ARIZONA PUBLIC SERVICE COMPANY

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August 17, 1981
ANPP-18670 - JMA/KWG

Mr. R. L. Tedesco
Assistant Director for Licensing
Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Palo Verde Nuclear Generating Station
(PVNGS) Units 1, 2 and 3
Docket Nos. STN-50-528/529/530
File: 81-056-026

Reference: Your letter of June 17, 1981, Subject:
Draft SER Input, AC Power Systems

Dear Mr. Tedesco:

Please find attached our responses to the open items identified in your letter. Also attached is a marked-up copy of the FSAR sections referenced, as they will be incorporated in a future amendment.

Please contact us if you have any questions on this matter.

Very truly yours,

E. E. Van Brunt

E. E. Van Brunt, Jr.
APS Vice President,
Nuclear Projects
ANPP Project Director

EEVBJr/KWG/av
Attachments
cc: J. Kerrigan (w/a)
P. Hourihan (w/a)
A. C. Gehr. (w/a)

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1/1
Aperture Dist:
SEND DRAWINGS for
PM

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

I, Edwin E. Van Brunt, Jr., represent that I am Vice President, Nuclear Projects of Arizona Public Service Company, that the foregoing document has been signed by me on behalf of Arizona Public Service Company with full authority to do so, that I have read such document and know its contents, and that to the best of my knowledge and belief, the statements made therein are true.

Edwin E. Van Brunt

Edwin E. Van Brunt, Jr.

Sworn to before me this 17th day of AUGUST, 1981.

Connie Lou Armstrong

Notary Public

My Commission Expires:

June 24, 1983

The following are comments on paragraphs 1 and 2, page 26 of the draft SER:

Paragraph 1: The motor control center main bus feeder breaker is not used for backup protection because of its large rating relative to the individual load breaker ratings.

Paragraph 2: The response to Regulatory Guide 1.63, item D states that low-voltage control circuits are self-limiting so that the circuit resistance limits the fault current to a level that does not damage the penetration. In addition, these circuits are fused for backup protection.

QUESTION 6A.1 (AC Power SER Item 1)

Final approval of the overall off-site power system is withheld pending receipt of the following additional information.

1. A discussion of transmission line right-of-ways, height as well as spacing between transmission towers, etc.

2. Physical layout drawings of the circuits that connect the on-site distribution system to the off-site power system.

3. A description of the instrumentation provided for monitoring and indicating the status of the off-site power system and switchyard batteries.

RESPONSE:

Item 1. The following drawings have been provided to the NRC in response to this request.

1. Overall map showing the Transmission System 500kV lines.

2. Drawing K-675-503. Palo Verde/Kyrene line route map.

3. Bechtel Drawings 13-E-ZYP-012; ZVU-009 & 13-C-ZVA-001 showing line routing on the plant property.

4. Typical tower, pole and double tower right-of-way usage.

The plan and profile sheets for the Palo Verde/Kyrene line show the double right-of-way obtained for a portion of the line length for a future Saguaro line. Right-of-way acquisition beyond this common corridor has not yet been acquired.

Item 2. The circuits connecting the on-site distribution system to the off-site power system are shown in drawings 13-E-ZYP-012 Rev. 3 and 13-E-ZVU-009 Rev. 10, which have been provided to the NRC.

Item 3. The instrumentation provided for monitoring and indicating status of the off-site power system is presented in the following drawings, which have been provided to the NRC:

A. Bechtel Drawings -- 13-E-MAA-001 Rev. 4
01-E-NAA-001 Rev. 3
01-E-NAA-002 Rev. 3
02-E-NAA-001 Rev. 2
02-E-NAA-002 Rev. 3
03-E-NAA-001 Rev. 2
03-E-NAA-002 Rev. 3
13-E-NAA-003 Rev. 3
13-E-PBA-001 Rev. 3
13-E-PBA-002 Rev. 3

B. Vendor Drawings -- J200-205
J200-206
J200-263
J200-264
J200-265

<u>QUESTION 6A.2</u> (AC Power SER Item 2)

Revise the FSAR to include switchyard components for testing and perform periodic inspectuib and maintenance on all the switchyard and on-site power components.

RESPONSE: The auxiliary power system at the Palo Verde Switchyard consists of two redundant 13.8kV feeds from separate buses in the plant, a unit substation containing two 13,800/480 volt transformers, automatic transfer switch and 480 volt feeder breakers, and various 480 volt distribution panels, 480-240/120 volt transformers and 240/120 volt distribution panels. The dc auxiliary power system consists of two redundant 125 volt batteries and chargers for breaker control, two grounded 48 volt batteries and chargers for relay communications and two ungrounded 48 volt batteries and chargers for relay operations.

A maintenance crew will be on-site once a month for a routine inspection. At this time, the distribution panels and the unit substation are opened and inspected for any breaker operation or malfunction and the transformers are visually inspected for oil leaks or any other sign of damage that could impair the operation of the equipment. Oil level or temperature gauge readings are made and recorded. Any abnormalities identified during the inspection will result in immediate isolation of the problem and repair or replacement of defective parts.

The maintenance crew will also perform battery maintenance during the monthly inspection. At this time, a visual inspection of all the cells is made. Addition of water or cleaning of terminals is done as required. A voltage and specific gravity reading from a pilot cell in each battery bank is taken and recorded. Also, a spot check of several cell voltages is made to see if an equalizing voltage is required. If so, the charger is set at an elevated equalizing voltage with an automatic timer that returns the voltage to normal after 24 hours. Every six months all of the cells have the voltage and specific gravity measured and recorded.

The battery chargers are inspected during the monthly inspection. Each battery charger is equipped with a low dc and loss of ac alarm. Any alarm received will result in an immediate dispatch of a troubleshooter to determine the problem and correction required. A repair crew will be dispatched if required.

The automatic transfer switch is inspected monthly by a maintenance crew. Also monthly, the station load is switched from the normal to the standby 13.8kV source and the transfer back to the normal source after the time delay relay times out is verified. Once a year the transfer switch is cleaned and the contacts are checked for wear and proper alignment with adjustments made as required. The relays in the Unit Substation are maintained and recalibrated once a year.

Except for the batteries, the auxiliary power system is a low maintenance system. The maintenance program outlined above has resulted in high reliability for substation auxiliary power systems. The only other maintenance anticipated would be for component failure, which would be quickly responded to on an as required basis.

This information will be incorporated into a future FSAR amendment as well as that shown in amended section 8.2.1.3.2.

<u>QUESTION 6A.3</u> (AC Power SER Item 3)

Provide the transmission load flow diagram associated with the transient stability cases assumed in the FSAR.

RESPONSE: The load flow diagram has been submitted to the NRC.

<u>QUESTION 6A.4</u> (AC Power SER Item 4)

We require that new diesel generator designs to be used in nuclear power plant service undergo a reliability establishment testing program in accordance with IEEE-387. The applicant should submit the results of the reliability testing program for our review.

RESPONSE: A reliability testing program was performed on emergency diesel generator 1-M-DGB-H01, serial number 7183 at the manufacturer's shop during July 7, 1978 through September 10, 1978. The test period included standard shop tests to determine fuel and oil consumption, checkout and engine break in.

The report of the tests was provided by the manufacturer, Cooper Energy Services. following are excerpts from that report. Included is the time to rated speed for the first 24 starts. All starts reached rated speed between 5.6 and 5.9 seconds.

Requirement:

A total of at least 300 start and load tests shall be conducted to demonstarte reliability. A failure rate in excess of one per 100 will require complete retesting and a review of the system design adequacy.

a. 90% of the start and load tests will be performed with lube oil and jacket water temperatures initially at 120°F ± 10°F. The engine-generator set must achieve rated frequency and voltage within 10 seconds of the start initiation signal and be loaded to 2750 KW (resistive) min within 20 seconds of the start initiation signal. 2750 KW min load will be maintained until the engine jacket water and lube oil temperatures do not vary more than ±5F from design within a 5-minute interval. The engine will then be shut down and force cooled until jacket water and lube oil temperatures are less than 130°F at which time the next test cycle may begin.

b. 10% of the start and load tests will be performed from design hot equilibrium temperature conditions. The engine-generator set will be operated at 100% load for eight (8) hours to establish the required equilibrium condition. The engine will then be shut down.

The engine will be started and loaded within limits outlined in (a) above. After verification that jacket water and lube oil temperatures are within the required limits, the engine will then be shut down and the next test cycle may begin. If the engine is down for an extended period of time, the engine must be operated at 100% load to reestablish the design hot equilibrium temperature conditions.

Discussion

The test was started on August 25, 1978, and successfully completed on September 10, 1978 with a total of 303 starts.

Cooling the engine was accomplished with the engine running. to force cool the engine between starts, temporary valving was added to oil and jacket water piping to by-pass the oil and water thermostats.

During each official start and load test the thermostats were operative.

Starts No. 1 through 271 were cold starts.

Starts No. 272 through 303 were hot starts.

Before running the hot starts the engine was run for 8 hours at 100% load to establish the hot temperature conditions. During the 8-hour run the thermostats in the oil and water systems were operative.

Discussion of Starts Not Counted:

During the start and load tests the following starts were not counted because they resulted from shop facility equipment problems, operator error or from intermittent circuit operation of equipment which is by-passed when in the LOCA mode. This is in accordance with Regulatory Guide 1.108 paragraph B.2.e.2.

Between starts No. 14 and 15 a good start was made but not counted. A facility power failure in our shop caused a shutdown before the temperature stabilization run under load was completed.

Between starts No. 104 and 105 a good start was made bu not counted becasue of an incomplete Visicorder chart. This was an operator mistake in running the Visicorder.

Between starts No. 165 and 166 a second start failure occurred with an incomplete sequence light indication on the engine panel. this was not counted as a failure as the problem was identified as the same as in the previous start failure.

Between starts No. 166 and 167 a good start was made but not counted becasue of an incomplete Visicorder chart. This was an operator mistake in running the Visicorder.

Between starts No. 215 and 216 a good start was made but not counted because of an operator mistake in setting up the shop facility switchgear for automatic operation. Only two steps of the three step loading came on resulting in low load during the temperature stabilization run.

During start No. 238 and through the remaining starts the voltage trace on the Visicorder chart does not appear. This is because of a failure in the recording equipment which has no effect on the engine-generator set operation.

Between starts No. 251 and 252 a good start was made but not counted because of an operator mistake in adjusting the water rheostats for the proper load. The load was too light.

Investigation of Circuitry Problems:

In accordance with Regulatory Guide 1.108, the following tests were made to pinpoint problem circuitry.

a. After the start failure between starts No. 155 and 156, five trial engine starts were made to see if the problem would repeat or if it was intermittent. They were all successful but were not counted because they were not continued through the loaded part of the official tests.

b. After the start failure between starts No. 165 and 166, the failures were judged to be an intermittent fiber optics component or a contact associated with 2-68B1 alarm shutdown by-pass timer and the following action taken to confirm that judgement.

