500 KV SWITCHYARD VOLTAGE

References:

1. Surry Units 1 & 2 GDC 17 Analysis, Letter dated 3-31-82, S. N. 175 to H. R. Denton from R. H. Leasburg
2. Generator Capability Curves (Page 44 of Unit 2 Curve Book)
3. Unit 1 Control Room Operators Instrument Surveillance Log 2-PT-36, page 1 of 12.
4. Surry 500 KV Bus Voltage Schedule
5. Op-43.0, Generator Hydrogen System
6. FE 21A, 21F

1.0 Purpose

This procedure provides recommendations for corrective action to be taken in the event the 500 KV Bus Voltage schedule cannot be met. By adhering as closely as possible to the scheduled voltage, the basis for the GDC-17 analysis (505 KV-535 KV) will not be violated. By maintaining the voltage above 505 KV following a one or two unit trip, it has been demonstrated by analysis that the voltage on the station buses will be such to ensure the starting of all safety related equipment required under worst case conditions without transferring loads to the emergency diesels. By maintaining the voltage below 535 KV, it has been demonstrated by analysis that the voltage on the station buses will typically be such as not to exceed equipment ratings and hence not result in reduced equipment life.

2.0 Initial Conditions

2.1 The main generator is in service.

2.2 The generator voltage regulator is operating in automatic. If the regulator is operating in manual, extra operator attention may be required to maintain voltage schedule.

2.3 The control room operators are monitoring 500 KV Bus voltage in accordance with Attachment II. If the voltage is exhibiting instability or other evolutions are in progress which require the attention of the control room operator(s), enter computer alarm points at plus and minus 2 KV of the scheduled voltage. These alarm points will have to be updated each hour that the voltage schedule changes until the operators can resume their normal surveillance.

2.4 The actual 500 KV Bus voltage deviates by more than 2 KV from the scheduled voltage as noted on the Control Rm Operator's Instrument Surveillance Log, 2-PT-36.

3.0 Precautions and Limitations

3.1 Maintain H_2 pressure between 55 PSIG and 60 PSIG. Be prepared to increase generator pressure in order to attain full MVAR capability. This is especially important when operating the generator in the overexcited mode since at 55 PSIG, MVARs out are limited to 400 MVAR. Gas pressure must be increased to 60 PSIG before increasing MVARs out to ultimate limit of 430 MVAR.
NOTE: MVAR limitations specified in this procedure are for operation at 100% power. At lower power levels, the limits are higher (Reference Attachment I).

3.2 Monitor the generator core monitor closely during periods when the generator is being operated at high MVA loadings.

3.3 Limit generator amps to 24,713 at rated voltage of 22 KV.

3.4 The Summer continuous 90°C ratings for the 4 KV Cable between the Reserve Station Service Transformers and the Transfer Buses are as follows: 1684 Amperes for the cable on the secondary side of RSSTs A and C, 1624 Amperes for the cable on the secondary side of RSST B. During startup of one unit or within 1 hour of a one unit trip RSST loadings must be reduced below these ratings. With one unit in startup and one unit tripping or with two units tripping, RSST loadings must be reduced to 3000 Amperes within 30 minutes and to the specific cable ratings within 60 minutes.

3.5 Generator Output voltage shall be maintained between 20.9 KV and 23.1 KV.

3.6 The Unit 2 Station Service Buses 2B and 2C shall be operated between 4.0 KV and 4.4 KV. The 4.0 KV limit is based on limiting the stator temperature of the High Pressure Heater Drain Pump motors and most likely will be the limiting factor when operating a unit in the underexcited (MVARs in) mode. Station Service Bus 2A should normally be operated between 4.0 KV and 4.4 KV until operation between 3.6 KV and 4.0 KV has been demonstrated to be acceptable by further testing.

