to peak torque. For an oscillating torque, the zero to peak value can be taken to be (Maximum Torque – Minimum Torque)/2.0.

The total % damage = Σ 100/NF, where the summation is over all the closed stress-strain loops shown in Figure 4-3. Thus, for one small stress-strain loop corresponding to a .5949 pu torque level, the damage contribution is (NF=1.E7):

$$\% \text{ Damage} = \frac{100}{1E7} = .00001\%$$

A torque level smaller than .5949 p.u. will also have .00001% damage. However, from Figure 4-4, one loop of a 2.2 pu torque oscillation would contribute (NF = 10): 100/10 = 10% damage. Thus, the damage increases very fast as the pu torque level increases.

IP12_005424

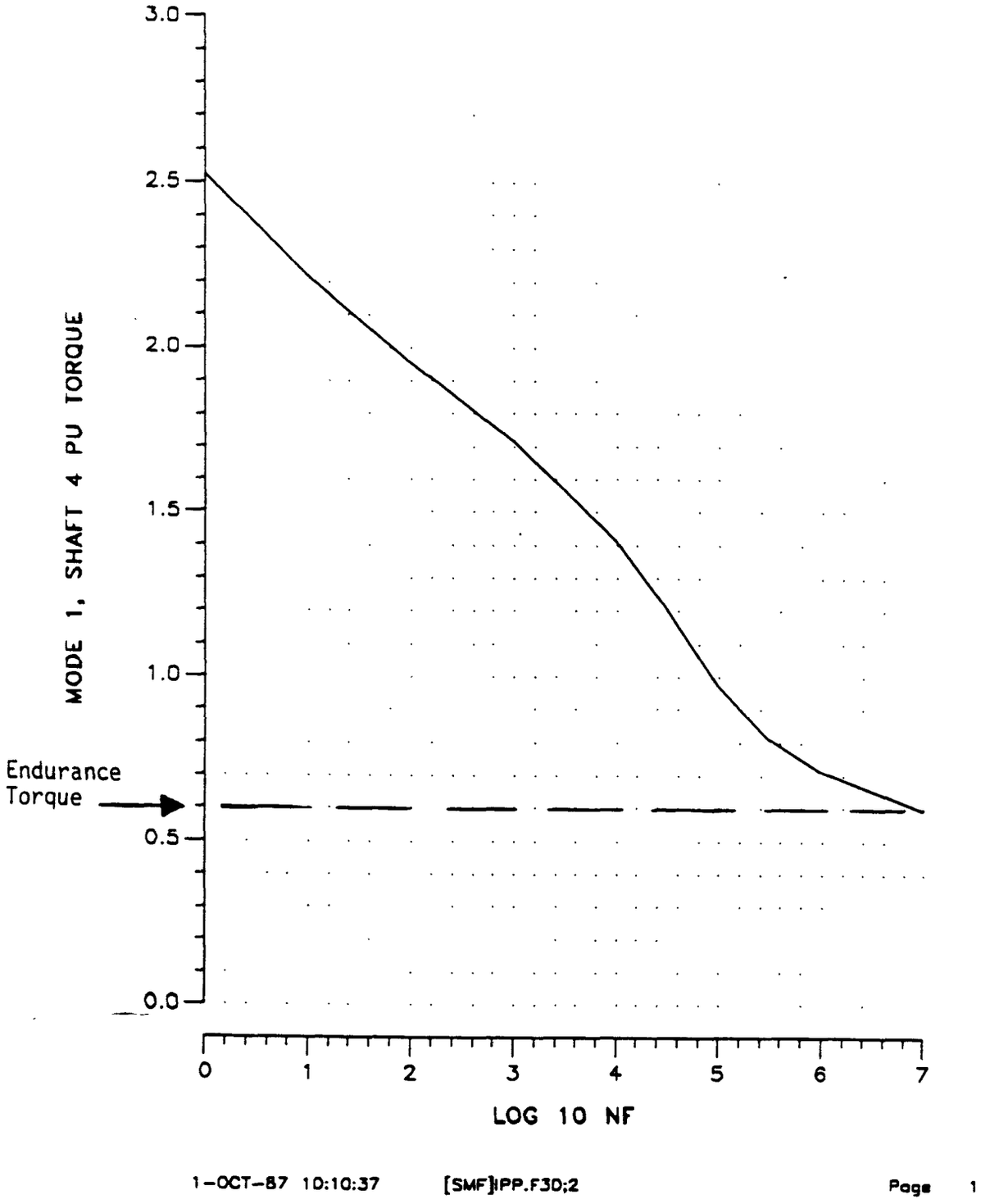


Figure 4-4. Intermountain SMF Relay PU Torque versus NF.

IP12_005425

Section 5
CASE RESULTS

5.1 AC FAULTS

AC1 Two Generators, Three-Phase Fault at IPP, Trip AC and Both Generators (ACF2GT)

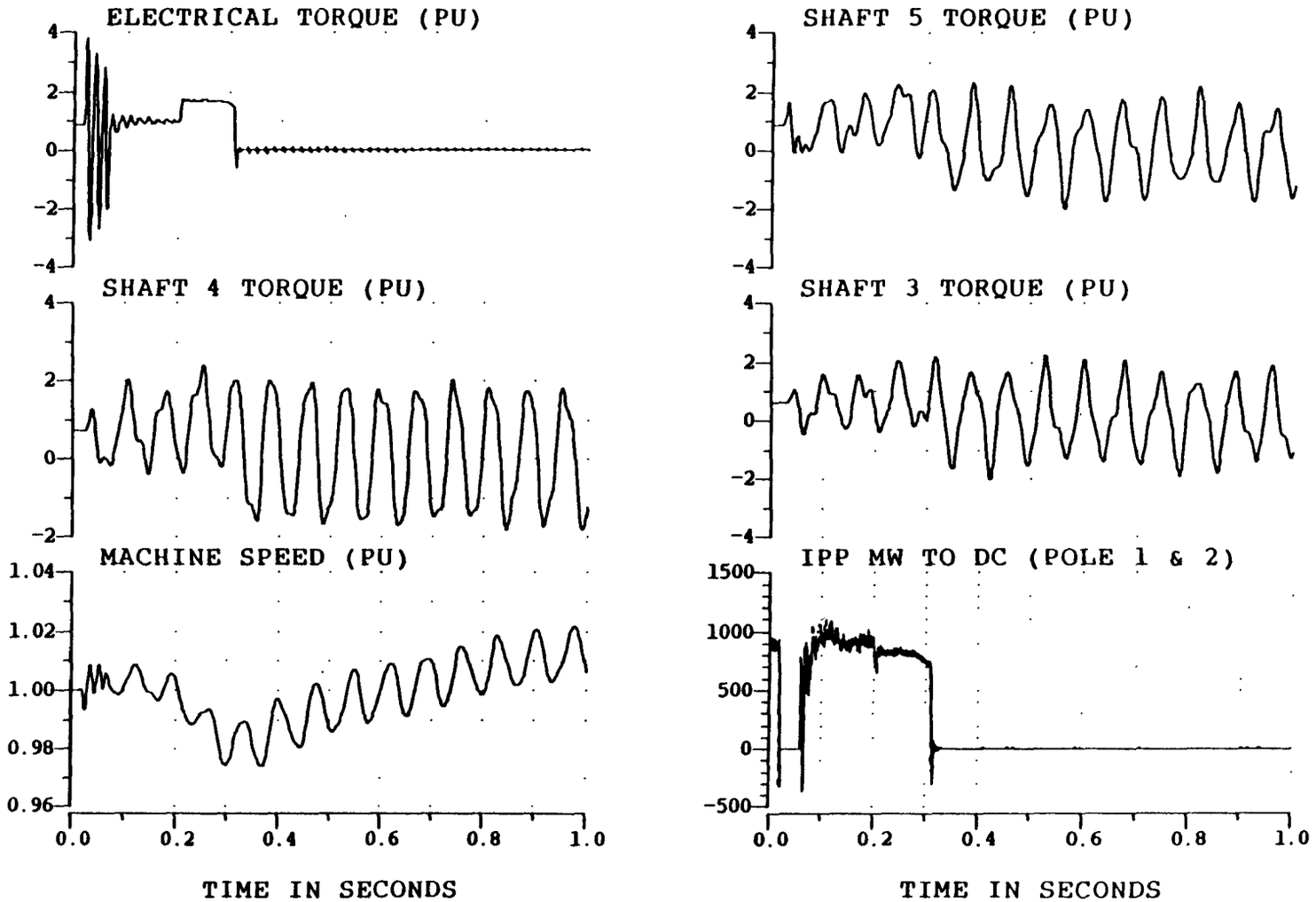
Two generators. 1760 MW on dc line, 800 MW on generators 1 and 2, 160 MW on ac line.

Events:

1. Three-phase fault at IPP at .02 seconds.
2. Clear fault at .0557 seconds.
3. Trip ac tie at .1271 seconds.
4. Trip generator 2 at .1986 seconds.
5. Trip generator 1 at .3057 seconds.

IP12_005426

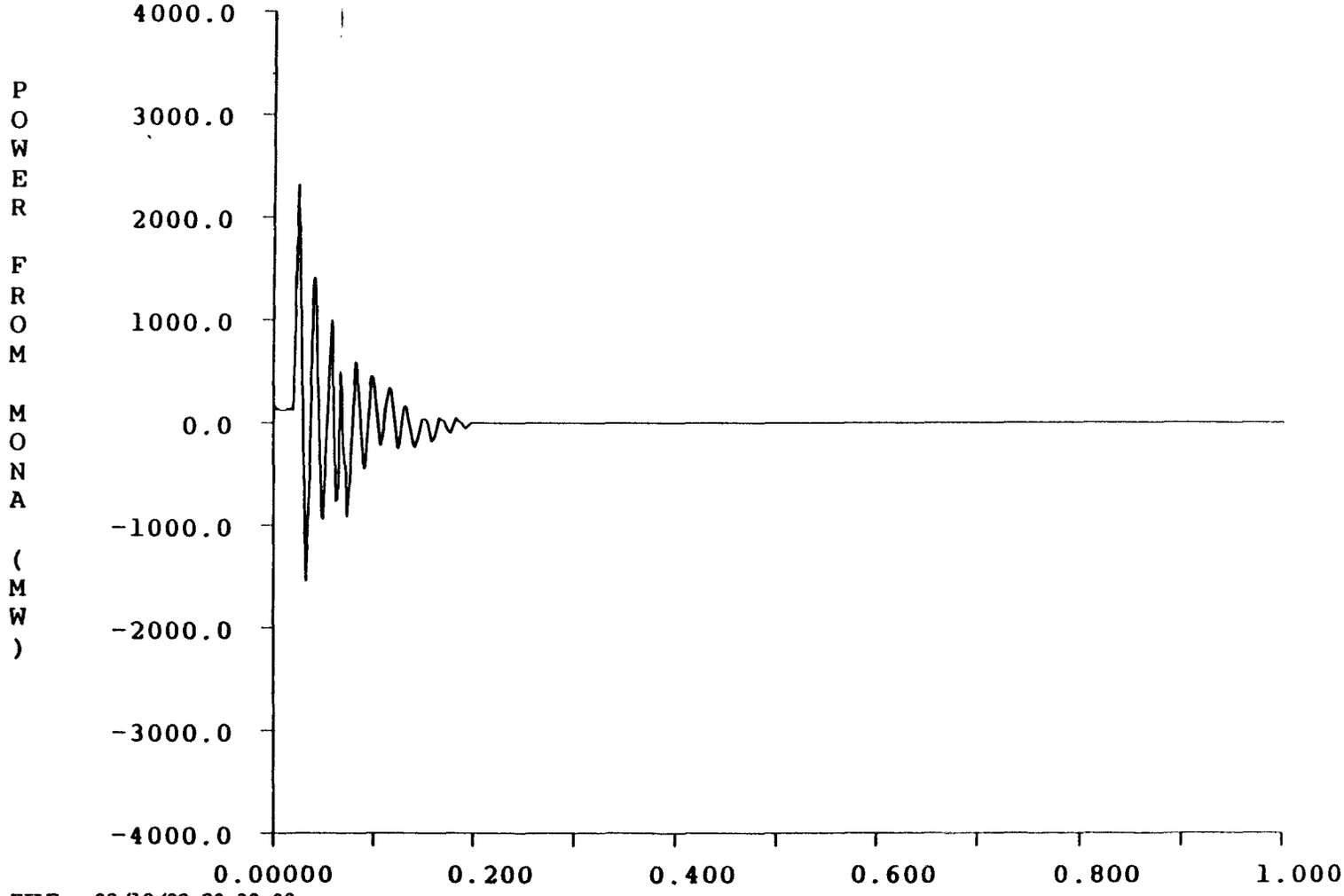
AC1 CASE ACF2GT



IP12_005427

IPP TORSIONAL STUDY, 3 PHASE FAULT AT IPP .02 TO .0557 SEC.

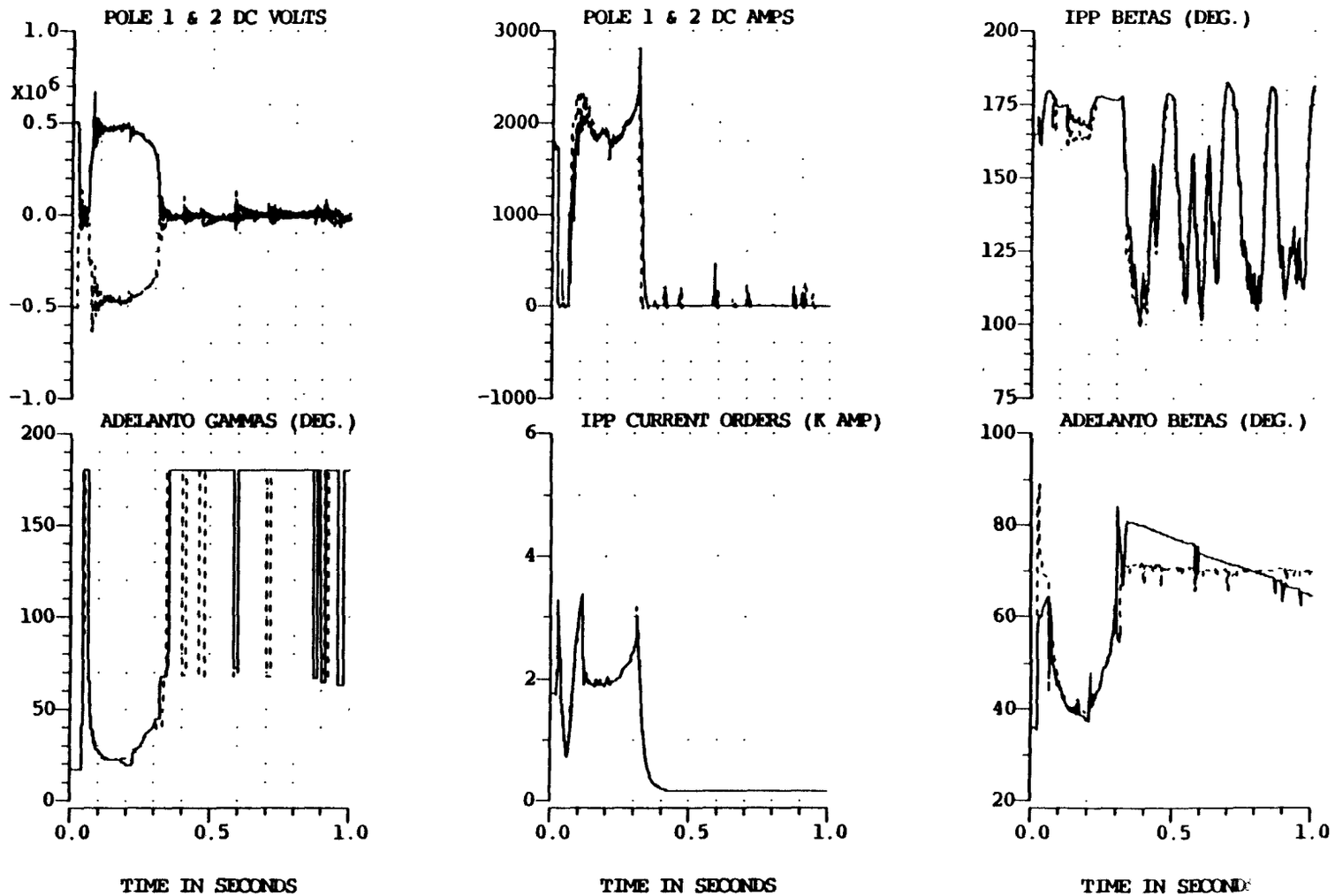
AC1 CASE # ACF2GT, 1760 MW ON DC LINE, 800 MW EACH GEN # 1 & 2,
160 MW ON MONA LINE, TRIP: AC, GEN2 & FINALLY GEN 1



FILE : 02/18/88 20.38.00
ACF2GT.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005428

AC1 CASE ACF2GT



HWM 02/18/88 20.38.00 [IPPTOR]ACF2G[illegible]4;1 Page 1

IP12_005429

AC2 Two Units, 3ϕ Fault at IPP, Trip AC & Both Units (ACF2GT)

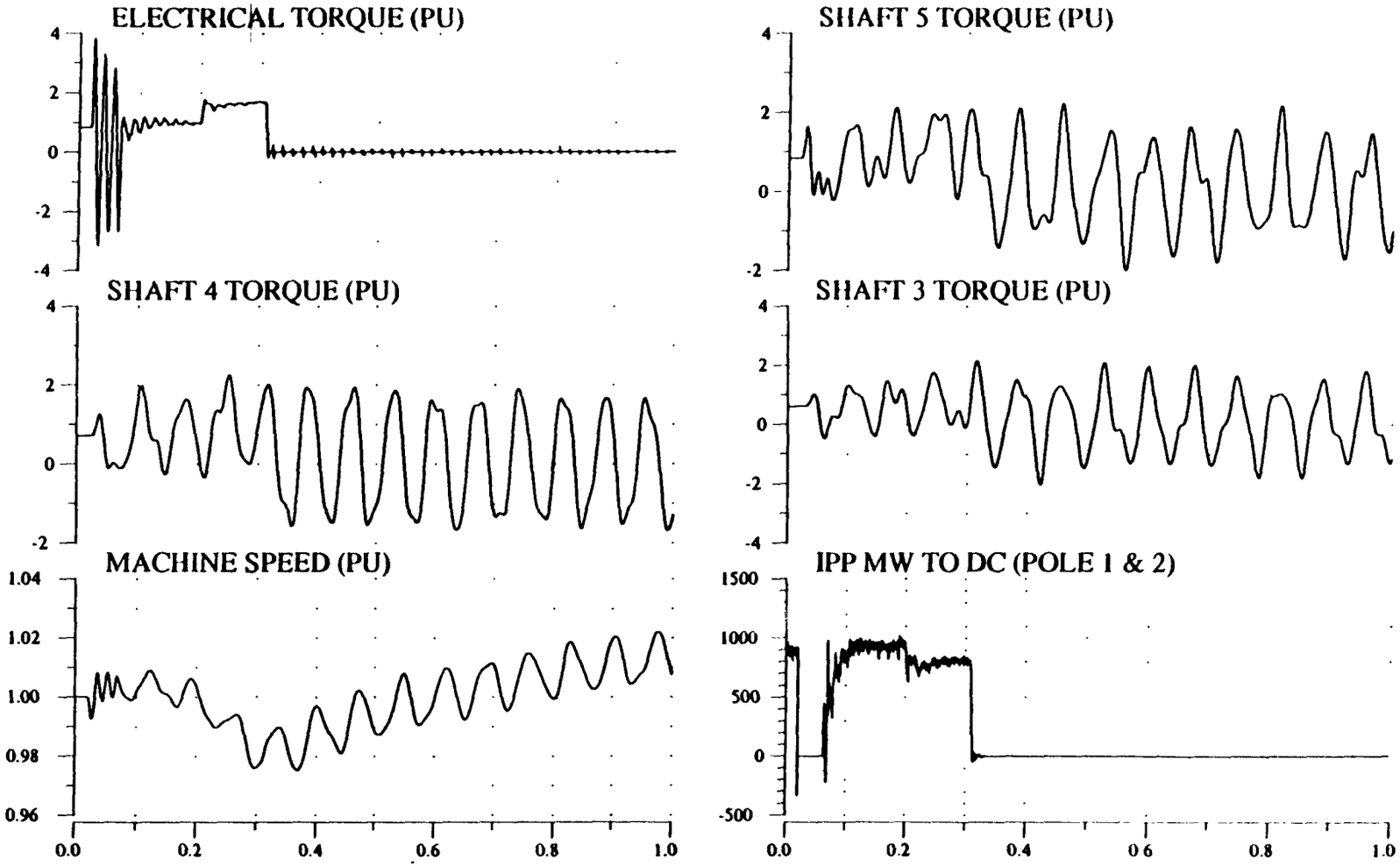
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 2.5 cycle, 3ϕ Fault at IPP from .02 to .0617 sec.
2. Trip ac tie at .1271 sec.
3. Trip generator #2 at .1986 sec.
4. Trip generator #1 at .3057 sec.

IP12_005430

AC2 3 PH FAULT @ IPP, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 2 & GEN 1
CASE ACF2GT, FIGURE



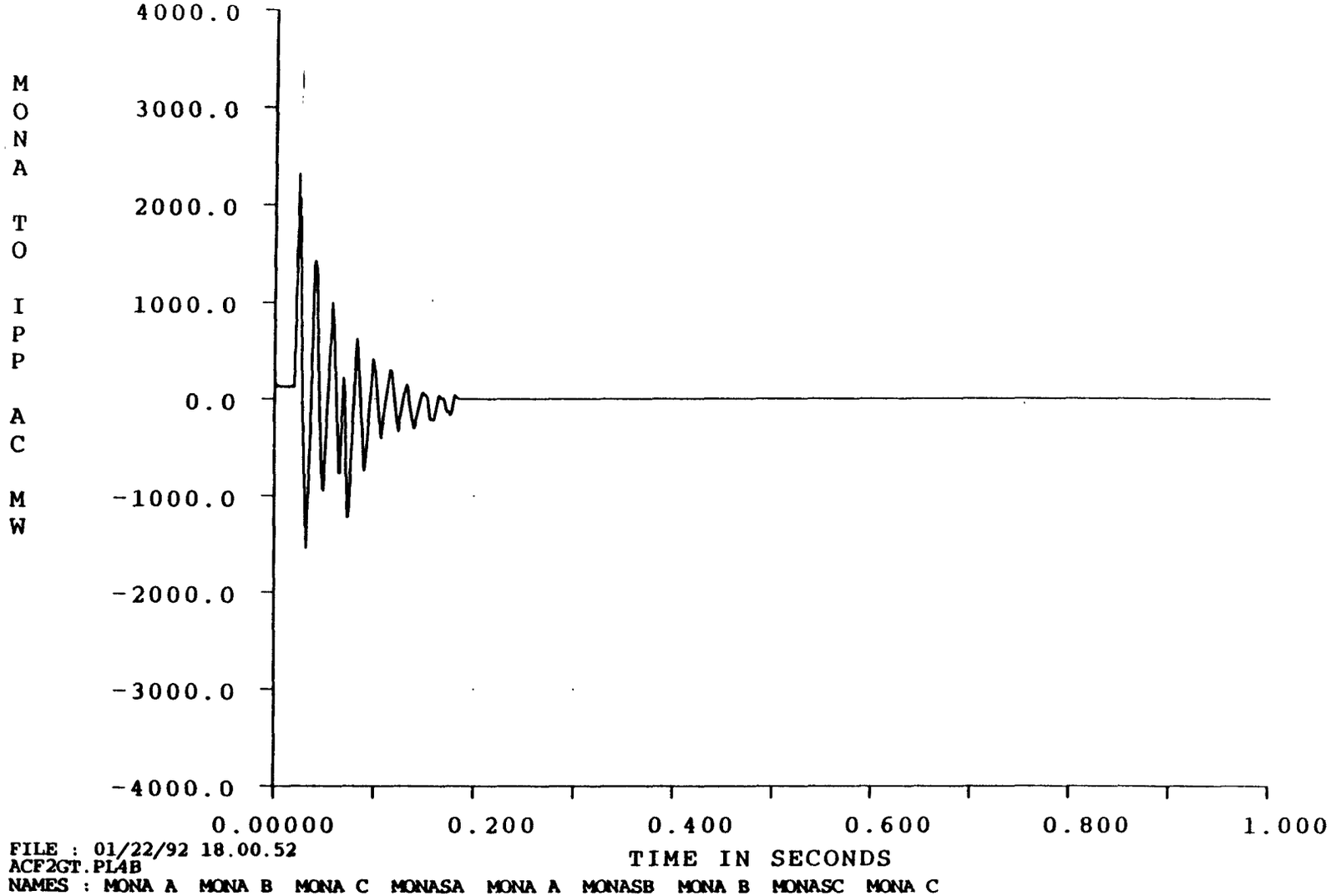
01/22/92 18.00.52 [IPPTOR]ACF2GT.PL4B;1

Page 1

IP12_005431

AC2

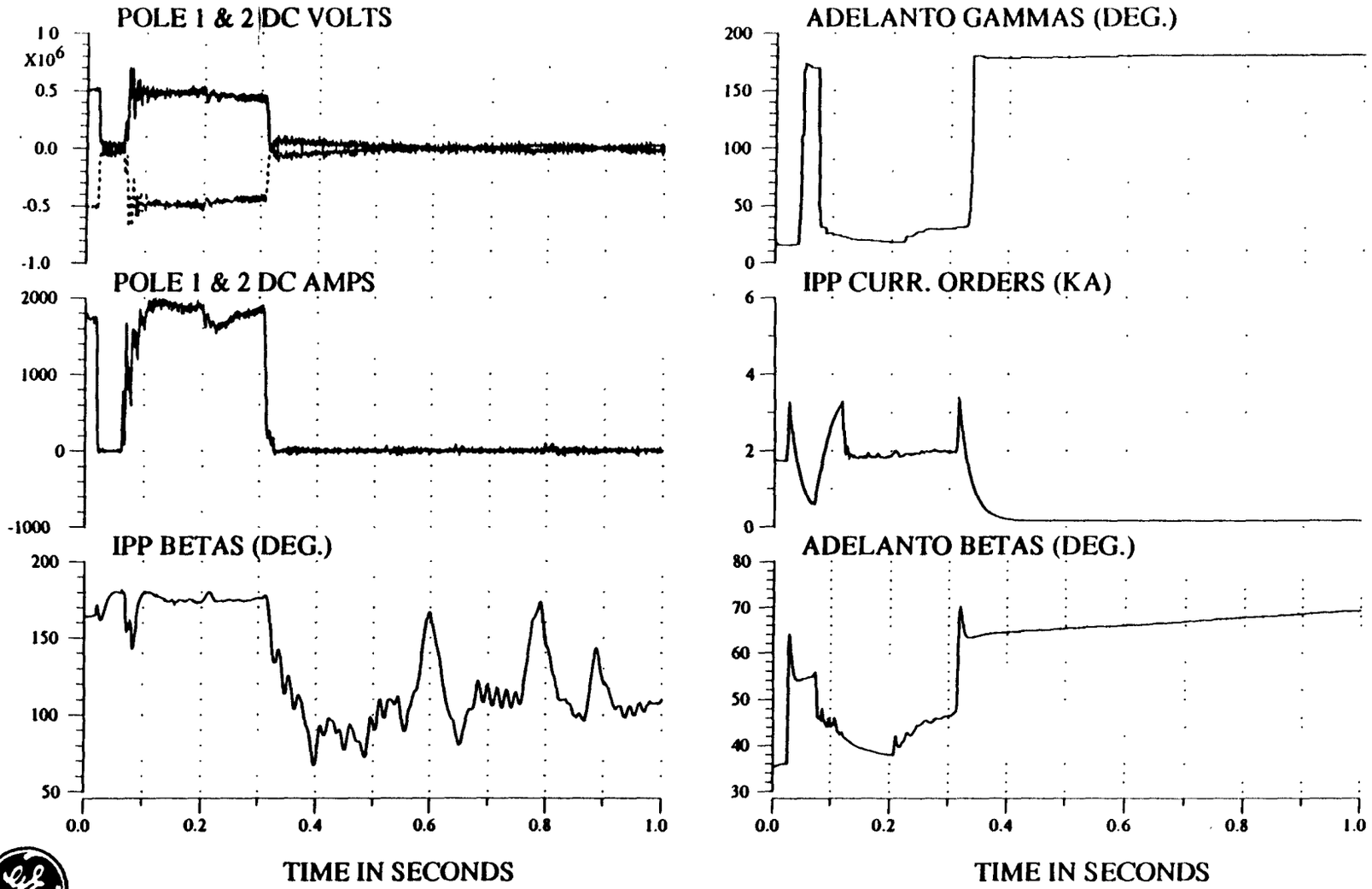
IPP TORSIONAL STUDY, 3 PHASE FAULT AT IPP .02 TO .0617 SEC.
CASE ACF2GT, #23 ,1760 MW ON DC LINE, 800 MW EACH GEN 1 & 2,
MONA TO IPP=160 MW, TRIP: AC, GEN2 & FINALLY GEN 1



FILE : 01/22/92 18.00.52
ACF2GT.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005432

AC2 3 PH FAULT @ IPP, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 2 & GEN 1
CASE ACF2GT, FIGURE



01/22/92 18.00.52 [IPPTOR]ACF2GT.PL4B;1

IP12_005433

AC3 Two Units, 3ϕ Fault at IPP, Trip AC & Both Units Plus DCPSC (ACF2GT)

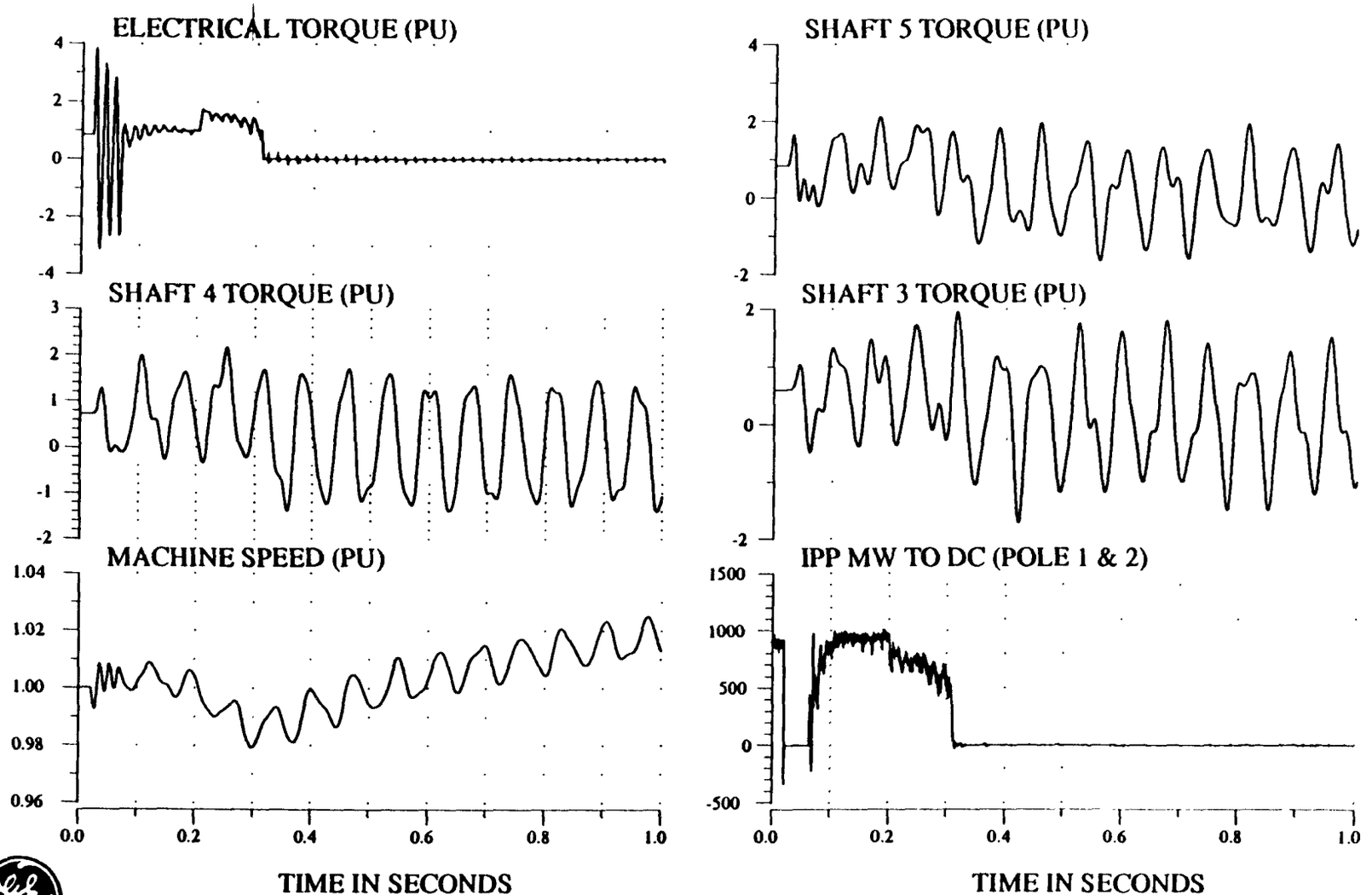
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 2.5 cycle, 3ϕ fault at IPP from .02 to .0617 sec.
2. Trip ac tie at .1271 sec.
3. Trip generator #2 at .1986 sec.
4. Trip generator #1 at .3057 sec.

IP12_005434

AC3 3 PH FAULT @ IPP, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 2 & GEN 1
CASE ACF2GT, DCPSC, FIGURE

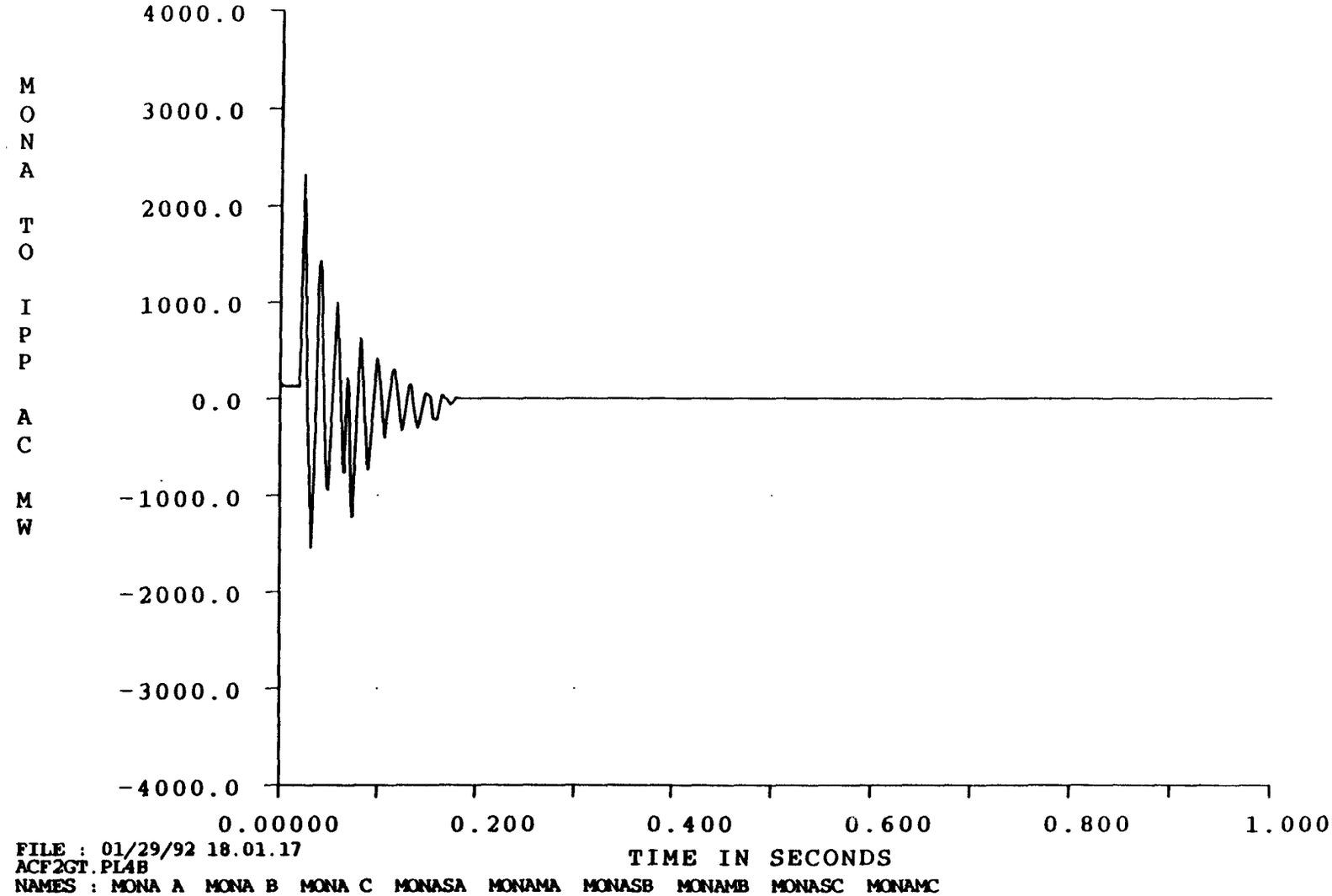


01/29/92 18.01.17 [IPPTOR]ACF2GT.PL4B;2

IP12_005435

AC3

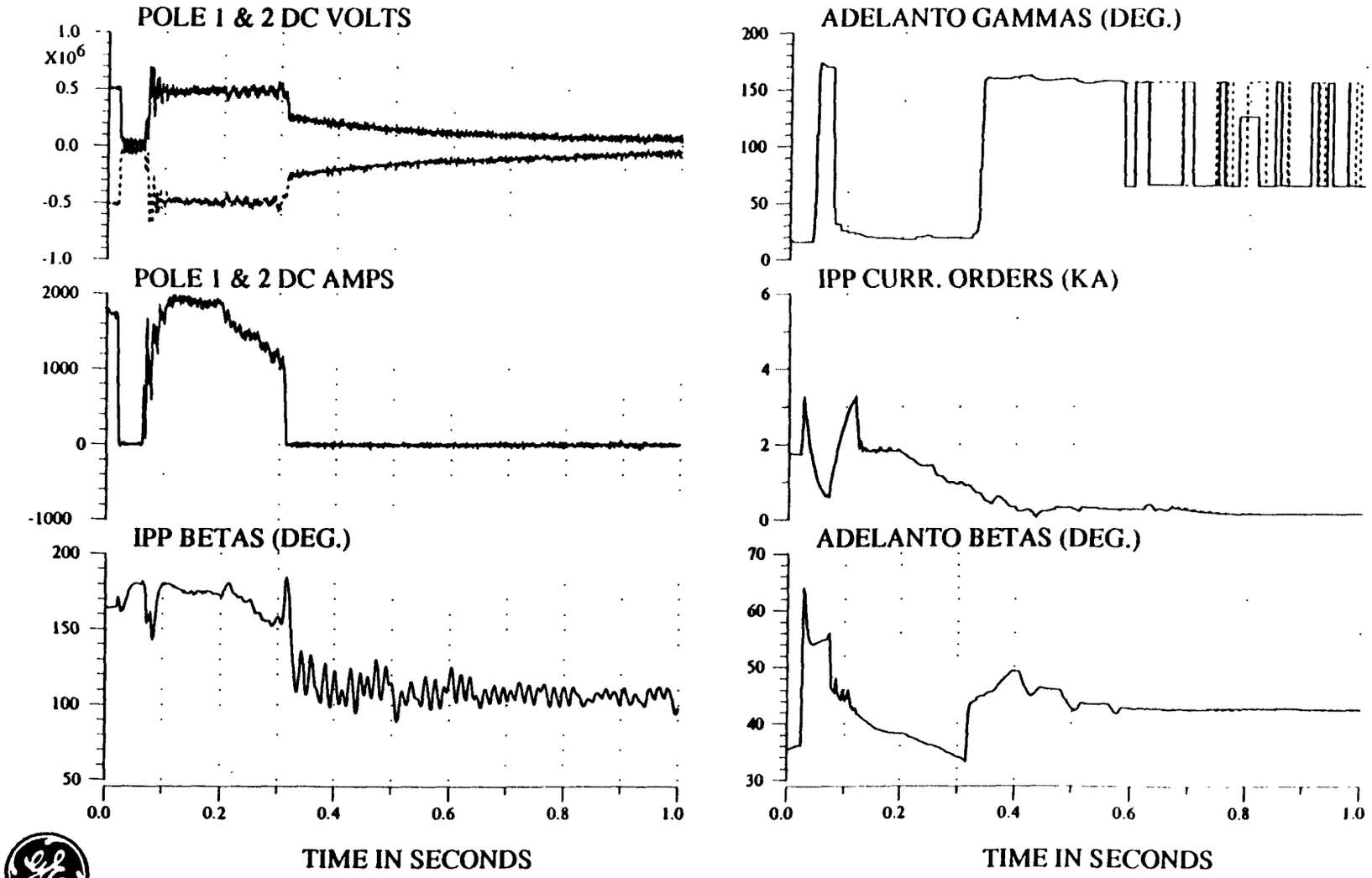
IPP TORSIONAL STUDY, 3 PHASE FAULT AT IPP .02 TO .0617 SEC.
CASE ACF2GT, #29, DCPSC ,1760 MW DC LINE, 800 MW
GEN 1 & 2, MONA TO IPP=160 MW, TRIP: AC, GEN2 THEN GEN 1



FILE : 01/29/92 18.01.17
ACF2GT.PL4B
NAMES : MONA A MONA B MONA C MONASA MONAMA MONASB MONAMB MONASC MONAMC

IP12_005436

AC3 3 PH FAULT @ IPP, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 2 & GEN 1
CASE ACF2GT, DCPSC, FIGURE



01/29/92 18.01.17 [IPPTOR]ACF2GT.PL4B;2

IP12_005437

AC4 Two Units, 3ϕ Fault at Adelanto, Trip AC (ACF2GB12T)

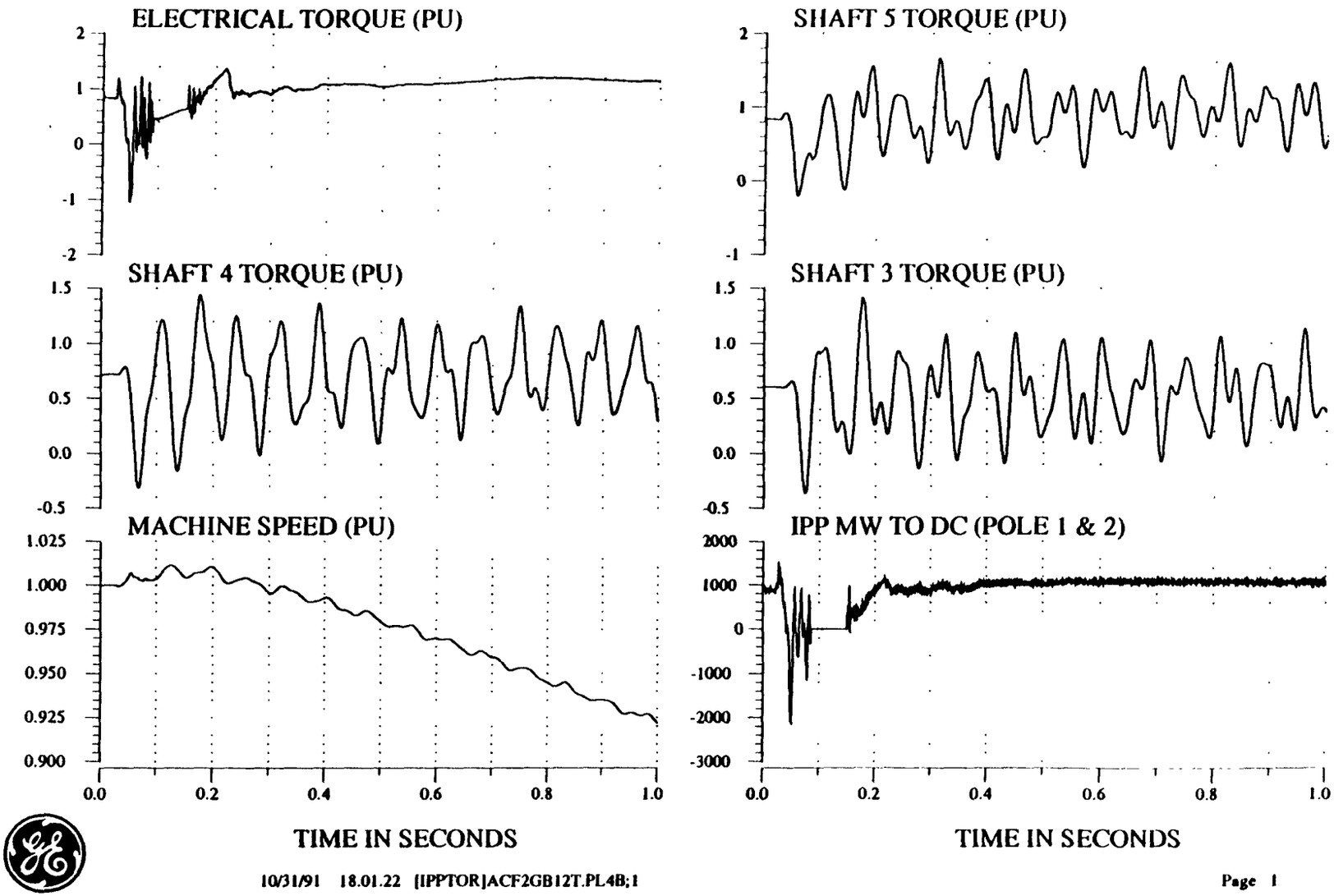
Two generators. 1760 MW on dc line, 800 MW each generator 1 & 2. 160 MW on ac line.

Events:

1. Four-cycle, 3ϕ fault at Adelanto from .02 to .0867 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.
3. Trip ac tie at .22 sec.

IP12_005438

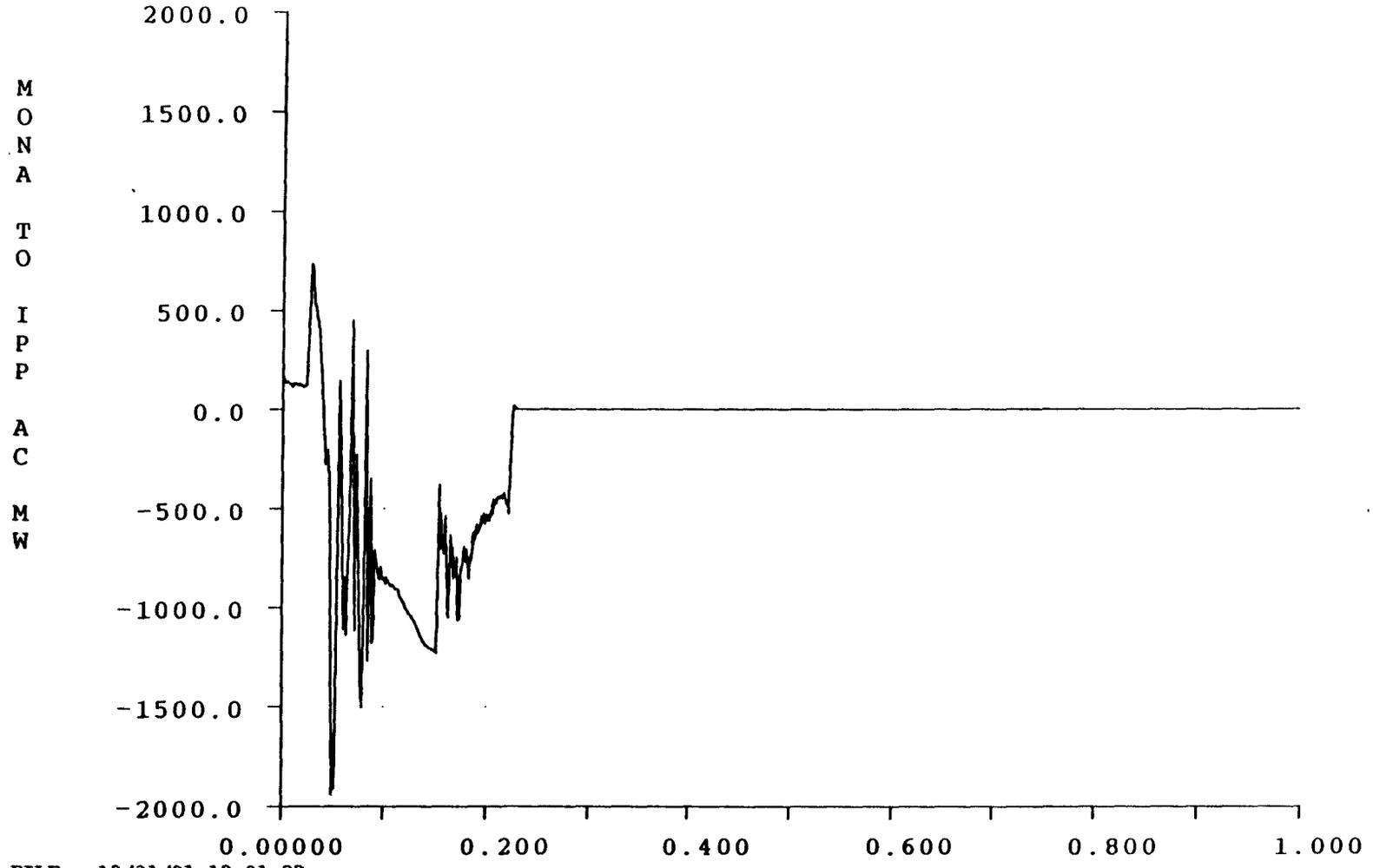
AC4 3 PH FAULT @ ADELANTO, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP AC TIE
CASE ACF2GB12T, FIGURE



10/31/91 18.01.22 [IPPTOR]ACF2GB12T.PL4B;1

IP12_005439

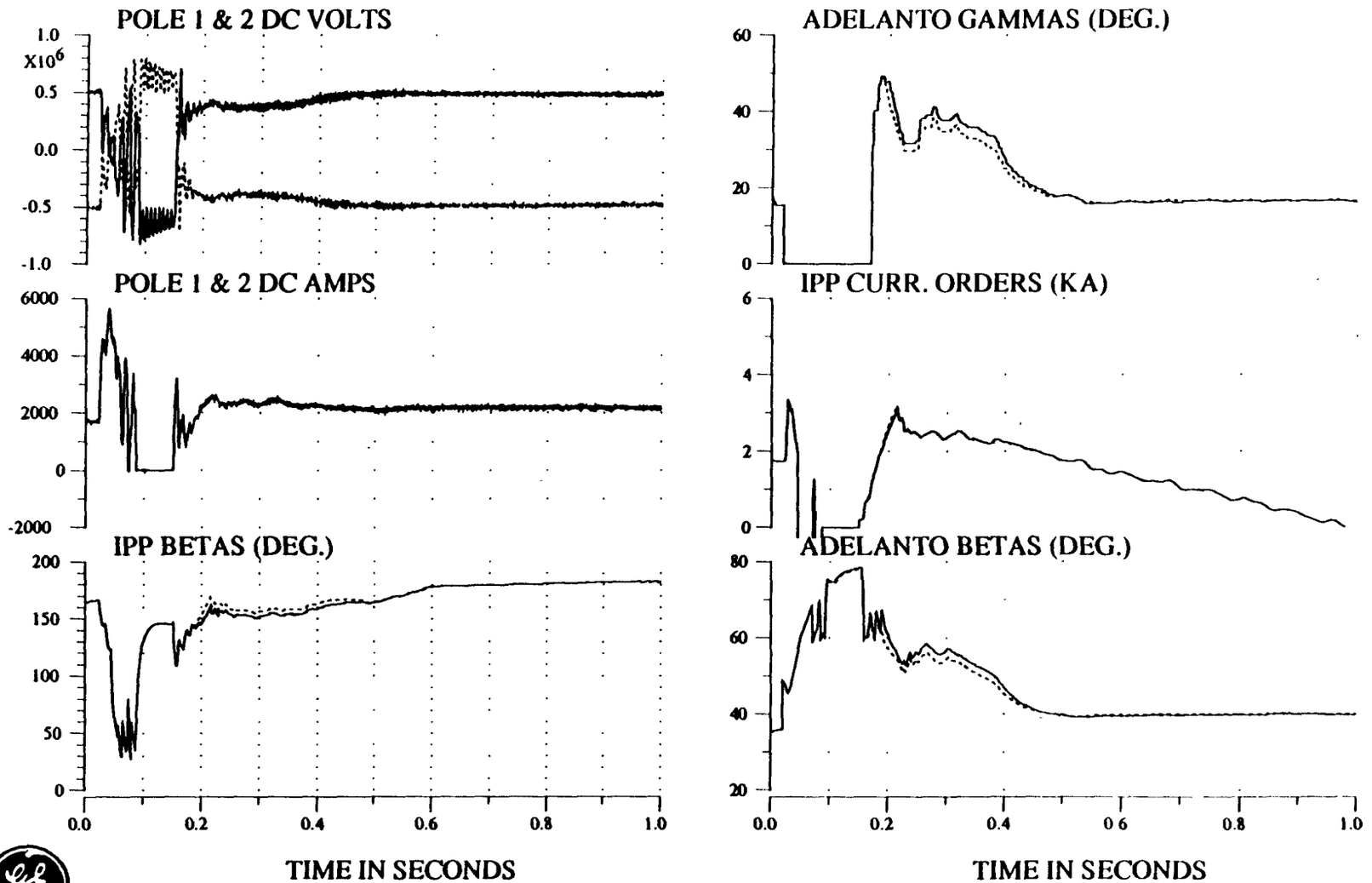
IPP TORSIONAL STUDY, 3 PHASE FAULT ON BUS ADDCS
AC4 CASE ACF2GB12T, #21, 1760 MW ON DC LINE, 800 MW EACH GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP AC TIE



FILE : 10/31/91 18.01.22
ACF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005440

AC4 3 PH FAULT @ ADELANTO, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP AC TIE
CASE ACF2GB12T, FIGURE



10/31/91 18.01.22 [IPPTOR]ACF2GB12T.PL4B;1

IP12_005441

AC5 Two Units, 2ϕ Fault at Adelanto (ACF2GB12)

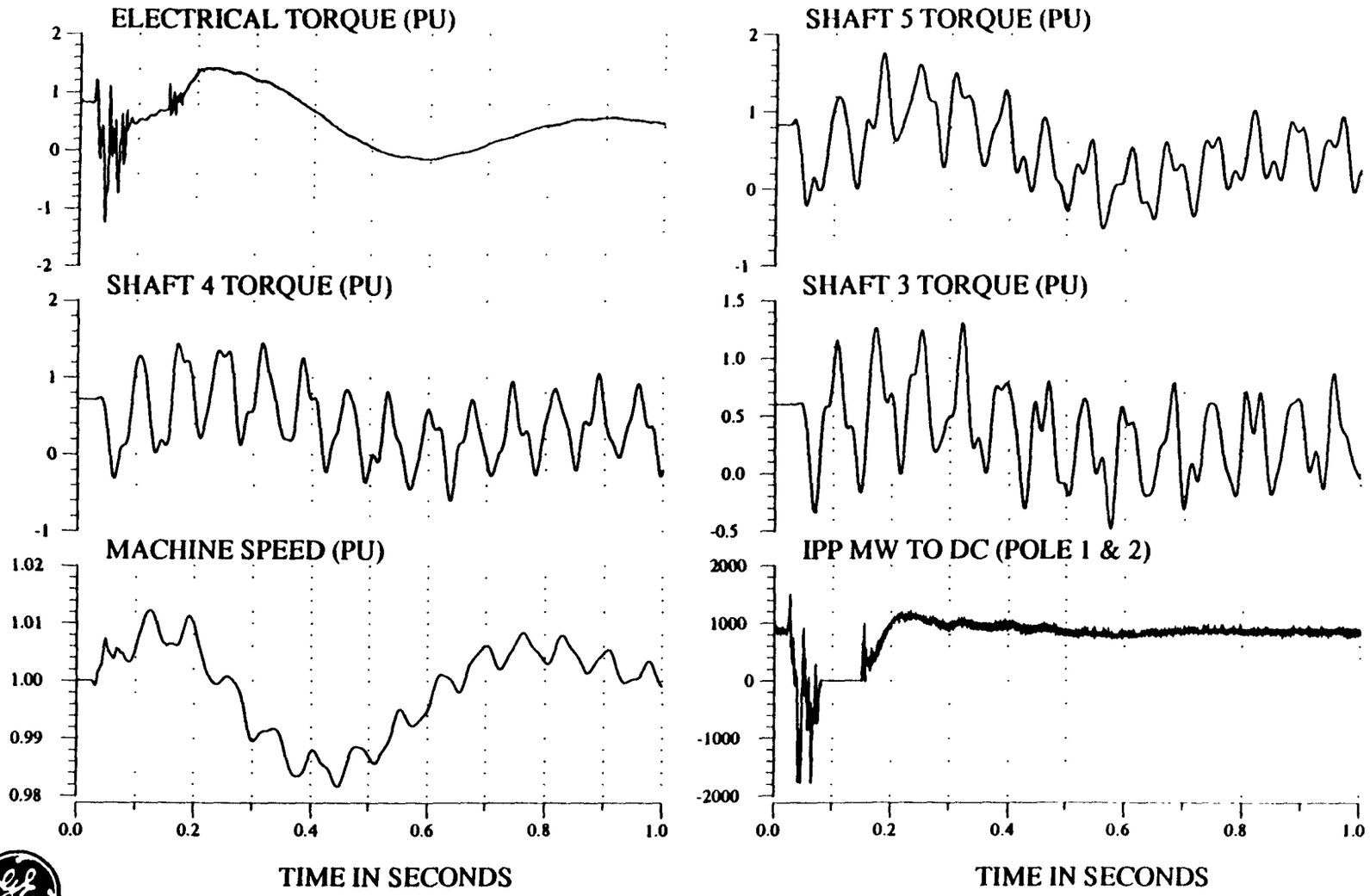
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. Three-cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.

IP12_005442

AC5 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, FIGURE

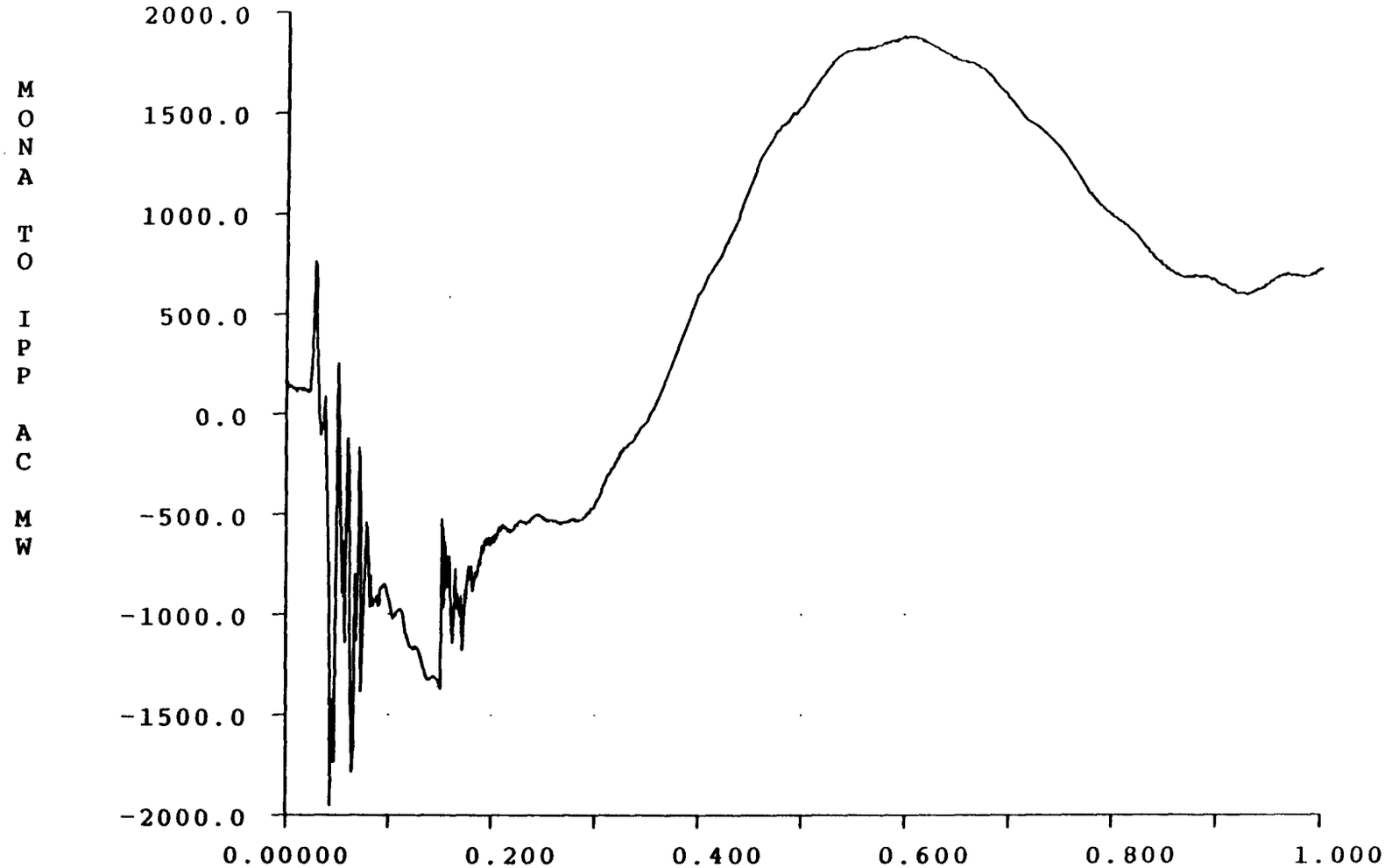


12/06/91 18.00.24 [IPPTOR]ACF2GB12.PL4B;1

Page 1

IP12_005443

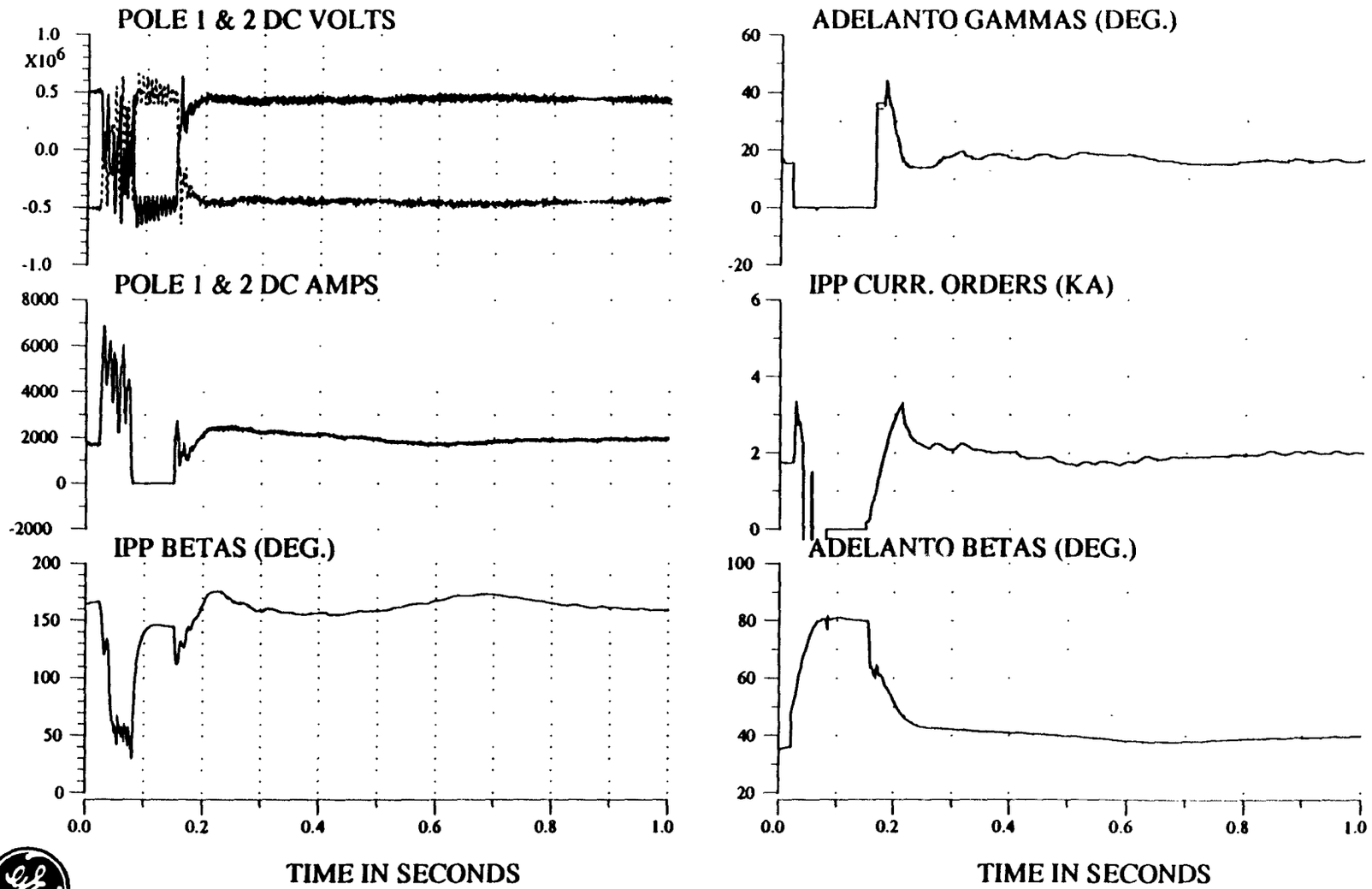
AC5 IPP TORSIONAL STUDY, PH B TO PH C FAULT AT BUS VICVX
CASE ACF2GB12, #22, 1760 MW ON DC LINE, 800 MW
EACH GEN 1 & 2, MONA TO IPP=160 MW, BLOCK POLES 1 & 2



FILE : 12/06/91 18.00.24
ACF2GB12.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005444

AC5 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, FIGURE



12/06/91 18.00.24 [IPPTOR]ACF2GB12.PL4B;1

IP12_005445

AC6 Two Units, 2ϕ Fault at Adelanto Plus CFC (ACF2GB12)

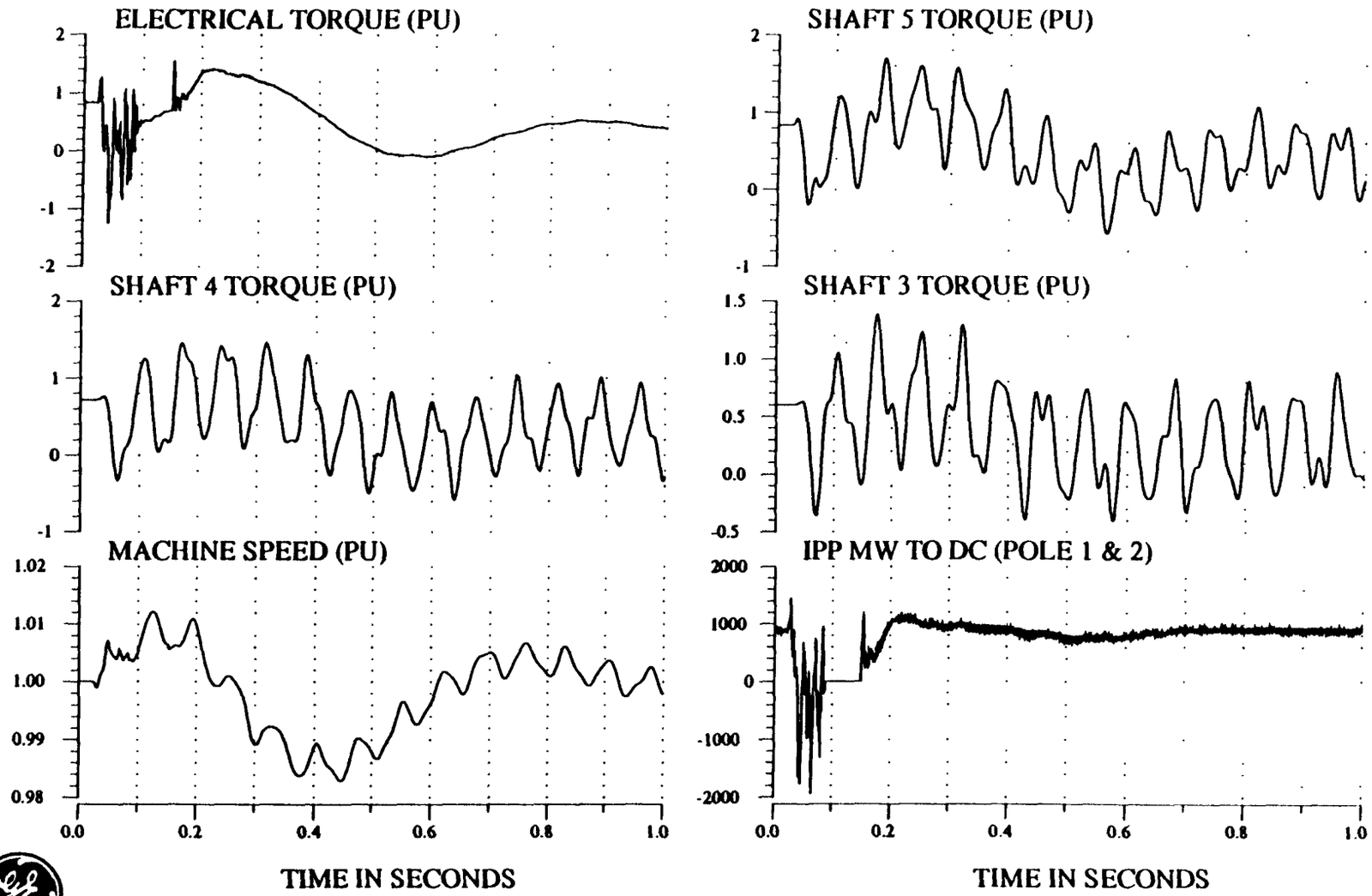
Two generators, 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.

IP12_005446

AC6 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, CFC, FIGURE



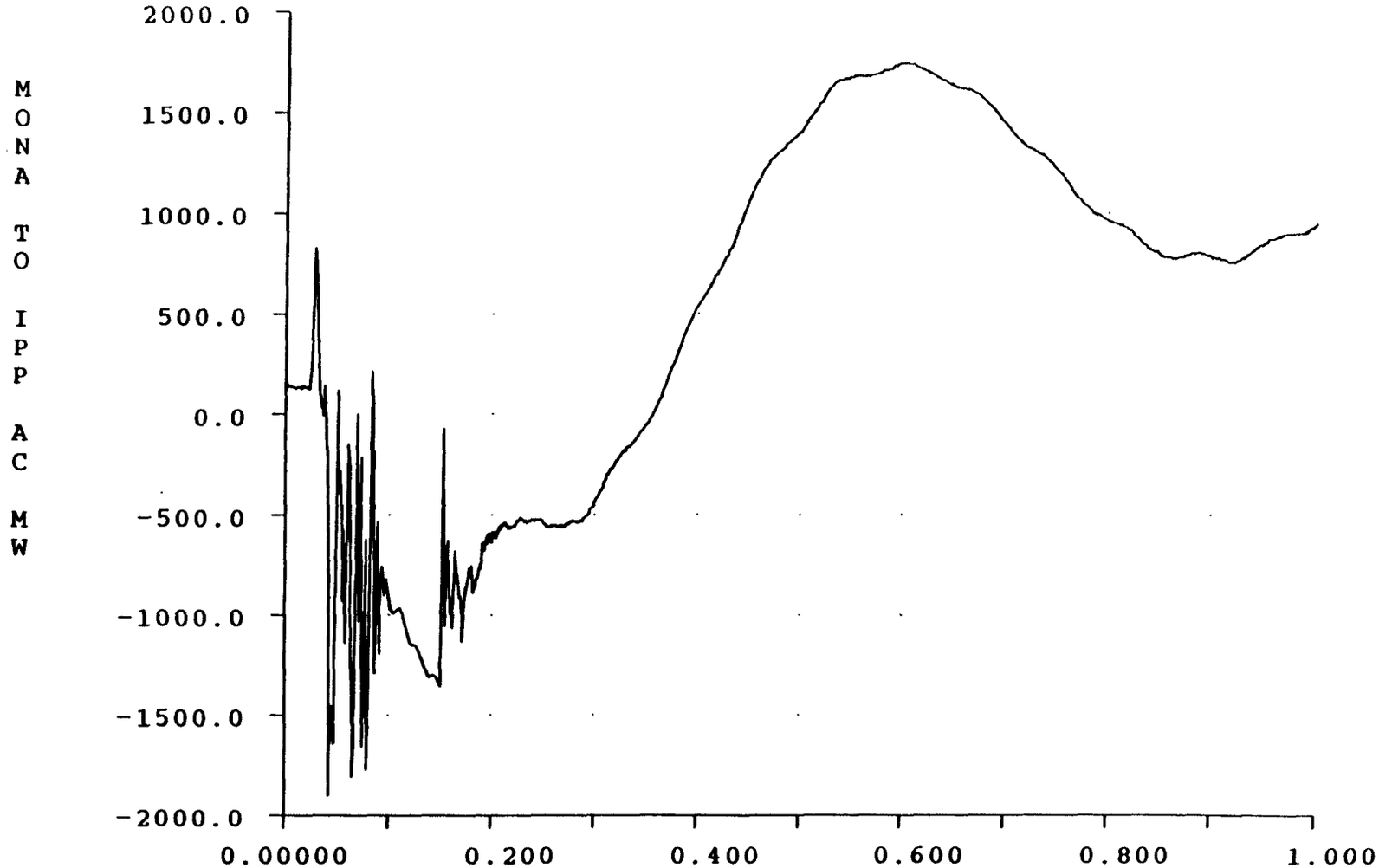
01/24/92 18.00.47 [IPPTOR]ACF2GB12.PL4B;3

Page 1

IP12_005447

AC6

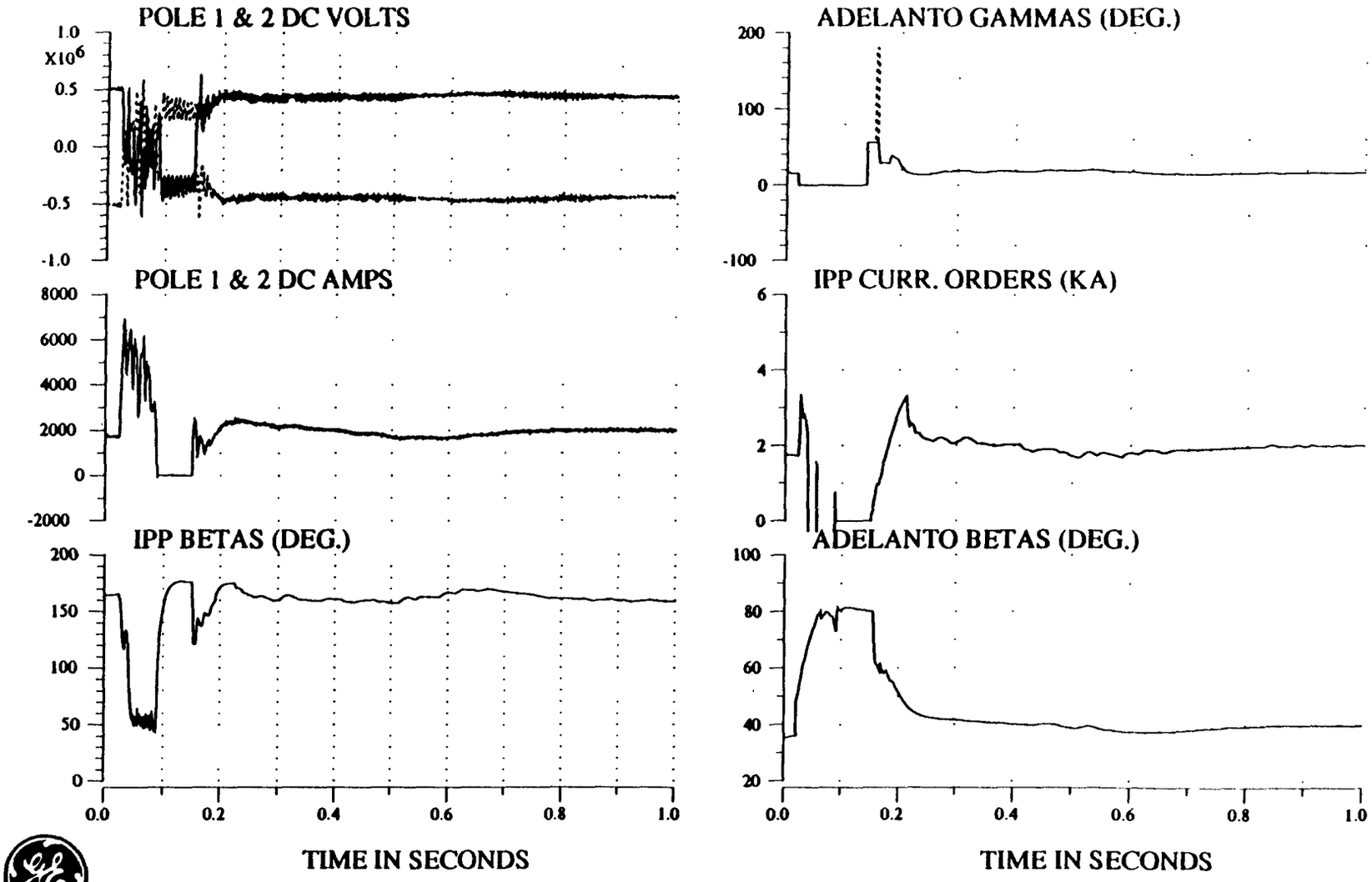
IPP TORSIONAL STUDY, PH B TO PH C FAULT AT BUS VICVX
CASE ACF2GB12, #28, CFC, 1760 MW ON DC LINE, 800 MW
EACH GEN 1 & 2, MONA TO IPP=160 MW, BLOCK POLES 1 & 2



FILE : 01/24/92 18.00.47
ACF2GB12.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005448

AC6 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, CFC, FIGURE



01/24/92 18.00.47 [IPPTOR]ACF2GB12.PL4B;3

IP12_005449

AC7 Two Units, 2ϕ Fault at Adelanto Plus BPPO (ACF2GB12)

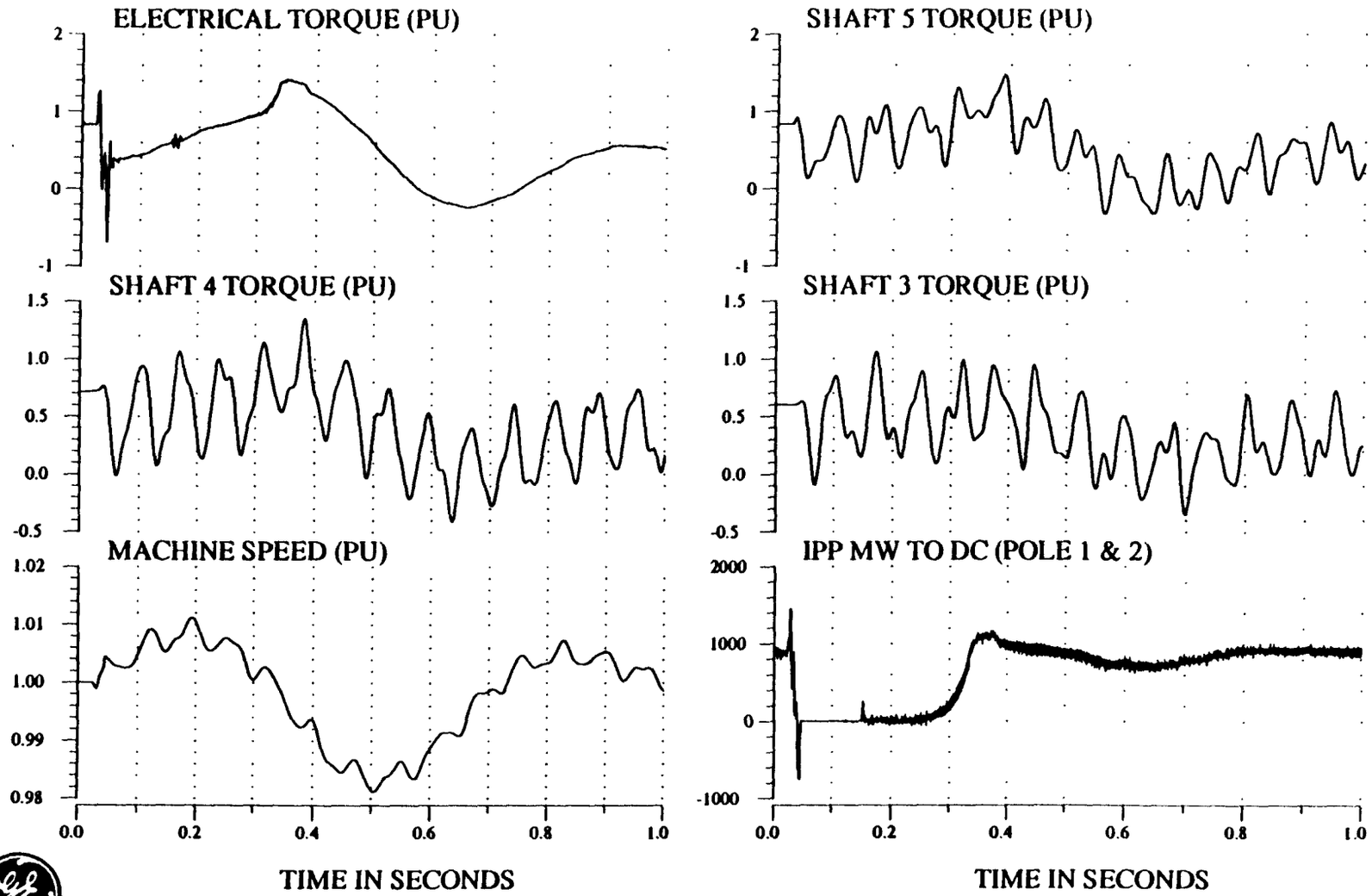
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.