   1. After all wire connections were checked for tightness, air to the engine was shut off and 32 starts simulated without starting the engine. All were good starts.

   2. Several trials were then made to show that the suspected fault would have caused the problem. This was done by removing the wire from contact 4 of 2-68B1 on some trial starts.

1st Trial	-	DGS Mode - wire connected - good start.
2nd Trial	-	DGSS Mode - wire disconnected.
3rd Trial	-	Incomplete sequence light came on and
4th Trial	-	unit failed to start.
6th Trial	-	LOCA Mode - wire disconnected.
7th Trial	-	Incomplete sequence light came on and unit made a good start.

3. Instrumentation was added to the Visicorder to monitor 268B1 relay and the fiber optics components associated with this circuit in order to pinpoint the problem if any further shutdowns should occur. However, no more shutdowns occurred during the remainder of the start and load tests.

START & LOAD TEST DATA
(From Visicorder Charts)

Start No.	Time to 600 RPM Sec.	Step 1 KW	Step 2 KW	Step 3 KW	Total Load KW	Time to Step 3
1	5.6	1175	850	775	2800	15.2
2	5.8	1550	800	650	3000	15.3
3	5.9	1100	1100	900	3100	15.5
4	5.6	1550	900	800	3250	15.3
5	5.7	1675	925	750	3350	15.2
6	5.7	1800	850	750	3400	15.0
7	5.7	1775	825	700	3300	14.6
8	5.7	1775	825	700	3300	14.5
9	5.7	1750	800	700	3250	14.7
10	5.7	1750	850	650	3250	14.5
11	5.8	1750	725	775	3250	14.6
12	5.8	1650	900	725	3275	14.6
13	5.8	1675	825	800	3300	14.6
14	5.7	1750	850	700	3300	14.5
15	5.7	1150	1100	1000	3250	14.6
16	5.9	1500	950	950	3400	14.7
17	5.8	1800	850	750	3400	14.7
18	5.8	1800	950	700	3450	14.7
19	5.8	1800	850	750	3400	14.8
20	5.7	1800	850	750	3400	14.6
21	5.7	1800	800	750	3350	14.7
22	5.7	1700	850	750	3300	14.6
23	5.7	1550	750	700	3000	14.7
24	5.8	1650	850	700	3250	14.7

QUESTION 6A.5 (AC Power SER Item 5)

Local and control room alarms are provided for each diesel generator. The local annunciator provides first out indication for all alarms initiated by the diesel generator protective devices; this conforms with the guidance of Regulatory Guide 1.9, position C.8 and is acceptable. The control room annunciation consists of single input alarms and common alarms. In addition the following alarms are annunciated on the control room Safety Equipment Status annunciator for each diesel generator:

1. Diesel generator inoperable.

2. Diesel generator failed to start.

The applicant should provide additional information in this area.

RESPONSE: The response is given in amended section 8.3.1.1.4.10.

QUESTION 6A.6 (AC Power SER Item 6)

Revise the separation criteria in the following areas:

a. Where cable of different separation groups approach the same or adjacent control panels with less than the minimum horizontal and vertical separation distance, isolation is maintained by installing cables of one of the separation groups in metallic conduit. this is inconsistent with the recommendations of IEEE-384 and is unacceptable. Therefore, we require that cables of both separation groups be installed in metallic conduit or a barrier be installed between separation groups.

b. If a 6-inch minimum physical separaton between two separation groups inside the control boards or other panels cannot be maintained, the cables of at least one of the separation groups

is installed in an enclosed raceway. This is inconsistent with the recommendations of IEEE-384 and is unacceptable. Therefore, we require that 1) cables of both separation groups be installed in enclosed raceways or, 2) a barrier be installed between separation groups, or, 3) provide an analysis to justify that the separation is adequate.

Also, the applicant should document the interval at which these cables and raceways are marked for physical identification.

RESPONSE: The response is given in amended FSAR sections 8.3.1.3, 8.3.1.4.1.1, and 8.3.1.4.1.2.

<u>QUESTION 6A.7</u> (AC Power SER Item 7)

Based on our evaluation of the information provided by the applicant, we conclude that in order to accept current limiting transformers as isolation devices we require a clear demonstration that these transformers are current limiting under faulted conditions and their limiting current will not compromise the remainder of the Class 1E system. In addition, we also require the applicant to provide a discussion of those non-Class 1E circuits that are connected to the Class 1E batteries.

RESPONSE: IEEE 384 Section 6.1.2.3 states "devices which will limit the input current to an acceptable value under faulted conditions of the output qualify as isolation devices .... Note: Devices in this category may include inverters, regulating transomers, "... etc. Voltage requlators used in PVNGS utilize a ferro-resonant transformer, which operates at saturated (magnetic core) condition and has current limiting characteristics in the overload region.

The transformer supplier has stated that "the current on the primary when a bolted short is applied to output is less than the high line full load primary current." This statement is based on supplier's review of test data sheets for this equipment.

Non-Class 1E dc loads are not fed from Class 1E dc buses.

<u>QUESTION 6A.8</u> (AC Power SER Item 8)

Part A

It is stated in the FSAR that separate control power is not required for these breakers. We disagree with this statement and require that control power from separate sources be provided to the load feeder breakers and bus feeder breakers so that failure of either source will not violate the single failure criterion.

RESPONSE: The statement in the FSAR is correct in that load center breaker overcurrent trip is independent of the 125V dc (control) power. Breaker trip units are direct acting, i.e. "Breaker Latch Release is powered by the line overcurrent."

The direct-acting trip device is an adjustible dual magnetic direct acting overcurrent apparatus which relies on the current flowing through the circuit breaker to provide the required tripping power in the event of short circuits or locked rotors in motors. Since the unit is self contained, no external dc or ac control power is required for protective tripping. The direct-acting trip device monitors the current flowing in each phase and employs a dual aramature, one of which is connected to an oil displacement dashpot, to provide long time delay for stalled or locked induction motors. The second armature provides an instantaneous trip function for short circuits.

Part B

For circuits fed from motor control centers, the load feeder breaker is coordinated with, and backed up by, the bus feeder breaker, control power of bus feeder breakers is separate from that of load feeder breakers.

The low-voltage control systems, power circuits and high energy level control circuits use self fusing characteristics of field cables to ensure that under all circumstances the penetration maintain its integrity. We have informed the applicant that this is unacceptable; we do not permit self fusing of cables as backup protection. Subsequently, the applicant committed to provide two breakers in series for each control circuit that passes through a containment penetration.

We have reviewed the above information and conclude that the applicant has not provided enough information on this subject for us to make an evaluation, therefore, we would require the applicant to provide the following additonal information on this subject.

1. A discussion of (1) the direct current circuits and (2) circuits that are required for short periods of time during startup refueling or a maintenance shutdown that pass through the containment penetrations and describe how these circuits meet the guidance of Regulatory Guide 1.63 position 1.

2. Submit time-current characteristic curves of protective devices provided for each size of penetration to demonstrate that adequate time-current coordination exists between the motor primary and backup protection devices and the penetration itself.

3. A commitment to periodically test the primary and secondary protective devices.

RESPONSE: Refer to amended Section 1.8, describing PVNGS compliance with Regulatory Guide 1.63.

Item 1(1)

DC circuits utilizing penetrations are of the low voltage control type. These circuits are self-limiting in that the circuit resistance limits the fault current to a level that does not damage the penetration.

Item 1(2)

Circuits that are required for short periods of time during startup, refueling or maintenance shutdown that pass through the containment penetrations and are permanently installed meet the guidance of Regulatory Guide 1.63 position 1.

Item 2

Thirty-three time-current characteristic curves were submitted to the NRC under separate cover.

Item 3

PVNGS agrees to periodically test the primary and secondary protective devices.

<u>QUESTION 6A.9</u> (AC Power SER Item 9)

The Palo Verde station design motor operated valves activated by a safety injection signal in the event of a LOCA have their respective thermal overload protection devices bypassed during accident

conditions. This conforms with the guidance of Regulatory Guide 1.106, positions C.1 and C.2 and is acceptable. However, to complete our evaluation and verification of this design feature, the applicant should provide a description and drawings indicating how this is accomplished.

RESPONSE: The starter thermal overload relay contact is bypassed by a contact of the same initiating relay that activates the motor operated valve in the event of a LOCA. The bypass remains in effect until the initiating signal is manually reset. Drawings 13-E-SIB-012, -020, and -022, which have been provided to the NRC, indicate how thermal overload devices are bypassed during accident condition.

<u>QUESTION 6.A.10</u> (AC Power SER Item 10)

It is not clear from the information provided in the FSAR how the Palo Verde design meets the guidelines of Branch Technical Position ICSB 18 (PSB) concerning power lockout to selected ESF valve actuators as means of designing against a single failure that might cause an undesirable valve motion in the fluid system. In addition, this position requires that all such valves be listed in the Technical Specifications and that the positon indication for these valves meet the single failure criterion. We therefore, require the applicant to provide the following specific information on this item.

1. A list in the Technical Specifications of all valves that require power lockout in order to meet the single failure criterion in the fluid system.

2. A description of (1) the design feature for locking out control power to these valves, (2) how electrical power can be restored to the valves from the control room if valve repositioning is required at a later time, and (3) the testability of the power lockout feature. In addition, provide the associated schedmatic diagrams showing these design features.

3. Redundant and independent valve position indication in the control room which meets the single failure criterion.

RESPONSE:

Item 1: The following valves require power lockout:

A. Safety Injection Tank Isolation Valves

Valve No.	Elementary No.
J-SIA-UV-634	13-E-SIB-005
J-SIA-UV-644	13-E-SIB-005
J-SIA-UV-614	13-E-SIB-006
J-SIB-UV-624	13-E-SIB-006

B. Safety Injection Tank Vent Valves

Valve No.	Elementary No.
J-SIA-HV-605	13-E-SIB-050
J-SIA-HV-606	13-E-SIB-050
J-SIA-HV-607	13-E-SIB-051
J-SIA-HV-608	13-E-SIB-051
J-SIB-HV-613	13-E-SIB-052
J-SIB-HV-623	13-E-SIB-052
J-SIB-HV-633	13-E-SIB-053
J-SIB-HV-643	13-E-SIB-053

and Elementary 13-E-SIB-054
for Power Disconnect Switches

Item 2:

A. Safety Injection Tank Isolation Valves

1. Valve motor power feeder breakers are to be locked open when the reactor coolant system pressure exceeds the minimum safety injection tank operating pressure plus 100 psi.

2. Electrical power cannot be restored to the valves from the control room. The safety injection tanks can be depressurized for cold shutdown by venting rather than performing tank isolation in the event the motor centers are not accessible during an emergency shutdown.

3. Testing is performed by manually opening the breaker and verifying breaker position, with indication provided in the control room.

