PACIFIC GAS & ELECTRIC COMPANY

DIABLO CANYON NUCLEAR POWER PLANT

INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT

VERIFICATION OF THE CONTROL ROOM VENTILATION AND PRESSURIZATION SYSTEM ELECTRICAL DESIGN

PERFORMED BY

STONE & WEBSTER ENGINEERING CORPORATION

Docket No. 50-275

License No. DPR-76

PROJECT MANAGER Frank Sestak, Jr. DATE 12-21-82

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PROGRAM MANAGER'S PREFACE

DIABLO CANYON NUCLEAR POWER PLANT - UNIT I

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VERIFICATION OF THE CONTROL ROOM VENTILATION
AND
PRESSURIZATION SYSTEM
ELECTRICAL DESIGN

This is the twenty-sixth of a series of Interim Technical Reports prepared by the DCNPP-IDVP for the purpose of providing a conclusion of the program.

This report provides the analytical results, recommendations and conclusions of the IDVP with respect to the initial sample.

As IDVP Program Manager, Teledyne Engineering Services has approved this ITR including the conclusions and recommendations. The methodology followed by TES in performing this review and evaluation is described by Appendix C to this report.

ITR Reviewed and Approved
IDVP Program Manager
Teledyne Engineering Services

D.C. Stratouly

D. C. Stratouly
Assistant Project Manager

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1.0 INTRODUCTION

Stone & Webster Engineering Corporation (SWEC) has reviewed the design of the Control Room Ventilation and Pressurization (CRVP) System. This review was performed in accordance with the SWEC scope of work in Appendix D (DCNPP-IDVP-PP-002) of the IDVP Phase II Program Management Plan issued by Teledyne Engineering Services (TES) as IDVP Program Manager. The review included terminal voltages, cable and raceway sizing, relay and protective device settings, cable and equipment separation, and harsh environment equipment qualification.

2.0 DEFINITION OF ITEMS REVIEWED

2.1 Terminal Voltage on Power Circuits

The voltages required at the 480 V buses to provide adequate voltage at 460 V motor terminals for all design conditions were reviewed.

Documentation was reviewed to determine whether 460 V motors have the capability to start and accelerate the load to rated speed with 80 percent voltage (368 V) applied at the motor terminals.

2.2 Sizing of Cable and Raceway for Power Circuits

The ampacities of cables supplying power to 460 V safety-related equipment were reviewed.

2.3 Relay and Protective Device Settings for Power Circuits

The protective devices for the CRVP power circuits were determined, and the suitability of their settings was reviewed.

2.4 Electrical Equipment Separation and Redundancy

Electrical redundancy of power sources for electrical devices was reviewed. Cable and raceway separation was reviewed.

2.5 Environmental Qualification of Electrical Equipment

Environmental qualification of equipment required to be qualified for a harsh environment was reviewed.

3.0 DESCRIPTION OF REVIEW

The review was initiated by reviewing the Design Chain to determine the service-related contractors and internal PG&E engineering groups involved in the electrical design of the Control Room Ventilation and Pressurization System. This review identified only the PG&E engineering group as being involved in the electrical design of this system. The following DCNPP-1 licensing documents pertaining to the CRVP electrical systems were reviewed, and applicable electrical licensing commitments were identified:

FSAR, Chapters 8 and 9
ANSI C50.41 - 1977.
NEMA MG-1 - 1978
PG&E to NRC Correspondence

The detailed review in this section was then conducted to determine if all the Control Room Ventilation and Pressurization System electrical licensing commitments (acceptance criteria) were met.

3.1 Terminal Voltage on Power Circuits

An independent calculation was performed to determine the voltage required at 480 V buses 1F, 1G, and 1H to support required voltages at motor terminals for all design conditions. The as-built electrical equipment and cables in the CRVP system were identified by reviewing one line diagrams, flow diagrams, conduit drawings, cable and raceway schedules, and by field inspection.

Documented vendor data, circuit layouts, and impedance tables were used to calculate the voltage drop in feeder cables for full load and starting conditions. The required voltages at the buses were determined by adding the calculated cable voltage drop to the required motor terminal voltage for full load and starting conditions.

Manufacturer's data was requested from PG&E and reviewed to determine whether motors have the capability to start and accelerate the load to rated speed with 80 percent voltage applied at the motor terminals, without damage to the motor or driven equipment. The 80 percent criterion is in accordance with PG&E letter to the NRC dated October 3, 1977.