IP12_005450

AC7 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, BPPO, FIGURE

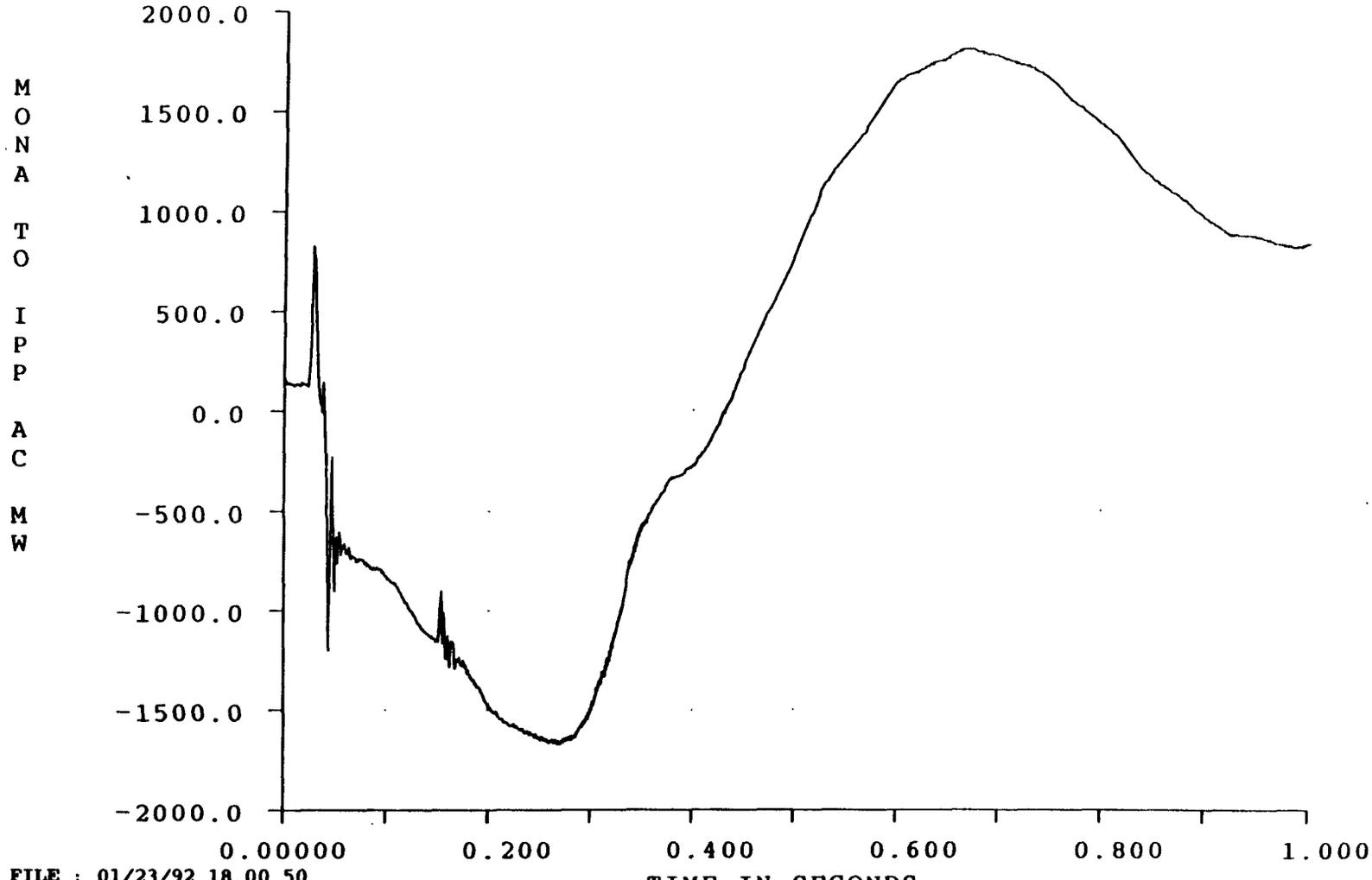


01/23/92 18.00.50 [IPPTOR]ACF2GB12.PL4B;2

Page 1

IP12_005451

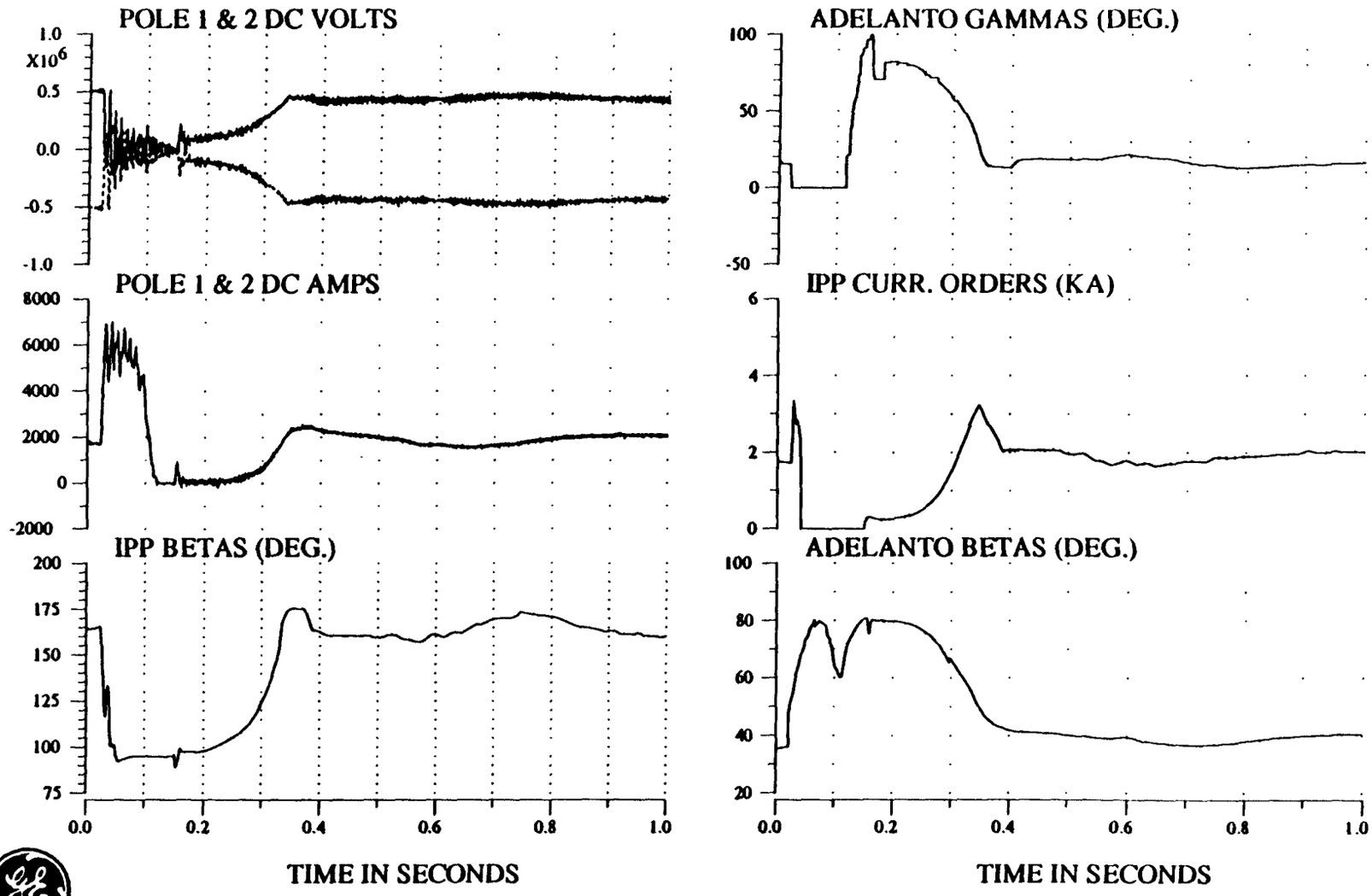
AC7 IPP TORSIONAL STUDY, PH B TO PH C FAULT AT BUS VICVX
CASE ACF2GB12, #27, BPPO, 1760 MW ON DC LINE, 800 MW
EACH GEN 1 & 2, MONA TO IPP=160 MW, BLOCK POLES 1 & 2



FILE : 01/23/92 18.00.50
ACF2GB12.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005452

AC7 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2
CASE ACF2GB12, BPPO, FIGURE



01/23/92 18.00.50 [IPPTOR]ACF2GB12.PL4B;2

IP12_005453

AC8 Two Units, 2ϕ Fault at Adelanto, Trip AC & Both Units (2PF2GB12T)

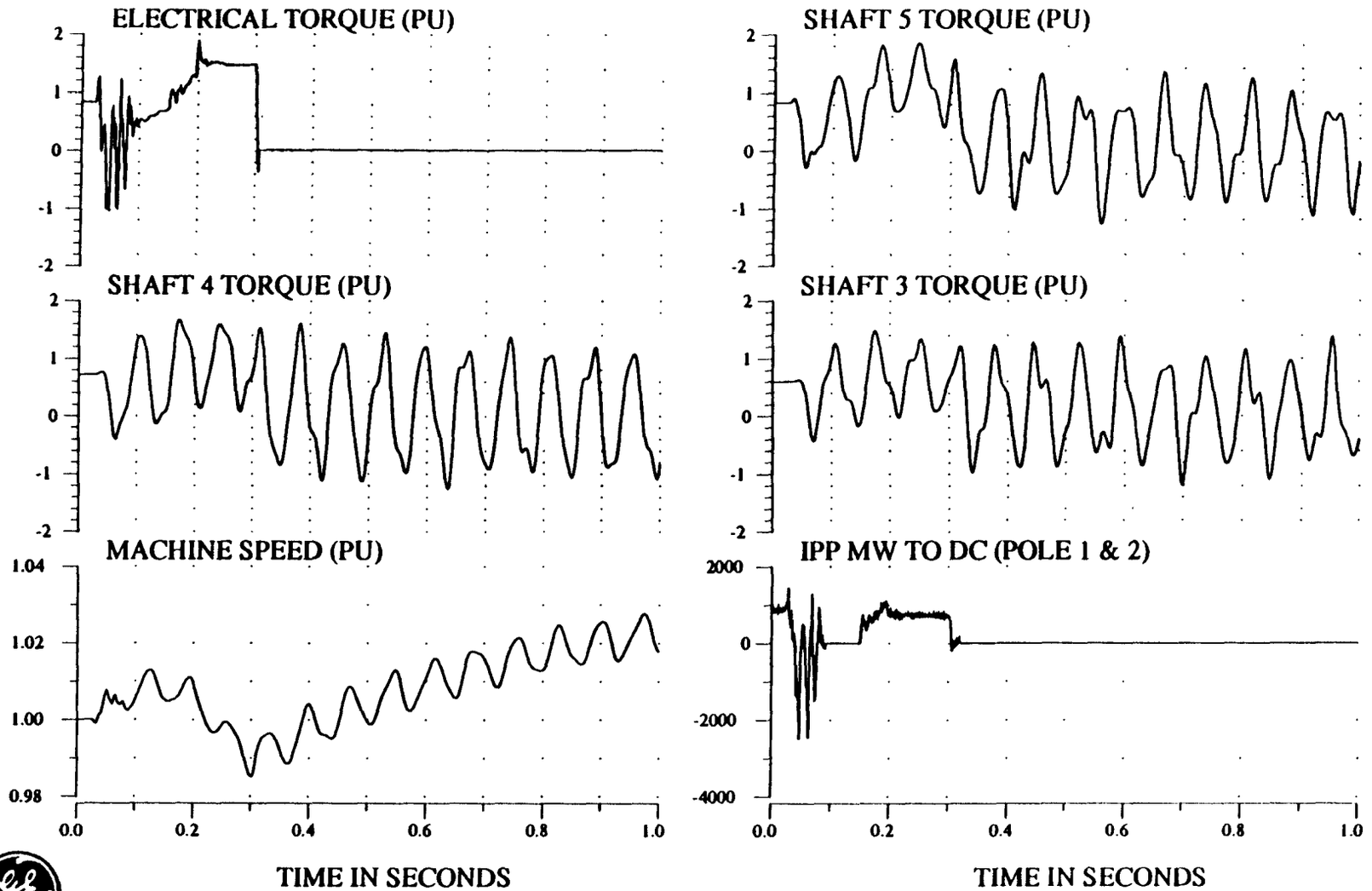
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.
3. Trip ac tie & generator 2 at .1929 sec.
4. Trip generator 1 at .3 sec.

IP12_005454

AC8 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, FIGURE

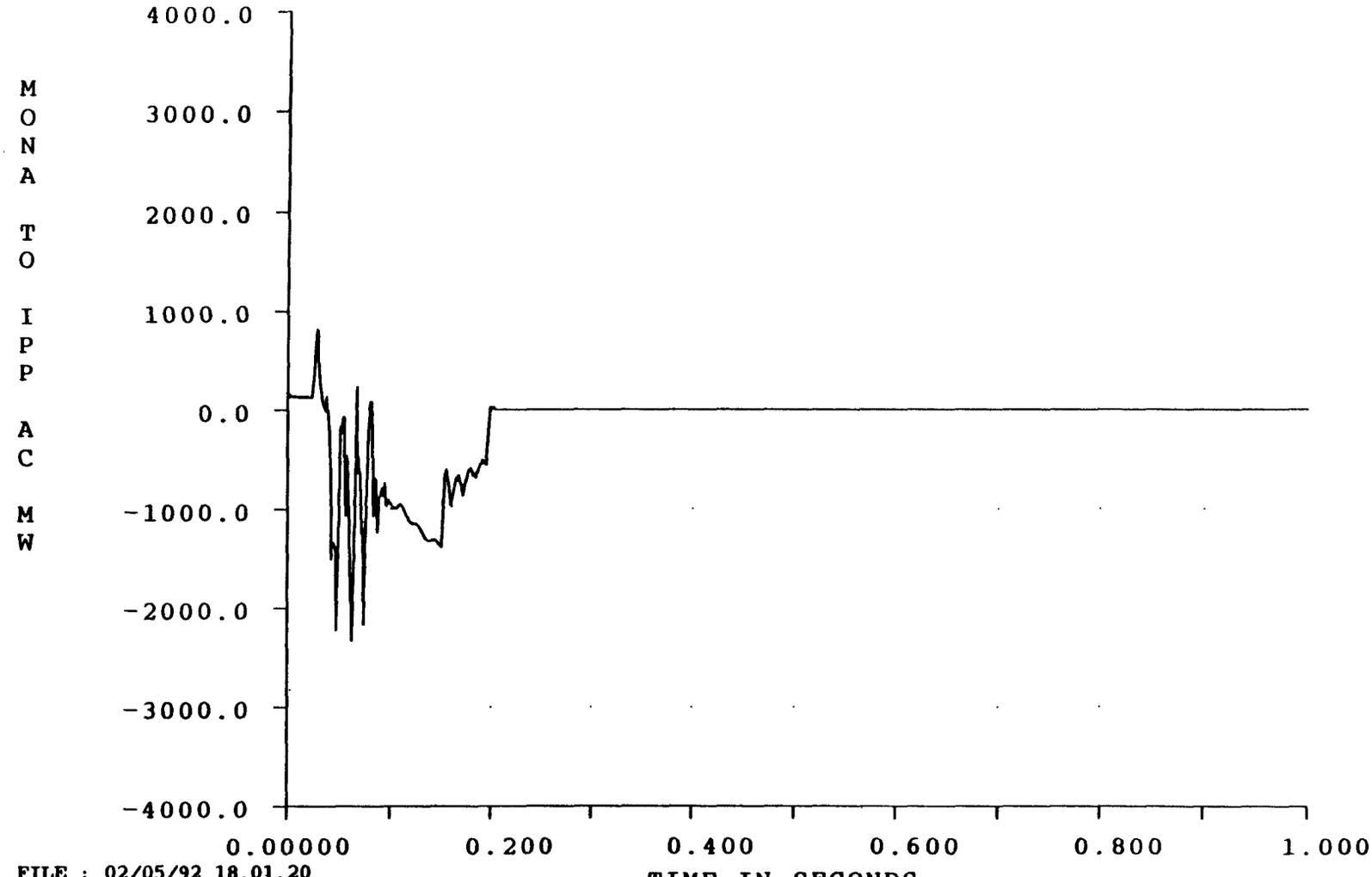


02/05/92 18.01.20 [IPPTOR]2PF2GB12T.PL4B;1

Page 1

IP12_005455

AC8 IPP TORSIONAL STUDY, 2 PH FAULT AT BUS VICVX,
CASE 2PF2GB12T ,#30, 1760 MW DC LINE, 800 MW ON G1 & G2,
MONA TO IPP=160 MW, BLOCK P1 & P2, TRIP G1,G2,MONA

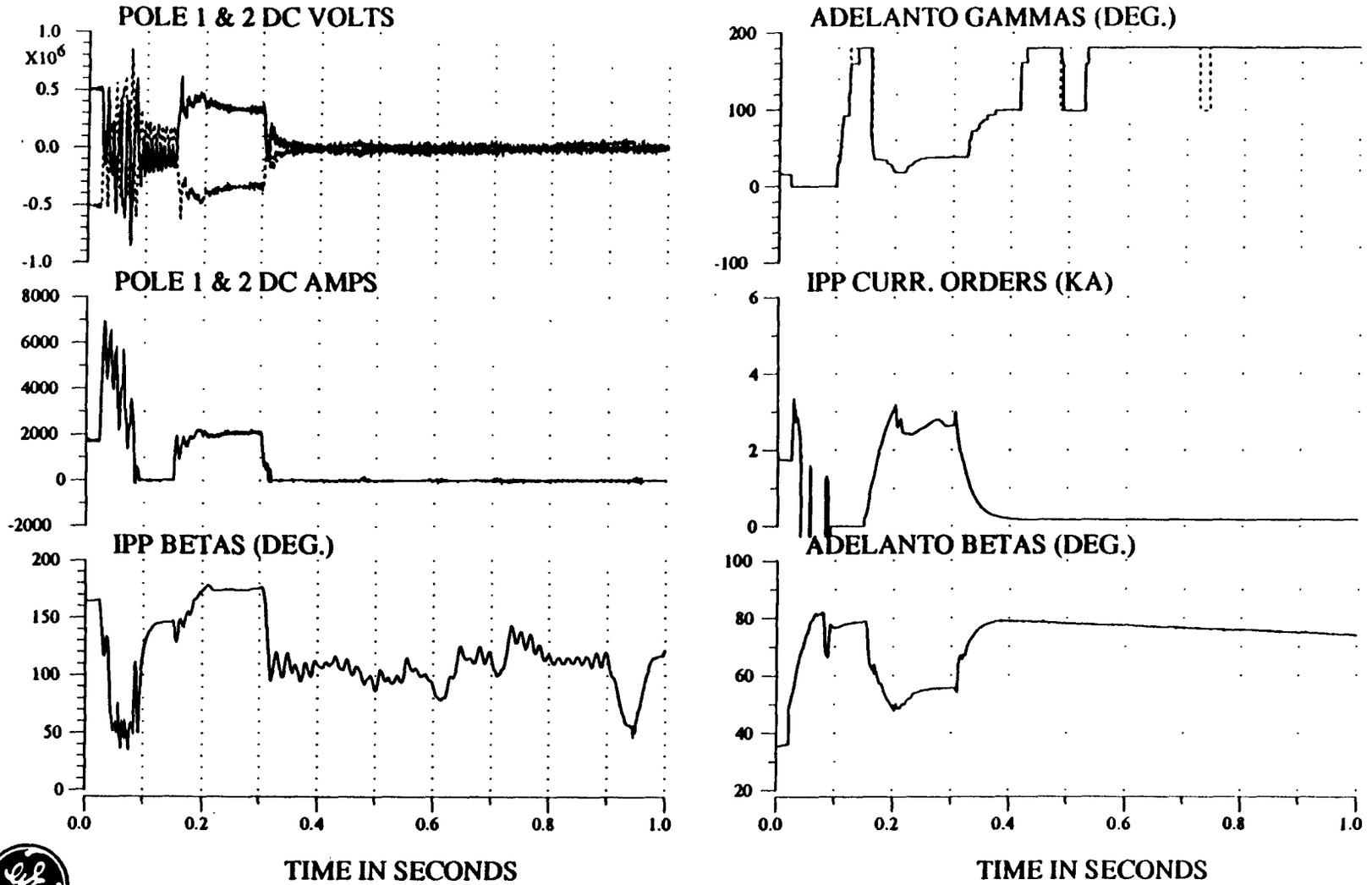


FILE : 02/05/92 18.01.20
2PF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005456

AC8

PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2 MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA CASE 2PF2GB12T, FIGURE



02/05/92 18.01.20 [IPPTOR]2PF2GB12T.PL4B;1

IP12_005457

AC9 Two Units, 2ϕ Fault at Adelanto, Trip AC & Both Units Plus DCPSC (2PF2GB12T)

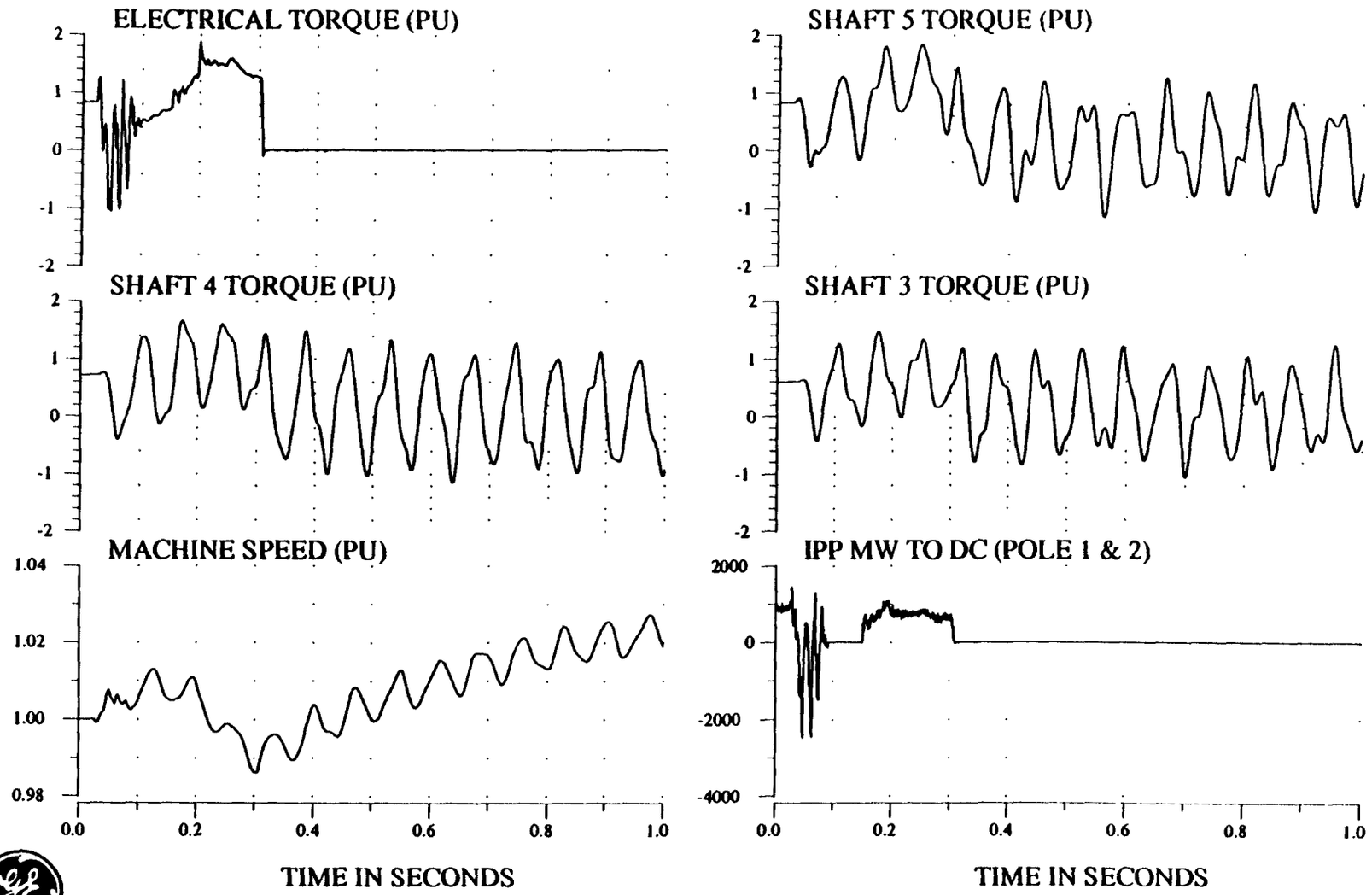
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.
3. Trip ac tie & generator 2 at .1929 sec.
4. Trip generator 1 at .3 sec.

IP12_005458

AC9 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, FIGURE

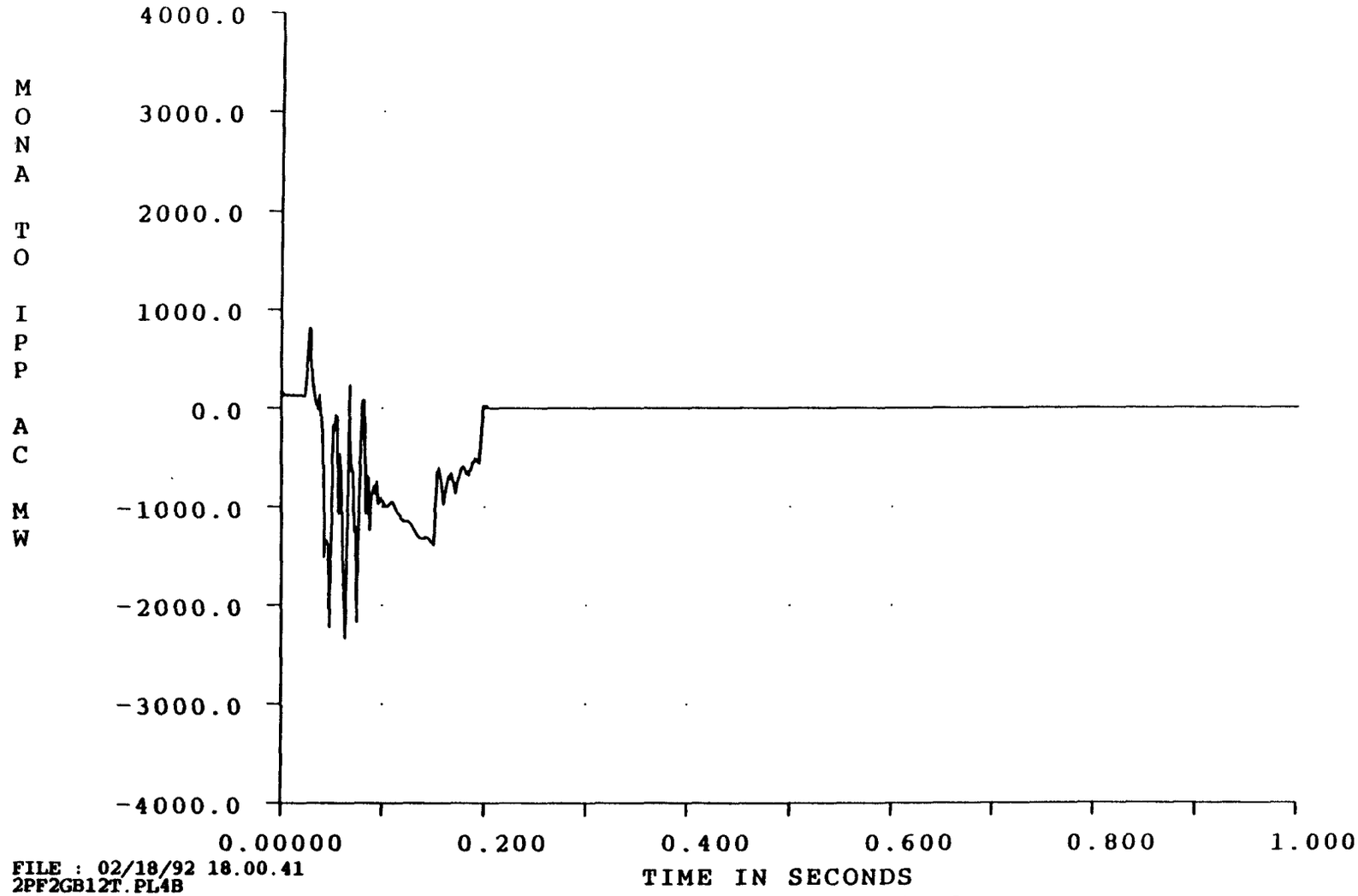


02/18/92 18.00.41 [IPPTOR]2PF2GB12T.PL4B;2

Page 1

IP12_005459

AC9 IPP TORSIONAL STUDY, 2 PH FAULT AT BUS VICVX,
CASE 2PF2GB12T ,#31, DCPSC, 1760 MW DC LINE, 800 MW ON G1
& G2, MONA TO IPP=160 MW, BLOCK P1 & P2, TRIP G1,G2,MONA

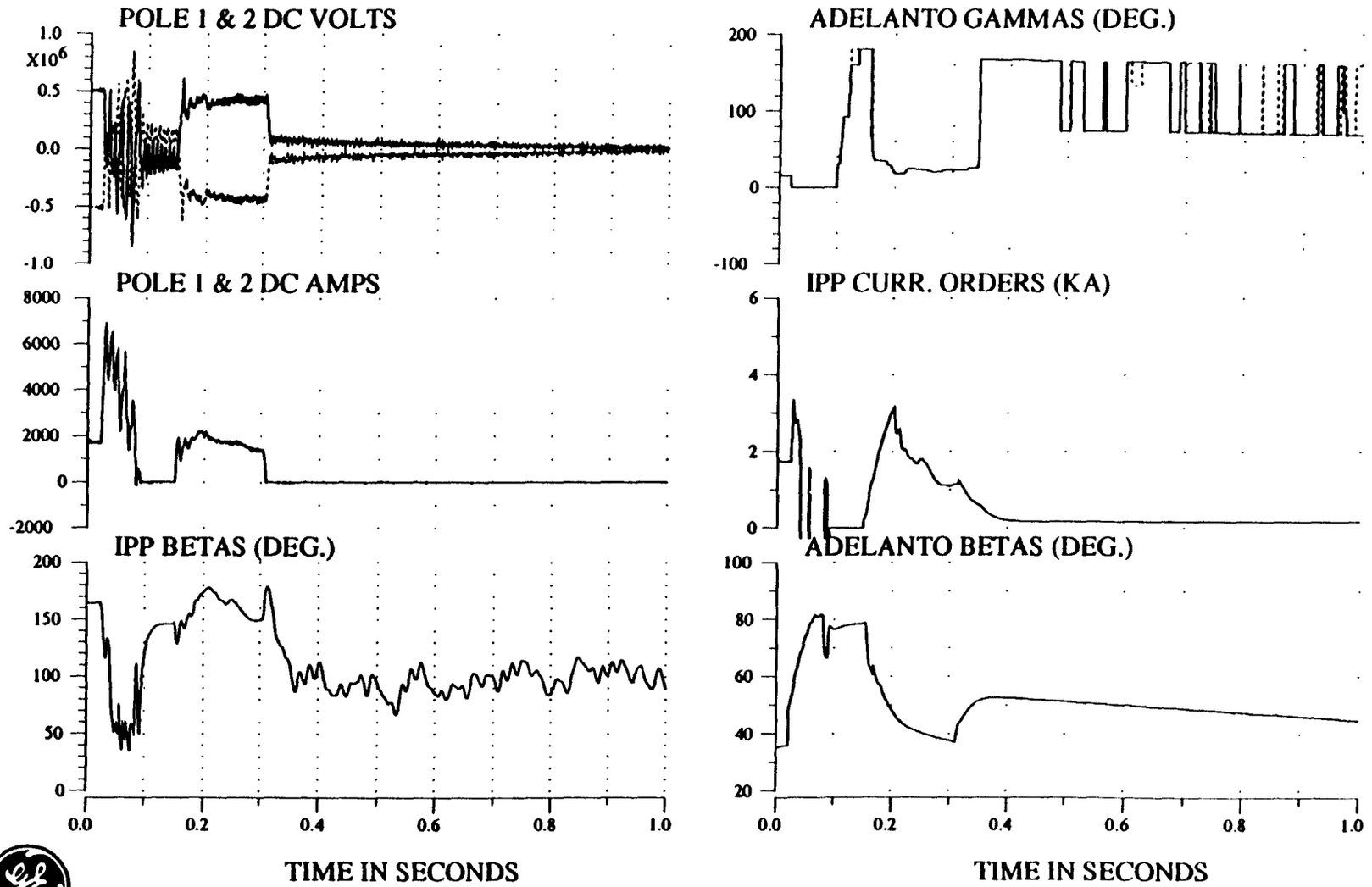


FILE : 02/18/92 18.00.41
2PF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONAMA MONASB MONAMB MONASC MONAMC

IP12_005460

AC9

PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, FIGURE



02/18/92 18.00.41 [IPPTOR]2PF2GB12T.PL4B;2

IP12_005461

AC10 Two Units, 2ϕ Fault at Adelanto, Trip AC & Both Units Plus DCPSC & CFC (2PF2GB12T)

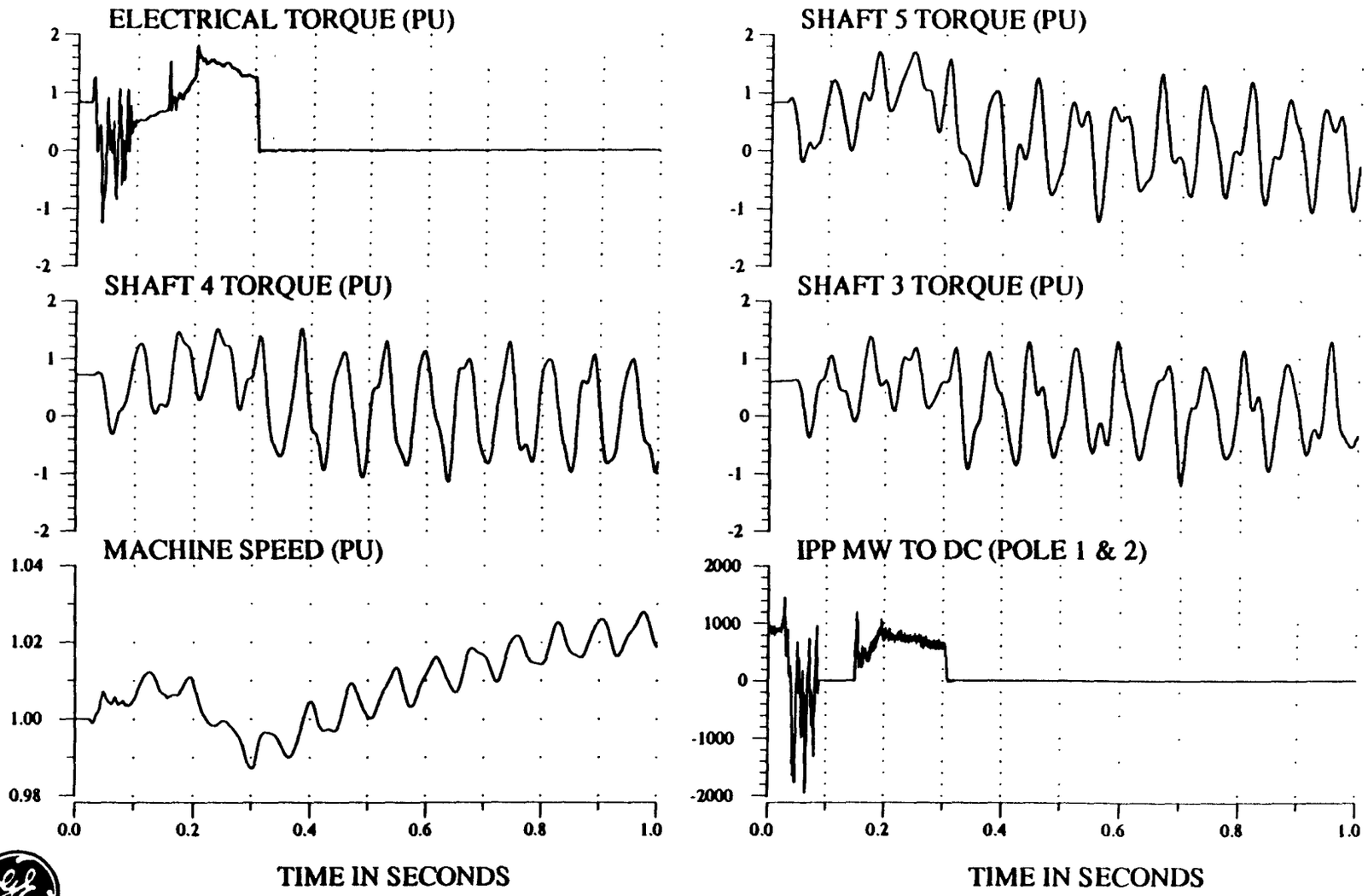
Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.
3. Trip ac tie & generator 2 at .1929 sec.
4. Trip generator 1 at .3 sec.

IP12_005462

AC10 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, CFC, FIGURE

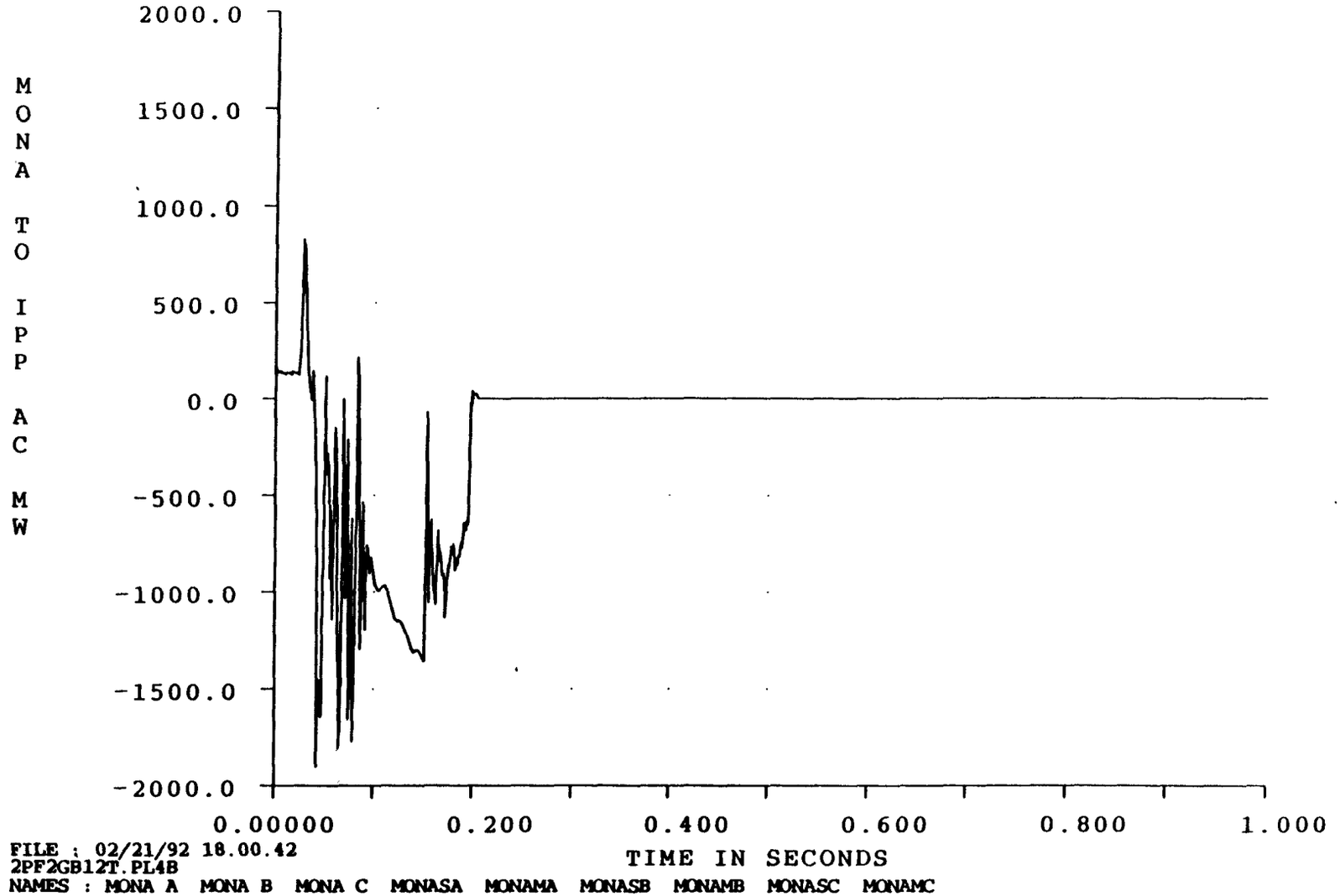


02/21/92 18.00.42 [IPPTOR]2PF2GB12T.PL4B;4

Page 1

IP12_005463

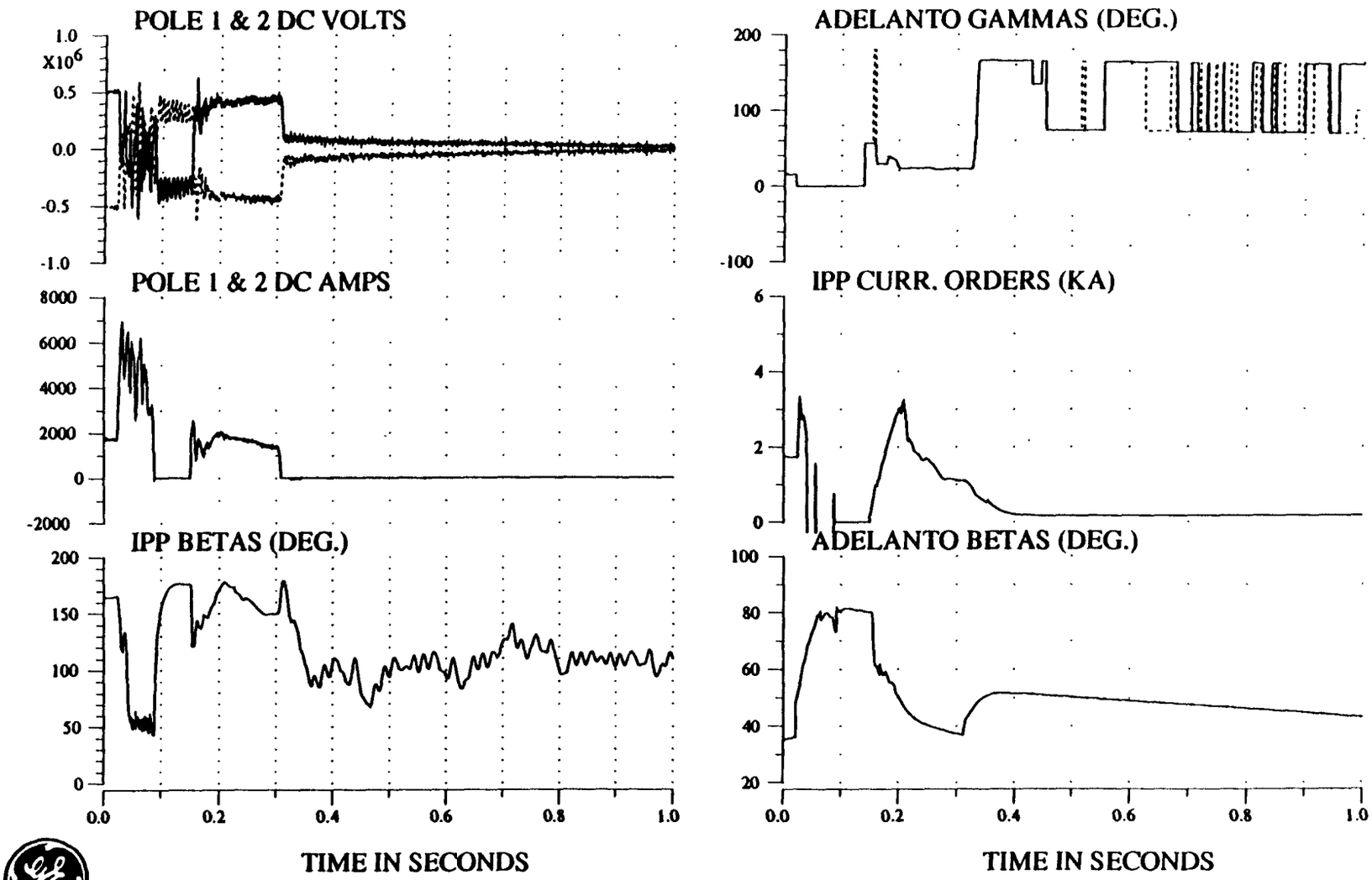
AC10 IPP TORSIONAL STUDY, 2 PH FAULT AT BUS VICVX,
CASE 2PF2GB12T ,#33, DCPSC, CFC, 1760 MW DC LINE, 800 MW ON G1 & G2, MONA TO IPP=160 MW, BLOCK P1 & P2, TRIP G1,G2,MONA



FILE : 02/21/92 18.00.42
2PF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONAMA MONASB MONAMB MONASC MONAMC

IP12_005464

AC10 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, CFC, FIGURE



02/21/92 18.00.42 [IPPTOR]2PF2GB12T.PL4B;4

IP12_005465

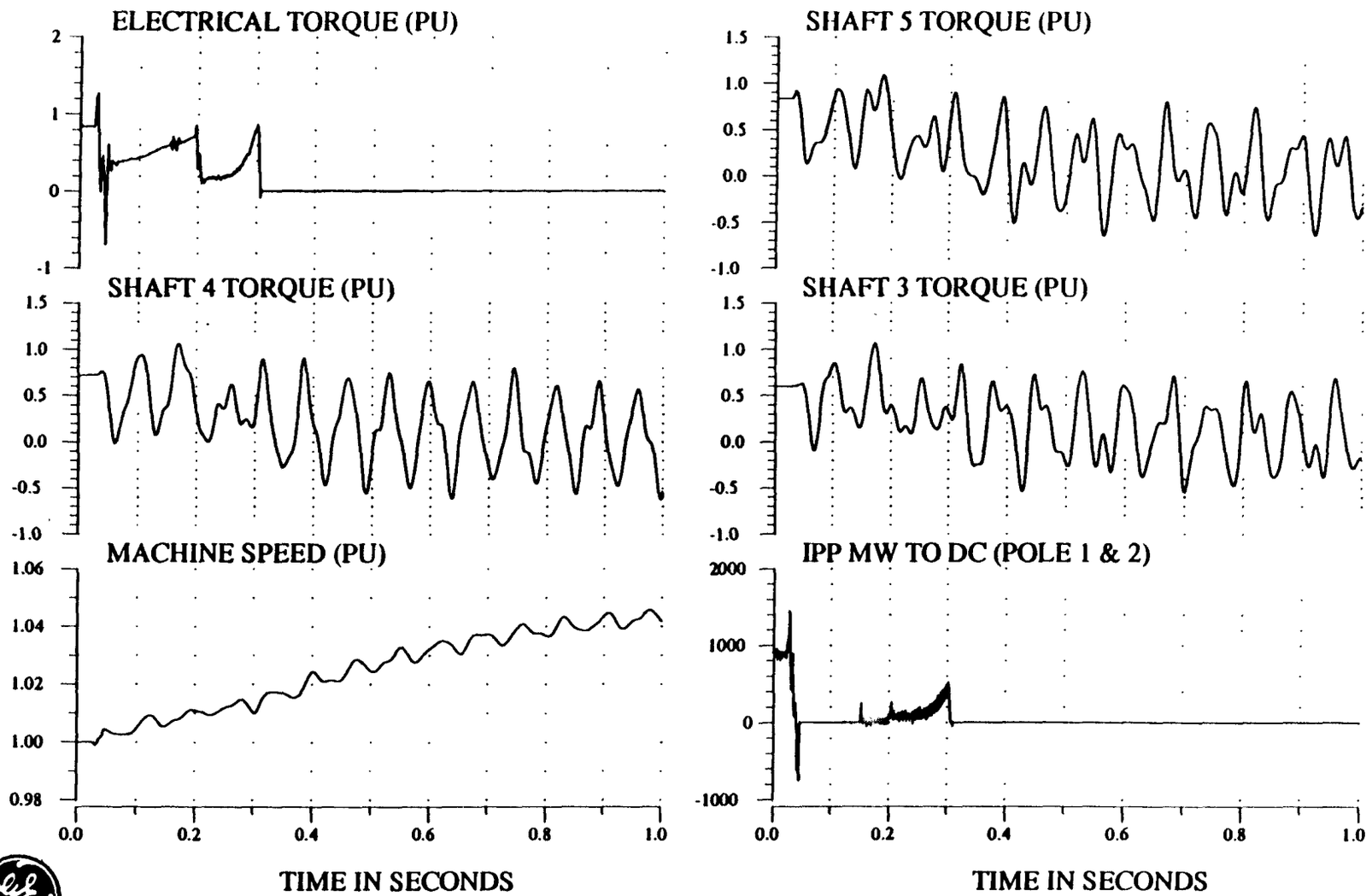
AC11 Two Units, 2ϕ Fault at Adelanto, Trip AC & Both Units Plus DCPSC & BPPO (2PF2GB12T)

Two generators. 1760 MW on dc line. 800 MW each generators 1 & 2. 160 MW on ac line.

Events:

1. 3 cycle, ϕ B to ϕ C fault at Adelanto from .02 to .07 sec.
2. Block dc poles 1 & 2 at .04 sec., unblock poles 1 & 2 at .15 sec.
3. Trip ac tie & generator 2 at .1929 sec.
4. Trip generator 1 at .3 sec.

AC11 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, BPPO, FIGURE

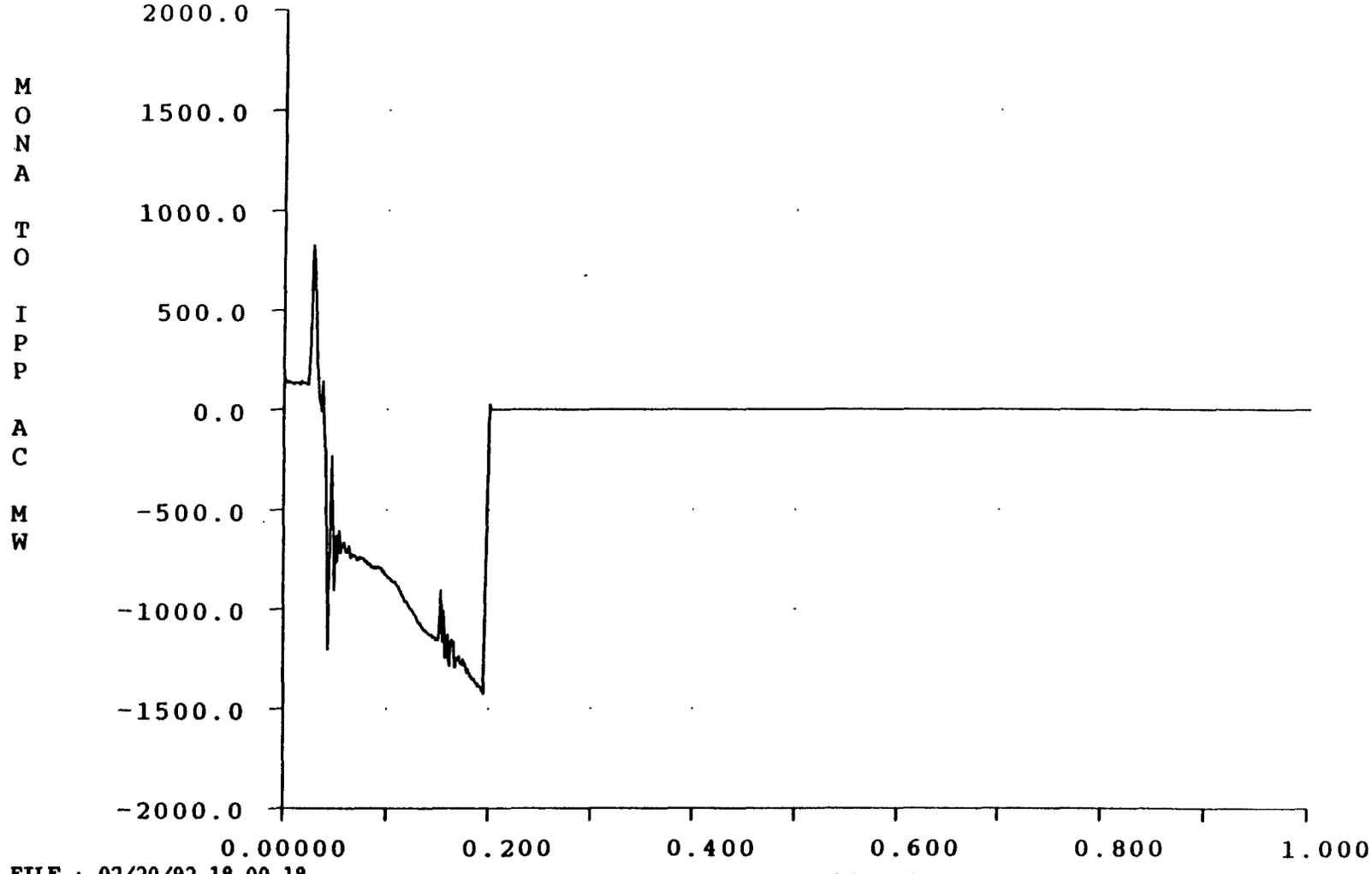


02/20/92 18.00.18 [IPPTOR]2PF2GB12T.PL4B;3

Page 1

IP12_005467

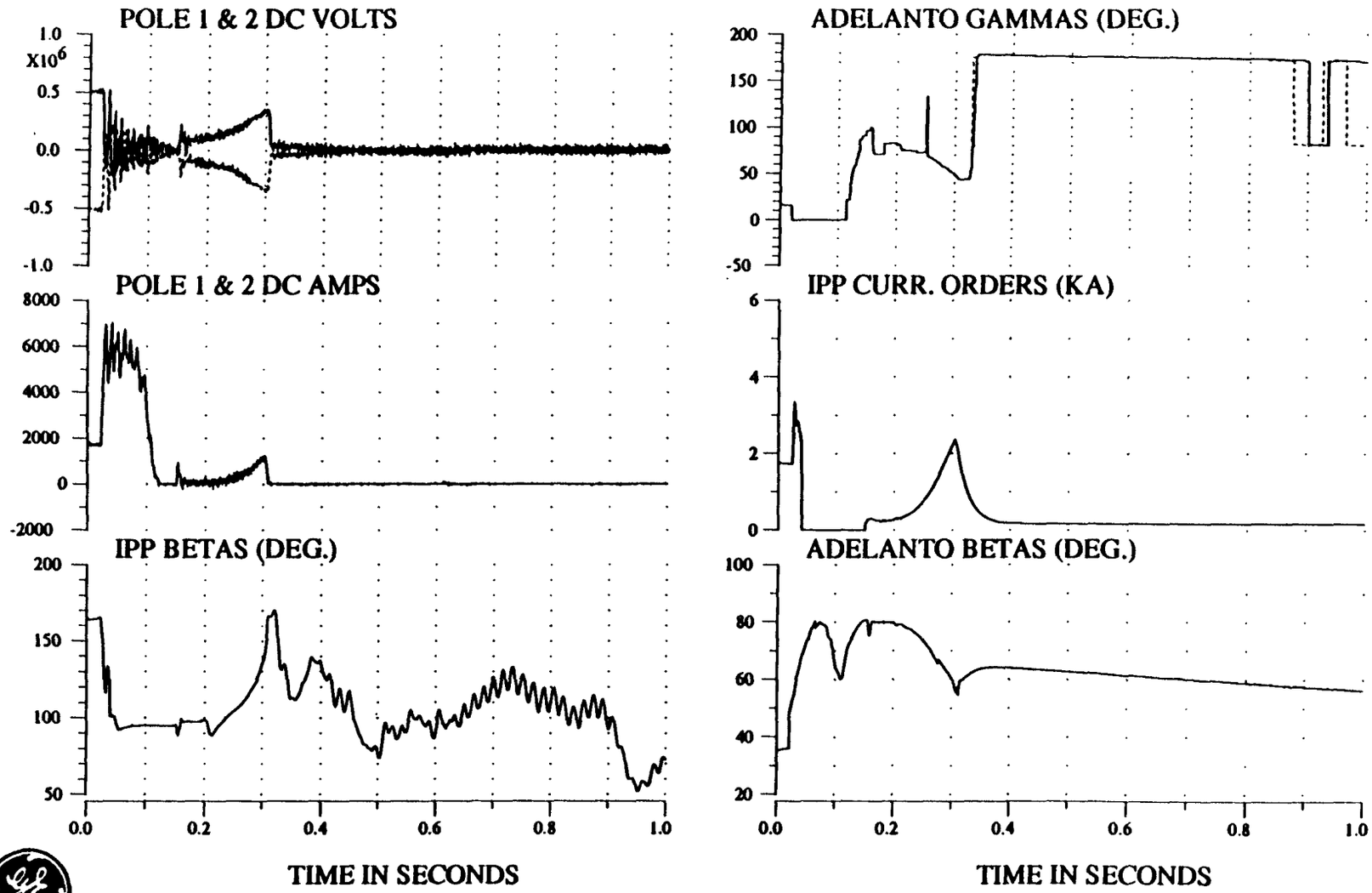
AC11 IPP TORSIONAL STUDY, 2 PH FAULT AT BUS VICVX,
CASE 2PF2GB12T ,#32, DCPSC, BPPO, 1760 MW DC LINE, 800 MW ON
G1 & G2, MONA TO IPP=160 MW, BLOCK P1 & P2, TRIP G1,G2,MONA



FILE : 02/20/92 18.00.18
2PF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONAMA MONASB MONAMB MONASC MONAMC

IP12_005468

AC11 PH B TO PH C FAULT AT VICVX, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, BLOCK POLES 1 & 2, TRIP GEN 1 & 2 & MONA
CASE 2PF2GB12T, DCPSC, BPPO, FIGURE



02/20/92 18.00.18 [IPPTOR]2PF2GB12T.PL4B;3

Page 2

IP12_005469

5.2 DC Faults

DC1 One Generator, Bipolar DC Fault at IPP with Restarts, Trip AC and One Generator (DCF1GB12T)

One generator. 1100 MW on dc line, 840 MW on generator 1, 260 MW on ac line.

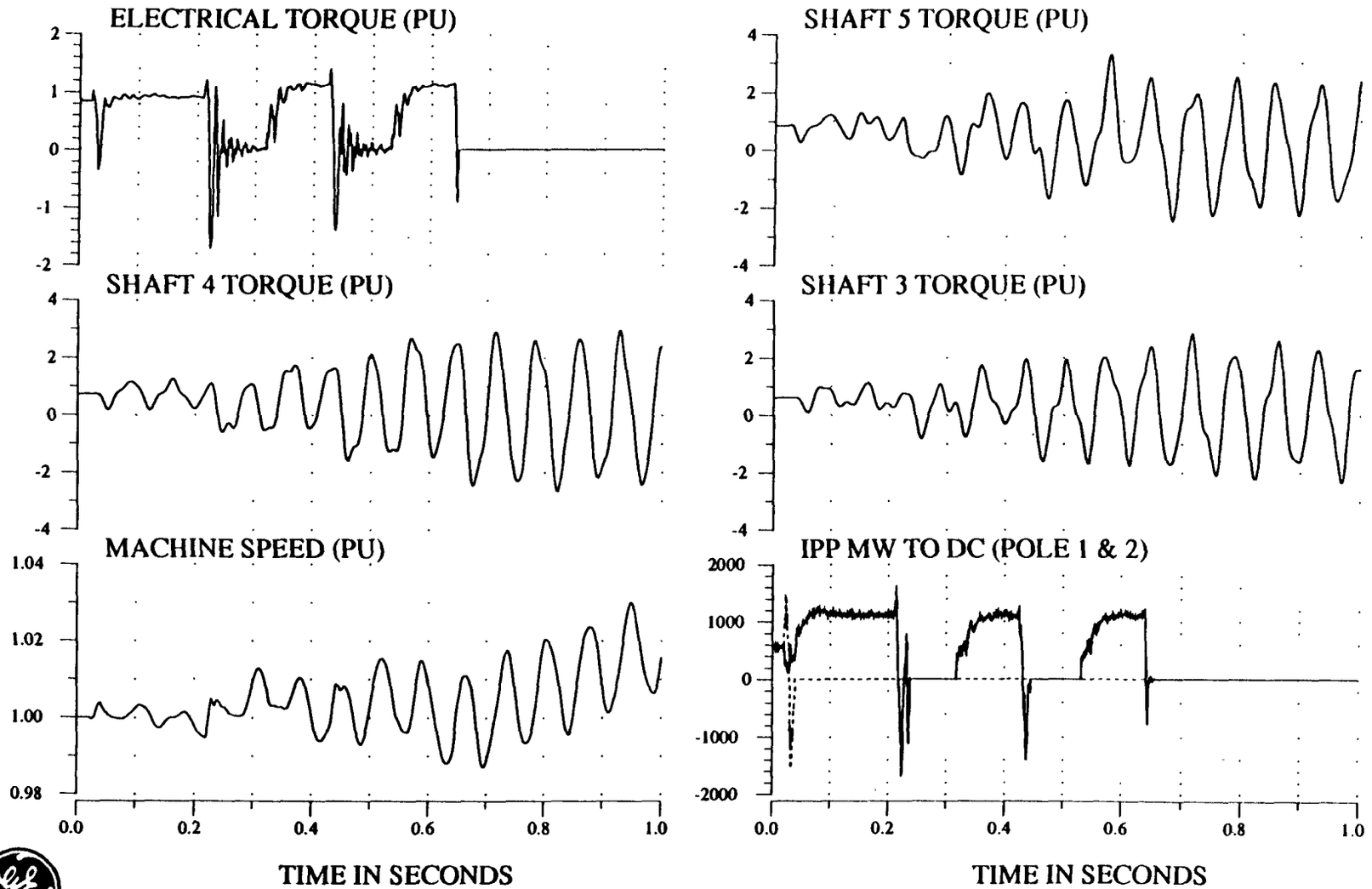
Events:

1. Fault/block pole 2 at IPP at .02 seconds. Lose pole 2.
2. Trip ac tie and fault/block pole 1 at IPP at .21 seconds.
3. Remove fault/unblock pole 1 at .3171 seconds.
4. Fault/block pole 1 at IPP at .4243 seconds.
5. Remove fault/unblock pole 1 at .5314 seconds.
6. Trip generator 1 and fault/block pole 1 at IPP at .6386 seconds.

IP12_005470

DC1

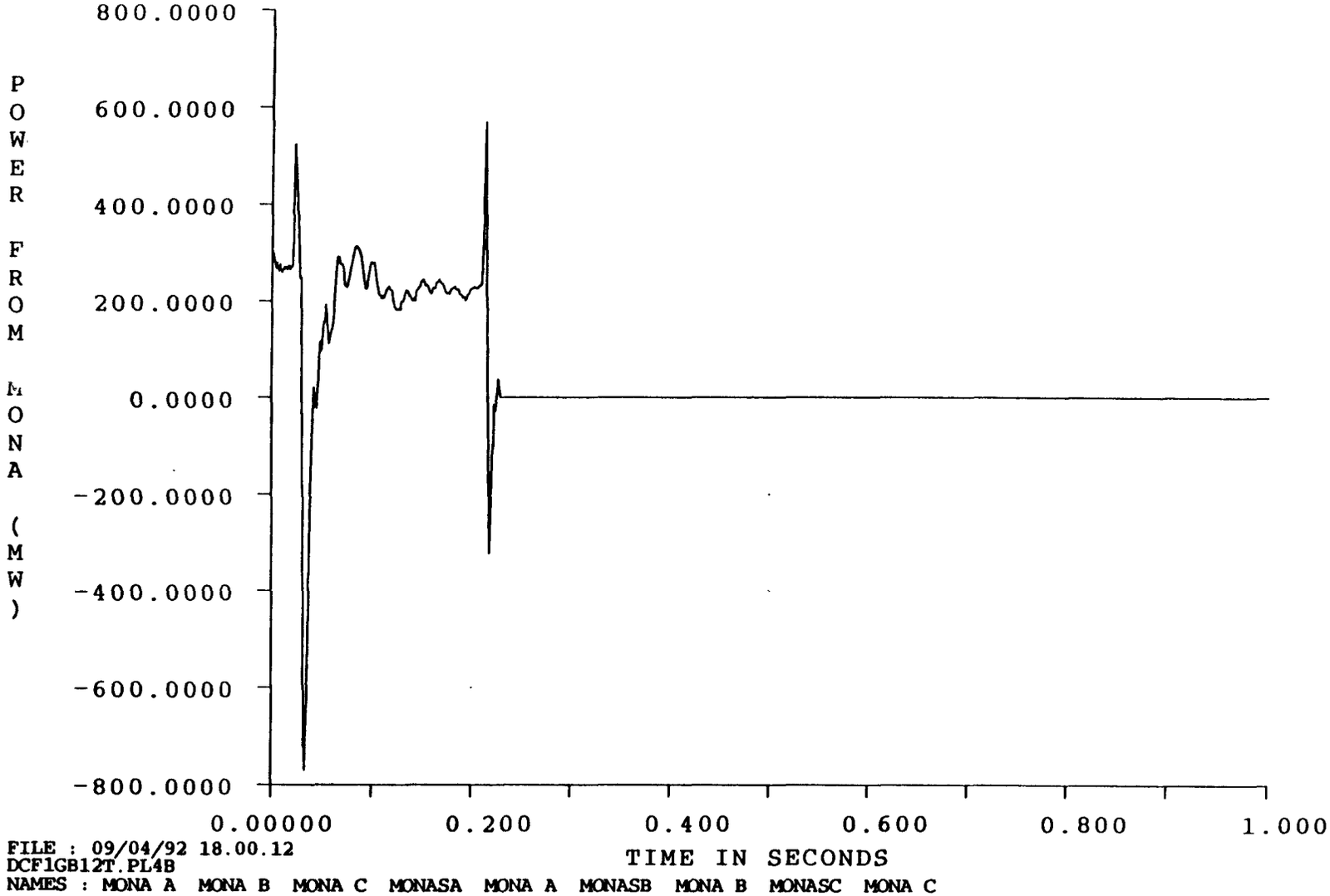
POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE



09/04/92 18.00.12 [IPPTOR]DCF1GB12T.PL4B;3

IP12_005471

DC1 IPP TORSIONAL STUDY, LOSE POLE 2
CASE # DCF1GB12T, 1100 MW ON DC LINE, 840 MW GEN # 1,
260 MW ON MONA LINE, BLOCK POLE 1, TRIP AC TIE AND GEN 1

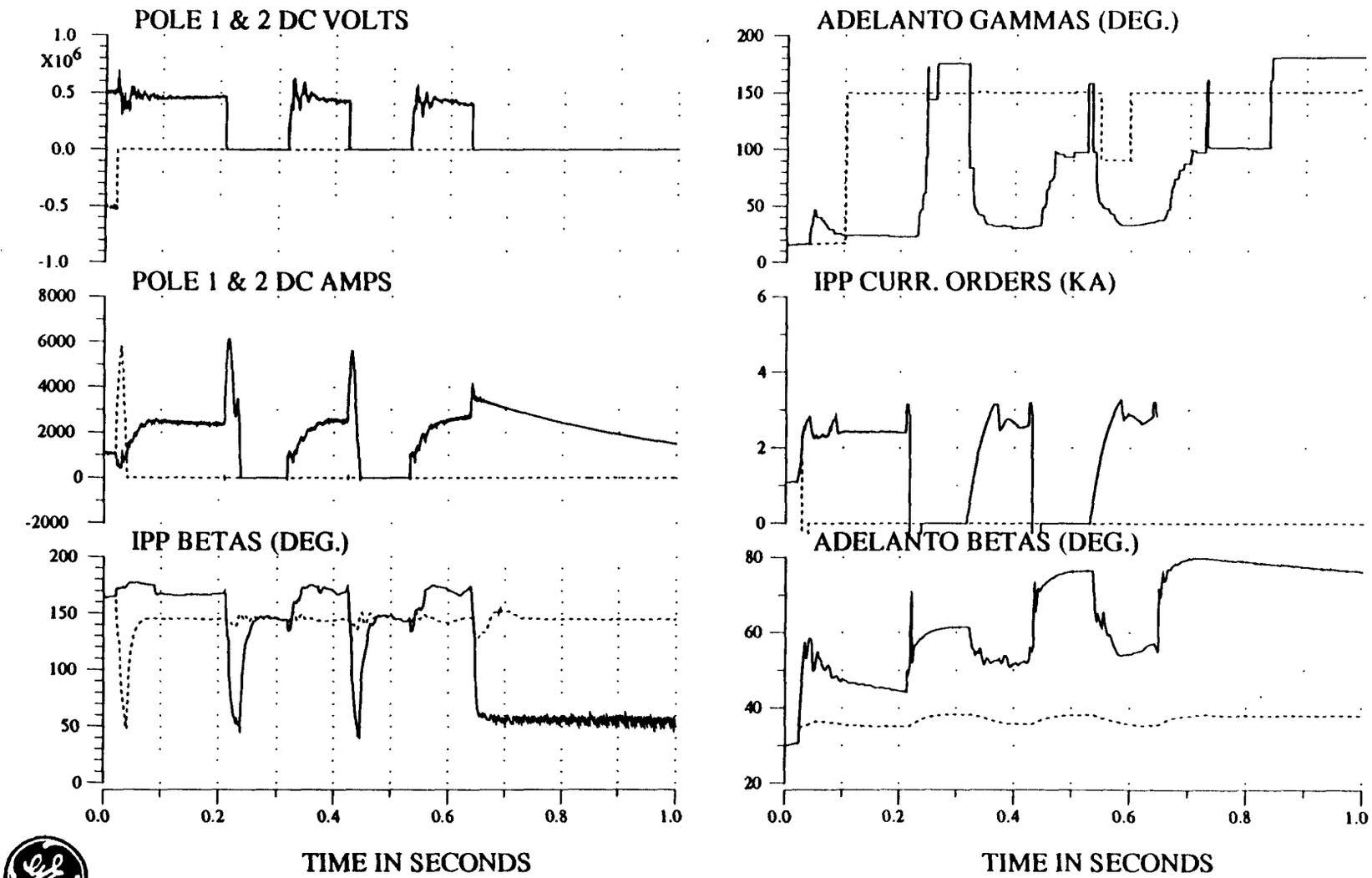


FILE : 09/04/92 18.00.12
DCF1GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005472

DC1

POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE



09/04/92 18.00.12 [IPPTOR]DCF1GB12T.PL4B;3

IP12_005473

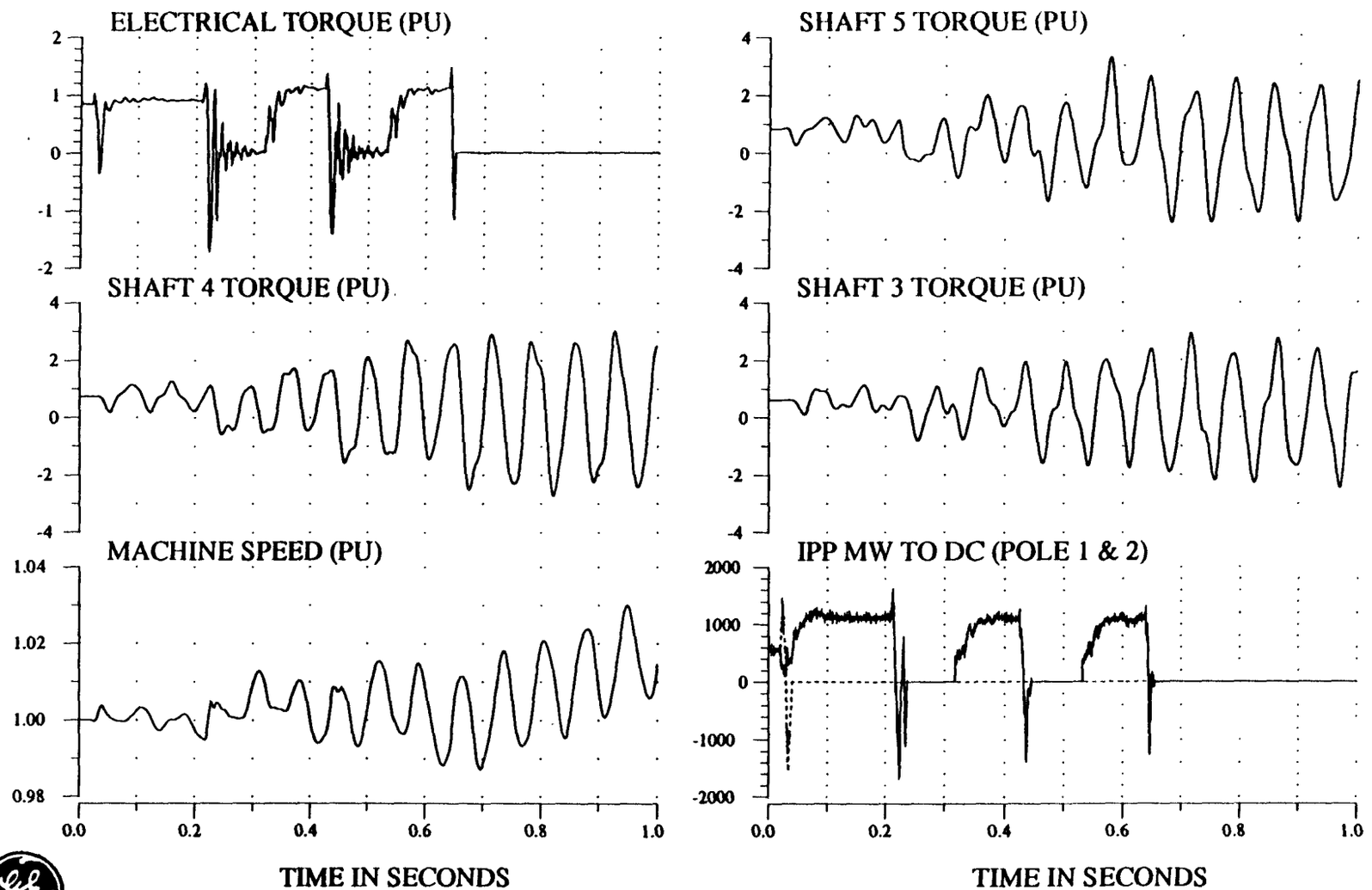
DC2 One Generator, Bipolar DC Fault at IPP with Restarts, Trip AC and One Generator Plus DCPSC (DCF1GB12T)

One generator. 1100 MW on dc line, 840 MW on generator 1, 260 MW on ac line.

Events:

1. Fault/block pole 2 at IPP at .02 seconds. Lose pole 2.
2. Trip ac tie and fault/block pole 1 at IPP at .21 seconds.
3. Remove fault/unblock pole 1 at .3171 seconds.
4. Fault/block pole 1 at IPP at .4243 seconds.
5. Remove fault/unblock pole 1 at .5314 seconds.
6. Trip generator 1 and fault/block pole 1 at IPP at .6386 seconds.

DC2 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, DCPSC, FIGURE



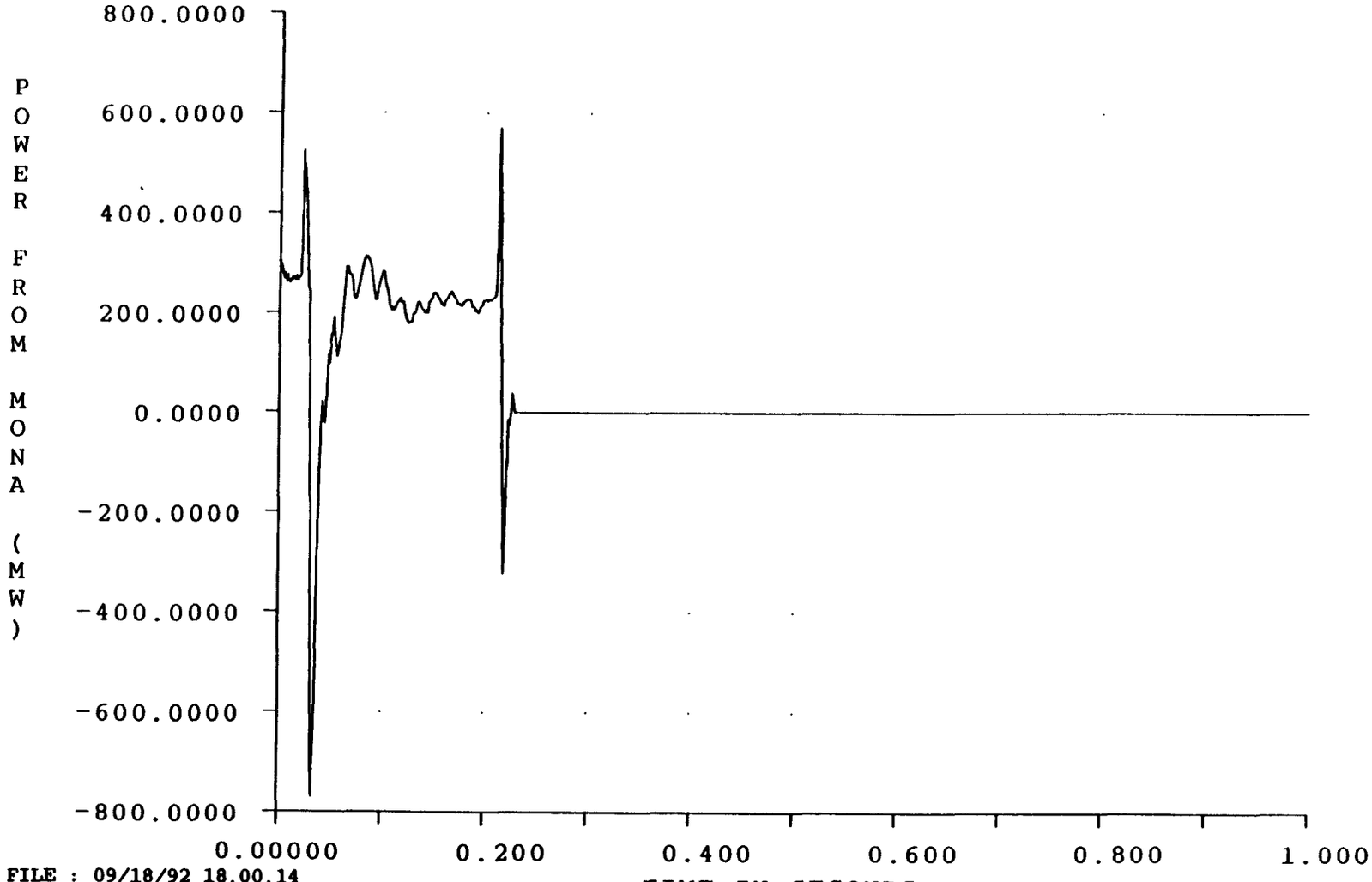
09/18/92 18.00.14 [IPPTOR]DCF1GB12T.PL4B;4

Page 1

IP12_005475

DC2

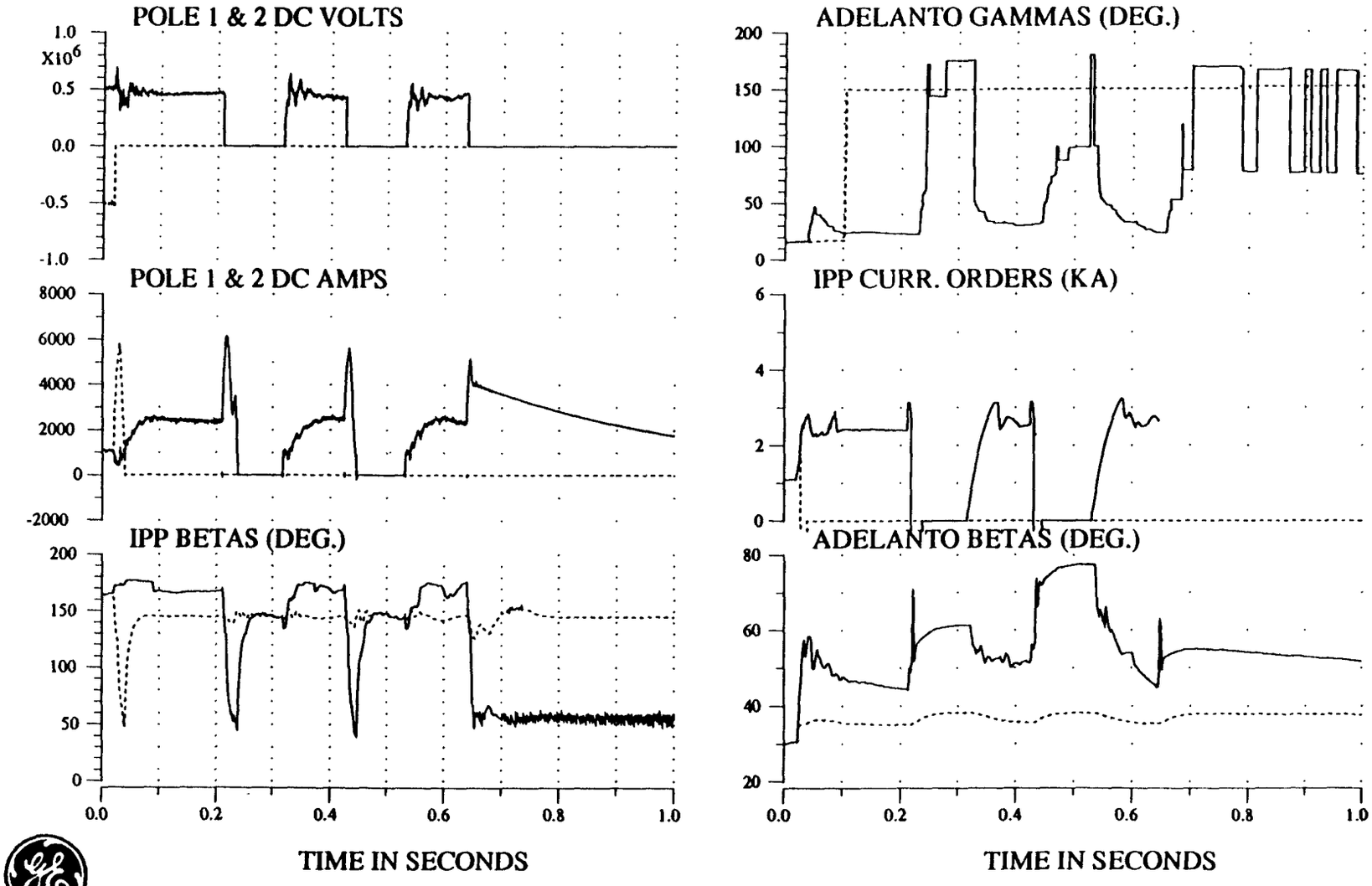
IPP TORSIONAL STUDY, LOSE POLE 2
CASE DCF1GB12T, #35, DCPSC, 1100 MW ON DC LINE, 840 MW GEN # 1,
260 MW ON MONA LINE, BLOCK POLE 1, TRIP AC TIE AND GEN 1



FILE : 09/18/92 18.00.14
DCF1GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONAMA MONASB MONAMB MONASC MONAMC

IP12_005476

DC2 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, DCPSC, FIGURE



09/18/92 18.00.14 [IPPTOR]DCF1GB12T.PL4B;4

IP12_005477

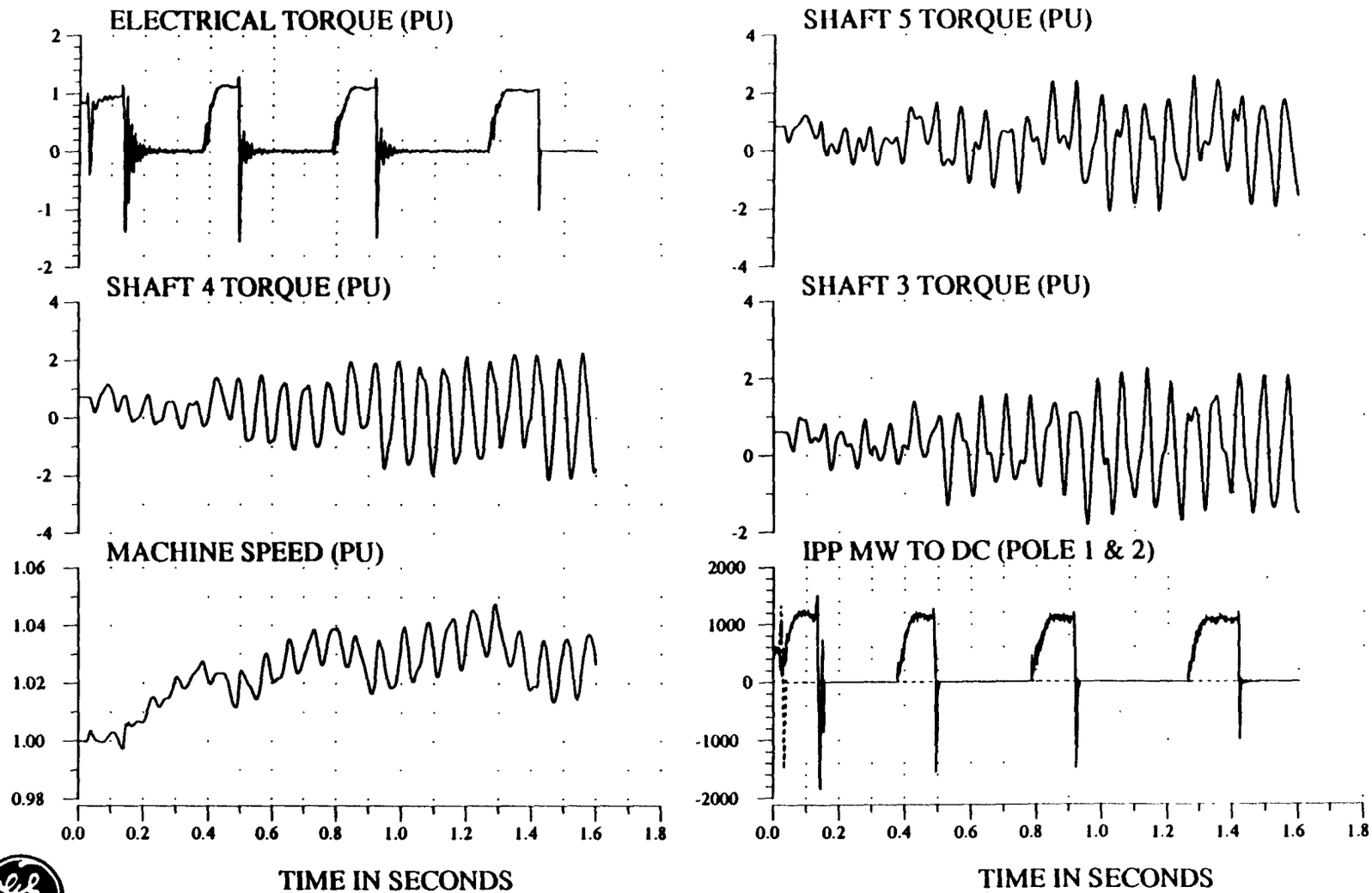
DC3 One Unit, Bipolar DC Fault at IPP with Restarts, Trip AC & One Unit (DCF1GB12T)

One generator. 1100 MW on dc line. 840 MW on generator 1, 260 MW on ac tie.