B. Safety Injection Tank Vent Valves

1. Power is disconnected from the solenoid valves by a switch in the control room. One switch disconnects power for the train A valves, and one switch disconnects power for the train B valves.

2. Electrical power can be restored to the valves by the control room switches.

3. Testing is performed by disconnecting power and verifying proper operation by indication provided in the control room.

Item 3:

A. Safety Injection Tank Isolation Valves

Valve position indication is provided by indicating lights driven from valve limit switches and by a redundant and independent positon indicator.

B. Safety Injection Tank Vent Valves

One set of valve position indicating lights driven from proximity type limit switches on each solenoid valve is provided in the control room. due to the small size of the

solenoid valve, a second means of direct valve position indication cannot be provided. Indication of valve position can, however, be derived from safety injection tank pressure.

QUESTION 6A.11 (AC Power SER Item 11a)

In order to accept the use of a single load sequencer for both off-site and on-site power sources, the applicant should provide a detailed analyses to assure that there are no credible sneak circuits or common mode failures in the sequencer design that could render both on-site and off-site power sources unavailable. Furthermore, we would require the applicant to provide the following additional information:

1. A full description of the load sequencer design feature in the FSAR. This should include sequencer power supplies, test features and alarms.

2. A reliability study on the sequencer.

RESPONSE: A sequencer design demonstration test was performed to test the sequencer to assure that no credible sneak circuits or common mode failures could render both on-site and off-site power sources unavailable. The testing included approximately 130 credible scenarios combining accident situations with and without off-site power available. The test results were satisfactory and demonstrated that no sneak logic paths exist in the design that could result in failure of the sequencer to perform its required function. The test report "ESF Load Sequencer Design Demonstration Test Report," E160972, February 1981, which was submitted to the NRC.

Item 1:

A. Load Sequencer Design

Each redundant ESF load sequencer system performs logic functions to generate the loss of off-site power (LOP) signal/load shed signal, the diesel generator start signal (DGSS), and the load sequencer start and permissive signals.

Each redundant ESF load sequencer system is supplied from a separate 120 V vital ac distribution bus and a separate Class 1E 125 V dc distribution bus.

The LOP signal/load shed signal logic continuously monitors the Class 1E 4.16 kV bus for an undervoltage condition using four undervoltage relays. If an undervoltage trip occurs, annunciation and indication is provided to the operator. On a 2-out-of-4 coincidence of undervoltage relay trips or upon manual actuation, an LOP signal and load shed pulse are generated. The LOP signal is sent to the DGSS logic. The LOP signal (maintained through a 60-second off delay) also actuates forced shutdown system loads by de-energizing actuation relays. The load shed pulse (1 second) sheds 4.16 kV and selected 480-V loads from the Class 1E 4.16 kV bus and trips the 4.16-kV Class 1E bus preferred (off-site) power supply breakers by energizing actuation relays.

The DGSS logic combines the LOP, SIAS, AFAS, and manual actuation in a logical "OR" to generate a DGSS to start the diesel generator.

The load sequencer start and permissive signal logic monitors input signals, detemines the appropriate mode of operation, and generates sequentially timed start and permissive signals to ESF and forced shutdown loads as required to prevent instability of Class 1E buses. Start signals actuate devices

by de-energizing actuation relays. The permissive signals, however, allow loading of devices by energizing actuation relays. The load sequencer controls only pumps, fans, and chillers, and does not control any valves or dampers.

As such, the load sequencer does not cause complete ESF system actuation. The load sequencer responds to the following conditions:

- LOCA, with or without off-site power available
- Accident other than LOCA, with or without off-site power available
- LOP with or without an accident other than LOCA, but followed at a later time by a LOCA
- LOCA that is followed at a later time by a LOP

The load sequencer has a normal mode (mode 0) and the following four operating modes:

1. SIAS/CSAS without an LOP

2. SIAS/CSAS coincident with an LOP. Sequencing is started on a diesel generator breaker closure signal.

3. LOP without an SIAS/CSAS. Sequencing is started on a diesel generator breaker closure signal.

4. Other signals without an SIAS/CSAS and without an LOP. These signals are:

   a. CRVIAS or CREFAS
   b. FBEVAS
   c. AFAS-1 or AFAS-2
   d. Diesel generator running

Receipt of subsequent input signals requiring a change of operating mode causes the load sequencer to reset, transfer to the required mode, and initiate sequencing of the required loads.

The devices sequentially actuated through the load sequencer receive a load shed signal on bus undervoltage to trip the device load, and a load sequencer start signal to start the device at the appropriate time. Reset of the load sequencer and its actuation relays does not stop or shed actuated devices. Devices are shed only on the load shed signal.

B. Testing

1. Manual Testing

Provisions are made to permit periodic testing of the ESF load sequencer system. Tests cover the trip actions from input signals through the system and the actuation devices. System test does not interfere with the protective function of the system.

Actuation of the components controlled by the ESF load sequencer system does not disturb normal plant operating conditions; therefore, the ESF load sequencer system is tested by complete actuation. Proper operation may be verified by the following:

- Checking the position of each ESF component
- Checking the actuation annunciation
- Checking the ESF component status indication

Response time testing will be performed at refueling intervals.

2. Auto Test Function

a. Scope

The ESF load sequencer for each logic train contains the necessary hardware and associated software programs stored in read-only memory to determine that each functional channel within that train will respond to field initiated input contact action and that the ESF load sequencer in the opposite train is operative.

(1) The auto test function does not check:

(a) The Cross Logic Train Actuation Signal Operation -

Response times dictated by specified signal filtering bandpass limit of 30Hz do not allow test pulses to propagate to the opposite train.

(b) Actual Actuation Relay Contact Transfer -

Only the relay drive current response is monitored.

(c) Manually Initiated Actuation Inputs

b. Module Selection and Test Scheme

(1) Address Select and Test Enable Bus

Each module has an address code associated with its position in the system (e.g. FBEVAS-01, CREFAS-02, CPIAS-03, LOP/LG-04, CRVIAS-05, DGSS-06) which is set within the module via a minidip switch unit. As the module address select signal bus (4 lines) is strobed with each successive code, the selected module will admit test pulses (10 msec wide; 250 msec apart; 4 per test) which propagate through the logic and are

sensed in such a way as to prepare a return signal to be sent back to the auto test function contained within the ESF load sequencer for interpretation. The LOP/LS module requires an additional four line (test enable) to interpret the module response to all possible two of four pairs.

(2) Module Test Response Return Interpretation

As the modules are successively selected, the auto test features within the sequencer examines the test returns and active signals received from the modules and looks for a particular pattern based upon the system configuration, and within the time frame of the test. The auto test feature is then able to determine if the module has passed or failed a test, or if a field related signal (actual input) has been received. In the case of a failed test or an actual input, the auto test feature will cease operation.

(3) Test Failure Indication

Each module contains a test indicator lamp that illuminates in a steady state while that module is under test. As the auto test feature strobes each module, the test indication will appear to "walk" across the face of the bin assembly containing the modules. If the auto test feature determines an erroneous response, it will cause the test indicator on the module where the failure was detected to flash. The error may or may not be within that module dependent upon the system configuration and the position of the module in the test order (e.g.

if the FBEVAS module correctly responded to the test, yet a failure in the CREFAS module failed to provide its required automatic output, the auto test feature would flash the error indicator in the FBEVAS module). Further manual tests might be required to isolate the fault. When the auto test feature terminates testing under either an error detection or receipt of an acutal input, the required auto test terminate (fail) annunciator contacts will transfer to the alarm state. During auto test operation the "auto test on" annunciator contacts are transferred.

(4) Test Success Indication

As the modules are strobed into test by the module select bus (solid test indicator illumination), the test pulses propagating through the module actuation logic will cause the associated indicators to "flicker." As the module successfully completes its test, the next module in line is strobed and its actuation associated indicators "flicker," until all modules are tested including the ESF load sequencer itself.

Item 2: The response is given in the submitted report "Reliability Analysis Report for Balance of Plant Engineered Safety Features Actuation System," E-115-751 (Rev.), January 1979.

QUESTION 6A.10 (AC Power SER Item 11)

The analytical techniques and assumptions used in the voltage analyses must be verified by actual measurement. The verification and test should be performed prior to initial full power reactor operation on all sources of off-site power by:

a. loading the station distribution buses, including all Class IE buses down to the 120/208 v level, to at least 30%.

b. recording the existing grid and Class IE bus voltages and bus loading down to the 120/208 volt level at steady state conditions and during the starting of both a large Class IE and non-Class IE motor (not concurrently);

NOTE: To minimize the number of instrumnted locations (recorders) during the motor starting transient tets, the bus voltages and loading need only be recorded on that string of buses which previously showed the lowest anlayzed voltages from item above.

RESPONSE: PVNGS will measure the station distribution buses including Class IE buses initially, prior to loading and record voltages. PVNGS will also measure and record the station distribution buses including Class IE buses upon loading the bus to at least 30%. This will occur prior to start-up.

PVNGS will measure and record grid and Class IE bus voltages and bus loading during the start-up of a large Class IE motor and also during the starting of a large non-Class IE motor.

The above information will be reviewed to verify analytic data.

QUESTION 6A.12 (AC Power SER Item 12)

Part 1

Provide the time delay settings for the two 4160 volt safety related bus undervoltage relays.

RESPONSE: The induction disc relays have a dropout voltage that varies with time, so that they drop out if the voltage falls below 90% for a long time (9 sec or less) or below about 75% for a short time (4.2 sec or less) at dial setting 3 of the undervoltage relay.