3.2 Sizing of Cable and Raceway for Power Circuits

The ampacities of the cables as installed were determined by multiplying cable rated ampacities taken from the National Electric Code (NFPA-70-1968) by raceway derating factors (also from NFPA-70-1968). Raceway fill was assumed to be 100 percent.

3.3 Relay and Protective Device Settings for Power Circuits

A list of the condenser, compressor, fan, damper, and heater loads from 480 V CRVP panels was prepared, and protective devices for these loads were identified. From PG&E provided data and by field verification, the protective devices and their settings for the CRVP panels and above loads were reviewed.

3.4 Electrical Equipment Separation and Redundancy

A preliminary list of safety-related devices in the system was provided by PG&E. This list was revised after a review of flow diagrams, instrumentation schematics and electrical schematics. The power sources for these devices were determined from one line drawings, electrical schematics, cable studies, wiring diagrams, and circuit schedules. The power sources for these devices were then reviewed for electrical redundancy.

Vital circuits for the identified safety-related electrical equipment were determined by reviewing circuit schedules, cable studies, electrical schematics, and one line drawings. Raceway routings for these circuits were determined from the circuit schedules. Since adequate separation is assumed if circuits are installed in conduit, a field inspection was performed to determine the locations of only the tray portions of the raceway routings.

AC electrical power enclosures containing more than one vital electrical train were identified by reviewing electrical schematics, one line drawings, and circuit schedules. A field inspection of these enclosures was performed to determine the as-built condition.

3.5 Environmental Qualification of Electrical Equipment

A listing of safety-related electrical equipment requiring qualification was requested from PG&E. This listing was then reviewed to determine which equipment was included as part of the CRVP system. The following two types of equipment were identified as being part of the CRVP system; the Okonite power cable and the Raychem control cable. For these two types of equipment the qualification documentation packages were requested from PG&E and then reviewed to determine if the documentation existed to support this qualification. This documentation in general consisted of manufacturer's test data and analyses.

In conjunction with the documentation package review above, a review was conducted with the pipe crack field investigation (described in the Interim Technical Report (ITR), Verification of the Mechanical/Nuclear Design of the CRVP System). As a part of the investigation, electrical equipment which could be subjected to high temperatures due to a pipe crack was identified. The equipment's qualification to these temperatures was reviewed.

4.0 SUMMARY OF REVIEW RESULTS

4.1 Terminal Voltage on Power Circuits

Results of calculations to determine 480 V bus voltages (included in the ITR, Verification of the 4160 V Safety-Related Electrical Distribution System) indicate that bus voltages, under some operating modes, will be less than required to supply adequate voltage at the equipment terminals.

The review of documentation for Class IE motors identified motors that required additional information to verify motor capability to start and accelerate to rated speed at 80 percent rated voltage.

Results of the calculation of cable voltage drops are that voltage drops are in accordance with design criteria.

4.2 Sizing of Cable and Raceway for Power Circuits

Results of calculations are that rated full load currents of equipment are not greater than 80 percent (NFPA-70-1968) of the derated ampacity values of the cables as installed in raceways.

4.3 Relay and Protective Device Settings for Power Circuits

Overload protection for condenser, compressor, fan, damper, and heater loads provided by thermal overload heaters was in accordance with the manufacturer's recommendations of 115 to 125 percent at full load requirements.

4.4 Electrical Equipment Separation and Redundancy

Safety-related electrical equipment was identified which did not have the required power supply redundancy. In some instances a device is supplied from a Unit 1 source and its redundant device is supplied by a Unit 2 source. Color coded circuits are routed in conduit outside of the separate dedicated switchgear and cable spreading rooms. Color coded circuits are installed in tray only in separate dedicated rooms. However, discrepancies were identified in the use of color coding to distinguish vital circuits. A review of the cable separation within ac electrical power enclosures indicates that the cable separation criteria identified in DCNPP-1 licensing documents are not met.

4.5 Environmental Qualification of Electrical Equipment

For the equipment identified in the documentation package review, qualification documentation was adequate for environmental qualification.

For the equipment identified in the pipe crack investigation, the review of available documentation for one type of control cable and one splice showed that the cable and splice are not qualified to 540°F, the maximum pipe crack temperature excursion.

4.6 EOI Reports Issued

Five files were opened as a result of the design review of the electrical portion of the CRVP system. The status of these files is presented in Appendix B.

EOI 8011 was issued because a cable type, other than that identified in the FSAR as environmentally qualified, was used in some circuits. This file is presently an Open Item transferred to PG&E for review of circuit routing to identify circuits exposed to a severe temperature and humidity environment in the event of a pipe crack.