Events:

1. Fault/block pole 2 at IPP at .02 seconds. Lose pole 2.
2. Trip ac tie and fault/block pole 1 at IPP at .1286 seconds.
3. Remove fault/unblock pole 1 at IPP at .3786 sec.
4. Fault/block pole 1 at IPP at .4857 sec.
5. Remove fault/unblock pole 1 at IPP at .7857 sec.
6. Fault/block pole 1 at IPP at .9143 sec.
7. Remove fault/unblock pole 1 at IPP at 1.2643 sec.
8. Fault/block pole 1 at IPP & trip generator 1 at 1.4143 sec.

DC3 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE



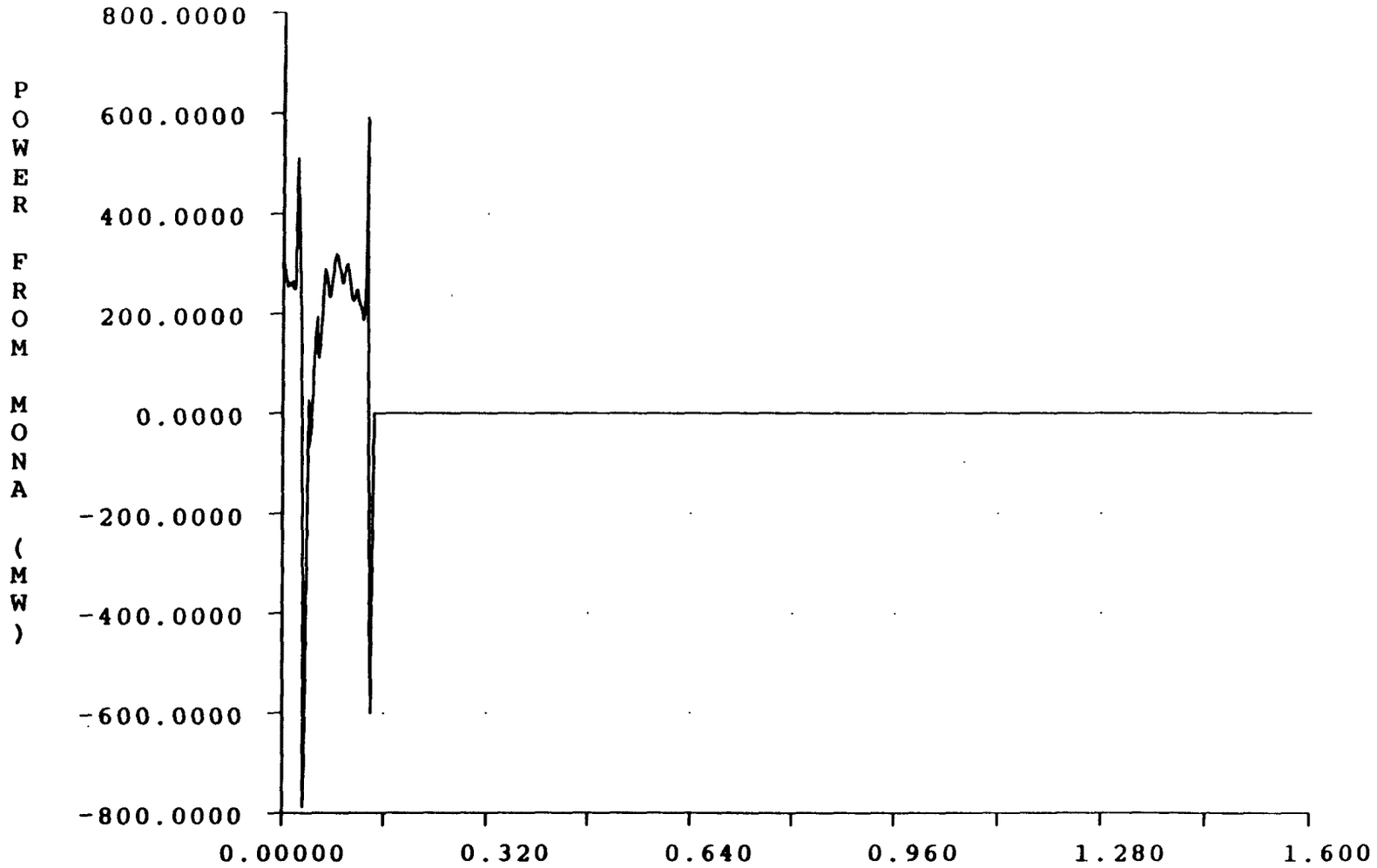
11/05/91 18.01.17 [IPPTOR]DCF1GB12T.PL4B;1

Page 1

IP12_005479

DC3

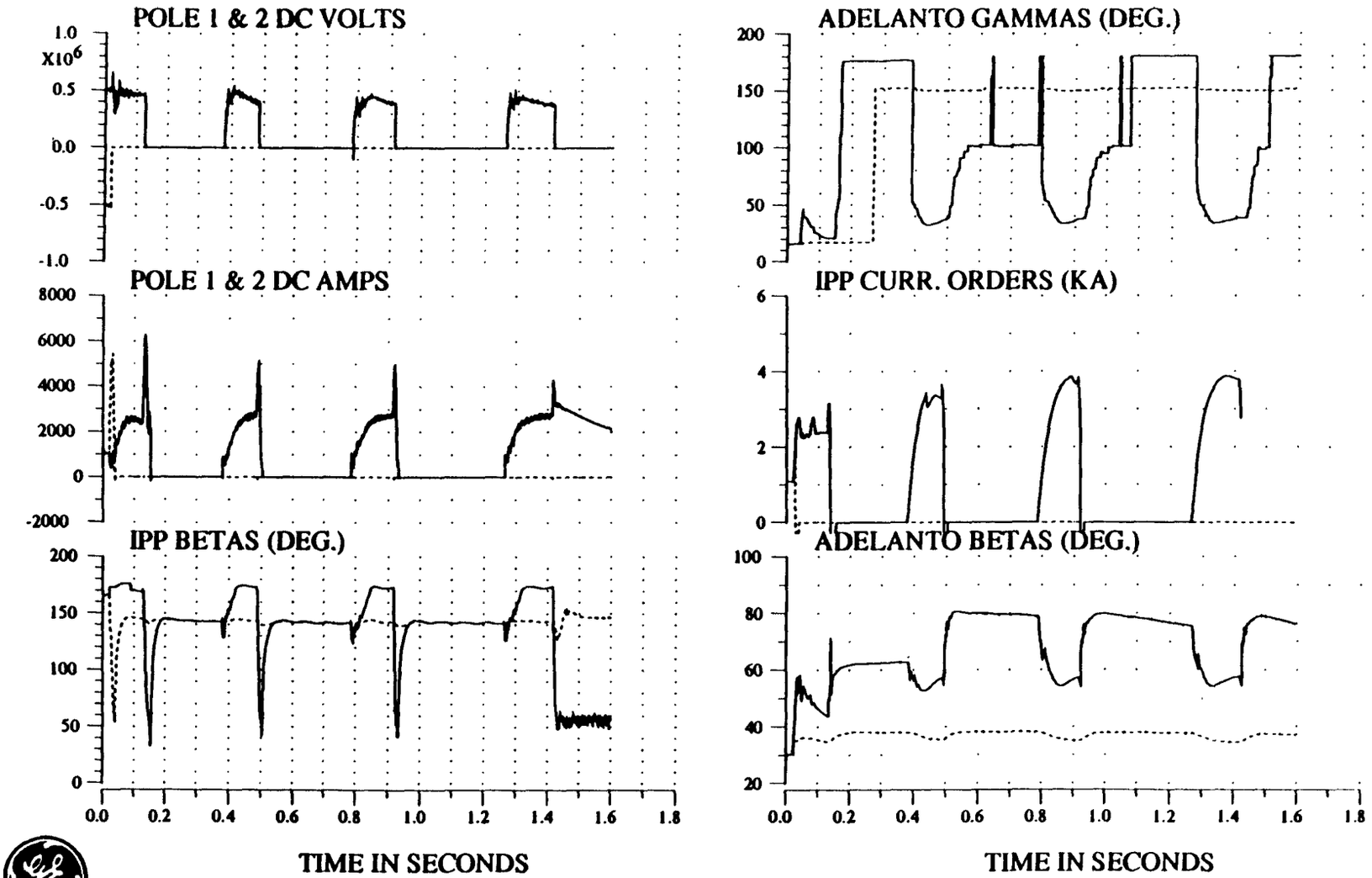
IPP TORSIONAL STUDY, LOSE POLE 2
CASE # DCF1GB12T, 1100 MW ON DC LINE, 840 MW GEN # 1,
260 MW ON MONA LINE, BLOCK POLE 1, TRIP AC TIE AND GEN 1



FILE : 11/05/91 18.01.17
DCF1GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005480

DC3 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE



11/05/91 18.01.17 [IPPTOR]DCF1GB12T.PL4B;1

IP12_005481

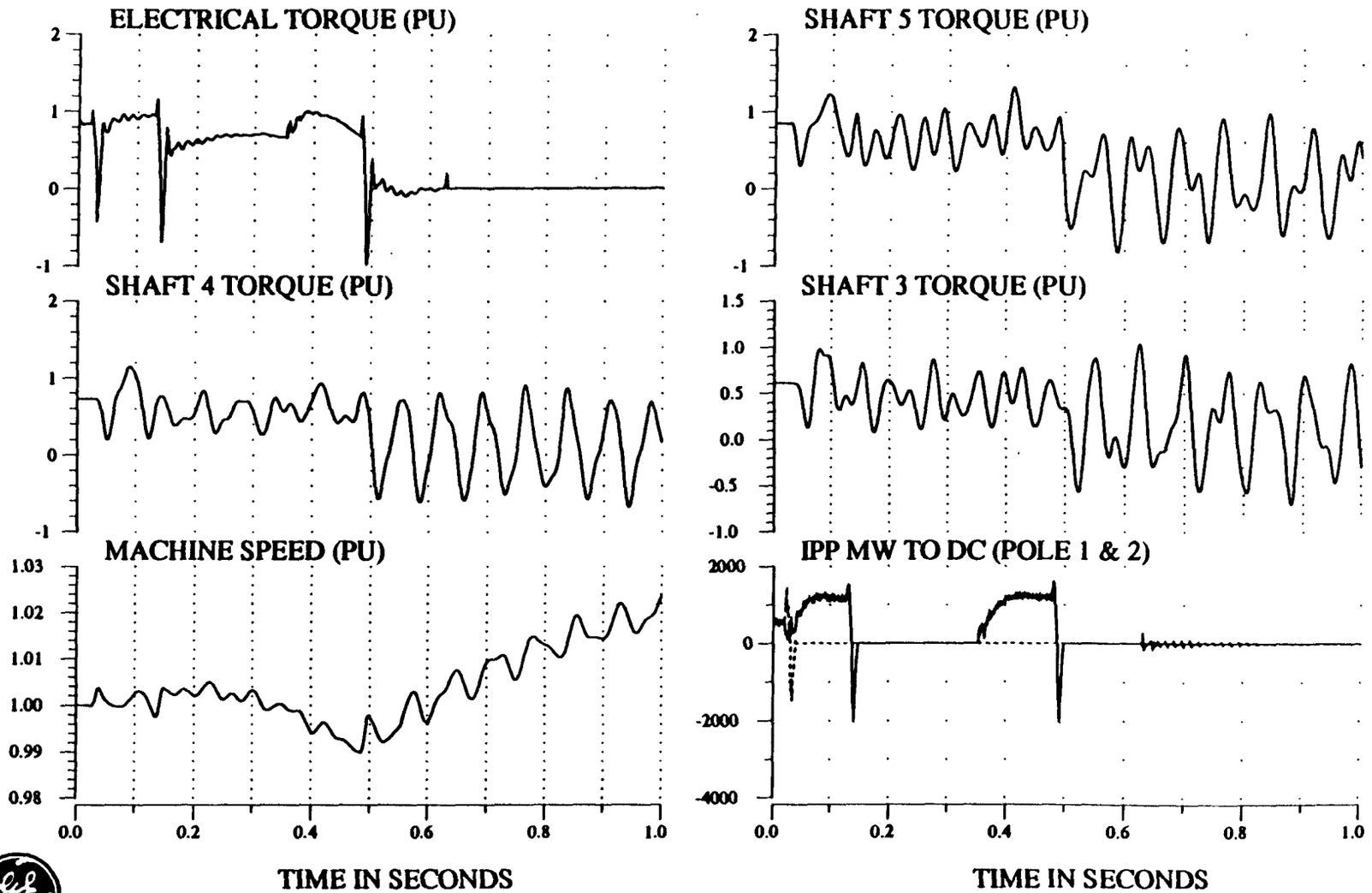
DC4 One Unit, Bipolar DC Fault at IPP with Restarts, Trip AC & One Unit (DCF1GB12T)

One generator. 1100 MW on dc line. 840 MW on generator 1. 260 MW on ac tie.

Events:

1. Fault/block pole 2 at IPP at .02 seconds. Lose pole 2.
2. Fault/block pole 1 at IPP at .1286 sec.
3. Remove fault/unblock pole 1 at IPP at .3536 sec.
4. Fault/block pole 1 at IPP at .4786 sec.
5. Trip ac tie & generator 1 at .6214 sec.

DC4 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE

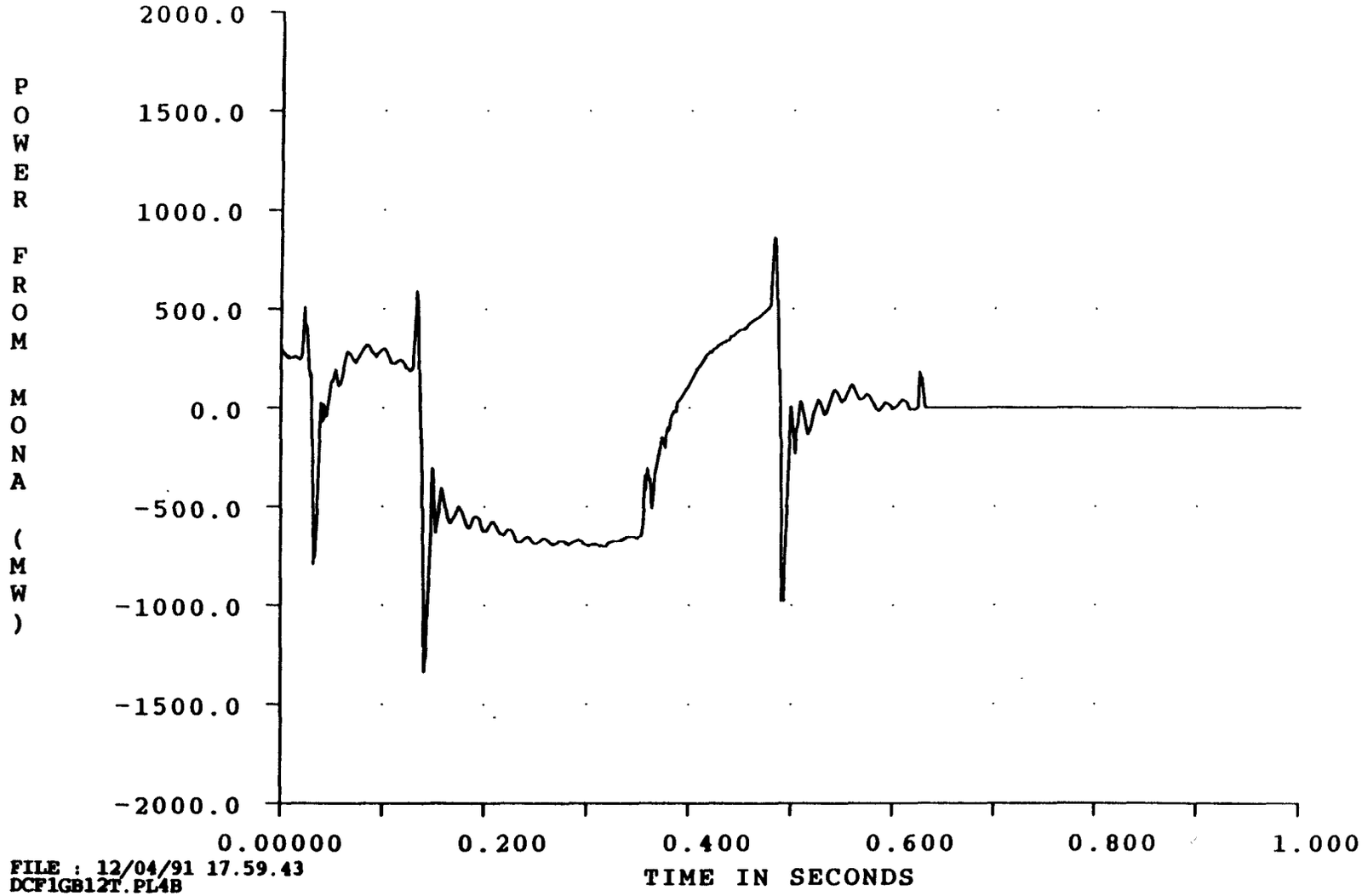


12/04/91 17.59.43 [IPPTOR]DCF1GB12T.PL4B;2

IP12_005483

IPP TORSIONAL STUDY, LOSE POLE 2

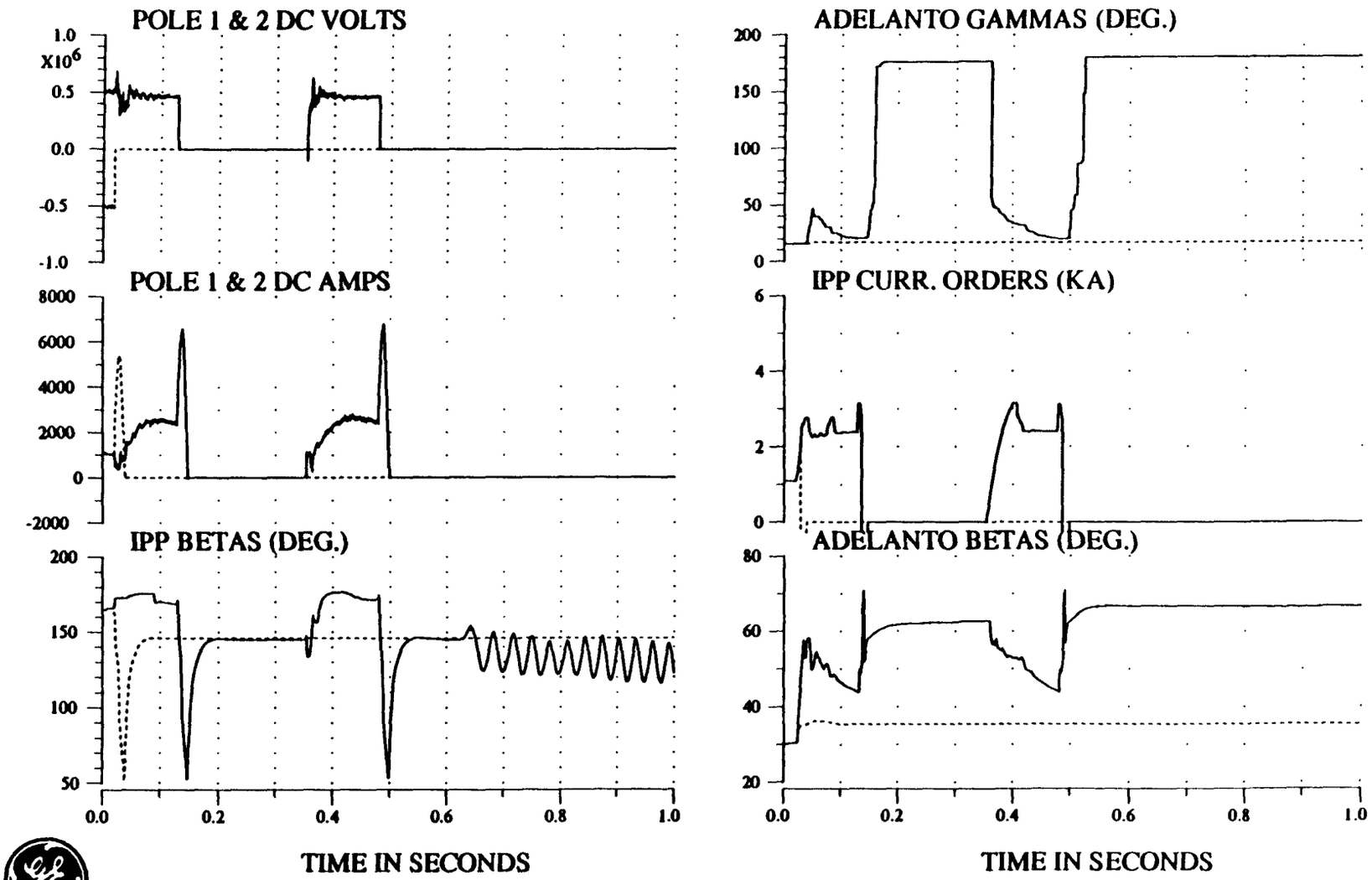
DC4 CASE # DCF1GB12T, 1100 MW ON DC LINE, 840 MW GEN # 1, 260 MW ON MONA LINE, BLOCK POLE 1, TRIP AC TIE AND GEN 1



FILE : 12/04/91 17.59.43
DCF1GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005484

DC4 POLE 1 DC FAULTS, 1100 MW DC LINE, 840 MW GEN 1
MONA TO IPP=260 MW, TRIP: AC TIE & GEN 1
CASE DCF1GB12T, FIGURE



12/04/91 17.59.43 [IPPTOR]DCF1GB12T.PL4B;2

IP12_005485

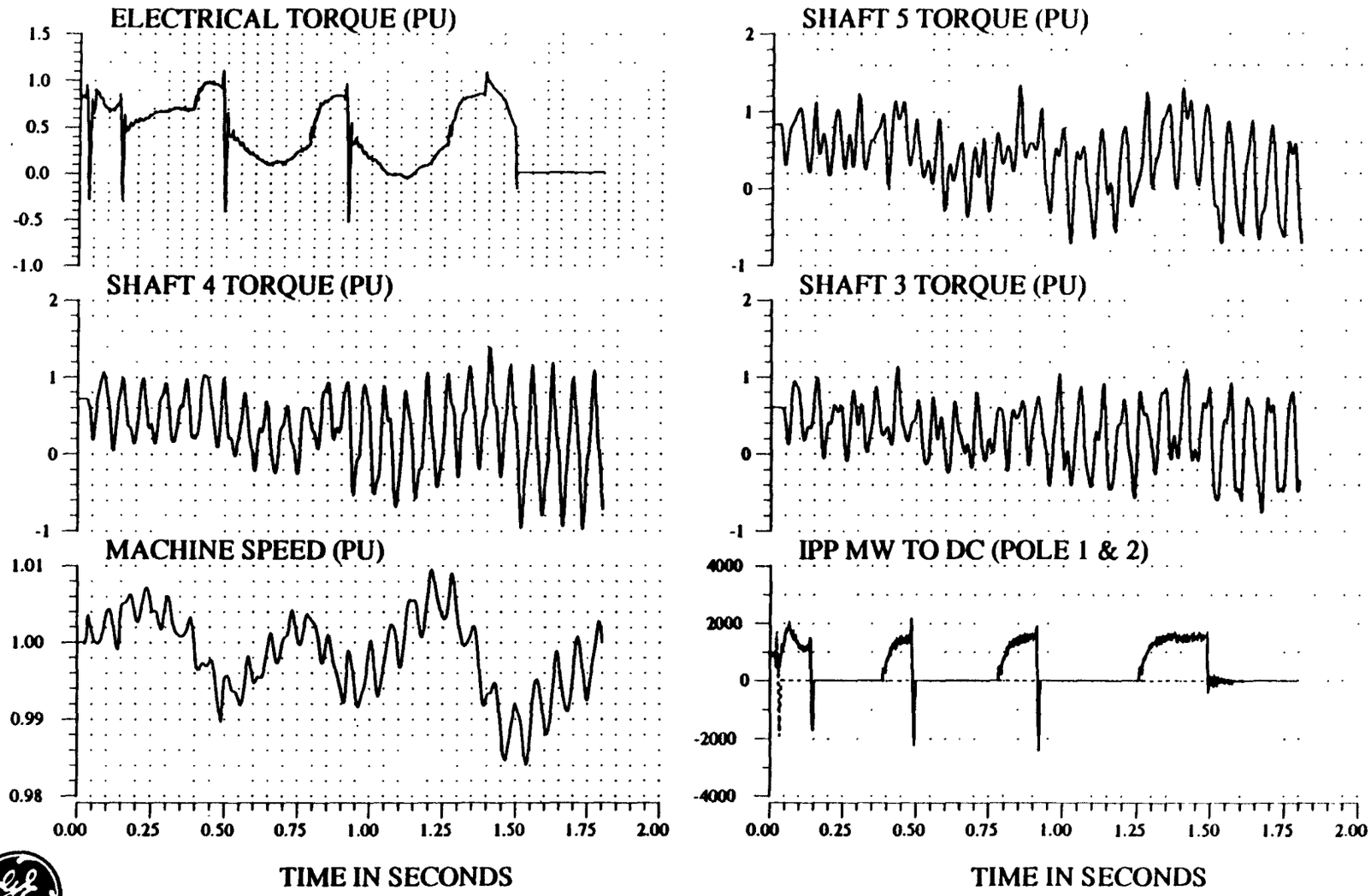
DC5 Two Units, Bipolar DC Fault at IPP with Restarts, Trip AC & Both Units (DCF2GB12T)

Two generators. 1760 MW on dc line. 800 MW each on generators 1 & 2. 160 MW on ac tie.

Events:

1. Fault/block pole 2 at IPP at .02 seconds. Lose pole 2.
2. Fault/block pole at IPP at .1357 sec.
3. Remove fault/unblock pole 1 at IPP at .3857 sec.
4. Fault/block pole 1 at IPP at .4814 sec.
5. Remove fault/unblock pole 1 at IPP at .7814 sec.
6. Fault/block pole 1 at IPP at .9071 sec.
7. Remove fault/unblock pole 1 at IPP at 1.2571 sec.
8. Trip generator 2 at 1.3786 sec.
9. Trip ac tie & generator 1 at 1.4857 sec.

DC5 POLE 1 DC FAULTS, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 1 & 2
CASE DCF2GB12T, FIGURE



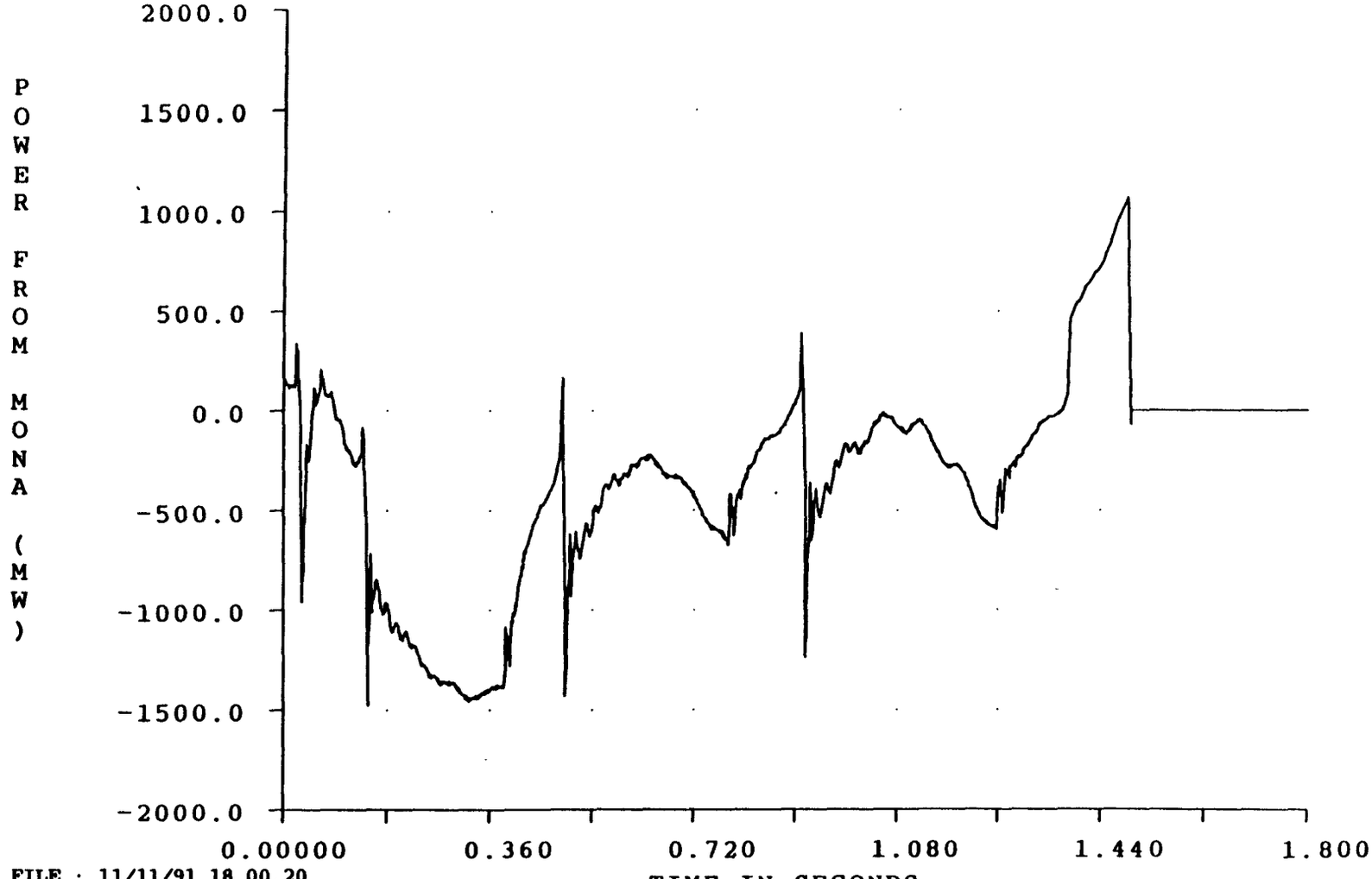
11/11/91 18.00.20 [IPPTOR]DCF2GB12T.PL4B;1

Page 1

IP12_005487

IPP TORSIONAL STUDY, LOSE POLE 2

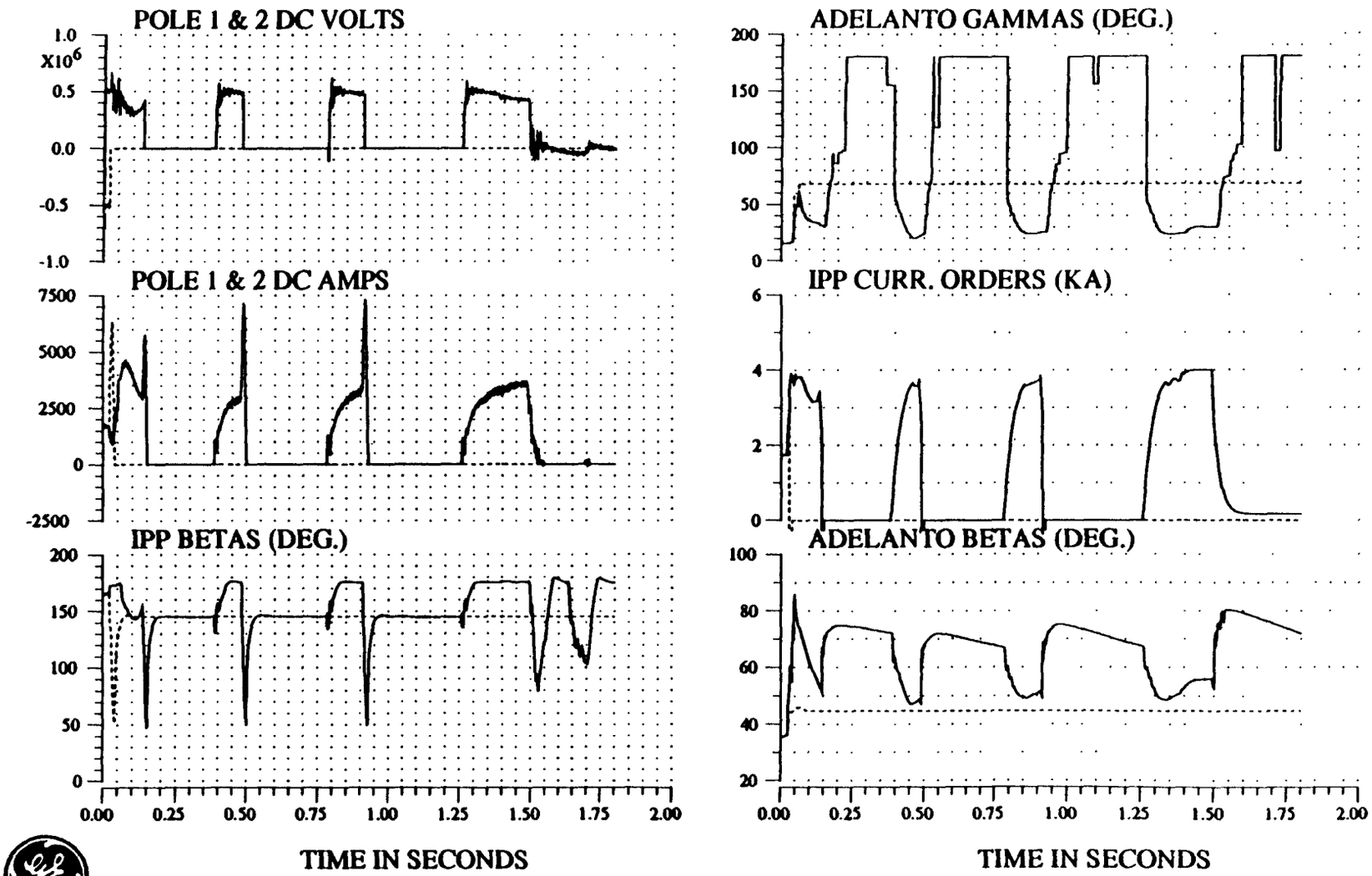
DC5 CASE DCF2GB12T, 1760 MW ON DC LINE, 800 MW EACH GEN 1 & 2,
MONA TO IPP-160 MW, FAULT POLE 1, TRIP: AC TIE, GEN 1 & 2



FILE : 11/11/91 18.00.20
DCF2GB12T.PL4B
NAMES : MONA A MONA B MONA C MONASA MONA A MONASB MONA B MONASC MONA C

IP12_005488

DC5 POLE 1 DC FAULTS, 1760 MW DC LINE, 800 MW GEN 1 & 2
MONA TO IPP=160 MW, TRIP: AC TIE, GEN 1 & 2
CASE DCF2GB12T, FIGURE



11/11/91 18.00.20 [IPPTOR]DCF2GB12T.PL4B;1

IP12_005489

Section 6

REFERENCES

[1] K. Carlsen, E.H. Lenfest, J.J. LaForest, "MANTRAP-Machine and Network Transients Program," Proceedings PICA, 1975, pp. 144-151.

[2] J.C. White, R.J. Placek, D.N. Walker, "Turbine-Generator Shaft Torsional Fatigue Analysis and Monitoring," A.I.M.-CIGRE II Joint Session, Liege, Belgium, Fall 1981.

[3] Electric Power Research Institute, RP1531-1, "Torsional Fatigue Strength of Large Turbine-Generator Shafts," Final Report, EL-3083, December 1982.

[4] N.E. Dowling, "Fatigue Failure Prediction for Complicated Stress- Strain Histories," Journal of Materials, JMLSA, Vol. 75, No. 1, March 1972, pp. 71-87.

[5] Don Menzies, "IPP Transient Power Reversal Study," ABB Power Systems Technical Report LK-90-039, December, 1990.

IP12_005490

Appendix
CASE RENUMBERING SCHEME

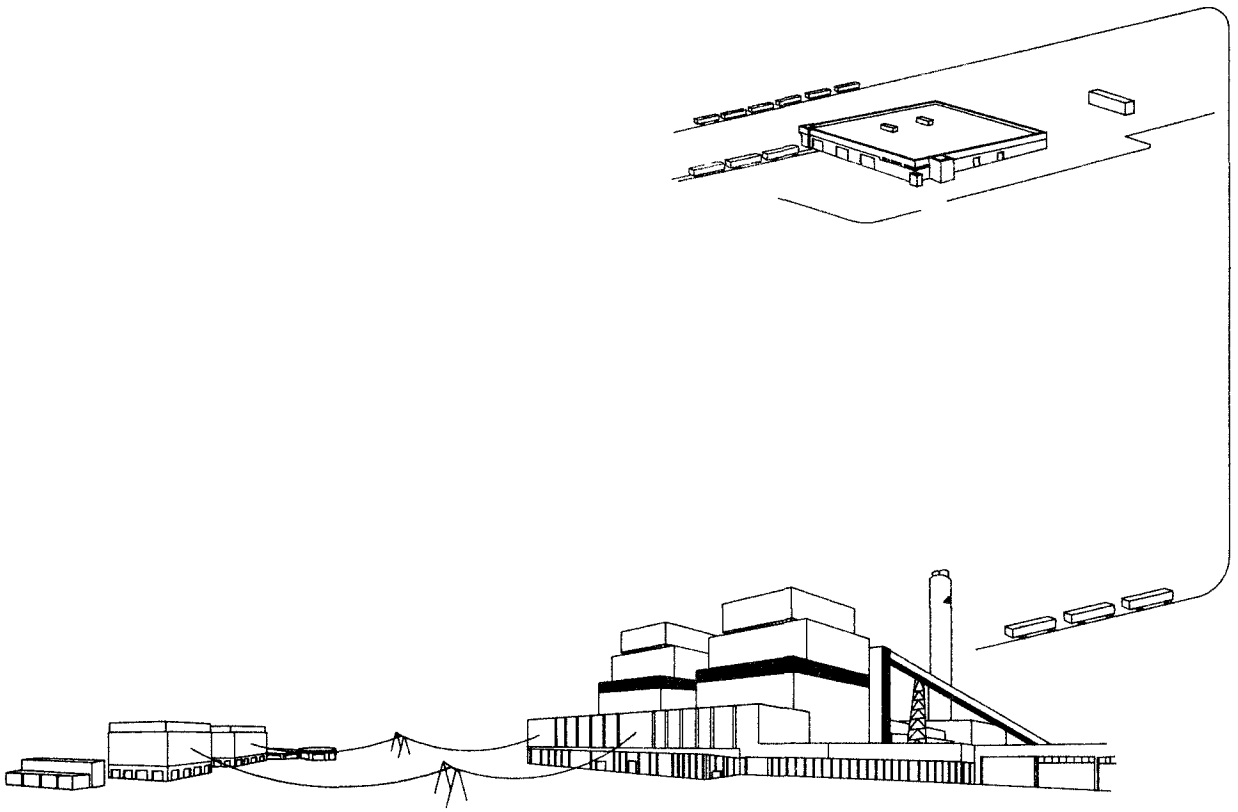
IP12_005491

Old Case	New Case	Comments
5.3.7	DC1	Worst Case
5.3.11	DC2	Same as DC1 + DCPSC
5.3.8	DC3	
5.3.10	DC4	
5.3.9	DC5	
5.2.9	AC1	Worst Case
5.2.12	AC2	
5.2.15	AC3	Same as AC2 + DCPSC
5.2.10	AC4	
5.2.11	AC5	
5.2.14	AC6	Same as AC5 + CFC
5.2.13	AC7	Same as AC5 + BPPO
5.2.16	AC8	
5.2.17	AC9	Same as AC8 + DCPSC
5.2.19	AC10	Same as AC9 + CFC
5.2.18	AC11	Same as AC9 + BPPO

IP12_005492

INTERMOUNTAIN POWER SERVICE CORP.

[redacted]



CAPITAL PROJECT IGS91-28

PA FAN PERFORMANCE REVIEW

INTERMOUNTAIN POWER SERVICE CORPORATION

b2084
File: 01.03.01
IGS91-28

December 21, 1992

Mr. Bruce E. Blowey
Assistant Engineer - Operations & Maintenance
LADWP
111 North Hope Street, Room 1255-C
Los Angeles, CA 90012-2694

Dear Mr. Blowey:

Capital Project IGS91-28 PA Fan Performance Review

Attached is our analysis of the operating performance of the Primary Air Fans at the Intermountain Generating Station. We recommend changing the nameplate rating on these motors in accordance with a report provided by the motor manufacturer. The motor will be rerated to 5000/3200 HP.

Please review the attached report and approve this package by March 1, 1993. If you have any questions or require additional information, please have your staff contact Jon P. Christensen at Extension 6481.

Sincerely,

S. Gale Chapman
President & Chief Operations Officer

SGC:JHN:jrc
Attachments

cc: Byron Fujikawa (2 copies)

850 West Brush Wellman Road, Delta, Utah 84624 / Telephone: (801) 864-4414 / FAX: (801) 864-4970

INTERMOUNTAIN POWER SERVICE CORPORATION

CAPITAL PROJECT IGS91-28

W.O. # 91-97827-00 Date Dec 16,1992

PROJECT APPROVAL	Title Change Rating on PA Fan Motors (See attached capital project justification for scope.) Budget Source: Approved Capital Budget Documentation Affected by This Project: Summary of Relay Settings for the Intermountain Power Project IGS Unit 1 and 2 pages 13 and 32 IPSC Pres. & COO Approval
LADWP DESIGN REVIEW	IPSC Contact Jon P. Christensen JHN Ext. 6481 Total Est. Costs: $7300 Scheduled Start Mar 1993 (Mtl. $5500 Labor $800 Engring. $1000 PD&C Appvl. _____ PO&M Appvl. _____
INSTALLATION	Tagging 'CONSTRUCTION' update _____ Date _____ Preconstruction Appvl (Oper.) _____ Date _____ Work Pkg. to Planning (Engr.) _____ Date _____ QA/QC Completion (QA/QC Engr.) _____ Date _____ Startup Complete (IPSC Engr.) _____ Date _____ Install. Complete (Planner) _____ Date _____ As-Built Pkg to Engr (Planner) _____ Date _____ Released to Oper. (IPSC Engr.) _____ Date _____
PROJECT CLOSEOUT	Tagging 'AS-BUILT' update _____ Date _____ Closeout Complete(IPSC Engr.) _____ Date _____ Project Complete(SGC) _____ Date _____

INTERMOUNTAIN POWER SERVICES CORPORATION

DOCUMENTATION TRANSMITTAL FORM

TO: Mr. Bruce E. Blowey, PO&M, (w/o attach.) CAP. PROJ. #IGS91-28

COPY DISTRIBUTION: J.P.MUSTO, CMOB IPSC W.O. #91-87827-00

TITLE: Rerate PA Fan Motors DATE: Dec 16, 1992

PREPARED BY: JPC JHN T.S.SUPT. IPSC PRES.

The following preconstruction drawings are attached for design reviewww and approval by LADWP.

ITEM 1- CONSTRUCTION DRAWINGS

Dwg. No.	Rev. No.	DATE	Markup Print Size	Micflm Aperture Card	Comments
Not Applicable					

ITEM 2- MANUFACTURERS' DRAWINGS

Dwg. No.	Rev. No.	DATE	Markup Print Size	Micflm Aperture Card	Comments
Not Applicable					

ITEM 3 - INSTRUCTION MANUALS

Instr. Man/Section/Page	Directions and Comments
Not Applicable	

ITEM 4 - SYSTEM DESCRIPTIONS (INCLUDES TEXT, MARKED UP SKETCHES, K-1000, E1000, M1000 DRAWINGS AND 11x17 COPY OF P&IDS).

System Code	System Title/Page	Comments
Not Applicable		

ITEM 5 - POWRTRAK REVISIONS

Device No.	New/ Revised/ Deleted	Screen Prints	Comments
Not Applicable			

IP12_005497

ASSOCIATED DOCUMENTATION FOR WHICH IPSC IS RESPONSIBLE:
(NOT TRANSMITTED)

ITEM 6- LOVELAND REVISIONS

Device No.	New/ Revised/ Deleted	Screen Prints	Comments
Not Applicable			

ITEM 7- TALYOR SOFTWARE REVISIONS

System Code and Title	New/Revised Network	Comments
Not Applicable		

ITEM 8- RELAY MANUAL UPDATES

Manual and Page	Relay #	Comments
Summary of Relay Settings Intermountain Power Project IGS Unit 1 and 2 pages 13 and 32		Replace existing pages with new pages

ITEM 9- MISCELLANEOUS
Not Applicable

cc: CP IGS91-28__ file w/ attachments
Doc.Trans.file (01.03.04) w/o attachments
Robert E. Gentner w/ attachments

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

PROJ. NO. 9255

SUMMARY OF
RELAY SETTINGS FOR
Intermountain Power Project
IGS Unit 1
6,900-Volt Unit Switchgear 1A2

SHEET NO. 13
MADE BY DJS
CKD. BY DEU
DATE 06/12/87
Revised 5-5-92
By WKC

BREAKER REFERENCE NUMBER	DESCRIPTION	RELAY SETTING		
		INDUCTION		INST.
		TAP	TIME DIAL	
7	Device 50-1, 1SGB-FAN-2A (Low Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		20 sec	4.1 x rating 328 amp primary
7	Device 50/51-1, 1SGB-FAN-2A (Low Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	7	4.8 x tap
7	Device 50-2, 1SGB-FAN-2A (High Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		30 sec	5.5 5 x rating 400 amp primary 440
7	Device 50/51-2, 1SGB-FAN-2A (High Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	8	8 x tap
7	Device 50G, 1SGB-FAN-2A Ground Overcurrent Relay, Instantaneous ITE GR5 202D6141UL 5-50 ampere pickup Reference: IB 18.1.7-2 Issue H		2 cycles	5.0 amp

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

PROJ. NO. 9255

SUMMARY OF
RELAY SETTINGS FOR
Intermountain Power Project

IGS Unit 1

6,900-Volt Unit Switchgear 1B2

SHEET NO. 32
MADE BY DJS
CKD. BY DEU
DATE 06/12/87
Revised 5-5-92
By WKC

BREAKER REFERENCE NUMBER	DESCRIPTION	RELAY SETTING		
		INDUCTION		INST.
		TAP	TIME DIAL	
6	Device 87M, 1SGB-MFAN-1B Phase Current Differential Relay, Instantaneous ITE 50H 238T0545 CT Ratio: 50/5 0.8-8 ampere pickup Reference: IB 18.2.7-5E			2 x rating
7	Device 50-1, 1SGB-FAN-2B (Low Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		20 sec	4.1 x rating 328 amp primary
7	Device 50/51-1, 1SGB-FAN-2B (Low Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	7	4.8 x tap
7	Device 50-2, 1SGB-FAN-2B (High Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		30 sec	5.5 5 x rating 400 amp primary 440
7	Device 50/51-2, 1SGB-FAN-2B (High Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	8	8 x tap

SUMMARY

Our analysis of the primary air fans indicate the most economical solution to reducing outage costs associated with single fan operation is to rerate the motors in accordance with recommendations provided by the motor manufacturer, Westinghouse Electric. Changing the nameplate rating of the motors from 4000/2100 HP to 5000/3200 HP will restore the capability of the Primary Air (PA) System to support unit operation at 500 MWg (60% maximum unit capacity) with a single fan in service. The existing electrical system is adequate to support this revision with revised protective relay settings.

PROJECT DESCRIPTION

The scope of Capital Project IGS91-28 included a review of the design and operating performance of the Primary Air (PA) Fans and recommendations for correction of any deficiencies.

The original design of the PA fan motors was changed during contract negotiations to Westinghouse 2 speed motors to provide auxiliary power savings during normal operation (Appendix A-Black and Veatch cover letter on PA fan report dated January 22, 1992). The two speed Westinghouse Pole Amplitude Modulated (PAM) motors provided by Babcock and Wilcox did not include with any overload capability.

Since startup, the motors have operated slightly above original nameplate values (183 amperes), during low speed operation, to maintain acceptable PA System performance levels. This overload operation has been required because of higher system pressures and flows than originally specified in the design of the primary air system and significantly lower fan efficiency.

The nameplate rating of the motors is 4000/2100 horsepower, 302/183 amperes (Appendix B-Westinghouse Induction Motor Data). We reviewed the capability of these motors, with Westinghouse, to determine if the slight overload condition would reduce the useful life of the motor. Westinghouse agreed these motors could be operated at 10 to 15 amperes above nameplate on a continuous basis without loss of useful life (Appendix C-Westinghouse letter dated September 14,1990). This review resulted in the existing operating limits of 302/200 amperes.

In discussing the capability of these motors with Westinghouse they said they would have to perform a detailed design analysis to determine the maximum rating available on these motors. We issued a purchase order to have Westinghouse perform a design analysis and determine the maximum capacity of the motor. Westinghouse determined the motor could be upgraded from 4000/2100 horsepower, 302/183 amperes 1.0 service factor to 5000/3200 horsepower, 380/265 amperes 1.15 service factor (Appendix D-Westinghouse report dated February 25, 1992).

Temperature rise of the stator winding when the motor is operating at 5000/3200 HP is still expected to be within allowable limits for class B insulation. Since rise is within class B, the thermal life of the insulation will not be reduced from design.

In addition, during performance testing of these fans we have been unable to achieve the original design capacity of 60% unit load with one fan, in high speed,(Appendix E-Black and Veatch Specification 62.3401 section) without exceeding the motor amperage rating.

Based on our performance testing (Appendix F-Performance Test 11/4-5/89) and acceptance testing with Babcock and Wilcox (Appendix G-Performance Test 1/18/89) the fans are not capable of providing a significant increase in fan capacity,in high speed, without exceeding the existing motor nameplate rating (302 amperes).

Review of the test data by the original equipment supplier, Babcock and Wilcox, indicates the specified margins on fan performance result in a fan efficiency that is unattractive in the normal operating range and extremely inefficient at high speed. They recommend a fan motor rated at 2700 HP at low speed. The recommended motor rerate will provide a motor rated at 3200 HP at low speed.

Testing with the fan manufacturer, Howden Sirocco, (Appendix H-Howden Sirocco Test Reports) indicates a single fan is currently only capable of 300 MWg (36% unit load) at either high or low speed operation. Maximum fan capacity was determined by increasing the load on the unit until the fan motor reached full nameplate amperage limits. Howden Sirocco indicates the additional horsepower available from low speed to high speed operation is lost because of inefficiencies associated with the position of the inlet vanes during high speed operation and because the fan is significantly less efficient than specified.

Other problems discovered during our review of the performance of the PA Fans were incorrect warning and absolute alarm levels for the motor stator temperature sensors and an incorrect setting for the motor air filter differential switch. The motor stator alarms have been changed to the setting provide by Westinghouse of 130 C for warning and 135 C for absolute alarm.

The motor air filter differential air switch should be replaced with a model having a range .5 to 1.0 inches of water. The new switch should be set at .65 inches of water. The original setting of .35 is no longer valid because of modifications made to the air filters to provide for access without removing the motor from service.

Based on our review we compared the following options to determine the costs of outages associated with PA fan motor failures.

OPTIONS

1. Operate the PA Fans at the present limits of 200 amperes low speed and 303 amperes high speed. 300 MWg with single fan operation. (Base Case)

2. Change the wheel and vanes on the existing fans to provide for 500 MWg (60% unit capability) with one fan in service. Motor will be limited to high speed operation only with a maximum of 4000 HP. We estimated this option will increase auxiliary power use 10% because of losses associated with high speed operation. Increasing auxiliary power use increases the cost for this option $1,850,000.

3. Rerate the motor to 5000/3200 HP 1.15 service factor per the analysis performed by Westinghouse. New motor rating is capable of providing unit operation at 500 MWg (60% maximum unit capacity). No changes are being made to the fan efficiency and consequently no changes to auxiliary power use during normal two fan operation.

4. Replace the motors with new two speed motors capable of 840 MWg with one fan in service at high speed. No changes are being made to fan efficiency and consequently no changes to auxiliary power use during normal two fan operation.

5. Install variable frequency drives and new motors. Equipment costs exceed assumed outage costs and auxiliary power savings were not considered.

ECONOMIC EVALUATION

ASSUMPTIONS

1. Cost of money is 8 percent, extra cost of one unit lost IGS generation is $10,000 per unit, per hour.

2. Motor failures associated with windings and/or rotors would require 4 weeks to repair. PA Fan motor failures would result in a unit trip with a minimum of two hours to return the unit to the full capability of unit operation with a single fan.

3. Failures associated with the bearings would require 8 hours for replacement. Failures would progress slowly enough to schedule the unit off line for repairs.

4. Net output factor for each unit is 90% During reductions in unit capability the other unit would be loaded to maximum capacity.

5. There will be at least one motor failure and a bearing failure during the remaining life of the motors. Motor life is assumed to match the useful life of the plant.

Based on our evaluation the cost for each option are broken down as follows: (Costs for motor repair are assumed to be equal for all options.)

OPTION	Description	Outage Cost	Installation & Operation	Total
1	Existing Oper.	$3,031,429	$ None	$3,031,429
2	New Wheels	$1,412,381	$2,624,512	$4,036,893
3	Rerate Motor	$1,412,381	$ 1,800	$1,414,118
4	New Motor	$ 0	$2,134,000	$2,134,000
5	New Drives	$ 0	>$2,400,000	>$2,400,000

We recommend increasing the rating on the PA fan motors in accordance with the computer analysis performed by Westinghouse. This recommendation is the most cost effective way to minimize outage costs associated with PA fan failures.

We have reviewed the existing electrical system with Black & Veatch (Appendix I-Black and Veatch report dated June 2, 1992) to determine the system capability to support to the proposed horsepower revisions to the PA fan motors. The existing power cables and switchgear cubicles are adequately sized to handle the proposed increase. The new high speed 1.15 service factor rating of 437 amperes exceeds the speed changer switch nominal nameplate rating of 400 amperes continuous by 9.25% However, the switch manufacturer, Esco has stated the switch can be operated at 440 amperes on a continuous basis with a slight increase in switch losses. The protective relays settings will have to be changed to accommodate the horsepower revisions.

Black and Veatch has also reviewed the increased loading on the foundations associated with the proposed horsepower revisions. The existing foundations are adequate for these changes.

The alarm limits on the stator winding temperature RTDs should remain the same to provide warning of thermal degradation of the motor insulation. The alarm limits on the motor cooling air filters should be revised to match existing site conditions. The alarm limits on the motor current will be changed to the new horsepower ratings. The Fox 1A will be set to give a warning alarm at 265 amperes low speed and 380 amperes high speed. The absolute alarm will be 304/437 to match the service factor ratings.

The motor ratings should be changed even if it is assumed there will not be any motor or fan failures which lead to a unit derate. The new ratings provide a greater capability for the PA Fans to respond to disturbances without affecting the life of the motors.

INTERMOUNTAIN POWER SERVICE CORPORATION

PROJECT NO. IGS 91-28 WO NO. _____ PAGE 1 OF 1

ORIGINATED BY J. CHRISTENSEN DATE 7/92 CHECKED BY _____ DATE _____

DESCRIPTION BASE CASE - OPTION 1

OUTAGE COST FOR A MOTOR FAILURE

2 HOURS UNIT OUTAGE
672 HOURS REDUCED GENERATION

REDUCTION IN GENERATION = (NET OUTPUT FACTOR)*(UNIT CAPABILITY)
- NET OUTPUT SINGLE FAN OPERATION
- OTHER UNIT CAPABILITY*(1 - NET OUTPUT FACTOR)

$= (.90)(840) - 300 - (840)(.10)$

$= 372$ MW/HR

OUTAGE COST = $\$10{,}000 \left(2 + 672\left(\frac{372}{840}\right)\right) = \$2{,}996{,}000$

OUTAGE COST FOR A BEARING FAILURE

8 HOURS REDUCED GENERATION = $8\left(\frac{372}{840}\right) \times \$10{,}000 = \$35{,}429$

IP12_005506

PROJECT NO. IGS 91-28 WO NO. _____ PAGE 1 OF 2

ORIGINATED BY J. CHRISTENSEN DATE 7/92 CHECKED BY _____ DATE _____

DESCRIPTION CHANGE WHEELS OPERATE FANS AT HIGH SPEED OPTION 2

MATERIALS

WHEELS	$93,000
SHAFT	$32,000
INLETS	$12,000
	$137,000 / FAN

MISC ERECTION MATERIAL $5000

LABOR

6 MEN x 4 WK x 5 DAY/WK x 8 HR/DAY = 960 HRS

960 HRS @ $25 HR. $24,000 / FAN

TOTAL INSTALLED COST

MATERIAL	$142,000
LABOR	24,000
	166,000
ENGINEERING/QA	10,000
	176,000
CONTINGENCY 10%	17,600
	193,600

ADDITIONAL AUXILIARY POWER USE AT HIGH SPEED OPERATION

ASSUME A LOSS IN EFFICIENCY OF 10% DUE TO HOUSING/ROTOR MISMATCH AND AUXILIARY POWER LOSSES.

(160 KW / PER MOTOR) (30 YEARS) (365 DAYS/YR) (24 HOURS/DAY) (1.1¢/KWH)

= $462,528

INSTALLATION & OPERATION COST

($193,600 + $462,528) x 4 = $2,624,512

OUTAGE COST FOR A MOTOR FAILURE WITH NEW ROTORS

$$= (10{,}000)\left(2 + 672\left(\frac{(.9)(840) - 500 - (840)(.10)}{840}\right)\right)$$

= $1,396,000

IP12_005507

OUTAGE COST FOR A BEARING FAILURE

$$= 8 \left(\frac{172}{840} \right) * 10{,}000 = \$16{,}381$$

THIS OPTION WOULD DECREASE THE CONTROLLABILITY OF THE FANS AND CHANGE THE MINIMUM LOAD ON THE UNITS FROM 300 MWg TO ≈ 400 MWg SINGLE FAN OPERATION.

INTERMOUNTAIN POWER SERVICE CORPORATION

PROJECT NO. IGS 91-28 WO NO. _____ PAGE 1 OF 1

ORIGINATED BY J. CHRISTENSEN DATE _____ CHECKED BY _____ DATE _____

DESCRIPTION REVISE MOTOR RATING
OPTION 3

INSTALLATION

CHANGE RELAY SETTINGS = (2 MEN) (4 HOURS) ($25/HR)/MOTOR
= $200

REVISE DOCUMENTATION = (40 HRS) @ $25 /HR = $1000

TOTAL COST = (4)(200) + $1000 = $1800

EXISTING MOTORS RERATED ARE CAPABLE OF 500 MWg SINGLE FAN OPERATION

OUTAGE COST SAME AS OPTION 2

PROJECT NO. IGS 91-28 WO NO. _____ PAGE 1 OF 1

ORIGINATED BY _____ DATE _____ CHECKED BY _____ DATE _____

DESCRIPTION NEW MOTORS FOR FULL LOAD OPERATION WITH 1 MOTOR OPTION 4

NEW MOTORS	3750 HP @ LOW SPEED 6500 HP @ HIGH SPEED	$ 400,000	EA
SPEED CHANGER SWITCHES		$ 35,000	EA
MODIFICATIONS TO FOUNDATIONS, SWITCHGEAR, CONTROLS, CABLING ETC		$ 20,000	EA
INSTALLATION	(1000 HRS @ 25/HR)	$ 25,000	EA
		480,000	EA

CONSTRUCTION BOTH UNITS	1,920,000
ENGINEERING / QA	20,000
	1,940,000
10 % CONTINGENCY	194,000
	2,134,000

THERE ARE NO OUTAGE COSTS ASSOCIATED WITH THIS OPTION. A SINGLE FAN WOULD BE ABLE TO PROVIDE SUFFICIENT AIR FOR FULL UNIT LOAD.

INTERMOUNTAIN POWER SERVICE CORPORATION

PROJECT NO. IGS 91-28 WO NO. _____ PAGE _____ OF _____

ORIGINATED BY _____ DATE _____ CHECKED BY _____ DATE _____

DESCRIPTION VARIABLE FREQUENCY DRIVES
OPTION 5

ROSS HILL COMPANY PROVIDED AN ESTIMATING PRICE OF $600,000 PER DRIVE FOR VARIABLE FREQUENCY DRIVES IN THIS HORSEPOWER RANGE. BASED ON EQUIPMENT COSTS AND THE FACT THAT MAJOR MODIFICATIONS WOULD BE REQUIRED TO PROVIDE ROOM FOR DRIVES, THIS OPTION WAS NOT EVALUATED.

APPENDIX A

Black & Veatch Cover Letter dated January 22, 1992

BLACK & VEATCH

8400 Ward Parkway, P.O. Box No. 8405, Kansas City, Missouri 64114, (913) 339-2000

Intermountain Power Project
Intermountain Generating Station

B&V Project 15119
B&V File 802
January 22, 1992

Intermountain Power Service Corporation
850 West Brush Wellman Road
Delta, UT 84624

Subject: Primary Air Fans

Attention: Mr. G. K. Hintze,
Working Group Chariman

Gentlemen:

At the request of the Inside Working Group, we have reviewed the documentation included in Attachment A related to the recent tests of the Primary Air Fans.

BACKGROUND INFORMATION

The following comments are offered based upon our review of the IPP project files. Referenced documents are attached to this letter.

1. The Primary Air Fans were purchased using procurement documents prepared by the Department of Water & Power for the Steam Generators. Black & Veatch (B&V) offered comments and suggestions to Department of Water and Power (DWP) to review copies of the specifications prior to issuing the documents to bidders. Attachment B is an example of the type of comments offered to Ron Nelson and Doug Fowler of the DWP during the review process.

   The specification documents, we believe, are clear to Babcock & Wilcox's (B&W) design responsibility in procuring the Primary Air Fans.

2. The original proposal contained alternatives for two-speed fan motors as shown in Attachment C. B&V was requested to evaluate the various offerings of B&W. This evaluation was

intiated by our internal memorandum dated June 4, 1981. Our original evaluation of the Primary Air Fans was documented in our memorandum of June 15, 1981. This memorandum is included in Attachment D. Revised data sheets were provided by B&W in their letter of June 24, 1981. This letter is included in Attachment E.

3. As a result of our initial evaluation and discussions with DWP engineers, we provided B&W our letter of June 26, 1981 indicating that their initial offering did not meet all of the anticipated unit load points and requested a new two-speed selection of the Primary Air Fans be offered for consideration. This letter is included in Attachment F.

4. In response to our request, B&W offered their August 5, 1981 proposal for various two-speed fan alternatives. (This proposal from B&W is included in Attachment G.

5. B&W's August 5, 1981 proposal was evaluated by B&V in our August 21, 1981 memorandum. This evaluation is included in Attachment H. As indicated in the evaluation, there were operating cost savings of $4,300,000 in the selection of two-speed motors for the Primary Air Fans as compared to the single speed design. This evaluation was performed using the 35 year load model provided by the Department of Water & Power and expressed in 1986 dollars. The recommended fans were approved by the Department of Water & Power and incorporated into the B&W contract by Change Order.

6. Other historical background records noted in review of our files have been included in Attachment I.

The selection of the two-speed Primary Air Fans was intended to provide fans capable of full load operation at low speed while burning design Coal B with the following margins:

	B&W Proposal Data	Low Speed Design Req.	Design Margin
Primary Air Fan Flow per Fan, lb/hr	804,500	889,000	11%
Primary Air Fan Static Pressure, in. w.g.	35.6	44.3	24%

High speed operation of the Primary Air Fans would be required only if one of the two Fans were out-of-service or if the above margins were exceeded (e.g. excessive air heater leakage or pluggage) or the fuel analysis was significantly different from design Coal B.

ANALYSIS

The following comments were noted in our review of the test data provided by HOWDEN SIROCCO who has acquired the Westinghouse Sturtevant Fan Division's designs, and engineering and manufacturing facilities.

1. The Primary Air Fan flow at the low speed test condition was 295,000 acfm, thirty percent greater than the flow predicted by B&W in their proposal and eighteen percent higher than the specified fan requirements including margins.

2. The performance test data and performance curves indicate that low speed operation is 897 rpm. The B&W proposal data sheets indicated operation at 876 rpm. This increase in operating speed increases the fan flow capacity by 2.4 percent, the fan pressure capacity by 5 percent, and the fan maximum power requirement by 7.4 percent.

   Similarily, the high speed operation recorded during the tests is at 1,194 rpm compared to the B&W proposal data showing 1,168 rpm. This increase in operating speed increased the fan power requirements by 6.8 percent.

   The actual operating speeds at low and high speed should be determined by field measurement. The noted speeds of 897 rpm and 1,194 rpm appear to be too close to synchronous speeds.

3. Fan motors were procured by B&W as part of the steam-generator contract. We concur with the HOWDEN SIROCCO analysis that "there is no margin on motor power". Our calculations indicate that, under the original performance conditions, the motor rating should have been 2,350 hp at low speed and 5,570 hp at high speed to allow operation with the inlet damper vanes at their full open position.

   Under the current operating conditions noted during the fan testing, the motor rating should be 2,520 hp at low speed and 5,950 hp at high speed.

4. We do not concur with the B&W evaluation that the selection of two-speed fans was inappropriate or that the logic used in sizing the fans was incorrect.

   It is also our opinion that the fan silencer revisions did not contribute significantly to the current problem as noted by Babcock & Wilcox since the Primary Air Fan operating pressure is currently below the Primary Air Fan low speed design pressure capacity. The higher than predicted Primary Air Fan flow condition is the major contributor to the fan limitations.

RECOMMENDATIONS

An analysis is required to determine the optimum modifications based upon actual unit operating parameters and an agreed upon load model. We recommend that this analysis be performed to determine if motor replacement can be economically justified. The analysis would be performed by Kris Gamble who was involved throughout the IPP draft system design and assisted in the preparation of these comments. Mr. Gamble's involvement and knowledge of the forced and induced draft system designs would offer a benefit to the project in determing the proper solution for the operation of the Primary Air Fans.

We estimate this study could be performed at a engineering cost of approximately $12,000 including 15 mandays of engineering and other direct expenses. This estimate does not include any additional testing of the fan systems. We do recommend that we meet with Howden Sirocco and Intermountain Power Service Corporation (IPSC) to review the testing that has been recently performed. This work could be performed under the General Services Agreement which we submitted with our proposal for the Induced Draft Fan Studies dated September 19, 1991 or under the existing Agreement managed by the Department.

Intermountain Power Service Corporation
Mr. G. K. Hintze

B&V Project 15119
January 22, 1992

We trust that the attachments will be beneficial in your understanding of the background of the existing fan and fan motor selections. Please contact Steve Rus, Kris Gamble or me with any questions regarding the sizing of the Primary Air Fans.

Very truly yours,

BLACK & VEATCH

Paul F. Bannister

mg
Enclosures

cc: Mr. J. P. Christensen - IPSC
Mr. R. E. Gentner - DWP
Mr. D. Glen - DWP
Mr. J. Nelson - IPSC

APPENDIX B

Westinghouse Induction Motor Data Sheet

PA FAN MOTOR

WESTINGHOUSE ELECTRIC CORPORATION
Heavy Industry Motor Division
Round Rock, Texas 78664

INDUCTION MOTOR DATA

Shop Order: 1667AA / 1668AA General O : CL30900

Customer: INTERMOUNTAIN POWER / BABCOCK AND WILCOX

R

HP: 4000/2100 Voltage: 6600 Amperes: 302/183 Service Factor 1.0

Phases: 3 Hertz: 60 F.L. Speed: 1194/897 RPM

Temp. Rise: 80 °C By RESISTANCE Insulation Class: B

Frame: 800-1800 Locked KVA Code: F/C

Performance

Load	S. F.	1.00	0.75	0.50	0.25
% Efficiency	—	96.4/95.9	96.4/95.6	95.8/94.6	93.1/90.9
% Power Factor	—	89.5/78.0	88.2/71.9	83.3/59.9	65.5/37.7

Rated Torque: 17582/12295 lb.-ft. Starting Torque: 90/108 %

Breakdown Torque: 253/321 % Pull-Up Torque: — % @ — % Speed

Locked Rotor Current: 1945/1343 Amps 643/734 % F. L. Slip: .45/.34 %

Circuit Constants

Per Unit on 2984/1566.6 KVA Base

Transient Reactance, X'_d: 3.396/1.500 X/R: 6.06/6.55

Sub-Transient Reactance, X''_d: 0.168/.127 PAM Motors Only

Open Circuit Time Constant, T'_{do}: 2.29/1.38 Sec Switching Time Delay

Short Circuit Time Constant, T': .113/.117 Sec Low-to-High Speed: 2 Sec

Engineer: Donald H Coleman Date: 2/6/82

Approval: _____ Revision _____ Date: _____

FORM # HPMD-297

IP12_005519

APPENDIX C

Westinghouse letter dated September 14, 1990

Westinghouse
Electric Corporation

Heavy Industry Motor Parts Support
Center

Box 185
Round Rock Texas 78680-0185
(512) 388 0116

September 14, 1990

Intermountain Power Service Corp.
Route 1, Box 864
Delta, Utah 84624
Attn: John Christianson

Reference: PAM motors S.O. 1667AA and 1668AA minor overload operation

Dear Mr. Christianson,

These motors can be operated at 10 to 15 amperes above nameplate rating on either speed without affecting the motor adversely. There is sufficient mechanical and thermal margin to accommodate these small increases in load on a continuous basis.

There appears to be significant thermal margin on these machines but we would have to perform a study to determine the maximum horsepower capability on the machines. There is a short term problem with design program access now but the problem should clear shortly and we will be able to quote a study.

Regards,

Duane McEachron

Duane McEachron

DM:jh
HIMSC370

APPENDIX D

Westinghouse Report dated February 25,1992

MOTOR DATA

Customer: INTERMOUNTAIN POWER SERVICE CORP.

Apparatus: PAM INDUCTION MOTOR

Date Prepared: 02-26-98

Customer's Purchase Order: 92-52591

Westinghouse General Order: XH20246

Westinghouse Motor Co. Shop Order 25155AA

WMC
Westinghouse
Motor Company

Post Office Box 277
Round Rock, Texas 78680-0277

WESTINGHOUSE MOTOR COMPANY
ROUND ROCK, TEXAS

WMC ENGINEERING REPORT
WMC-EER-92-002

DATE: February 25, 1992

SUBJECT: Study to determine the maximum loading capability of the machines supplied earlier on S.O. 1667AA-1668AA without exceeding temperature rise up to ANSI/NEMA Class B.

DISTRIBUTION: J. M. Lidell
R. J. Connolly

ABSTRACT: It has been found that the machines can be uprated from 4000/2100HP 6/8 poles, PAM, 1.0 service factor to 5000/3200HP, 6/8 poles, PAM, 1.15 service factor and can operate without exceeding the ANSI/NEMA Class B temperature rise limits.

APPROVED: J. Conomos 2/26/92
J. J. Conomos
Manager
Induction Engineering

BY: S. P. Bansal
S. P. Bansal
Advanced Design Engineer

APPROVED: 2/26/92
M. K. Wen
Manager
Advance Design &
Development Engineering

BY: D. F. Kosar
D. F. Kosar
Staff Engineer

OBJECTIVE:

The purpose of the study was to determine the maximum loading capability within ANSI/NEMA Standard requirements of Westinghouse Motors supplied under shop order 1667AA and 1668AA.

DESCRIPTION OF EXISTING MOTORS

4000/2100 HP, 6600V, 3 PH, 60 HZ, 1195/897 RPM, WP-I enclosure, 1.0 service factor, 80°C rise (by resistance). Frame size 8018, horizontal induction motor.

Rated Amps	303/186	Efficiency	
Starting torque	89/106%	Full Load	96.32/95.82%
Pull out torque	252/321%	3/4 Load	96.36/95.52%
Inrush	1953/1352 Amps (643/728%)	1/2 Load	95.63/94.48%

Power Factor:

F.L. 89.2/76.9%
3/4 Load: 87.9/70.5%
1/2 Load 82.8/58.4%2

Machine was designed for 85% reduced voltage start, unloaded start per Curve # 7-7-81-2 (Revision 2) and driven equipment load inertia 152185 LB-FT^2.

LOADING CAPABILITY

The machine can be operated at 5000/3200 HP at 6 and 8 pole respectively at 1.15 service factor without exceeding the NEMA Class B temperature rise limits.

Expected temperature rise at 5000 HP, 6P speed at 1.0 service factor is 70°C and at 3200 HP, 8P speed at 1.0 service factor 46°C (by resistance) at an altitude of 4700 ft. For this study it is assumed that machine will be started unloaded per the earlier load curve #7-7-81-2 (Revision 2) and driven equipment load inertia is 152185 LB-ft^2.

Performance data at both the speeds, which includes the nameplate information is attached. Speed-torque curves and thermal limit curves at rated voltage and at 90%, 85% reduced voltage start are attached.

MECHANICAL CONSIDERATION

Many factors are taken into consideration when making a mechanical design integrity evaluation of electric motors. The basis of this study is the upgrading from 4000 HP to 5000 HP, 1.15 service factor, which is a torque function. Therefore, only those features of the motors that are torque related or dependent have been analyzed. The value of torque that was used in the calculations was the highest anticipated torque at any of the operating conditions.

The torque that is developed in the airgap is transmitted to the foundation through the stator core and to the driven equipment through the rotor core and shaft. The following were analyzed:

- Foundation Reactions
- Stator Core-to-Frame Attachment
- Rotor Core-to-Shaft Attachment
- Shaft Fabrication Stresses
- Bearing Journal Shear Stress
- Shaft Extension Stresses

The new foundation reactions are given below.

Foundation Reactions per Bolt

Rated Torque	Motor Weight/4	+/- 2,270
Maximum Torque	Motor Weight/4	+/- 18,000

CONCLUSION

Temperature rise of stator winding when motor is operating at 5000/3200 HP, S.F. 1.00 is still expected to be within class B. Since rise is within class B, the thermal life of the insulation will not be reduced compared to designed (nameplate) life at 80°C rise. Motor can be operated at 1.15 service factor with temperature rise limits per ANSI.

The calculated stresses in the locations given above have been judged acceptable for the new horsepower rating.

The foundation should be reviewed for the additional loading created by the increase in horsepower.

DISCLAIMER

The conclusion of this study is not to be interpreted in any way to include warranties or assumption of any responsibilities or liabilities.

WESTINGHOUSE MOTOR COMPANY

ROUND ROCK, TEXAS U.S.A.

CUSTOMER INTERMOUNTAIN POWER
CUSTOMER ORDER NO.
APPLICATION FAN
S.O. 25155AA

DATE - FEB 25,92

G.O. XH20246

DATA FOR WORLD SERIES, HORIZONTAL, BRACKET TYPE INDUCTION MOTOR

1. RATING

HP	5000	HERTZ	60	INSUL CLASS	F
RPM FL	1193	SERVICE FACTOR	1.15	KVA CODE	D
VOLTS	6600	RISE C (1.00 SF)	80	DUTY	CONTINUOUS
AMPS FL	380	METHOD	RES		
PHASES	3	AMBIENT C	40		

2. MECHANICAL

FRAME	8018	BRG TYPE	SLEEVE	END PLAY INCH	0.50
ENCL TYPE	WP-1	LUBE TYPE	SELF	MOTOR WK SQ	9576
ROTATION (ODE)	BI	NO. BRGS	2	LOAD WK SQ	152185
STATOR WT LBS	*	ROTOR WT LBS	*	TOTAL WT LBS	*
SHAFT EXTENSION	S70				

*** Per outline drg 1897F83**

3. STARTING PERFORMANCE - NOMINAL, VALUES WITH (*) ARE GUARANTEED

		100% VOLTS		90% VOLTS	85% VOLTS
TEMPERATURE		75C	40C	40C	40C
AMPS (LR)		1946	1953	1724	1612
AMPS (LR)	%	512	513	453	424
POWER FACTOR	%	16.4	15.9	15.6	15.4
START TORQUE	%	72	71	55	48
PULL-UP TORQUE	%	72	71	55	48
ACCELERATION SEC			40.4	56.7	69.5
SAFE LOCK	SEC	FROM HOT	40.5	51.8	59.3

AT 100% VOLTS:
PULLOUT TORQUE % = 202

4. EFFICIENCY - NOMINAL

LOAD	%	115	100	75	50	25
EFFICIENCY	%	96.11	96.33	96.49	96.16	94.08

5. POWER FACTOR - NOMINAL

LOAD	%	115	100	75	50	25	NO Load
POWER FACTOR	%	83.2	89.1	89.1	86.1	71.8	5.4

MAX KVAR = 707 MAX SL P.F. = 95.0 %

IP12_005527

WESTINGHOUSE MOTOR COMPANY

ROUND ROCK, TEXAS U.S.A.