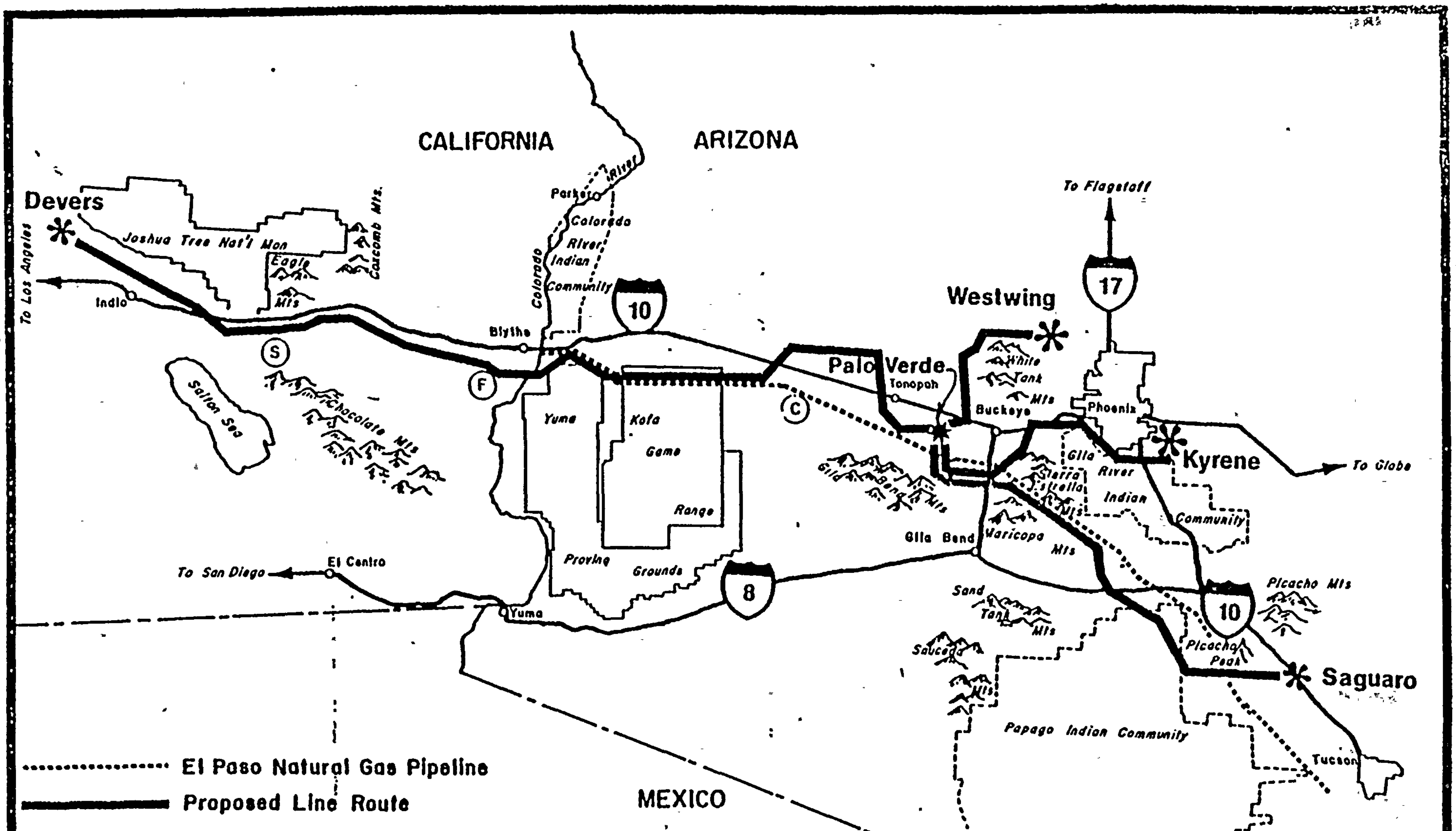
Part 2 Submit the following information: the voltage levels at the safety-related buses optimized for the maximum and minimum load conditions that are expected throughout the anticipated range of voltage variations of the off-site power sources by appropriate adjustment of the voltage tap settings of the intervening transformers. The tap settings selected should be based on an analysis of the voltage at the terminals of the Class IE loads. The analyses performed to determine minimum operating voltages should typically consider maximum unit steady state and transient loads for events such as a unit trip, loss of coolant accident, startup or shutdown; with the off-site power supply (grid) at minimum anticipated voltage and only the off-site source being considered available. maximum voltages should be analyzed with the off-site power supply (grid) at maximum expected voltage concurrent with minimum unit loads (e.g. cold shutdown, refueling). A separate set of the above analyses should be performed for each available connection to the off-site power supply.

RESPONSE: The maximum load condition at the minimum anticipated off-site voltage was considered when 1) winding "Z" of a start-up transformer was feeding train A of Unit 1 while undergoing a trip and train B of Unit 3 was undergoing a LOCA, and 2) the "Y" winding of the same startup transformer was feeding train B of Unit 2 under trip conditions. The analysis indicated the following worst-case voltage levels at 95% of switchyard voltage:

- 4.16 kV Switchgear 92.27%
- 480 V Load Center 94.80%
- 480 V Motor Control Center 93.91%

All voltage values are based on bus voltage.

I. LOCATION MAP



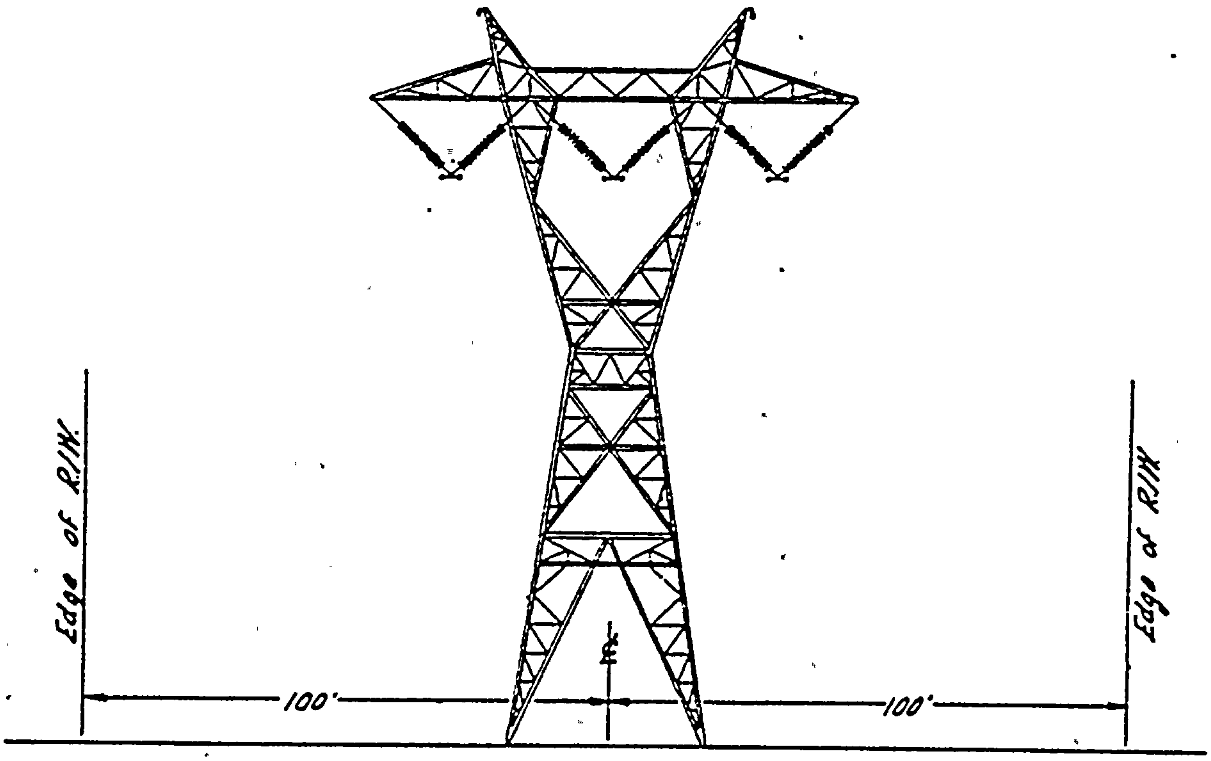
Palo Verde Nuclear Generating Station Transmission System Preliminary Alignment Map

REV. 3/20/80

Transmission Line Mileages	
Palo Verde/Westwing	44 Miles
Palo Verde/Kyrene	73 Miles
Palo Verde/Devers	240 Miles
Palo Verde/Saguaro	122 Miles

#1

#1



PRELIMINARY

REVISION	DATE	DES.	DR.	APP.