EOI 8041 was issued because two redundant trains were brought together in one power transfer switch. This file is presently an Open Item, pending the issuance of a Program Resolution Report.

EOI 8042 was issued because backup source cable (gray) is bundled with normal source cable (orange or purple) within panels PY11 and PY13. This file is presently an Open Item, pending issuance of a Program Resolution Report. Note: this EOI applies to the AFW system also.

EOI 8044 was issued because a Rockbestos cable splice was used in control circuits for MPD1A and MPD1. The splice is in an area subject to temperature excursions in the event of a pipe crack, and no qualification information about this splice has been obtained. This file is presently an Open Item, pending the issuance of a Program Resolution Report.

EOI 8061 was issued because the documentation for certain motors does not verify motor capability to start and accelerate to rated speed with 80 percent rated voltage applied at motor terminals. This file is presently an Error Class B.

5.0 EVALUATION OF REVIEW RESULTS

5.1 Terminal Voltage on Power Circuits

The calculated values of voltage drop are within the equipment ratings for power cables of the CRVP system.

The documentation for 460 V Class IE motors was reviewed. For certain motors the documentation is inadequate to verify motor capability to start and accelerate to rated speed with 80 percent rated voltage.

5.2 Sizing of Cable and Raceway for Power Circuits

Cable and raceway are sized in accordance with NFPA-70-1968.

5.3 Relay and Protective Device Settings for Power Circuits

Overload protection for individual CRVP loads is provided and meets protection criteria.

5.4 Electrical Equipment Separation and Redundancy

The electrical power redundancy for the safety-related devices does not meet the electrical power redundancy requirements (refer to the ITR, Verification of the Mechanical/Nuclear Design of the CRVP System). Cable separation of vital circuits in raceway does not meet separation requirements since color coding discrepancies of vital circuits were identified (refer to ITR, Verification of the Instrument and Control Design of the Control Room Ventilation and Pressurization System). Raceway separation meets separation requirements. Cable separation within ac power enclosures does not meet licensing criteria.

5.5 Environmental Qualification of Electrical Equipment

The review verified that equipment identified in the documentation package review has documentation for environmental qualification and meets the licensing commitment.

The documentation review of safety-related equipment affected by a pipe crack identified a cable and splice that is not qualified to 540°F, the licensing commitment.

6.0 CONCLUSIONS

This section provides the conclusions to the review of the electrical design for the CRVP system. This Interim Technical Report will be revised upon resolution of all identified Open Item Reports and completion of all additional verification described in this section.

6.1 Terminal Voltage on Power Circuits

Cable design is satisfactory. No additional verification is required for cable design.

Documentation of Class IE motor capability to start and accelerate to rated speed at 80 prcent rated voltage is unsatisfactory. Because this is a generic concern, additional verification will be required. (This concern was also identified in the AFW System).

6.2 Sizing of Cable and Raceway for Power Circuits

Sizing is satisfactory. No additional verification is required.

6.3 Relay and Protective Device Settings for Power Circuits

Settings are satisfactory. No additional verification is required.

6.4 Electrical Equipment Separation and Redundancy

Separation and redundancy are not satisfactory. Since there is evidence of a generic effect in the design of cable separation for alternative power sources within an enclosure, additional verification may be required. (This concern was also identified in the AFW System).

Upon resolution of EOI Nos. 8012 and 8016 (described in ITR, Verification of the Mechanical/Nuclear Design of the CRVP System), additional verification of redundant power sources may be required.

Upon resolution of EOI No. 8059 (described in ITR, Verification of the Instrument and Control Design of the Control Room Ventilation and Pressurization System) additional verification of cable separation may be required.

6.5 Environmental Qualification of Electrical Equipment

For equipment identified in the documentation package, evidence of environmental qualification is satisfactory, and therefore, no additional verification is required. However, for cables and splices affected by a pipe crack, additional verification is required to verify capability of safety-related cables and splices to operate in the postulated environment caused by a pipe crack.

If the resolution of EOI Nos. 8002, 8003, and 8004 (described in the ITR Verification of the Pressure, Temperature, Humidity and Submergence Environments) is a reanalysis of environments, this could result in an increase in the temperatures to which safety-related equipment had previously been qualified. In this event, additional verification will be required.