3.7 When operating the generator at a leading power factor (i.e. taking MVARs in), the MVAR limit shall be governed by the "Safe Operating Limit" on the generator capability curve unless directed otherwise by the System Operator. The Safe Operating Limit is a conservative limit for underexcited operation. Below this limit, there is the MEL (minimum excitation limiter) characteristic and the KLF (loss of field relay) characteristic. The MEL is a protective feature internal to the voltage regulator which will limit exciter field current to a predetermined level only when the regulator is

operated in automatic. If the regulator is operated in manual (Base Adjuster control), the MEL unit is not functional, and operation below the Safe Operating Limit could result in a KLF operation and unit trip without prior alarm. The control room operator has no means to know from the control room that the MEL unit has operated other than the fact that the regulator is not responding to demand for lowering voltage. Operation of the MEL unit can be verified locally at the regulator panel. The KLF relay protects the unit against a loss of stability by tripping the exciter field breaker and the generator output breakers. The curves for MEL and KLF plotted on Attachment I are for a generator voltage of 22 KV. As the voltage varies from 22 KV, the curves shift upward for voltages less than 22 KV and downward for voltages greater than 22 KV.

3.8 When operating the generator at a lagging power factor (i.e. putting MVARs out), the MVAR limit shall be governed by the generator capability curve. It will be necessary to increase generator hydrogen pressure to 60 PSIG in order to reach the limit of 430 MVARs out.

3.9 Although not shown on the generator capability curves, the regulator has internal to it certain alarm and protective circuits which protect the generator when operating in the overexcited mode. These circuits do not perform their functions until the generator is operating outside the 60 PSIG capability curve, and therefore, their characteristics are not overlayed on Attachment I. These circuits operate as follows:

3.9.1. Forcing alarm picks up via K4 relay. Forcing alarm senses the DC current from the regulator power amplifiers to the exciter through an isolation transducer. This is only an alarm (Ann. window J-7, "Excitation Field Forcing") and has no tripping function.

3.9.2 The OXP-2 circuit senses the same signal as the forcing alarm. It operates in the following manner:

3.9.2.1 K1 picks up on an initial overexcitation and starts an inverse time delay dependent on the level of overexcitation. K1 also runs the base adjuster to a predetermined position by use of cam switches. Note: While K1 is timing, the regulator is still in auto control and voltage adjustments may be attempted by using Voltage Adjuster control switch. Since the base adjuster unit is automatically running to a preset position which upon reaching this position illuminates the white light above the Base Adjuster control switch, do not adjust the Base Adjuster control switch during this time.

3.9.2.2 After time delay for K1 has timed out, K2 picks up and trips the regulator from auto to base control and alarms Ann. window J-23, "Voltage Regulator Auto Trip". A contact from K2 also alarms Ann. window J-8, "Overexcitation".

3.9.2.3 After a fixed time delay in base control (approx. 3 sec.) if the overexcitation condition still exists, K3 picks up and trips the exciter field breaker (Mach. Trip).

3.9.2.4 If the unit did not trip, place the auto voltage regulator to OFF and adjust voltage with the Base Adjuster. Notify the System Operator that the voltage on the machine is being controlled manually.

3.10 The loss of regulator sensing voltage supplied by the voltage regulator potential transformers (possibly caused by a blown fuse) will automatically trip the regulator from auto to base control accompanied by the alarming of Ann. Window J-62, "Gen PT Blown Fuse" and Ann. window J-23, "Voltage Regulator Auto Trip".

3.11 The lights above the Base Adjuster control switch provide the following information:

Green light - Base Adjuster output is at lower limit.
Red light - Base Adjuster output is at upper limit.
Amber light - Base Adjuster output is at no load pre-position level.
Any time the exciter field breaker is opened or the breaker is racked to the Disconnect or Test position, the Base Adjuster is run back to this predetermined position.
White light - Base Adjuster output is at full load pre-position level.
When the K1 relay in the overexcitation protection circuit is energized, the Base Adjuster is run back to this predetermined position.

3.12 The lights above the Voltage Regulator control switch provide the following information:

Green light - Regulator output is at lower limit
Red light - Regulator output is at upper limit
Amber light - Regulator output at intermediate level as determined by adjustable cam switch setting.