POWER STANDARDS

PALO VERDE PROJECT

500 KV RIGHT OF WAY UTILIZATION

A-50004.1

DES.	NCS
DR.	EG
APP.	JML
11/12/74	

DATE	DES.	DR.	APP.	REVISION

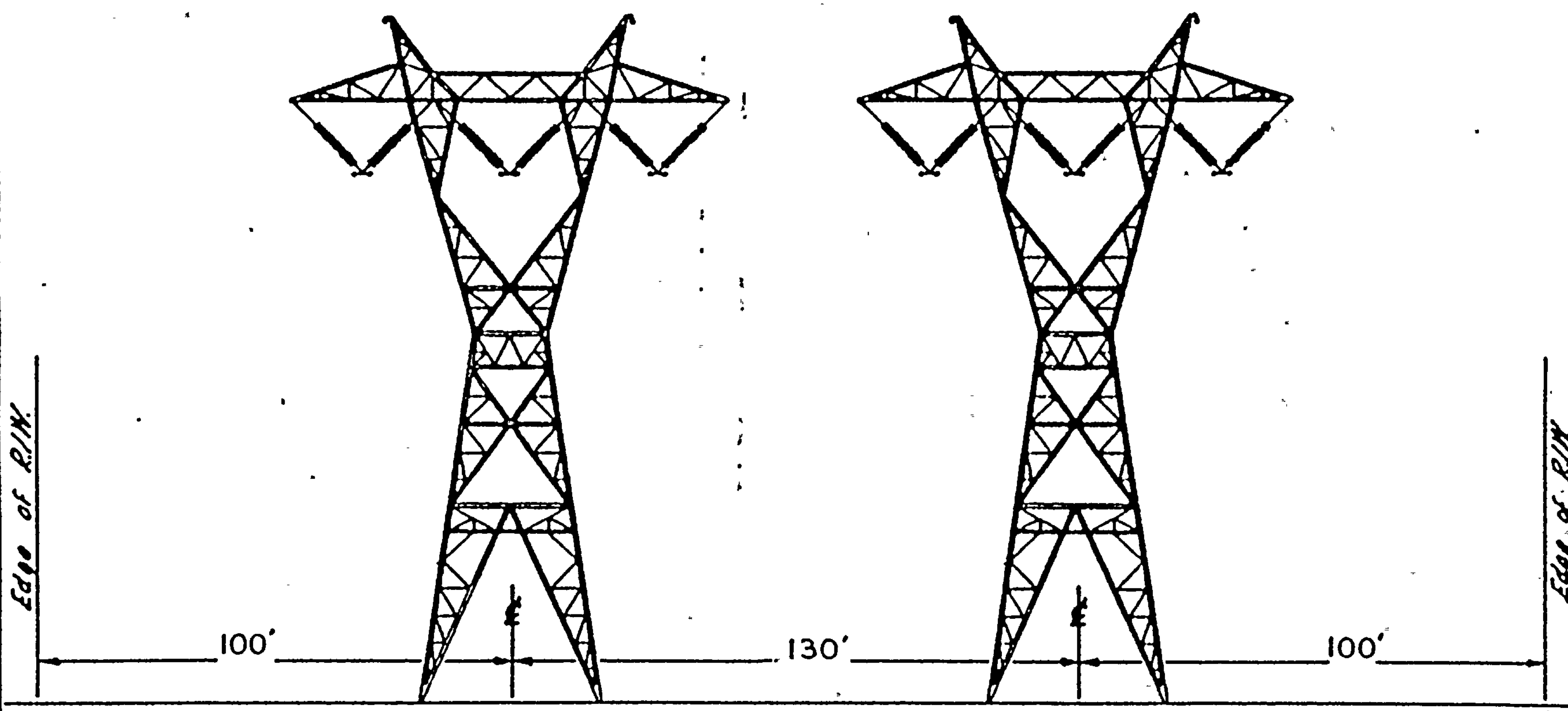
SALT RIVER PROJECT

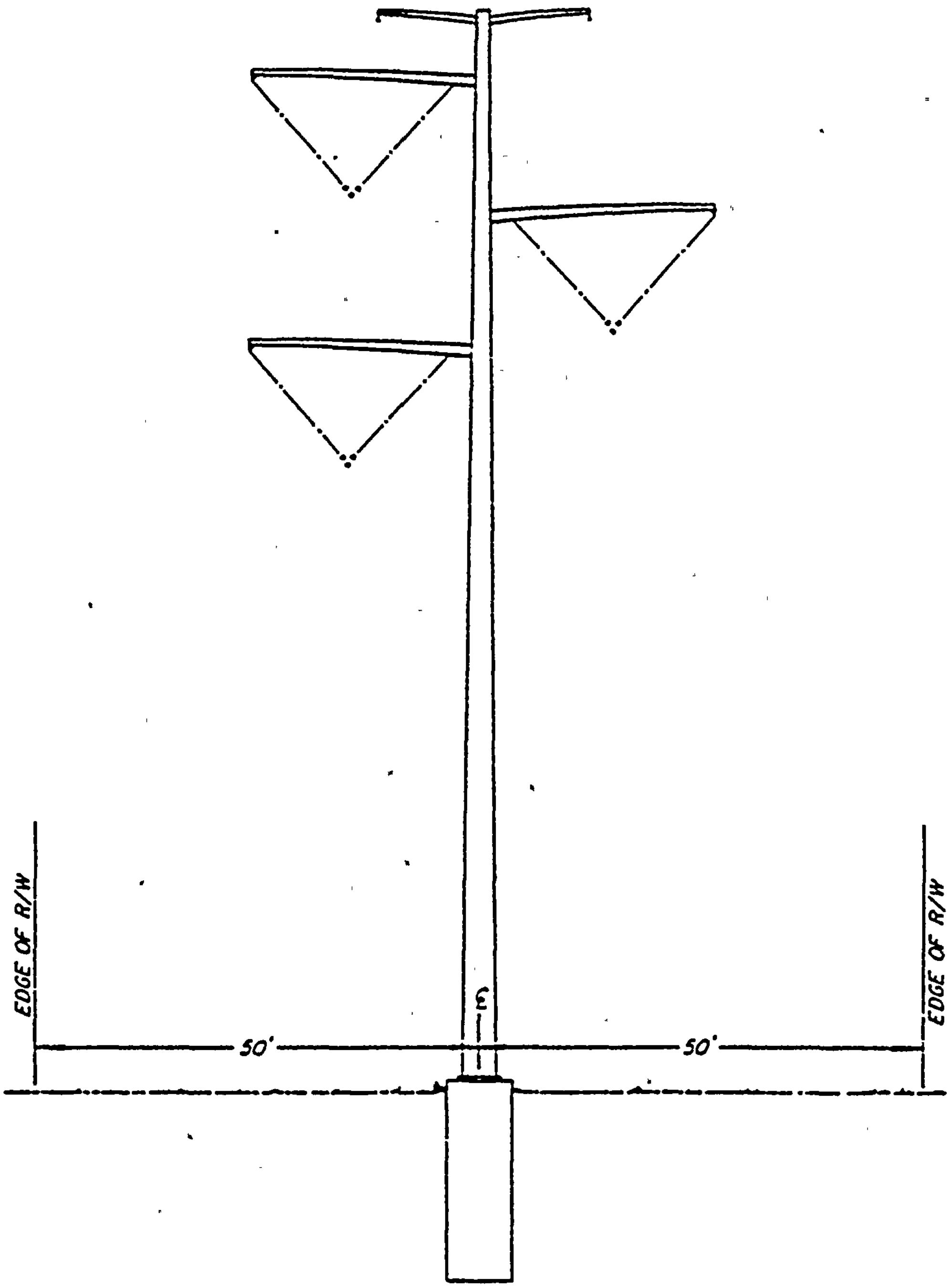
POWER STANDARDS

500 KV

RIGHT OF WAY UTILIZATION

A-50004-D



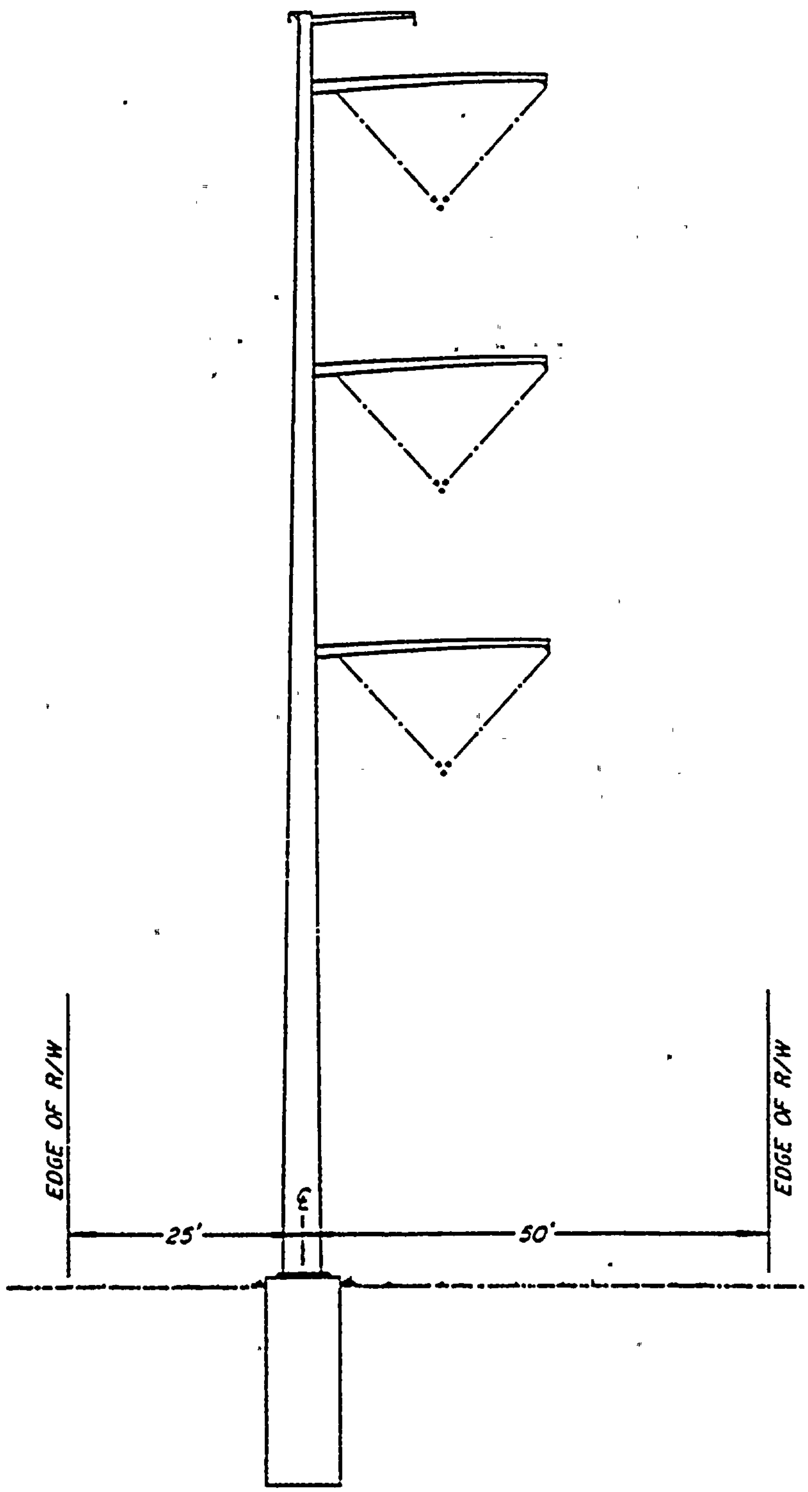


CONSTRUCTION PRINT

REVISION	DES	DR.	APP.
	DCS	DCA	16/80

DELTA POLE - PALO VERDE PROJECT

500KV RIGHT OF WAY UTILIZATION



CONSTRUCTION PRINT

REVISION	E	DES	DR.	APP.