APPENDIX A

REFERENCES

APPENDIX A

References

1. Final Safety Analysis Report, Chapters 8 and 9
2. ANSI C50.41-1977, American National Standard Institute - Polyphase Induction Motors for Power Generating Stations, Part III
3. NEMA MG1-1978, Large Apparatus Induction Motors, Part 20
4. AIEE Publication S-135-1, Power Cable Ampacities
5. Voltage Profile and Cable Ampacity Study - Calculation 14296-E-2-11
6. PG&E Letter to NRC, 10/3/77, Answer 1-C - 80 Percent Motor Starting Capability
7. National Electric Code, NFPA-70-1968 - Cable Rated Ampacities and Raceway Derating Factors
8. DCVP 44 - Relay test Data, Circuit Schedules
9. DCVP 46 - Flow Diagrams, Electrical Schematics
10. DCVP 64 - List of Safety-Related Devices, Conduit Drawings
11. DCVP-180 - Circuit Schedules, Raceway Schedules
12. DCVP 187 - Cable Block Diagrams
13. DCVP 193 - Cable Block Diagrams
14. DCVP 197 - Circuit Schedules
15. DCVP 209 - Raceway Schedules
16. Environmental Qualification Report, Rev. 1, Appendix A, Files EH-2 and EH-3, September 2, 1982

APPENDIX B

EOI FILES

DCNPP IDVP STATUS REPORT

FILE NO.	REV. DATE	LATEST REV. REV.	DATE	BY	STATUS	SUBJECT
8011	820923	0	820923	SWEC	OIR	AUX FW & CONTROL RM VENT. & PRESS. SYS. CABLE
8011	820923	1	821001	SWEC	PPRR/OIP	AUX FW & CONTROL RM VENT. & PRESS. SYS. CABLE
8011	820923	2	821022	TES	PRR/OIP	AUX FW & CONTROL RM VENT. & PRESS. SYS. CABLE
8041	821022	0	821022	SWEC	OIR	CRVP SYSTEM TRANSFER SWITCH, EPCHN
8041	821022	1	821028	SWEC	PER/AB	CRVP SYSTEM TRANSFER SWITCH, EPCHN
8041	821022	2	821123	TES	OIR	CRVP SYSTEM TRANSFER SWITCH, EPCHN
8041	821022	3	821207	SWEC	PPRR/OIP	CRVP SYSTEM TRANSFER SWITCH, EPCHN
8041	821022	4	821214	TES	PRR/OIP	CRVP SYSTEM TRANSFER SWITCH, EPCHN
8042	821022	0	821022	SWEC	OIR	AFW, CRVP INSTRUMENT PANELS PY11, PY13
8042	821022	1	821028	SWEC	PER/AB	AFW, CRVP INSTRUMENT PANELS PY11, PY13
8042	821022	2	821123	TES	OIR	AFW, CRVP INSTRUMENT PANELS PY11, PY13
8042	821022	3	821207	SWEC	PPRR/OIP	AFW, CRVP INSTRUMENT PANELS PY11, PY13
8042	821022	4	821213	TES	PRR/OIP	AFW, CRVP INSTRUMENT PANELS PY11, PY13
8044	821022	0	821022	SWEC	OIR	AFW - CABLE SPLICES IN CONTROL CIRCUITS
8044	821022	1	821028	SWEC	PER/AB	AFW - CABLE SPLICES IN CONTROL CIRCUITS
8044	821022	2	821123	TES	OIR	AFW - CABLE SPLICES IN CONTROL CIRCUITS
8044	821022	3	821203	SWEC	PPRR/OIP	AFW - CABLE SPLICES IN CONTROL CIRCUITS
8061	821109	0	821109	SWEC	OIR	MOTOR RATINGS-AFW AND CRVP
8061	821109	1	821123	SWEC	OIR	MOTOR RATINGS-AFW AND CRVP
8061	821109	2	821123	SWEC	PER/B	MOTOR RATINGS-AFW AND CRVP
8061	821109	3	821206	TES	ER/B	MOTOR RATINGS-AFW AND CRVP

APPENDIX C

PROGRAM MANAGER'S ASSESSMENT

APPENDIX C

PROGRAM MANAGER'S ASSESSMENT

Independent review by TES of the tasks performed by SWEC to verify the design of the CRVP Electrical System was done in accordance with IDVP Phase II Program Management Plan dated June 18, 1982 and the Engineering Procedure EP-1-014.

The review involved a visit to the site and several visits to the SWEC offices for detailed discussions and review, with SWEC personnel, of the work performed by SWEC including the methodology used in the evaluation of this task.

The files used by SWEC were reviewed thoroughly and specific recommendations were made to the IDVP Manager delineating appropriate resolution.

As a result of the verification of initial sampling selected by SWEC and the assessment of the impact of SWEC findings, TES, as Program Manager is of the opinion that additional verification is needed.