3.13 The modes of operation of the voltage regulator are as follows:

3.13.1 OFF (Green light illuminated) - The only control of machine voltage is by the Base Adjuster control switch. There is no feedback of actual voltage via the regulator to the Trinistat Firing Circuit and the MEL unit is not operational. Before closing into the system, variations in turbine speed will change generator voltage.

3.13.2 TEST (Amber light illuminated) - The Base Adjuster control switch is the only means to control generator voltage. The output of the regulator logic drawer is not connected to the Trinistat Firing Circuit. The Voltage Adjuster control switch can be used to balance the regulator output meter since its operation will not change generator voltage.

3.13.3 ON (Red light illuminated) - The Voltage Adjuster control switch is used to adjust the desired setpoint for generator voltage. The feedback intelligence circuit will compare actual voltage with desired voltage and generate the appropriate buck or boost signal to the Trinistat Firing Circuit to vary exciter field current. The Base Adjuster control switch can be used to balance the regulator output meter since its operation will not change generator voltage.

3.14 The voltage regulator "balance volts" should be maintained at 0 using the appropriate control switch. When operating with the voltage regulator control switch in "ON", balancing should be done by using the Base Adjuster control switch. With the voltage regulator switch in "OFF", the switch must be placed in "TEST" before balancing using the Voltage Adjuster control switch. These operations will not cause generator voltage to change. They ensure that the voltage regulator output signal will not be overranged and will permit full regulator action under transient conditions.

3.15 There exists the possibility that the tertiary of the 500/230/36.5 KV autotransformers (rated for 97.7 MVA at a 55°C winding temperature rise) could become overloaded when the reactor banks on the 34.5 KV buses are in service. At 85 MVA loading, the System Operator will receive an alarm and will notify the Shift Supervisor of the condition. The station should remove one reactor bank at a time from service until the alarm clears. This action shall be taken within 30 minutes of the time the System Operator contacts the station.

3.16 There exists the possibility that the 230/36.5 KV transformer (rated for 112 MVA) could become overloaded when it is feeding a 34.5 KV Bus with reactor banks in service. At 95 MVA loading, the System Operator will receive an alarm and will notify the Shift Supervisor of the condition. The station should remove one reactor bank at a time from service until the alarm clears. This action shall be taken within 30 minutes of the time the System Operator contacts the station.

Initials

4.0 Procedure

4.1 Corrective actions to be taken in the event 500 KV voltage is sagging below scheduled voltage (Attachment II).

_____ 4.1.1 Initial conditions are noted and satisfied.

_____ 4.1.2 Precautions and Limitations are noted.

_____ 4.1.3 Verify generator core monitor is energized.

NOTE: The following steps assume the regulator is in automatic. If the regulator is operating in manual, the Base Adjuster control switch must be used to raise generator voltage.

_____ 4.1.4 Use Voltage Adjuster control switch in the raise direction to attempt to increase 500 KV voltage to scheduled value. This will tend to increase the outward flow of VARS from the generator.

CAUTION: Reference Attachment I and Precaution and Limitation 3.1.

_____ 4.1.5 If the 500 KV Bus voltage falls more than 4 KV below scheduled, start taking hourly readings of the 500 KV Bus voltage and record data on Attachment III. Continue to adjust the Voltage Adjuster control switch in the raise direction as required in an attempt to meet the scheduled voltage.

_____ 4.1.6 If the 500 KV Bus voltage falls to 515 KV, verify that the 34.5 KV reactor banks are out of service. If they are in service, notify the System Operator before removing them from service.

_____ 4.1.7 Review Precautions and Limitations 3.5, 3.6, 3.8, and 3.9. At any time these limitations prevent increasing MVAR output of generator, notify the System Operator and document the reason on Attachment III.

_____ 4.1.8 If 500 KV Bus voltage falls to 514 KV, increase generator hydrogen pressure to 60 PSIG if not already done.

_____ 4.1.9 If the 500 KV Bus voltage falls to 512 KV, make sure the generator is being operated at the limit of 430 MVARs out unless other restrictions prohibit such operation.