DCS

DCA

9/16/80

POWER STANDARDS

VERTICAL POLE - PALO VERDE PROJECT

500 KV RIGHT OF WAY UTILIZATION

A-50004.3

ATE	DES	DR.	APP.	REVISION

DES.
DR.
APP.
/ /

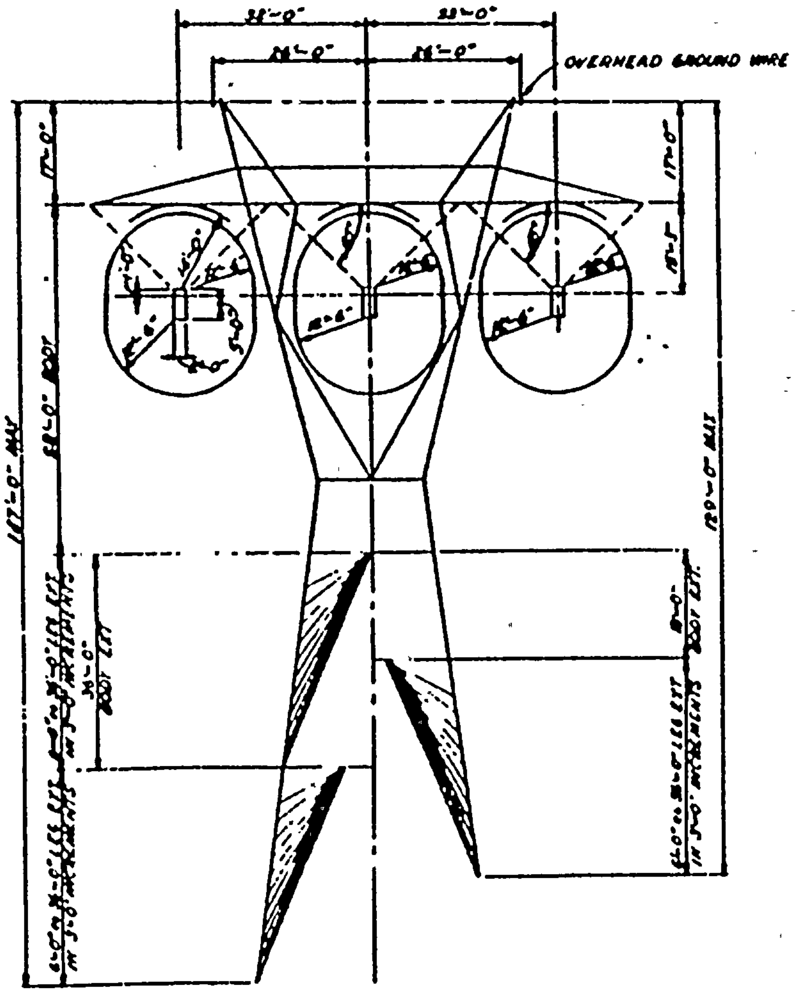
POWER STANDARDS

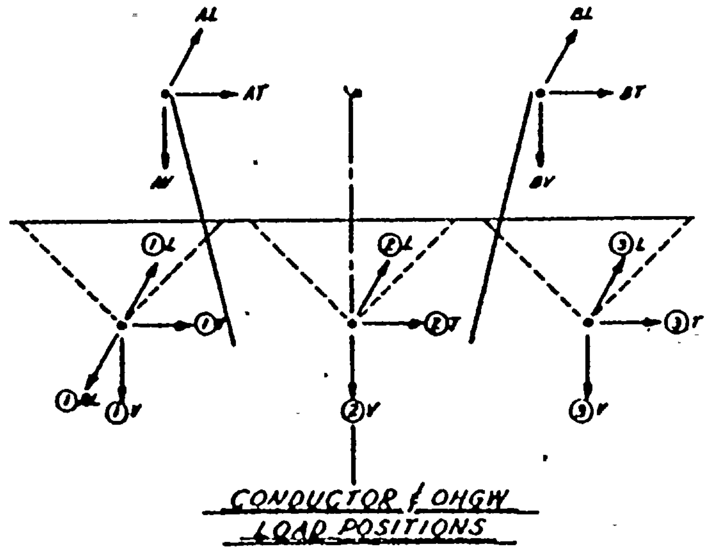
SALT RIVER PROJECT

WATER POWER

500kV TANGENT TOWER
TYPE 5T2 GEOMETRICAL REQUIREMENTS
For Three CHUKAR Conductors Per Phase
Palo Verde/Kyrene Line

A-50018





PRELIMINARY

#2

Transmission line protective relays can be tested on a routine basis. This can be accomplished without removing the transmission lines from service. Generator, main transformer, and service transformer relays are tested on a routine basis when the generator is offline.

INSERT A → Response to 6.A.2 (next page)

8.2.1.3.3 Regulatory Guide 1.32

As described in section 8.2.1.3.1 listing I, an independent immediate access circuit is provided to each Class IE bus for each unit.

8.2.1.3.4 Industry Standards

The design will comply with applicable standards and recommendations of:

- Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- National Electrical Manufacturers Association (NEMA)
- National Electrical Code (NEC)
- American Society of Civil Engineers (ASCE)
- Underwriters' Laboratory, Inc. (UL)
- American Iron and Steel Institute (AISI)

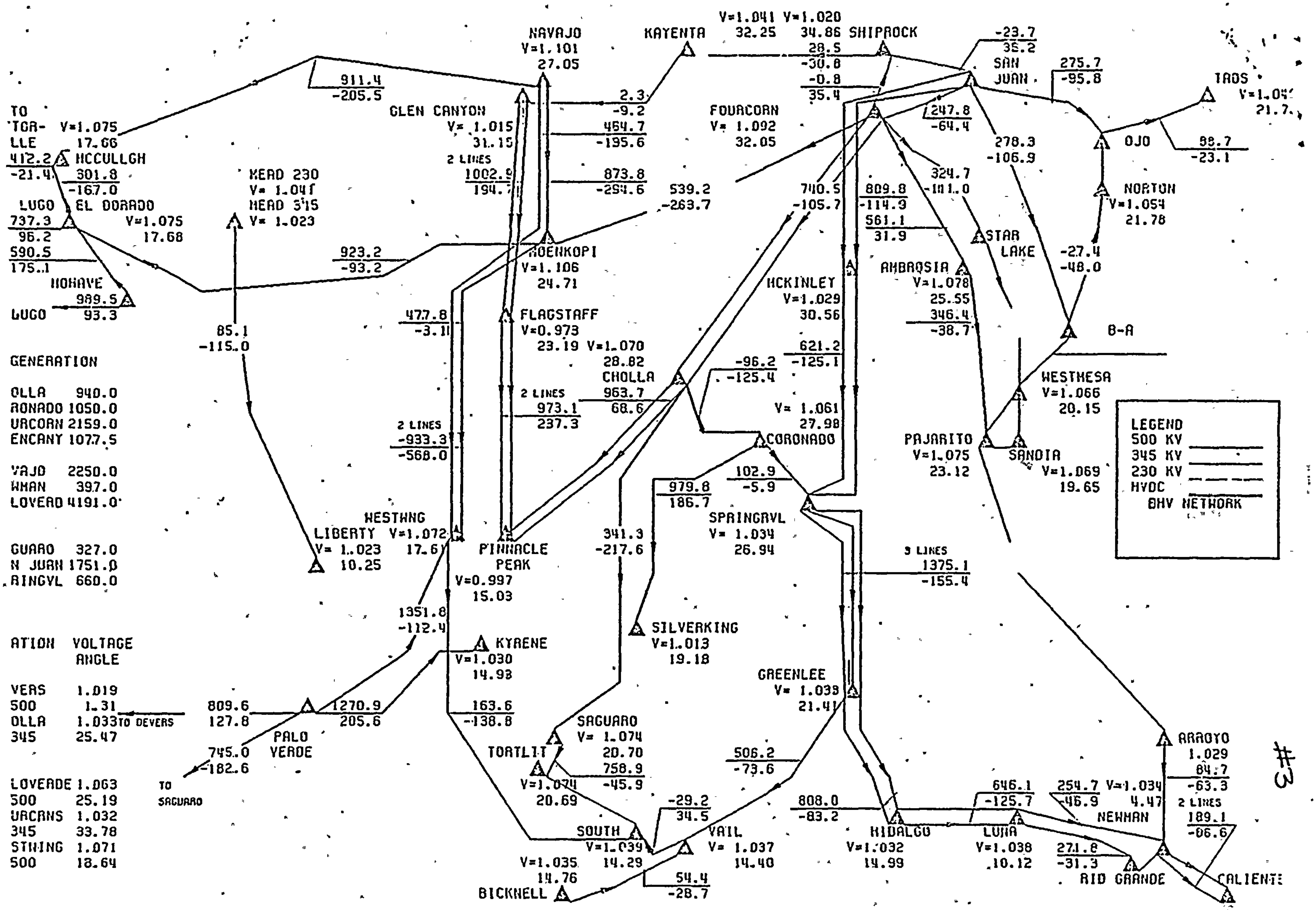
8.2.2 ANALYSIS

The transmission system associated with PVNGS is planned so that the loss of a single transmission element (i.e., line or transformer) does not result in loss of load, transmission overload, undervoltage condition, or loss of system stability to the Southern California Edison-Arizona-New Mexico-West Texas extra high voltage (EHV) grid. Offsite power supply reliability is determined by the performance of the four 525 kV supply circuits associated with PVNGS. The source stations for these circuits

INSERT A

Onsite power components will be periodically inspected and maintained as required. This can be accomplished without removing the transmission lines, generators, or transformers from service.

(additional info will be included in FSAR amendment #6. per the response to 6.A.2)


NAVAJO
V=1.101
27.05
KAYENTA
V=1.041 V=1.020
32.25 34.86 SHIPROCK
SAN JUAN
TAOS
GLEN CANYON
V= 1.015
31.15
2 LINES
FOURCORN
V= 1.092
32.05
OJO
NORTON
V=1.054
21.78
MCCULLGH
LUGO
EL DORADO
V=1.075
17.68
MEAD 230
V= 1.041
MEAD 345
V= 1.023
MOENKOPI
V=1.106
24.71
STAR LAKE
AMBROSIA
V=1.078
25.55
MOHAVE
LUGO
MCKINLEY
V=1.029
30.56
B-A
FLAGSTAFF
V=0.973
23.19
V=1.070
28.82
CHOLLA
WESTMESA
V=1.066
20.15
GENERATION
OLLA 940.0
RONADO 1050.0
URCORN 2159.0
ENCANT 1077.5
VAJO 2250.0
WMAN 397.0
LOVERD 4191.0
GUARO 327.0
N JUAN 1751.0
RINGVL 660.0
V= 1.061
27.98
CORONADO
PAJARITO
V=1.075
23.12
SANDIA
V=1.069
19.65
LEGEND
500 KV
345 KV
230 KV
HVDC
EHV NETWORK
WESTWNG
LIBERTY V=1.072
V= 1.023 17.61
10.25
PINNACLE PEAK
V=0.997
15.03
SPRINGRVL
V= 1.034
26.94
3 LINES
SILVERKING
V=1.013
19.18
ATION VOLTAGE ANGLE
VERS 1.019
500 1.31
OLLA 1.033
345 25.47
TO DEVERS
KYRENE
V=1.030
14.98
GREENLEE
V= 1.038
21.41
PALO VERDE
SAGUARO
V= 1.074
20.70
TORTLIT
V=1.074
20.69
ARROYO
1.029
TO SAGUARO
LOVERDE 1.063
500 25.19
URCRNS 1.032
345 33.78
STIING 1.071
500 18.64
SOUTH
V=1.039
14.29
VAIL
V= 1.037
14.40
HIDALGO
V=1.032
14.99
LUNA
V=1.038
10.12
V=1.034
4.47
NEWMAN
2 LINES
RIO GRANDE
CALIENTE
V=1.035
14.76
BICKNELL
#3

8.3.1.1.4.10 Instrumentation and Control Systems for Standby Diesel Power Supply. Pertinent instrumentation and control systems are as follows:

A. Equipment is provided in the control room for each diesel generator for the following operations:

- Remote manual starting and stopping
- Remote manual synchronization
- Remote manual frequency and voltage regulation
- Governor and voltage droop selection
- Automatic or manual voltage regulator selection

B. Equipment is provided at each local control panel for the following operations:

- Manual starting and stopping
- Frequency and voltage regulation
- Automatic or manual regulator selection
- Exciter field removal and reset
- Manual emergency stop
- OFF-LOCAL-REMOTE control selection | 3

The local control operation is annunciated in the control room. The dc power source for the Class IE diesel generator instrumentation and control system is associated with the same load group as the diesel generator.