CUSTOMER INTERMOUNTAIN POWER DATE - FEB 25,92
CUSTOMER ORDER NO.
APPLICATION FAN
S.O.25155AA

S.O. XH20246

DATA FOR WORLD SERIES, HORIZONTAL, BRACKET TYPE INDUCTION MOTOR

1. RATING

HP	3200	HERTZ	60	INSUL CLASS	F
RPM FL	395	SERVICE FACTOR	1.15	KVA CODE	E
VOLTS	6600	RISE C (1.00 SF)	80	DUTY	CONTINUOUS
AMPS FL	265	METHOD	RES		
PHASES	3	AMBIENT C	40		

2. MECHANICAL

FRAME	8018	BRG TYPE	SLEEVE	END PLAY INCH	0.50
ENCL TYPE	WP-1	LUBE TYPE	SELF	MOTOR WK SQ	9576
ROTATION (ODE)	BI	NO. BRGS	2	LOAD WK SQ	152185
STATOR WT LBS	*	ROTOR WT LBS	*	TOTAL WT LBS	*
SHAFT EXTENSION	S70				

*** Per outline drg 1897F83**

3. STARTING PERFORMANCE - NOMINAL, VALUES WITH (*) ARE GUARANTEED

		100% VOLTS		90% VOLTS	85% VOLTS
TEMPERATURE		75C	40C	40C	40C
AMPS (LR)		1348	1352	1193	1115
AMPS (LR)	%	509	511	451	422
POWER FACTOR	%	15.1	14.7	14.4	14.2
START TORQUE	%	71	70	55	48
PULL-UP TORQUE	%	71	70	55	48
ACCELERATION SEC			33.6	46.0	55.6
SAFE LOCK SEC	FROM HOT		63.7	81.2	93.0

AT 100% VOLTS:
PULLOUT TORQUE % = 211

4. EFFICIENCY - NOMINAL

LOAD	%	115	100	75	50	25
EFFICIENCY	%	96.13	96.30	96.36	95.89	93.49

5. POWER FACTOR - NOMINAL

LOAD	%	115	100	75	50	25	No Load
POWER FACTOR	%	82.2	81.9	79.1	70.9	49.3	3.5

MAX KVAR = 388 MAX FL P.F. = 84.4

IP12_005528

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 100% LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL

NEG 25155AA

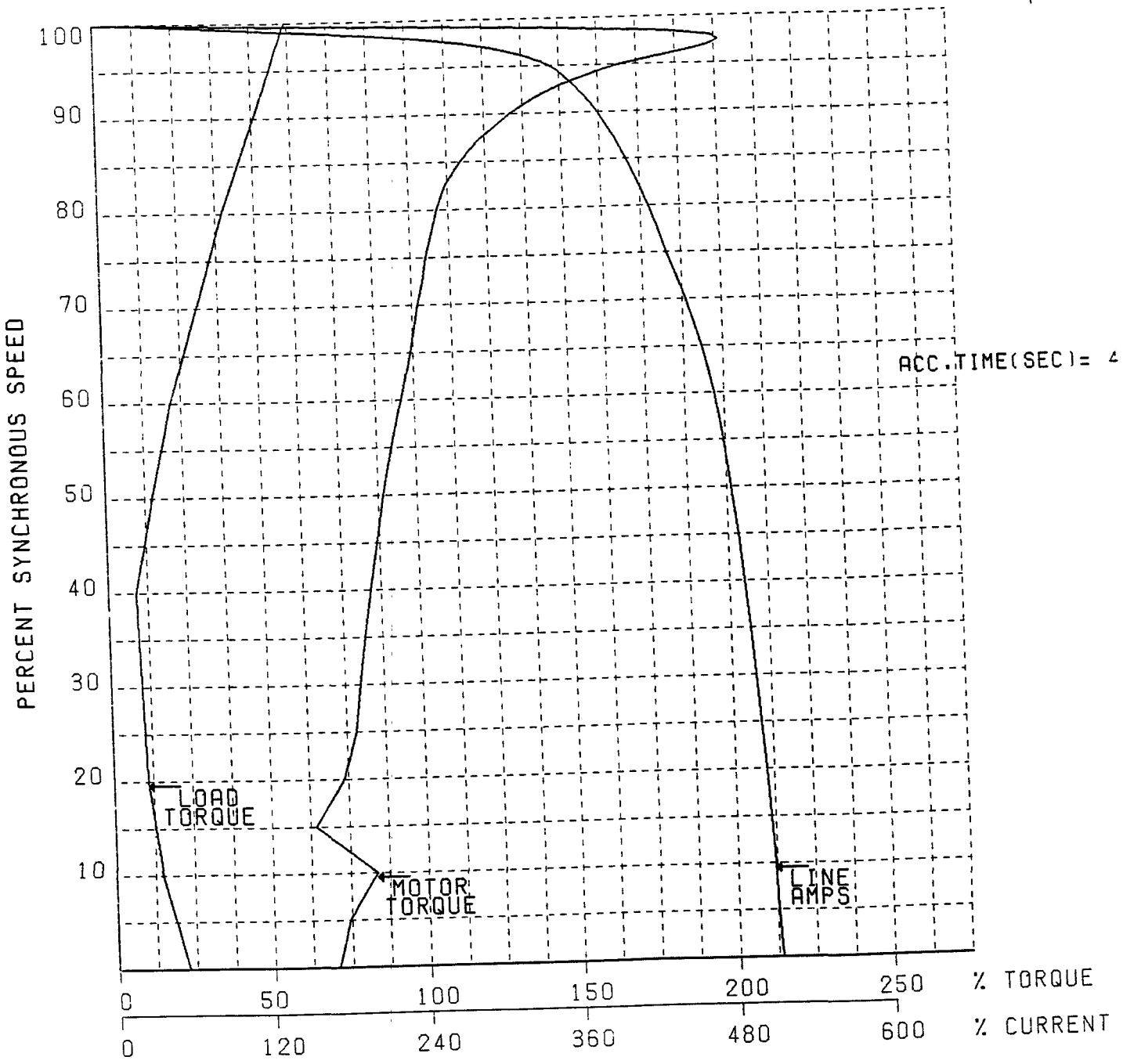
HP 5000 VOLTS 6600 PH 3 HZ 60 POLES 6 RPM (FL) 1193

PF 0.89 FL AMPS 380 LOCK AMPS(%) 514 RPM (SYN) 1200

FL TORQUE(LB-FT) 22023 LOCK TORQUE(%) 71

LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018

LOAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN



WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 90 % LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL

NEG 25155AA

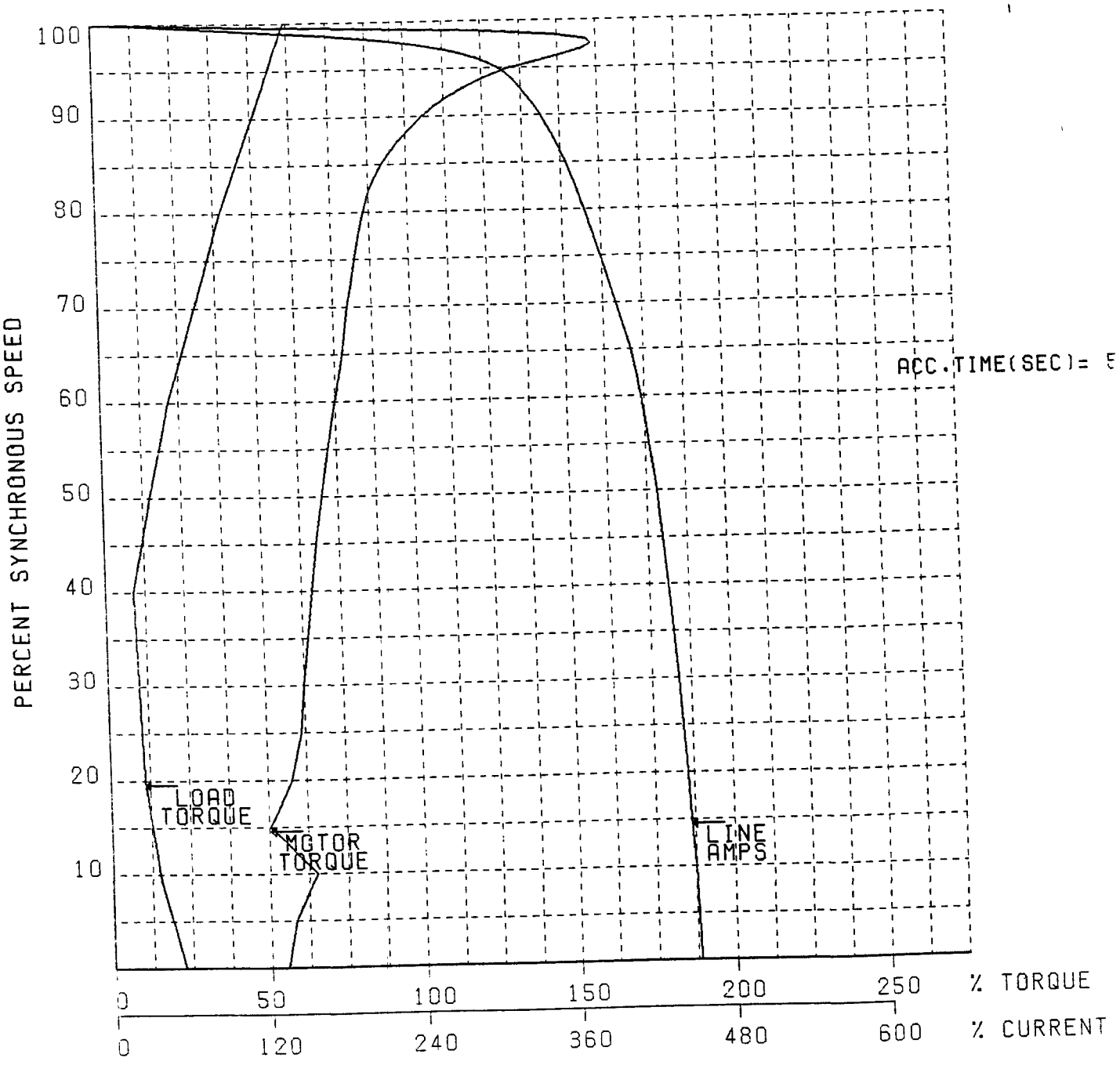
HP 5000 VOLTS 6600 PH 3 HZ 60 POLES 6 RPM (FL) 1193

PF 0.89 FL AMPS 380 LOCK AMPS(%) 454 RPM (SYN) 1200

FL TORQUE(LB-FT) 22023 LOCK TORQUE(%) 55

LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018

LOAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN



WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005530

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 85 % LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL

NEG 25155AA

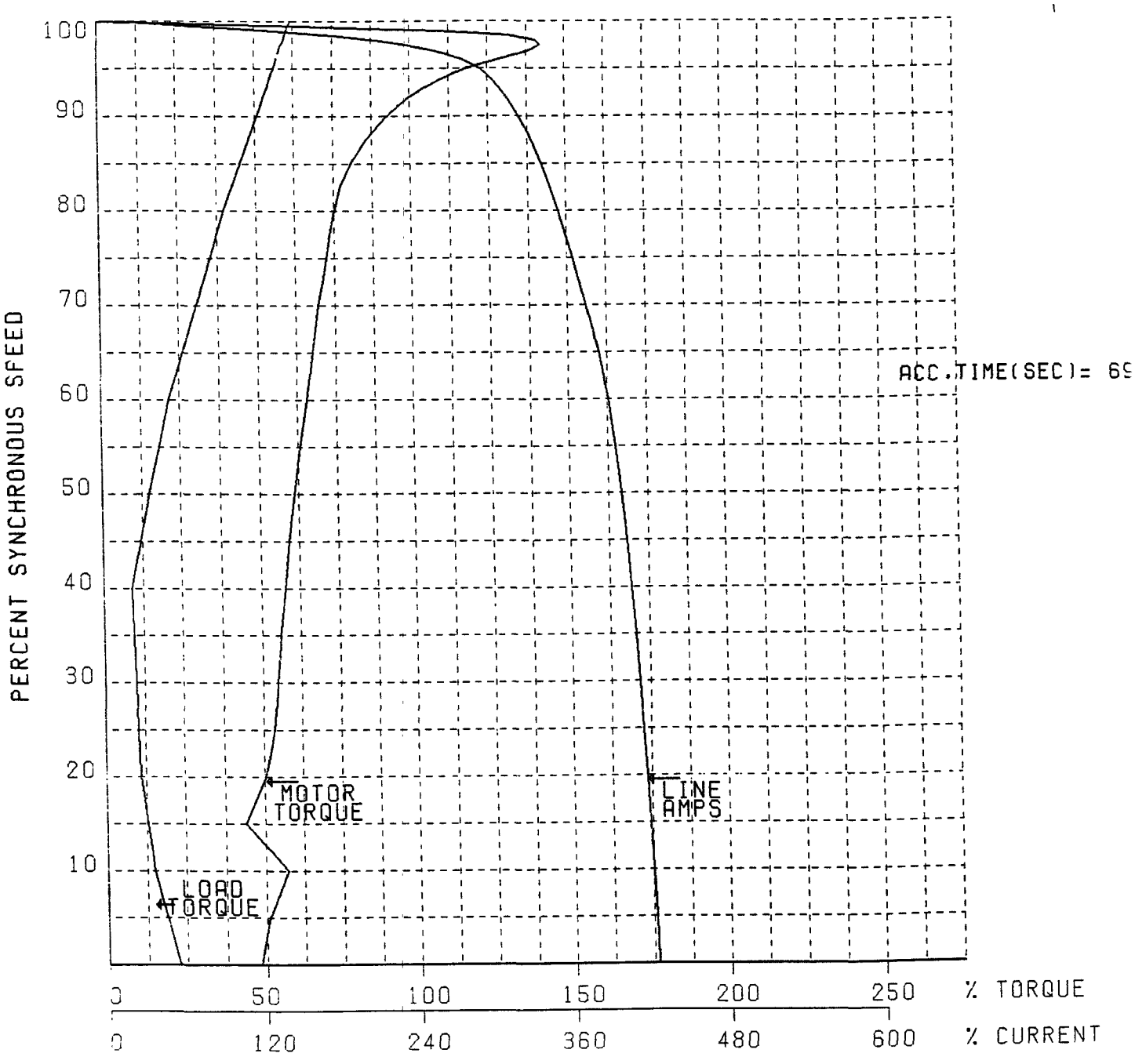
HP 5000 VOLTS 6600 PH 3 HZ 60 POLES 6 RPM (FL) 1193

PF 0.89 FL AMPS 380 LOCK AMPS(%) 424 RPM (SYN) 1200

L TORQUE(LB-FT) 22023 LOCK TORQUE(%) 48

LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018

OAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN



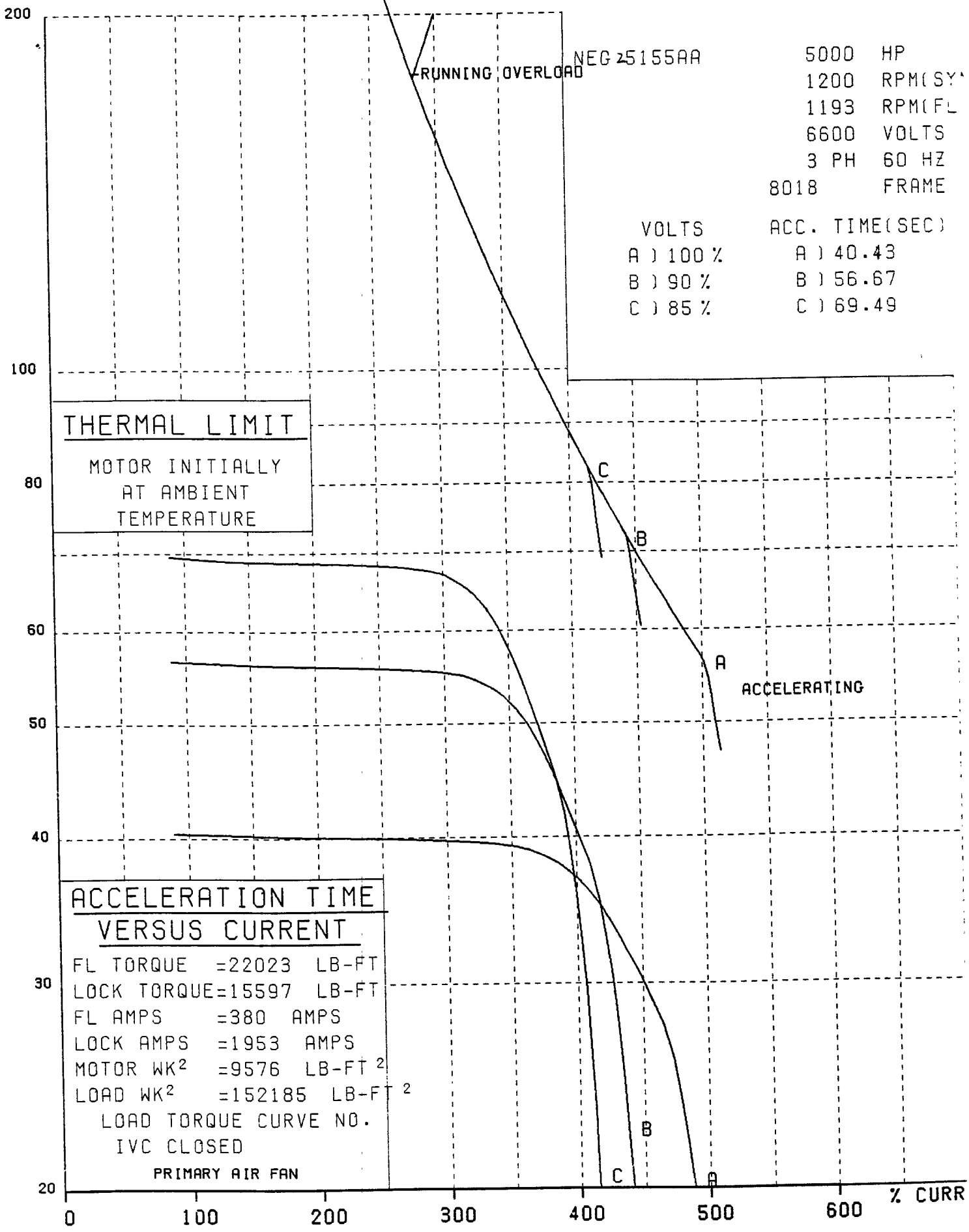
WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005531

TIME - CURRENT AND THERMAL LIMIT CURVES

CUSTOMER: INTERMOUNTAIN POWER

ENGINEER: BANSAL



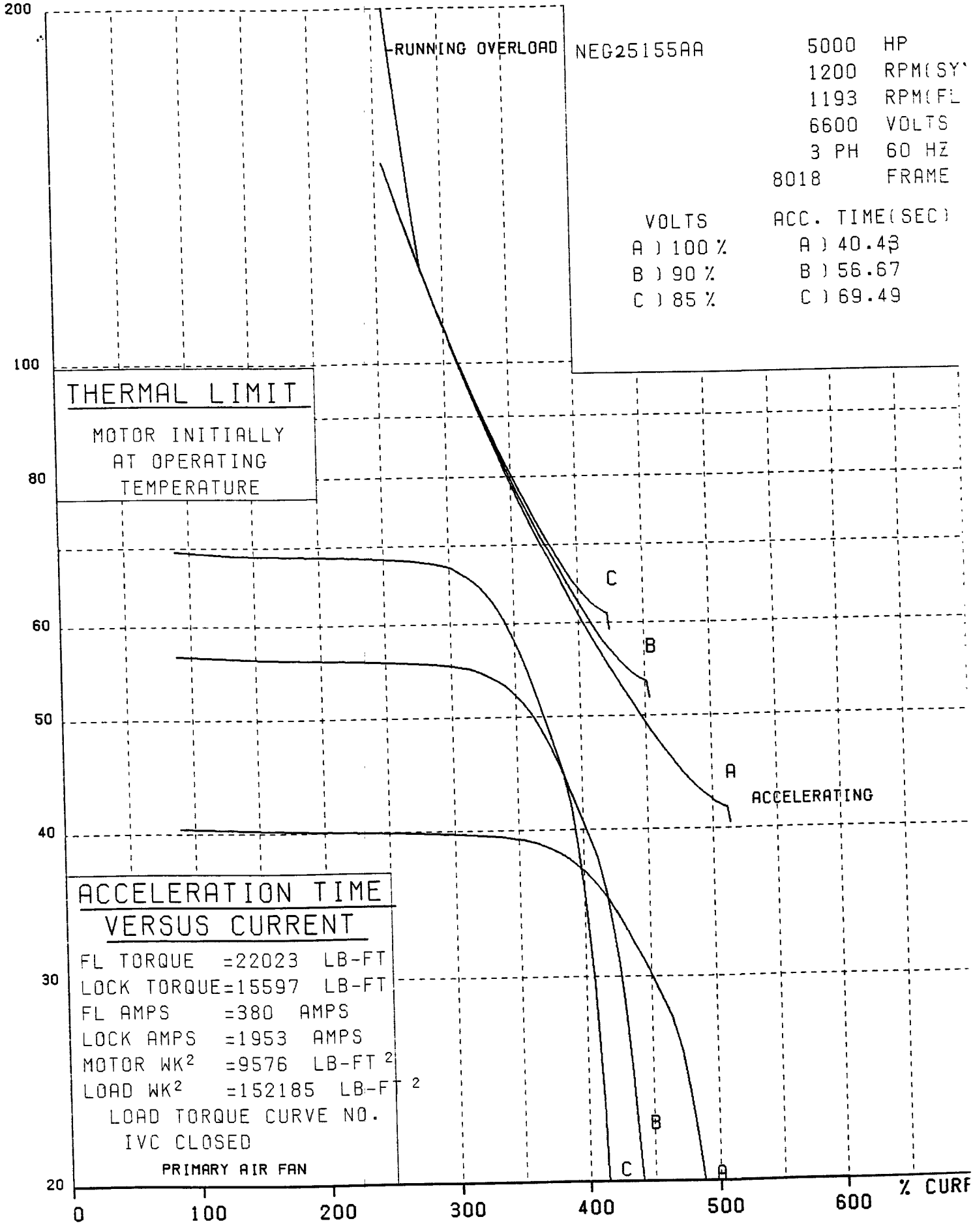
WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005532

TIME - CURRENT AND THERMAL LIMIT CURVES

CUSTOMER: INTERMOUNTAIN POWER

ENGINEER: BANSAL



WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005533

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 100% LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL

NEG 25155AA

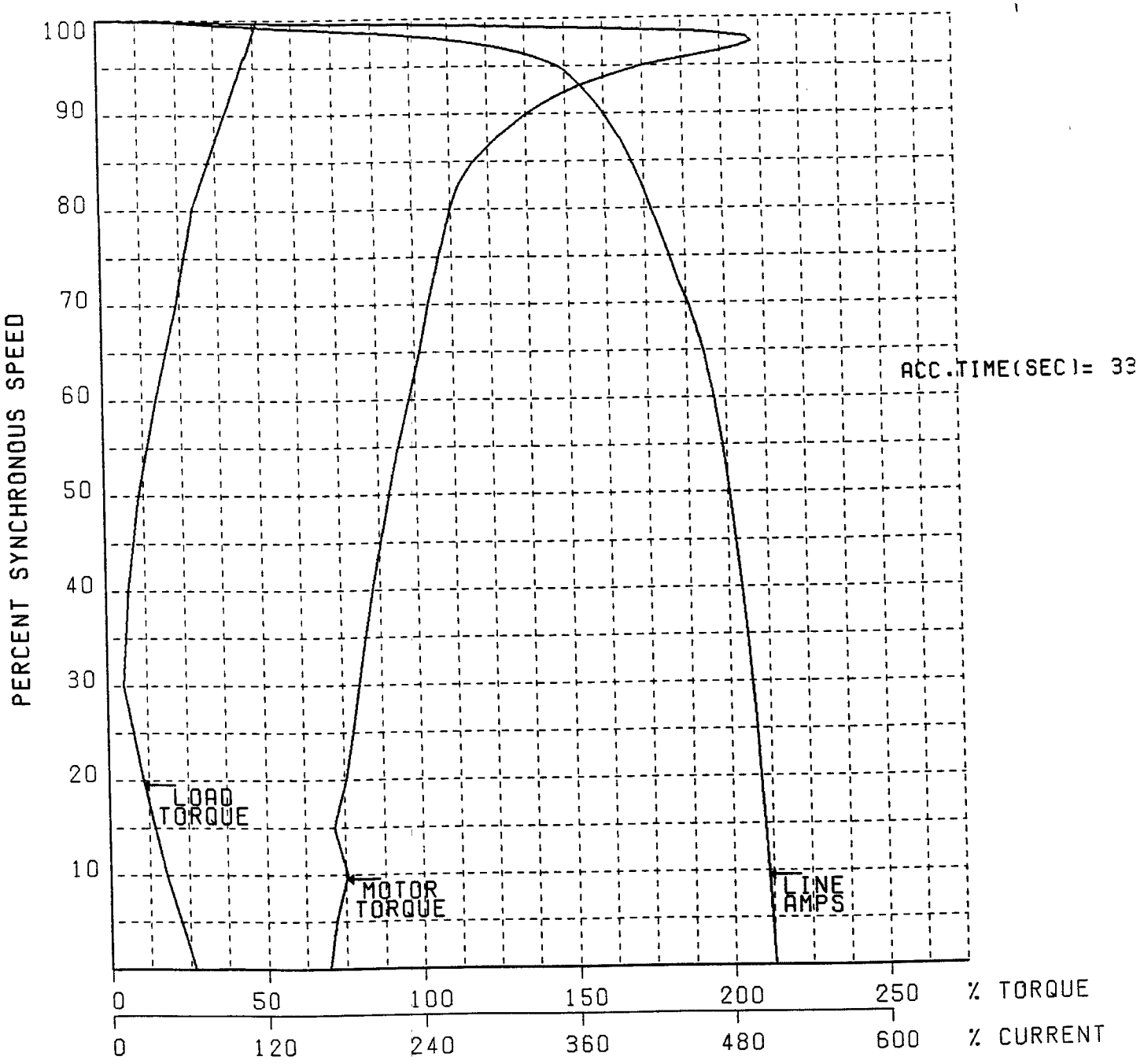
HP 3200 VOLTS 6600 PH 3 HZ 60 POLES 8 RPM (FL) 895

PF 0.82 FL AMPS 265 LOCK AMPS(%) 510 RPM (SYN) 900

L TORQUE(LB-FT) 18764 LOCK TORQUE(%) 70

LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018

LOAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN

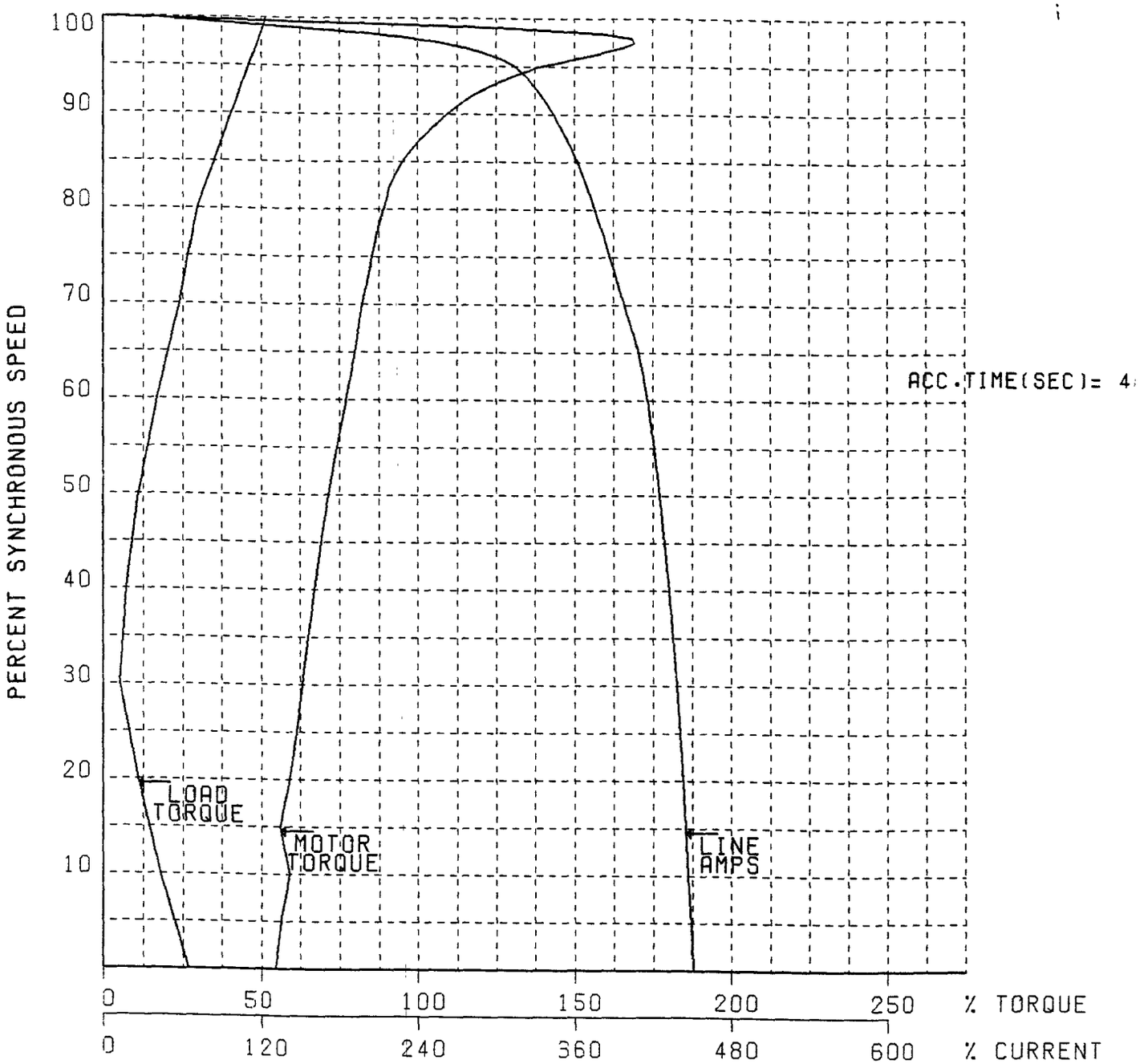


WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005534

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 90 % LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL
NEG 25155AA
HP 3200 VOLTS 6600 PH 3 HZ 60 POLES 8 RPM (FL) 895
PF 0.82 FL AMPS 265 LOCK AMPS(%) 450 RPM (SYN) 900
FL TORQUE(LB-FT) 18764 LOCK TORQUE(%) 55
LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018
LOAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN



WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005535

INDUCTION MOTOR STARTING CHARACTERISTICS (CALCULATED) AT 85 % LINE VOLTAGE

CUSTOMER INTERMOUNTAIN POWER ENGINEER BANSAL

NEG 25155AA

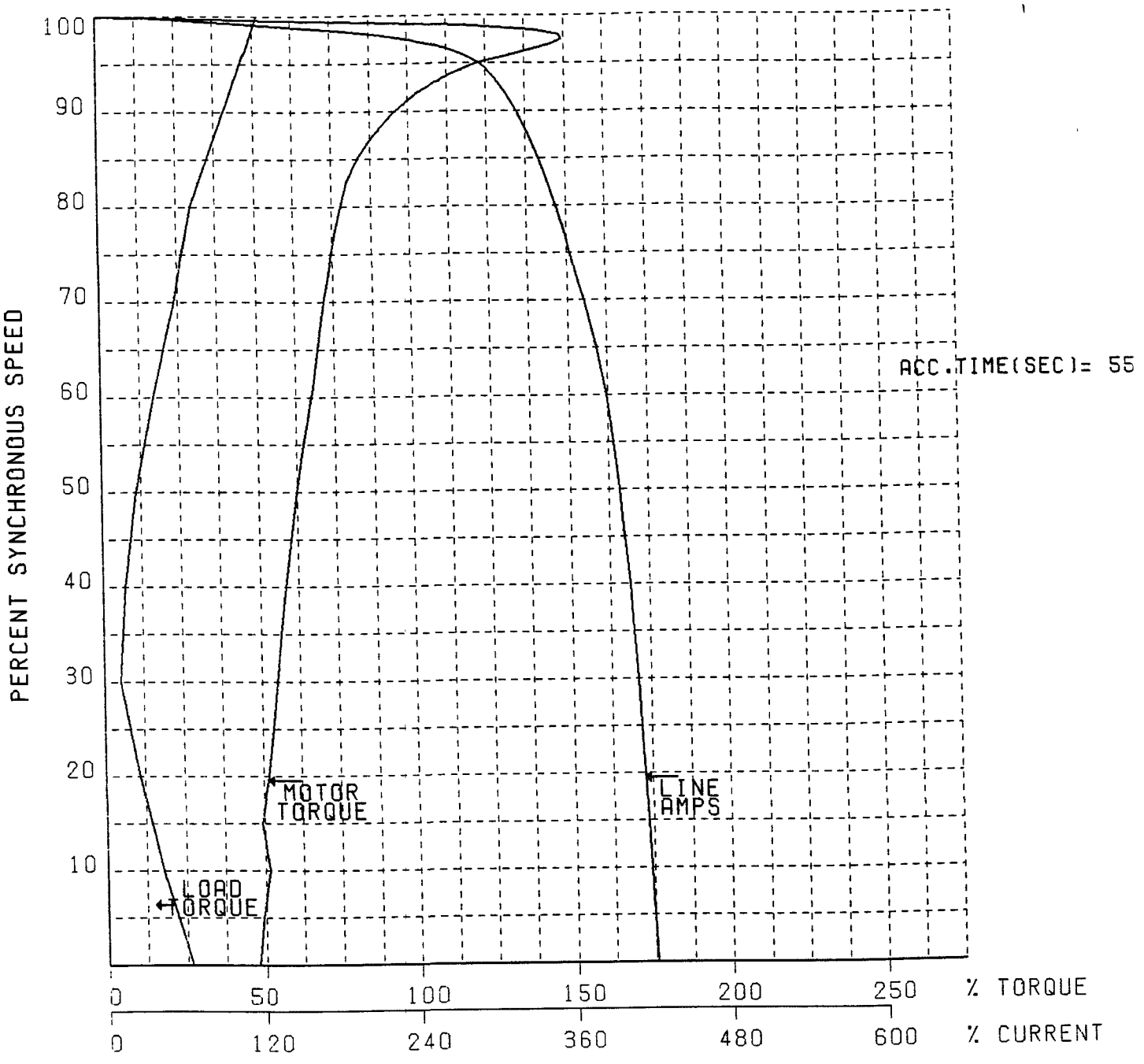
HP 3200 VOLTS 6600 PH 3 HZ 60 POLES 8 RPM (FL) 895

PF 0.82 FL AMPS 265 LOCK AMPS(%) 421 RPM (SYN) 900

L TORQUE(LB-FT) 18764 LOCK TORQUE(%) 48

LOAD WK²(LB-FT²) 152185 MOTOR WK²(LB-FT²) 9576 FRAME 8018

OAD CURVE IVC CLOSED APPLICATION PRIMARY AIR FAN



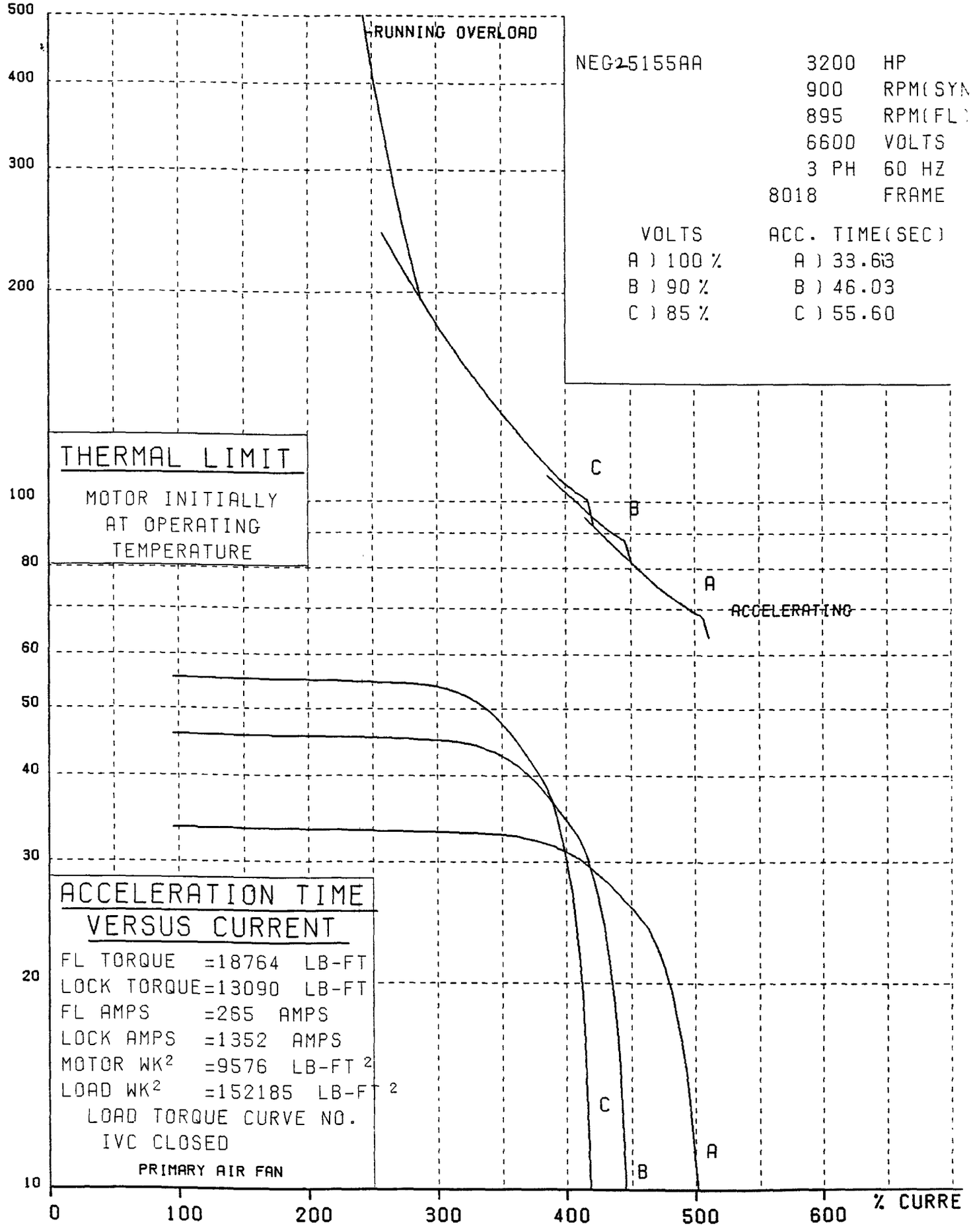
WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005536

TIME - CURRENT AND THERMAL LIMIT CURVES

CUSTOMER: INTERMOUNTAIN POWER

ENGINEER: BANSAL



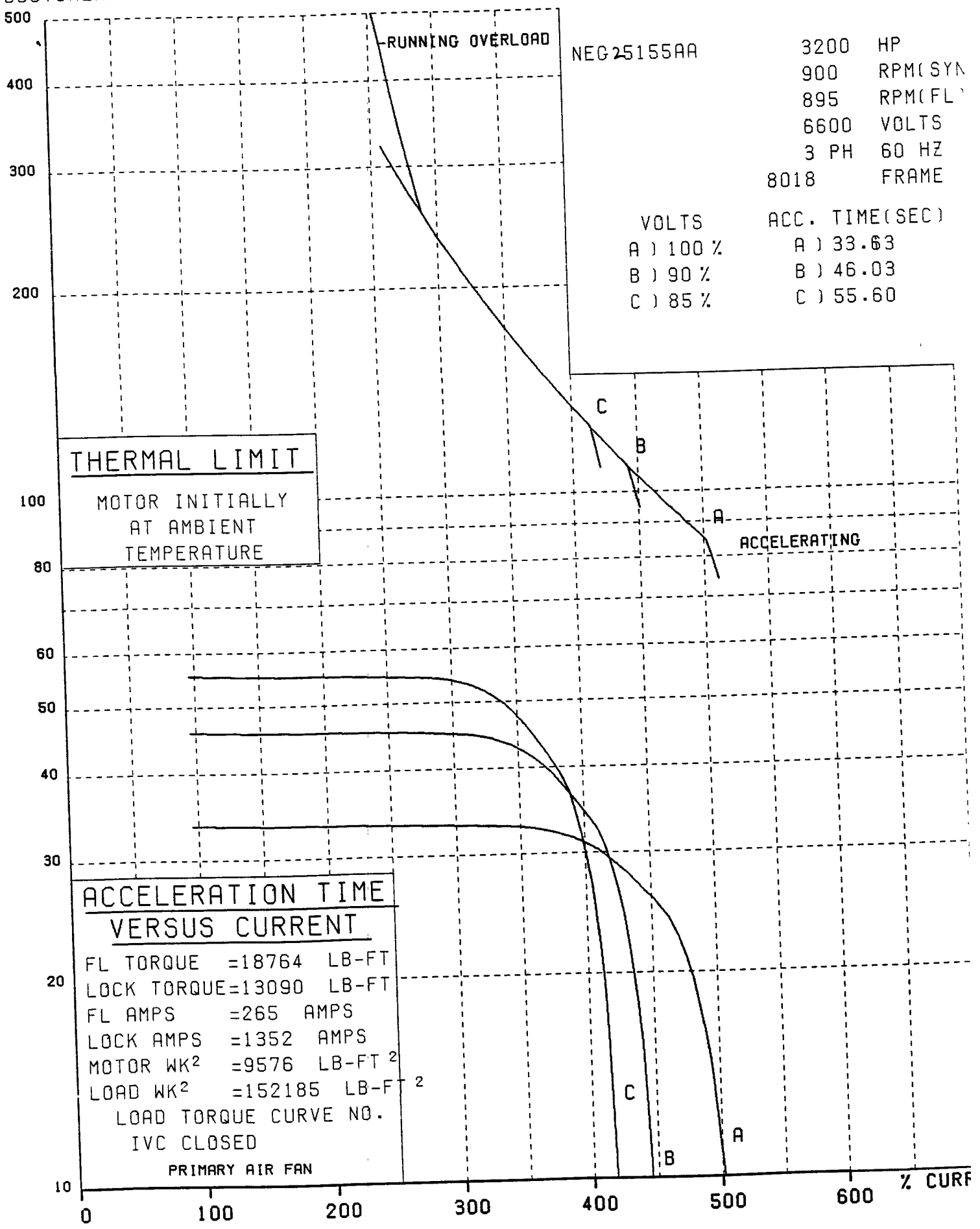
WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

IP12_005537

TIME - CURRENT AND THERMAL LIMIT CURVES

CUSTOMER: INTERMOUNTAIN POWER

ENGINEER: BANSAL



WESTINGHOUSE MOTOR COMPANY ROUND ROCK, TEXAS

DRAWING NO. SPB02249

IP12_005538

APPENDIX E

Black & Veatch Specification 2010N Division G3 paragraph 21.9

each rotating shaft and complying with the requirements of the State of Utah shall be furnished for each coupling of each fan. The coupling guard shall be provided with a removable plate or other equivalent means for inspection and oiling.

21.8 Sole Plates: Steel sole plates for each fan bearing pedestal shall be provided. Bearing pedestals shall be bolted to the IPA foundation by means of anchor bolts extending through the sole plates.

21.9 Primary Air Fans: Primary air fans shall be provided as necessary for proper boiler operation. With one primary fan out of service the remaining fans shall be capable of providing sufficient primary air to permit boiler operation up to not less than 60 percent of Maximum Capacity with each of the specified coals. Test block performance of each fan with inlet boxes and silencers shall be greater than its expected operating performance by not less than 25 percent for weight flow, not less than 50 percent for static discharge pressure, and not less than 25F for temperature at the plant's elevation for each of the specified coals.

The primary air fans shall be of the full shrouded type with backwardly curved airfoil blades and shall be double width, double inlet. The fans shall have inlet boxes complete with silencers. An annubar and 2 thermocouples shall be provided in each inlet box for measuring the primary air flow.

The bearings shall be of the self-aligning, split sleeve type capable of withstanding high thrust loads due to any unbalanced forces on the fan wheel. The bearings shall be cooled with oil from the lubricating oil package specified herein. The bearing lubrication system shall be of the flow-through flood type.

An independent lubricating oil package shall be furnished for each fan and motor unit. Each lubricating oil package shall be capable of supplying the required amount of lubricating oil to the fan and motor bearings at test block conditions.

Each package shall be complete with dual full-capacity water-to-oil heat exchangers, dual full-capacity oil filters, and dual full-capacity pumps and motors. The filter shall be cleanable or replaceable without interrupting the oil flow. The complete package shall be factory-wired, assembled, and mounted on a common base. The packaged system shall be arranged and wired such that either pump may serve as the main supply pump while the other pump serves as the standby pump.

IP12_005540

APPENDIX F

Performance Test 11/4-5/1989

DEPT. OF WATER & POWER
CODE 02814

EQUIPMENT BID AND RECORD

Requested by Garry Christensen Div. IPSC Sec. Tech Services Submitted by _____ Operator _____ Time AM PM _____ Date

Out of Service Clearance (O.K.) TO Garry Christensen Responsible Party Div. IPSC Sec. Tech Services

EQUIPMENT REQUESTED: Unit 1 515 MW gross (see attached load profile)

NATURE OF WORK: Boiler Primary Air Fan Testing
1 PA Fan o/s, isolate dampers on Primary Air heater, other PA Fan in high speed 4 pulverizers I/s
(Bid in MST)

Bid from Nov 4 & Nov 5 Time AM PM 07:00 Am ~~Date~~ To 15:00 pm Time AM PM _____ Date

Work Time from _____ Time AM PM _____ Date To _____ Time AM PM _____ Date

PREPARATION REQUIRED:
Take 1 PA Fan o/s / Other PA Fan @ high speed
Isolate 1 PAH by closing gas inlet & air outlet-inlet dampers
We also want to increase PA Duct pressure to improve/increase PA flow

BID APPROVED:

Shift Supv. _____ Time AM PM _____ Date Removed by _____ Time AM PM _____ Date

Supt. _____ Time AM PM _____ Date Issued to _____ Time AM PM _____ Date

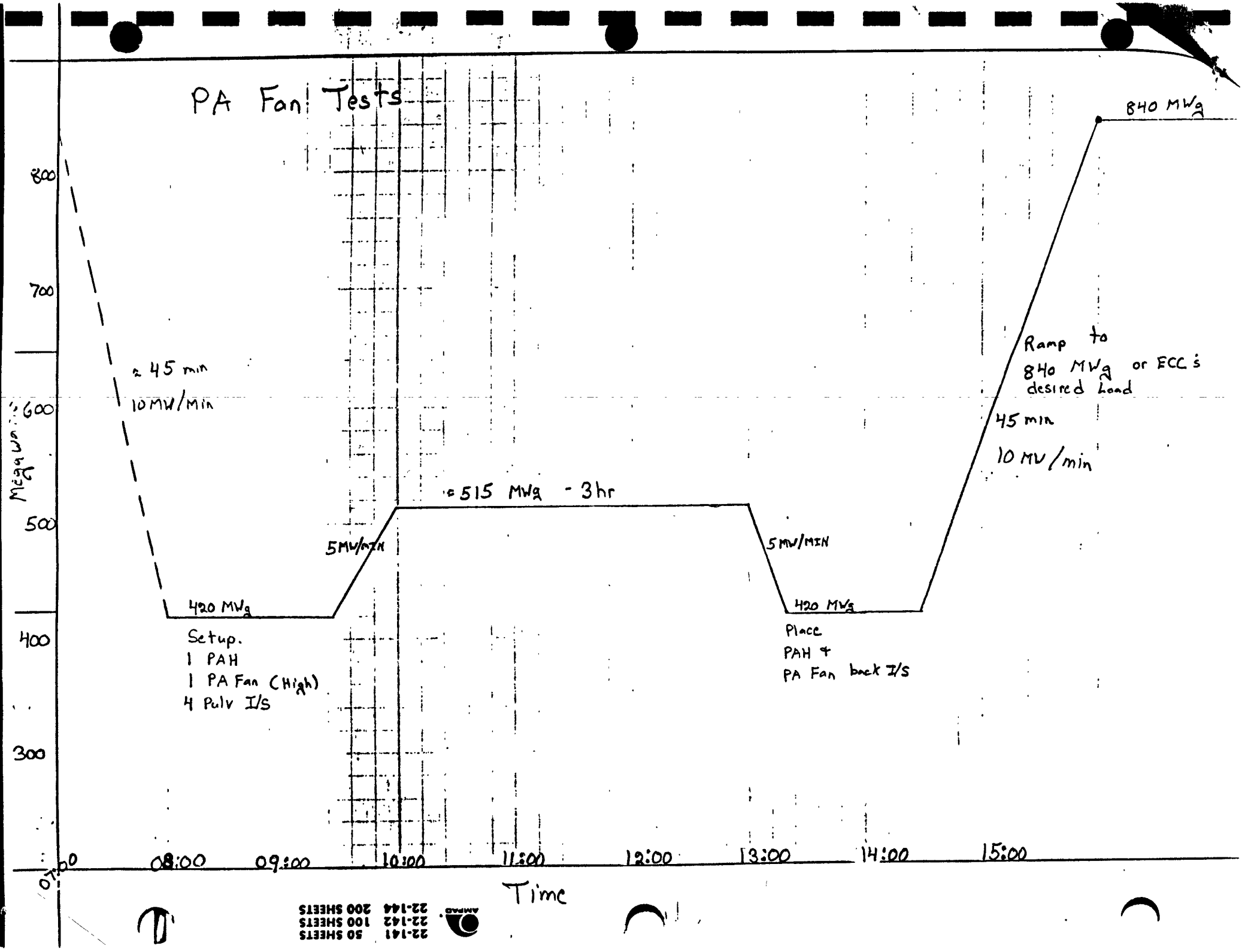
Dispatcher _____ Time PM _____ Date Returned by _____ Time PM _____ Date

EQUIPMENT NORMAL: Time AM PM _____ Date By _____ Operator _____ Foreman

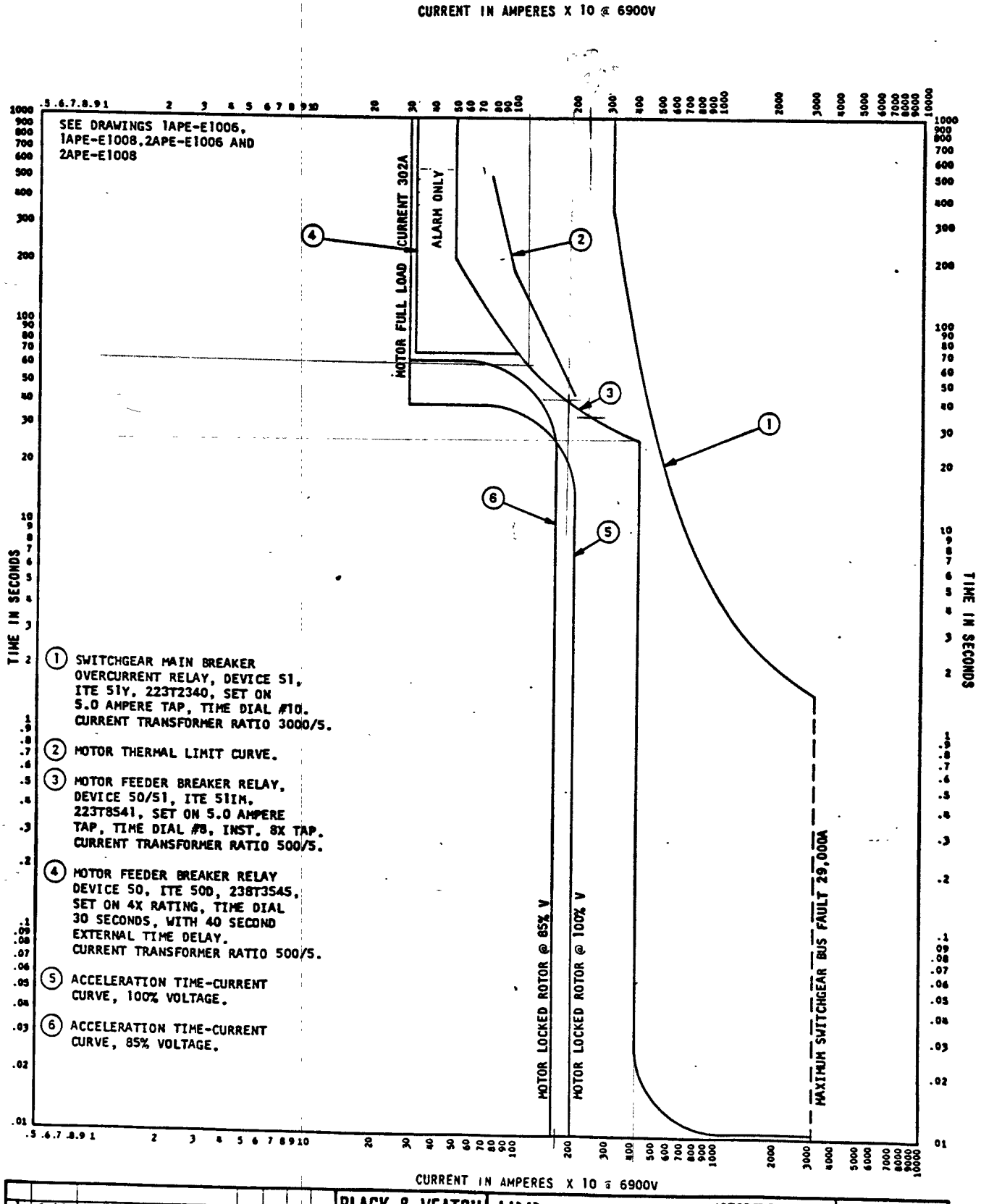
Remarks:

AIR. Item No. _____ Clearance Page _____ Entry No. _____ F.E.R. _____

IP12_005542


PA Fan Tests
Megawatts
800
700
600
500
400
300
07:00
08:00
09:00
10:00
11:00
12:00
13:00
14:00
15:00
Time
≈ 45 min
10 MW/min
420 MWg
Setup.
1 PAH
1 PA Fan (High)
4 Pulv I/S
5MW/MIN
≈ 515 MWg - 3hr
5MW/MIN
420 MWg
Place
PAH &
PA Fan back I/S
Ramp to
840 MWg or ECC's
desired Load
45 min
10 MW/min
840 MWg

IP12_005543



NO	DATE	REVISION	DWN	CK	ACC	APP
1	6-12-87	CONFORMED TO CONSTRUCTION RECORDS	DE		LWS	
0	9-07-84	INITIAL ISSUE	DS		LWS	

BLACK & VEATCH CONSULTING ENGINEERS
PROJECT 9255

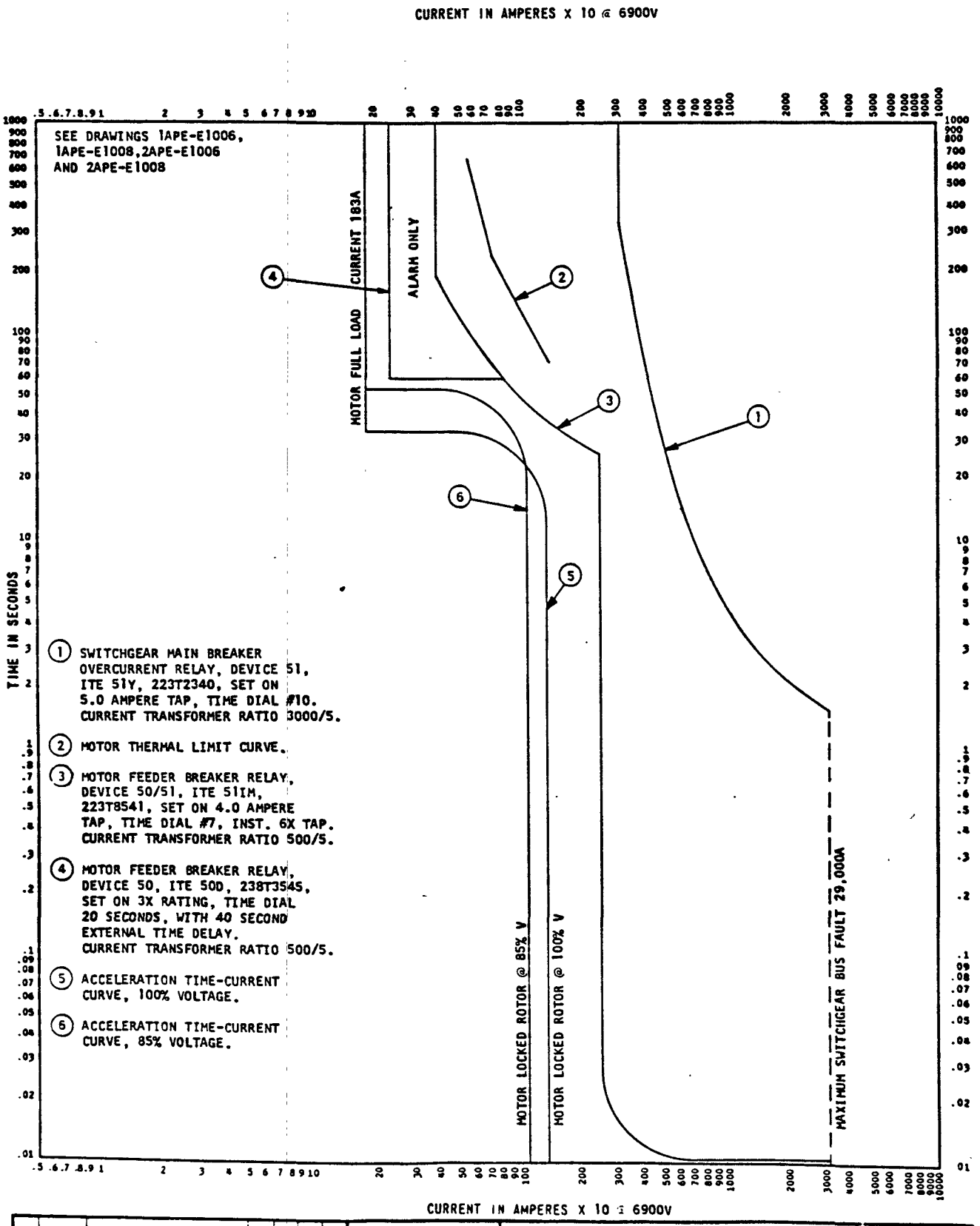
IPP INTERMOUNTAIN POWER PROJECT

6900 VOLT UNIT SWITCHGEAR
PRIMARY AIR FAN MOTOR
HIGH SPEED

FIG. 4-16

IP12_005544

P-EL-076C



NO	DATE	REVISION	DWN	CK	ACC	APP
1	6-12-87	CONFORMED TO CONSTRUCTION RECORDS	DE		LWS	
0	9-07-84	INITIAL ISSUE	DS		LWS	

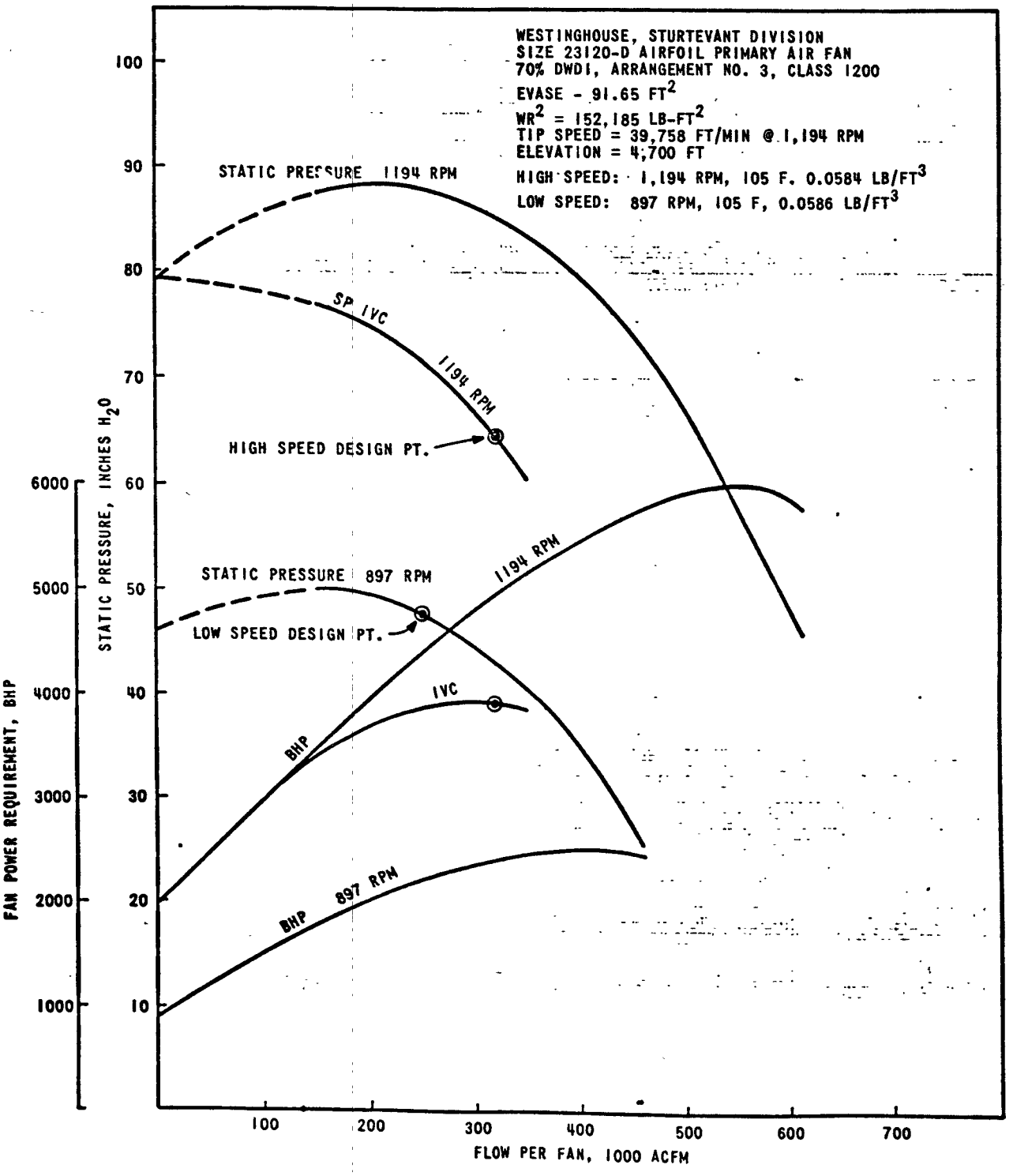
BLACK & VEATCH CONSULTING ENGINEERS
PROJECT 9255

IPP INTERMOUNTAIN POWER PROJECT

6900 VOLT UNIT SWITCHGEAR
PRIMARY AIR FAN MOTOR
LOW SPEED

FIG. 4-17

IP12_005545



PRIMARY AIR FAN STATIC PRESSURE AND HORSEPOWER PERFORMANCE CURVES
FIGURE 3-6

IP12_005546

TABLE 3-2. PRIMARY AIR FAN PREDICTED PERFORMANCE

Item	Test Block	MCR
Inlet Air Temperature, F	105	105
Inlet Air Density, lb/ft^3	0.0588	0.0588
Capacity, each fan		
Pounds per hour	1,120,300	882,000
Actual cfm	317,500	250,000
Fan Static Pressure, in. wg	62.5	44.5
Fan Static Efficiency, per cent	81.9	84.9
Design Fan Speed, rpm	1,194	897
Input Horsepower	3,810	2,061

IP12_005547

WSD General Order No. AKY-6081 Item No. 1&

RATE OF TEMPERATURE CHANGE:

3. CONTRACT PERFORMANCE

	FAN LOAD	VOLUME CFM	STATIC PRESSURE INLET	STATIC PRESSURE OUTLET	STATIC PRESSURE RISE	TEMP °F	SPEED RPM	BHP	DENSITY #/FT.^{3}
High Spd.	T.B.	320,000	-3.73	60.71	64.44	105	1194	3989	0.0584
	NET	244,000	-2.40	39.37	41.77	80	1194	3150	0.0614
Low Spd.	T.B.	252,600	-2.36	45.22	47.58	105	897	2217	0.0586
	NET	222,600	-2.16	34.46	36.62	60	897	1739	0.0637

Performance based on elevation of 4700 feet, 25.18" Hg Bar. Pressure

Performance based on use of Evase expanded to INCL sq. ft.

4. NOISE LEVELS

BAND Center Frequency

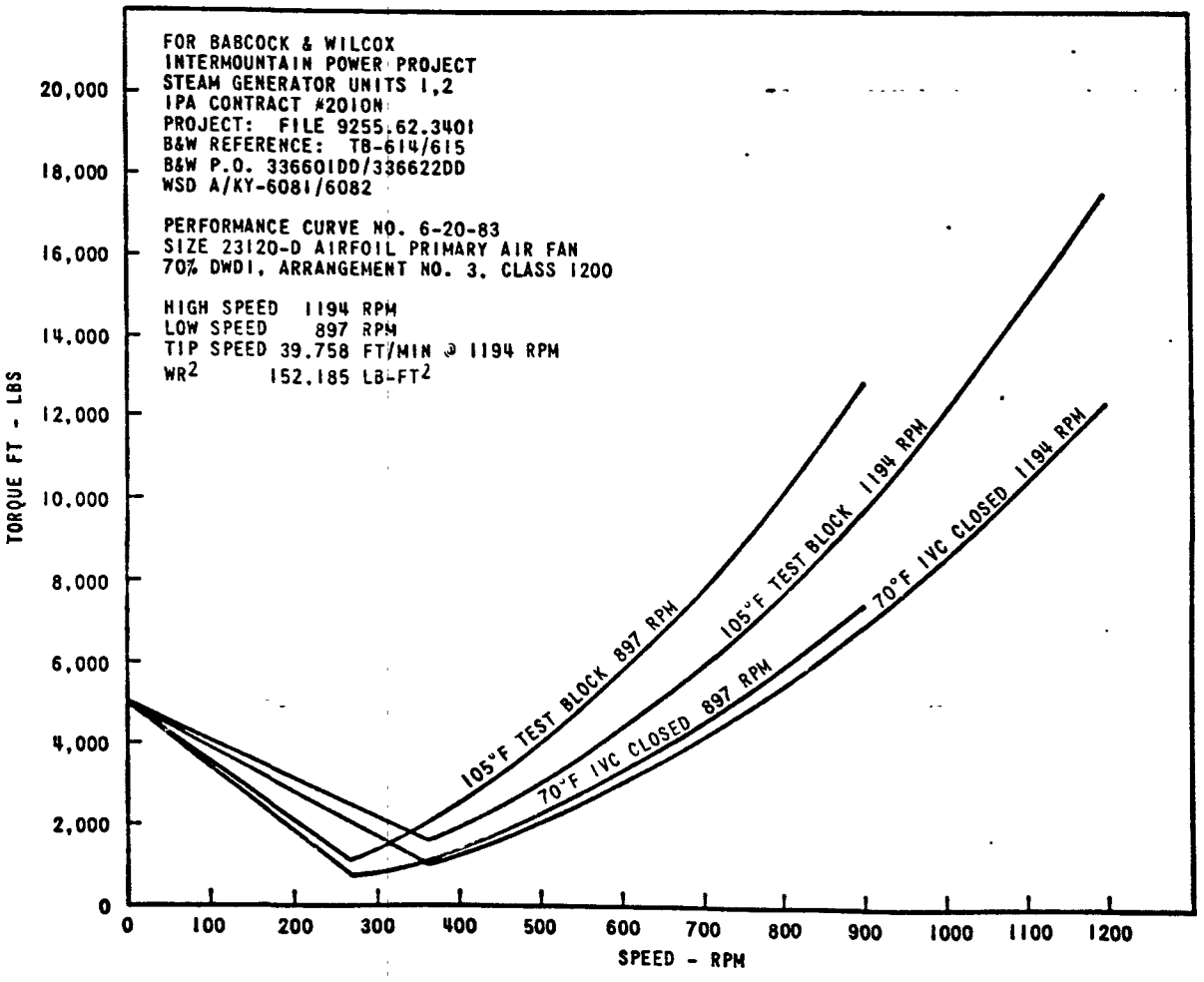
Measured at

Hz	1 63	2 125	3 250	4 500	5 1000	6 2000	7 4000	8 8000	Overa
A	75	78	78	72	58	67	77	78	85
B	105	108	115	116	118	118	115	108	124
C	82	85	89	89	90	89	81	69	96
D									

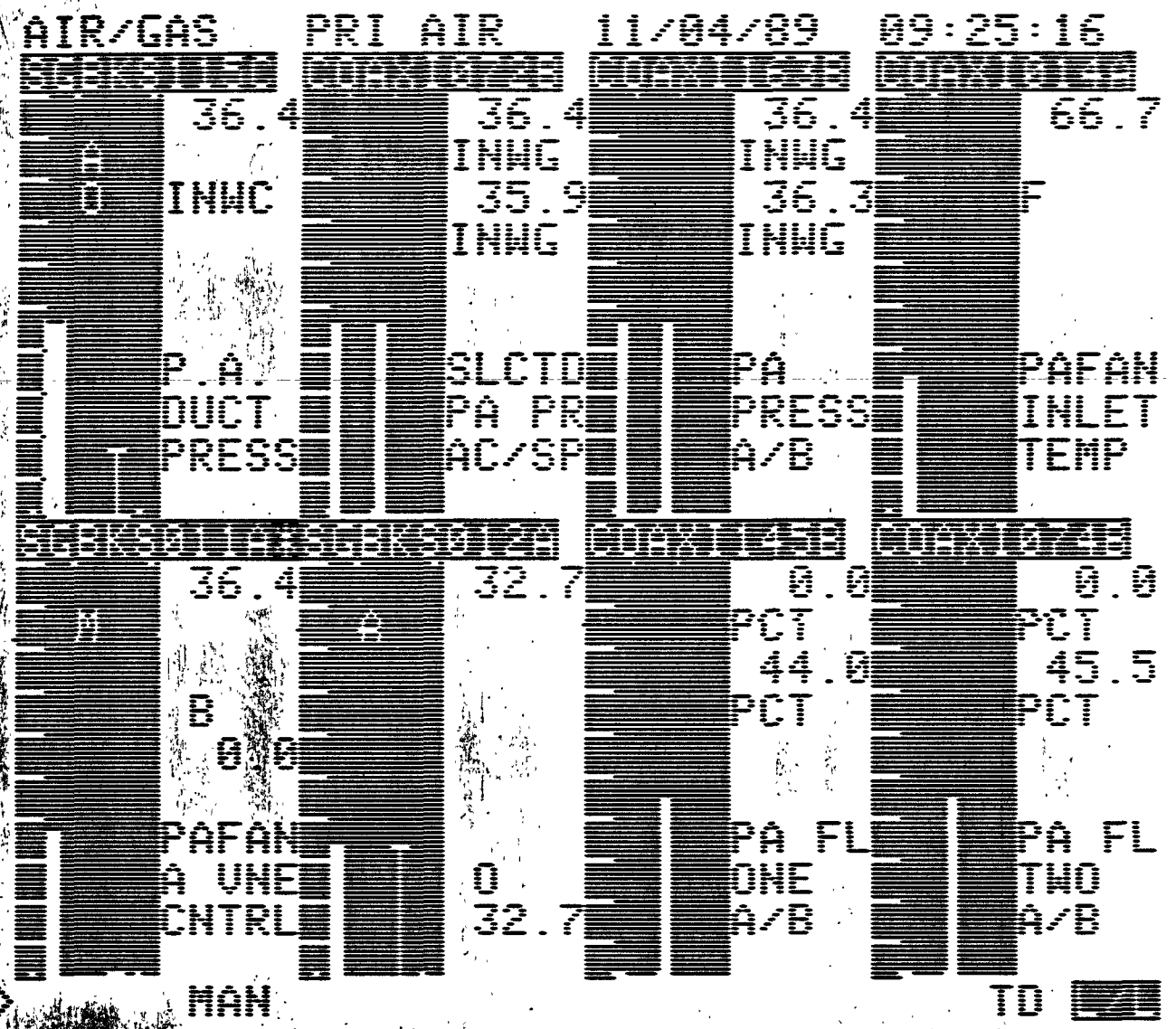
A - Inlet noise, measured 5 feet from inlet
B - Discharge Noise, measured 5 feet from discharge
C - Noise thru housing, measured 5 feet from housing, without inlet noise added
D - Noise around fan, measured _____ feet from housing with inlet noise added, BUT WITHOUT discharge drive or noise effect of other equipment added.

Above noise levels are:

☐ Sound power Ref. 10^{-12} Watts (metric)
☒ Sound pressure Ref. .0002 microbars
☒ A scale ☐ C scale



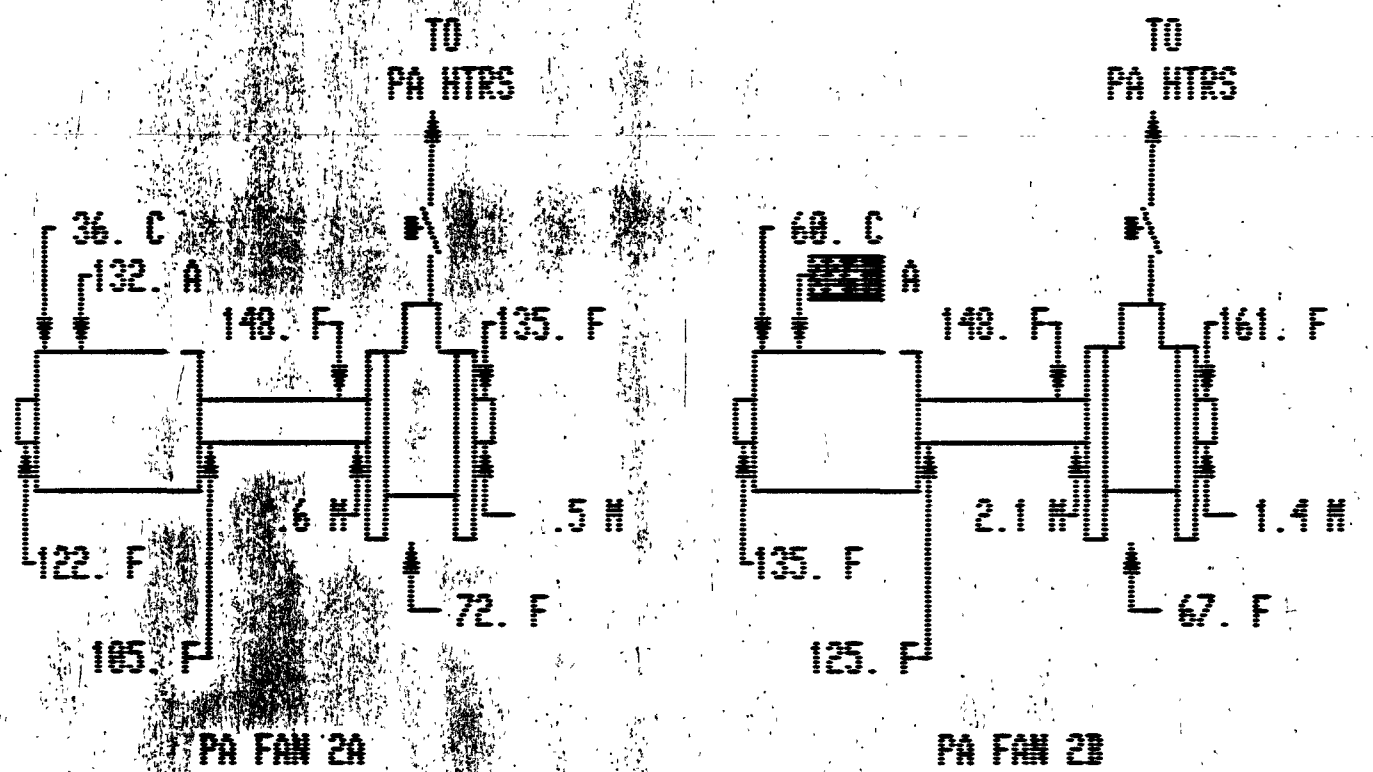
PRIMARY AIR FAN
SPEED-TORQUE CURVES
FIGURE 3-7


AIR/GAS PRI AIR 11/04/89 09:25:16
36.4
36.4
36.4
66.7
A
INWG
INWG
D
INWC
35.9
36.3
F
INWG
INWG
P.A.
SLCTD
PA
PAFAN
DUCT
PA PR
PRESS
INLET
PRESS
AC/SP
A/B
TEMP
36.4
32.7
0.0
0.0
M
A
PCT
PCT
44.0
45.5
B
PCT
PCT
0.0
PAFAN
PA FL
PA FL
A VNE
0
ONE
TWO
CNTRL
32.7
A/B
A/B
MAN
TD

IP12_005550

UNDER SOFTWARE LOCK 11/04/89 09:24:41 UIMAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS

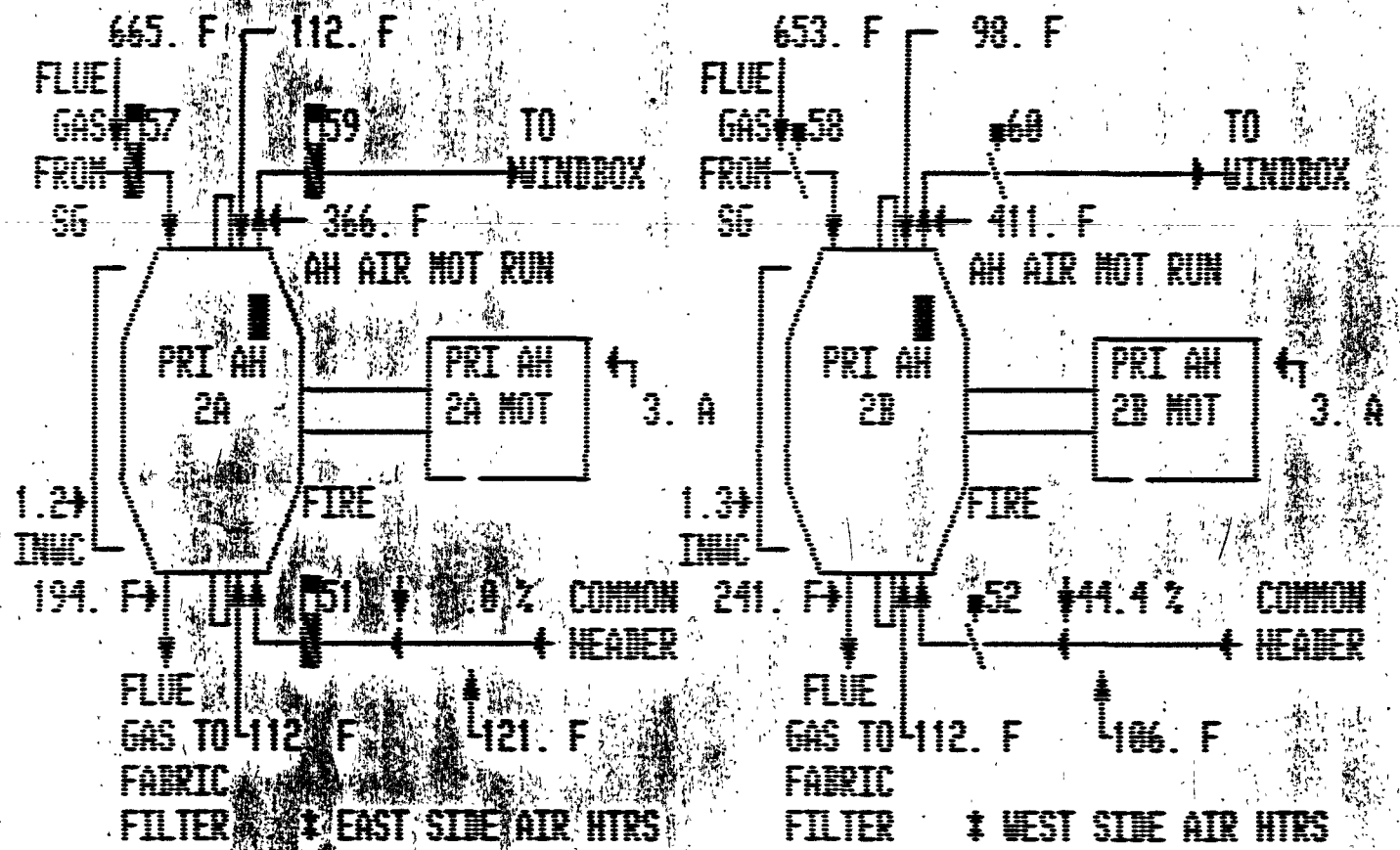


FORWARD PAGING SGBG09

IP12_005551

UNDER SOFTWARE LOCK 11/04/09 09:24:31 U1MAIN

SGBC06 SUBSYSTEM - PRIMARY AIR HEATERS PG 6 OF 6



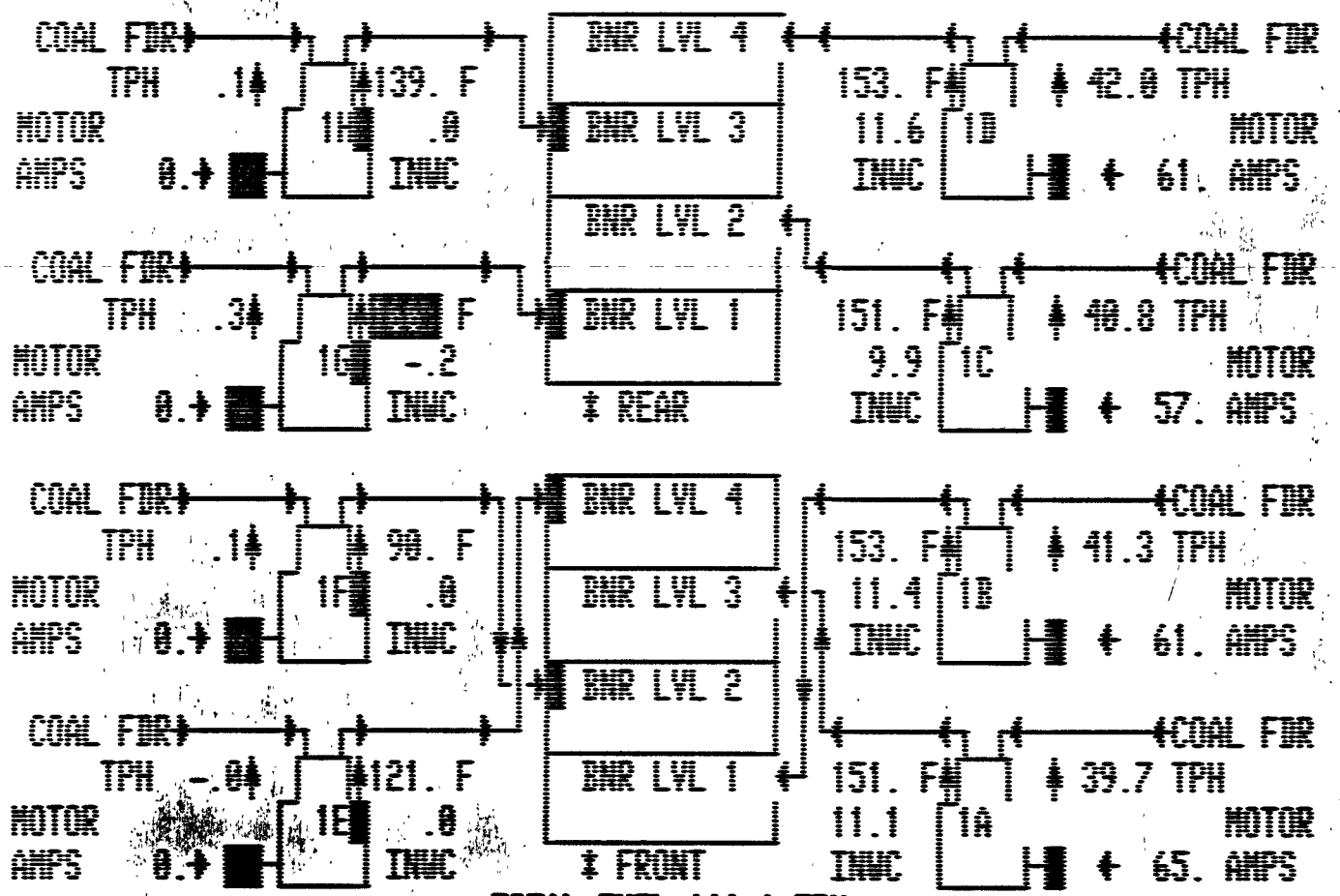
FORWARD PAGING SGBC06

IP12_005552

UNDER SOFTWARE LOCK 11/04/89 08:58:39 U1MAIN

UNIT LOAD 422. MW SGAC88 SYSTEM - FUEL PG 1 OF 6

‡ PRIMARY AIR ‡ BURNER TEMPS ‡ FUEL OIL



TOTAL FUEL 166.1 TPH

FORWARD PAGING SGAC88

IP12_005553

AIR/GAS PRI AIR 11/04/89 08:41:40

37.3	37.3	37.3	63.1
A	INWG	INWG	
0 INWC	35.5	37.3	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP

33.0	29.7	0.0	0.0
M	A	PCT	PCT
		41.9	42.9
B		PCT	PCT
0.0			
PAFAN		PA FL	PA FL
A VNE	0	ONE	TWO
CNTRL	29.7	A/B	A/B

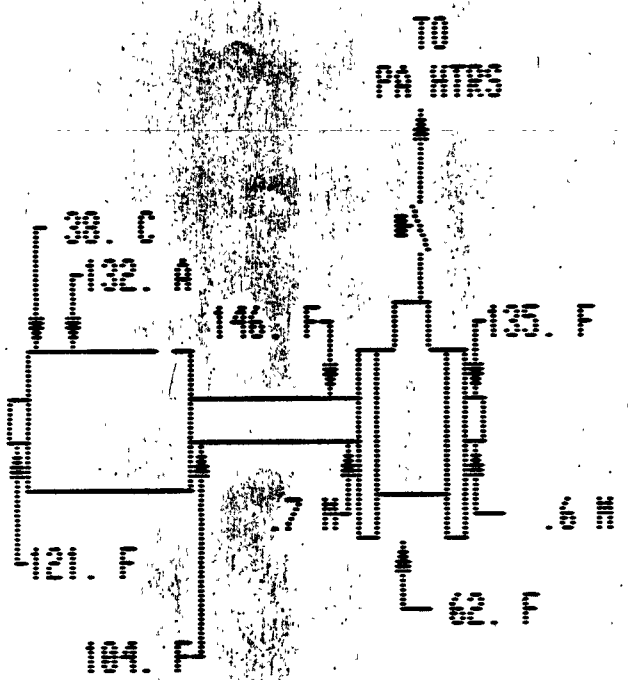
> MAN TD

IP12_005554

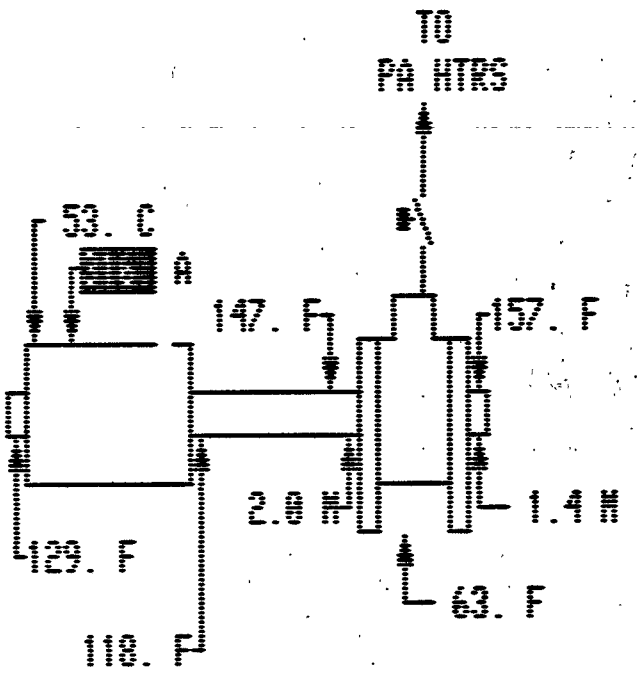
UNDER SOFTWARE LOCK

11/04/89 08:40:28 UTMATN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



PA FAN 2A



PA FAN 2B

FORWARD PAGING SGBG09

IP12_005555

UNDER SOFTWARE LOCK 11/04/89 08:42:46 U1MAIN

MEASUREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

BLOCK	VALUE		DESCRIPTION	STATUS	ALARM
COAXI027A	421.	MW	UNIT LOAD		
COAXI024A	2833.	KPPH	TURBINE STEAM FLOW		
FWAFT0025	2596.	KPPH	BOILER FEEDWATER F		
SGATE0863	692.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
SGATE0864	694.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
SGGTE0002	1004.	DEGF	SEC SUPHTR OUTLET STEAM T		
SGGPT0001	1590.	PSIG	MAIN STEAM LINE PR		
SGAFT0070	6.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
SGAFT0072	151.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
SGATE0991	285.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
SGAFT0071	0.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
SGAFT0073	152.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
SGATE0991	285.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
SGJTE0022	593.	DEGF	SG E COLD REHEAT INLET T		
SGJTE0019	592.	DEGF	SG W COLD REHEAT INLET T		
SGJPT0011	253.	PSIG	SG E COLD REHEAT INLET PR		
SGJTE0011	1004.	DEGF	SG N HOT REHEAT OUTLET T		
SGJPT0006	243.	PSIG	TURBINE N HOT REHEAT INLET PR		
SGJFT0020	0.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
SGJTE0060	120.	DEGF	REHEAT DESUPERHEATER SPRAY T		