NOTE: At 510 KV on the Surry 500 KV Bus, the System Operator will receive a computer data acquisition alarm. He will refer to Page 11.01(2) of the System Operators' Procedures Manual and initiate system level actions as specified in his procedure.

_____ 4.1.10 If voltage continues to drop below 511 KV and all actions above have been taken, immediately notify the System Operator.

_____ 4.1.11 Continue to log the information as started in Step 4.1.5 on Attachment III on an hourly basis until the 500 KV Bus voltage returns to scheduled voltage ±2 KV.

Completed By: _____

Date: _____

Initials

4.2 Corrective actions to be taken in the event 500 KV voltage is rising above scheduled voltage (Attachment II).

_____ 4.2.1 Initial conditions are noted and satisfied.

_____ 4.2.2 Precautions and Limitations are noted.

_____ 4.2.3 Verify generator core monitor is energized.

NOTE: The following steps assume the regulator is in automatic. If the regulator is operating in manual, the Base Adjuster control switch must be used to lower generator voltage.

_____ 4.2.4 Use Voltage Adjuster control switch in the lower direction to attempt to decrease 500 KV voltage to scheduled value. This will tend to increase the inward flow of MVARs from the system.

CAUTION: Reference Attachment I. Operation of the regulator in Base Adjuster control beyond the Safe Operating Limit requires prior System Operator approval (See Step 4.2.10).

_____ 4.2.5 If the 500 KV Bus voltage increases to more than 4 KV above scheduled, start taking hourly readings of 500 KV Bus voltage and record data on Attachment III. Continue to adjust the Voltage Adjuster control switch in the lower direction as required in an attempt to meet the scheduled voltage.

_____ 4.2.6 If the 500 KV Bus voltage increases to 520 KV, verify that the 34.5 KV reactor banks are in service. If they are out of service, notify the System Operator before placing them in service.

NOTE: Refer to Precaution and Limitation 3.15 and 3.16.

_____ 4.2.7 Review Precautions and Limitations 3.5, 3.6, and 3.7. At any time these limitations (especially the 4 KV limit on Station Service Buses) prevent increasing MVAR intake of the generator, notify the System Operator and document the reason on Attachment III. See Step 4.2.13 for further action.

_____ 4.2.8 If the 500 KV Bus voltage increases to 525 KV, increase generator hydrogen pressure up to 60 PSIG (Max.) as required. Note that higher pressures will not be required unless the generator is to be operated beyond the Safe Operating Limit (Reference Attachment I) or generator temperatures dictate the higher pressure.

_____ 4.2.9 If the 500 KV Bus voltage increases to 528 KV, make sure the generator is being operated at the Safe Operating Limit of 210 MVARs in provided the regulator is operating in automatic.

If generator output voltage drops sufficiently, the MEL unit may operate before reaching 210 MVAR in as explained in Precaution and Limitation 3.7.

NOTE: At 530 KV on the Surry 500 KV Bus, the System Operator will receive a computer data acquisition alarm. At this point, he will refer to Page 11.01(5) of the System Operators' Procedures Manual and initiate system level actions as specified in his procedure.

_____ 4.2.10 If the 500 KV Bus voltage increases above 528 KV, notify the System Operator that the generator is operating at the Safe Operating Limit of 210 MVARs in or is limited by the MEL unit as the case may be. If the regulator is operating in automatic and the MEL has not already limited MVARs in, the station will be authorized to operate beyond the Safe Operating Limit with concurrence of the Shift Supervisor. If the regulator is operating in manual (ie. Base Adjuster control), the System Operator will be responsible for authorizing operation beyond the Safe Operating Limit. Note authorized higher limit: _____.

CAUTION: If regulator is being operated in manual, the MEL unit is not functional (Reference Precaution and Limitation 3.7).