C. Each diesel generator is equipped with the following alarms on the local control panel:

- Lube oil low pressure
- Lube oil high or low temperature
- Jacket coolant low pressure

PRELIMINARY

- Jacket coolant high or low temperature
- Jacket coolant low level in expansion tank
- Fuel oil high level in day tank
- Fuel oil low level in day tank
- Fuel oil low level in storage tank
- Fuel oil low pressure
- Fuel oil transfer pump low discharge pressure
- Incomplete sequence (start failure)
- Generator field ground
- Generator undervoltage
- Generator overvoltage
- Generator underfrequency
- Crankcase low oil level
- Starting air low pressure
- Excitation bridge failure
- Crankcase high pressure
- Generator overcurrent
- Engine overspeed
- Diesel generator bypassed or inoperable (COMMON ALARM)
- Turbo thrust bearing failure
- Bearing high temperature
- Generator neutral overvoltage (ground overcurrent)
- Loss of field
- Generator differential
- Reverse power
- 31 Fuel oil filter high differential pressure

4

PRELIMINARY

- Fuel oil strainer differential pressure high
- Fuel oil supply to day tank high differential pressure
- Generator or high voltage cubicle space heater trouble (COMMON ALARM) 3
- Essential exhaust fan overload pre-trip
- Annunciator ground
- Any switch not in auto (COMMON ALARM)
- Lube oil filter high differential pressure
- Diesel generator high vibration
- Generator load unbalance

The local annunciator provides first out indication for all alarms initiated by the diesel generator protective devices listed in section 8.3.1.1.4.3.

D. The following alarms are annunciated in the control room: 3

- Diesel generator trip (common alarm)
- Diesel generator running
- Diesel generator differential trip
- Diesel generator overspeed trip
- Diesel generator low lube oil pressure trip
- Diesel generator emergency manual trip
- Diesel generator high priority trouble (COMMON ALARM)
- Diesel generator low priority trouble (COMMON ALARM)
- Diesel generator system trouble (COMMON ALARM)
- Diesel generator in local mode 3

The following alarms will be annunciated on the control room Safety Equipment Status annunciator:

- Diesel generator inoperable
- Diesel generator failed to start

The common diesel generator trip alarm is initiated only when the diesel generator is actually shutdown by a protective device. The diesel generator high priority trouble alarm is initiated by any of the protective devices listed in section 8.3.1.1.4.3 whether a diesel generator shutdown results or not. The diesel generator low priority trouble alarm is initiated by any alarm condition listed in section 8.3.1.1.4.10.C other than the high priority alarms.

The diesel generator system trouble alarm is initiated by any of the following:

- Diesel generator day tank low level
- Diesel generator fuel oil transfer pump low discharge pressure

The diesel generator inoperable and failed to start alarms are annunciated on a common DIESEL GENERATOR SYSTEM safety equipment status system window. This window is horizontally split, with the top half illuminated in white for an inoperable condition and the bottom half in blue for a start failure.

Conditions which render a diesel generator inoperable on an automatic start signal are:

- Low starting air pressure
- Diesel generator turning gear engaged
- Loss of dc control power
- 3 Manual emergency trip pushbutton not reset

PRELIMINARY

- Control mode selector switch in OFF position
- Generator differential lockout relay not reset
- Fuel oil supply valve closed

Low-starting air pressure or turning gear engaged are indicated by a white AIR START SYSTEM indicator light. Loss of dc, selector switch in OFF, lockout relay not reset or emergency trip switch not reset are indicated by a white START LOGIC SYSTEM indicator light. Fuel oil supply valve closed is indicated by a white FUEL OIL SUPPLY VALVE indicator light. In addition a DIESEL GENERATOR indicator light is provided to indicate loss of breaker control power (white) or failed to close (blue), or diesel generator failed to start (blue). | 3

Electrical metering instruments are provided in the control room and at the local control panel for surveillance of generator voltage, current, frequency, power and reactive power. Fuel oil day tank level indicators are also provided.

8.3.1.1.4.11 Prototype Qualification Program. A start and load reliability test program was performed to certify 0.99 reliability for the diesel generators. A valid start and load test was defined as a start from design cold ambient conditions with loading to at least 50% of the continuous rating within the required time interval, and continued operation until temperature equilibrium is attained. At least 300 qualification tests were performed on one PVNGS diesel. The failure rate was less than 1 per 100. | 3

Prior to delivery to the site, the diesel generator sets are fully assembled at the supplier's factory, and each is subjected

Class IE raceways are identified at the ends with colored nameplate stickers and along their lengths by colored diamonds or
51 dots of separation group designation, at intervals not exceeding 15 feet.

Identification is provided for safety-related field cables by a colored jacket along the length of the cable. Cable markers with the separation group identification are provided at each end of each cable.

Associated circuit cables treated as Class IE are identified by the separation group color code. In addition, the following cables are uniquely identified as associated in accordance with sections 1.8 and 7.1.3.16:

- Interconnecting cables between the safety equipment status system (SESS) logic cabinet and the SESS status panels on the main control boards.
- Interconnecting cables between the electronic isolation system (EIS) and the SESS logic cabinet.

Power cable for the standby third of a kind load (charging pump motor only) is CLASS IE WITH BLACK JACKET AND IS routed in conduit. The conduit is marked with red and green stripes. (SEE INSERT "A" ATTACHED) "In cabinets where other separation groups are present, the cables shall be marked with red and green stripes."

Within control panels where more than one separation group is present, field wiring is identified by separation group color code, or, if enclosed by conduit, the conduit is identified by separation group designation and color code.

Within a cabinet or panel which is associated and identified with a single separation group, the internal wiring is exclusively associated with the same separation group and, therefore requires no further identification.

Design drawings provide distinct identification of Class IE equipment. The applicable channel or load group designation is also identified.

INSERT "A"

PRELIMINARY

THIS CABLE AND RACEWAY ARE ASSIGNED A SEPERATION GROUP "E" IDENTIFIER ONLY TO INDICATE THE UNIQUE SEPARATION GROUP CONDITION WHICH IS TRAIN "A" OR TRAIN "B" AT A UNIQUE TIME DEPENDING ON THE TRANSFER SWITCH POSITION.

8.3.1.4.1.1 Raceway and Cable Routing. The arrangement of raceway and cable routing within the plant adheres to the following practices:

A. Wherever possible, cable trays are arranged from top to bottom, with trays containing the highest voltage cables at the top and trays containing the lowest voltage cables at the bottom. A raceway designated for a single voltage category of cables contains only those cables of the same voltage category. Voltage categories are listed below.

1. 15-kV power (Non-Class IE)

2. 5-kV power

3. Large 600V power (cables from load centers)

4. 600V power and control

5. Instrumentation cables

B. Cables associated with each separation group, as defined in section 8.3.1.3 are run in separate conduits, cable trays, ducts, or penetrations.

C. The arrangement of raceways and cabling prevents a fire in one separation group from propagating to another separation group. In the absence of confirming analyses to support less stringent requirements, the following general rules are applied.

~~1. Routing of instrumentation, control, or power cables through rooms or spaces where there is potential for accumulation of large quantities of combustible fluids is avoided when possible. Where such routing is unavoidable, only cables of one separation group are allowed in any such space.~~

1. In any area in which the only source of fire is electrical, (other than cable spreading rooms) cable trays of different separation groups have a minimum horizontal separation of 3 feet if no physical barrier exists between trays. In the limited number of areas where horizontal separation of 3 feet is unattainable, a fire barrier is installed extending at least 1 foot above the top of the tray (or to the ceiling) and 1 foot below the bottom of the tray (or to the floor). SEE INSERT (B-1) ATTACHED

2. For cable trays of different separation groups in any area in which the only source of fire is electrical, (other than cable spreading rooms) there is a minimum vertical separation of 5 feet between open-top trays stacked vertically. In the limited number of areas where trays of different separation groups are stacked with less than 5 feet of vertical separation, a fire barrier is placed between the two separation groups. The barrier extends 1 foot to each side of the tray system. SEE INSERT (B-2) ATTACHED

3. In the case where a tray of one separation group crosses over a tray of a different separation group, in any area (other than cable spreading rooms) in which the only source of fire is electrical and the vertical separation is less than 5 feet, a fire barrier is installed extending 1 foot from each side of each tray and 5 feet along each tray from the crossover. SEE INSERT (B-3) ATTACHED

4. In cable spreading rooms, cable trays of different separation groups have a minimum horizontal separation of 1 foot and a minimum vertical separation of 3 feet if no physical barrier exists between

PRELIMINARY

INSERT "B-1"

..., THE REDUNDANT CIRCUITS ARE RUN IN TOTALLY ENCLOSED RACEWAYS OR ...

INSERT "B-2"

..., THE REDUNDANT CIRCUITS IN THE TOP TRAY ARE RUN IN SOLID BOTTOM TRAY AND THE REDUNDANT CIRCUITS IN THE LOWER TRAY ARE RUN IN TRAY WITH SOLID COVER OR ...

INSERT "B-3"

..., THE REDUNDANT CIRCUITS IN THE TOP TRAY ARE RUN IN SOLID BOTTOM TRAY AND THE REDUNDANT CIRCUITS IN THE LOWER TRAY ARE RUN IN TRAY WITH SOLID COVER FOR A DISTANCE OF 1 FOOT ALONG EACH TRAY FROM THE CROSSOVER OR ...

trays. In the limited number of areas where redundant cable trays cross each other and separation is unattainable, a fire barrier is placed between the two separation groups. The fire barriers meet the same requirements as those given for barriers between cable trays in the other areas where the only source of fire is electrical. SEE INSERT "C-1" ATTACHED

5 ~~6~~. Openings in the floors for vertical runs of raceways are sealed with fire resistant material. Fire stops are also provided at fire rated wall penetrations.

6 ~~7~~. Where it is necessary that cables of different separation groups approach the same or adjacent control panels with less than the minimum horizontal and vertical separation distance, isolation is maintained by installing cables of ~~all but one of~~ the REDUNDANT separation groups in SEPARATE ~~metallic conduit~~ ENCLOSED RACEWAYS WITH ONE INCH MINIMUM SEPARATION BETWEEN THEM, or by installing suitable barriers between separation groups. ~~The barriers installed in lieu of horizontal separation extend from 1 foot below the bottom of the tray to 1 foot above the top of the tray (or to the ceiling). The barrier installed in lieu of vertical separation extends 1 foot beyond each side of the tray system (or to a wall).~~

INSERT NEW ITEM 7 ATTACHED

~~8~~. Isolation between separation groups is considered to be adequate where physical separation is less than that indicated in sections 8.3.1.4.1.1.C.~~2~~ 1, 8.3.1.4.1.1.C.~~3~~ 2 ~~and~~ 8.3.1.4.1.1.C.~~4~~ 3 AND 8.3.1.4.1.1.C4 provided that CABLES ~~all but one of the separation groups are routed in rigid steel conduit or wireway maintaining a one inch separation between conduits and the only source of fire is electrical.~~

OF THE REDUNDANT SEPARATION GROUPS ARE RUN IN ENCLOSED RACEWAYS (CONDUIT, SOLID BOTTOM AND SOLID TOP TRAY OR WIREWAY) MAINTAINING A MINIMUM ONE INCH SEPARATION BETWEEN THEM.