FORWARD PAGING DW1

IP12_005556

UNDER SOFTWARE LOCK 11/04/89 08:43:11 U1MAIN

MEASUREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

BLOCK	VALUE		DESCRIPTION	STATUS	ALARM
SGAPT0174	-1.1	INWC	BNR LVL 2 S WINDBOX PR		
SGAPT0176	-1.1	INWC	BNR LVL 4 S WINDBOX PR		
SGAPT0179	-.8	INWC	BNR LVL 3 N WINDBOX PR		
SGAPT0177	-.7	INWC	BNR LVL 1 N WINDBOX PR		
SGAPT0173	-.2	INWC	BNR LVL 1 S WINDBOX PR		
SGAPT0175	-.1	INWC	BNR LVL 3 S WINDBOX PR		
SGAPT0180	.2	INWC	BNR LVL 4 N WINDBOX PR		
SGAPT0178	.1	INWC	BNR LVL 2 N WINDBOX PR		
COAKS007A	52.8	PCT	SECONDARY AIR DAMPER POS 1A		
COAKS003A	56.1	PCT	SECONDARY AIR DAMPER POS 1B		
COAKS005A	56.4	PCT	SECONDARY AIR DAMPER POS 1C		
COAKS009A	56.4	PCT	SECONDARY AIR DAMPER POS 1D		
COAKS010A	10.0	PCT	SECONDARY AIR DAMPER POS 1E		
COAKS006A	10.0	PCT	SECONDARY AIR DAMPER POS 1F		
COAKS004A	10.0	PCT	SECONDARY AIR DAMPER POS 1G		
COAKS008A	30.0	PCT	SECONDARY AIR DAMPER POS 1H		
SGAPT0171	-1.1	INWC	SG EAST FLUE GAS PR		

FORWARD PAGING BW2

IP12_005557

UNDER SOFTWARE LOCK 11/04/89 08:42:11 U1MAIN

MEASUREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 3

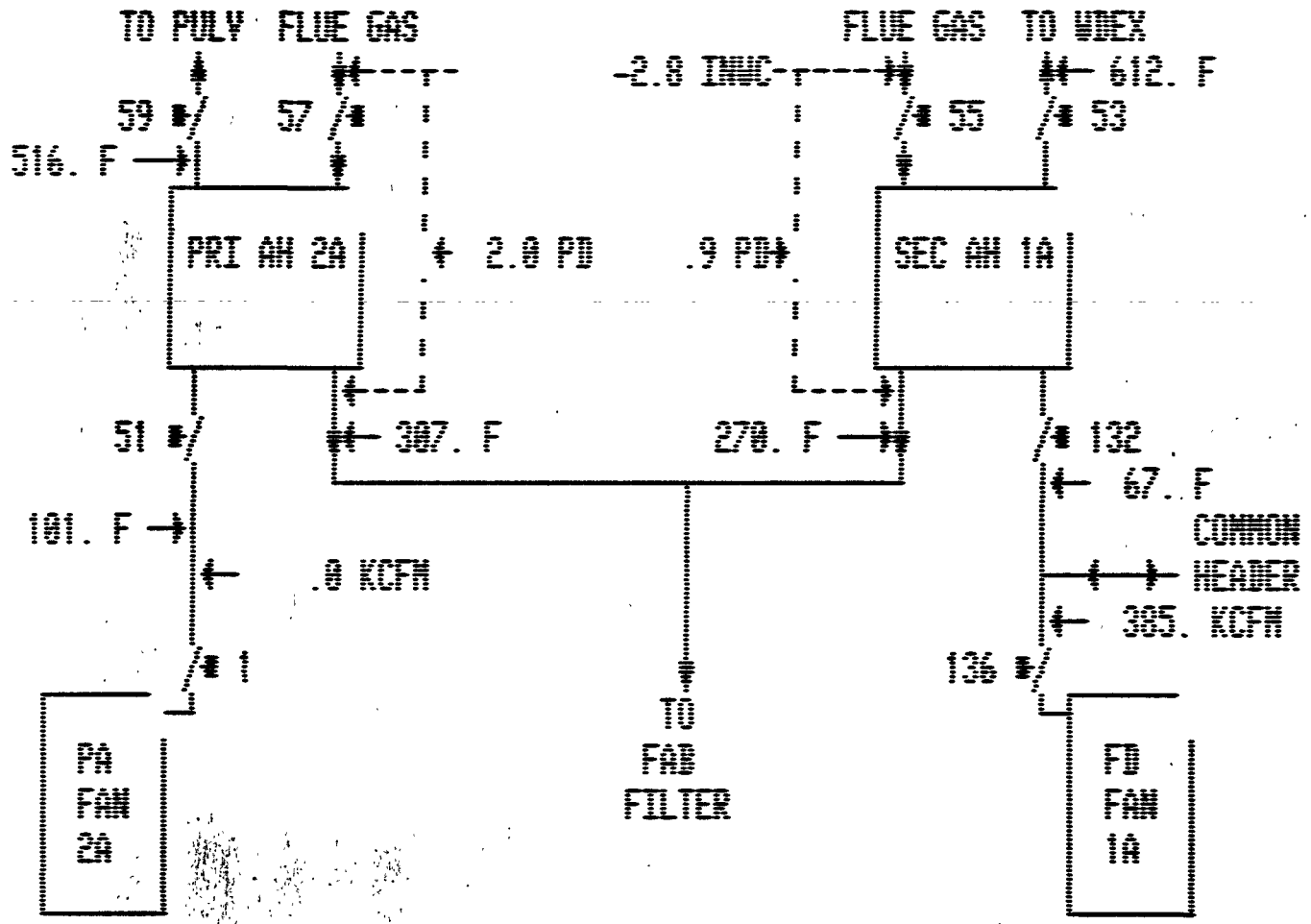
BLOCK	VALUE		DESCRIPTION	STATUS	ALARM
COAXI001A	165.4	TPH	TOTAL FUEL FLOW		
COAXI002A	39.9	TPH	PULV 1A COAL FLOW		
COAXI003A	41.6	TPH	PULV 1B COAL FLOW		
COAXI004A	41.5	TPH	PULV 1C COAL FLOW		
COAXI005A	42.4	TPH	PULV 1D COAL FLOW		
COAXI006A	-.0	TPH	PULV 1E COAL FLOW		
COAXI007A	.1	TPH	PULV 1F COAL FLOW		
COAXI008A	.3	TPH	PULV 1G COAL FLOW		
COAXI009A	.1	TPH	PULV 1H COAL FLOW		
COAXI080A	3.2	PCT	WEST FLUE GAS O2		
COAXI079A	5.5	PCT	EAST FLUE GAS O2		
SGATE0707	665.	DEGF	ECON EAST OUTLET FLUE GAS T		
SGATE0710	657.	DEGF	ECON WEST OUTLET FLUE GAS T		
SGBTE0927	262.	DEGF	SEC AH 1A GAS OUT T		
SGBTE0929	251.	DEGF	SEC AH 1B GAS OUT T		
SGBTE0913	293.	DEGF	PRI AH 2A GAS OUT T		
SGBTE0916	284.	DEGF	PRI AH 2B GAS OUT T		
COAXI072A	38.0	INWC	PA DUCT PRESS		
COAXI084A	-8.1	INWC	ID FANS SUCT PRESS		
SGAPT0165	-1.4	INWC	SG ECON OUTLET FLUE GAS PR		

FORWARD PAGING DW3

IP12_005558

UNDER SOFTWARE LOCK 11/04/89 08:45:57 U1MAIN

SGBG07 SUBSYSTEM - EAST SIDE AIR HEATERS

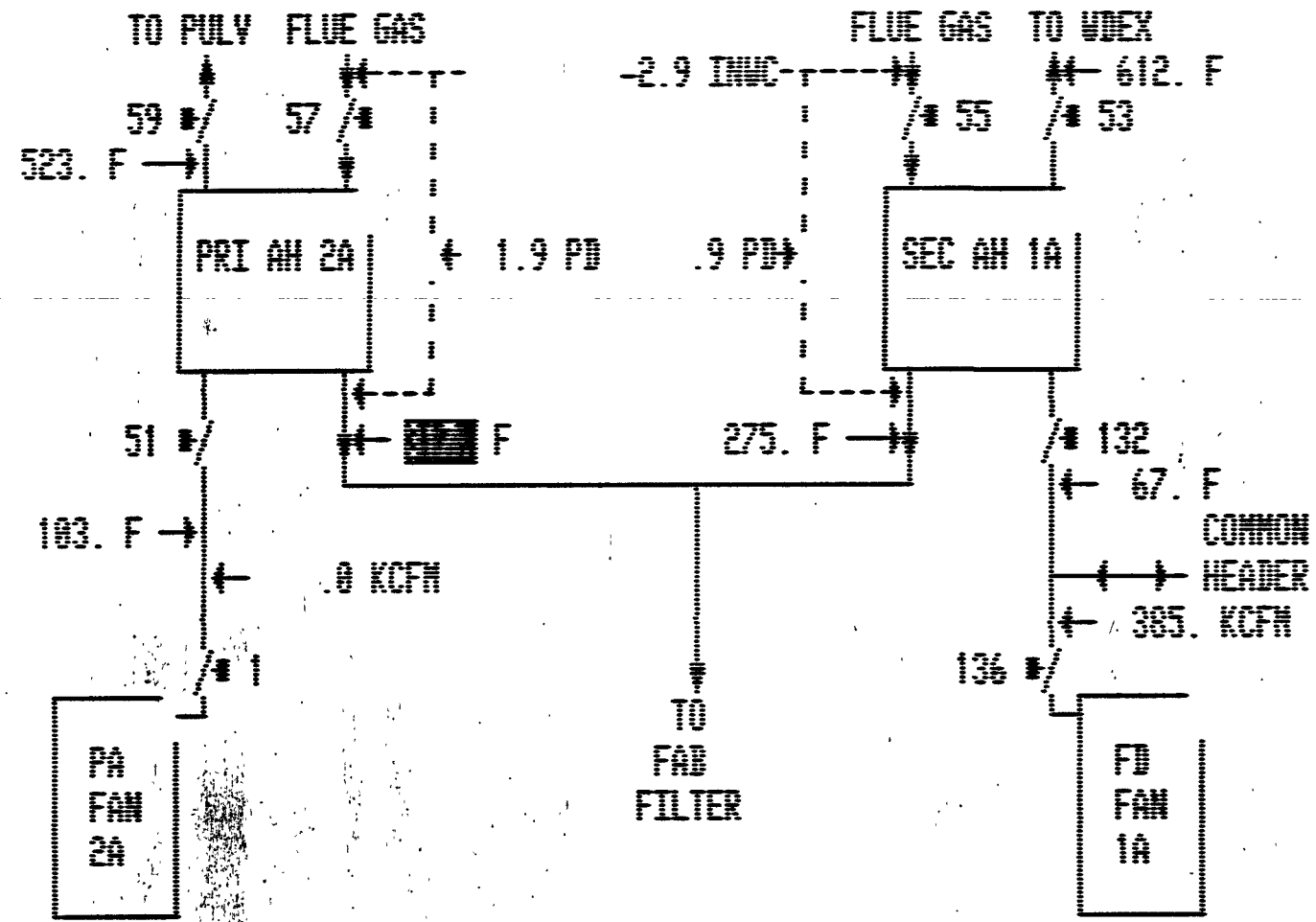


FORWARD PAGING SGBG07

IP12_005559

UNDER SOFTWARE LOCK 11/04/89 08:49:00 U1MAIN

SGB607 SUBSYSTEM - EAST SIDE AIR HEATERS



FORWARD PAGING SGB607

IP12_005560

AIR/GAS PRI AIR 11/04/89 08:55:39

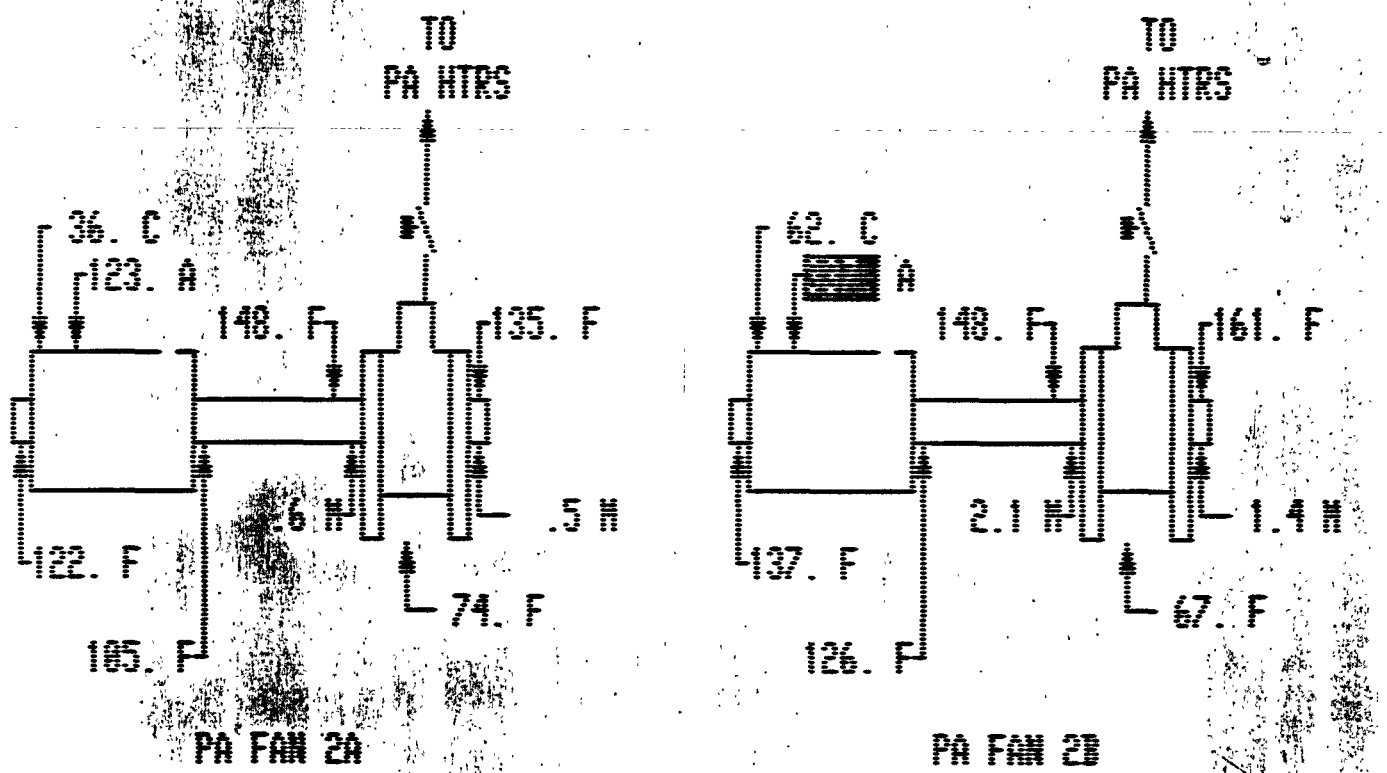
37.9	37.9	37.9	64.2
B	INWG	INWG	
0 INWC	35.6	37.9	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
33.3	30.0	0.0	0.0
M	A	PCT	PCT
		42.1	42.9
B		PCT	PCT
0.0			
PAFAN		PA FL	PA FL
A VNE	0	ONE	TWO
CNTRL	30.0	A/B	A/B

> MAN TD

IP12_005561

UNDER SOFTWARE LOCK 11/04/89 09:35:49 UIMAIN

SG1G09 SUBSYSTEM -PRIMARY AIR FANS



FORWARD PAGING SG1G09

IP12_005562

AIR/GAS PRI AIR 11/04/89 09:36:27

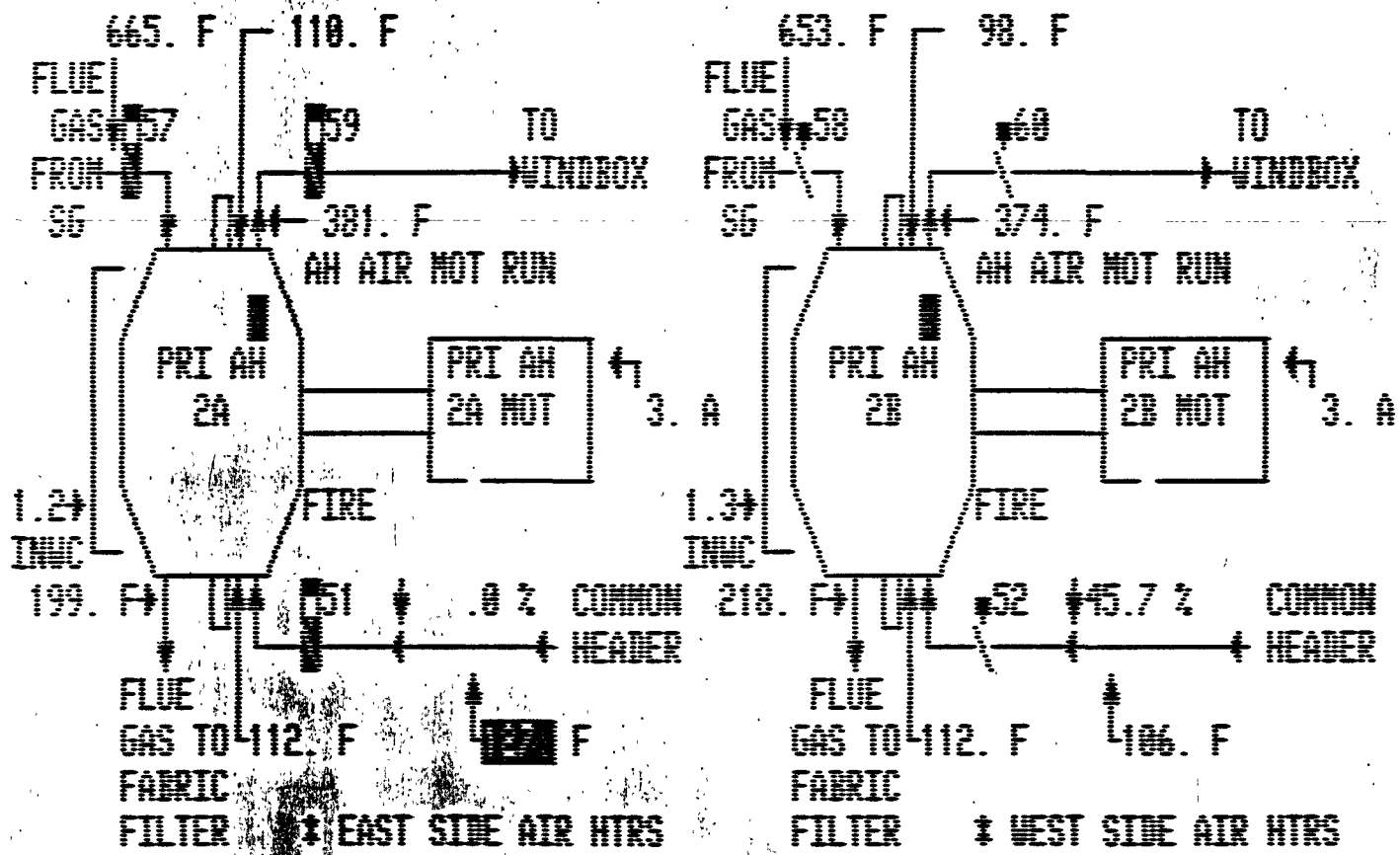
38.1	38.0	38.0	66.5
A	INWG	INWG	
B INWC	35.2	38.0	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
36.3	32.6	0.0	0.0
M	A	PCT	PCT
		45.8	45.5
B		PCT	PCT
0.0			
PAFAN	PAFAN	PA FL	PA FL
A VNE	B VNE	ONE	TWO
CNTRL	CNTRL	A/B	A/B

L/L SCN L/L < > L/L L/L GTD

IP12_005563

UNDER SOFTWARE LOCK 11/04/89 09:35:54 U1MAIN

SGBG06 SUBSYSTEM - PRIMARY AIR HEATERS PG 6 OF 6



FORWARD PAGING SGBG06

IP12_005564

APPENDIX G

Babcock and Wilcox Performance Test 1/18/89

Summary PA Fan test Results Unit 2

FAN IDENTITY	TEST #	UNITS	OUTPUT POWER HP	INPUT POWER HP	VOLUMETRIC FLOW RATE ACFM	STATIC PRESS.RISE in. wg.	VELOCITY PRESS. RISE in. wg.	TOTAL PRESS. RISE in. wg.	TOTAL EFFICIENCY %	STATIC EFFICIENCY %
WEST	1	INLET	1344	3757	243421	38.79	0.55	39.34	35.77	35.27
		OUTLET	1511	3704	275260	38.24	0.55	38.79	40.80	40.22
		AVERAGE	1428	3729	259332	38.49	0.55	39.04	38.28	37.75
WEST	2	INLET	1345	3789	245053	38.51	0.58	39.09	35.50	34.97
		OUTLET	1560	3722	286232	37.83	0.58	38.41	41.91	41.28
		AVERAGE	1452	3752	265629	38.14	0.58	38.72	38.70	38.13
WEST	3	INLET	1329	3760	242599	38.47	0.56	39.04	35.35	34.84
		OUTLET	1526	3699	280262	37.83	0.56	38.4	41.25	40.65
		AVERAGE	1427	3727	261420	38.13	0.56	38.69	38.30	37.74
EAST	4	INLET	1195	3657	225283	37.38	0.48	37.85	32.69	32.72
		OUTLET	1361	3597	258154	36.75	0.48	37.23	37.84	37.35
		AVERAGE	1278	3625	241707	37.04	0.48	37.52	35.26	34.81
EAST	5	INLET	1305	3733	234299	39.26	0.55	39.81	34.95	34.49
		OUTLET	1556	3655	281569	38.43	0.55	38.98	42.58	41.98
		AVERAGE	1431	3690	257915	38.80	0.55	39.35	38.78	38.24
EAST	6	INLET	1339	3763	241408	39.02	0.55	39.57	35.59	35.10
		OUTLET	1559	3695	282950	38.31	0.55	38.86	42.18	41.59
		AVERAGE	1449	3726	262165	39.63	0.55	39.18	38.89	38.34

IP12_005566

Relay Techs 6846
Lamar & Ron

TEST 1

one change speeds on leave in auto, other in manual

Test #1 Unit 2

1/18/89 PA Fan Testing U.O. Darwin Cheff

test start 10:00 -12:00 testing PA 2B Fan

could only traverse (11)
12 taps on outlet, 16 on each inlet

wet bulb and dry bulb, watt readings, rpm using strobe

Fan 2B in high speed auto, 2A Fan low speed in manu

@ 10:10 wet bulb 38.3°F dry bulb 51.4°F

@ 10:38 PA 2A Fan air flow 44 on position feedback

PA 2B Fan air flow 25 on position feedback

300 amps on 2B Fan, 182 amps on 2A Fan

Power 3.070 - 3.080 MW

2B Fan
Test #2 start 13:00 Finish 14:40

dry 49.9 wet 38.0 @ 13:25

PA 2A Fan air flow position feedback 44

PA 2B Fan air flow position feedback 25

Amps 2B 308 Amps 2A 182

~~4 Capas~~
~~test Code~~

Test #3 2B Fan

start 15:00 end 16:30

Log 13
Group 35
SGBKK0008

IP12_005567

2B Fan Test #1

Start 10:00 PRS

#Dm 3.086MW .88PF
18-Jan-89 09:47:13

#Dm 3.088MW .88PF
18-Jan-89 09:57:13

Status
18-Jan-89 10:03:56

Avg 6.709 KV

T 3.504 MVA

T 3.075 MW

T .88 PF

#Dm 3.075MW .88PF
18-Jan-89 10:07:13

#Dm 3.087MW .88PF
18-Jan-89 10:17:13

#Dm 3.072MW .88PF
18-Jan-89 10:27:13

#Dm 3.083MW .88PF
18-Jan-89 10:37:13

#Dm 3.082MW .88PF
18-Jan-89 10:47:13

Status
18-Jan-89 10:47:49

Avg 6.708 KV

T 3.512 MVA

T 3.082 MW

T .88 PF

#Dm 3.071MW .88PF
18-Jan-89 10:57:13

#Dm 3.080MW .88PF
18-Jan-89 11:07:13

Status
18-Jan-89 11:11:42

Avg 6.699 KV

T 3.502 MVA

T 3.074 MW

T .88 PF

#Dm 3.070MW .88PF
18-Jan-89 11:17:13

#Dm 3.077MW .88PF
18-Jan-89 11:27:13

#Dm 3.068MW .88PF
18-Jan-89 11:37:13

Status
18-Jan-89 11:45:34

Avg 6.696 KV

T 3.501 MVA

T 3.072 MW

T .88 PF

#Dm 3.078MW .88PF
18-Jan-89 11:47:13

#Dm 3.086MW .88PF
18-Jan-89 11:57:13

Status
18-Jan-89 12:03:43

Avg 6.692 KV

T 3.514 MVA

T 3.085 MW

T .88 PF

Test #1 End 12:00

IP12_005568

BDS 120-1

BABCOCK & WILCOX

Time Test start 10:00 Test Finish 12:00	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Baro	Fan Bias	Fuel Flow	Gross MW
					N/A		
10:00	300	30.6%	25.75	72°		91%	853
10:45	300	30.4%	25.75	72°		91%	853
11:15	300	30.4	25.75	72°		90%	854
11:30	300	30.5	25.74	72		88.7	852
11:45	300	30.4	25.74	72		90	853
12:00	300	29.7	25.74	72		90	853

CUSTOMER Intermountain Power Project

SUBJECT PP [illegible] Tester Control Room Data

Test # 1 B Fan Full Load

FPC 10

JOB NO. RB-615

BY JM Jr

DATE 1/18/88

IP12_005569

BDS 120-1

BABCOCK & WILCOX

Time Test start 10:00 Test Finish	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
10:00	-.25" wak	38.4	51.8	1203			
10:45	-.25"	39.3	52.9	1203			
11:15	-.25"	37.9	50.1	12:03			
11:30	-.23	37.6	50.0	1203			
11:45	-.23	37.4	49.5				
12:00	-.23	37.5	49.8				

CUSTOMER Intermountain Power Project	JOB NO. RB-615
SUBJECT CA Fan Test, Fan Room Data	
Test #1 BFan Full Load	BY JM Jr.
[illegible]	DATE 1/15/88

IP12_005570

BDS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∠	TEMP			
TAP 1 POINT 1	0.9	.249	-2.5	52.2			
1 - 2	0.9	.197	+2.5	52.4			
1 - 3	0.9	.202	-1.0	53.2			
1 - 4	0.9	.207	0	[illegible]			
2 - 1	0.9	.273	-2.0	53.4			
2 - 2	0.9	.214	+2.0	53.0			
2 - 3	0.9	.258	-2.0	53.4			
2 - 4	0.9	.300	-1.0	53.6			
3 - 1	0.9	.273	0	53.8			
3 - 2	0.9	.236	+1.0	53.6			
3 - 3	1.0	.278	-1.0	53.4			
3 - 4	1.0	.212	0	53.4			
4 - 1	1.0	.224	-1.0	53.4			
4 - 2	1.0	.202	-3.0	52.4			
4 - 3	1.0	.197	-3.0	52.4			
4 - 4	1.0	.197	-1.0	52.6			
5 - 1	1.0	.247	+1.0	52.8			
5 - 2	1.0	.229	-1.0	53.6			
5 - 3	1.0	.244	-1.0	52.6			
5 - 4	1.0	.266	-2.0	52.4			
6 - 1	1.0	.251	+3.0	53.6			
6 - 2	1.0	.170	+1.0	52.8			
6 - 3	1.0	.241	+1.0	52.2			
6 - 4	1.0	.314	-2.0	52.8			
7 - 1	1.0	.310	-1.0	54.0			
7 - 2	1.0	.253	+3.0	52.8			
7 - 3	1.0	.312	+2.0	52.0			
7 - 4	1.0	.341	0	52.0			
8 - 1	1.0	.319	+1.0	52.8			
8 - 2	1.0	.300	-1.0	52.2			
8 - 3	1.0	.336	+1.0	51.6			
8 - 4	1.0	.300	+2.0	51.6			
9 - 1	1.0	.280	0	52.0			
9 - 2	1.0	.261	-3.0	52.0			
9 - 3	1.0	.268	-2.0	51.4			
9 - 4	1.0	.283	0	51.0			
10 - 1	1.0	.239	0	51.6			
10 - 2	1.0	.227	-6.0	51.4			
10 - 3	1.0	.212	-5.0	51.0			
10 - 4	1.0	.202	0	50.8			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET EAST SIDE

Test # 1 10:00 A.M.

EAST WEST FAN

JOB NO.

BY MCB

DATE 11/17/79

IP12_005571

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 11	POINT 1	1.0	.314	-6	52.6			
11	2	1.0	.285	-3	52.2			
11	3	1.0	.317	-3	51.0			
11	4	1.0	.251	-6	50.6			
12	1	1.0	.285	0	52.8			
12	2	1.0	.268	-1	51.8			
12	3	1.0	.314	+1	50.6			
12	4	1.0	.2[illegible]	+2	50.[illegible]			
13	1	1.0	.283	+1	51.8			
13	2	1.0	.283	+1	50.8			
13	3	1.0	.271	+2	49.8			
13	4	1.0	.283	+1	49.4			
14	1	1.0	.302	0	50.8			
14	2	1.0	.292	-3	50.0			
14	3	1.0	.263	-3	49.4			
14	4	1.0	.361	+1	49.6			
15	1	1.0	.200	+3	50.0			
15	2	1.0	.139	-2	50.0			
15	3	1.0	.146	-3	49.2			
15	4	1.0	.192	+2	48.6			
16	1	1.0	.141	+2	49.8			
16	2	1.0	.117	-5	49.8			
16	3	1.0	.063	-5	49.0			
16	4	1.0	.129	+5	48.8			
BARO P								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET; East Side

Test # 1 10 mm

File ID WEST FAN

JOB NO.

BY MCB

DATE 1/18/79

IP12_005572

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 17	Point 1	1.0	.209	-1	50.2			
	2	1.0	.173	-7	50.6			
	3	1.0	.175	-5	51.2			
	4	1.0	.175	-3	52.0			
18	1	1.0	.205	-3	51.6			
	2	1.0	.158	-10	52.4			
	3	1.0	.180	-7	52.4			
	4	1.0	.222	-5	53.0			
19	1	1.0	.241	-7	53.0			
	2	1.0	.227	-7	52.8			
	3	1.0	.263	-5	53.2			
	4	1.0	.271	-5	53.6			
20	1	1.0	.168	-5	54.0			
	2	1.0	.148	-4	53.6			
	3	1.0	.166	-5	53.4			
	4	1.0	.161	-7	54.0			
21	1	1.0	.173	-7	53.2			
	2	1.0	.209	-3	53.6			
	3	1.0	.202	-6	54.0			
	4	1.0	.209	-5	54.2			
22	1	1.0	.197	-10	53.6			
	2	1.0	.190	-6	53.4			
	3	1.0	.214	-8	53.8			
	4	1.0	.271	-10	54.4			
23	1	1.0	.241	-4	53.6			
	2	1.0	.212	-8	53.6			
	3	1.0	.258	-5	53.6			
	4	1.0	.249	-6	53.6			
24	1	1.0	.222	-6	53.2			
	2	1.0	.214	-6	53.2			
	3	1.0	.251	-5	53.4			
	4	1.0	.253	-6	53.4			
25	1	1.0	.288	-4	53.0			
	2	1.0	.212	0	53.2			
	3	1.0	.295	+1	53.6			
	4	1.0	.251	-1	53.4			
26	1	1.0	.214	-3	52.8			
	2	1.0	.197	+3	53.0			
	3	1.0	.241	0	53.0			
	4	1.0	.244	-5	53.0			

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Inlet West Side

Test # 1 [illegible]

File ID [illegible]

JOB NO.

BY [illegible]

DATE [illegible]

IP12_005573

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 27	Point 1	1.0	.295	+3	52.8			
	2	1.0	.246	-2	52.6			
	3	1.0	.307	0	52.8			
	4	1.0	.311	+2	53.0			
28	1	1.0	.256	-4	52.4			
	2	1.0	.241	-2	52.6			
	3	1.0	.263	-2	52.6			
	4	1.0	.275	-2	52.6			
29	1	1.0	.227	-6	52.2			
	2	1.0	.217	-2	52.0			
	3	1.0	.236	-2	51.2			
	4	1.0	.219	-6	51.2			
30	1	1.0	.253	-6	51.4			
	2	1.0	.219	+2	51.4			
	3	1.0	.244	-2	50.8			
	4	1.0	.283	-2	50.2			
31	1	1.0	.200	-8	50.2			
	2	1.0	.094	-1	50.4			
	3	1.0	.131	-4	49.4			
	4	1.0	.153	-5	49.2			
32	1	1.0	.112	-10	49.8			
	2	1.0	.053	+3	50.0			
	3	1.0	.039	-1	49.4			
	4	1.0	.114	-7	49.4			

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Inlet test side

Test # 1 10:00 AM

Flo TD WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005574

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP	POINT							
1	1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10							
2	1	39	0.454	30	96.4			
2	2	39	0.542	30	97.2			
2	3	39	0.421	23	97.0			
2	4	39	0.361	15	97.4			
2	5	39	0.373	15	97.6			
2	6	39	0.410	10	97.2			
2	7	39	0.339	10	97.2			
2	8	39	0.411	15	97.2			
2	9	39	0.615	15	97.2			
2	10	39	0.893	20	97.6			
3	1	39	0.09	~~10~~ 60	97.2			
3	2	38	0.107	~~15~~ 61	97.6			
3	3	38	0.31	25	97.4			
3	4	38	0.321	15	97.6			
3	5	39	0.211	0	97.4			
3	6	39	0.192	5	97.4			
3	7	39	0.231	10	97.4			
3	8	39	0.419	15	97.2			
3	9	39	0.739	20	97.2			
3	10	39	0.847	20	97.2			
4	1	39	0.546	35	104			
4	2	39	0.512	30	97.4			
4	3	39	0.292	15	97.2			
4	4	39	0.151	5	97.4			
4	5	39	0.073	0	97.0			
4	6	39	0.126	5	97			
4	7	39	0.151	0	97			
4	8	39	0.40	10	96.8			
4	9	39	0.739	15	96.8			
4	10	39	0.913	15	97.2			

CUSTOMER [illegible]

SUBJECT [illegible] OUTLET

[illegible] # 1

[illegible]

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005575

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 5	POINT 1	39	0.598	30	97.2			
5	2	39	0.463	30	97.4			
5	3	39	0.231	30	97.4			
5	4	39	0.109	30	97.6			
5	5	39	0.029	5	97.4			
5	6	39	0.041	0	97.2			
5	7	39	0.126	0	97.2			
5	8	39	0.319	5	97.4			
5	9	39	0.786	10	97.4			
5	10	39	1.074	15	97.4			
6	1	39	0.747	30	97			
6	2	39	0.468	30	97			
6	3	39	0.185	25	97			
6	4	39	0.046	15	97			
6	5	39	0.026	10	97			
6	6	39	0.026	0	97			
6	7	39	0.217	10	97.2			
6	8	39	0.319	10	97.4			
6	9	39	1.01	10	97.6			
6	10	39	1.193	10	97.8			
7	1	39	0.749	20	96.8			
7	2	39	0.549	20	97.4			
7	3	39	0.104	15	97.4			
7	4	39	0.056	10	97.4			
7	5	39	0.051	10	97.4			
7	6	39	0.061	10	97.4			
7	7	39	0.145	5	97.4			
7	8	39	0.445	10	97.6			
7	9	39	1.045	5	97.8			
7	10	39	1.303	10	97.8			
8	1	40	0.998	-20	95.6			
8	2	40	0.588	15	97			
8	3	39	0.212	20	97.2			
8	4	39	0.053	20	96.8			
8	5	39	0.058	10	97.2			
8	6	39	0.090	10	97.2			
8	7	39	0.234	10	97.8			
8	8	39	0.478	5	97.6			
8	9	39	1.181	5	97.4			
8	10	39	1.342	5	98			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TBT DELTA

TEST # 1

FILE ID

JOB NO.

BY Paul Wu

DATE 1/18/89 Brent

IP12_005576

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	40	0.881	10	96.6			
9	2	40	0.622	10	96.8			
9	3	40	0.30	10	96.6			
9	4	40	0.212	5	96.6			
9	5	40	0.092	10	96.6			
9	6	40	0.209	0	96.6			
9	7	40	0300	0	96.6			
9	8	40	0.70	.5	96.6			
9	9	40	1.272	5	96.6			
9	10	40	1.452	5	96.8			
10	1	40	0.637	10	97			
10	2	40	0.666	10	97.2			
10	3	40	0.427	10	97.4			
10	4	40	0.292	15	97.4			
10	5	40	0.266	0	97.4			
10	6	40	0.214	5	97.2			
10	7	40	0.463	0	97.4			
10	8	40	0.734	0	97.6			
10	9	40	1.152	0	97.6			
10	10	40	1.084	5	97.6			
11	1	40	0.681	0	97.2			
11	2	40	0.461	0	97.0			
11	3	40	0.544	10	97.2			
11	4	40	0.505	0	96.8			
11	5	40	0.71	0	97			
11	6	40	.686	0	96.8			
11	7	40	.881	10	97			
11	8	40	.881	5	97			
11	9	40	0.775	10	97			
11	10	40	.587	0	95.4			
12	1	40	0.236	0	96.4			
12	2	40	0.151	0	96.6			
12	3	40	0.266	0	96.8			
12	4	40	0.412	0	96.8			
12	5	40	0.432	5	97			
12	6	40	0.449	0	97			
12	7	40	0.354	5	97			
12	8	40	0.354	0	97			
12	9	40	0.176	0	97			
12	10	40	0.075	0	97			

Continued on Next

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PRE-FAN TEST OUTLET

Test #1

Blue Ro

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005577

AIR/GAS PRI AIR 01/18/89 09:48:13

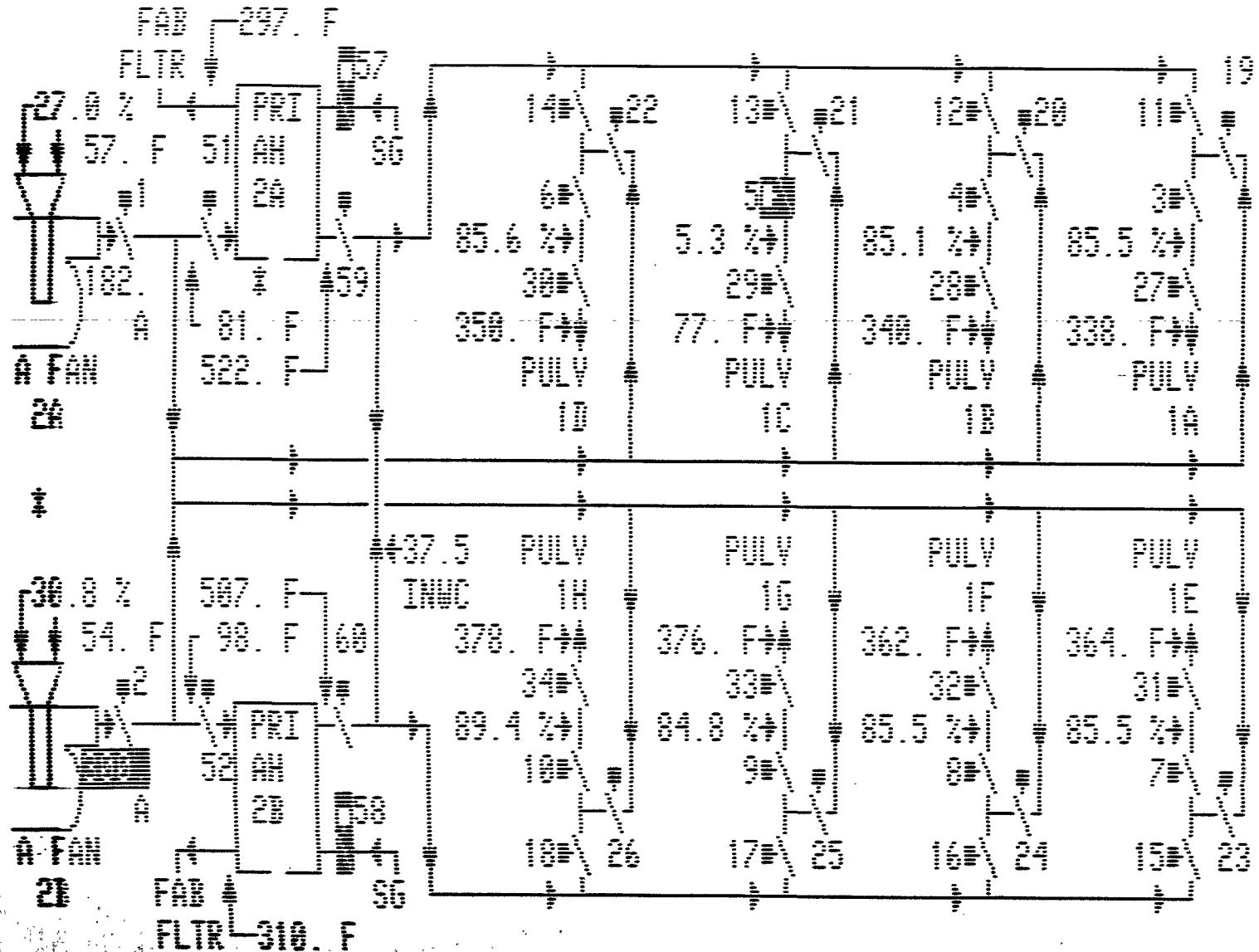
37.0	37.9	37.9	54.6
INWC	INWC	INWC	
INWC	37.5	38.0	F
	INWC	INWC	
P.A. DUCT PRESS	SLCTD PA PR AC/SP	PA PRESS A/B	PAFAN INLET TEMP
28.6	25.7	28.6	27.0
B	B	PCT	PCT
0.0		31.7	30.8
HB		PCT	PCT
50.0			
LB			
-50.0	PAFAN B VNE CNTRL	PA FL ONE A/B	PA FL TWO A/B
0 42.9			

> AUT +S- ASN +F- TD

IP12_005578

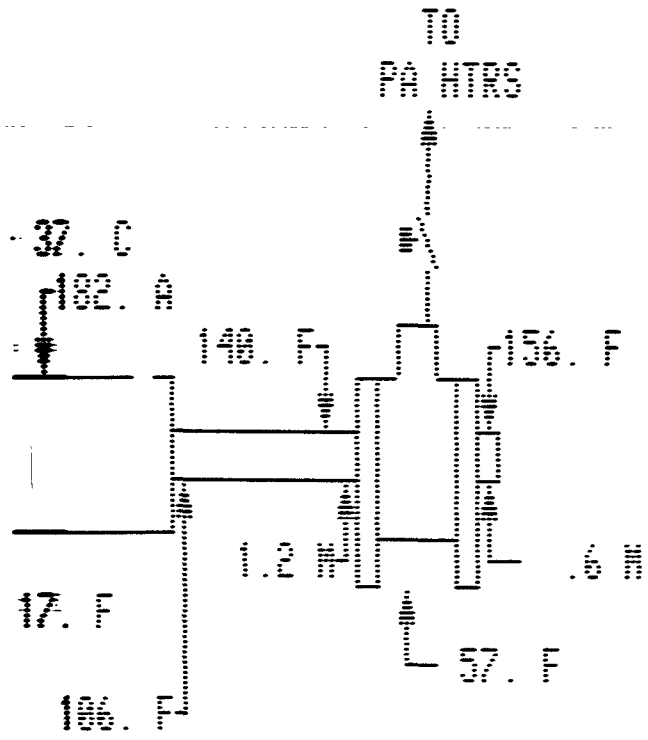
SOFTWARE LOCK 01/18/89 10:04:09 U2MAIN

SGB605 SYSTEM - PRIMARY AIR PG 4 OF 6

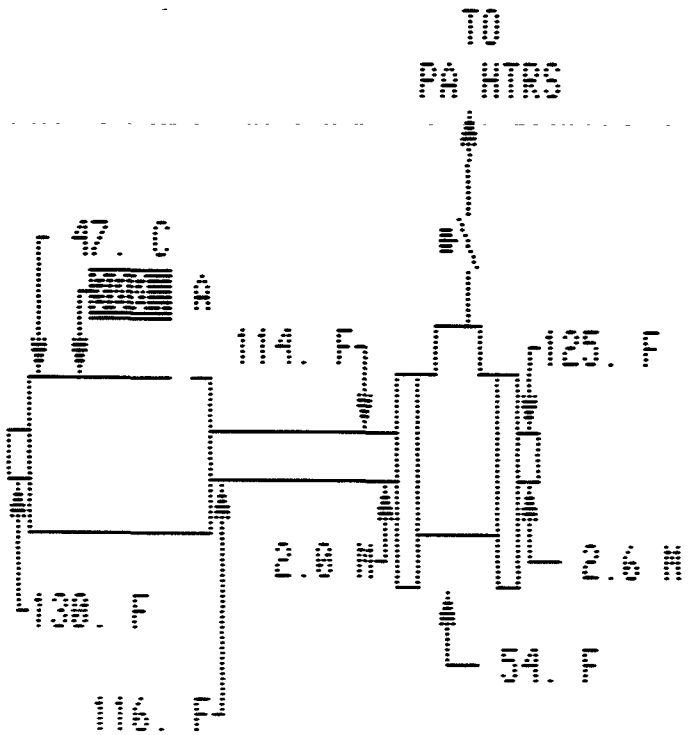


SOFTWARE LOCK 01/18/89 10:02:53 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



PA FAN 2A



PA FAN 2B

CODUADR DACTWC SCBC09

IP12_005580

SOFTWARE LOCK 01/18/89 10:02:00 U2MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	318.4	TPH	TOTAL FUEL FLOW		
XI002A	43.5	TPH	PULV 1A COAL FLOW		
XI003A	44.8	TPH	PULV 1B COAL FLOW		
XI004A	[redacted]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	43.8	TPH	PULV 1D COAL FLOW		
XI006A	43.8	TPH	PULV 1E COAL FLOW		
XI007A	45.3	TPH	PULV 1F COAL FLOW		
XI008A	43.9	TPH	PULV 1G COAL FLOW		
XI009A	49.2	TPH	PULV 1H COAL FLOW		
XI088A	1.6	PCT	WEST FLUE GAS O2		
XI079A	4.3	PCT	EAST FLUE GAS O2		
TE0707	723.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	723.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	279.	DEGF	SEC AH 1A GAS OUT T		
TE0929	269.	DEGF	SEC AH 1B GAS OUT T		
TE0913	297.	DEGF	PRI AH 2A GAS OUT T		
TE0916	310.	DEGF	PRI AH 2B GAS OUT T		
XI072A	37.7	INWC	PA DUCT PRESS		
XI084A	-14.2	INWC	ID FANS SUCT PRESS		
PT0165	-2.1	INWC	S6 ECON OUTLET FLUE GAS PR		

ENQUADR DACTWC DUO

IP12_005581

SOFTWARE LOCK 01/18/89 18:01:38 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE	DESCRIPTION	STATUS	ALARM
PT0174	.9 INWC	BNR LVL 2 S WINDBOX PR		
PT0176	1.0 INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.5 INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.6 INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.8 INWC	BNR LVL 1 S WINDBOX PR		
PT0175	1.1 INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.3 INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.5 INWC	BNR LVL 2 N WINDBOX PR		
KS007A	61.2 PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	61.2 PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0 PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	61.2 PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	61.3 PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	61.1 PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	61.3 PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	71.5 PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.5 INWC	SG EAST FLUE GAS PR		

EDUADR DACTWC DU3

IP12_005582

SOFTWARE LOCK 01/18/89 10:01:15 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI027A	854.	MW	UNIT LOAD		
XI024A	5947.	KPPH	TURBINE STEAM FLOW		
FT0025	5863.	KPPH	BOILER FEEDWATER F		
TE0863	719.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	718.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1009.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2410.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	74.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	10.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	65.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	623.	DEGF	SG E COLD REHEAT INLET T		
TE0019	622.	DEGF	SG W COLD REHEAT INLET T		
PT0011	535.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1010.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	496.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	11.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	100.	DEGF	REHEAT DESUPERHEATER SPRAY T		

EAQUADR DACTWC DU1

IP12_005583

SOFTWARE LOCK 01/18/89 10:00:48 U2MAIN

UREMENT DISPLAY

WEATHER DATA

LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.62 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.69 IN HG	BAROMETRIC PRESSURE		
KK0531	14. DEGF	AMBIENT TEMPERATURE		
TE1160	12. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	86. PCT	RELATIVE HUMIDITY		

ENQUADR DACTWC UTUD

IP12_005584

SOFTWARE LOCK 01/18/89 10:40:53 U2MAIN

UREMENT DISPLAY

WEATHER DATA

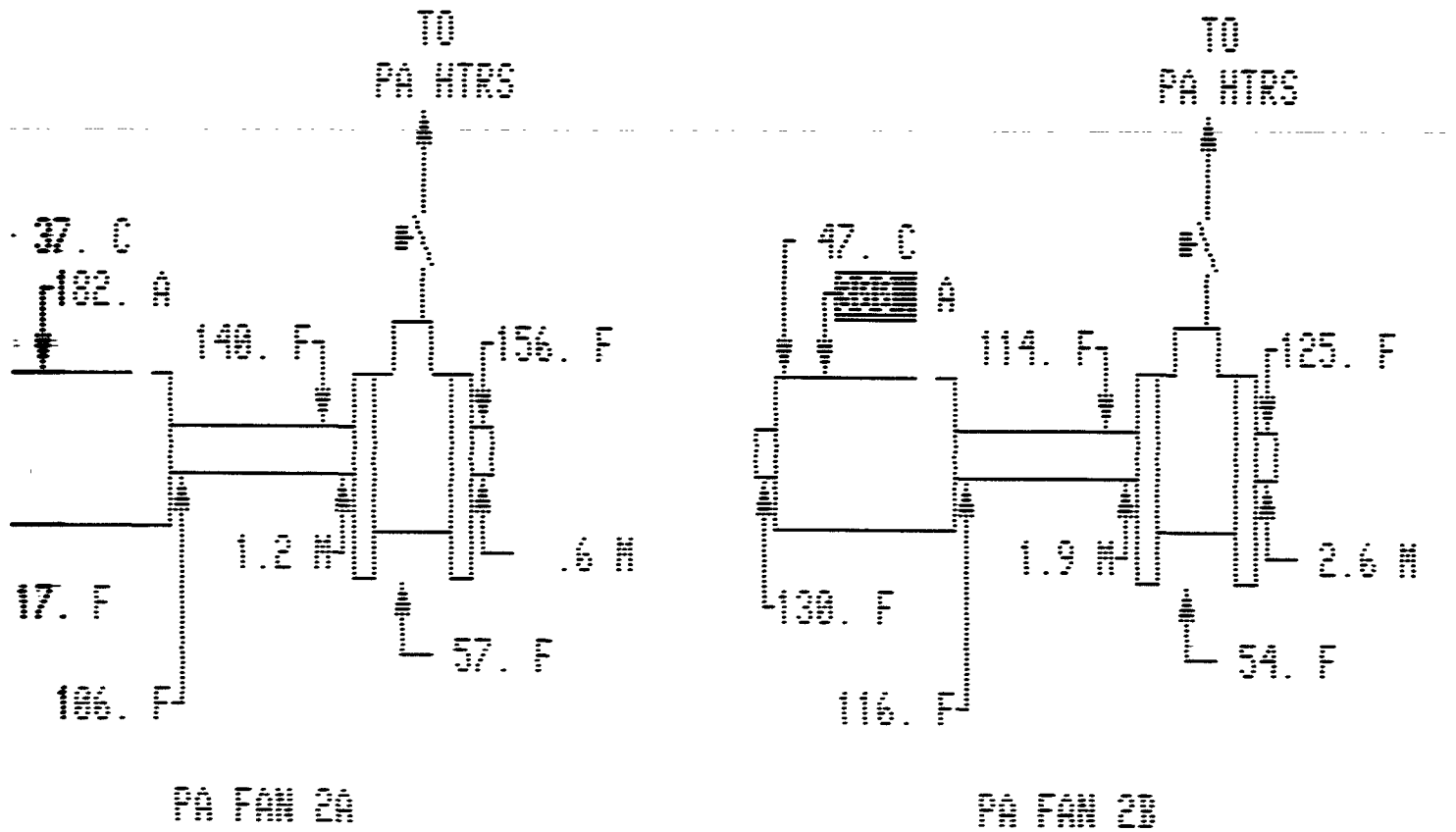
LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.62 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.69 IN HG	BAROMETRIC PRESSURE		
KK0531	18. DEGF	AMBIENT TEMPERATURE		
TE1160	15. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	82. PCT	RELATIVE HUMIDITY		

CONVAR DACTUC UTUD

IP12_005585

SOFTWARE LOCK 01/18/89 10:40:27 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS

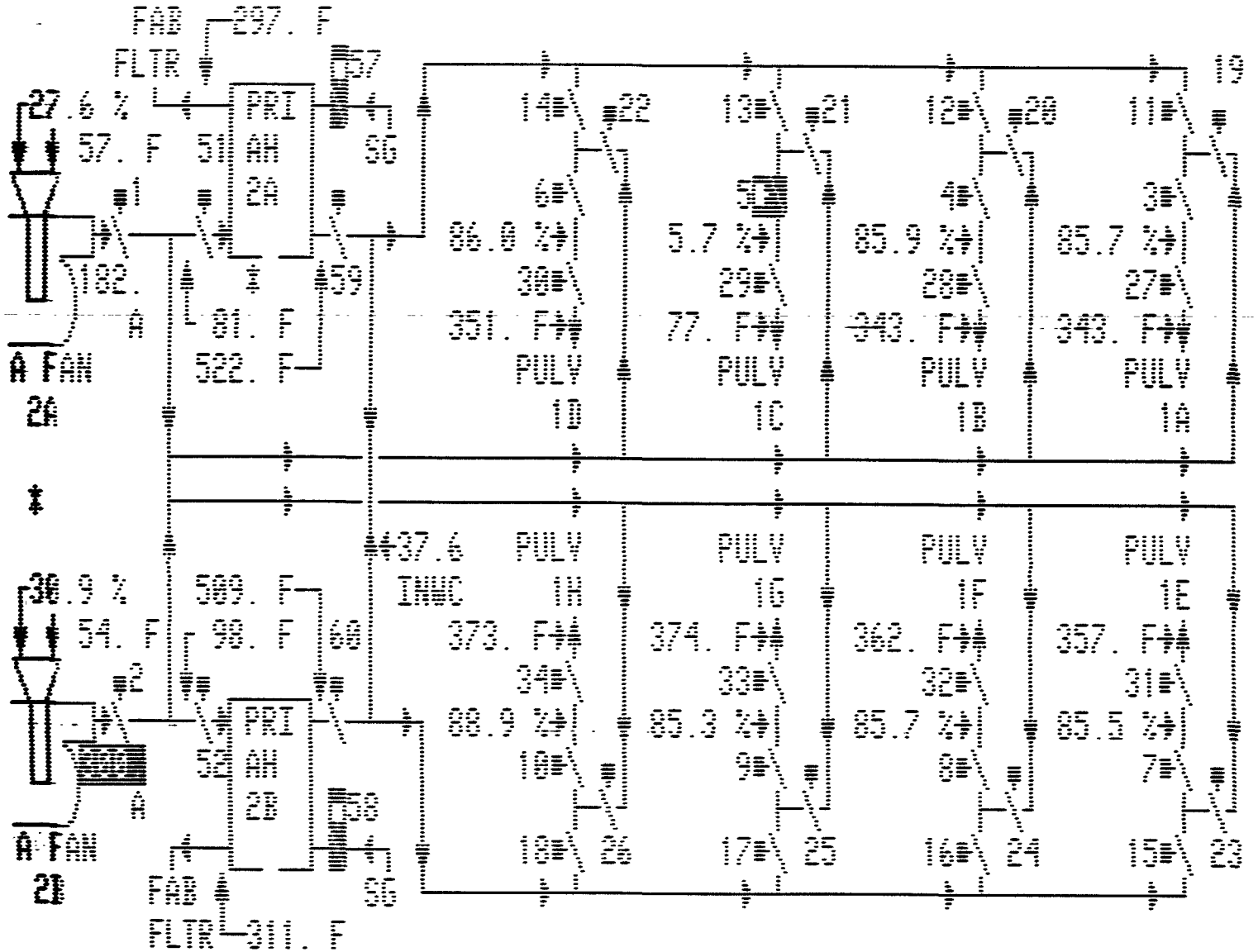


ENDUADR DACTUC SCBCAG

IP12_005586

SOFTWARE LOCK 01/18/89 10:39:59 U2MAIN

SGBG05 SYSTEM - PRIMARY AIR PG 4 OF 6



TEST 2

#Dm 3.105MW .88PF
18-Jan-89 14:07:13

#Dm 3.095MW .88PF
18-Jan-89 14:17:13

Status
18-Jan-89 14:23:09

Avg 6.684 KV

T 3.533 MVA

T 3.102 MW

T .88 PF

#Dm 3.091MW .88PF
18-Jan-89 14:27:13

#Dm 3.100MW .88PF
18-Jan-89 14:37:13

#Dm 3.094MW .88PF
18-Jan-89 14:47:13

Test #2 End @ 14:45

****

Test #2
2B DA Fan
Start 13:00 HRS

#Dm 3.079MW .88PF
18-Jan-89 12:57:13

Status
18-Jan-89 13:06:10

Avg 6.691 KV

T 3.535 MVA

T 3.104 MW

T .88 PF

#Dm 3.101MW .88PF
18-Jan-89 13:07:13

#Dm 3.085MW .88PF
18-Jan-89 13:17:13

#Dm 3.096MW .88PF
18-Jan-89 13:27:13

Status
18-Jan-89 13:35:13

Avg 6.689 KV

T 3.519 MVA

T 3.089 MW

T .88 PF

#Dm 3.097MW .88PF
18-Jan-89 13:37:13

#Dm 3.098MW .88PF
18-Jan-89 13:47:13

#Dm 3.099MW .88PF
18-Jan-89 13:57:13

Status
18-Jan-89 14:03:29

Avg 6.690 KV

T 3.554 MVA

T 3.121 MW

T .88 PF

BDS 120-1

BABCOCK & WILCOX

Time Time start 13:00 HRS Time stop 14:45	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
13:00 HRS	-.25	38.4	50.6	1203			
13:30 HRS	-.25	38.0	49.4				
14:00 HRS	-.25	39.7	52.5				
14:30 HRS	-.25	38.4	51.5				
14:45	-.25	39.0	51.4				

CUSTOMER Intermountain Power Project	JOB NO. RB-615
SUBJECT PA Fan Test, Fan Room Data	
Test #2	BY Jm Jr.
1st Test	DATE 1/13/88

IP12_005589

BDS 120-1

BABCOCK & WILCOX

Time Time Start Time Stop	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Burner	Fan Bias	Fuel Flow	Gross MW
13:00	300	31.2	25.70	72°	NA	92%	850
13.30	300	30.8	25.70	72°		91%	955
14:00	300	30.4	25.69	72°		90%	950
14:30	300	31.1	25.69	72°		91%	850
14:45	308	31.6	25.69	72°		91%	810

CUSTOMER Intermountain Power Project

SUBJECT PC Fan Test Control Room Data

Test # 2

Test 10

JOB NO. RB-615

BY JM Jr

DATE 1/13/88

IP12_005590

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	39	0.911	15	95.4			
9	2	39	0.639	20	95.6			
9	3	39	0.334	15	95.6			
9	4	39	0.134	10	95.6			
9	5	39	0.104	10	95.6			
9	6	39	0.144	10	95.8			
9	7	39	0.302	10	95.4			
9	8	39	0.888	5	95.6			
9	9	39	1.313	5	95.6			
9	10	39	1.545	0	95.6			
10	1	39	0.761	10	95.6			
10	2	39	0.732	0	96.0			
10	3	39	0.468	5	96.0			
10	4	39	0.271	10	95.6			
10	5	39	0.273	20	95.8			
10	6	39	0.366	5	95.6			
10	7	39	0.656	5	95.8			
10	8	39	1.023	0	95.6			
10	9	39	1.401	0	95.8			
10	10	39	1.162	0	96.0			
11	1	39	0.461	0	95.4			
11	2	39	0.043	0	96.0			
11	3	39	0.695	0	96.2			
11	4	39	0.544	0	96.4			
11	5	39	0.554	0	96.2			
11	6	39	0.651	0	96.0			
11	7	39	0.998	5	96.2			
11	8	39	0.922	5	96.2			
11	9	39	0.766	5	96.2			
11	10	39	0.573	5	96.2			
12	1	39	0.305	0	95.6			
12	2	39	0.295	0	95.8			
12	3	39	0.378	0	96.0			
12	4	39	0.40	0	96.0			
12	5	39	0.419	0	96.2			
12	6	39	0.454	0	96.0			
12	7	39	0.378	0	96.0			
12	8	39	0.312	5	96.0			
12	9	39	0.221	5	96.0			
12	10	39	0.085	10	96.0			
Bottom of Duct								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT F2 FAN TEST OUTLET

Test # 2

File ID

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005591

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP
TAP 5	POINT 1	39	0.554	30	96.6
5	2	39	0.612	30	96.8
5	3	39	0.148	25	96.6
5	4	39	0.097	15	96.6
5	5	39	0.041	0	96.6
5	6	39	0.061	0	96.6
5	7	39	0.244	0	96.4
5	8	39	0.329	10	96.6
5	9	39	0.866	15	96.6
5	10	39	0.988	15	96.8
6	1	39	0.811	30	96.6
6	2	39	0.561	30	96.6
6	3	39	0.15	30	96.4
6	4	39	0.031	25	96.6
6	5	39	0.043	0	96.4
6	6	39	0.081	0	96.4
6	7	40	0.124	5	96.6
6	8	39	0.471	10	96.6
6	9	40	1.032	10	96.8
6	10	40	1.198	10	97.4
7	1	39	0.851	20	95.4
7	2	39	0.554	25	95.4
7	3	39	0.19	30	95.4
7	4	39	0.051	0	95.2
7	5	39	0.021	0	95.4
7	6	39	0.060	0	95.4
7	7	39	0.173	5	95.4
7	8	39	0.531	10	95.6
7	9	39	1.13	10	95.6
7	10	39	1.255	15	95.6
8	1	39	0.910	20	95.2
8	2	39	0.610	20	95.4
8	3	39	0.219	20	95.4
8	4	39	0.056	0	95.4
8	5	39	0.141	0	95.4
8	6	39	0.070	0	95.4
8	7	39	0.112	10	95.2
8	8	39	0.607	10	95.4
8	9	39	1.118	10	95.4
8	10	39	1.419	10	95.4

CUSTOMER [illegible]

SUBJECT [illegible]

[illegible] 2

[illegible] ID

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005592

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
Top of Duct								
TAP 1	POINT 1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10							
2	1	39	0.388	25	98.4			
2	2	39	0.49	30	97.2			
2	3	40	0.532	20	97.6			
2	4	40	0.434	15	97.6			
2	5	39	0.307	10	97.8			
2	6	39	0.278	7	97.8			
2	7	39	0.432	10	97.8			
2	8	39	0.402	15	97.4			
2	9	40	0.744	20	97.4			
2	10	40	0.869	20	97.4			
3	1	39	0.405	30	97			
3	2	39	0.639	30	97.6			
3	3	39	0.390	25	97.6			
3	4	39	0.278	15	97.4			
3	5	39	0.214	5	97.0			
3	6	39	0.219	5	97.0			
3	7	39	0.221	5	97.0			
3	8	39	0.441	5	97.2			
3	9	39	0.734	20	97.4			
3	10	39	0.852	20	97.4			
4	1	39	0.644	30	97.0			
4	2	39	0.578	30	97.4			
4	3	39	0.317	25	97.2			
4	4	39	0.109	10	97.2			
4	5	39	0.144	0	97.2			
4	6	39	0.144	10	97.2			
4	7	39	0.185	10	97.0			
4	8	39	0.415	15	97.0			
4	9	39	0.761	20	97.2			
4	10	39	1.054	20	97.2			

CUSTOMER [illegible] POWER

SUBJECT PH FAN TEST OUTLET

Test # 2

[illegible]

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005593

BDS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∠	TEMP			
TAP 1 POINT 1	1.0	.236	-4	51.6			
1 - 2	1.0	.178	0	51.8			
1 - 3	1.0	.249	-1	52.0			
1 - 4	1.0	.239	-2	52.2			
2 - 1	1.0	.273	-3	51.6			
2 - 2	1.0	.207	-1	51.8			
2 - 3	1.0	~~.310~~ .275	-2	51.8			
2 - 4	1.0	.310	-3	52.0			
3 - 1	1.0	.275	-2	51.2			
3 - 2	1.0	.229	-1	51.2			
3 - 3	1.0	.218	0	51.6			
3 - 4	1.0	.245	0	52.0			
4 - 1	1.0	.236	-3	51.0			
4 - 2	1.0	.185	-4	51.2			
4 - 3	1.0	.185	-3	51.4			
4 - 4	1.0	.219	-1	51.8			
5 - 1	1.0	.244	0	51.0			
5 - 2	1.0	.224	-2	51.2			
5 - 3	1.0	.249	-1	51.2			
5 - 4	1.0	.231	-3	51.6			
6 - 1	1.0	.263	+5	50.6			
6 - 2	1.0	.200	0	50.6			
6 - 3	1.0	.251	+3	50.8			
6 - 4	1.0	.288	+3	50.6			
7 - 1	1.0	.329	-2	50.2			
7 - 2	1.0	.253	+4	50.2			
7 - 3	1.0	.310	0	50.2			
7 - 4	1.0	.332	0	50.6			
8 - 1	1.0	.336	+1	50.0			
8 - 2	1.0	.307	-1	50.0			
8 - 3	1.0	.332	+2	50.2			
8 - 4	1.0	.339	+2	50.2			
9 - 1	1.0	.283	0	49.8			
9 - 2	1.0	.273	-4	50.0			
9 - 3	1.0	.268	-2	50.0			
9 - 4	1.0	.247	0	50.2			
10 - 1	1.0	.266	0	50.0			
10 - 2	1.0	.251	-5	50.0			
10 - 3	1.0	.244	-1	50.0			
10 - 4	1.0	.300	-1	50.0			

CUSTOMER INTERMOUNTAIN POWER

JOB NO.

SUBJECT PA FAN TEST - INLET: East Side

Test # 2 1:00 pm

BY MCB

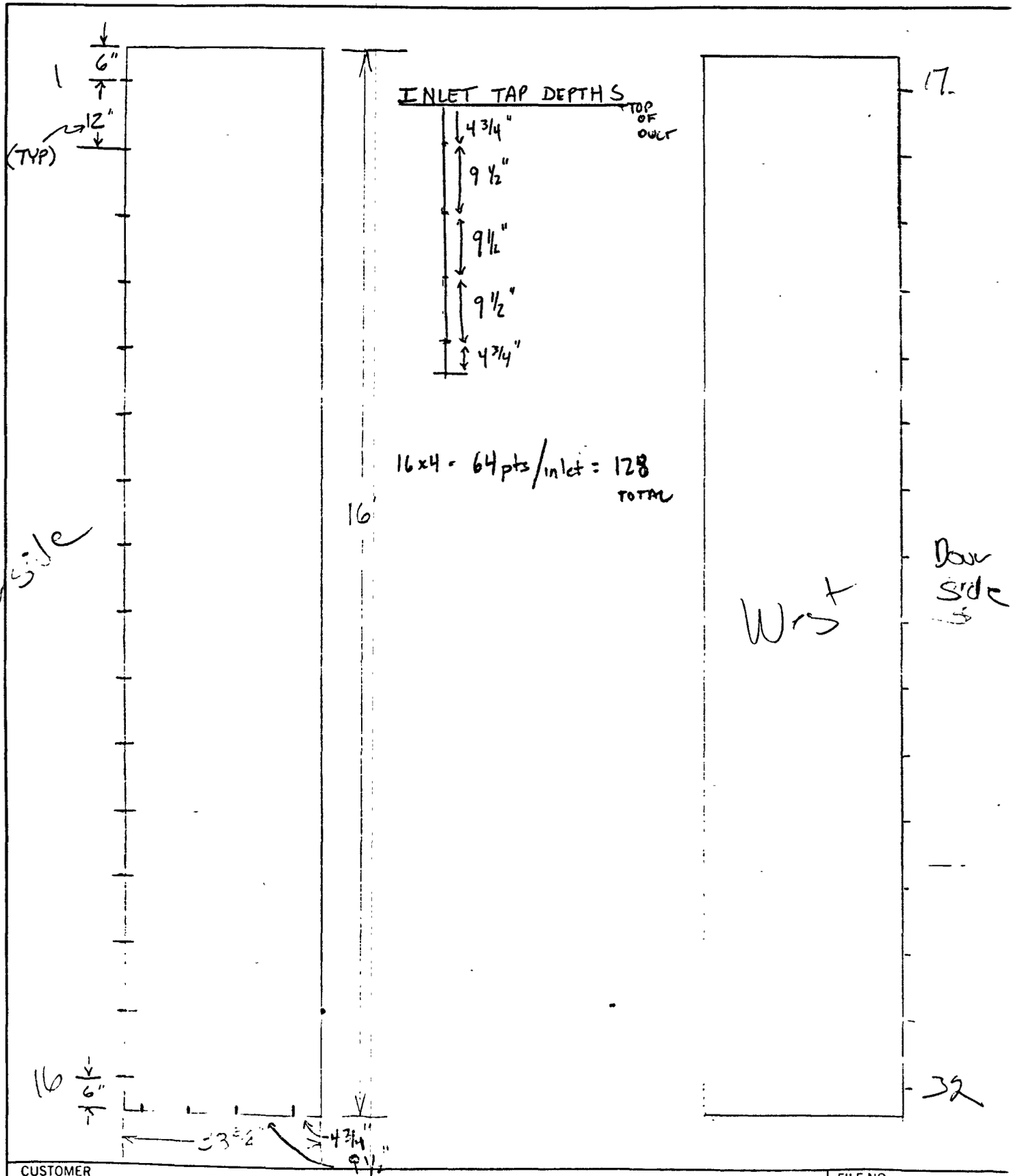
EAST WEST FAN

DATE 1/16/89

IP12_005594

PG-1979-1

Babcock & Wilcox
GENERAL CALCULATIONS



CUSTOMER	FILE NO
IPP	RB-615

SUBJECT	PREPARED BY	DATE
PA. FAN TEST TAP LAYOUT INLET	R W WEWER	11/17/89

IP12_005595

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 27	Point 1	1.0	.300	+3	52.8			
	2	1.0	.231	-1	52.8			
	3	1.0	.288	-1	52.4			
	4	1.0	.237	+1	52.4			
28	1	1.0	.268	-4	52.4			
	2	1.0	.229	-3	52.4			
	3	1.0	.258	-2	52.0			
	4	1.0	.288	-2	51.8			
29	1	1.0	.212	-6	51.8			
	2	1.0	.209	-5	51.4			
	3	1.0	.227	-4	51.4			
	4	1.0	.234	-6	51.0			
30	1	1.0	.258	-7	50.6			
	2	1.0	.239	+1	50.2			
	3	1.0	.239	-4	50.2			
	4	1.0	.290	-3	50.6			
31	1	1.0	.175	-10	50.6			
	2	1.0	.124	+3	50.2			
	3	1.0	.117	-4	49.8			
	4	1.0	~~.189~~ .170	~~-8~~ -5	50.0			
32	1	1.0	.102	-10	50.4			
	2	1.0	.068	0	50.0			
	3	1.0	.063	0	50.0			
	4	1.0	.119	-7	50.0			

CUSTOMER Intermountain Power Project

SUBJECT [illegible]

Test # 2 1:00 pm

[illegible] WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005596

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	yaw ∠	Temp			
Tap 17	Point 1	1.0	.209	-3	53.2			
	2	1.0	.175	-8	53.0			
	3	1.0	.156	-7	53.4			
	4	1.0	.175	-5	53.8			
18	1	1.0	.236	-4	53.0			
	2	1.0	.180	-6	53.0			
	3	1.0	.222	-6	53.0			
	4	1.0	.234	-4	53.0			
19	1	1.0	.229	-4	53.2			
	2	1.0	.207	-5	53.4			
	3	1.0	.222	-7	53.6			
	4	1.0	.211	-3	53.4			
20	1	1.0	.161	-4	53.6			
	2	1.0	.168	-2	53.8			
	3	1.0	.158	-4	53.8			
	4	1.0	.200	-4	54.0			
21	1	1.0	.205	-4	53.4			
	2	1.0	.188	-5	53.8			
	3	1.0	.234	-3	53.8			
	4	1.0	.224	-4	53.4			
22	1	1.0	.234	-8	53.6			
	2	1.0	.205	-4	53.8			
	3	1.0	.234	-8	53.8			
	4	1.0	.263	-7	53.4			
23	1	1.0	.271	-4	53.2			
	2	1.0	.231	-8	53.4			
	3	1.0	.273	-5	53.4			
	4	1.0	.302	-4	53.0			
24	1	1.0	.271	-5	53.2			
	2	1.0	.229	-4	53.4			
	3	1.0	.273	-5	53.2			
	4	1.0	.268	-5	53.2			
25	1	1.0	.297	-4	53.4			
	2	1.0	.222	-2	53.6			
	3	1.0	.297	-3	53.4			
	4	1.0	.241	-3	53.4			
26	1	1.0	.209	-4	53.0			
	2	1.0	.214	+3	53.0			
	3	1.0	.246	-1	53.0			
	4	1.0	.258	-4	52.6			

CUSTOMER Intermountain Power Project

SUBJECT IP Fan Test Test West Side

Test # 2 1:00 pm

Fan TC WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005597

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 11	POINT 1	1.0	.341	-6	~~49~~ 50.0			
11	2	1.0	.295	-4	50.2			
11	3	1.0	.305	-4	50.0			
11	4	1.0	.361	-5	50.6			
12	1	1.0	.285	+1	50.0			
12	2	1.0	.266	0	49.6			
12	3	1.0	.334	0	50.0			
12	4	1.0	.332	+2	50.4			
13	1	1.0	.292	+3	50.0			
13	2	1.0	.285	0	49.4			
13	3	1.0	.249	0	49.8			
13	4	1.0	.283	0	50.0			
14	1	1.0	.332	-1	49.6			
14	2	1.0	.322	+2	49.4			
14	3	1.0	.283	-4	49.8			
14	4	1.0	.368	0	50.0			
15	1	1.0	.251	+5	49.6			
15	2	1.0	.161	-1	49.6			
15	3	1.0	.141	-3	50.2			
15	4	1.0	.166	+1	50.0			
16	1	1.0	.104	0	49.8			
16	2	1.0	.104	-4	49.6			
16	3	1.0	.065	-6	49.4			
16	4	1.0	.112	+1	49.6			
BARO P								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET; E... - Side

Test # 2 1:00 pm

F1 BD WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005598

Unit 2 Test # 2

PA Fan 2B

AIR/GAS PRI AIR 01/18/89 14:15:28

37.7	37.7	37.8	51.5
A	INWG	INWG	
INWC	38.0	37.9	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
30.1	27.1	28.9	27.3
M B	A	PCT	PCT
0.0		31.9	31.0
HB		PCT	PCT
50.0			
LB			
-50.0	PAFAN	PA FL	PA FL
	B VNE	ONE	TWO
	CNTRL	A/B	A/B

> AUT +S- ASN +F- TD

IP12_005599

SOFTWARE LOCK 01/18/89 14:19:13 U2MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	323.1	TPH	TOTAL FUEL FLOW		
XI002A	45.5	TPH	PULV 1A COAL FLOW		
XI003A	44.2	TPH	PULV 1B COAL FLOW		
XI004A	[illegible]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	44.5	TPH	PULV 1D COAL FLOW		
XI006A	44.9	TPH	PULV 1E COAL FLOW		
XI007A	44.1	TPH	PULV 1F COAL FLOW		
XI008A	44.5	TPH	PULV 1G COAL FLOW		
XI009A	49.5	TPH	PULV 1H COAL FLOW		
XI080A	1.1	PCT	WEST FLUE GAS O2		
XI079A	4.0	PCT	EAST FLUE GAS O2		
TE0707	727.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	723.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	281.	DEGF	SEC AH 1A GAS OUT T		
TE0929	269.	DEGF	SEC AH 1B GAS OUT T		
TE0913	300.	DEGF	PRI AH 2A GAS OUT T		
TE0916	313.	DEGF	PRI AH 2B GAS OUT T		
XI072A	38.0	INWC	PA DUCT PRESS		
XI084A	-14.3	INWC	ID FANS SUCT PRESS		
PT0165	-2.6	INWC	SG ECON OUTLET FLUE GAS PR		

SOFTWARE LOCK 01/18/89 14:18:51 U2MAIN
UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
PT0174	.9	INWC	BNR LVL 2 S WINDBOX PR		
PT0176	1.0	INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.5	INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.6	INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.8	INWC	BNR LVL 1 S WINDBOX PR		
PT0175	1.1	INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.3	INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.5	INWC	BNR LVL 2 N WINDBOX PR		
KS007A	63.4	PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	63.4	PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0	PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	63.5	PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	63.5	PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	63.4	PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	63.6	PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	74.1	PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.5	INWC	SG EAST FLUE GAS PR		

ENDUADR DACTUC DUO

IP12_005601

SOFTWARE LOCK 01/18/89 14:18:26 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI027A	855.	MW	UNIT LOAD		
XI024A	5964.	KPPH	TURBINE STEAM FLOW		
FT0025	5884.	KPPH	BOILER FEEDWATER F		
TE0863	719.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	718.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1006.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2408.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	74.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	10.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	73.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	624.	DEGF	SG E COLD REHEAT INLET T		
TE0019	624.	DEGF	SG W COLD REHEAT INLET T		
PT0011	531.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1014.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	493.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	11.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	100.	DEGF	REHEAT DESUPERHEATER SPRAY T		

EDGUARD DACTWC DU1

IP12_005602

SOFTWARE LOCK 01/18/89 14:17:55 U2MAIN

MEASUREMENT DISPLAY

WEATHER DATA

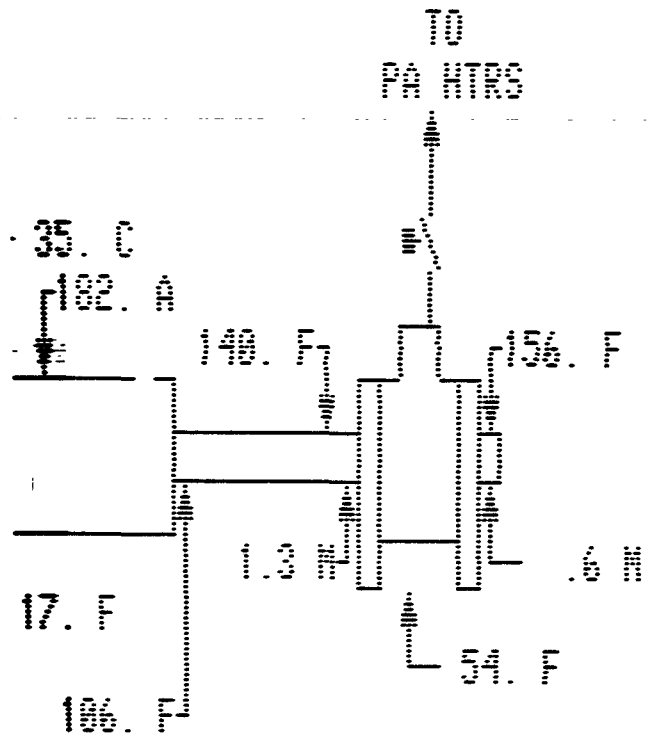
LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.60 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.66 IN HG	BAROMETRIC PRESSURE		
KK0531	32. DEGF	AMBIENT TEMPERATURE		
TE1160	28. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	57. PCT	RELATIVE HUMIDITY		

CADUADB DACTWC UTUD

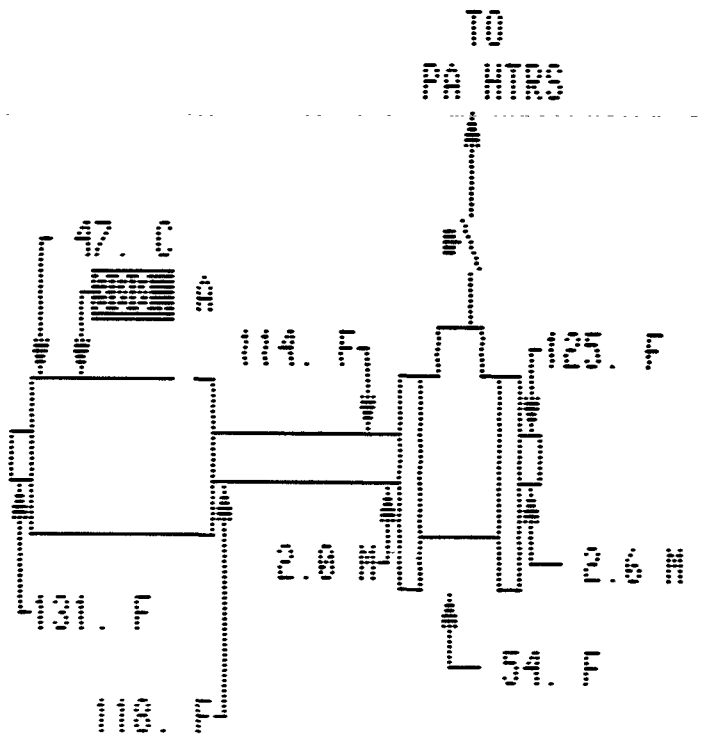
IP12_005603

SOFTWARE LOCK 01/18/89 14:17:27 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



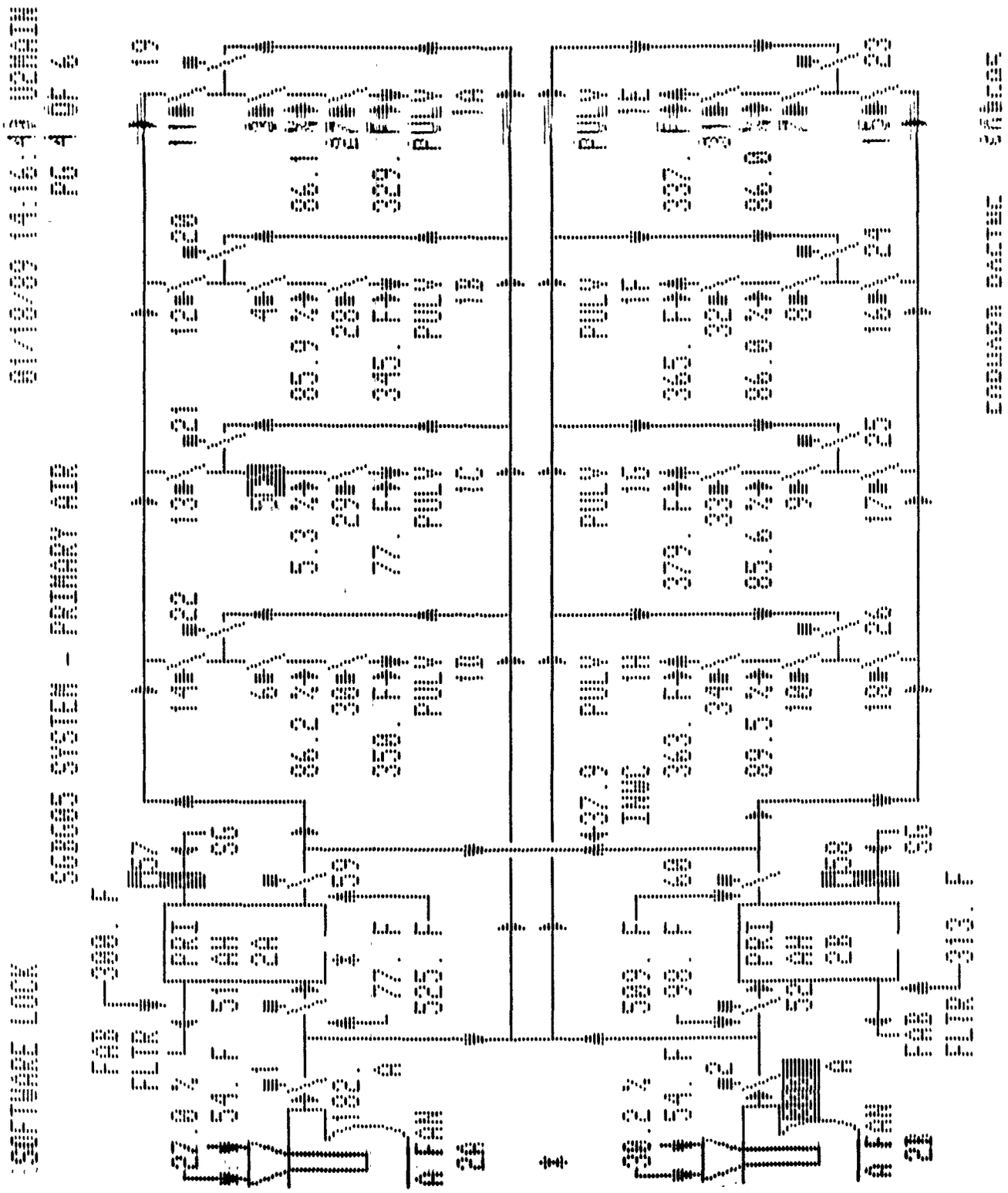
PA FAN 2A



PA FAN 2B

ENQUADR DACTWC SCBC09

IP12_005604



TEST 3

TO #3 Start 15:00 HR 2B PA FU

#Dm 3.097MW .88PF
18-Jan-89 14:57:13

Status
18-Jan-89 15:04:05

Avg 6.664 KV

T 3.454 MVA

T 3.030 MW

T .88 PF

#Dm 3.057MW .88PF
18-Jan-89 15:07:13

#Dm 3.068MW .88PF
18-Jan-89 15:17:13

#Dm 3.075MW .88PF
18-Jan-89 15:27:13

Status
18-Jan-89 15:32:16

Avg 6.663 KV

T 3.504 MVA

T 3.076 MW

T .88 PF

#Dm 3.075MW .88PF
18-Jan-89 15:37:13

#Dm 3.078MW .88PF
18-Jan-89 15:47:13

#Dm 3.072MW .88PF
18-Jan-89 15:57:13

Status
18-Jan-89 16:04:15

Avg 6.660 KV

T 3.516 MVA

T 3.088 MW

T .88 PF

#Dm 3.084MW .88PF
18-Jan-89 16:07:13

#Dm 3.083MW .88PF
18-Jan-89 16:17:13

#Dm 3.082MW .88PF
18-Jan-89 16:27:13

Status
18-Jan-89 16:32:00

Avg 6.654 KV

T 3.508 MVA

T 3.081 MW

T .88 PF

BDS 120-1

BABCOCK & WILCOX

Time	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Baro	Fan Bias	Fuel Flow	Gross MW
Time Start 15:00							
Time Stop 16:30							
15:00 Hrs	300	29.9	25.69	72°	NA	92	851
15:30	300	30.0	25.68	72°		91	852
16:00	300	30.4	25.68	72°		93	853
16:15	300	30.8	25.68	72°		91	854
16:30	300	29.9	25.68	72		93	850

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test - Control Room Data

Test # 3 ; 2B PA Fan

FCC 10

JOB NO. RB-615

BY JM Jr

DATE 1/10/88

IP12_005607

BDS 120-1

BABCOCK & WILCOX

Time Time Stack Time Stop	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
1500 HRS	-.25"	37.4	48.4	1203			
15:30	-.25	37.9	49.0	1203			
16:00	-.25	37.7	48.6	1203			
16:15	-.25	37.1	47.4	1203			
16:35	-.25	37.4	48.5	1203			

CUSTOMER Intermountain Power Project	JOB NO. KB-615
SUBJECT PA Fan Testing, Fan Room Data	
Test #3 2B PA Fan	BY JM JL
Unit T1	DATE 1/16/85

IP12_005608

BDS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∡	TEMP
TAP 1 POINT 1	1.0	.236	-5	51.0
1 - 2	1.0	.185	0	51.0
1 - 3	1.0	.241	-2	51.2
1 - 4	1.0	.192	-9	51.6
2 - 1	1.0	.268	-2	52.4
2 - 2	1.0	.197	-1	52.2
2 - 3	1.0	.258	-1	51.4
2 - 4	1.0	.273	-2	51.6
3 - 1	1.0	.268	0	52.4
3 - 2	1.0	.253	+1	52.4
3 - 3	1.0	.290	0	52.0
3 - 4	1.0	.273	0	51.8
4 - 1	1.0	.219	-1	54.0
4 - 2	1.0	.180	-5	53.4
4 - 3	1.0	.147	-2	52.4
4 - 4	1.0	.218	0	52.2
5 - 1	1.0	.231	+1	52.6
5 - 2	1.0	.205	-2	52.6
5 - 3	1.0	.222	0	51.8
5 - 4	1.0	.261	0	51.8
6 - 1	1.0	.273	+6	53.0
6 - 2	1.0	.212	0	52.4
6 - 3	1.0	.251	+3	51.6
6 - 4	1.0	.319	+4	51.4
7 - 1	1.0	.317	-1	53.0
7 - 2	1.0	.246	+3	51.8
7 - 3	1.0	.319	0	51.0
7 - 4	1.0	.247	0	50.8
8 - 1	1.0	.327	+1	51.4
8 - 2	1.0	.305	-1	51.2
8 - 3	1.0	.310	0	50.4
8 - 4	1.0	.327	0	50.4
9 - 1	1.0	.292	-1	51.8
9 - 2	1.0	.246	-5	51.4
9 - 3	1.0	.253	-2	50.6
9 - 4	1.0	.275	-1	50.4
10 - 1	1.0	.241	+1	51.2
10 - 2	1.0	.214	-7	51.0
10 - 3	1.0	.212	-5	50.2
10 - 4	1.0	.283	0	50.0

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET EAST SIDE

Test # 3 3:00 pm

EAST WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005609

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 11	POINT 1	1.0	.324	-5	50.6			
11	2	1.0	.302	~~-5~~ -1	50.6			
11	3	1.0	.297	-2	49.6			
11	4	1.0	.383	-5	49.4			
12	1	1.0	.297	0	51.6			
12	2	1.0	.268	0	50.6			
12	3	1.0	.322	0	49.2			
12	4	1.0	.327	+1	48.8			
13	1	1.0	.268	+2	50.4			
13	2	1.0	.258	0	50.2			
13	3	1.0	.244	+1	49.0			
13	4	1.0	.271	+1	48.8			
14	1	1.0	.300	+1	51.0			
14	2	1.0	.297	-1	50.0			
14	3	1.0	.263	-4	48.8			
14	4	1.0	.336	0	48.6			
15	1	1.0	.209	+5	51.4			
15	2	1.0	.173	0	50.4			
15	3	1.0	.148	-2	49.2			
15	4	1.0	.163	0	49.0			
16	1	1.0	.139	+7	49.6			
16	2	1.0	.092	-5	49.4			
16	3	1.0	.061	-4	48.8			
16	4	1.0	.090	0	48.6			
BARO P								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET; East Side

Test # 3 3:00 pm

Ft. ID WEST SIDE

JOB NO.