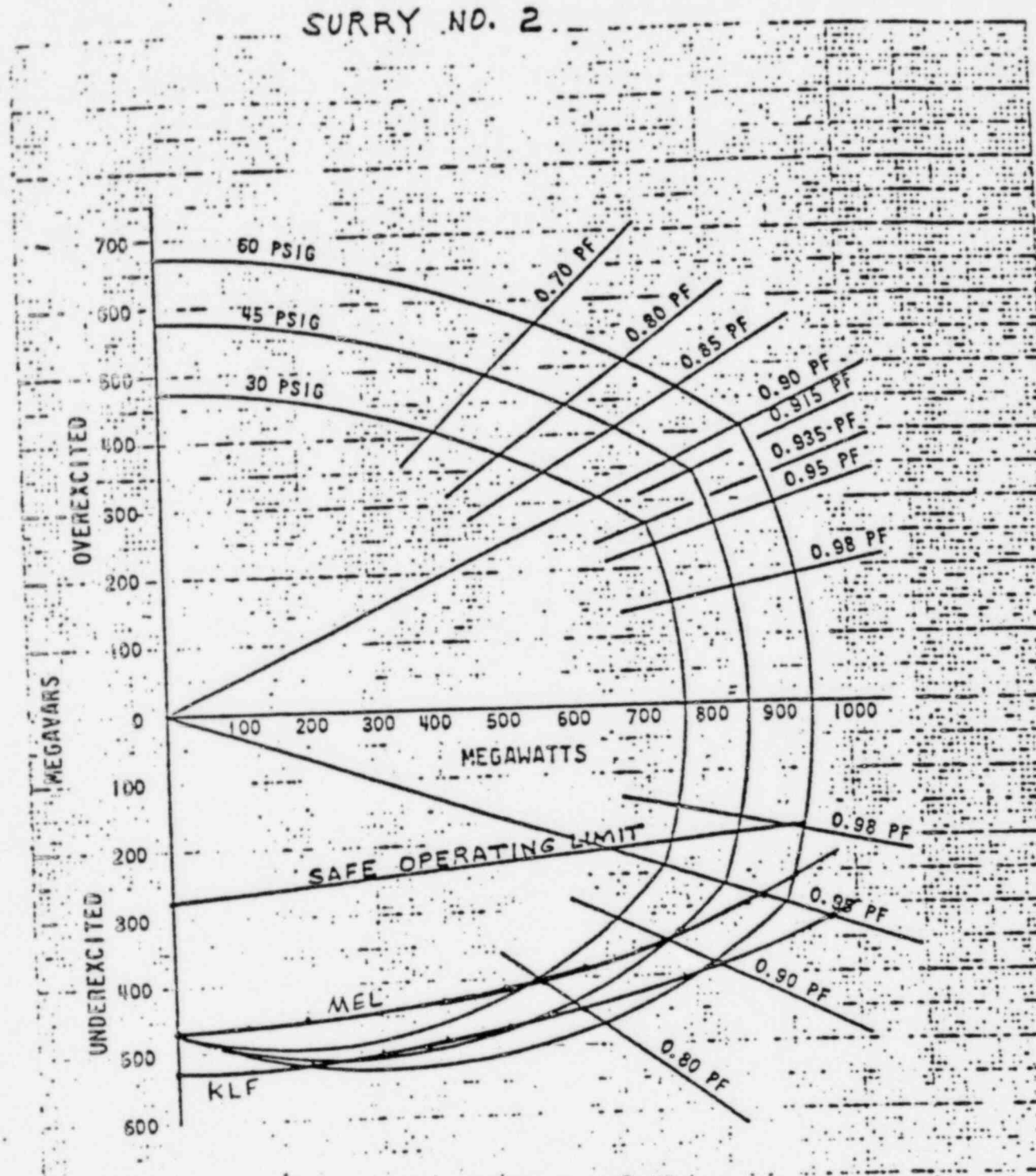
_____ 4.2.11 When operating beyond the Safe Operating limit, increase the MVAR loading in 5 MVAR increments being careful to zero the "Regulator Balance Volts" meter after each increase using the Base Adjuster control switch. Use Voltage Adjuster if in manual regulator operation . If during this process of increasing the MVARs in, the MEL unit operates, the regulator will not respond to a demand signal for lowering voltage, and the generator will not take in any additional MVARs. Confirm that the MEL unit has operated by checking at the local regulator panel.