INSERT "C-1"

PRELIMINARY

..., THE REDUNDANT CIRCUITS IN THE TOP TRAY ARE RUN IN SOLID BOTTOM TRAY AND THE REDUNDANT CIRCUITS IN THE LOWER TRAY ARE RUN IN SOLID COVERED TRAY FOR A DISTANCE OF 1 FOOT ALONG EACH TRAY FROM THE CROSSOVER OR...

ITEM 7. MINIMUM SEPARATION DISTANCE BETWEEN SAFETY RELATED AND NON SAFETY RELATED OPEN-TOP TRAYS IS THE MINIMUM SEPARATION DISTANCE THAT APPLIES BETWEEN TRAYS OF DIFFERENT SEPARATION GROUPS, EXCEPT THAT MINIMUM SEPARATION DISTANCE BETWEEN SAFETY RELATED OPEN-TOP TRAYS AND NON-SAFETY RELATED TOTALLY ENCLOSED RACEWAYS IS 1 INCH

(AS DESCRIBED IN SECTIONS 8.3.1.4.1.1.C.1, 8.3.1.4.1.1.C.2, 8.3.1.4.1.1.C.3 8.3.1.4.1.1.C.4, AND 8.3.1.4.1.1.C.6)

D. Arrangement and/or protective barriers preclude locally generated forces or missiles from destroying redundant systems. In the absence of confirming analyses to support less stringent requirements, the following rules are applied:

1. In rooms or compartments containing cranes or heavy rotating machinery (such as the reactor coolant pumps) or in rooms containing high-pressure piping (such as reactor coolant piping, high-pressure feedwater piping, or high-pressure steam lines) a degree of separation commensurate with the criteria of Regulatory Guide 1.75 is provided such that the independence of redundant Class IE systems is maintained at an acceptable level.

2. Redundant load groups of 4.16-kV switchgear, 480V load centers, and motor control centers are separated by a protective barrier equivalent to a 6-inch-thick reinforced concrete wall.

E. Nonsafety-related cables are not routed through safety-related raceways. However, if a nonsafety ~~cable~~ load is fed from a safety-related power ~~service~~ source it is routed in a ~~non~~safety related raceway up to the isolation device ~~such that it is not associated with non-safety-related cables fed from redundant safety-related power sources.~~

F. Load group 1 and protection channels A and C and load group 2 and protection channels B and D cables are routed through separate cable chases and cable spreading rooms. The former circuits enter the upper cable spreading room, while the latter circuits enter the lower cable spreading room.

8.3.1.4.1.2 Control Board and Other Panels. Single control devices to which different separation groups are connected are avoided. Within the main control boards, non-Class IE wiring is run separated from Class IE wiring. Harnesses of different separation groups are separated physically by a minimum distance of 6 inches, or where physical separation is impractical, metal barriers, metallic conduit, metallic gutter, or wire duct is used for maintenance of independence.

A. A 6-inch minimum physical separation is maintained between field cables of different separation groups entering an enclosure (main control boards, switchboards, equipment cabinets, panels, and termination cabinets) between any of these cables and internal wiring of the separation groups within the enclosure and between the internal wiring of different separation groups within the enclosure. Where a 6-inch minimum physical separation between two separation groups cannot be maintained, one of the following is performed:

1. The cables or cable conductors of ~~at least one of the~~ REDUNDANT SAFETY RELATED separation groups ~~is~~ ARE installed in ~~an~~ SEPARATE enclosed raceway (rigid steel, CONDUIT, FLEXIBLE conduit, EMT, or enclosed metallic gutter) MAINTAINING A ONE INCH MINIMUM SEPARATION BETWEEN ENCLOSED RACEWAYS. The enclosed raceways are installed over the entire length of the cables or cable conductors from/to the point where a 6-inch minimum separation distance can be established.

2. A metal barrier is erected between the cabling, terminal boxes, or components of the separation groups, and a one-inch air gap is maintained between the barrier and the separation group component. To ensure a one-inch air gap equivalent, ceramic fiber insulation is used between the barrier and the component where one-inch of physical separation cannot be maintained.

B. Wiring for Class IE enclosures, (switchboards, equipment cabinets, panels and termination boxes, etc.) or devices, which contain non-Class IE instrumentation and/or control wiring (field cabling or internal wiring) and wiring (field or internal wiring) of only a single Class IE separation group, are considered as associated circuits and are treated as Class IE wiring, IF MINIMUM SEPARATION BETWEEN THE CLASS IE DEVICES AND WIRING AND THE NON-CLASS IE DEVICES AND WIRING CAN NOT BE MAINTAINED.

C. When ~~a~~ non-Class IE ~~power~~ cables ~~circuit~~ enter~~s~~ an enclosure with Class IE wiring (field or internal wiring), a 6-inch minimum physical separation is maintained between the non-Class IE ~~power~~ cables ~~circuit~~ and any Class IE wiring. Where a 6-inch separation cannot be maintained, the non-Class IE ~~power~~ cables ~~and/or the Class IE wiring is barriered or~~ ARE installed in ~~an~~ enclosed raceways (RIGID STEEL CONDUIT, FLEX CONDUIT, EMT, OR ENCLOSED METALLIC GUTTER) ~~as described in section 8.3.1.4.1.2.A.2~~ AND A MINIMUM OF 1 INCH SEPARATION IS MAINTAINED BETWEEN THE NON-CLASS IE ENCLOSED RACEWAYS AND THE CLASS IE CABLES.

8.3.1.4.1.3 Reactor Containment Penetration Areas. Four separate penetration areas are provided for all cables that must pass through the containment wall. The two southeast penetration areas contain cable for separation groups 2 and 4 at two levels, each located in a separate area. The two southwest penetration areas contain cable for separation groups 1 and 3, at two levels each located in a separate area. Raceway separation criteria, as described in this section, applies in routing cable through the penetration areas. Non-safety-related penetration assemblies are located in each of the 4 areas.

8.3.1.4.2 Administrative Responsibilities and Controls for Assuring Separation Criteria

The cable and raceway channel identification described in section 8.3.1.3 facilitates and ensures the maintainence of

failure of either battery will not violate the single failure criteria.

#9

B. 480V Load Center Systems

For 480V load center power circuits feeding loads in the containment, similar protection is provided as in the case of the medium voltage system. The individual load circuit breaker provides primary protection. The penetration withstands the available fault current and time duration for the load center bus feeder breaker. Separate battery sources are not required, since breaker trip is independent of the 125V dc power. Breaker trip units are direct acting.

C. 480V Motor Control Center Systems

INSERT A ATTACHED

~~The 480V motor control center circuits feeding loads in the containment, the main feeder breaker acts as a back up protection to the feeder breakers. The main feeder breaker continuous setting is such that the minimum fault at the MCC feeder cables can be detected and cleared by the main feeder breaker.~~

The penetration withstands the available fault current and time duration of the main feeders (backup) circuit breaker. As in the case of the load center feeds, separate battery sources are not provided. Molded case circuit breakers have direct-acting trips.

D. Low-Voltage Control Systems

The low-voltage control circuits are self-limiting and are provided with fuses so that the circuit resistance limits the fault current to a level that does not damage the penetration.

E. Instrument Systems

The energy levels in the instrument systems are sufficiently low so that no damage can occur to the containment penetration.

INSERT F

FOR ~~the~~ 480V motor control ~~circuits~~ center circuits feeding loads in the containment, a second breaker in series with the primary breaker of each load is used. The motor control center main bus feeder breaker is not used for backup protection because of its large rating relative to the individual load breaker ratings.

Table 1.8-1 lists the parameters that show the capability of each typical electrical containment penetration assembly to withstand, without loss of mechanical integrity, the maximum fault current vs. time condition that could occur as a result of single random failures of the primary circuit overload protection.

The circuit overload protection system for electric penetration assemblies meets the single failure criterion set forth in IEEE Standard 279-1971. ~~Electric penetration assemblies used for power circuits and high energy level control circuits of field wire sizes No. 6 AWG and larger are protected against loss of mechanical integrity by back-up overcurrent protective equipment. For field wire sizes No. 8 AWG and smaller, the penetration conductors have the capability of withstanding the maximum fault current based on thermal fusing of the field cables in one-half the time, as a maximum, of the fusing time of the penetration conductor. Instrumentation and control circuits are not provided with back-up overload protection when analysis demonstrates that a sustained maximum overload cannot produce an unacceptable temperature rise within the electric penetration that would jeopardize its mechanical integrity. Thus the overload protection system conforms to the single failure criterion set forth in IEEE Standard 279-1971.~~

The overload protection systems do not conform to the on-line testability, bypassing, or manual initiation criteria of IEEE-279-1971, since these criteria do not apply to these systems.

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Table 1.8-1

ELECTRICAL PENETRATION ASSEMBLY SHORT CIRCUIT CAPABILITY(c)

	Penetration Rated Voltage	Penetration Service Voltage	Penetration Conductor Size	Penetration Capability				Calculated S.C. Current (amp)		Back-up Breaker	
				Symmetrical S.C. Current (amp)	Duration (sec) Primary	Duration (sec) Back-up	I^2t (b)	Minimum (amp)	Maximum (amp)	Opening Time (sec)	I^2t (a) (b)
1	15 kV	13.8 kV	750 KCMIL	37600	0.3	2.2	3110	NA	35215	0.4	441.3
2	600V	480V	500 KCMIL	21000	0.33	0.63	277.8	3733	15136	19	264.8
3	600V	480V	350 KCMIL	21000	0.33	0.63	277.8	3733	6008	19	264.8
4	600V	480V	No. 4/0	21000	0.33	0.63	277.8	3506	11787	21	258
5	600V	480V	No. 2/0	21000	0.0625	0.63	277.8	3004	18466	0.4	136.4
6	600V	480V	No. 2	19600	0.02	0.33	126.7	1923	10653	0.4	45.4
7	600V	480V	No. 4	18500	0.02	0.33	133	2083	6442	0.4	16.6
8	600V	480V	No. 6	10000	0.02	0.33	33	556	4000	88	27.2
9	600V	480V	No. 8	1500(d)	0.02	60	135	665	7726	58	25.6
10	600V	480V	No. 10	580(d)	0.02	200	67.2	1926	7310	238	32.6

a. The value of current used for the penetration I^2t value is the value which results in the maximum I^2t for penetration seals due to back-up clearing time. In some cases the minimum value of current provides the maximum I^2t value due to long back-up breaker tripping time.

b. Units are kilo ampere^2 seconds.

c. Non-Class IE breakers, with the exception of RCP breakers, feeding non-Class IE loads through the electric penetrations are designed to withstand OBE seismic conditions. The 13.8 kV RCP breakers withstand static OBE seismic conditions.

d. The value of current used is for back-up protection purpose. Conductor capacity for primary protection is much higher.