BY MCB

DATE 1/18/89

IP12_005610

BDS 120-1

BABCOCK & WILCOX

		Static	velocity	yaw ∠	Temp			
Tap 17	Point 1	1.0	.277	-2	50.6			
	2	1.0	.180	-7	50.8			
	3	1.0	.185	-3	50.8			
	4	1.0	.163	-5	51.0			
18	1	~~1.0~~ 1.0	.234	-4	52.6			
	2	1.0	.192	-3	52.2			
	3	1.0	.202	-6	52.0			
	4	1.0	.247	-4	52.0			
19	1	1.0	.214	-5	53.4			
	2	1.0	.201	-5	52.6			
	3	1.0	.229	-5	52.6			
	4	1.0	.275	-4	52.8			
20	1	1.0	.161	-4	52.6			
	2	1.0	.163	0	52.8			
	3	1.0	.136	-7	53.2			
	4	1.0	.168	-6	53.2			
21	1	1.0	.180	-5	54.8			
	2	1.0	.190	-4	54.0			
	3	1.0	.227	-4	53.6			
	4	1.0	.214	-5	53.4			
22	1	1.0	.239	-10	53.8			
	2	1.0	.197	-5	53.4			
	3	1.0	.239	-5	53.0			
	4	1.0	.244	-10	53.0			
23	1	1.0	.251	-4	53.0			
	2	1.0	.209	-8	52.8			
	3	1.0	.278	-5	53.0			
	4	1.0	.278	-4	52.8			
24	1	1.0	.234	-4	52.6			
	2	1.0	.224	-5	52.8			
	3	1.0	.261	-5	52.6			
	4	1.0	.253	-5	52.6			
25	1	1.0	.263	-5	52.8			
	2	1.0	.202	0	53.0			
	3	1.0	.280	0	52.8			
	4	1.0	.266	-3	52.8			
26	1	1.0	.207	-5	53.6			
	2	1.0	.207	+2	53.6			
	3	1.0	.249	0	52.8			
	4	1.0	.258	-2	52.4			

CUSTOMER Innovative Power Project

SUBJECT PA Fan Test Inlet West Side

Test # 3 3:00pm

File ID

JOB NO.

BY MCB

DATE 1/18/89

IP12_005611

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 27	Point 1	1.0	.285	+4	52.4			
	2	1.0	.227	-2	52.2			
	3	1.0	.266	0	52.0			
	4	1.0	.317	+2	51.8			
28	1	1.0	.231	-4	52.2			
	2	1.0	.227	-3	52.4			
	3	1.0	.253	-3	51.8			
	4	1.0	.266	-5	52.2			
29	1	1.0	.212	-6	52.6			
	2	1.0	.207	-5	52.6			
	3	1.0	.234	-4	51.8			
	4	1.0	.231	-4	51.6			
30	1	1.0	.278	-5	52.6			
	2	1.0	.205	0	52.4			
	3	1.0	.261	-2	51.8			
	4	1.0	.288	-2	52.0			
31	1	1.0	.185	-10	52.4			
	2	1.0	.129	0	52.4			
	3	1.0	.151	-4	52.0			
	4	1.0	.166	-4	52.0			
32	1	1.0	.097	-10	52.2			
	2	1.0	.068	+2	52.0			
	3	1.0	.056	0	51.8			
	4	1.0	.117	-8	51.4			

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Inlet West Side

Test # 3 3:00pm

File ID WEST FAN

JOB NO.

BY MCB

DATE 1/18/89

IP12_005612

BOS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TEST POINT								
TAP 1	POINT 1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10	39	0.421	31	94.8			
2	1	39	0.622	30	96.8			
2	2	39	0.956	24	96.8			
2	3	39	0.324	17	97.0			
2	4	39	0.290	10	96.8			
2	5							
2	6	39	0.310	5	96.8			
2	7	39	0.341	10	97.2			
2	8	39	0.466	15	97.4			
2	9	39	0.800	20	97.4			
2	10	39	0.898	20	97.4			
3	1	39	0.434	35	96.4			
3	2	39	0.529	33	96.2			
3	3	39	0.38	25	96.6			
3	4	39	0.209	10	97.0			
3	5	39	0.166	10	96.6			
3	6	39	0.236	0	96.8			
3	7	39	0.268	5	96.6			
3	8	39	0.400	15	96.2			
3	9	39	0.808	15	96.4			
3	10	39	0.839	20	96.4			
4	1	39	0.490	35	97.0			
4	2	39	0.595	30	97.4			
4	3	39	0.373	25	97.4			
4	4	39	0.156	10	97.2			
4	5	39	0.078	5	97.2			
4	6	39	0.119	5	97.2			
4	7	39	0.251	5	97.2			
4	8	39	0.424	10	96.8			
4	9	39	0.651	15	96.8			
4	10	39	1.064	15	97.0			

CUSTOMER [illegible]

SUBJECT [illegible]

Test # 3

[illegible]

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005613

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 5	POINT 1	39	0.847	30	96.2			
5	2	39	0.505	30	96.0			
5	3	39	0.107	15	95.8			
5	4	39	0.056	10	96.8			
5	5	39	0.034	20	96.8			
5	6	39	0.036	0	97.0			
5	7	39	0.219	0	96.8			
5	8	39	0.402	10	96.4			
5	9	39	0.854	15	96.6			
5	10	39	1.198	20	97.0			
6	1	39	0.712	30	96.0			
6	2	39	0.522	25	96.2			
6	3	39	0.146	20	96.4			
6	4	39	0.031	0	96.4			
6	5	39	0.038	0	96.4			
6	6	39	0.073	0	96.8			
6	7	39	0.183	10	96.6			
6	8	39	0.371	10	96.6			
6	9	39	0.927	10	96.6			
6	10	39	1.228	10	96.8			
7	1	39	0.844	20	97.2			
7	2	39	0.491	20	96.4			
7	3	39	0.124	25	96.4			
7	4	39	0.040	10	96.2			
7	5	39	0.053	0	96.6			
7	6	39	0.06	0	96.6			
7	7	39	0.185	10	96.6			
7	8	39	0.480	10	96.6			
7	9	39	1.096	15	96.8			
7	10	39	1.535	10	96.8			
8	1	39	0.883	20	96.0			
8	2	39	0.664	20	96.0			
8	3	39	0.215	20	96.0			
8	4	39	0.051	5	96.0			
8	5	39	0.053	0	95.8			
8	6	39	0.102	10	95.8			
8	7	39	0.170	10	95.8			
8	8	39	0.607	10	95.8			
8	9	39	1.189	10	96.0			
8	10	39	1.364	5	96.2			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT [illegible] PILOT

TEST # 3

[illegible] ID

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005614

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	39	0.542	15	96.4			
9	2	39	0.312	15	96.2			
9	3	39	0.158	10	96.0			
9	4	39	0.153	15	96.2			
9	5	39	0.029	10	96.2			
9	6	39	0.15	5	96.2			
9	7	39	0.29	10	96.2			
9	8	39	0.744	5	96.2			
9	9	39	1.228	5	96.2			
9	10	39	1.32	5	96.2			
10	1	39	0.739	10	96.0			
10	2	39	0.642	10	96.6			
10	3	39	0.385	5	96.4			
10	4	39	0.373	15	96.4			
10	5	39	0.319	10	96.4			
10	6	39	0.349	10	96.4			
10	7	39	0.522	5	96.4			
10	8	39	0.888	0	96.4			
10	9	39	1.091	0	96.8			
10	10	39	1.223	5	96.6			
11	1	39	0.475	0	96.8			
11	2	39	0.456	0	96.8			
11	3	39	0.539	5	96.8			
11	4	39	0.561	10	96.6			
11	5	39	0.534	5	96.4			
11	6	39	0.642	0	96.4			
11	7	39	0.822	0	96.4			
11	8	39	0.905	5	96.4			
11	9	39	0.835	5	96.6			
11	10	39	0.712	5	96.6			
12	1	39	0.173	10	96.8			
12	2	39	0.192	0	97.0			
12	3	39	0.323	0	96.6			
12	4	39	0.361	0	96.6			
12	5	39	0.424	0	96.6			
12	6	39	0.529	0	96.4			
12	7	39	0.532	0	96.2			
12	8	39	0.339	0	96.2			
12	9	40	0.175	10	96.2			
12	10	39	0.085	15	96.0			
Bottom of Duct								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT FF FAN JET OUTLET

Test # 3

File ID

JOB NO.

BY Paul Wu

DATE 1/18/89

IP12_005615

Unit 2

PA Fan 2B

```
AIR/GAS    PRI AIR    01/18/89   16:08:17
BOBK3L5A   BOBX1G2A   BOBX1E6A   BOBX1G2B
  37.9       38.0       38.0       52.6
 A          INWG       INWG
 E  INWC    37.9       38.1        F
            INWG       INWG

 P.A.       SLCTD      PA         PAFAN
 DUCT       PA PR      PRESS      INLET
 PRESS      AC/SP      A/B        TEMP

BBCBK5D1A  BOBK3D2A   BOBX1E5B   BOBX1G2A
  29.6       26.5       28.6       26.1
 A  D        A          PCT        PCT
   0.0                  31.2       30.1
  HB                    PCT        PCT
  50.0
  LB
 -50.0      PAFAN      PA FL      PA FL
   0        B VNE      ONE        TWO
  40.0      CNTRL      A/B        A/B

>      AUT                  +S- ASN +F- TD
```

IP12_005616

SOFTWARE LOCK 01/18/89 16:11:23 02MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	324.3	TPH	TOTAL FUEL FLOW		
XI002A	45.8	TPH	PULV 1A COAL FLOW		
XI003A	45.7	TPH	PULV 1B COAL FLOW		
XI004A	[illegible]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	45.5	TPH	PULV 1D COAL FLOW		
XI006A	46.0	TPH	PULV 1E COAL FLOW		
XI007A	45.1	TPH	PULV 1F COAL FLOW		
XI008A	45.5	TPH	PULV 1G COAL FLOW		
XI009A	50.0	TPH	PULV 1H COAL FLOW		
XI080A	1.6	PCT	WEST FLUE GAS O2		
XI079A	4.2	PCT	EAST FLUE GAS O2		
TE0707	727.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	723.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	281.	DEGF	SEC AH 1A GAS OUT T		
TE0929	271.	DEGF	SEC AH 1B GAS OUT T		
TE0913	300.	DEGF	PRI AH 2A GAS OUT T		
TE0916	313.	DEGF	PRI AH 2B GAS OUT T		
XI072A	37.9	INWC	PA DUCT PRESS		
XI084A	-14.5	INWC	ID FANS SUCT PRESS		
PT0165	-2.4	INWC	SG ECON OUTLET FLUE GAS PR		

ENDWADR DACTWC DU9

IP12_005617

SOFTWARE LOCK 01/18/89 16:11:02 U2MAIN

MENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
PT0174	.9	INWC	BNR LVL 2 S WINDBOX PR		
PT0176	1.1	INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.5	INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.6	INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.8	INWC	BNR LVL 1 S WINDBOX PR		
PT0175	1.1	INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.3	INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.5	INWC	BNR LVL 2 N WINDBOX PR		
KS007A	62.9	PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	62.9	PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0	PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	63.0	PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	63.0	PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	62.9	PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	63.1	PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	73.5	PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.6	INWC	SG EAST FLUE GAS PR		

EDUARDO DACTUC DU3

IP12_005618

SOFTWARE LOCK 01/18/89 16:10:29 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI027A	853.	MW	UNIT LOAD		
XI024A	5943.	KPPH	TURBINE STEAM FLOW		
FT0025	5825.	KPPH	BOILER FEEDWATER F		
TE0863	719.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	718.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1010.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2409.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	96.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	8.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	88.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	619.	DEGF	SG E COLD REHEAT INLET T		
TE0019	622.	DEGF	SG W COLD REHEAT INLET T		
PT0011	529.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1018.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	493.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	11.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	100.	DEGF	REHEAT DESUPERHEATER SPRAY T		

SOFTWARE LOCK 01/18/89 16:09:48 U2MAIN

UREMENT DISPLAY

WEATHER DATA

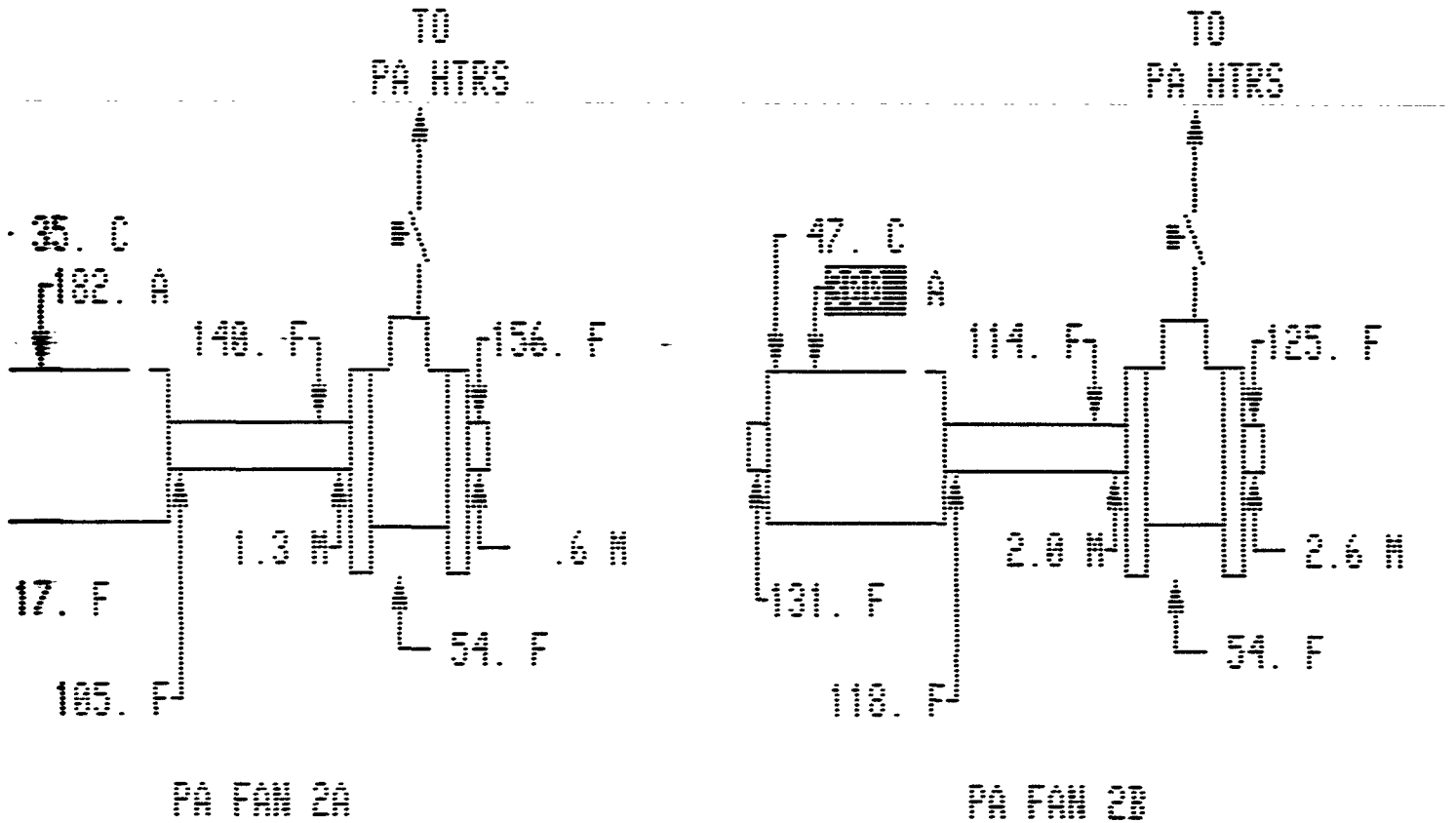
LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.60 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.66 IN HG	BAROMETRIC PRESSURE		
KK0531	34. DEGF	AMBIENT TEMPERATURE		
TE1160	30. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	56. PCT	RELATIVE HUMIDITY		

EDUARDO BACTUC UTUD

IP12_005620

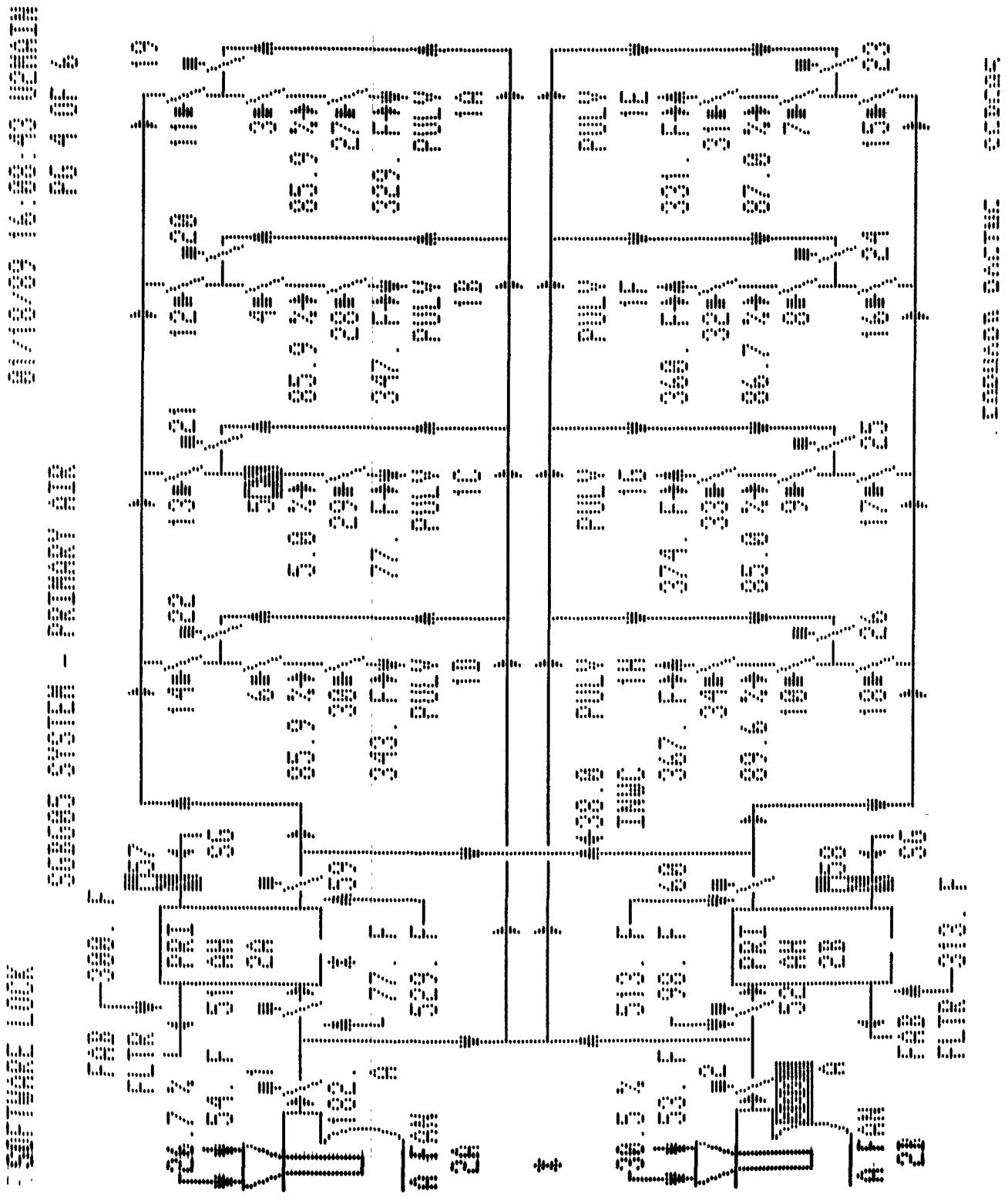
SOFTWARE LOCK 01/18/89 16:09:13 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



EDUARD DACTUC SGBG09

IP12_005621



Unit 2

PA Fan 2A Test 1 overall Test # 4

AIR/GAS PRI AIR 01/19/89 09:59:25

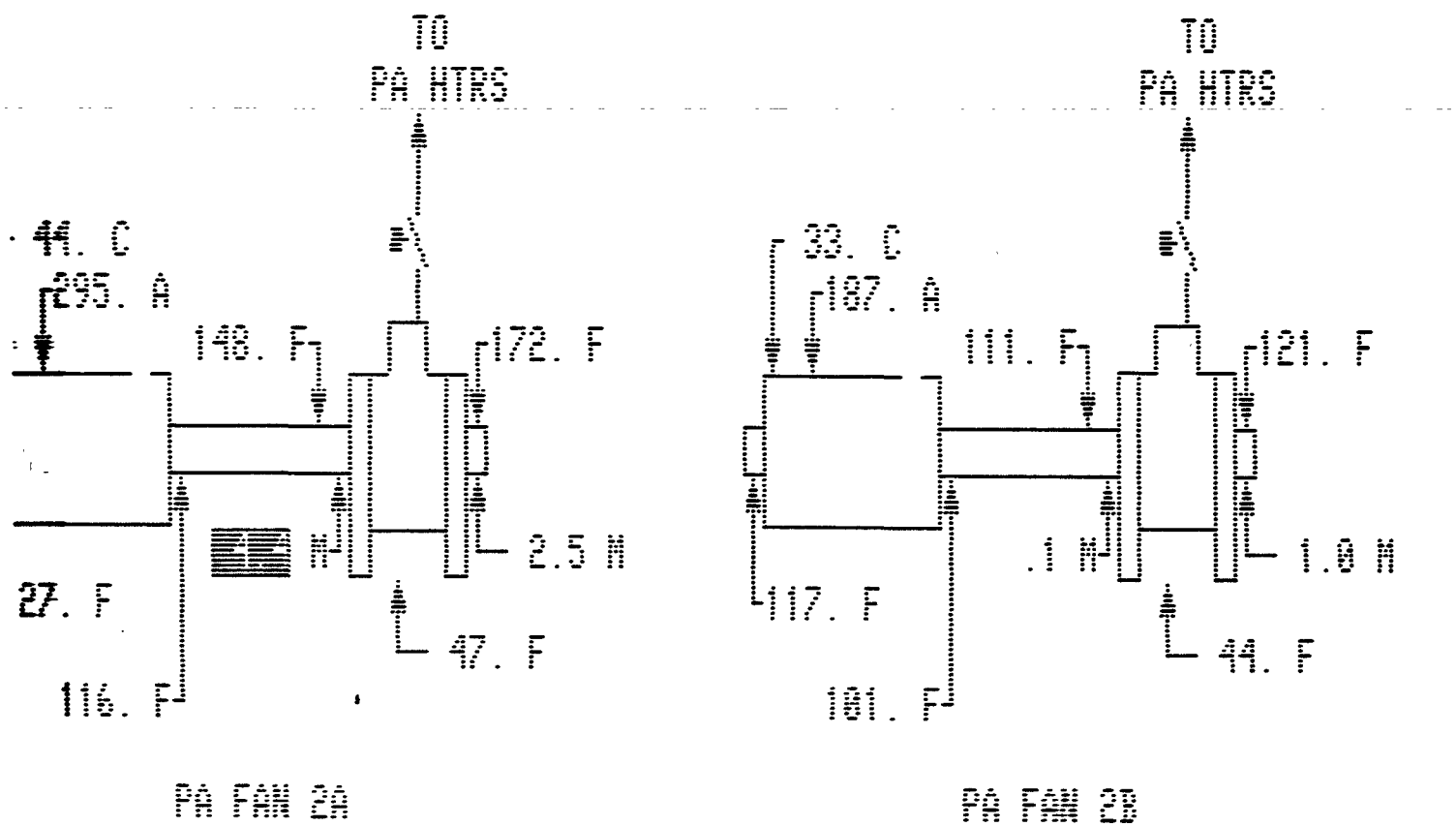
37.3	37.3	37.4	44.2
A	INWG	INWG	
INWC	37.7	37.5	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
21.5	23.9	29.4	27.8
A		PCT	PCT
		30.3	29.3
B	C	PCT	PCT
0.0	D		
	TC		
PAFAN	PAFAN	PA FL	PA FL
A VNE	B VNE	ONE	TWO
CNTRL	CNTRL	A/B	A/B

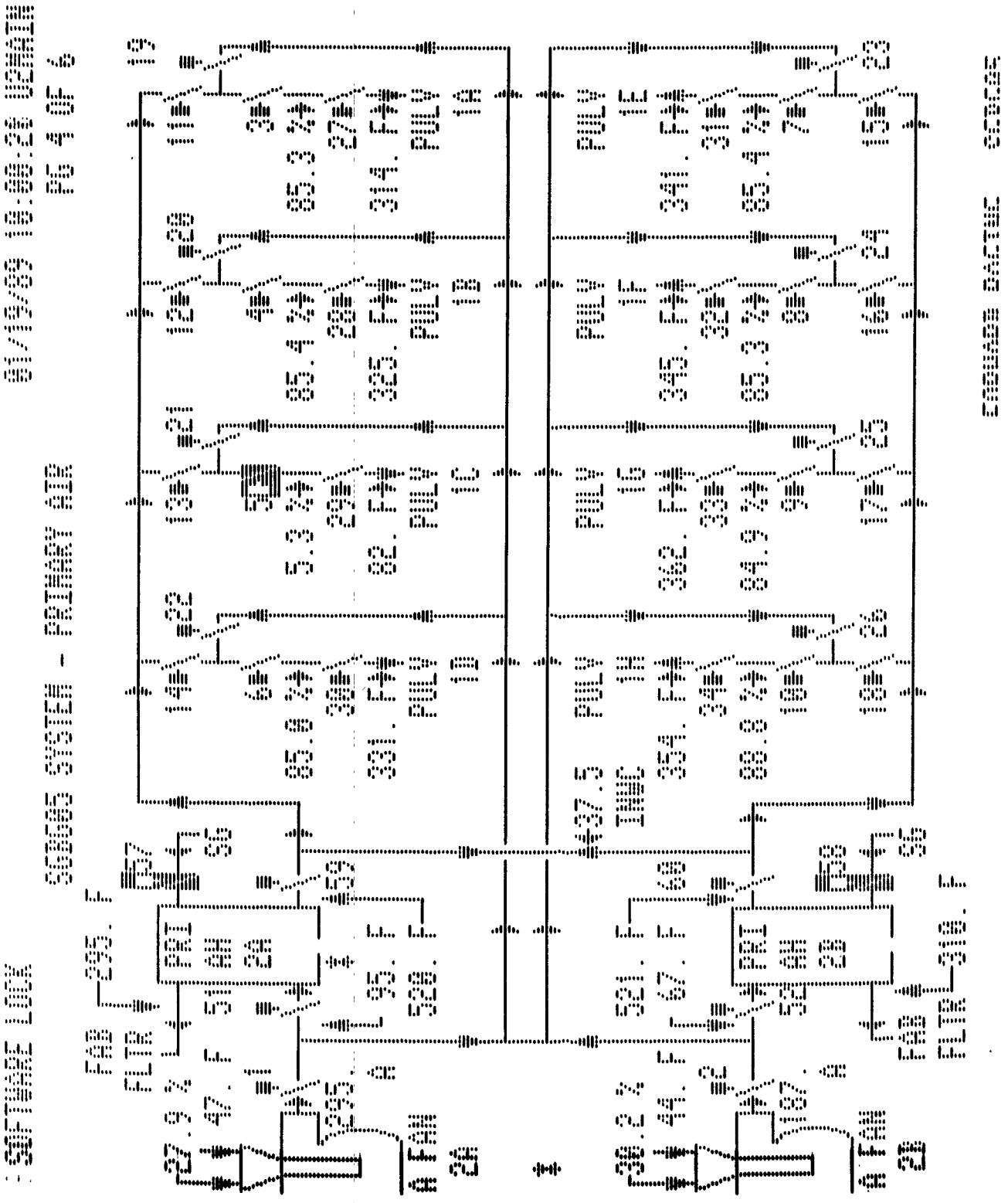
L/L SCN L/L < > L/L L/L GTD

IP12_005623

SOFTWARE LOCK 01/19/89 10:01:04 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS





AIR/GAS PRI AIR 01/19/89 08:58:54

37.8	37.8	37.0	48.6
INWC	INWG	INWG	
	37.5	37.8	F
	INWG	INWG	
P.A. DUCT PRESS	SLCTD PA PR AC/SP	PA PRESS A/B	PAFAN INLET TEMP
21.9	24.2	29.7	28.1
		PCT	PCT
		30.8	30.0
B 0.0		PCT	PCT
PAFAN A VNE CNTRL	PAFAN B VNE CNTRL	PA FL ONE A/B	PA FL TWO A/B

L/L SCN L/L < > L/L L/L GTD

IP12_005626

SOFTWARE LOCK 01/19/89 09:02:03 U2MAIN

MENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI0001A	318.0	TPH	TOTAL FUEL FLOW		
XI0002A	44.1	TPH	PULV 1A COAL FLOW		
XI0003A	44.4	TPH	PULV 1B COAL FLOW		
XI0004A	[redacted]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI0005A	43.9	TPH	PULV 1D COAL FLOW		
XI0006A	44.3	TPH	PULV 1E COAL FLOW		
XI0007A	44.4	TPH	PULV 1F COAL FLOW		
XI0008A	43.7	TPH	PULV 1G COAL FLOW		
XI0009A	50.9	TPH	PULV 1H COAL FLOW		
XI0080A	1.5	PCT	WEST FLUE GAS O2		
XI0079A	3.4	PCT	EAST FLUE GAS O2		
TE0707	741.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	740.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	280.	DEGF	SEC AH 1A GAS OUT T		
TE0929	267.	DEGF	SEC AH 1B GAS OUT T		
TE0913	295.	DEGF	PRI AH 2A GAS OUT T		
TE0916	315.	DEGF	PRI AH 2B GAS OUT T		
XI0072A	37.7	INWC	PA DUCT PRESS		
XI0084A	-14.4	INWC	ID FANS SUCT PRESS		
PT0165	-2.5	INWC	SG ECON OUTLET FLUE GAS PR		

EDUARD BACTUC DU3

IP12_005627

SOFTWARE LOCK 01/19/89 09:01:37 U2MAIN

MENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE	DESCRIPTION	STATUS	ALARM
PT0174	.7 INWC	BNR LVL 2 S WINDBOX PR		
PT0176	.7 INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.2 INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.3 INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.5 INWC	BNR LVL 1 S WINDBOX PR		
PT0175	.8 INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.0 INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.3 INWC	BNR LVL 2 N WINDBOX PR		
KS007A	62.0 PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	62.6 PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0 PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	62.0 PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	62.1 PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	61.9 PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	62.8 PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	72.3 PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.5 INWC	SG EAST FLUE GAS PR		

EDUARD BACTWC DU3

IP12_005628

Unit 2

PA Fan 2A Test 1 overall Test # 4

AIR/GAS PRI AIR 01/19/89 09:59:25

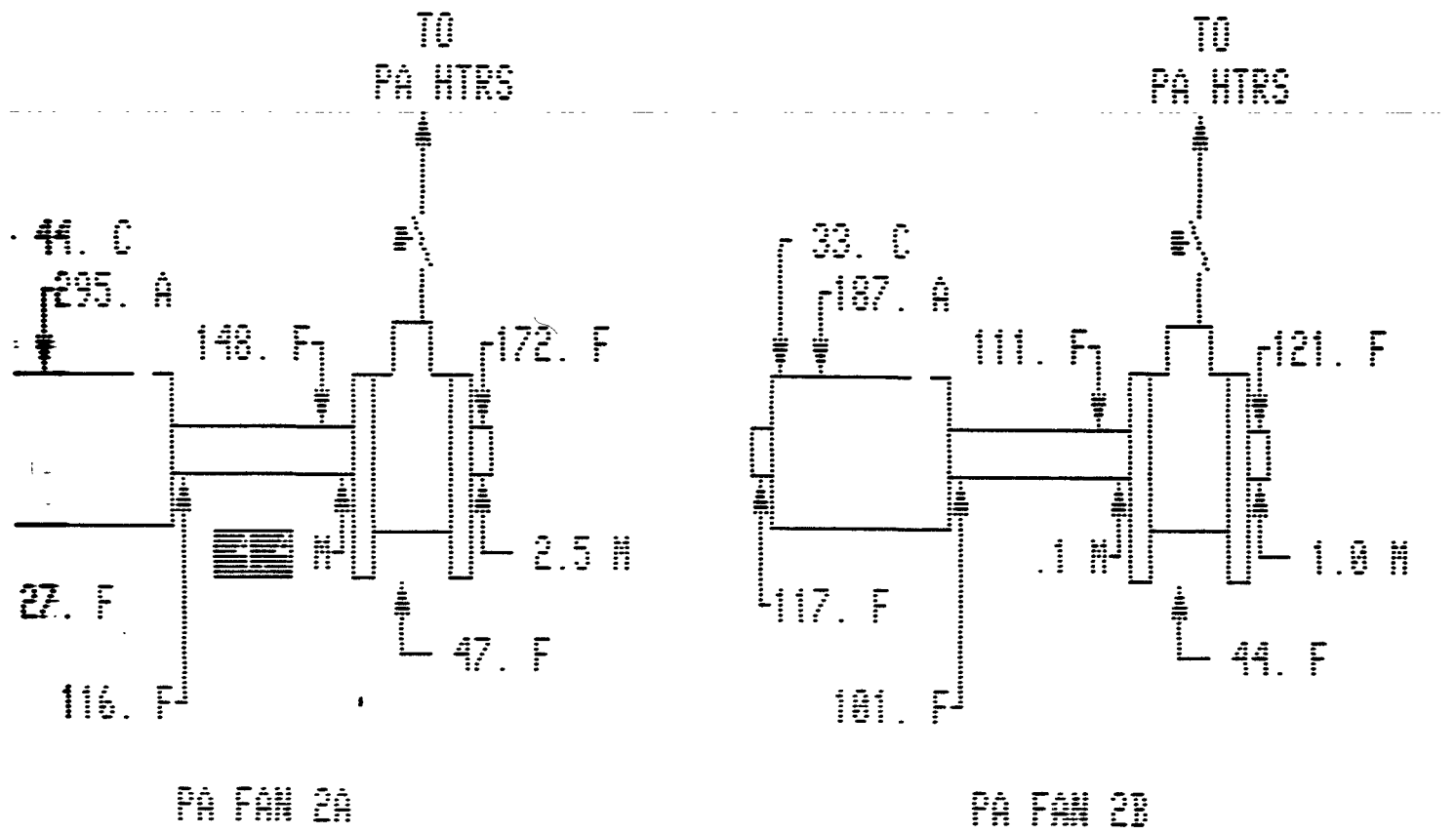
37.3	37.3	37.4	44.2
INWC	INWG	INWG	F
	37.7	37.5	
	INWG	INWG	
P.A. DUCT PRESS	SLCTD PA PR AC/SP	PA PRESS A/B	PAFAN INLET TEMP
21.5	23.9	29.4	27.8
A		PCT	PCT
		30.3	29.3
B 0.0		PCT	PCT
PAFAN A VNE CNTRL	PAFAN B VNE CNTRL	PA FL ONE A/B	PA FL TWO A/B

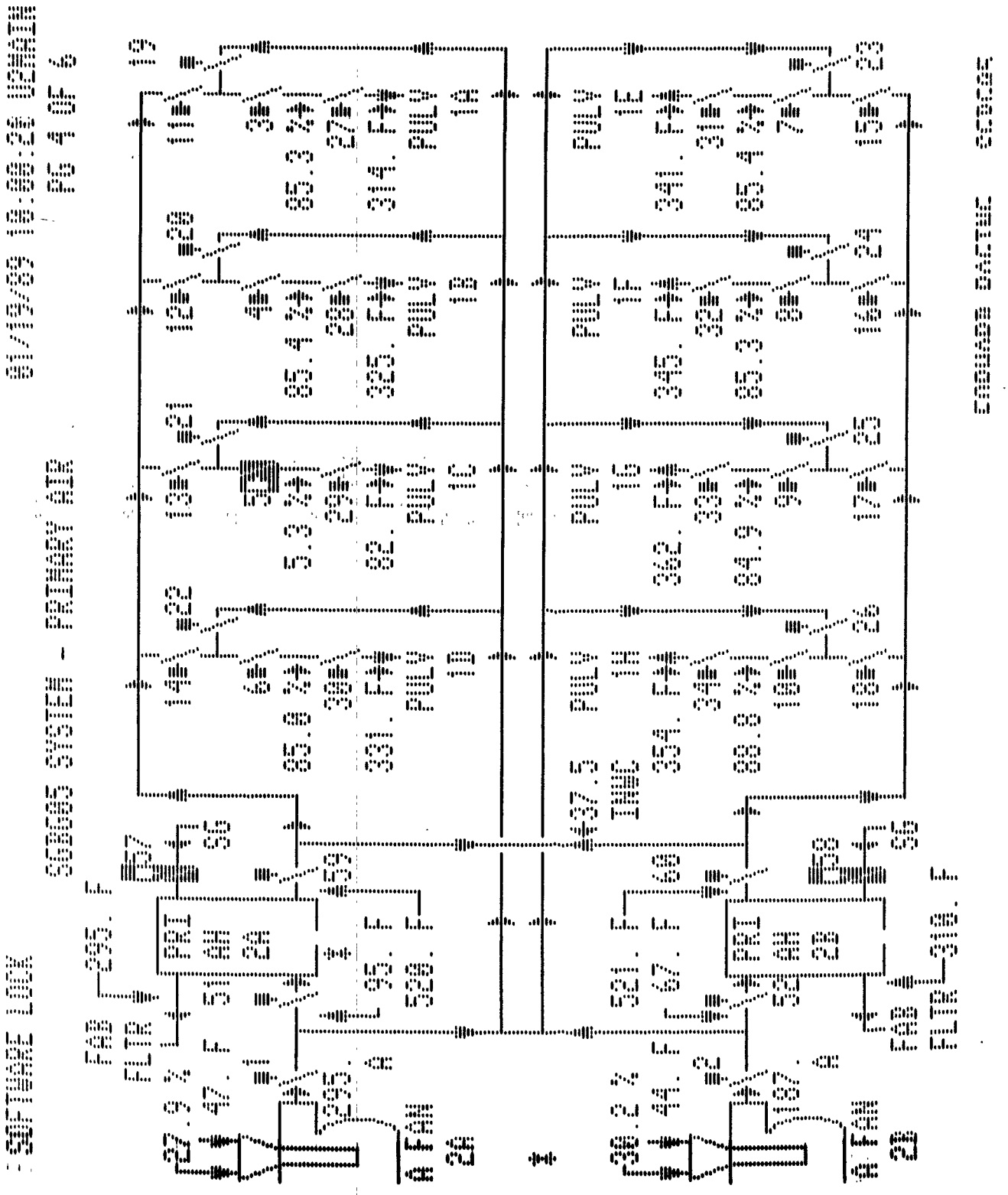
L/L SCN L/L < > L/L L/L GTD

IP12_005629

SOFTWARE LOCK 01/19/89 10:01:04 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS





AIR/GAS PRI AIR 01/19/89 08:58:54

37.8	37.8	37.7	48.6
A	INWG	INWG	
INWC	37.5	37.8	F
	INWG	INWG	
P.A.	SLCTD	PA.	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
21.8	24.2	29.7	28.1
A		PCT	PCT
		30.8	30.0
B		PCT	PCT
0.0	0		
	TO		
PAFAN	PAFAN	PA FL	PA FL
A VNE	B VNE	ONE	TWO
CNTRL	CNTRL	A/B	A/B

L/L SCN L/L < > L/L L/L GTD

IP12_005632

SOFTWARE LOCK 01/19/89 09:02:03 U2MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	318.0	TPH	TOTAL FUEL FLOW		
XI002A	44.1	TPH	PULV 1A COAL FLOW		
XI003A	44.4	TPH	PULV 1B COAL FLOW		
XI004A	[illegible]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	43.9	TPH	PULV 1D COAL FLOW		
XI006A	44.3	TPH	PULV 1E COAL FLOW		
XI007A	44.4	TPH	PULV 1F COAL FLOW		
XI008A	43.7	TPH	PULV 1G COAL FLOW		
XI009A	50.9	TPH	PULV 1H COAL FLOW		
XI080A	1.5	PCT	WEST FLUE GAS O2		
XI079A	3.4	PCT	EAST FLUE GAS O2		
TE0707	741.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	740.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	280.	DEGF	SEC AH 1A GAS OUT T		
TE0929	267.	DEGF	SEC AH 1B GAS OUT T		
TE0913	295.	DEGF	PRI AH 2A GAS OUT T		
TE0916	315.	DEGF	PRI AH 2B GAS OUT T		
XI072A	37.7	INWC	PA DUCT PRESS		
XI084A	-14.4	INWC	ID FANS SUCT PRESS		
PT0165	-2.5	INWC	SG ECON OUTLET FLUE GAS PR		

ENQUARD DACTWC DU3

IP12_005633

RSOFTWARE LOCK 01/19/89 09:01:37 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
PT0174	.7	INWC	BNR LVL 2 S WINDBOX PR		
PT0176	.7	INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.2	INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.3	INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.5	INWC	BNR LVL 1 S WINDBOX PR		
PT0175	.8	INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.0	INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.3	INWC	BNR LVL 2 N WINDBOX PR		
KS007A	62.0	PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	62.6	PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0	PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	62.0	PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	62.1	PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	61.9	PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	62.8	PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	72.3	PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.5	INWC	SG EAST FLUE GAS PR		

EADUADR DACTWC DUO

IP12_005634

SOFTWARE LOCK 01/19/89 09:01:17 U2MAIN

MENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI027A	856.	MW	UNIT LOAD		
XI024A	5989.	KPPH	TURBINE STEAM FLOW		
FI0025	6085.	KPPH	BOILER FEEDWATER F		
TE0863	711.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	708.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1006.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2420.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	22.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	10.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	0.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	620.	DEGF	SG E COLD REHEAT INLET T		
TE0019	620.	DEGF	SG W COLD REHEAT INLET T		
PT0011	530.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1012.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	492.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	0.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	217.	DEGF	REHEAT DESUPERHEATER SPRAY T		

EDQUADR DACTWC DU1

IP12_005635

SOFTWARE LOCK 01/19/89 09:00:43 U2MAIN

UREMENT DISPLAY

WEATHER DATA

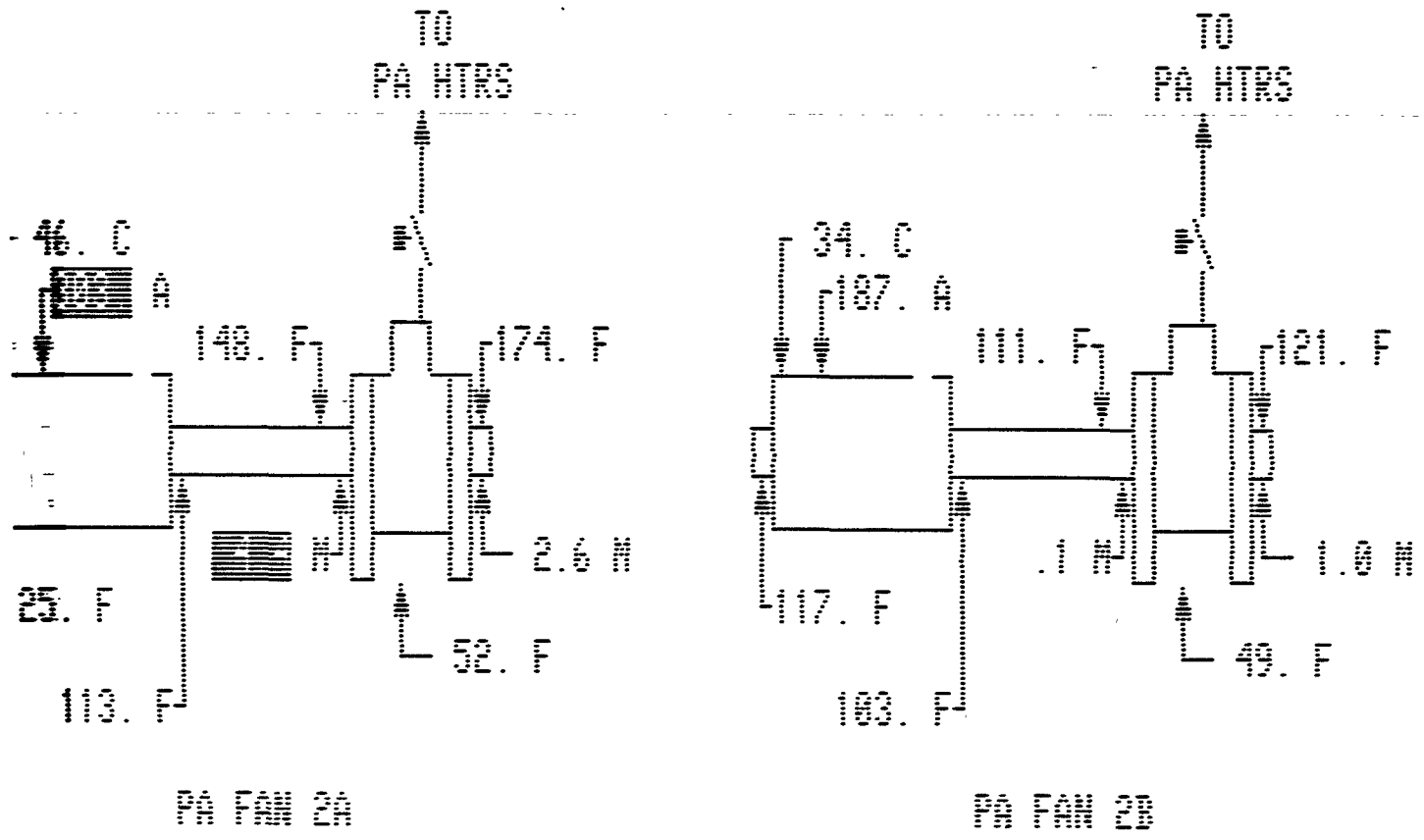
LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.60 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.66 IN HG	BAROMETRIC PRESSURE		
KK0531	12. DEGF	AMBIENT TEMPERATURE		
TE1160	13. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	89. PCT	RELATIVE HUMIDITY		

ENQUADR DACTWC UTUD

IP12_005636

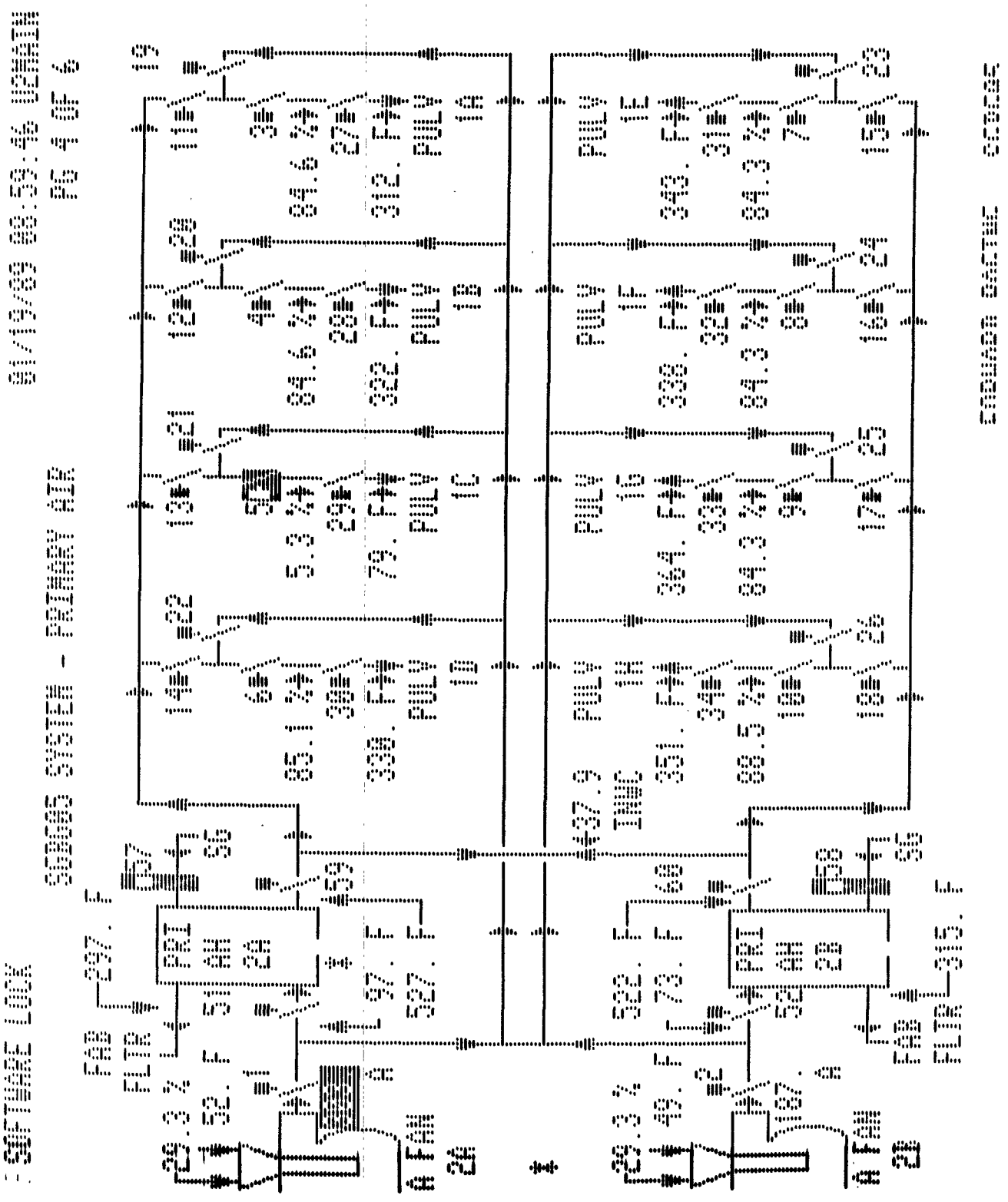
SOFTWARE LOCK 01/19/89 09:00:12 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



ENQUADR DACTUC SCBG09

IP12_005637



Unit 2 PA Fan 2A Testing 1/19/89

U.O. Bill Johnson

Test #1

test start 9:00 problems with power to outlets

Fan 2B in manual, Fan 2A in high speed

2A Fan amps 303 4.4 mils on Inboard bearing

Primary Air Fan 2A Air Flow position Feedback 23

Primary Air Fan 2B Air Flow position Feedback 45

Started 9:50 Finish 11:40

AXI074A

75A

13

Group 16, 35

Test #2 Fan 2A

test start 12:30 Finish 14:20

2A Fan amps 304 2B Fan 187

Primary Air Fan 2A Air Flow position Feedback 23

Primary Air Fan 2B Air Flow position Feedback 45

Test #3 Fan 2A

start 14:20 Finish

#Dm 3.051MW .88PF
19-Jan-89 09:55:40

Test #4 APAFan
Start 09:50

A 294.2 A
B 297.0 A

Status
19-Jan-89 09:59:37

Avg 6.706 KV

T 3.470 MVA

T 3.040 MW

T .88 PF

#Dm 3.050MW .88PF
19-Jan-89 10:05:40

#Dm 3.064MW .88PF
19-Jan-89 10:15:40

Status
19-Jan-89 10:20:39

Avg 6.701 KV

T 3.492 MVA

T 3.061 MW

T .88 PF

A 295.7 A
B 298.7 A

#Dm 3.058MW .88PF
19-Jan-89 10:25:40

#Dm 3.062MW .88PF
19-Jan-89 10:35:40

#Dm 3.050MW .88PF
19-Jan-89 10:45:40

Status
19-Jan-89 10:50:17

Avg 6.692 KV

T 3.494 MVA

T 3.064 MW

T .88 PF

A 297.3 A
B 299.2 A

#Dm 3.061MW .88PF
19-Jan-89 10:55:40

#Dm 3.061MW .88PF
19-Jan-89 11:05:40

#Dm 3.073MW .88PF
19-Jan-89 11:15:40

Status
19-Jan-89 11:19:04

Avg 6.692 KV

T 3.479 MVA

T 3.052 MW

T .88 PF

A 295.9 A
B 297.7 A

#Dm 3.067MW .88PF
19-Jan-89 11:25:40

#Dm 3.068MW .88PF
19-Jan-89 11:35:40

Status
19-Jan-89 11:40:23

Avg 6.689 KV

T 3.500 MVA

T 3.073 MW

T .88 PF

A 297.4 A
B 300.6 A

#Dm 3.073MW .88PF
19-Jan-89 11:45:40

Test #4
End 11:45

IP12_005640

BDS 120-1

BABCOCK & WILCOX

Time	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Base	Fan Bias	Fuel Flow	Gross MW
Time Start 09.50							
Time Stop 11:45							
10.00	303 *	23.0%	25.73	72°	NA	90%	855
10.15	304	26.5%	25.73	72°		90%	855
10:45	304	25.9%	25.74	72°		90%	952
11:15	304	27.5	25.74	72°		90	953
11.45	304	29.1	25.74	72°		90	952

* Fan amps on A & B Phase at 09:54:37 294.2A & 297.0A Respectively. See Metro printout

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test. Control Room Data

Test # 4 2A PA Fan

ID

JOB NO. RB-615

BY JM

DATE 1/19/90

IP12_005641

BDS 120-1

BABCOCK & WILCOX

Time Time Start 09:50 Time Stop	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
10:00	-.25" wd	33.5	43.4	1209			
10:15	-.25"	32.4	41.1				
10:45	-.25"	33.6	42.6				
11:15	-.25"	33.6	44.0				
11:45	-.25	35.3	44.7				

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Fan Room Data

Test # 4 2A PA Fan

Life Tel

JOB NO. RB-615

BY JM

DATE 1/19/94

IP12_005642

DS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∡	TEMP			
TAP 1 POINT 1	1.0	.239	-2	49.2			
1 - 2	1.0	.188	+2	49.8			
1 - 3	1.0	.188	0	49.6			
1 - 4	1.0	.134	-3	48.8			
2 - 1	1.0	.273	-1	48.8			
2 - 2	1.0	.207	0	48.8			
2 - 3	1.0	.236	+1	48.4			
2 - 4	1.0	.283	-1	47.2			
3 - 1	1.0	~~.227~~ .271	-1	46.6			
3 - 2	1.0	.229	0	46.8			
3 - 3	1.0	.231	0	46.2			
3 - 4	1.0	.307	~~+2~~ +1	46.0			
4 - 1	1.0	.207	+2	45.2			
4 - 2	1.0	.197	0	45.6			
4 - 3	1.0	.217	+3	45.2			
4 - 4	1.0	.231	+4	44.8			
5 - 1	1.0	.188	+2	45.4			
5 - 2	1.0	.207	0	45.8			
5 - 3	1.0	.224	0	45.8			
5 - 4	1.0	.263	-2	45.6			
6 - 1	1.0	.239	+5	45.8			
6 - 2	1.0	.229	+2	46.6			
6 - 3	1.0	.231	+2	46.8			
6 - 4	1.0	.307	+4	46.6			
7 - 1	1.0	.263	0	46.6			
7 - 2	1.0	.234	+5	46.8			
7 - 3	1.0	.263	+3	47.0			
7 - 4	1.0	.324	0	46.8			
8 - 1	1.0	.295	+3	46.8			
8 - 2	1.0	.241	0	47.2			
8 - 3	1.0	.280	+1	47.6			
8 - 4	1.0	.324	+1	47.4			
9 - 1	1.0	.249	+1	47.2			
9 - 2	1.0	.222	-2	47.4			
9 - 3	1.0	.253	0	47.6			
9 - 4	1.0	.219	-2	46.8			
10 - 1	1.0	.173	+1	45.8			
10 - 2	1.0	.195	-4	46.2			
10 - 3	1.0	.197	-4	45.8			
10 - 4	1.0	.234	-1	45.6			

CUSTOMER [illegible]

SUBJECT [illegible]

[illegible] 10:00 AM
East FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005643

DS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 11	POINT 1	.7	.278	-6	43.2			
11	2	.7	.227	-2	43.2			
11	3	.7	.278	-3	43.2			
11	4	.7	.256	-7	43.4			
12	1	.7	.241	0	43.6			
12	2	.7	.197	-2	44.0			
12	3	.7	.253	-1	44.0			
12	4	.7	.261	+1	44.0			
13	1	.7	.192	-4	44.0			
13	2	.7	.202	-7	44.2			
13	3	.7	.214	-4	44.0			
13	4	.7	.214	-2	44.0			
14	1	.7	.278	+1	43.4			
14	2	.7	.224	-5	44.4			
14	3	.7	.268	-2	44.2			
14	4	.7	.295	-1	44.0			
15	1	.7	.180	+6	45.2			
15	2	.7	.126	-4	45.0			
15	3	.7	.131	-2	44.4			
15	4	.7	.222	+1	44.6			
16	1	.7	.073	+6	43.8			
16	2	.7	.070	-7	43.8			
16	3	.7	.080	-4	44.0			
16	4	.7	.139	+2	43.8			
BARO P								

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET: East Side

Test # 4 10:00 AM

File ID EAST FAN

JOB NO.

BY MCB

DATE 1/19/99

IP12_005644

DS 120-1

BABCOCK & WILCOX

		Static	velocity	yaw ∠	Temp
Tap 17	Point 1	.7	.146	+4	47.4
	2	.7	.151	-4	47.6
	3	.7	.161	-5	47.6
	4	.7	.202	0	47.6
18	1	.7	.204	0	47.6
	2	.7	.180	-5	47.6
	3	.7	.195	-2	47.2
	4	.7	.229	-2	47.6
19	1	.7	.202	-4	47.2
	2	.7	.180	-6	47.4
	3	.7	.173	-5	47.4
	4	.7	.258	-4	47.8
20	1	.7	.144	-3	48.0
	2	.7	.134	0	48.0
	3	.7	.141	-2	47.6
	4	.7	.188	-2	47.6
21	1	.7	.156	-6	48.0
	2	.7	.136	-4	48.2
	3	.7	.192	-4	48.0
	4	.7	.197	-2	47.8
22	1	.7	.190	-9	48.0
	2	.7	.163	-7	48.4
	3	.7	.231	-6	48.4
	4	.7	.219	-7	48.2
23	1	.7	.217	-4	47.6
	2	.7	.188	-8	47.2
	3	.7	.219	-5	47.2
	4	.7	.283	-4	47.6
24	1	.7	.180	-5	47.8
	2	.7	.192	-6	47.8
	3	.7	.258	-4	48.0
	4	.7	.217	-4	47.8
25	1	.7	.234	-2	47.2
	2	.7	.205	-2	47.0
	3	.7	.227	-1	47.0
	4	.7	.217	-4	46.8
26	1	.7	.192	-4	46.6
	2	.7	.156	+2	46.8
	3	.7	.222	-3	46.2
	4	.7	.183	-4	45.8

CUSTOMER Intermountain Power Project

SUBJECT PA Test Tap West Side

Test #4 10:00 AM

Fan ID EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005645

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 27	Point 1	.7	.239	42	46.2			
	2	.7	.207	-3	45.8			
	3	.7	.231	0	45.2			
	4	.7	.202	+1	45.4			
28	1	.7	.217	-3	44.4			
	2	.7	.170	-2	44.2			
	3	.7	.244	-3	44.0			
	4	.7	.205	-5	44.2			
29	1	.7	.168	-6	44.4			
	2	.7	.156	-4	43.6			
	3	.7	.193	-7	43.4			
	4	.7	.146	-6	44.6			
30	1	.7	.219	-6	45.2			
	2	.7	.180	+1	44.4			
	3	.7	.209	-3	44.4			
	4	.7	.266	-3	44.4			
31	1	.7	.144	-10	44.6			
	2	.7	.092	-2	44.2			
	3	.7	.104	-3	44.4			
	4	.7	.158	-7	44.8			
32	1	.7	.056	-14	44.8			
	2	.7	.036	-2	44.6			
	3	.7	.026	-5	44.4			
	4	.7	.087	-8	44.6			

CUSTOMER [illegible] Project

SUBJECT [illegible]

[illegible] # 4 10:00 AM

[illegible] East FAN

JOB NO.

BY MCD

DATE 1/19/89

IP12_005646

DS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
T.F. [illegible]								
TAP 1	POINT 1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10							
2	1	39	0.327	5	68.2			
2	2	40	0.506	10	66.0			
2	3	40	0.456	10	64.0			
2	4	40	0.390	0	64.2			
2	5	39	0.634	5	66.0			
2	6	39	0.415	5	86.4			
2	7	39	0.390	5	87.8			
2	8	39	0.490	0	88.6			
2	9	39	0.705	5	89.4			
2	10	39	1.027	5	90.0			
3	1	39	0.344	15	64.0			
3	2	39	0.505	15	62.4			
3	3	39	0.471	10	61.8			
3	4	39	0.30	0	63.4			
3	5	39	0.275	5	71.4			
3	6	39	0.198	10	89.0			
3	7	39	0.271	15	91.2			
3	8	39	0.437	5	92.4			
3	9	39	0.749	0	93.0			
3	10	39	0.32	5	93.0			
4	1	39	0.485	20	94.2			
4	2	39	0.498	15	94.8			
4	3	39	0.234	10	93.8			
4	4	39	0.114	5	93.8			
4	5	39	0.136	10	93.4			
4	6	39	0.148	15	93.2			
4	7	39	0.231	10	93.0			
4	8	39	0.373	5	93.0			
4	9	39	0.781	0	92.2			
4	10	39	0.930	0	91.4			

CUSTOMER [illegible]

SUBJECT [illegible] #2 unit

[illegible] #4

[illegible]

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005647

DS 120-1

BABCOCK & WILCOX

			STATIC	VELOCITY	YAW ∠	TEMP			
TAP	5	POINT 1	39	0.400	15	92.2			
	5	2	39	0.421	15	92.6			
	5	3	39	0.197	15	93.0			
	5	4	39	0.173	5	93.2			
	5	5	39	0.090	15	93.2			
	5	6	39	0.083	15	94.0			
	5	7	39	0.148	10	95.0			
	5	8	39	0.429	5	95.6			
	5	9	39	0.835	0	96.0			
	5	10	39	1.211	0	96.2			
	6	1	39	0.671	10	94.4			
	6	2	39	0.126	15	93.8			
	6	3	39	0.170	10	93.8			
	6	4	39	0.056	0	93.2			
	6	5	39	0.051	10	93.6			
	6	6	39	0.036	15	93.0			
	6	7	39	0.192	5	92.4			
	6	8	39	0.339	5	92.4			
	6	9	39	0.874	5	92.2			
	6	10	39	1.433	5	92.2			
	7	1	39	0.434	10	93.8			
	7	2	39	0.456	10	93.2			
	7	3	39	0.080	0	92.8			
	7	4	39	0.053	10	92.4			
	7	5	39	0.080	5	92.2			
	7	6	39	0.059	0	92.6			
	7	7	39	0.119	5	92.6			
	7	8	39	0.610	5	92.4			
	7	9	39	1.02	5	92.6			
	7	10	39	1.335	5	92.4			
	8	1	39	0.669	0	93.4			
	8	2	39	0.554	0	93.4			
	8	3	39	0.246	0	94.0			
	8	4	39	0.212	10	92.8			
	8	5	39	0.087	5	92.6			
	8	6	39	0.075	10	92.8			
	8	7	39	0.200	10	92.6			
	8	8	39	0.490	10	92.6			
	8	9	38	0.078	10	92.8			
	8	10	38	0.078	10	93.0			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT [illegible] #2 unit

TEST # 4

FILE ID

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005648

DS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	39	0.424	10	93.4			
9	2	39	0.502	0	92.8			
9	3	39	0.393	5	93.0			
9	4	38	0.107	10	92.8			
9	5	38	0.153	5	93.0			
9	6	38	0.107	10	93.0			
9	7	38	0.449	15	92.8			
9	8	38	0.688	15	92.8			
9	9	38	1.152	15	93.0			
9	10	38	1.150	15	93.0			
10	1	38	0.100	20	93.6			
10	2	38	0.588	15	94.0			
10	3	38	0.512	15	93.8			
10	4	38	0.376	20	93.8			
10	5	39	0.493	10	93.6			
10	6	39	0.327	20	93.6			
10	7	39	0.805	20	94.0			
10	8	39	0.698	20	94.2			
10	9	39	1.000	20	93.8			
10	10	39	1.040	20	94.0			
11	1	38	0.175	25	92.0			
11	2	38	0.271	20	92.4			
11	3	38	0.314	20	92.4			
11	4	38	0.632	20	93.0			
11	5	38	0.576	15	92.8			
11	6	38	0.583	20	92.8			
11	7	38	0.676	25	92.8			
11	8	38	0.578	20	93.2			
11	9	38	0.288	27	93.8			
11	10	38	0.222	27	93.8			
12	1	38	0.039	0	91.2			
12	2	38	0.063	20	91.0			
12	3	38	0.175	20	91.2			
12	4	38	0.151	20	91.2			
12	5	38	0.183	20	91.2			
12	6	38	0.390	25	91.6			
12	7	38	0.231	20	91.6			
12	8	38	0.207	20	91.8			
12	9	38	0.087	20	91.6			
12	10	38	0.124	13	91.6			

CUSTOMER [illegible]	JOB NO.
SUBJECT [illegible] #2 unit	
Test # 4	BY Paul Wu
[illegible]	DATE 1/19/89

IP12_005649

TEST 5

```
Avg 6.688 KV

T    3.541 MVA

T    3.107 MW

T    .88   PF

A    300.3 A
B    303.3 A

#Dm 3.084MW    .88PF
 19-Jan-89 13:35:40

#Dm 3.104MW    .88PF
 19-Jan-89 13:45:40

#Dm 3.089MW    .88PF
 19-Jan-89 13:55:40

Status
19-Jan-89 14:03:43

Avg 6.689 KV

T    3.556 MVA

T    3.120 MW

T    .88   PF

A    301.9 A
B    305.1 A

#Dm 3.109MW    .88PF
 19-Jan-89 14:05:40

#Dm 3.116MW    .88PF
 19-Jan-89 14:15:40
```

Test was End

```
#Dm 3.082MW    .88PF
 19-Jan-89 12:35:40

Status
19-Jan-89 12:41:39

Avg 6.689 KV

T    3.517 MVA

T    3.086 MW

T    .88   PF

A    298.8 A
B    301.7 A

#Dm 3.088MW    .88PF
 19-Jan-89 12:45:40

#Dm 3.088MW    .88PF
 19-Jan-89 12:55:40

Status
19-Jan-89 12:59:28

Avg 6.688 KV

T    3.542 MVA

T    3.108 MW

T    .88   PF

A    300.6 A
B    303.3 A

#Dm 3.091MW    .88PF
 19-Jan-89 13:05:40

#Dm 3.075MW    .88PF
 19-Jan-89 13:15:40

#Dm 3.109MW    .88PF
 19-Jan-89 13:25:40

Status
19-Jan-89 13:30:01
```

DS 120-11

BABCOCK & WILCOX

Date	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Bars.	Fan Bias	Fuel Flow	Gross MW
Time Start 12:30							
Time Stop 14:15							
12:30	304	29.9	25.72	72°		90%	852
13:00 HRS	304	29.1	25.71	72°		91%	853
13:30	304	28.4	25.70	72°		92%	852
14:00	304	29.6	25.70	72°		93%	853

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test. Control Room Data

Test # 5 2A PA Fan

File ID

JOB NO. RB-615

BY [illegible]

DATE 1/19/89

IP12_005651

BS 120-1

BABCOCK & WILCOX

Time	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
12:00	-.25	37.6	48.5	1209			
13:00	-.25	38.1	49.8	1209			
13:30	-.25	32.6	40.6				
14:00	-.25	41.6	55.7				

CUSTOMER Intermountain Power Project	JOB NO. RB-615
SUBJECT PA Fan Test, Fan Room Dirty	
Test # 5 2A PA Fan	BY JM Jr
Fire Id	DATE 1/19/89

IP12_005652

DS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 27	Point 1	0.7	.234	+3	55.0			
	2	0.7	.227	-2	54.0			
	3	0.7	.258	0	53.0			
	4	0.7	.268	+1.0	52.0			
28	1	0.7	.244	-4	52.0			
	2	0.7	.188	-4	51.6			
	3	0.7	.222	-3	49.0			
	4	0.7	.239	-3	47.8			
29	1	0.7	.188	-8	50.4			
	2	0.7	.170	-4	49.2			
	3	0.7	.207	-5	44.0			
	4	0.7	.205	-6	42.6			
30	1	0.7	.251	-6	44.0			
	2	0.7	.188	-1	44.2			
	3	0.7	.236	-3	41.4			
	4	0.7	.258	-3	40.0			
31	1	0.7	.156	-10	41.2			
	2	0.7	.095	-1	42.2			
	3	0.7	.107	-4	43.2			
	4	0.7	.173	-6	45.2			
32	1	0.7	.037	-10	47.0			
	2	0.7	.048	-5	47.6			
	3	0.7	.039	-3	50.2			
	4	0.7	.102	-6	51.8			

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Inlet West Side

Test # 5 12:30pm

File TD East FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005653

BS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∡	TEMP			
TAP 1 POINT 1	1.0	.219	-4	44.2			
1 - 2	1.0	.161	+3	44.4			
1 - 3	1.0	.170	+1	44.4			
1 - 4	1.0	.146	-3	45.6			
2 - 1	1.0	.263	-1	46.2			
2 - 2	1.0	.205	+1	47.0			
2 - 3	1.0	.256	+1	49.4			
2 - 4	1.0	.300	-1	50.8			
3 - 1	1.0	.200	0	53.0			
3 - 2	1.0	.258	+1	52.4			
3 - 3	1.0	.266	+3	54.2			
3 - 4	1.0	.314	0	53.2			
4 - 1	1.0	.249	+3	53.6			
4 - 2	1.0	.231	+3	54.2			
4 - 3	1.0	.236	+4	54.6			
4 - 4	1.0	.275	+3	55.0			
5 - 1	1.0	.234	0	53.6			
5 - 2	1.0	.241	-1	53.0			
5 - 3	1.0	.231	0	53.4			
5 - 4	1.0	.290	-1	53.2			
6 - 1	1.0	.263	+6	52.0			
6 - 2	1.0	.234	+1	51.8			
6 - 3	1.0	.249	+4	51.2			
6 - 4	1.0	.341	+4	50.8			
7 - 1	1.0	.275	0	50.2			
7 - 2	1.0	.251	+6	49.2			
7 - 3	1.0	.288	+3	48.3			
7 - 4	1.0	.354	-1	47.2			
8 - 1	1.0	.275	+1	48.2			
8 - 2	1.0	.256	+1	45.8			
8 - 3	1.0	.278	+1	45.6			
8 - 4	1.0	.327	+1	44.2			
9 - 1	1.0	.231	-1	45.0			
9 - 2	1.0	.209	-1	44.0			
9 - 3	1.0	.249	-2	43.4			
9 - 4	1.0	.236	-1	43.6			
10 - 1	1.0	.205	+1	44.6			
10 - 2	1.0	.173	-6	45.6			
10 - 3	1.0	.217	-3	47.4			
10 - 4	1.0	.222	0	49.2			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT PA FAN TEST INLET East Side

Test # 5 12:30pm

EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005654

BOS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∠	TEMP			
TAP 11 POINT 1	1.0	.288	-6	49.6			
11 2	1.0	.256	-1	52.4			
11 3	1.0	.341	-3	54.6			
11 4	1.0	.297	-6	56.0			
12 1	1.0	.290	0	55.2			
12 2	1.0	.231	-1	54.6			
12 3	1.0	.302	0	55.4			
12 4	1.0	.312	+1	56.2			
13 1	1.0	.227	-2	55.0			
13 2	1.0	.231	-6	54.6			
13 3	1.0	.258	-4	54.8			
13 4	1.0	.222	-3	54.4			
14 1	1.0	.290	0	53.4			
14 2	1.0	.251	-5	52.2			
14 3	1.0	.256	-3	51.0			
14 4	1.0	.322	0	50.4			
15 1	1.0	.188	+3	50.2			
15 2	1.0	.148	-3	49.8			
15 3	1.0	.146	-2	48.0			
15 4	1.0	.217	0	47.4			
16 1	1.0	.083	+6	47.8			
16 2	1.0	.078	-7	47.2			
16 3	1.0	.068	-9	46.2			
16 4	1.0	.119	0	43.6			
BARO P							

CUSTOMER INTERMOUNTAIN POWER

SUBJECT FA FAN TEST INLET; East Side

Test # 5 12:30 pm

E.L. 20 EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005655

DS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp			
Tap 17	Point 1	0.7	.163	+3	53.6			
	2	0.7	.166	-3	54.0			
	3	0.7	.183	-3	56.0			
	4	0.7	.207	-1	55.6			
18	1	0.7	.239	0	56.0			
	2	0.7	.195	-5	55.2			
	3	0.7	.202	-3	54.8			
	4	0.7	.290	+1	54.4			
19	1	0.7	.205	-2	53.8			
	2	0.7	.185	-6	53.4			
	3	0.7	.200	-4	52.0			
	4	0.7	.251	-4	51.4			
20	1	0.7	.136	-4	52.2			
	2	0.7	.146	-1	52.2			
	3	0.7	.158	-1	50.0			
	4	0.7	.200	0	49.2			
21	1	0.7	.166	-5	49.4			
	2	0.7	.146	-4	49.8			
	3	0.7	.214	-4	46.2			
	4	0.7	.200	-2	46.0			
22	1	0.7	.197	-8	45.6			
	2	0.7	.166	-7	46.0			
	3	0.7	.202	-4	45.2			
	4	0.7	.209	-7	46.4			
23	1	0.7	.205	-2	47.6			
	2	0.7	.197	-8	48.6			
	3	0.7	.227	-4	50.4			
	4	0.7	.227	-4	51.8			
24	1	0.7	.202	-6	52.8			
	2	0.7	.207	-5	53.6			
	3	0.7	.241	-4	56.6			
	4	0.7	.249	-4	58.4			
25	1	0.7	.253	-2	58.2			
	2	0.7	.214	-1	57.8			
	3	0.7	.268	0	58.6			
	4	0.7	.273	-1	58.8			
26	1	0.7	.219	-4	57.8			
	2	0.7	.161	+1	57.4			
	3	0.7	.205	-1	56.6			
	4	0.7	.244	-4	56.0			

CUSTOMER Intermountain Power Project

SUBJECT PA Fan Test Inlet West Side

Test # 5 12:30 pm

File 10 EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005656

BOS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	VIEW %	TEMP			
TAP	POINT							
1	1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10							
2	1	39	0.341	10	67.6			
2	2	39	0.490	10	66.6			
2	3	40	0.483	5	67.2			
2	4	40	0.434	0	68.2			
2	5	40	0.383	0	82.0			
2	6	39	0.295	5	92.8			
2	7	40	0.334	0	98.0			
2	8	40	0.512	0	97.4			
2	9	40	0.703	5	96.6			
2	10	40	0.930	5	96.0			
3	1	40	0.415	20	90.4			
3	2	40	0.459	15	92.0			
3	3	40	0.398	10	90.8			
3	4	40	0.283	0	91.0			
3	5	40	0.212	15	90.0			
3	6	40	0.173	15	90.0			
3	7	40	0.358	10	89.6			
3	8	40	0.432	0	90.2			
3	9	40	0.669	0	91.2			
3	10	40	0.893	5	92.2			
4	1	39	0.595	20	69.6			
4	2	39	0.432	15	68.8			
4	3	39	0.207	5	69.4			
4	4	39	0.092	5	74.8			
4	5	39	0.124	20	86.8			
4	6	39	0.100	25	94.4			
4	7	40	0.310	10	96.6			
4	8	40	0.445	10	97.0			
4	9	40	0.842	0	97.2			
4	10	40	1.096	0	97.2			

CUSTOMER Intermountain Power

SUBJECT PA FAN TEST OUTLET

Test # 5

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005657

BOS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∡	TEMP			
TAP 5	POINT 1	40	0.710	20	89.0			
5	2	40	0.522	15	86.0			
5	3	40	0.219	15	83.4			
5	4	40	0.083	10	82.2			
5	5	40	0.062	10	86.4			
5	6	40	0.095	15	88.2			
5	7	40	0.070	15	88.6			
5	8	40	0.346	5	88.6			
5	9	39	0.854	0	91.2			
5	10	39	1.184	5	94.2			
6	1	39	0.842	10	85.6			
6	2	39	0.412	10	83.2			
6	3	39	0.109	0	82.4			
6	4	40	0.083	0	86.4			
6	5	40	0.056	10	84.8			
6	6	40	0.065	15	85.4			
6	7	40	0.231	10	93.8			
6	8	40	0.417	5	95.6			
6	9	40	0.952	5	96.0			
6	10	40	1.296	5	90.2			
7	1	40	0.307	5	82.2			
7	2	40	0.483	10	89.6			
7	3	40	0.188	0	88.2			
7	4	40	0.068	10	91.0			
7	5	40	0.053	5	96.2			
7	6	40	0.129	5	98.8			
7	7	40	0.271	0	99.8			
7	8	40	0.895	10	103.2			
7	9	40	1.106	5	104.2			
7	10	40	1.435	10	104.8			
8	1	40	0.92	0	100.4			
8	2	40	0.532	0	99.2			
8	3	40	0.300	0	98.6			
8	4	40	0.114	0	97.8			
8	5	40	0.190	10	96.8			
8	6	40	0.124	10	96.4			
8	7	40	0.197	5	95.8			
8	8	40	0.637	10	95.0			
8	9	40	1.171	10	94.8			
8	10	40	1.399	10	94.8			