_____ 4.2.12 Notify the System Operator that the MVAR loading on the generator is limited by the regulator MEL unit. Record the MVAR limit on Attachment III.

_____ 4.2.13 Continue logging the information as started in Step 4.2.5 on Attachment III on an hourly basis until the 500 KV Bus voltage returns to scheduled voltage ±2 KV.

Completed By: _____

Date: _____



HYDROGEN INNER-COOLED TURBINE GENERATOR

CALCULATED CAPABILITY CURVES

941,700 KVA, 0.90 PF, 0.58 SCR, 60 PSIG, 3 PH

60 CYCLES, 1800 RPM

$I_{FL} = \frac{941,700}{(\sqrt{3})(22)} = 24,713$

APPROVED J.W. Wilson

CHAIRMAN, SURRY POWER STATION
NUCLEAR SAFETY AND OPERATING
COMMITTEE

DATE APR 10 1981

Curve 820411 Capability Curve FIG. 1

VIRGINIA ELECTRIC AND POWER COMPANY
VOLTAGE SCHEDULE

STATION Surry VOLTAGE 500 kV

Monday - Friday			Saturday - Sunday - Holiday		
Time	Schedule Voltage (KV)	On/Off Peak	Scheduled Voltage (KV)	On/Off Peak	Time
1:00 A	515	off	515	off	1:00 A
2:00 A	515	off	515	off	2:00 A
3:00 A	515	off	515	off	3:00 A
4:00 A	515	off	515	off	4:00 A
5:00 A	515	off	515	off	5:00 A
6:00 A	515	off	515	off	6:00 A
7:00 A	520	on	515	off	7:00 A
8:00 A	520	on	515	off	8:00 A
9:00 A	520	on	515	off	9:00 A
10:00 A	520	on	515	off	10:00 A
11:00 A	520	on	515	off	11:00 A
12:00 N	520	on	515	off	12:00 N
1:00 P	520	on	515	off	1:00 P
2:00 P	520	on	515	off	2:00 P
3:00 P	520	on	515	off	3:00 P
4:00 P	520	on	515	off	4:00 P
5:00 P	520	on	515	off	5:00 P
6:00 P	520	on	515	off	6:00 P
7:00 P	520	on	515	off	7:00 P
8:00 P	520	on	515	off	8:00 P
9:00 P	520	on	515	off	9:00 P
10:00 P	515	off	515	off	10:00 P
11:00 P	515	off	515	off	11:00 P
12:00 M	515	off	515	off	12:00 M

Authorized by: R. W. Ellis Manager-Power Supply Dept.
Date Effective: 6/7/82 Supersedes Schedule Dated 8-20-80

Notes:
1) All voltage changes should be made in the 10 minute period prior to the hour.
2) Only the following days will be considered as holidays: New Years Day, Memorial Day, Fourth of July, Labor Day, Thanksgiving Day, Christmas Day
3) In addition to days specified in (2) the system operator may designate holiday schedule for any other appropriate day.

SURRY

DEVIATION LOG
500KV Voltage Schedule

Purpose: Record Data as required by 2-OP-26.5 whenever 500 KV Bus Voltage deviates by more than 4 KV from scheduled voltage.

UNIT	TIME	500KV		GEN		EXCITER		STATION SERVICE BUS(4K.V-4.4K.V)						REMARKS IF OTHER THAN STATION SERVICE VOLTAGE LIMITS	
		ACTUAL	SCHEDULE	VOLTS	VARS	VOLTS	AMPS	A VOLTS	AMPS	B VOLTS	AMPS	C VOLTS	AMPS		DATE

ADDITIONAL ADMINISTRATIVE LIMITS

NOTE: Until directed otherwise, at the end of each month, forward one copy of each completed Deviation Log to Director Power Supply Technical Services (4th Floor, OJRP). Questions related to the use of log should be directed to Phil Powell on Ext. 4343.