CUSTOMER INTERMOUNTAIN POWER

SUBJECT [illegible]

Test # 5

File ID

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005658

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	40	0.512	10	90.0			
9	2	40	0.505	5	89.0			
9	3	40	0.285	10	88.6			
9	4	40	0.151	5	89.0			
9	5	40	0.285	15	90.0			
9	6	40	0.117	10	91.4			
9	7	40	0.227	15	93.4			
9	8	40	0.759	15	96.0			
9	9	40	1.174	15	98.8			
9	10	40	1.264	15	100.8			
10	1	40	1.180	20	105.6			
10	2	40	0.788	15	106.2			
10	3	40	0.502	20	106.6			
10	4	40	0.501	20	107.0			
10	5	40	0.495	15	107.0			
10	6	40	0.571	20	107.0			
10	7	40	0.769	20	106.8			
10	8	40	1.003	20	106.8			
10	9	40	0.683	20	106.4			
10	10	40	0.900	20	106.2			
11	1	40	0.185	25	105			
11	2	40	1.062	25	104.8			
11	3	40	0.966	25	104.4			
11	4	40	0.69	20	97.4			
11	5	40	0.710	20	92.6			
11	6	40	0.725	25	97.8			
11	7	40	0.730	25	98.6			
11	8	40	0.769	25	98.5			
11	9	40	0.078	25	98.6			
11	10	40	0.178	30	98.8	STATIC	Velocity	∠ A
12	1	39	0.341	10	87.6	40	0.126	20
12	2	39	0.490	10	96.6	40	0.087	25
12	3	40	0.483	5	97.2	40	0.280	20
12	4	40	0.434	0	98.2	40	0.461	20
12	5	40	0.383	0	89.0	40	0.341	25
12	6	39	0.295	5	92.8	40	0.505	20
12	7	40	0.334	0	98.0	40	0.401	20
12	8	40	0.512	0	97.0	40	0.295	25
12	9	40	0.703	5	96.0	40	0.278	25
12	10	40	0.930	5	96.4	40	0.109	15

Bottom of Duct

CUSTOMER INTL & MOUNTAIN POWER

SUBJECT [illegible] OUTLET

Test # 5

Fac ID

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005659

Unit 2
PA Fan 2A Test 2 overall Test #5

AIR/GAS PRI AIR 01/19/89 12:43:32

37.8	37.9	37.9	52.6
8	INWG	INWG	
INWC	37.9	38.0	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
24.7	27.5	31.0	29.6
8	T	PCT	PCT
		29.4	28.5
B	U	PCT	PCT
0.0	0		
	0		
PAFAN	PAFAN	PA FL	PA FL
A VNE	B VNE	ONE	TWO
CNTRL	CNTRL	A/B	A/B

L/L SCN L/L < > L/L L/L GTD

IP12_005660

SOFTWARE LOCK 01/19/89 12:46:40 U2MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	321.4	TPH	TOTAL FUEL FLOW		
XI002A	45.8	TPH	PULV 1A COAL FLOW		
XI003A	45.3	TPH	PULV 1B COAL FLOW		
XI004A	[illegible]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	45.2	TPH	PULV 1D COAL FLOW		
XI006A	43.7	TPH	PULV 1E COAL FLOW		
XI007A	44.8	TPH	PULV 1F COAL FLOW		
XI008A	45.3	TPH	PULV 1G COAL FLOW		
XI009A	50.0	TPH	PULV 1H COAL FLOW		
XI080A	2.6	PCT	WEST FLUE GAS O2		
XI079A	3.4	PCT	EAST FLUE GAS O2		
TE0707	724.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	727.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	280.	DEGF	SEC AH 1A GAS OUT T		
TE0929	268.	DEGF	SEC AH 1B GAS OUT T		
TE0913	295.	DEGF	PRI AH 2A GAS OUT T		
TE0916	313.	DEGF	PRI AH 2B GAS OUT T		
XI072A	38.2	INWC	PA DUCT PRESS		
XI084A	-13.7	INWC	ID FANS SUCT PRESS		
PT0165	-2.4	INWC	SG ECON OUTLET FLUE GAS PR		

CADWARD DACTWC DW3

IP12_005661

-SOFTWARE LOCK 01/19/89 12:46:16 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
PT0174	.9	INWC	BNR LVL 2 S WINDBOX PR		
PT0176	.9	INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.5	INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.6	INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.8	INWC	BNR LVL 1 S WINDBOX PR		
PT0175	1.1	INWC	BNR LVL 3 S WINDBOX PR		
PT0180	1.3	INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.5	INWC	BNR LVL 2 N WINDBOX PR		
KS007A	64.0	PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	64.0	PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0	PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	64.0	PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	61.4	PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	64.1	PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	64.2	PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	74.8	PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.3	INWC	SG EAST FLUE GAS PR		

ENDWADR DACTWC DWS

IP12_005662

SGFTwAE LOGA 01/19/89 12:45:55 U2MAIN

UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI0027A	853.	MW	UNIT LOAD		
XI0024A	5962.	KPPH	TURBINE STEAM FLOW		
FT0025	5942.	KPPH	BOILER FEEDWATER F		
TE0863	715.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	717.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1008.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2415.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	34.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	10.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	23.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	620.	DEGF	SG E COLD REHEAT INLET T		
TE0019	620.	DEGF	SG W COLD REHEAT INLET T		
PT0011	529.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1012.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	491.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	8.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	198.	DEGF	REHEAT DESUPERHEATER SPRAY T		

ENQUADR DACTUC DU1

IP12_005663

SOFTWARE LOCK

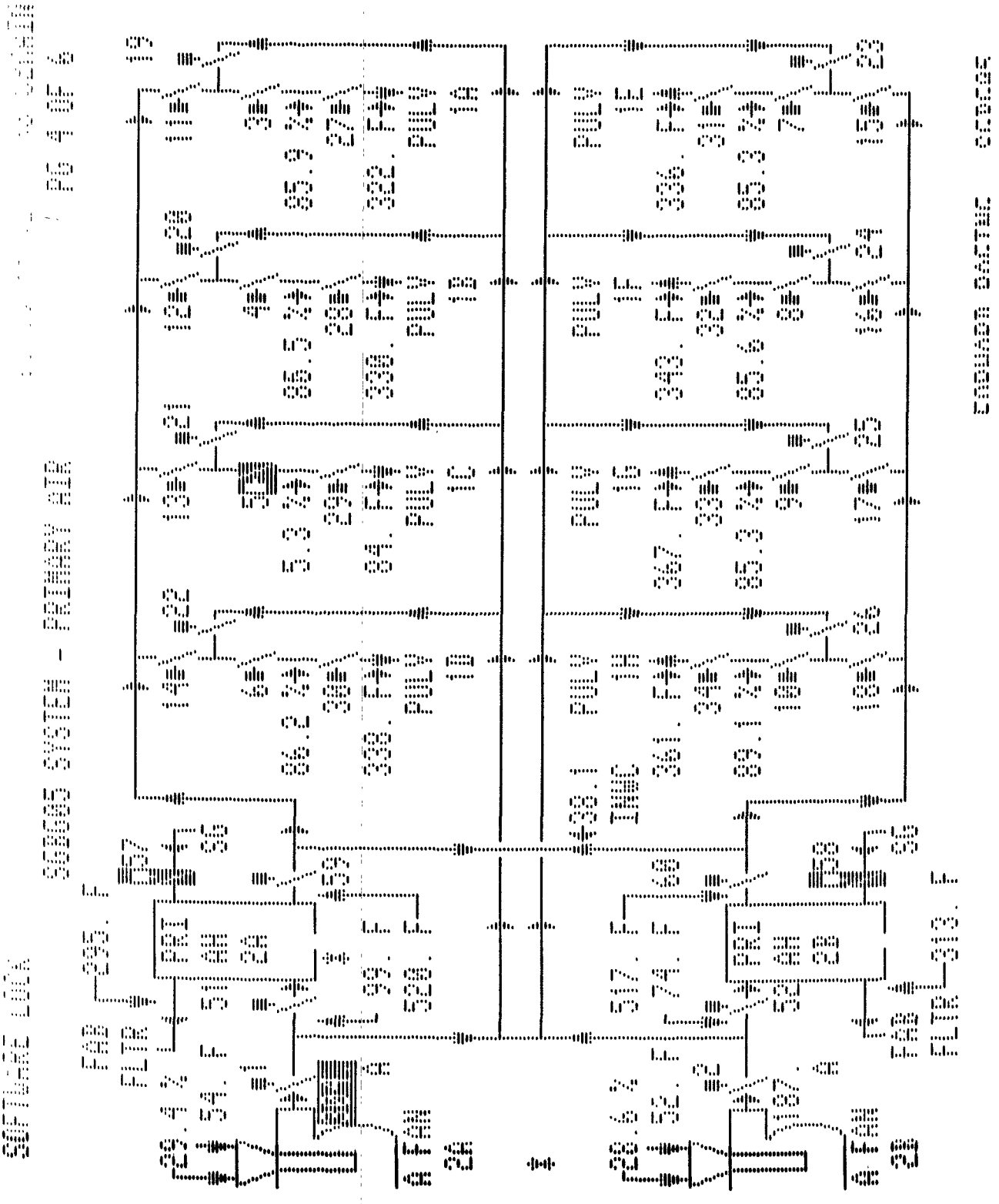
UREMENT DISPLAY

WEATHER DATA

LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.62 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.69 IN HG	BAROMETRIC PRESSURE		
KK0531	28. DEGF	AMBIENT TEMPERATURE		
TE1160	23. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	67. PCT	RELATIVE HUMIDITY		

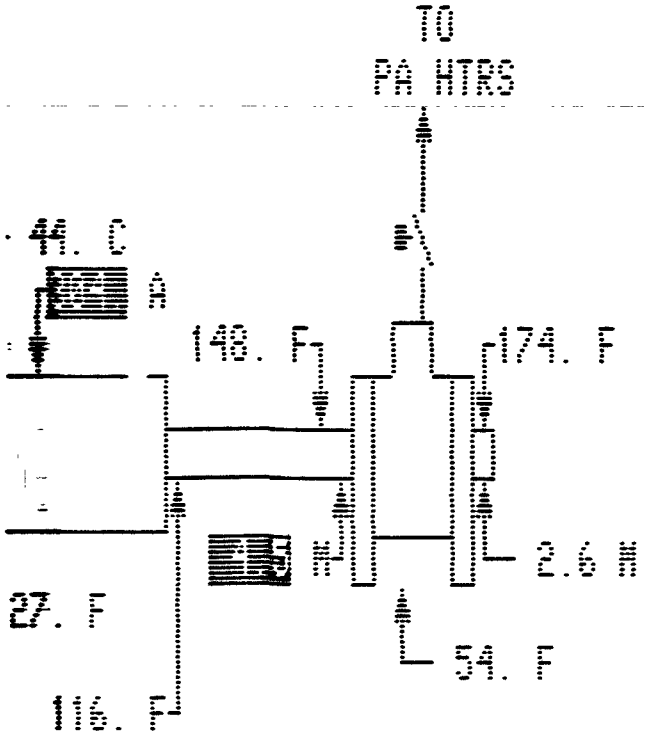
EADUADA DACTUC UTUD

IP12_005664

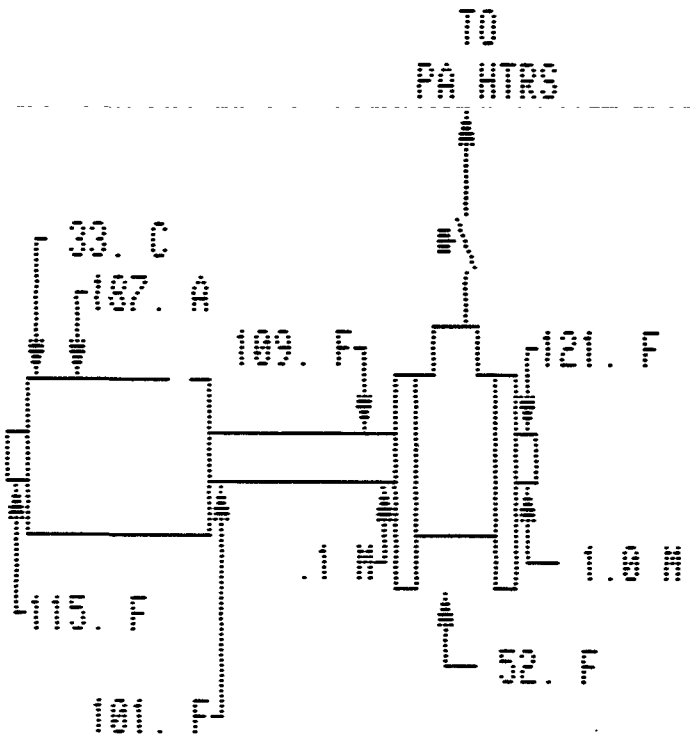


SOFTWARE LOCK 01/19/89 12:44:14 U2HAIN

SCBC09 SUBSYSTEM -PRIMARY AIR FANS



PA FAN 2A



PA FAN 2B

EDUARD DACTUC SCBC09

IP12_005666

UNIT 2

TEST 6

PA FAN TEST
PA FAN 2A HIGH SPEED
2B LOW SPEED

Test #6 Start
2A PA Fan
10:15 HRS

Status
19-Jan-89 14:21:14

Avg 6.690 KV

T 3.495 MVA

T 3.066 MW

T .88 PF

A 297.1 A
B 299.2 A

#Dm 3.086MW .88PF
19-Jan-89 14:25:40

#Dm 3.108MW .88PF
19-Jan-89 14:35:40

#Dm 3.102MW .88PF
19-Jan-89 14:45:40

#Dm 3.097MW .88PF
19-Jan-89 14:55:40

#Dm 3.105MW .88PF
19-Jan-89 15:05:40

#Dm 3.098MW .88PF
19-Jan-89 15:15:40

#Dm 3.098MW .88PF
19-Jan-89 15:25:40

#Dm 3.107MW .88PF
19-Jan-89 15:35:40

#Dm 3.108MW .88PF
19-Jan-89 15:45:40

#Dm 3.093MW .88PF
19-Jan-89 15:55:40

Status
19-Jan-89 16:02:23

Avg 6.689 KV

T 3.547 MVA

T 3.112 MW

T .88 PF

A 301.2 A
B 304.3 A

BDS 120-1

BABCOCK & WILCOX

Time Test start 14:15 Test End	Fan Amps	Blade Position	Barometric Pressure	Temperature @ Baro	Fan Bias	Fuel Flow	Gross MW
14:30	304	28.9	25.69	72		93	852
15:00	304	29.0	25.69	72		92	852
15:30	304	29.2	25.69	72		93	852
16:00	304	29.4	25.69	72.		93	852

CUSTOMER Intermountain Power Project

SUBJECT PA [illegible] Test [illegible] Room Data

[illegible] 6

[illegible] 10

JOB NO. RB-615

BY JM

DATE 1/19/89

IP12_005668

BDS 120-1

BABCOCK & WILCOX

Time Test Start 14:15 Test End	Fan Room Static	Wet Bulb Temperature	DRY Bulb Temperature	Fan RPM	Fan Power		
14:30	-.25	36.8	46.1	1209			
15:00	-.25	38.4	50.3	1209			
15:30	-.25	37.9	48.5	1209			
16:00	-.25	37.5	48.1	1209			

CUSTOMER Intermountain Power Project

SUBJECT [illegible] Fan Room Data

[illegible]

[illegible]

JOB NO. RB-615

BY JM

DATE 1/19/89

IP12_005669

BDS 120-1

BABCOCK & WILCOX

	STATIC	VELOCITY	YAW ∡	TEMP			
TAP 1 POINT 1	1.0	.280	-3	52.0			
1 - 2	1.0	.180	+1	52.2			
1 - 3	1.0	.170	0	52.4			
1 - 4	1.0	.158	-4	52.2			
2 - 1	1.0	.290	-1	52.8			
2 - 2	1.0	.227	+1	52.8			
2 - 3	1.0	.273	+1	52.8			
2 - 4	1.0	.263	-1	52.6			
3 - 1	1.0	.283	+1	53.0			
3 - 2	1.0	.246	0	53.2			
3 - 3	1.0	.266	+3	53.4			
3 - 4	1.0	.317	+1	53.0			
4 - 1	1.0	.266	+4	53.2			
4 - 2	1.0	.246	+4	53.2			
4 - 3	1.0	.244	+3	53.6			
4 - 4	1.0	.278	+4	53.2			
5 - 1	1.0	.229	+1	53.8			
5 - 2	1.0	.249	0	53.8			
5 - 3	1.0	.241	0	53.8			
5 - 4	1.0	.271	-2	53.0			
6 - 1	1.0	.241	+6	53.8			
6 - 2	1.0	.244	Ø	54.0			
6 - 3	1.0	.253	+2	53.8			
6 - 4	1.0	.341	+4	53.6			
7 1	1.0	.300	-1	52.6			
7 - 2	1.0	.271	+6	53.0			
7 - 3	1.0	.297	+4	53.2			
7 - 4	1.0	.358	Ø	52.6			
8 - 1	1.0	.322	+1	52.4			
8 - 2	1.0	.275	+1	52.4			
8 - 3	1.0	.327	+1	52.4			
8 - 4	1.0	.378	+1	52.0			
9 - 1	1.0	.280	-1	52.2			
9 - 2	1.0	.244	-2	52.4			
9 - 3	1.0	.290	-1	52.2			
9 - 4	1.0	.310	Ø	51.8			
10 - 1	1.0	.229	+1	51.0			
10 - 2	1.0	.200	-6	52.0			
10 - 3	1.0	.239	-2	52.0			
10 - 4	1.0	.285	Ø	51.8			

CUSTOMER INTERMOUNTAIN [illegible]

SUBJECT [illegible]

Test # 6 2:30

[illegible] EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005670

BDS 120-1

BABCOCK & WILCOX

		Static	Velocity	Yaw ∠	Temp
Tap 27	Point 1	0.7	.209	+3	~~54.8~~ 48.6
	2	0.7	.222	-3	48.4
	3	0.7	.253	-1	48.6
	4	0.7	.273	+2	50.4
28	1	0.7	.236	-4	49.2
	2	0.7	.212	-1	49.0
	3	0.7	.236	-6	49.6
	4	0.7	.256	-5	51.4
29	1	0.7	.217	-6	50.6
	2	0.7	.195	-3	50.6
	3	0.7	.224	-6	51.0
	4	0.7	.195	+6	52.2
30	1	0.7	.273	-4	52.6
	2	0.7	.195	+1	53.0
	3	0.7	.202	0	53.2
	4	0.7	.275	-2	53.6
31	1	0.7	.209	-7	53.4
	2	0.7	.119	0	53.6
	3	0.7	.134	-3	54.0
	4	0.7	.175	-5	54.8
32	1	0.7	.102	-10	54.2
	2	0.7	.056	+1	54.2
	3	0.7	.036	-4	54.4
	4	0.7	.102	-7	54.8

CUSTOMER [illegible]

SUBJECT [illegible]

Test # 6 2:30pm

[illegible] EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005671

BDS 120-1

BABCOCK & WILCOX

		Static	velocity	yaw ∠	Temp			
Tap 17	Point 1	0.7	.163	0	54.6			
	2	0.7	.136	-6	54.8			
	3	0.7	.166	-6	55.2			
	4	0.7	.236	-1	55.2			
18	1	0.7	.231	-1	54.8			
	2	0.7	.200	-6	55.0			
	3	0.7	.185	-4	55.4			
	4	0.7	.263	-1	55.0			
19	1	0.7	.251	-2	54.4			
	2	0.7	.222	-4	54.6			
	3	0.7	.231	-3	54.6			
	4	0.7	.280	-3	54.6			
20	1	0.7	.183	0	55.2			
	2	0.7	.156	-1	55.6			
	3	0.7	.185	0	55.6			
	4	0.7	.219	+1	56.0			
21	1	0.7	.188	-4	54.4			
	2	0.7	.175	-2	54.4			
	3	0.7	.224	-1	54.8			
	4	0.7	.222	-3	55.0			
22	1	0.7	.222	-10	55.4			
	2	0.7	.183	+7	55.6			
	3	0.7	.234	-4	55.6			
	4	0.7	.256	-6	55.4			
23	1	0.7	.217	-2	55.4			
	2	0.7	.212	-8	55.6			
	3	0.7	.251	-4	55.4			
	4	0.7	.280	-4	55.0			
24	1	0.7	.205	-6	54.4			
	2	0.7	.200	-4	54.6			
	3	0.7	.251	-2	54.0			
	4	0.7	.222	-5	53.8			
25	1	0.7	.244	-2	53.6			
	2	0.7	.197	-1	53.8			
	3	0.7	.251	0	54.0			
	4	0.7	.229	-1	54.4			
26	1	0.7	.229	-3	51.2			
	2	0.7	.168	+4	51.0			
	3	0.7	.200	0	50.8			
	4	0.7	.222	-4	51.2			

CUSTOMER [illegible]

SUBJECT [illegible]

Test # 6 2:30pm

[illegible] East Fan

JOB NO.

BY MCB

DATE 1/19/89

IP12_005672

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 11	POINT 1	1.0	.329	-7	51.4			
11	2	1.0	.288	-1	52.0			
11	3	1.0	.336	-2	52.0			
11	4	1.0	.275	-5	51.0			
12	1	1.0	.280	-1	51.4			
12	2	1.0	.251	-2	51.0			
12	3	1.0	.297	0	51.2			
12	4	1.0	.300	0	50.6			
13	1	1.0	.222	-4	50.2			
13	2	1.0	.222	-8	49.6			
13	3	1.0	.239	-4	50.4			
13	4	1.0	.244	-3	51.4			
14	1	1.0	.314	+2	49.2			
14	2	1.0	.263	-5	49.8			
14	3	1.0	.283	-3	50.0			
14	4	1.0	.332	-1	49.8			
15	1	1.0	.207	+5	49.4			
15	2	1.0	.156	-2	49.0			
15	3	1.0	.188	-2	49.4			
15	4	1.0	.256	+1	49.4			
16	1	1.0	.070	+4	50.0			
16	2	1.0	.085	-7	50.0			
16	3	1.0	.080	-7	50.2			
16	4	1.0	.139	0	50.8			
BARO P								

CUSTOMER [illegible]

SUBJECT [illegible]

TEST 6 2:30 pm

EAST FAN

JOB NO.

BY MCB

DATE 1/19/89

IP12_005673

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW X	TEMP			
TAP 1	POINT 1							
1	2							
1	3							
1	4							
1	5							
1	6							
1	7							
1	8							
1	9							
1	10							
2	1	40	0.429	10	98.6			
2	2	40	0.603	15	98.4			
2	3	40	0.437	10	100.8			
2	4	40	0.429	0	98.6			
2	5	40	0.388	10	98.8			
2	6	40	0.329	10	98.6			
2	7	40	0.383	5	98.8			
2	8	40	0.617	0	98.8			
2	9	40	0.781	5	98.6			
2	10	40	0.957	5	98.6			
3	1	40	0.444	20	97.2			
3	2	40	0.522	15	97.2			
3	3	40	0.444	15	97.4			
3	4	40	0.268	10	97.6			
3	5	40	0.249	5	98.0			
3	6	40	0.295	15	98.2			
3	7	40	0.317	10	98.2			
3	8	40	0.439	5	98.2			
3	9	40	0.576	10	98.2			
3	10	40	0.549	5	98.4			
4	1	40	0.083	5	99.8			
4	2	40	0.454	15	99.0			
4	3	40	0.275	10	99.0			
4	4	40	0.242	5	99.0			
4	5	40	0.256	5	98.8			
4	6	40	0.180	20	99.0			
4	7	40	0.168	10	98.8			
4	8	40	0.446	5	98.6			
4	9	40	0.949	0	98.4			
4	10	40	1.001	0	98.6			

CUSTOMER [illegible]

SUBJECT [illegible]

[illegible] = 6

[illegible]

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005674

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 5	POINT 1	40	0.669	20	98.0			
5	2	40	0.485	15	98.2			
5	3	40	0.246	15	98.0			
5	4	40	0.104	5	97.8			
5	5	40	0.083	15	97.8			
5	6	40	0.065	20	98.6			
5	7	40	0.151	15	98.0			
5	8	40	0.400	5	98.6			
5	9	40	0.832	0	98.6			
5	10	40	1.110	10	98.6			
6	1	40	0.683	15	97.8			
6	2	40	0.481	15	98.4			
6	3	40	0.178	5	97.8			
6	4	40	0.078	0	97.6			
6	5	40	0.039	0	97.8			
6	6	40	0.085	10	98.0			
6	7	40	0.156	5	97.8			
6	8	40	0.576	5	97.6			
6	9	40	0.962	5	97.8			
6	10	40	1.259	10	97.8			
7	1	40	1.159	10	96.8			
7	2	40	0.466	5	97.2			
7	3	40	0.170	0	96.7			
7	4	40	0.043	0	97.6			
7	5	40	0.029	0	97.4			
7	6	40	0.097	5	97.4			
7	7	40	0.095	5	97.2			
7	8	40	0.412	10	98.2			
7	9	40	1.130	5	98.0			
7	10	40	1.374	5	98.8			
8	1	40	0.800	0	99.0			
8	2	40	0.585	0	99.2			
8	3	40	0.224	0	98.6			
8	4	40	0.058	0	98.4			
8	5	40	0.034	0	98.2			
8	6	40	0.136	10	98.2			
8	7	40	0.297	10	97.8			
8	8	40	0.654	10	98.0			
8	9	40	1.125	5	97.8			
8	10	40	1.411	10	97.6			

CUSTOMER [illegible]

SUBJECT [illegible]

[illegible] 6

[illegible]

JOB NO.

BY Paul Wil

DATE 1/19/89

IP12_005675

BDS 120-1

BABCOCK & WILCOX

		STATIC	VELOCITY	YAW ∠	TEMP			
TAP 9	POINT 1	39	0.827	10	99.4			
9	2	39	0.752	5	99.6			
9	3	39	0.429	5	99.4			
9	4	39	0.131	10	99.0			
9	5	40	0.209	20	99.4			
9	6	40	0.739	20	99.8			
9	7	40	0.410	15	99.6			
9	8	40	0.688	20	99.4			
9	9	39	1.157	15	98.8			
9	10	40	1.352	15	98.8			
10	1	40	0.358	15	92.8			
10	2	40	0.649	15	98.2			
10	3	39	0.966	20	98.4			
10	4	39	0.473	20	98.8			
10	5	39	0.444	15	99.0			
10	6	39	0.502	15	99.0			
10	7	39	0.678	15	99.2			
10	8	39	0.783	25	99.4			
10	9	39	0.72	20	99.8			
10	10	39	0.781	20	100.4			
11	1	40	0.446	25	96.4			
11	2	40	0.576	20	96.4			
11	3	40	0.434	15	95.8			
11	4	40	0.471	25	96.2			
11	5	40	0.554	20	95.2			
11	6	40	0.637	20	95.0			
11	7	40	0.761	25	95.4			
11	8	40	0.642	25	95.4			
11	9	40	0.249	30	95.8			
11	10	40	0.344	25	96.8			
12	1	40	0.019	10	100			
12	2	40	0.126	20	100.4			
12	3	40	0.256	20	100.0			
12	4	40	0.441	20	90.0			
12	5	40	0.449	20	99.4			
12	6	40	0.456	20	99.6			
12	7	40	0.407	25	99.0			
12	8	40	0.295	25	98.8			
12	9	40	0.087	20	98.6			
12	10	40	0.036	20	98.6			

CUSTOMER [illegible]

SUBJECT [illegible] 6

[illegible]

JOB NO.

BY Paul Wu

DATE 1/19/89

IP12_005676

Unit 2

PA Fan 2A Test 3 Overall Test #6

AIR/GAS PRI AIR 01/19/89 15:11:25

37.9	38.1	38.1	51.5
INWC	INWG	INWG	
	38.0	38.2	F
	INWG	INWG	
P.A. DUCT PRESS	SLCTD PA PR AC/SP	PA PRESS A/B	PAFAN INLET TEMP
23.9	26.4	31.2	29.8
A		PCT	PCT
		29.4	28.4
B		PCT	PCT
0.0			
PAFAN A VNE CNTRL	PAFAN B VNE CNTRL	PA FL ONE A/B	PA FL TWO A/B

L/L SCH L/L < > L/L L/L GTD

IP12_005677

AIR/GAS PRI AIR 01/19/89 14:26:00

37.9	37.9	37.9	53.0
A	INWG	INWG	
B INWC	37.9	38.1	F
	INWG	INWG	
P.A.	SLCTD	PA	PAFAN
DUCT	PA PR	PRESS	INLET
PRESS	AC/SP	A/B	TEMP
25.0	27.8	31.1	29.3
A		PCT	PCT
		28.7	28.0
B		PCT	PCT
0.0			
PAFAN	PAFAN	PA FL	PA FL
A VNE	B VNE	ONE	TWO
CNTRL	CNTRL	A/B	A/B
L/L SCN	L/L < >	L/L	L/L GTD

IP12_005678

SOFTWARE LOCK 01/19/89 14:29:28 U2MAIN

UREMENT DISPLAY

BOILER PORFORMANCE DATA - TABLE 3

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI001A	323.0	TPH	TOTAL FUEL FLOW		
XI002A	46.1	TPH	PULV 1A COAL FLOW		
XI003A	46.4	TPH	PULV 1B COAL FLOW		
XI004A	[illegible]	TPH	PULV 1C COAL FLOW	BYPASS	NO-IN
XI005A	45.7	TPH	PULV 1D COAL FLOW		
XI006A	43.7	TPH	PULV 1E COAL FLOW		
XI007A	45.3	TPH	PULV 1F COAL FLOW		
XI008A	45.7	TPH	PULV 1G COAL FLOW		
XI009A	52.3	TPH	PULV 1H COAL FLOW		
XI080A	2.0	PCT	WEST FLUE GAS O2		
XI079A	3.6	PCT	EAST FLUE GAS O2		
TE0707	724.	DEGF	ECON EAST OUTLET FLUE GAS T		
TE0710	731.	DEGF	ECON WEST OUTLET FLUE GAS T		
TE0927	281.	DEGF	SEC AH 1A GAS OUT T		
TE0929	273.	DEGF	SEC AH 1B GAS OUT T		
TE0913	297.	DEGF	PRI AH 2A GAS OUT T		
TE0916	308.	DEGF	PRI AH 2B GAS OUT T		
XI072A	38.0	INWC	PA DUCT PRESS		
XI084A	-14.0	INWC	ID FANS SUCT PRESS		
PT0165	-2.7	INWC	SG ECON OUTLET FLUE GAS PR		

CODWARD DACTWC DW3

IP12_005679

SOFTWARE LOCK 01/19/89 14:28:56 U2MAIN
MENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 2

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
PT0174	.6	INWC	BNR LVL 2 S WINDBOX PR		
PT0176	.5	INWC	BNR LVL 4 S WINDBOX PR		
PT0179	1.1	INWC	BNR LVL 3 N WINDBOX PR		
PT0177	.2	INWC	BNR LVL 1 N WINDBOX PR		
PT0173	.3	INWC	BNR LVL 1 S WINDBOX PR		
PT0175	.7	INWC	BNR LVL 3 S WINDBOX PR		
PT0180	.9	INWC	BNR LVL 4 N WINDBOX PR		
PT0178	.1	INWC	BNR LVL 2 N WINDBOX PR		
KS007A	63.8	PCT	SECONDARY AIR DAMPER POS 1A		
KS003A	63.7	PCT	SECONDARY AIR DAMPER POS 1B		
KS005A	53.0	PCT	SECONDARY AIR DAMPER POS 1C		
KS009A	63.8	PCT	SECONDARY AIR DAMPER POS 1D		
KS010A	61.1	PCT	SECONDARY AIR DAMPER POS 1E		
KS006A	63.7	PCT	SECONDARY AIR DAMPER POS 1F		
KS004A	63.9	PCT	SECONDARY AIR DAMPER POS 1G		
KS008A	74.4	PCT	SECONDARY AIR DAMPER POS 1H		
PT0171	-.7	INWC	SG EAST FLUE GAS PR		

EDUARDO BACTUC DUO

IP12_005680

SOFTWARE LOCK 01/19/89 14:28:35 U2MAIN
UREMENT DISPLAY

BOILER PERFORMANCE DATA - TABLE 1

LOCK	VALUE		DESCRIPTION	STATUS	ALARM
XI0027A	855.	MW	UNIT LOAD		
XI0024A	5980.	KPPH	TURBINE STEAM FLOW		
FT0025	5986.	KPPH	BOILER FEEDWATER F		
TE0863	719.	DEGF	FIRST STG SUPHTR E ATTEMP INL T		
TE0864	721.	DEGF	FIRST STG SUPHTR W ATTEMP INL T		
TE0002	1006.	DEGF	SEC SUPHTR OUTLET STEAM T		
PT0001	2414.	PSIG	MAIN STEAM LINE PR		
FT0070	0.	KPPH	FIRST STAGE SUPHTR E ATTEMP FLO		
FT0072	64.	KPPH	SEC STAGE SUPHTR E ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
FT0071	9.	KPPH	FIRST STAGE SUPHTR W ATTEMP FLO		
FT0073	58.	KPPH	SEC STAGE SUPHTR W ATTEMP FLOW		
TE0991	341.	DEGF	SUPHTR ATTEMP SPRAY WTR SPLY T		
TE0022	620.	DEGF	SG E COLD REHEAT INLET T		
TE0019	620.	DEGF	SG W COLD REHEAT INLET T		
PT0011	529.	PSIG	SG E COLD REHEAT INLET PR		
TE0011	1016.	DEGF	SG N HOT REHEAT OUTLET T		
PT0006	493.	PSIG	TURBINE N HOT REHEAT INLET PR		
FT0020	0.	KPPH	REHEAT DESUPERHEATER SPRAY FLOW		
TE0060	185.	DEGF	REHEAT DESUPERHEATER SPRAY T		

ENDUADR DACTUC DU1

IP12_005681

SOFTWARE LOCK 01/19/89 14:28:10 U2MAIN

UREMENT DISPLAY

WEATHER DATA

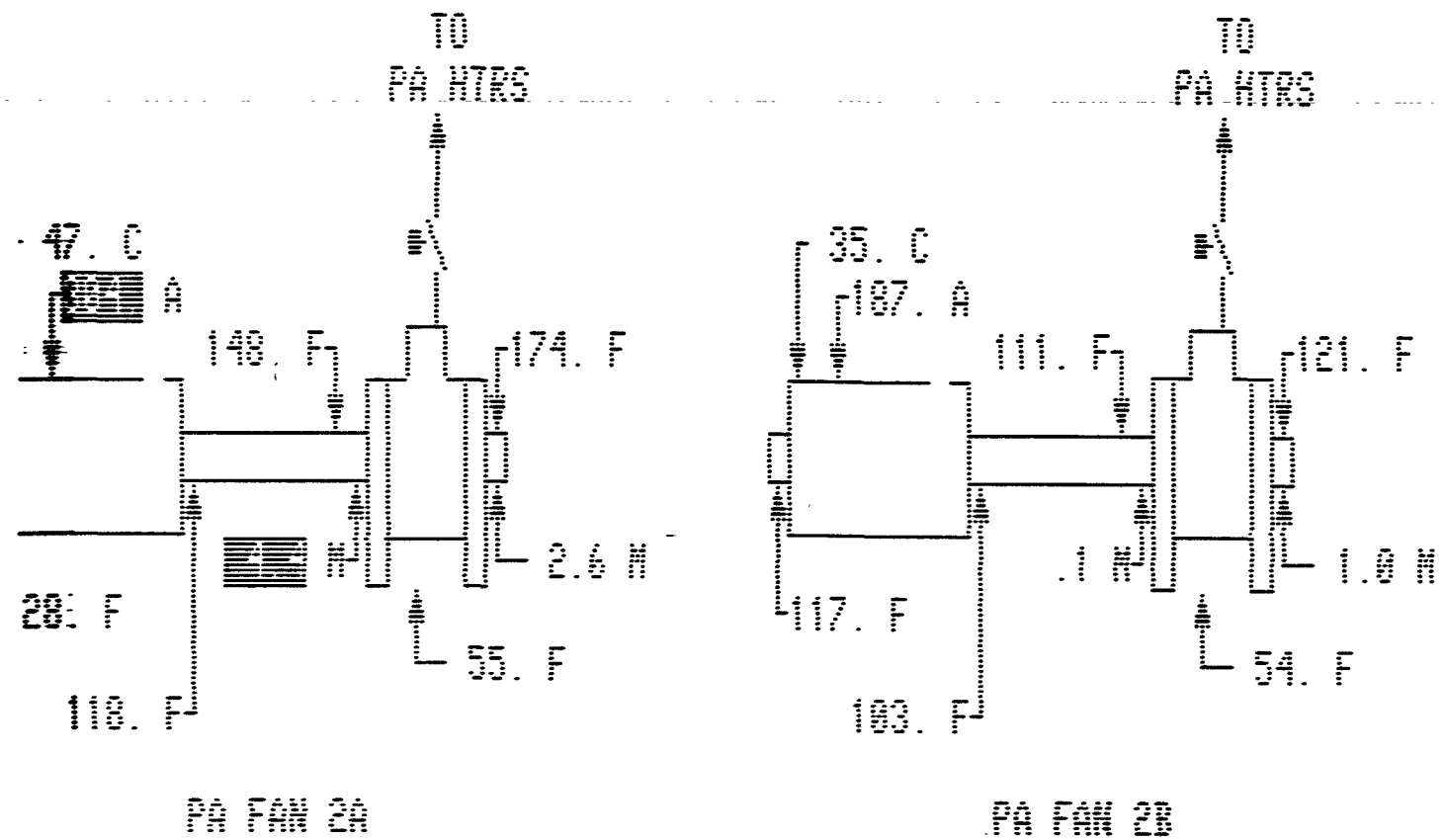
LOCK	VALUE	DESCRIPTION	STATUS	ALARM
KV0001	12.62 PSIA	ATMOSPHERIC PRESSURE		
PT0227	25.69 IN HG	BAROMETRIC PRESSURE		
KK0531	31. DEGF	AMBIENT TEMPERATURE		
TE1160	26. DEGF	FAN ROOM OUTSIDE AMBIENT TEMP		
KK0530	64. PCT	RELATIVE HUMIDITY		

ENQUADB DACTWC UTUD

IP12_005682

SOFTWARE LOCK 01/19/89 14:27:26 U2MAIN

SGBG09 SUBSYSTEM -PRIMARY AIR FANS



APPENDIX H

Howden Sirocco Performance Test

HOWDEN SIROCCO

Howden Sirocco Inc.

One Westinghouse Plaza, Suite 300
Hyde Park, MA 02136
Telephone (617) 361-3700
Fax (617) 361-0493

A Howden Group Company

August 5, 1992

To: Intermountain Power Service Corp.

Attention: Mr. Jon Christensen

From: Mr. Cecil Ireland

FAX MESSAGE

Subject: I.P.P. - PA Fan Performance

Please find herewith revised curves for the PA fans at Intermountain Power, Delta, Utah. We apologize for our poor response in getting these curves out to you.

We have redrawn the curves, making separate ones for high and low speed.

The output of the top (90°) curve has been reduced slightly in line with other test data. The vane closure curves have been 'bunched' towards the top curve and this makes the angles at the test points agree closely with what was recorded during the tests. The power curves have been reconstructed to give efficiencies observed on other tests and also to give the as - tested efficiencies at Intermountain. Finally, we have labelled the curves in degrees from closed, which is in line with your nomenclature. These now are, in effect, customized curves for the Intermountain project.

Turning now to Westinghouse report WMC-EER-92-002, this redefines allowable motor powers as 5000 HP at 1194 RPM and 3200 HP at 897 RPM and it is our understanding that a 1.15 service factor on top of these values can be accommodated.

Two-Fan Low Speed Operation

We have indicated the nominal limit of 3,200 HP on the graph and it may be seen that any point on the curve is well within this power, without having to use any of the service factor.

One-Fan High Speed Operation

The tests showed the operating system to be to the right of the original specified system and we have shown this operating system as a dotted line. It is assumed, for purposes of discussion here, that higher fan loadings would lie on this line. Again we have shown lines for the power limitations. It may be seen that a duty of 375,000 CFM at 56.5 ins. SP can be reached at 5,000 BHP and a duty of 413,000 CFM at 69 ins. SP can be reached at 5,750 BHP.

We also include, for reference, the test results summary sheet originally faxed to you 12/10/91.

We hope the foregoing will allow you to proceed with your evaluation. If you have further questions regarding specific duties or conditions, or relative efficiencies, please let us know.

Regards,

Cecil Ireland

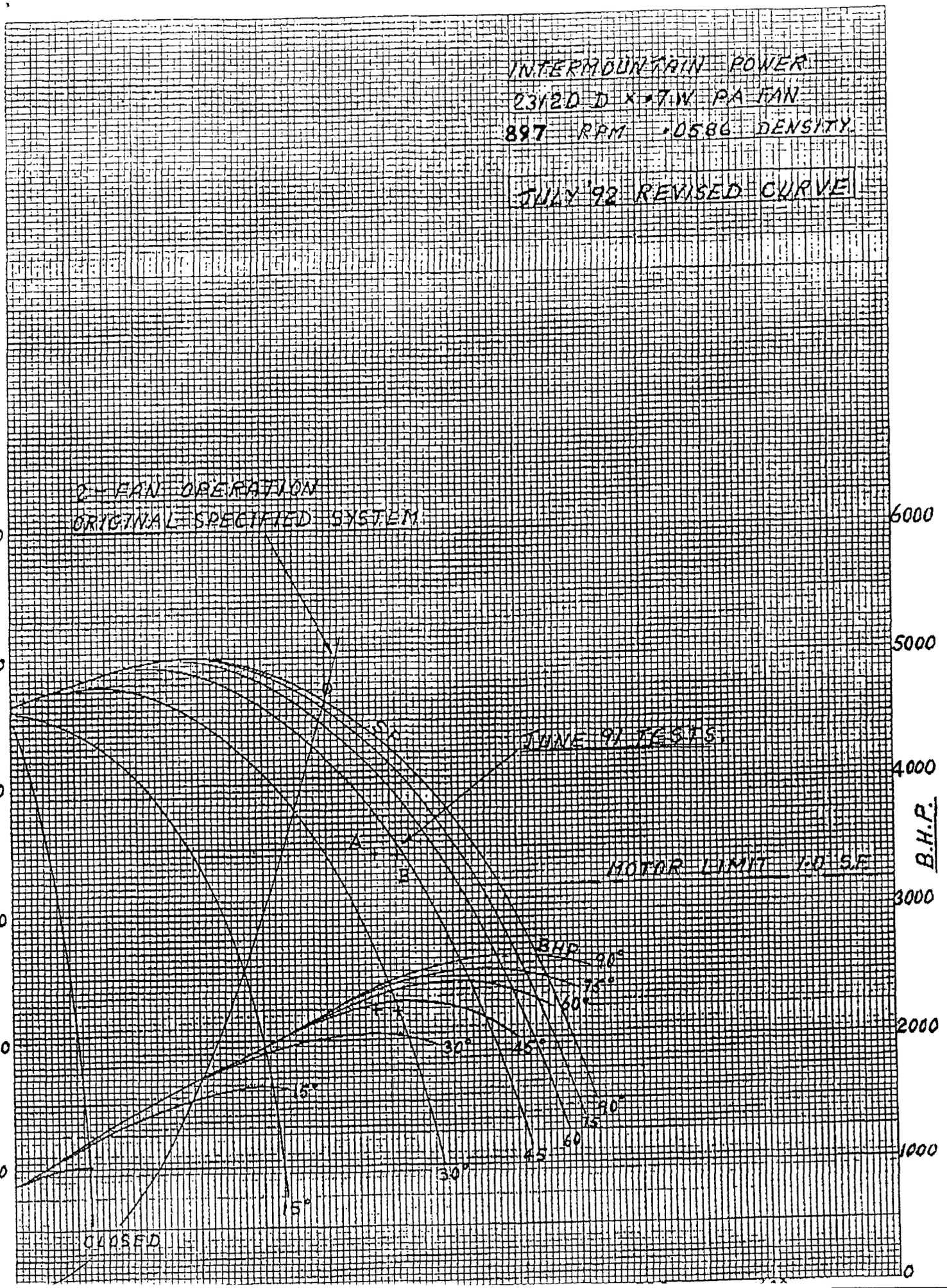
Cecil Ireland

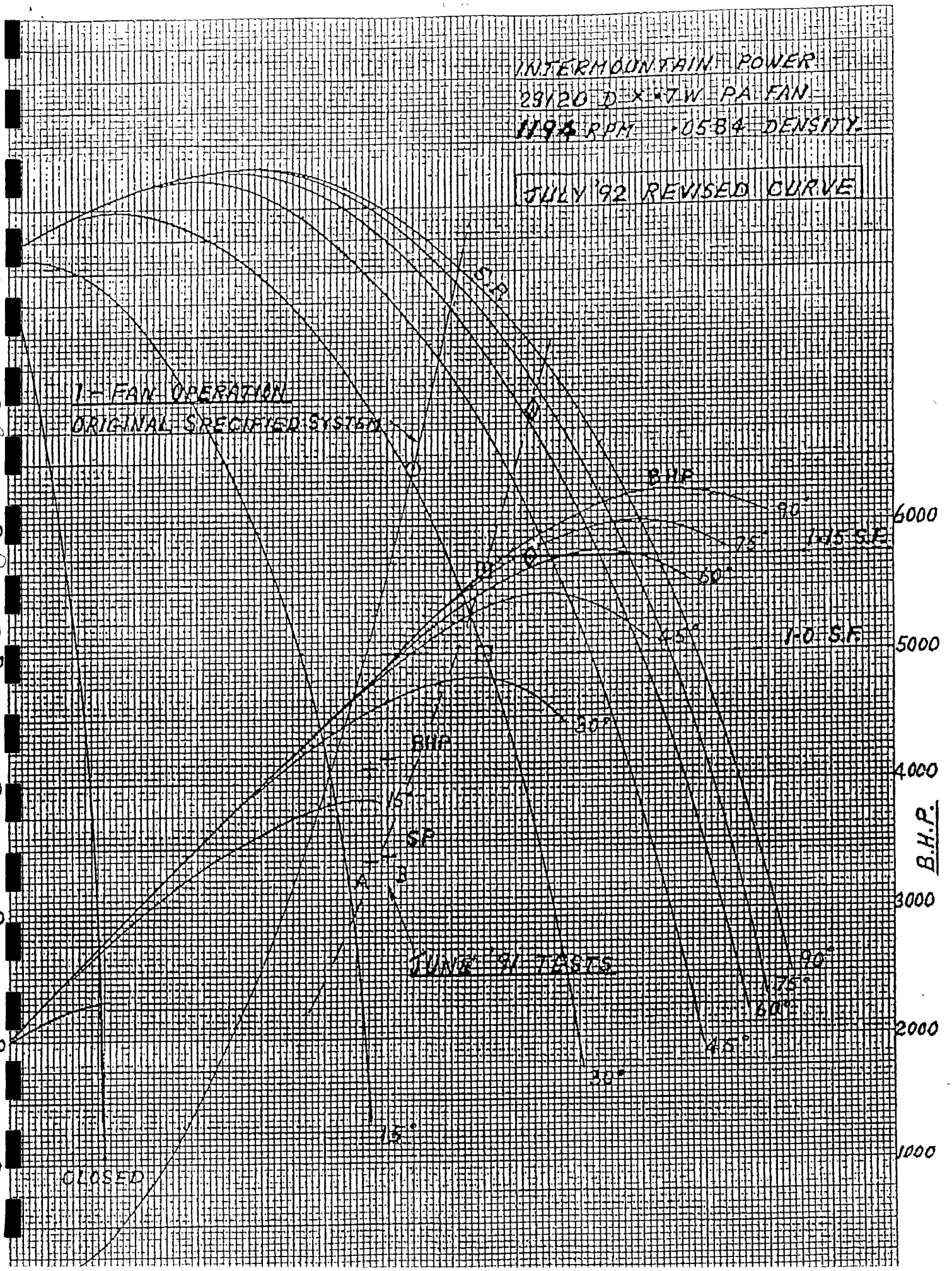
CI/srm-1368E

cc: J. McLaughlin - Aurora, CO
L. Krieger - Aurora, CO
J. Srivastava - Hyde Park, MA
J. Sharer - Hyde Park, MA

Enclosures:

(Total pages faxed: 5


INTERMOUNTAIN POWER
23½D D x 7W PA FAN
897 RPM .0586 DENSITY
JULY '92 REVISED CURVE
2-FAN OPERATION
ORIGINAL SPECIFIED SYSTEM
JUNE 91 TESTS
MOTOR LIMIT 1.0 S.F.
BHP
90°
75°
60°
45°
30°
15°
CLOSED
80
70
40
30
20
0
6000
5000
4000
3000
2000
1000
0
B.H.P.


INTERMOUNTAIN POWER
29/20 D X ·7W PA FAN
1194 RPM ·0584 DENSITY
JULY '92 REVISED CURVE
1-FAN OPERATION
ORIGINAL SPECIFIED SYSTEM
BHP
90°
75°
60°
45°
30°
15°
1·15 S.F.
1·0 S.F.
SP
JUNE '91 TESTS
CLOSED
6000
5000
4000
3000
2000
1000
B.H.P.

SIROCCO INC.
One Westinghouse Plaza
Hyde Park, MA 02136

TEST SUMMARY (RAW DATA)

SIDE	TP IN "WG	VP IN "WG	SP IN "WG	SP OUT	BAR.	TD	TW	TIN	TOUT	RPM
DRIVE	-.619	.4502	-1.578		25.41	72	54	67.3		898
OUTBOARD	-.463	.376	-.803	37.05	25.40	64	51	67.7	99.8	897
DRIVE		.4414	-.9903		25.41	65	46	64.8		1194
OUTBOARD	-.4837	.376	-.6958	36.53	25.40	63	51	68.17	114.7	
DRIVE	-.5113	.4671	-.6156		25.44	65	46	66.03		
OUTBOARD	-.586	.4766	-.7895	37.05	25.45	65	46	66.4	93.6	897
DRIVE	-.579	.4565	-.6022		25.47	70	49	75.2		
OUTBOARD	-.593	.447	-.749	36.734	25.46	69	49	69.4	118.6	

SUMMARY (RESULTS CONVERTED TO CURVE CONDITION)

LOW SPEED FAN 2A
287515 CFM 34.64" WG 55.5° VANES 2241 HP

HIGH SPEED FAN 2A
285496 CFM 33.98" WG 75° VANES 4116 HP

LOW SPEED FAN 2B
306219 CFM 34.44" WG 54.5° VANES 2238 HP

HIGH SPEED FAN 2B
300566 CFM 34.2678" WG 74.5° VANES 4187 HP

Wm. C. Ireland.

June 28, 1991

INTERMOUNTAIN POWER PROJECT

UPDATE ON ANALYSIS OF PERFORMANCE OF P.A. FANS

Attention: Jon Christensen

As promised we are sending you this update on our analysis of the P.A. fan performance.

We have calculated the results of the June 22 tests and they basically confirm the earlier figures from your tests. Because only one fan is feeding the unit the system line is further to the right on the fan curve, as would be expected.

If we accept the powers measured by you, then the efficiency of the fans is significantly lower than it should be - especially at the higher speed. We do not see any one reason why this should be; such things as rotation and vane direction have been checked, also a few leading dimensions on wheel and housing have been checked.

We are, therefore, looking at a number of other aspects as follows:

Original Selection:	We will check to see whether Westinghouse was fair and accurate in the fan selection.
Curve Accuracy:	Further study of the recently drawn curve with vane settings shows that some regions of this are not accurate. The efficiency between the 30° and 45° settings calculates to be almost as good as the top curve and we know this is not right.
Fan Output/Vane Position:	The tests show the fan output to be higher than it should be for the vane angle at which it was supposed to be set. From the vane stroking which our serviceman did we should know the vane angle within ± 3°.
Velocities:	We are looking closely at the air velocities through the fan compared to those in the dozens of other units which are working satisfactorily in the field.

Unfortunately, there is no margin on motor power on these units. Test block BHP at low speed is 2,217 while motor nameplate HP is 2,100. At high speed it is 3,989 BHP with a 4,000 HP motor. The fact that the system line moves to the right can add 3% or 4% to power.

One of the reasons why the high speed performance is so poor is because the vanes have to be closed down so much (to keep the amps down) and the efficiency at this condition is very low. As an example, if the vanes could be opened a further 10° the efficiency would improve by 20% to 25%.

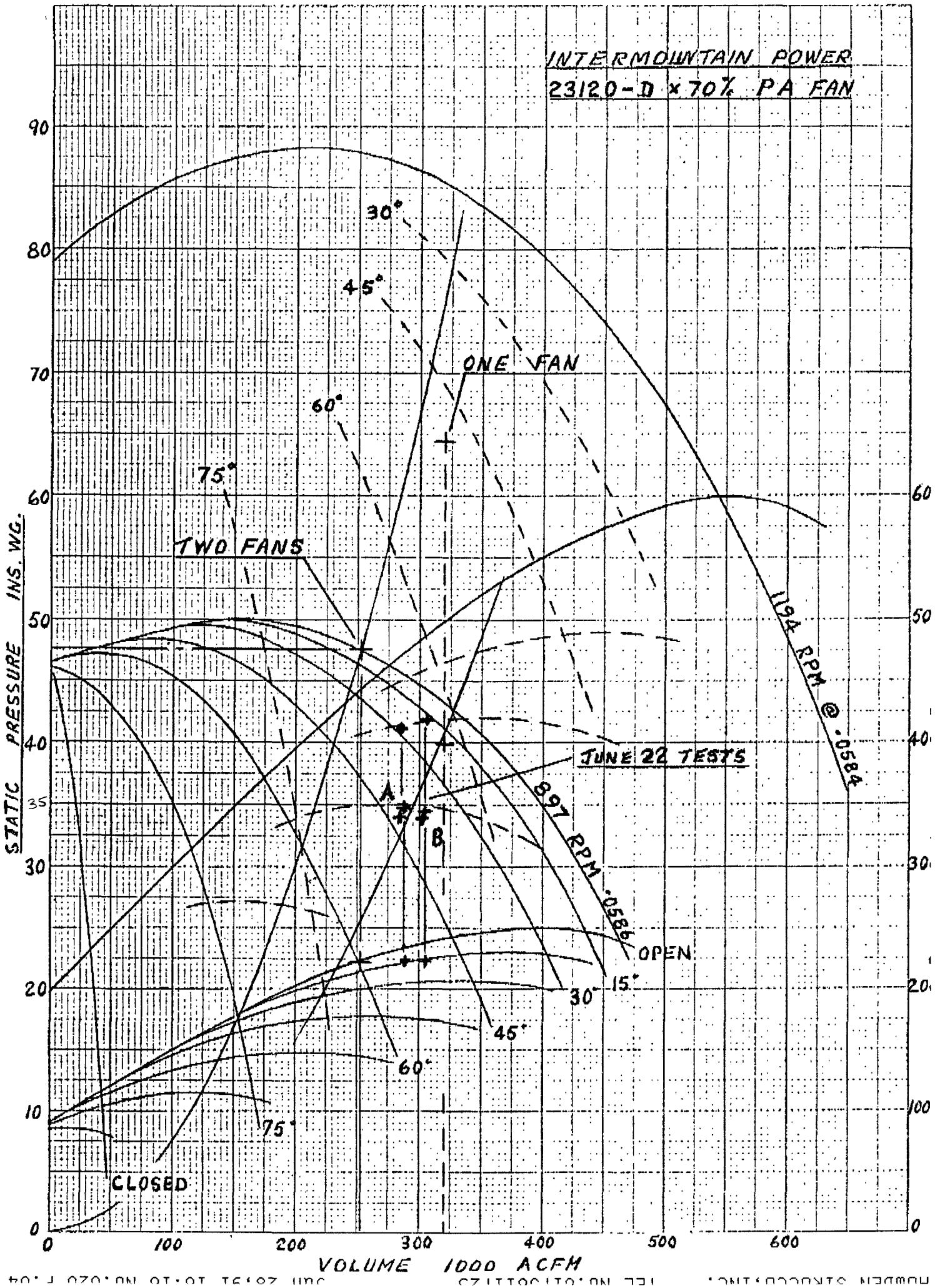
There are vane tabs on these vanes, to prevent vibration which sometimes occurs at mid vane settings. These probably reduce efficiency by a couple of points so removing these would not make much contribution. Another way of achieving more open vanes is to de-tip the wheel. However, with these aerofoil blades only very limited de-tipping could be done.

We will continue to study the figures and other data to establish how much shortfall in efficiency is present and the likely causes for it. We will try to have more specific conclusions in about 10 days.

Cecil Ireland.

W. C. Ireland
Senior Development Engineer

WCI/srm-0824E


INTERMOUNTAIN POWER
23120-D × 70% PA FAN
STATIC PRESSURE INS. WG.
VOLUME 1000 ACFM
ONE FAN
TWO FANS
30°
45°
60°
75°
1194 RPM @ .0584
897 RPM .0586
JUNE 22 TESTS
A
B
OPEN
15°
30°
45°
60°
75°
CLOSED
0
10
20
30
35
40
50
60
70
80
90
100
200
300
400
500
600

IP12_005692

OWDEN SIROCCO INC
Westinghouse Plaza
e, MA 02136

FROM: W.C. Ireland DATE: 1st July 91
DEPT: Engineering
TEL: (617) 361-3700 EXT-239 FAX: (617) 361-0493

TO FAX #: 1·801·864·4970 PAGE 1 OF 4
ATTENTION: JON P. CHRISTENSEN

SUBJECT: P.A. FAN TEST RESULTS

ATTACHED IS ONE PAGE SHOWING A SUMMARY OF THE RAW DATA. THE FOLLOWING TWO PAGES SHOW THE CALCULATION OF PERFORMANCE BASED ON THIS DATA FOR TEST 1.

THE INVOICE FOR THIS TEST WILL BE MAILED TO YOUR ATTENTION TOMORROW JULY 2nd. AS REQUESTED.

IF YOUR REQUIRE FURTHER CLARIFICATION OF THE RESULTS PLEASE CALL US.

Regards
Neill Shaw

HOWDEN SIROCCO INC.
One Westinghouse Plaza
Hyde Park, MA 02136

SUMMARY:

SIDE	TP_{IN} "WG	VP_{IN} "WG	SP_{IN} "WG	SP_{OUT}	BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM
DRIVE	-.619	.4502	-1.578		25.41	72	54	67.3		898
OUT	-.463	.376	-.803	37.05	25.40	64	51	67.7	99.8	897
DRIVE		.4414	-.9903		25.41	65	46	64.8		1194
OUT	-.4837	.376	-.6958	36.53	25.4	63	51	68.7	114.7	
DRIVE	-.5113	.4671	-.6156		25.44	65	46	66.03		
OUT	-.586	.4766	-.7895	37.05	25.45	65	46	66.4	93.6	897
DRIVE	-.579	.4565	-.6022		25.47	70	49	75.2		
OUT	-.593	.447	-.749	36.734	25.46	69	49	69.4	118.6	

HOWDEN SIROCCO INC.
One Westinghouse Plaza
Hyde Park, MA 02136

TEST 1 PA FAN 2A LOW SPEED

CALCULATION OF TEST RESULTS:

DRIVE SIDE

$T_{DRY} = 72°F$ $T_{WET} = 54°F$ BAR. = 25.41" Hg

FROM AMCA 203 FIG. N-1 $\rho_o = 0.0631$ lb/ft³

OUTBOARD SIDE

$T_{Dry} = 64°F$ $T_{WET} = 51°F$ BAR = 25.4" Hg

gives $\rho_o = 0.0641$

DRIVE SIDE

Density at Traverse $\rho_3 = \rho_o \left(\frac{P_{s3} + 13.6 P_b}{13.6 P_b}\right)\left(\frac{td_o + 460}{td_3 + 460}\right)$

Ambient

Traverse

$$\rho_3 = 0.0631\left(\frac{-1.578 + 13.6 \times 25.41}{13.6 \times 25.41}\right)\left(\frac{72+460}{67.3+460}\right)$$

$$\rho_3 = 0.06337 \text{ lb/ft}^3$$

Traverse Area = 51.45 ft²

Velocity at Traverse $V_3 = 1096\sqrt{\frac{P_{v3}}{\rho_3}} = 1096\sqrt{\frac{.4502}{.06337}}$

$= 2921$ fpm

Volume flow at Traverse $Q_3 = 2921 \times 51.45$

Volume at Inlet $Q_1 = Q_3 = 150304$ cfm

OUTBOARD SIDE

$$\rho_3 = 0.0641\left(\frac{-.803 + 13.6 \times 25.4}{13.6 \times 25.4}\right)\left(\frac{64+460}{67.7+460}\right)$$

$$= 0.0641 \times .9977 \times .99299 = 0.063504 \text{ lb/ft}^3$$

Traverse Area = 51.45 ft²

$$V_3 = 1096\sqrt{\frac{.376}{.063504}} = 2666.88 \text{ fpm}$$

$$Q_1 = Q_3 = 2666.88 \times 51.45 = 137211 \text{ cfm}$$

WDEN SIROCCO
One Westinghouse Plaza
Hyde Park, MA 02136

Fan Static Pressure $= P_{S_2} - P_{T_1}$

$= 37.05 - \left(\frac{-.619 - .463}{2}\right)$

$= 37.591$

CONVERT TO CURVE CONDITIONS.

Test Speed = Curve Speed

Test Size = Curve Size

Test density = 0.0636

Curve density = 0.0586.

Curve flow = 287515 cfm

Curve Pressure $= 37.591 \times \frac{.0586}{.0636}$

$= 34.64''$ Wg

Vanes at 57% open.

or 55.5° VANES ANGLE SETTING

HOWDEN SIROCCO INC
One Westinghouse Plaza
Hyde Park, MA 02136

FROM: W.C. Ireland DATE: 7.24.91

DEPT: Engineering

TEL: (617) 361-3700 EXT-239 FAX: (617) 361-0493

TO FAX #: 1·801·864·4970

PAGE 1 OF 5

ATTENTION: JON CHRISTENSEN

****

SUBJECT: P.A. FAN PERFORMANCE

Herewith our analysis of the PA fan performance. We apologize for the delay but there was more work and cross-checking involved than we first thought.

Regards, Cecil Ireland.

HOWDEN SIROCCO

Howden Sirocco Inc.

One Westinghouse Plaza, Suite 300
Hyde Park, MA 02136
Telephone (617) 361-3700
Fax (617) 361-0493

A Howden Group Company

July 24, 1991

Intermountain Power Service Corporation
Route 1 Box 864
Delta, Utah 84624

Attention: Mr. Jon Christensen

Subject: I.P.P. - P.A. Fan Performance

Dear Jon:

Further to our update of June 28, 1991, we give below the findings from our analysis of the problems assocated with one - fan operation at the Intermountain plant and we discuss the options available to overcome these problems.

There are three main factors causing the problem.

Firstly, as already stated, the tests have shown the fan efficiency to be lower than expected, especially at the high speed operating point. We now know that this has happened because some of the lower load regions of the basic selection data were incorrect.

Secondly, there is no margin on motor power. The quoted test block BHP at 897 RPM is 2217 while the motor is rated at 2000 HP and the 5% service factor raises this to only 2100 HP. At the high speed duty the quoted BHP is 3989 with a motor rating of 4000.

The combination of lower efficiency and motor power limitation creates a 'Catch 22' situation. The vane setting has to be reduced to keep the amps down and this reduces fan efficiency still further. The present fans are capable of developing much more output at both speeds and of doing it more efficiently, if only the vanes could be opened further.

Another factor which is adding to the problem is that the actual operating systems for one and two - fan operation are to the right hand side of the original specified systems. Depending on the actual volume-pressure required, this can add from zero to 4% to power at low speed and zero to about 6% at high speed. It seems that the possibility of a variance in operating system, particularly under one - fan operation, was not taken into account when sizing the motors.

There appears to be only two options available to overcome the problem.

1. Replacing the present wheels and inlets.

   We have tried a considerable number of wheel selections and find that none of these will develop the original MCR duty of 252000 CFM at 47 ins WG and do it within the present motor limit of 2100 BHP.

   This prompted us to look at other possibilities. Our first idea was that, in the light of operating experience, the opportunity should be taken to re-specify the load points. We have, therefore, chosen revised load points as follows. These points take into account the fact that the systems are futher to the right and also we have reduced the pressures to keep within motor powers. Your earlier tests indicate that 100% MCR operation required about 37 ins. WG (at graph conditions). We have marked these new points on the test results graph for comparison.

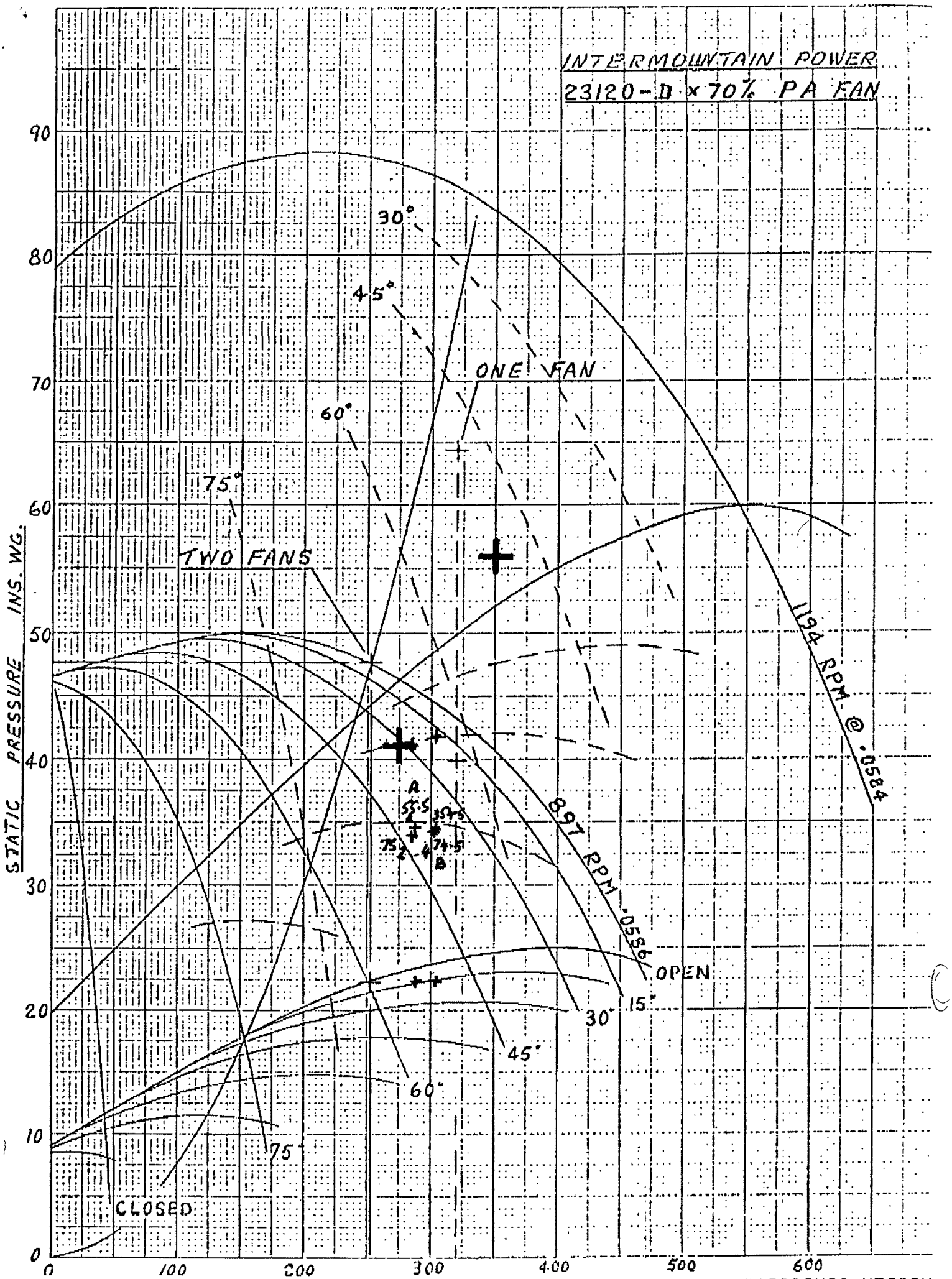
   MCR: 275,000 CFM @41 Ins. SP.
   High Speed: 350,000 CFM @56 Ins. SP.

   However, even this course has problems. We can certainly select 2 or 3 different wheels which will achieve these duties within the present motor power. Unfortunately, for the wheel sizes required, the present housing is not sufficiently close to what it should be, which creates doubt as to whether this arrangement would perform satisfactorily.

   This leaves us with one other suggestion, which is to select the fans for the high speed duty and to run at high speed for both modes. This means we could cope with a high speed duty of 350000 CFM at 57 to 58 ins. WG and stay well within the 4000 power limit. The MCR operation would be achieved by closing the vanes. There would no longer be a power or output limitation at MCR and our selections show that the efficiency at this vane setting would be about the same as is presently achieved at this load. The wheel diameter would be much the same as at present and thus the housing will be close to what is required.

2) Replace the motors.

   The other option for solving the problem is obviously to modify or replace the motors. This option would be more expensive and a longer lead time would be associated with it.


INTERMOUNTAIN POWER
23120-D × 70% PA FAN
STATIC PRESSURE INS. WG.
ONE FAN
TWO FANS
30°
45°
60°
75°
1194 RPM @ .0584
897 RPM .0556
OPEN
15°
30°
45°
60°
75°
CLOSED
A
B
0
10
20
30
40
50
60
70
80
90
100
200
300
400
500
600

IP12_005700

We hope the foregoing will be helpful in deciding the most viable course of action and we await your comments with regard to the new duty points. If the high speed option as discussed above is acceptable, we would be able to fine tune the selection and work up budget prices and delivery information within 5 or 6 days.

Sincerely,

Wm C. Ireland

W. C. Ireland
Senior Development Engineer

WCI/srm-0840E

cc: Mr. L. W. Krieger - Aurora, CO
Mr. R. E Mahoney
Mr. J. P. Srivastava
Mr. R. G. Eddy

PA Fan Performance Test
June ~~15~~, 1991,
22 ACTUAL

Initial setup

Maintenance will build scaffolding on both sides of the inlets for access to the test taps on the Unit 1 PA fans. A relay technician will connect monitoring equipment to the 6900 volt cubicles to record voltage, current and power during each test. This work should be completed by June 14, 1991.

Test requirements

Each test is expected to take two to two and one half hours. Boiler load should be steady before starting the test and throughout each test. (Unit load may need to be varied between 300 MWg and 400MWg during periods when fans are switched). Amperage limits on the motors are not to exceed specified values (Low Speed 200 amperes, High speed 302 amperes). It may be necessary to isolate the primary air heater for the fan not under test to meet minimum loading requirements.

Test Sequence

Test 1 (1SGB-FAN-2A Low Speed)

Verify both fans are operating in auto at low speed. Switch Fan 2B to manual and slowly close inlet vanes on Fan 2B. With Fan 2A still in auto, Fan 2A will increase in load until the amperage limits are reached. At this point we will record motor amperage, inlet vane position, power, wet and dry bulb temperature, rpm, unit load, and duct pressure. Thereafter, fan flow will be manually rebalanced between fans and both fans will be returned to auto control.

Test 2 (1SGB-FAN-2A High Speed)

Switch Fan 2A to high speed in auto control. Switch Fan 2B to manual control. Slowly close inlet vanes on Fan 2B until the vanes are fully closed or until the amperage limit on Fan 2A is reached. At this point we will record motor amperage, inlet vane position, power, wet and dry bulb temperature, rpm, unit load, and duct pressure. Thereafter, fan flow will be manually rebalanced between fans, Fan 2A will be returned to low speed and both fans will be returned to auto control.

Test 3 (1SGB-FAN-2B Low Speed)

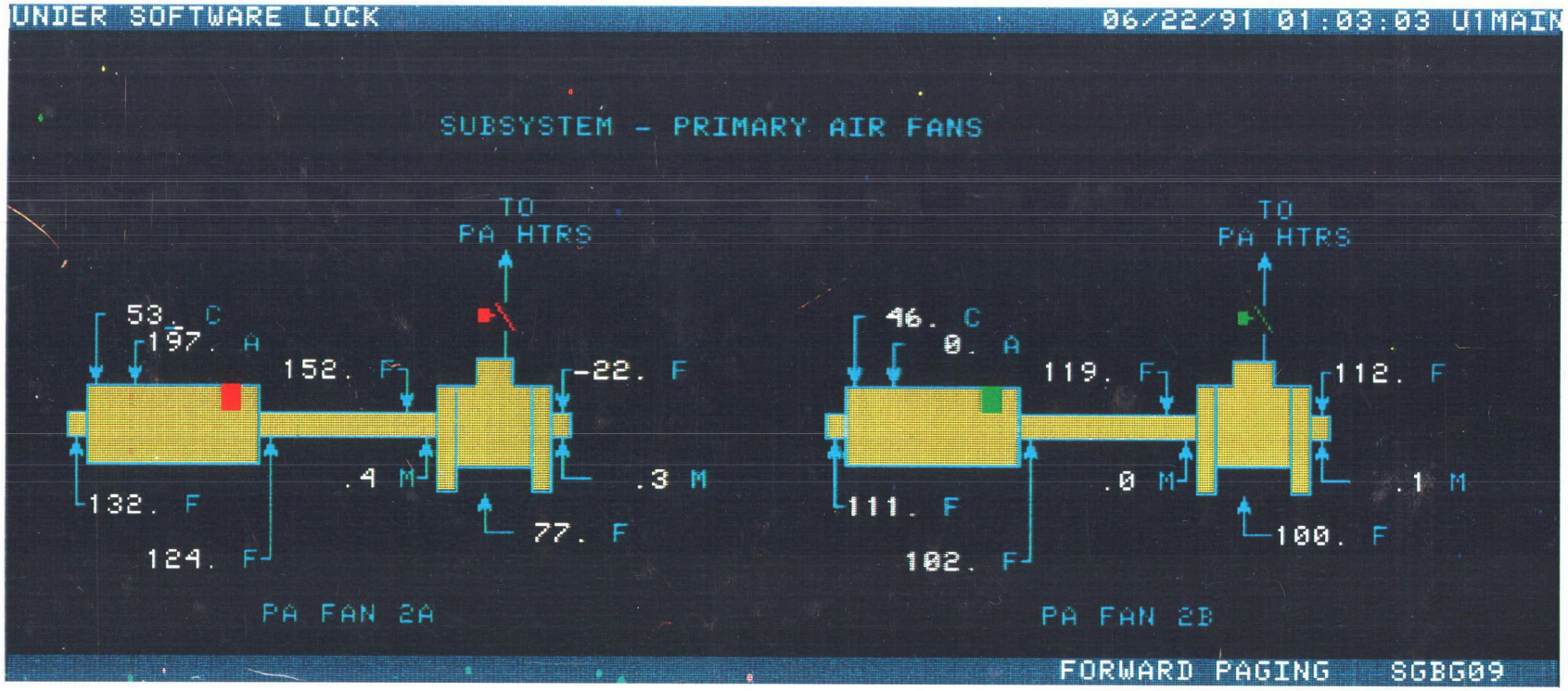
Verify both fans are operating in auto at low speed. Switch Fan 2A to manual and slowly close inlet vanes on Fan 2A. With Fan 2B still in auto, Fan 2B will increase in load until the amperage limits are reached. At this point we will record motor amperage,

inlet vane position, power, wet and dry bulb temperature, rpm, unit load, and duct pressure. Thereafter, fan flow will be manually rebalanced between fans and both fans will be returned to auto control.

Test 4 (1SGB-FAN-2B High Speed)

Switch Fan 2B to high speed in auto control. Switch Fan 2A to manual control. Slowly close inlet vanes on Fan 2A until the vanes are fully closed or the amperage limit on Fan 2B is reached. At this point we will record motor amperage, inlet vane position, power, wet and dry bulb temperature, rpm, unit load, and pressure. Thereafter, fan flow will be manually rebalanced between fans, Fan 2B will be returned to low speed and both fans will be returned to auto control.

TEST 1 PA FAN 2A LOW SPEED
PA FAN 2B OFF



IP12_005704

TEST 1 PA FAN 2A LOW SPEED INLET VANES 57.0 %
PA FAN 2B OFF

IP12_005705

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START - 1-00

FAN - PA # — TIME FINISH -

LOAD CONDITION - VANES 56.1% OPEN TEST 1

LOW SPEED 'A' FAN DRIVE SIDE (WEST)

TRAVERSE #	TP_{IN}	VP	VP_C	SP_{OUT}	SP_{IN}			BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AM
1	.8	.34			.41			25.41	72	54	66.8		898		
2	.8	.25			.43						67.2				
3	.8	.275			.34						67.9				
4	.8	.27													
5	.8	.43													
21	.6	.56													
2	.7	.47													
3	.6	.77													
4	.6	.49													
5	.6	.67													
31	.5	.73													
2	.6	.67													
3	.4	.94													
4	.6	.60													
5	.5	.79													
41	.6	.55													
2	.6	.46													
3	.6	.67													
4	.6	.46													
5	.6	.57													
51	.5	.60													
2	.6	.55													
3	.4	.84													
4	.6	.54													
5	.4	.70													
61	.4	.69													
2	.6	.56													
3	.4	.94													
4	.6	.56													
5	.6	.56													
71	.6	.41													
2	.6	.48													
3	.5	.84													
4	.6	.52													
5	.6	.75													

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER TIME START -

FAN - PA FAN # TIME FINISH -

LOAD CONDITION - ①

TRAVERSE DRIVE SIDE

#	TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMPS
81	.6	.66													
2	.6	.53													
3	.5	.89													
4	.6	.62													
5	.6	.8													
41	.6	.66													
2	.6	.52													
3	.6	.75													
4	.6	.56													
5	.6	.77													
101	.65	.35													
2	.6	.59													
3	.6	.83													
[illegible]	.6	.54													
[illegible]	.6	.75													
111	.6	.58													
2	.7	.47													
3	.6	.86													
4	.7	.52													
5	.65	.50													
21	.6	.58													
2	.65	.47													
3	.6	.75													
4	.65	.48													
5	.65	.66													
31	.65	.54													
2	.7	.45													
3	.65	.68													
4	.65	.46													
5	.65	.57													
41	.6	.63													
2	.65	.53													
3	.6	.88													
4	.7	.51													
5	.65	.74													

IP12_005707

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #A — Test — TIME FINISH - 1-30

LOAD CONDITION -

DRIVE SIDE

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM
1	.6	.69													
2	.7	.48													
3	.6	.82													
4	.7	.49													
5	.65	.74													
1	.75	.34													
2	.85	.34													
3	.7	.56													
4	.75	.38													
5	.70	.52													

IP12_005708

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START - 1-40

FAN - PA #

TIME FINISH -

LOAD CONDITION - TEST 1

TRAVERSE — OUTBOARD SIDE

#	TP_{IN}	VP	VP_C	SP_{OUT}				BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AI
1	.6	.36													
2	.6	.32													
3	.6	.40													
4	.6	.26													
5	.6	.39													
1	.4	.61													
2	.4	.53													
3	.4	.84													
4	.5	.46													
5	.4	.69													
1	.4	.64													
2	.5	.56													
3	.4	.84													
4	.5	.53													
[illegible]	.4	.73													
41	.5	.48													
2	.55	.45													
3	.55	.59													
4	.6	.44													
5	.55	.60													
51	.45	.55													
2	.55	.45													
3	.40	.80													
4	.35	.47													
5	.45	.65													
1	.60	.61													
2	.45	.54													
3	.45	.78													
4	.55	.54													
5	.55	.46													
[illegible]	.50	.47													
2	.50	.55													
3	.40	.79													
4	.55	.48													
5	.45	.64													

IP12_005709

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # — TIME FINISH -

LOAD CONDITION - 1 Out

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM
1	.45	.52													
2	.55	.56													
3	.45	.68													
4	.55	.52													
5	.40	.50													
1	.35	.42													
2	.35	.40													
3	.35	.59													
4	.4	.35													
5	.4	.46													
101	.45	.3													
2	.35	.40													
3	.3	.52													
4	.4	.36													
5	.35	.43													
111	.4	.32													
2	.4	.41													
3	.35	.57													
4	.45	.36													
5	.40	.49													
21	.30	.40													
2	.40	.40													
3	.40	.61													
4	.45	.42													
5	.4	.52													
31	.50	.34													
2	.55	.31													
3	.50	.41													
4	.5	.40													
5	.5	.36													
1	.5	.37													
2	.4	.46													
3	.4	.53													
4	.45	.42													
5	.4	.53													

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # — TIME FINISH - 2-40

LOAD CONDITION - 1

TRAVERSE — -30HGWATT ½ WAY — OUT

#	TP IN	VP	VPc	SP OUT	SP IN			BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM
1	.4	.47		9.23	-.25			25.40	51	64	69.6	99.8	897		
2	.5	.39		kPa	-.15						69.9				
3	.4	.63			.20						69.6				
4	.5	.40			kPa										
5	.4	.54													
1	.6	.30													
2	.55	.40													
3	.5	.44													
4	.5	.42													
5	.5	.49													

IP12_005711

TEST 1

UNIT 1

PA FAN 2A

LOW SPEED

Status
22-Jun-91 13:12:53

A	6 827	KV
B	6.846	KV
A	195.5	A
B	195.9	A
A	1.335	MVA
B	1.341	MVA
T	2.333	MVA
A	455.6	KW
B	1.315	MW
T	1.771	MW
A	1.255	MVAR
B	264.0	KVAR
T	1.519	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

PDm 1.766MW 13

Status
22-Jun-91 13:13:51

A	6.838	KV
B	6.833	KV
C	.0000	V
A	195.7	A
B	196.3	A
C	.0883	A
A	1.338	MVA
B	1.341	MVA
C	210.4	VA
T	2.333	MVA
A	455.8	KW
B	1.316	MW
C	210.4	W
T	1.772	MW
A	1.258	MVAR
B	260.0	KVAR
C	.0000	VAR
T	1.518	MVAR
A	.34	PF
B	.98	PF
C	.99	PF
T	.76	PF

PDm 1.767MW 14

#Dm 1.768MW .76PF
22-Jun-91 13:14:16

Status
22-Jun-91 13:18:23

A	6.824	KV
B	6.827	KV
A	195.4	A
B	195.9	A
A	1.333	MVA
B	1.337	MVA
T	2.328	MVA
A	455.9	KW
B	1.311	MW
T	1.767	MW
A	1.253	MVAR
B	262.5	KVAR
T	1.516	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

PDm 1.769MW 4

Status
22-Jun-91 13:25:04

A	6.829	KV
B	6.818	KV
A	195.6	A
B	195.9	A
A	1.336	MVA
B	1.335	MVA
T	2.328	MVA
A	457.5	KW
B	1.310	MW
T	1.768	MW
A	1.255	MVAR
B	258.6	KVAR
T	1.514	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

PDm 1.768MW 10

TEST 1

PA FAN 2A

LOW SPEED

2/2

#Dm 1.769MW .76PF
22-Jun-91 13:29:16

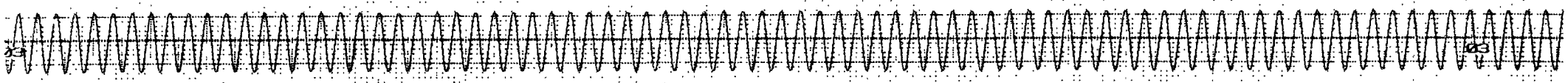
Status
22-Jun-91 13:31:20

A	6.827	KV
B	6.831	KV
A	195.6	A
B	196.0	A
A	1.335	MVA
B	1.339	MVA
T	2.331	MVA
A	457.3	KW
B	1.313	MW
T	1.771	MW
A	1.254	MVAR
B	260.9	KVAR
T	1.515	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

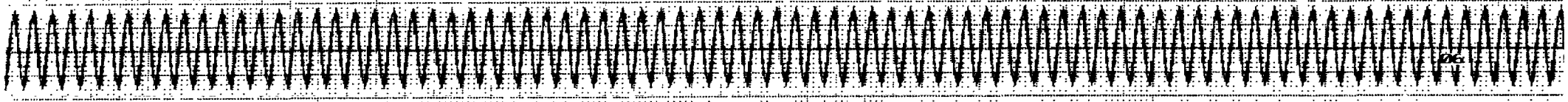
2374 Hp

PDm 1.760MW 2

00:48:27 *22 JUN 91 *SPD:200 MM/S *TIME SCALE: 5.000 MS/MM *ANALOG REAL TIME < 00:48:2

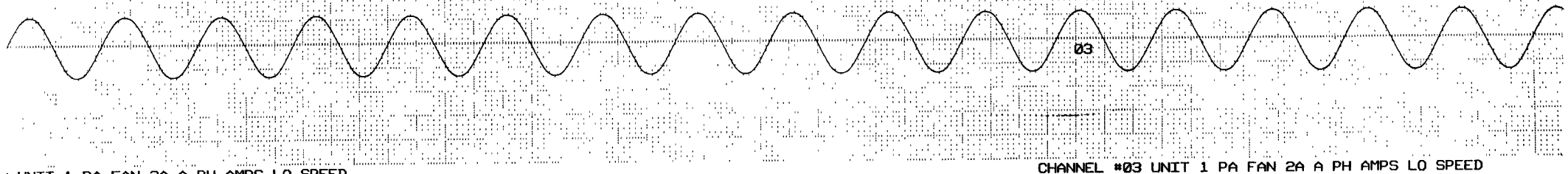


NEL #03 UNIT 1 PA FAN 2A A PH AMPS LO SPEED * Range = 1.00 Vfs CHANNEL #03

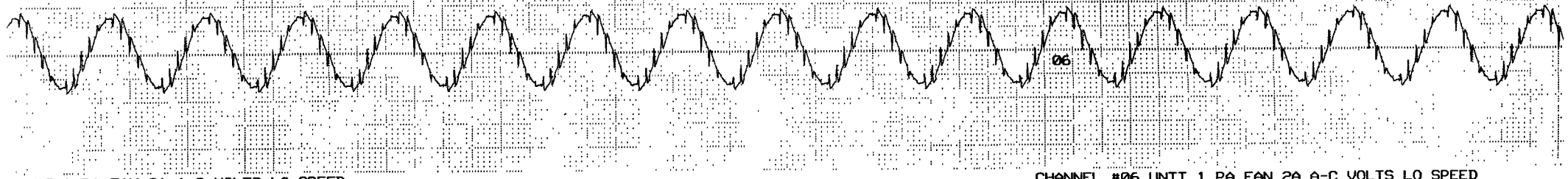


NEL #06 UNIT 1 PA FAN 2A A-C VOLTS LO SPEED * Range = 0.50 Vfs CHANNEL #06

37 *22 JUN 91 -PLAYBACK- *TIME SCALE: 2 MS/ 2MM *SNAPSHOT DATA < 00:53:37 *22 JUN 91 -PLAYBACK- *TIME SCALE:



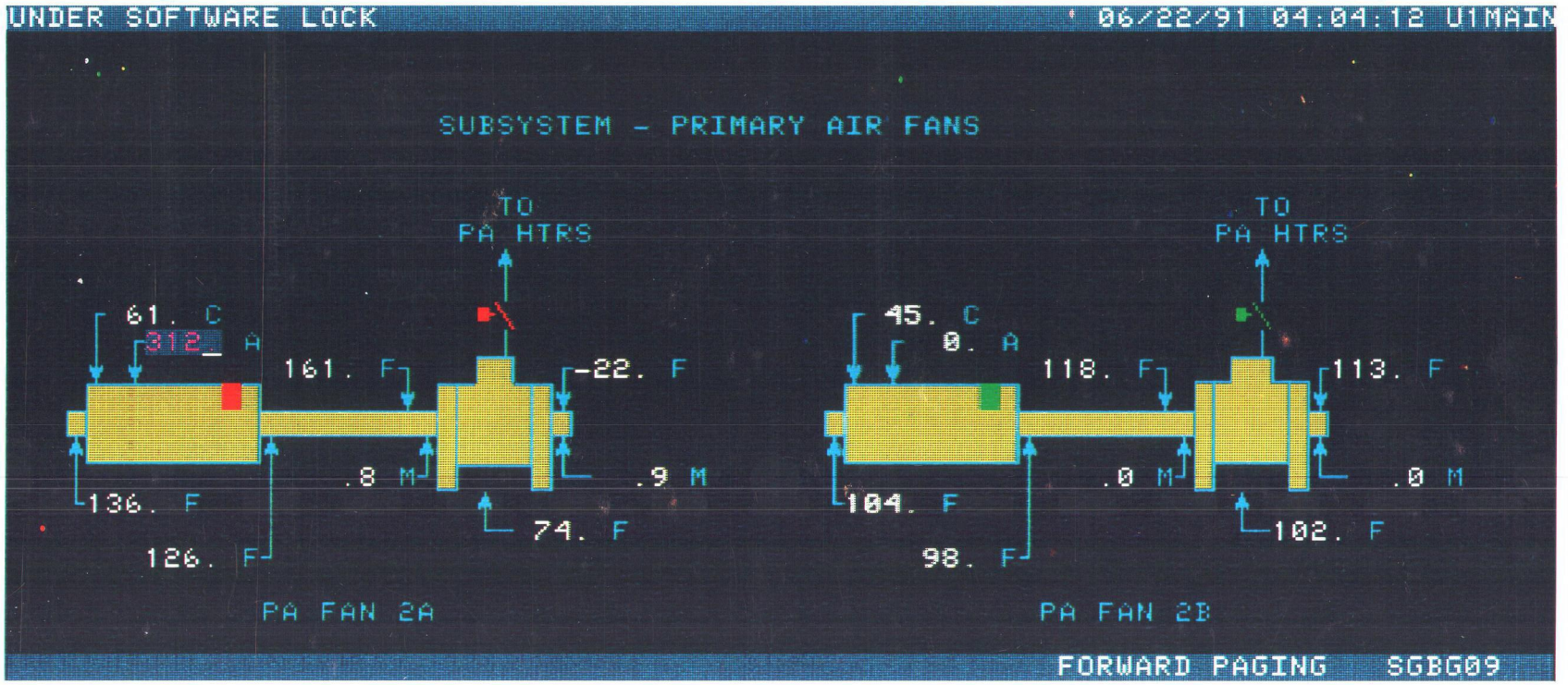
UNIT 1 PA FAN 2A A PH AMPS LO SPEED CHANNEL #03 UNIT 1 PA FAN 2A A PH AMPS LO SPEED



UNIT 1 PA FAN 2A A-C VOLTS LO SPEED CHANNEL #06 UNIT 1 PA FAN 2A A-C VOLTS LO SPEED

IP12_005714

TEST 2 PA FAN 2B OFF
PA FAN 2A HIGH SPEED INLET VANES 32.0%



IP12_005715

TEST 2 PA FAN 2A HIGH SPEED INLET VANES 32.0 %

PA FAN 2B OFF

IP12_005716

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START - 04:40

FAN - PA #2A — TIME FINISH -

LOAD CONDITION - Vanes % open Test 2

TRAVERSE — High Speed "A" Fan Drive side (W)

#	TP_{IN}	VP	VPc	SP_{OUT}			Pin	BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMI
1	.40	.37					.24	25.41	65.0	46.0	66.8		1194		
2	.50	.25					.26				63.0				
3	.50	.32					.24				64.6				
4	.50	.26													
5	.50	.40													
1	1.0	.59													
2	.8	.43													
3	.8	.65													
4	.9	.48													
5	.9	.62													
1	.9	.68													
2	.9	.59													
3	.9	.54													
4	.9	.53													
	.9	.73													
41	.8	.54													
2	.8	.47													
3	.8	.63													
4	.8	.42													
5	.8	.51													
51	.9	.63													
2	.9	.57													
3	.9	.82													
4	.9	.55													
5	.9	.60													
1	.9	.76													
2	.9	.64													
3	.9	.90													
4	.9	.51													
5	.9	.55													
1	1.2	.45													
2	1.3	.55													
3	1.3	.76													
4	1.3	.50													
5	1.3	.71													

Note
problems w
Slack tube manometer
incorrect static pressure
readings!!

IP12_005717

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #2A — TIME FINISH -

LOAD CONDITION - Test 2

TRAVERSE — High Speed A — Drive Side (W)

#	TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM.
1	1.4	.73													
2	1.4	.55													
3	1.4	.86													
4	1.4	.55													
5	1.3	.72													
1	1.0	.65													
2	1.0	.51													
3	1.0	.70													
4	1.0	.57													
5	1.0	.74													
1	1.0	.38													
2	1.0	.55													
3	1.0	.75													
4	1.0	.46													
	1.0	.70													
1	1.0	.70													
2	1.0	.46													
3	1.0	.76													
4	1.0	.49													
5	1.0	.46													
1	.9	.52													
2	.9	.45													
3	.9	.75													
4	.9	.45													
5	.9	.59													
1	.8	.54													
2	.8	.46													
3	.8	.61													
4	.8	.48													
5	.8	.53													
1	.9	.66													
2	.9	.49													
3	.9	.80													
4	.9	.49													
5	.9	.72													

IP12_005718

FIELD TEST DATA

DATE 6-22-91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # [illegible] — TIME FINISH -

LOAD CONDITION - Test 2

High Speed Test A Fan Drive Side (W)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMP
151	.8	.69													
2	.8	.46													
3	.8	.83													
4	.8	.46													
5	.8	.69													
61	.8	.40													
2	.8	.30													
3	.8	.59													
4	.8	.56													
5	.8	.53													

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER

TIME START -

FAN - PA #

TIME FINISH -

LOAD CONDITION - VANES % OPEN TEST 2

TRAVERSE HIGH SPEED 'A' FAN OUT BOARD SIDE (E)

#	TP_{IN}	VP	VP_C	SP_{OUT}				BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AMPS
1	.5	.31													
2	.5	.31													
3	.5	.34													
4	.5	.26													
5	.5	.34													
21	.4	.56													
2	.5	.43													
3	.4	.64													
4	.45	.40													
5	.45	.56													
31	.45	.60													
2	.45	.46													
3	.3	.74													
4	.5	.45													
5	.4	.62													
41	.5	.45													
2	.5	.37													
3	.5	.50													
4	.5	.39													
5	.5	.54													
51	.4	.58													
2	.5	.40													
3	.4	.7													
4	.5	.41													
5	.45	.59													
61	.48	.59													
2	.45	.50													
3	.48	.69													
4	.45	.42													
5	.45	.42													
71	.5	.52													
2	.5	.51													
3	.5	.66													
4	.45	.42													
5	.5	.58													

IP12_005720

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #

TIME FINISH -

LOAD CONDITION - 2

TRAVERSE — High Speed "A" Fan — Outboard side (E)

#	TP IN	VP	VPc	SP OUT		Po	Pin	BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM.
81	.45	.52				-9.1	.15	25.40	63	51	67.1	114.7			
2	.50	.46					.20				68.9				
3	.50	.60					.17				68.5				
4	.5	.48													
5	.50	.56													
91	.5	.58													
2	.50	.54													
3	.5	.71													
4	.5	.46													
5	.50	.59													
101	.50	.42													
2	.50	.53													
3	.5	.65													
4	.5	.46													
	.50	.56													
111	.50	.48													
2	.50	.40													
3	.50	.64													
4	.50	.42													
5	.50	.50													
121	.50	.48													
2	.50	.44													
3	.50	.64													
4	.50	.42													
5	.30	.52													
31	.50	.42													
2	.50	.34													
3	.50	.46													
4	.50	.35													
5	.50	.45													
41	.50	.58													
2	.50	.55													
3	.50	.52													
4	.50	.72													
5	.50	.42													

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # — TIME FINISH - 04:20

LOAD CONDITION - Test 2

High Speed "A" Fan Outboard Side (E)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMPS
51	.50	.46													
2	.50	.41													
3	.50	.60													
4	.50	.42													
5	.50	.58													
61	.50	.31													
2	.50	.33													
3	.50	.42													
4	.50	.36													
5	.50	.44													

IP12_005722

TEST 2

UNIT 1

PA FAN 2A HIGH SPEED

1/1
6/22/91

Status PA FAN 2A High
22-Jun-91 15:57:04

A	6.764	KV
B	6.763	KV
A	302.9	A
B	310.3	A
A	2.049	MVA
B	2.098	MVA
T	3.533	MVA
A	1.090	MW
B	2.089	MW
T	3.180	MW
A	1.734	MVAR
B	-195.0	KVAR
T	1.539	MVAR
A	.53	PF
B	-.99	PF
T	.90	PF

426 2

PDm 3.183MW 12

#Dm 3.183MW .90PF
22-Jun-91 15:59:16

#Dm 3.186MW .90PF
22-Jun-91 16:14:16

#Dm 3.198MW .90PF
22-Jun-91 16:29:16

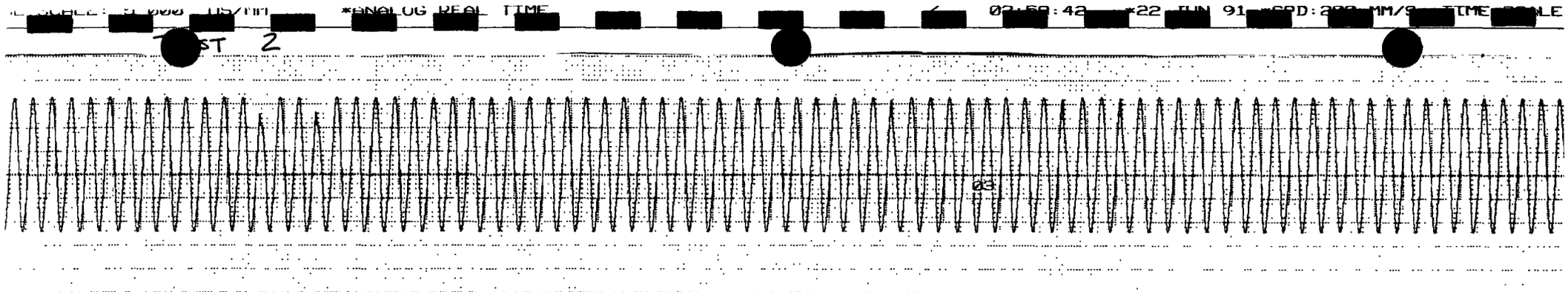
#Dm 3.205MW .90PF
22-Jun-91 16:44:16

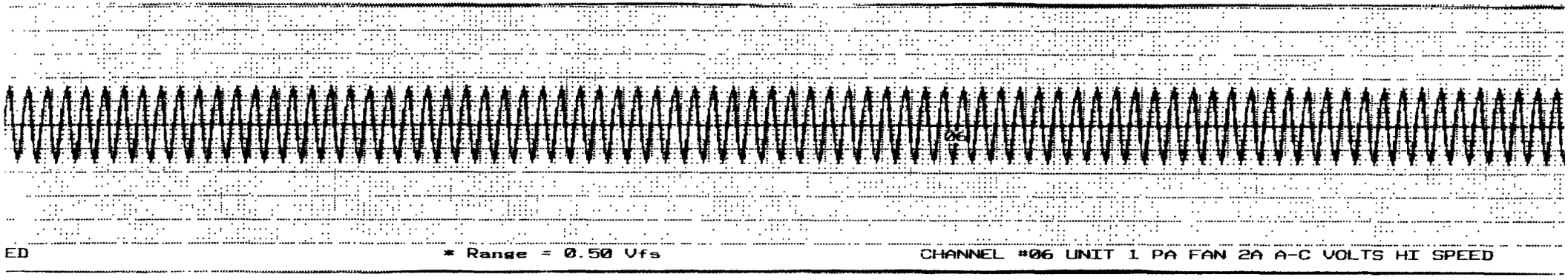
#Dm 3.202MW .90PF
22-Jun-91 16:59:16

#Dm 3.197MW .90PF
22-Jun-91 17:14:16

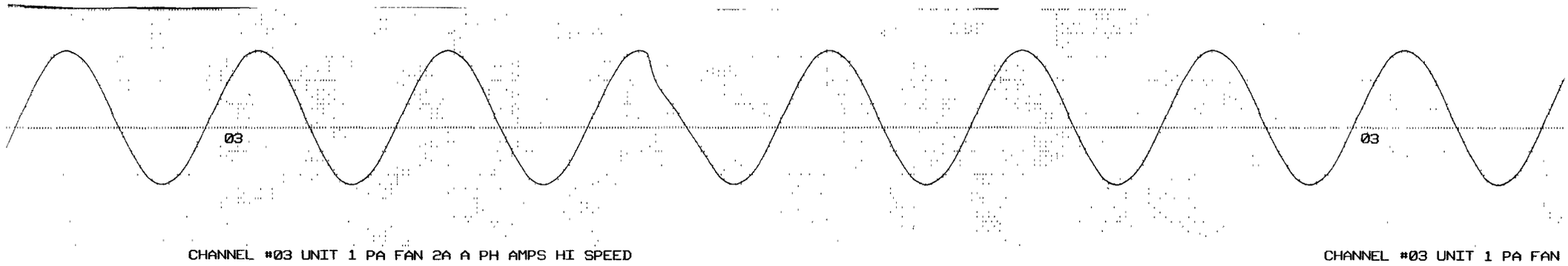
#Dm 3.199MW .90PF
22-Jun-91 17:29:16

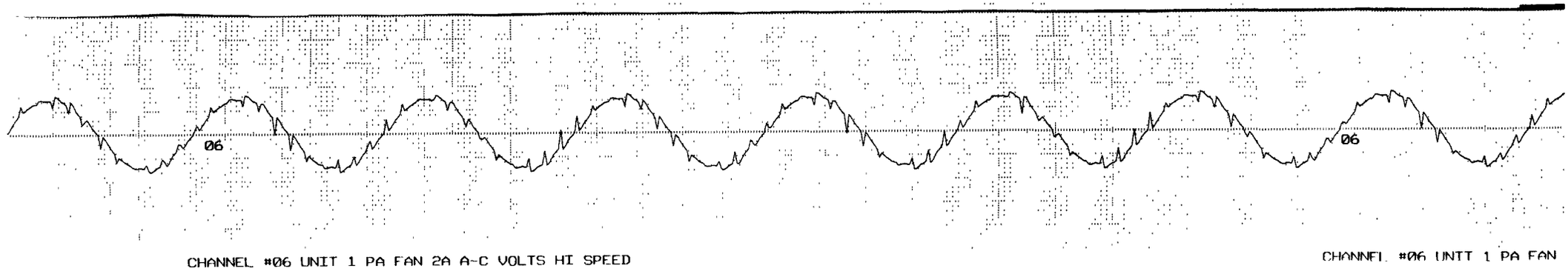
#Dm 3.140MW .90PF
22-Jun-91 17:44:16





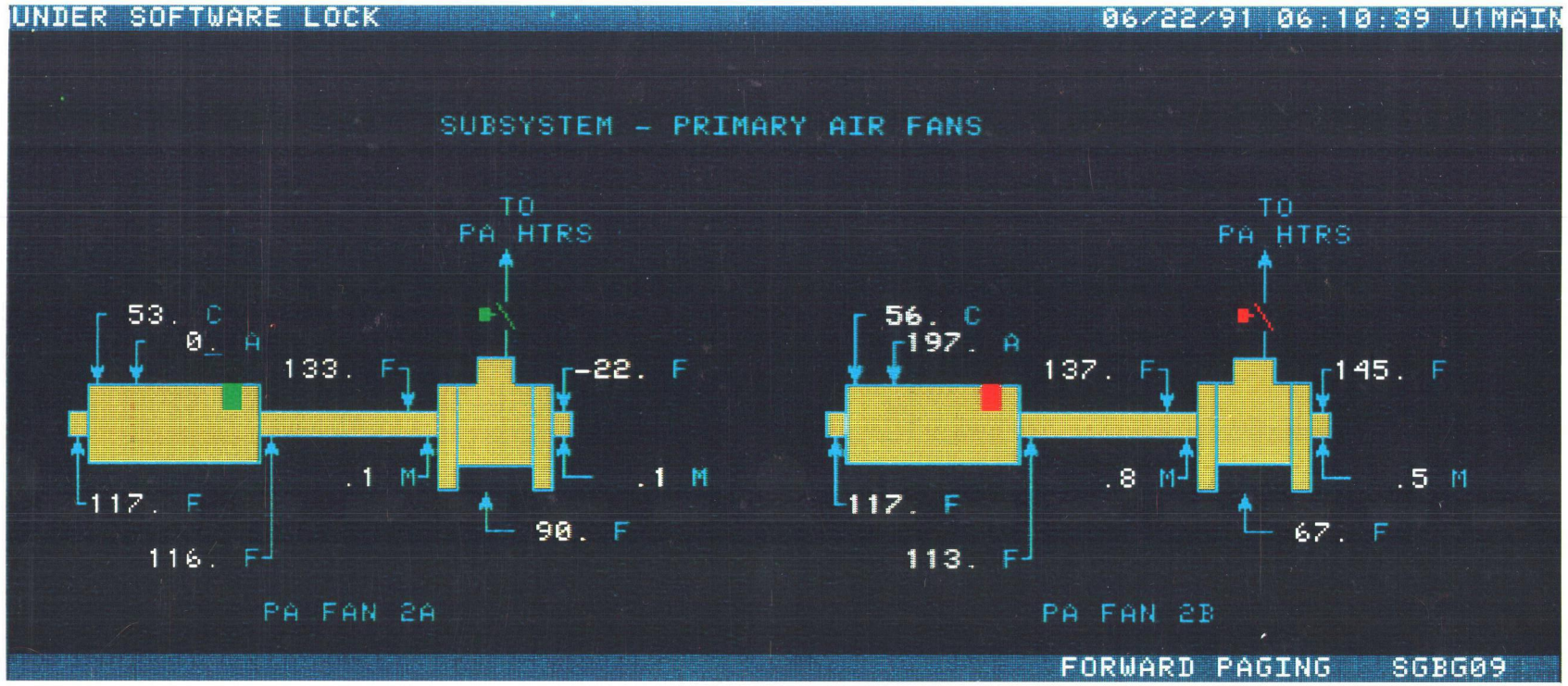
< 03:57:33 *22 JUN 91 -PLAYBACK- *TIME SCALE: 4 MS/ 8MM *SNAPSHOT DATA < 03:57:33 *22 JUN 91





IP12_005724

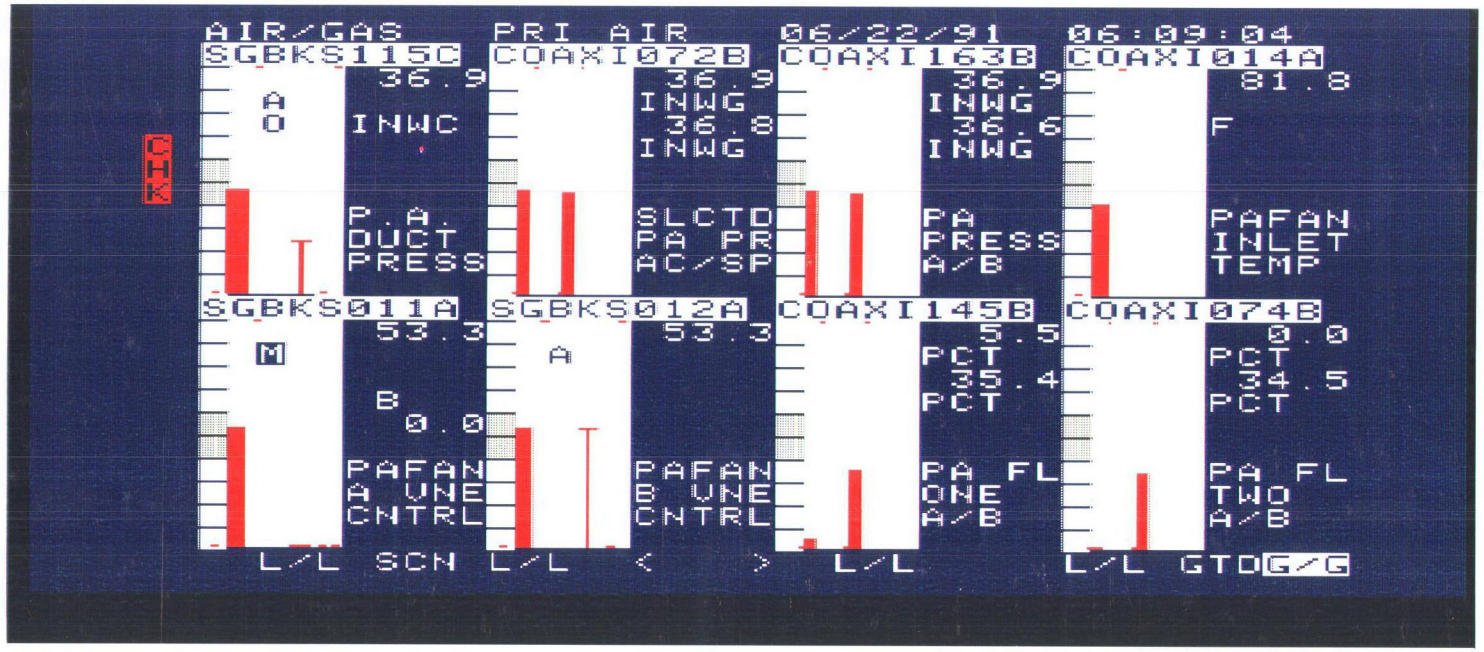
TEST 3 PA FAN 2A OFF
PA FAN 2B LOW SPEED



IP12_005725

TEST 3 PA FAN 2A OFF

PA FAN 2B LOW SPEED INLET VANES 53.3 %



IP12_005726

FIELD TEST DATA

DATE 6/22/

PLANT - INTERMOUNTAIN POWER — TIME START - 06:21

FAN - PA # 2B — TIME FINISH -

LOAD CONDITION - Vanes % open Test 3

TRAVERSE — Low Speed 'B' Fan Drive Side (E)

#	TP_{IN}	VP	VP_C	SP_{OUT}			P_{in}	BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AMI
1	.6	.45					.14	25.44	65	46	66.6		~~[illegible]~~		
2	.7	.29					.17				~~63.0~~	65.1	897		
3	.6	.44					.15				~~64.0~~				
4	.8	.30									65.4				
5	.6	.39													
1	.4	.61													
2	.6	.52													
3	.3	.73													
4	.7	.46													
5	.5	.68													
31	.4	.71													
2	.4	.57													
3	.3	.93													
4	.6	.62													
	.4	.87													
41	.5	.56													
2	.6	.50													
3	.4	.72													
4	.6	.51													
5	.5	.66													
51	.4	.69													
2	.5	.60													
3	.3	.82													
4	.6	.56													
5	.4	.80													
61	.5	.51													
2	.6	.47													
3	.3	.90													
4	.6	.68													
5	.6	.63													
71	.5	.52													
2	.6	.52													
3	.4	.87													
4	.6	.60													
5	.5	.84													

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # 2B — TIME FINISH -

LOAD CONDITION - ~~60~~ Vanes % open Test 3

Low Speed 'B' fan Drive Side (E)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMI
81	.4	.74													
2	.7	.59													
3	.4	.86													
4	.6	.60													
5	.5	.85													
1	.5	.58													
2	.5	.58													
3	.4	.81													
4	.6	.57													
5	.5	.74													
101	.5	.62													
2	.6	.58													
3	.4	.85													
4	.6	.63													
	.6	.67													
111	.5	.60													
2	.6	.51													
3	.4	.85													
4	.6	.53													
5	.5	.63													
121	.4	.64													
2	.5	.55													
3	.3	.82													
4	.5	.52													
5	.4	.73													
31	.5	.46													
2	.5	.53													
3	.6	.43													
4	.6	.58													
5	.5	.46													
41	.4	.49													
2	.6	.60													
3	.3	.86													
4	.5	.58													
5	.4	.75													

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN # 2B — TIME FINISH - 07:03

LOAD CONDITION - Vane % open Test 3

Low Speed "B" Drive Side (E)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMP
151	.4	.64													
2	.6	.57													
3	.4	.79													
4	.5	.58													
5	.5	.76													
111	.6	.41													
2	.7	.35													
3	.6	.42													
4	.7	.31													
5	.6	.46													

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA #2B — TIME FINISH -

LOAD CONDITION - Vanes % open Test 3

TRAVERSE — Low Speed "B" fan ~~to~~ outboard Side (W)

#	TP_{IN}	VP	VP_C	SP_{OUT}		P_o	P_{in}	BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AMP
1	.7	.34				-9.23	.24	25.45	65	46	66.8	93.6	897		
2	.8	.37					.20				66.0				
3	.7	.55					.15								
4	.8	.39									66.6				
5	.7	.47													
1	.5	.60													
2	.6	.62													
3	.4	.87													
4	.7	.55													
5	.5	.74													
1	.5	.75													
2	.6	.62													
3	.4	.80													
4	.6	.56													
[illegible]	.4	.83													
41	.5	.65													
2	.6	.55													
3	.5	.75													
4	.7	.51													
5	.5	.73													
51	.4	.68													
2	.6	.65													
3	.6	.65													
4	.5	.84													
5	.6	.59													
1	.4	.70													
2	.6	.69													
3	.4	.82													
4	.7	.55													
5	.7	.55													
[illegible]	.6	.50													
[illegible]	.7	.57													
3	.5	.84													
4	.7	.55													
5	.6	.79													

IP12_005730

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER TIME START -

FAN - PA FAN #2B TIME FINISH -

LOAD CONDITION - Vanes ~~#~~ open test 3

Low Speed "B" fan outboard (EV)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM.
8 1	.6	.56													
2	.7	.55													
3	.6	.74													
4	.7	.58													
5	.5	.74													
1	.6	.61													
2	.6	.66													
3	.4	.82													
4	.7	.57													
5	.5	.83													
10 1	.6	.57													
2	.6	.65													
3	.5	.90													
4	.7	.56													
	.6	.77													
11 1	.6	.51													
2	.7	.55													
3	.4	.90													
4	.7	.54													
5	.6	.63													
12 1	.6	.50													
2	.6	.51													
3	.5	.79													
4	.6	.52													
5	.5	.66													
13 1	.7	.45													
2	.8	.42													
3	.6	.80													
4	.7	.44													
5	.6	.57													
14 1	.5	.68													
2	.6	.53													
3	.5	.79													
4	.6	.54													
5	.5	.71													

IP12_005731

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #2B — TIME FINISH - 08:00

LOAD CONDITION - test 3

TRAVERSE — Low Speed '3' from Outboard side (W)

#	TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMP
1	.4	.65													
2	.6	.50													
3	.4	.84													
4	.7	.51													
5	.5	.71													
1	.6	.53													
2	.7	.42													
3	.6	.59													
4	.7	.38													
5	.6	.53													

TEST 3

UNIT 1

2A FAN 2B LOW SPEED

Po Fan 2B Lo Spd 1/1 6/22/91

#Dm 1.777MW .76PF
22-Jun-91 18:14:16

Status
22-Jun-91 18:15:15

A	6.755	KV
B	6.753	KV
A	194.9	A
B	200.6	A
A	1.317	MVA
B	1.355	MVA
T	2.326	MVA
A	448.4	KW
B	1.330	MW
T	1.778	MW
A	1.238	MVAR
B	260.8	KVAR
T	1.499	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

PDm 1.777MW 15

Status
22-Jun-91 17:58:50

A	6.750	KV
B	6.755	KV
A	195.6	A
B	201.5	A
A	1.320	MVA
B	1.361	MVA
T	2.336	MVA
A	457.5	KW
B	1.336	MW
T	1.794	MW
A	1.238	MVAR
B	257.1	KVAR
T	1.496	MVAR
A	.35	PF
B	.98	PF
T	.77	PF

PDm 900.8KW 14

#Dm 960.3KW .80PF
22-Jun-91 17:59:16

Status
22-Jun-91 18:05:00

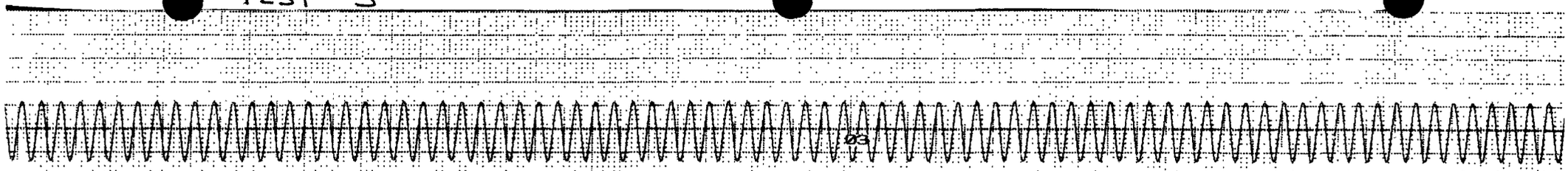
A	6.743	KV
B	6.745	KV
A	194.4	A
B	200.2	A
A	1.311	MVA
B	1.350	MVA
T	2.318	MVA
A	446.8	KW
B	1.325	MW
T	1.771	MW
A	1.233	MVAR
B	262.9	KVAR
T	1.496	MVAR
A	.34	PF
B	.98	PF
T	.76	PF

PDm 1.787MW 5

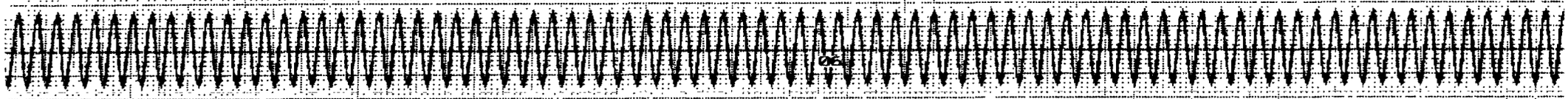
2374

.000 MS/MM *ANALOG REAL TIME < 06:15:15 *22 JUN 91 *SPD:200 MM/S *TIME SCALE: 5.000 MS

TEST 3

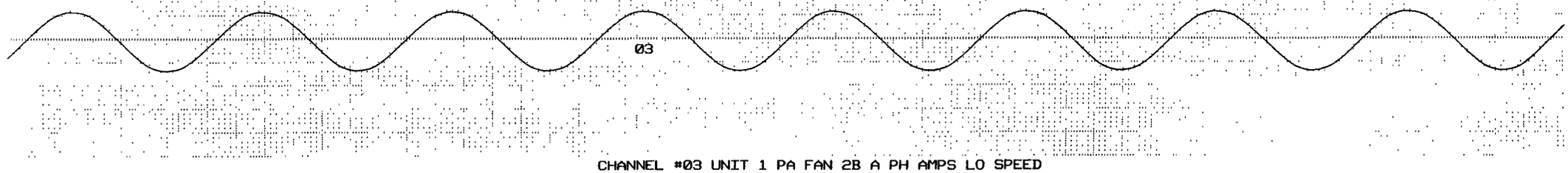


* Range = 1.00 Vfs CHANNEL #03 UNIT 1 PA FAN 2B A PH AMPS LO SPEED

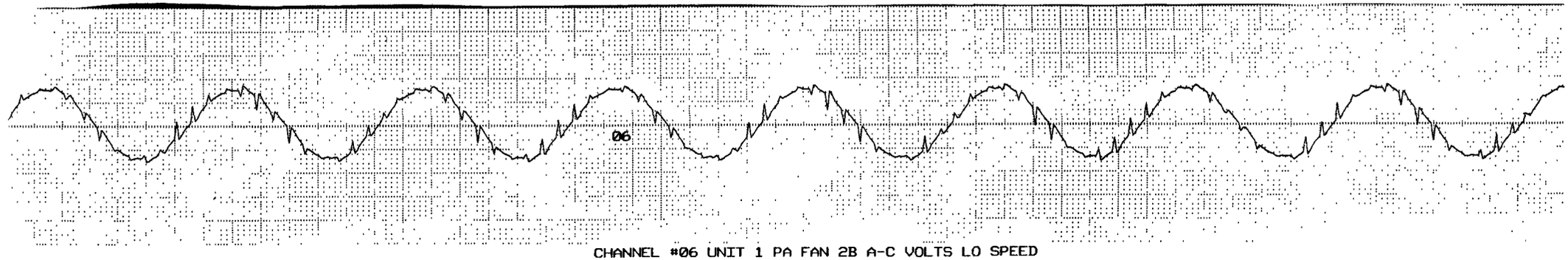


* Range = 0.50 Vfs CHANNEL #06 UNIT 1 PA FAN 2B A-C VOLTS LO SPEED

4 MS/ 8MM *SNAPSHOT DATA < 06:15:42 *22 JUN 91 -PLAYBACK- *TIME SCALE: 4 MS/ 8MM *SNAPSHOT DATA



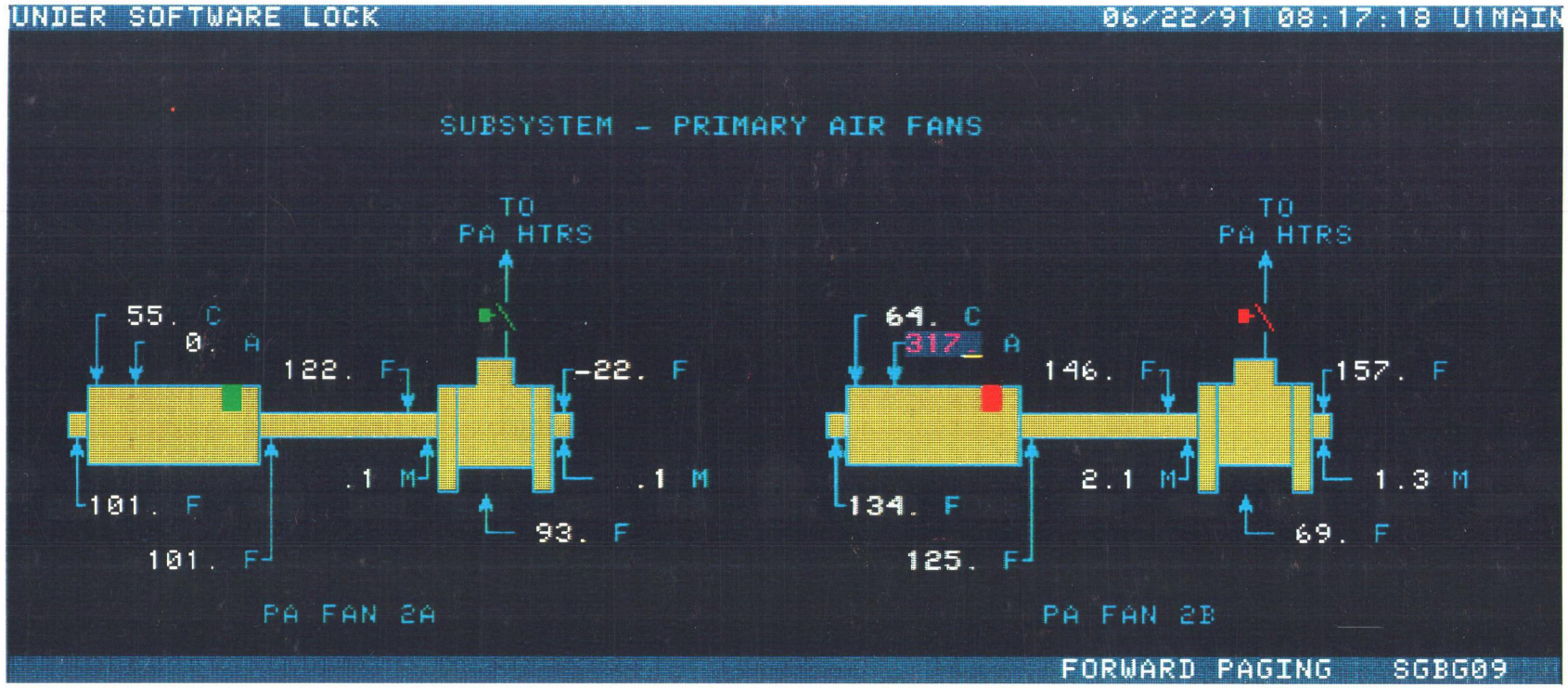
CHANNEL #03 UNIT 1 PA FAN 2B A PH AMPS LO SPEED



CHANNEL #06 UNIT 1 PA FAN 2B A-C VOLTS LO SPEED

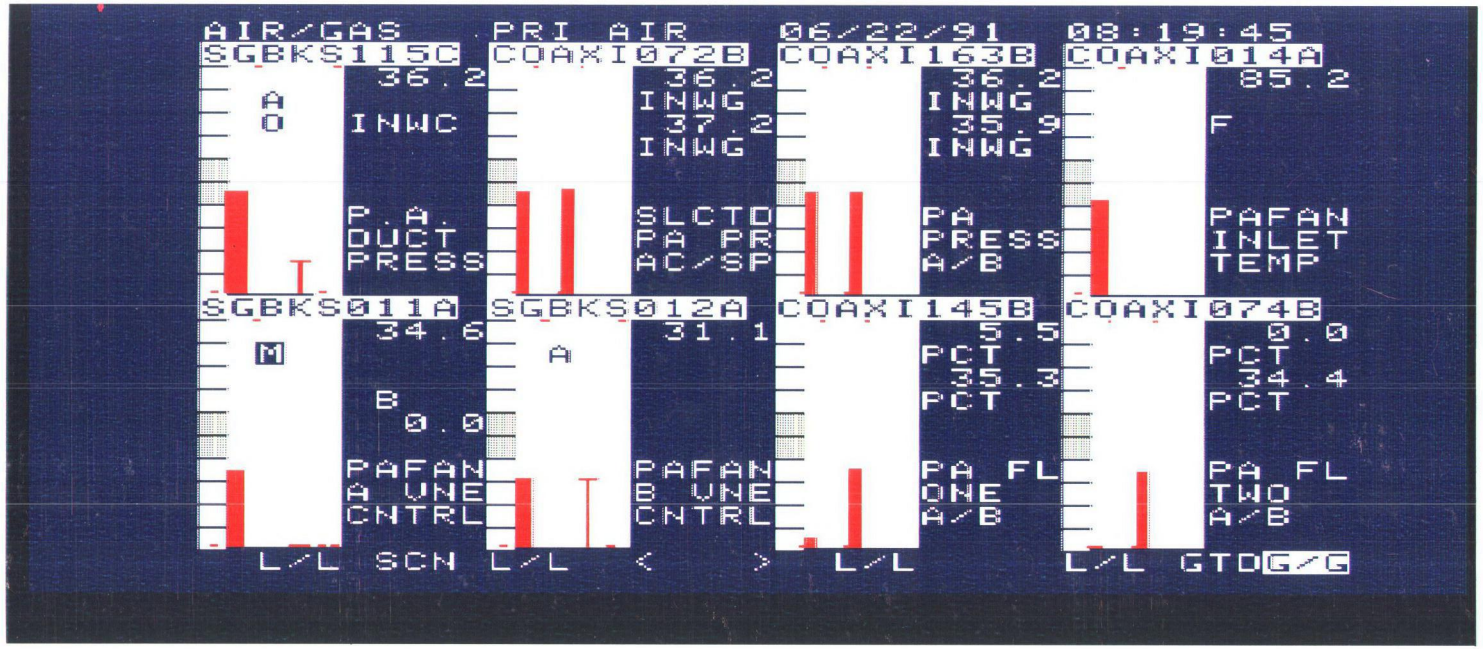
IP12_005734

Trial 4
PA FAN 2B HIGH SPEED



IP12_005735

TEST 4
PA FAN 2B HIGH SPEED INLET VANES 31.1%
PA FAN 1A OFF



IP12_005736

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA #2B — TIME FINISH -

LOAD CONDITION - Test 4

TRAVERSE — High Speed "B" fan outboard side (W)

#	TP_{IN}	VP	VPc	SP_{OUT}		P_{out}	P_{in}	BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AMP
1	.7	.30	~~.30~~			-9.15	.25	25.46	69	49	68.0	118.6	1194		
2	.8	.31					.14				69.6				
3	.7	.42					.17				70.5				
4	.8	.27													
5	.8	.40													
1	.6	.52													
2	.7	.53													
3	.5	.82													
4	.7	.50													
5	.6	.70													
31	.5	.63													
2	.6	.64													
3	.4	.80													
4	.7	.55													
[illegible]	.5	.76													
41	.6	.60													
2	.7	.56													
3	.6	.74													
4	.8	.45													
5	.6	.60													
51	.5	.59													
2	.7	.64													
3	.5	.75													
4	.6	.55													
5	.5	.59													
1	.5	.67													
2	.5	.70													
3	.4	.85													
4	.6	.57													
5	.6	.51													
[illegible]	.6	.46													
2	.6	.50													
3	.5	.86													
4	.7	.54													
5	.6	.70													

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER TIME START -

FAN - PA FAN #2B Test 4 TIME FINISH -

LOAD CONDITION -

TRAVERSE ~~Low Speed~~ high Speed "B" outboard side (W)

#	TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AM
1	.6	.80													
2	.7	.54													
3	.5	.75													
4	.7	.55													
5	.5	.68													
1	.5	.56													
2	.6	.68													
3	.4	.87													
4	.7	.58													
5	.5	.77													
1	.6	.51													
2	.7	.59													
3	.5	.82													
4	.7	.50													
	.6	.65													
1	.6	.50													
2	.7	.49													
3	.4	.84													
4	.6	.49													
5	.6	.56													
1	.6	.47													
2	.6	.53													
3	.4	.80													
4	.6	.48													
5	.5	.64													
1	.6	.50													
2	.7	.40													
3	.6	.59													
4	.7	.42													
5	.6	.50													
1	.5	.66													
2	.6	.57													
3	.4	.75													
4	.6	.58													
5	.5	.72													

IP12_005738

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START - 8:20

FAN - PA FAN #2B — Test 4 — TIME FINISH -

LOAD CONDITION - high Speed "B" fan outboard side (W)

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMP
1	.5	.68													
2	.7	.46													
3	.5	.77													
4	.6	.47													
5	.5	.60													
1	.6	.44													
2	.7	.33													
3	.5	.53													
4	.7	.36													
5	.6	.52													

IP12_005739

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA #2B — TIME FINISH -

LOAD CONDITION - Test 4

TRAVERSE — High Speed B' fan ~~Outboard side~~ Drive Side (E

#	TP_{IN}	VP	VP_c	SP_{OUT}		Pout	Pin	BAR	T_D	T_W	T_{IN}	T_{OUT}	RPM	VOLTS	AMP
1	.7	.37					.10	25.47	70	49	77.5				
2	.8	.32					.18				74.9				
3	.8	.32					.17				73.2				
4	.8	.25													
5	.7	.40													
1	.6	.65													
2	.7	.44													
3	.5	.75													
4	.6	.40													
5	.5	.67													
1	.4	.82													
2	.6	.57													
3	.3	.92													
4	.6	.60													
[illegible]	.4	.76													
41	.5	.59													
2	.5	.47													
3	.6	.62													
4	.7	.57													
5	.6	.61													
51	.5	.61													
2	.6	.55													
3	.4	.82													
4	.6	.54													
5	.4	.68													
1	.5	.52													
2	.6	.56													
3	.4	.89													
4	.7	.59													
5	.6	.61													
1	.6	.60													
2	.7	.51													
3	.4	.80													
4	.6	.58													
5	.5	.85													

IP12_005740

FIELD TEST DATA

DATE 6/22/91

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #23 — TIME FINISH -

LOAD CONDITION - Test 4 High Speed 'B' Fan Drive Side (E)

TRAVERSE

#	TPIN	VP	VPc	SPOUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMI
1	.5	.70													
2	.7	.70													
3	.4	1.00													
4	.7	.66													
5	.5	.85													
1	.6	.62													
2	.6	.53													
3	.5	.77													
4	.6	.60													
5	.5	.71													
101	.6	.60													
2	.6	.53													
3	.4	.84													
4	.6	.56													
[illegible]	.6	.70													
111	.6	.53													
2	.6	.50													
3	.5	.79													
4	.7	.51													
5	.6	.63													
21	.5	.64													
2	.6	.51													
3	.4	.88													
4	.6	.55													
5	.6	.60													
31	.6	.51													
2	.7	.44													
3	.6	.62													
4	.7	.45													
5	.6	.53													
[illegible]	.5	.69													
2	.7	.49													
3	.4	.92													
4	.6	.52													
5	.5	.73													

IP12_005741

FIELD TEST DATA

DATE

PLANT - INTERMOUNTAIN POWER — TIME START -

FAN - PA FAN #2B — TIME FINISH -

LOAD CONDITION - Test 4

(High Speed drive side (E) B fan

#	TRAVERSE TP IN	VP	VPc	SP OUT				BAR	TD	TW	TIN	TOUT	RPM	VOLTS	AMP
1	.5	.50													
2	.6	.50													
3	.6	.51													
4	.4	.79													
5	.6	.52													
1	.6	.39													
2	.7	.34													
3	.7	.46													
4	.8	.35													
5	.7	.50													

IP12_005742

TEST 4

UNIT 1 PA FAN 2B HIGH SPEED

1/1
6/22/91

Status
22-Jun-91 20:08:50

A	6.815	KV
B	6.813	KV
A	288.7	A
B	290.4	A
A	1.967	MVA
B	1.978	MVA
T	3.359	MVA
A	1.042	MW
B	1.970	MW
T	3.012	MW
A	1.668	MVAR
B	-182.9	KVAR
T	1.485	MVAR
A	.53	PF
B	-.99	PF
T	.90	PF

PDm 1.916MW 9

#Dm 2.388MW .82PF
22-Jun-91 20:14:16

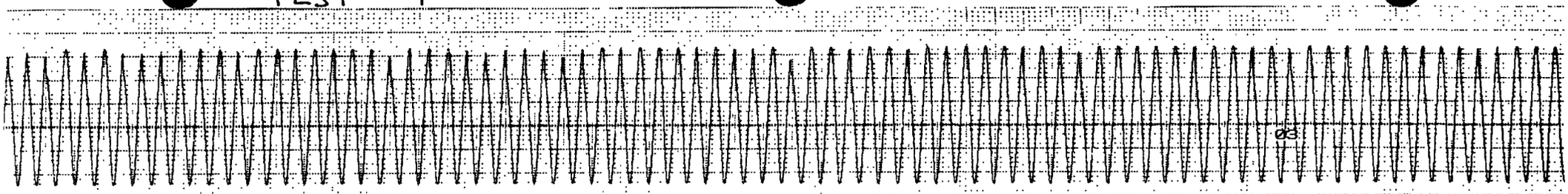
Status
22-Jun-91 20:26:53

A	6.822	KV
B	6.804	KV
A	308.5	A
B	310.6	A
A	2.105	MVA
B	2.113	MVA
T	3.596	MVA
A	1.127	MW
B	2.104	MW
T	3.231	MW
A	1.777	MVAR
B	-200.0	KVAR
T	1.577	MVAR
A	.54	PF
B	-.99	PF
T	.90	PF

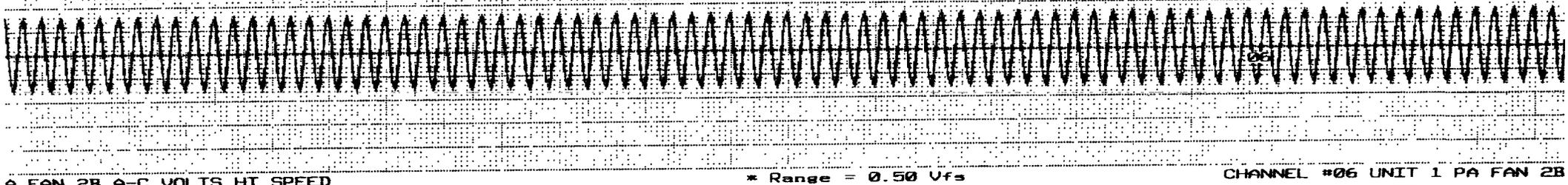
PDm 3.225MW 12

JU[redacted] *S[redacted]200 [redacted]S *[redacted] SC[redacted] 5[redacted] M[redacted] [redacted] *AN[redacted] RE[redacted]IME [redacted] < [redacted]08:2[redacted]7 [redacted] JL[redacted]

TEST #4

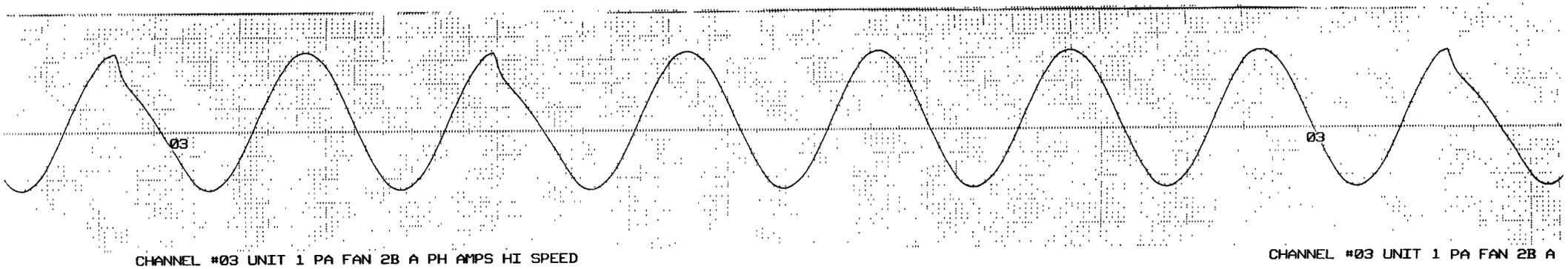


A FAN 2B A PH AMPS HI SPEED * Range = 1.00 Vfs CHANNEL #03 UNIT 1 PA FAN 2B

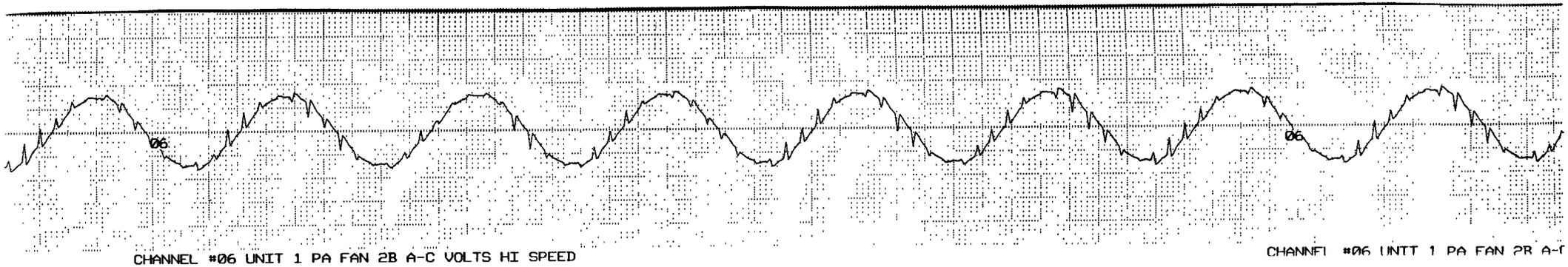


A FAN 2B A-C VOLTS HI SPEED * Range = 0.50 Vfs CHANNEL #06 UNIT 1 PA FAN 2B

< 08:25:14 *22 JUN 91 -PLAYBACK- *TIME SCALE: 4 MS/ 8MM *SNAPSHOT DATA < 08:25:14 *22 JUN 91 -PL



CHANNEL #03 UNIT 1 PA FAN 2B A PH AMPS HI SPEED CHANNEL #03 UNIT 1 PA FAN 2B A



CHANNEL #06 UNIT 1 PA FAN 2B A-C VOLTS HI SPEED CHANNEL #06 UNIT 1 PA FAN 2B A-C

IP12_005744

INTERMOUNTAIN POWER UNIT# 1 MAIN FOX 1/A

REQUESTED
08:13:19 07/05/91

REPORT # 21 W/O 91 98620 FOR JON CHRISTENSON

1. [illegible] DUCT PRESS
2. [illegible] 2A
3. [illegible]
4. [illegible]
5. PA FAN 2B MOTOR AMPS
6. PA FAN 2A MOT STATOR T
7. PA FAN 2B MOT STATOR T
8. GENERATOR 1 WATT XDCR 3
9.
10.
11.
12.

TIME	1 [illegible]	2 [illegible]	3 [illegible]	4 [illegible]	5 [illegible]	6 [illegible]	7 [illegible]	8 [illegible]	9	10	11	12
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]				
	[illegible]	74A	74A	007	[illegible]	[illegible]	85[illegible]	022				
	[illegible]		PCT	[illegible]	[illegible]	[illegible]	[illegible]					
06/21/[illegible]												
22: 0: 0	[illegible]	24.45	[illegible]	179.[illegible]	[illegible]	[illegible]	[illegible]	665.86	.00*	.00*	.00*	.00*
22: 5: 0	42.98	25.23	24.85	179.98	181.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.00*	[illegible]	.00*
22:10: 0	43.28	24.85	24.[illegible]	179.98	181.65	55.27	59.12	665.86	[illegible]	.00*	.00*	[illegible]
22:15: 0	4[illegible]12	25.10	25.37	179.98	181.65	55.27	5[illegible]	661.99	.00*	.00*	.00*	.00*
22:25: 0	43.10	25.45	25.50	179.98	181.[illegible]	54.26	58.11	661.99	.00*	.00*	.00*	.00*
22:30: 0	43.16	23.25	[illegible]3	179.98	181.65	54.26	58.11	640.20	.00*	.00*	.00*	.00*
22:35: 0	4[illegible]	25.05	24.80	179.98	181.65	54.26	58[illegible]	606.80	.00*	.00*	.00*	.00*
22:40: 0	42.78	25.68	24.75	179.98	181.[illegible]	53.24	58.11	583.59	.00*	.00*	.00*	.00*
22:50: 0	43.00	25.18	24.[illegible]	179.98	181.65	53.24	57.09	535.43	.00*	.00*	.00*	.00*
22:55: 0	4[illegible]	23.95	24.15	179.98	181.65	53.24	[illegible].09	513.28	.00*	.00*	.00*	.00*
23: 0: 0	43.78	21.12	21.27	170.82	[illegible]3.32	53.24	57.09	487.27	.00*	.00*	.00*	.00*
23: 5: 0	43.22	21.80	20.65	170.82	173.[illegible]	53.24	57.09	462.66	.00*	.00*	.00*	.00*
23:10: 0	42.78	20.95	21.63	170.82	173.32	52.23	57.09	436.6[illegible]	.00*	.00*	.00*	.00*
23:20: 0	43.40	21.05	20.87	170.82	173.32	52.23	56.08	389.88	.00*	.00*	.00*	.00*
23:25: 0	42.86	20.82	20.48	170.82	173.32	52.23	56.08	365.98	.00*	.00*	.00*	.00*
[illegible]0: 0	42.86	21.30	20.90	170.82	173.32	2.23	56.08	349.80	.00*	.00*	.00*	.00*
23:35: 0	43.32	18.98	18.07	170.82	173.[illegible]	52.23	55.07	338.20	.00*	.00*	.00*	.00*
23:40: 0	43.06	18.[illegible]	18.07	170.82	173.32	51.21	55.07	30[illegible]	.00*	.00*	.00*	.00*
23:45: 0	43.76	15.00	15.65	162.48	162.48	51.21	55.07	301.64	.00*	.00*	.00*	.00*
23:50: 0	43.10	14.45	14.03	162.48	162.48	51.21	54.05	301.64	.00*	.00*	.00*	.00*
[illegible]/22/91												
0: 0: 0	43.06	15.58	14.87	162.48	162.[illegible]	50.20	53.04	305.51	.00*	.00*	.00*	.00*
0: 5: 0	43.06	1[illegible].18	14.78	162.48	162.48	50.20	53.04	[illegible]1.64	.00*	.00*	.00*	.00*
0:10: 0	43.30	19.70	10.57	162.48	1[illegible].48	50.20	53.04	301.64	.00*	.00*	.00*	.00*
0:15: 0	43.10	2[illegible].30	.00	179.15	135.82	50.20	52.03	3[illegible].21	.00*	.00*	.00*	.00*
0:20: 0	41.50	31.18	.00	195.81	125.82	50.[illegible]	51.01	30[illegible].70	.00*	.00*	.00*	.00*
0:30: 0	37.58	35.70	.00	196.65	.00	51.01	47.97	[illegible]00.94	.00*	.00*	.00*	.00*
0:[illegible]: 0	39.12	36.10	.00	204.98A	.00	[illegible].27	46.96	300.94	.00*	.00*	.00*	.00*
0:40: 0	36.90	34.98	.00	196.65	.00	5[illegible].23	45.94	304.45	.00*	.00*	.00*	.00*
0:[illegible]: 0	37.18	35.62	.00	196.65	.00	52.23	45.94	300.94	.00*	.00*	.00*	.00*
0:[illegible]: 0	36.99	35.45	.00	196.65	.00	53.24	45.94	304.45	.00*	.00*	.00*	.00*
1: 0: 0	36.96	36.08	.00	196.65	.00	53.24	45.94	304.45	.00*	.00*	.00*	.00*
1: 5: 0	36.98	35.83	.00	196.65	.00	53.24	45.94	304.45	.00*	.00*	.00*	.00*
1:10: 0	37.00	35.85	.00	196.65	.00	53.24	45.94	304.80	.00*	.00*	.00*	.00*
1:15: 0	37.02	35.90	.00	196.65	.00	53.24	44.93	304.80	.00*	.00*	.00*	.00*
1:25: 0	37.10	35.80	.00	196.65	.00	53.24	44.93	301.29	.00*	.00*	.00*	.00*
1:30: 0	37.02	35.43	.00	196.65	.00	53.24	44.93	304.80	.00*	.00*	.00*	.00*
1:35: 0	36.96	35.65	.00	196.65	.00	53.24	43.92	304.80	.00*	.00*	.00*	.00*
1:40: 0	36.96	35.43	.00	196.65	.00	53.24	43.92	304.80	.00*	.00*	.00*	.00*
1:50: 0	36.86	35.70	.00	196.65	.00	53.24	43.92	303.40	.00*	.00*	.00*	.00*
1:55: 0	37.06	36.27	.00	196.65	.00	53.24	42.90	302.70	.00*	.00*	.00*	.00*

TEST # 1

IP12_005745

INTERMOUNTAIN POWER UNIT# 1 MAIN FOX 1/A

REQUESTED
08:18:32 07/05/91

REPORT # 21 W/O 91 98620 FOR JON CHRISTENSON

1. PA DUCT PRESS
2. PA FAN FLOW 2A
3. PA FAN FLOW 2B
4. PA FAN 2A MOTOR AMPS
5. PA FAN 2B MOTOR AMPS
6. PA FAN 2A MOT STATOR T
7. PA FAN 2B MOT STATOR T
8. GENERATOR 1 WATT XDCR 3
9.
10.
11.
12.

	TIME	1 COAXIO 72A INWC	2 COAXIO 74A PCT	3 COAXIO 75A PCT	4 SGBKKO 007 AMPS	5 SGBKKO 008 AMPS	6 SGBTEO 858 DEGC	7 SGBTEO 859 DEGC	8 TGBPKO 022 MW	9	10	11	12
	06/22/91												
TEST # 1	2: 0: 0	37.08	36.30	.00	196.65	.00	53.24	42.90	302.34	.00*	.00*	.00*	.00*
	2: 5: 0	37.00	35.62	.00	196.65	.00	53.24	42.90	302.34	.00*	.00*	.00*	.00*
	2:10: 0	37.08	29.50	.00	186.65	.00	52.23	42.90	279.49	.00*	.00*	.00*	.00*
	2:20: 0	36.82	32.03	.00	186.65	.00	52.23	41.89	309.37	.00*	.00*	.00*	.00*
	2:25: 0	36.88	34.65	.00	194.98	.00	51.21	41.89	302.34	.00*	.00*	.00*	.00*
	2:30: 0	37.06	33.62	.00	194.98	.00	51.21	41.89	302.70	.00*	.00*	.00*	.00*
	2:35: 0	36.42	38.50	.00	204.15A	.00	51.21	41.89	302.70	.00*	.00*	.00*	.00*
	2:45: 0	37.10	21.23	12.00	164.98	148.32	51.21	57.60	298.12	.00*	.00*	.00*	.00*
	2:50: 0	37.76	21.73	11.62	164.98	148.32	50.00	56.59	309.37	.00*	.00*	.00*	.00*
	2:55: 0	38.42	17.43	11.03	164.98	148.32	48.99	55.37	317.81	.00*	.00*	.00*	.00*
	3: 0: 0	38.28	16.68	10.93	164.98	148.32	48.99	54.15	311.84	.00*	.00*	.00*	.00*
	3: 5: 0	37.98	17.83	11.50	164.98	148.32	47.97	54.15	300.23	.00*	.00*	.00*	.00*
	3:15: 0	37.92	18.12	11.60	164.98	148.32	47.97	51.92	299.53	.00*	.00*	.00*	.00*
	3:20: 0	38.20	16.80	12.90	156.65	148.32	46.96	51.92	298.02	.00*	.00*	.00*	.00*
	3:25: 0	43.16	21.80	8.43	260.81A	147.48	57.09	50.91	301.[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3:30: 0	42.08	30.75	.00	294.14A	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	3:40: 0	37.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	00*
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45.[illegible]	[illegible]	[illegible]	.00*	.00*	.00*
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	45.84	303.75	.00*	.00*	.00*	.00*
	[illegible]	[illegible]	[illegible]	[illegible]	312.47A	.00	60.13	45.84	303.75	.00*	.00*	.00*	.00*
	[illegible]: 0	36.10	33.73	.00	312.47A	.00	61.15	44.83	303.75	.00*	.00*	.00*	.00*
	4:10: 0	35.98	34.23	.00	312.47A	.00	61.15	44.83	303.75	.00*	.00*	.00*	.00*
	4:15: 0	36.20	34.15	.00	312.47A	.00	62.16	44.83	303.75	.00*	.00*	.00*	.00*
	4:20: 0	35.96	34.50	.00	312.47A	.00	62.16	44.83	303.75	.00*	[illegible]	[illegible]	.00*
	4:25: 0	36.26	34.57	.00	312.47A	.00	62.16	[illegible]	[illegible]	.00*	.00*	.00*	.00*
	4:35: 0	36.20	34.55	.00	[illegible]	[illegible]	63.17	43.82	303.05	.00*	.00*	[illegible]	.00*
	4:40: 0	[illegible]	[illegible]	.00	312.47A	.00	63.17	[illegible]	[illegible]	.00*	.00*	.00*	.00*
	[illegible]: 0	36.18	34.23	.00	[illegible]	[illegible]	63.17	42.80	302.34	.00*	.00*	.00*	.00*
	[illegible]	[illegible]	[illegible]	.00	312.47A	.00	63.17	42.80	305.86	.00*	.00*	.00*	.00*
TEST # 2	[illegible]	36.28	34.55	.00	312.47A	.00	63.17	42.80	302.34	.00*	.00*	.00*	.00*
	5: 0: 0	35.90	34.33	.00	312.47A	.00	63.17	42.80	302.34	.00*	.00*	.00*	.00*
	5: 5: 0	36.12	34.42	.00	312.47A	.00	63.17	41.79	305.86	.00*	.00*	.00*	.00*
	5:15: 0	36.02	34.23	.00	312.47A	.00	64.19	41.79	306.21	.00*	.00*	.00*	.00*
	5:20: 0	36.02	35.27	.00	312.47A	.00	64.19	41.79	302.34	.00*	.00*	.00*	.00*
	5:25: 0	35.96	35.05	.00	312.47A	.00	64.19	40.78	302.34	.00*	.00*	.00*	.00*
	5:30: 0	36.06	34.45	.00	312.47A	.00	64.19	40.78	302.34	.00*	.00*	.00*	.00*
	5:35: 0	36.16	34.03	.00	312.47A	.00	64.19	40.78	302.34	.00*	.00*	.00*	.00*
	5:45: 0	37.52	15.63	14.43	151.65	149.15	62.16	57.30	302.34	.00*	.00*	.00*	.00*
	5:50: 0	38.98	.00	35.12	.00	197.48	58.11	56.28	302.34	.00*	.00*	.00*	.00*
	5:55: 0	37.26	.00	35.23	.00	205.81A	54.05	56.28	305.86	.00*	.00*	.00*	.00*

INTERMOUNTAIN POWER UNIT# 1 MAIN FOX 1/A

REQUESTED
08:22:55 07/05/91

REPORT # 21 W/O 91 98620 FOR JON CHRISTENSON

1. PA DUCT PRESS
2. PA FAN FLOW 2A
3. PA FAN FLOW 2B
4. PA FAN 2A MOTOR AMPS
5. PA FAN 2B MOTOR AMPS
6. PA FAN 2A MOT STATOR T
7. PA FAN 2B MOT STATOR T
8. GENERATOR 1 WATT XDCR 3
9.
10.
11.
12.

TIME	1 COAXIO 72A INWC	2 COAXIO 74A PCT	3 COAXIO 75A PCT	4 SGBKKO 007 AMPS	5 SGBKKO 008 AMPS	6 SGBTEO 858 DEGC	7 SGBTEO 859 DEGC	8 TGBDKO 022 MW	9	10	11	12
06/22/91												
6: 0: 0	37.08	.00	34.68	.00	205.81A	53.04	56.28	305.86	.00*	.00*	.00*	.00*
6:10: 0	37.00	.00	34.48	.00	197.48	53.04	56.28	301.99	.00*	.00*	.00*	.00*
6:15: 0	37.06	.00	34.85	.00	197.48	52.03	56.28	305.51	.00*	.00*	.00*	.00*
6:20: 0	37.08	.00	34.15	.00	197.48	52.03	56.28	300.23	.00*	.00*	.00*	.00*
6:25: 0	37.12	.00	34.85	.00	197.48	52.03	56.28	304.80	.00*	.00*	.00*	.00*
6:30: 0	37.02	.00	35.08	.00	197.48	52.03	56.28	304.80	.00*	.00*	.00*	.00*
6:40: 0	37.08	.00	34.63	.00	197.48	51.01	56.28	304.45	.00*	.00*	.00*	.00*
6:45: 0	37.10	.00	35.15	.00	197.48	51.01	56.28	304.45	.00*	.00*	.00*	.00*
6:50: 0	36.98	.00	34.23	.00	197.48	50.00	56.28	304.45	.00*	.00*	.00*	.00*
6:55: 0	36.98	.00	35.35	.00	197.48	50.00	56.28	300.94	.00*	.00*	.00*	.00*
7: 5: 0	36.86	.00	35.58	.00	197.48	48.99	55.27	305.51	.00*	.00*	.00*	.00*
7:10: 0	36.92	.00	34.68	.00	197.48	48.99	55.27	305.51	.00*	.00*	.00*	.00*
(M) 7:15: 0	36.98	.00	34.40	.00	197.48	47.97	55.27	305.51	.00*	.00*	.00*	.00*
7:20: 0	37.08	.00	34.87	.00	197.48	47.77	54.26	305.51	.00*	.00*	.00*	.00*
7:25: 0	37.06	.00	34.73	.00	197.48	47.77	54.26	301.64	.00*	.00*	.00*	.00*
7:35: 0	37.02	.00	34.83	.00	197.48	46.76	54.26	305.51	.00*	.00*	.00*	.00*
7:40: 0	37.10	.00	35.20	.00	197.48	46.76	54.26	305.51	.00*	.00*	.00*	.00*
7:45: 0	37.06	.00	34.83	.00	197.48	46.76	54.26	305.51	.00*	.00*	.00*	.00*
7:50: 0	37.08	.00	35.02	.00	197.48	45.74	54.26	304.80	.00*	.00*	.00*	.00*
8: 0: 0	37.10	.00	35.15	.00	197.48	45.74	54.26	304.80	.00*	.00*	.00*	.00*
8: 5: 0	41.56	10.75	21.98	140.82	275.80A	64.29	60.13	304.10	.00*	.00*	.00*	.00*
8:10: 0	36.76	.00	33.90	.00	308.30A	59.22	64.19	304.10	.00*	.00*	.00*	.00*
8:15: 0	36.06	.00	34.63	.00	316.64A	55.17	64.19	304.10	.00*	.00*	.00*	.00*
8:20: 0	36.10	.00	34.12	.00	316.64A	53.14	65.20	304.10	.00*	.00*	.00*	.00*
8:30: 0	36.18	.00	34.57	.00	316.64A	52.13	66.21	304.10	.00*	.00*	.00*	.00*
8:35: 0	35.96	.00	34.35	.00	316.64A	52.13	66.21	304.10	.00*	.00*	.00*	.00*
8:40: 0	35.98	.00	33.98	.00	316.64A	51.11	66.21	304.10	.00*	.00*	.00*	.00*
8:45: 0	35.96	.00	34.00	.00	316.64A	51.11	67.23	304.10	.00*	.00*	.00*	.00*
8:55: 0	36.08	.00	34.12	.00	316.64A	50.10	67.23	304.45	.00*	.00*	.00*	.00*
9: 0: 0	36.02	.00	33.55	.00	316.64A	50.10	67.23	304.45	.00*	.00*	.00*	.00*
9: 5: 0	36.00	.00	33.98	.00	316.64A	50.10	68.24	302.70	.00*	.00*	.00*	.00*
9:10: 0	35.80	.00	34.48	.00	316.64A	49.09	68.24	307.62	.00*	.00*	.00*	.00*
9:20: 0	35.98	.00	34.42	.00	316.64A	49.09	68.24	304.10	.00*	.00*	.00*	.00*
9:25: 0	36.02	.00	33.93	.00	316.64A	49.09	68.24	304.10	.00*	.00*	.00*	.00*
9:30: 0	36.10	.00	34.57	.00	316.64A	48.07	68.24	304.10	.00*	.00*	.00*	.00*
9:35: 0	36.28	.00	33.37	.00	316.64A	48.07	69.25	304.10	.00*	.00*	.00*	.00*
9:40: 0	36.28	.00	34.45	.00	316.64A	48.07	69.25	304.10	.00*	.00*	.00*	.00*
9:50: 0	36.00	.00	33.93	.00	316.64A	47.06	69.25	304.10	.00*	.00*	.00*	.00*
9:55: 0	36.08	.00	34.50	.00	316.64A	47.06	69.25	304.10	.00*	.00*	.00*	.00*
10: 0: 0	38.92	10.45	20.55	144.99	259.14A	64.79	68.24	304.45	.00*	.00*	.00*	.00*

TEST #

TEST 4

IP12_005747

INTERMOUNTAIN POWER UNIT# 1 MAIN FOX 1/A

REQUESTED
08:27:55 07/05/91

REPORT # 21 W/O 91 98620 FOR JON CHRISTENSON

1. PA DUCT PRESS
2. PA FAN FLOW 2A
3. PA FAN FLOW 2B
4. PA FAN 2A MOTOR AMPS
5. PA FAN 2B MOTOR AMPS
6. PA FAN 2A MOT STATOR T
7. PA FAN 2B MOT STATOR T
8. GENERATOR 1 WATT XDCR 3
9.
10.
11.
12.

TIME	1 COAXIO 72A INWC	2 COAXIO 74A PCT	3 COAXIO 75A PCT	4 SGBKKO 007 AMPS	5 SGBKKO 008 AMPS	6 SGBTEO 858 DEGC	7 SGBTEO 859 DEGC	8 TGBPKO 022 MW	9	10	11	12
06/22/91												
10: 5: 0	42.42	15.97	15.90	153.32	156.65	62.77	65.20	325.55	.00*	.00*	.00*	.00*
10:10: 0	42.90	15.93	16.15	153.32	156.65	60.74	62.16	333.98	.00*	.00*	.00*	.00*
10:15: 0	42.80	19.35	19.30	161.65	164.98	59.73	61.15	324.14	.00*	.00*	.00*	.00*
10:20: 0	43.08	19.85	19.98	161.65	164.98	58.71	59.12	332.58	.00*	.00*	.00*	.00*
10:30: 0	42.88	19.28	19.40	161.65	164.98	56.69	58.11	377.93	.00*	.00*	.00*	.00*
10:35: 0	43.00	19.98	19.03	161.65	164.98	56.69	57.09	396.56	.00*	.00*	.00*	.00*
10:40: 0	42.86	20.20	19.40	161.65	164.98	55.67	56.08	420.47	.00*	.00*	.00*	.00*
10:45: 0	42.88	20.55	20.12	161.65	164.98	54.66	56.08	451.41	.00*	.00*	.00*	.00*
10:50: 0	43.00	20.12	19.65	161.65	164.98	53.65	55.07	473.55	.00*	.00*	.00*	.00*
11: 0: 0	42.96	22.82	23.03	169.98	173.32	53.65	55.07	516.45	.00*	.00*	.00*	.00*
11: 5: 0	42.86	22.45	23.30	169.98	173.32	52.63	55.07	544.92	.00*	.00*	.00*	.00*
11:10: 0	42.96	23.45	23.18	169.98	173.32	52.63	55.07	566.02	.00*	.00*	.00*	.00*
11:15: 0	42.88	23.60	24.00	169.98	173.32	52.63	55.07	616.99	.00*	.00*	.00*	.00*
11:25: 0	43.12	25.32	25.18	178.32	181.65	52.63	55.07	689.41	.00*	.00*	.00*	.00*
11:30: 0	42.88	26.22	26.45	178.32	181.65	52.63	55.07	731.95	.00*	.00*	.00*	.00*
11:35: 0	43.12	25.65	26.25	178.32	181.65	52.63	55.07	752.70	.00*	.00*	.00*	.00*
11:40: 0	42.92	26.55	26.92	178.32	181.65	52.63	55.07	784.69	.00*	.00*	.00*	.00*
11:45: 0	43.06	26.15	26.77	178.32	181.65	52.63	55.07	816.68	.00*	.00*	.00*	.00*
11:55: 0	42.40	30.48	29.75	186.65	189.98	52.63	56.08	839.53	.00*	.00*	.00*	.00*
12: 0: 0	42.80	31.00	30.23	186.65	189.98	52.63	56.08	835.31	.00*	.00*	.00*	.00*

APPENDIX I

Black & Veatch letter June 2, 1992

BLACK & VEATCH

8400 Ward Parkway, P.O. Box No. 8405, Kansas City, Missouri 64114, (913) 339-2000

Intermountain Power Project
Intermountain Generating Station

B&V Project 15119
B&V File 806
June 2, 1992

Intermountain Power Service Corporation
1550 West Brush Wellman Road
Delta, UT 84624

Subject: Primary Air Fan Analysis

Attention: Mr. G. K. Hintze

Gentlemen:

This documents and summarizes discussions to date regarding our review of the Westinghouse Primary Air Fan Motor report dated February 26, 1992 which was transmitted by IPSC facsimile dated March 3, 1992.

The revised foundation loading included in Westinghouse's report for motor operation at 5000/3200 HP conditions does not exceed the existing foundation and anchor bolt design. The existing foundation is adequate for the indicated motor rerating.

We have reviewed the switchgear and electrical conductors based on switchgear data we have in-house and IPSC's confirmation that electrical conductors are 500 KCMIL 15 KV Type A. These components are capable of operation at the motor rerating of 5000/3200 HP. The ESCO transfer switch has a maximum listed capability of 400 amps, which is less than that required for rerated motor operation. However, IPSC has obtained confirmation from the manufacturer that the noted transfer switch is capable of operation continuously at 440 amps (attached facsimile). On this basis, the electrical components supplying the power to the Primary Air Fan motors are capable of continuous operation at the motor rerating of 5000/3200 HP.

We have attached copies of revised relay setting sheets 13 and 32 dated May 5, 1992 documenting the revised relay settings to reflect the motor rerating. The revised relay setting data sheets include marked up data to reflect continuous operation of the transfer switch at 440 amps.

If you have any questions regarding this information, please contact Steve Rus at (913) 339-2042.

Intermountain Power Service Corporation
Mr. G. K. Hintze

B&V Project 15119
June 2, 1992

Very truly yours,

BLACK & VEATCH

FOR

Paul F. Bannister

SER:skb
Enclosure

cc: Mr. J. Nelson w/enclosure
Mr. J. Chistensen w/enclosure
Mr. B. E. Blowey w/enclosure

6481

FAX TRANSMITTAL

TO: John CHRISTENSEN

COMPANY: INTERMOUNTAIN POWER CO.

FAX# 801-864-4970

FROM: WES COLBERT

COMPANY: POWELL-ESCO COMPANY
P.O. BOX 1039
GREENVILLE, TX 75403
PHONE# 903-455-6234
DALLAS: 214-442-7641

EXT 137

FAX# 903-455-3807

SUBJECT: 400 Amp SPEED CHANGER SWITCH

DATE: 5-15-92

NO OF PAGES: 1

John The 400 Amp RATED SWITCH WILL OPERATE AT 440 Amps Continuous LOAD WITH NO EFFECT ON The Unit.

WES COLBERT

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

PROJ. NO. 9255

SUMMARY OF
RELAY SETTINGS FOR
Intermountain Power Project

IGS Unit 1

6,900-Volt Unit Switchgear 1A2

SHEET NO. 13
MADE BY DJS
CKD. BY DEU
DATE 06/12/87
Revised 5-5-92
By WKC

BREAKER REFERENCE NUMBER	DESCRIPTION	RELAY SETTING		
		INDUCTION		INST.
		TAP	TIME DIAL	
7	Device 50-1, 1SGB-FAN-2A (Low Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		20 sec	4.1 x rating 328 amp primary
7	Device 50/51-1, 1SGB-FAN-2A (Low Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	7	4.8 x tap
7	Device 50-2, 1SGB-FAN-2A (High Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		30 sec	5.5 5 x rating 400 amp primary 440
7	Device 50/51-2, 1SGB-FAN-2A (High Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	8	8 x tap
7	Device 50G, 1SGB-FAN-2A Ground Overcurrent Relay, Instantaneous ITE GR5 202D6141UL 5-50 ampere pickup Reference: IB 18.1.7-2 Issue H		2 cycles	5.0 amp

BLACK & VEATCH
CONSULTING ENGINEERS
KANSAS CITY, MISSOURI

PROJ. NO. 9255

SUMMARY OF
RELAY SETTINGS FOR
Intermountain Power Project

IGS Unit 1

6,900-Volt Unit Switchgear 1B2

SHEET NO. 32
MADE BY DJS
CKD. BY DEU
DATE 06/12/87
Revised 5-5-92
By WKC

BREAKER REFERENCE NUMBER	DESCRIPTION	RELAY SETTING		
		INDUCTION		INST.
		TAP	TIME-DIAL	
6	Device 87M, 1SGB-MFAN-1B Phase Current Differential Relay, Instantaneous ITE 50H 238T0545 CT Ratio: 50/5 0.8-8 ampere pickup Reference: IB 18.2.7-5E			2 x rating
7	Device 50-1, 1SGB-FAN-2B (Low Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		20 sec	4.1 x rating 328 amp primary
7	Device 50/51-1, 1SGB-FAN-2B (Low Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	7	4.8 x tap
7	Device 50-2, 1SGB-FAN-2B (High Speed) Phase Overcurrent Relay, Instantaneous ITE 50D 238T3545 CT Ratio: 500/5 0.8-8 ampere pickup 1-30 second delay Reference: IB 18.2.7-5E		30 sec	5.5 5 x rating 400 amp primary 440
7	Device 50/51-2, 1SGB-FAN-2B (High Speed) Phase Overcurrent Relay, Long Time Inverse ITE 51IM 223T8541 CT Ratio: 500/5 2.5-5 ampere pickup (time) 2-20 times tap pickup (instantaneous) Reference: IB 7.2.1.7-1 Issue A	5.0 amp	8	8 x tap