PACIFIC GAS & ELECTRIC COMPANY

DIABLO CANYON NUCLEAR POWER PLANT

INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT NO. 47

REVISION 0

ADDITIONAL VERIFICATION OF ENVIRONMENTAL CONSEQUENCES OF POSTULATED PIPE RUPTURES OUTSIDE OF CONTAINMENT

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PROGRAM MANAGER'S PREFACE

DIABLO CANYON NUCLEAR POWER PLANT - UNIT 1

INDEPENDENT DESIGN VERIFICATION PROGRAM

INTERIM TECHNICAL REPORT

ADDITIONAL VERIFICATION OF ENVIRONMENTAL CONSEQUENCES OF POSTULATED PIPE RUPTURES OUTSIDE CONTAINMENT

This is the forty-seventh 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 a description of the work done, summary and evaluation of the results, and conclusions of the IDVP with respect to the concern of environmental consequences of postulated pipe ruptures outside containment.

As IDVP Program Manager, Teledyne Engineering Services has approved this ITR. The methodology followed by TES in performing this review and verification is described by Appendix A to this report.

ITR Reviewed and Approved
IDVP Program Manager
Teledyne Engineering Services

D. C. Stratouly
Assistant Project Manager

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SECTION 1

INTRODUCTION

Interim Technical Report (ITR) No. 34, Revision 1, describes all additional verification work required to be performed on the initial sample. This ITR describes work performed in one of the areas of concern, specifically, environmental consequences of postulated pipe ruptures outside containment. The original analysis which addressed the consequences of the postulated pipe ruptures outside containment at the Diablo Canyon Nuclear Power Plant Unit 1 (DCNPP-1) was performed by Nuclear Services Corporation (NSC) in 1974.

The Independent Design Verification Program (IDVP) reviewed a sample of the analysis performed by NSC which determined environments in areas GE and GW of the auxiliary building and turbine building. In addition, independent calculations of the pressure and temperature transients in these areas were performed. The results of the IDVP review identified concerns which showed that the pressure and temperature transients calculated by NSC were too low. This was reported in ITR No. 14. As a result of the IDVP concerns, the Pacific Gas & Electric Company (PG&E) decided to perform a reanalysis of all the pressure and temperature transients for postulated pipe ruptures outside containment.

The IDVP performed a detailed review of the PG&E reanalysis in areas GE and GW of the auxiliary building and the turbine building since these were the

areas identified as unsatisfactory in the initial review. In addition, the IDVP reviewed the environmental conditions in other areas outside containment to ensure that the concerns identified by the IDVP were addressed by PG&E in the reanalysis.

SECTION 2

SUMMARY

PG&E performed a reanalysis of the environmental consequences of postulated pipe ruptures in all areas outside containment. This reanalysis was performed as a result of concerns identified by the IDVP. The results of the reanalysis yielded new values of pressure and temperature transients.

PG&E supplied to the IDVP the complete reanalysis for areas GE and GW of the auxiliary building and the turbine building. In addition, PG&E supplied portions of the remaining auxiliary building reanalysis. This included the models, mass and energy release data, assumptions, and pressure and temperature results.

The IDVP reviewed the PG&E reanalysis and performed independent calculations of pressure and temperature in area GE and in the turbine building. The results of the review are summarized below:

- The PG&E reanalysis methodology is appropriate.
- The resulting environments calculated by PG&E are satisfactory.
- PG&E utilized the DCNPP-1 licensing commitment as a basis for the reanalysis. In addition, PG&E analyzed a spectrum of main steam line break sizes to produce limiting environments in areas GE, GW, and in the turbine building.

- The specific concerns identified in EOI Files 8001, 7004, 7005, 8003, 8006, 8033, and 8034 have been addressed by PG&E in its reanalysis.

- PG&E has described an Iterative Design Process which will be utilized by PG&E to incorporate the new values of pressure and temperature into the plant design.

Based on the satisfactory review of the PG&E reanalyses, no additional verification is required in this area.

SECTION 3

BASIS OF CONCERN

The results of the initial review by the IDVP identified concerns about the adequacy of the NSC calculations which determined the pressure and temperature values specified for safety-related equipment qualification outside containment. These concerns included the inappropriate application of the computer program CONTEMPT, as well as other analytical errors.

A description of the IDVP's initial scope of work, identification of concerns, and the summary and evaluation of the results are provided in ITR No. 14.

3.1 EOI FILES

Several EOI files were issued as a result of the initial review of the NSC analyses. A description of the EOI files is summarized below:

- EOI File 8001 was originally issued because of the inappropriate application of the computer program CONTEMPT for the calculation of the environment outside containment. This file was later revised to combine the concerns identified in EOI Files 7004, 7005, 8003, 8006, 8033, and 8034 with 8001.

- EOI File 7004 was issued by R. F. Reedy, Inc. (RFR) because PG&E/ NSC could not provide documented evidence that assumptions made in the report "Thermal Hydraulic Analysis of Postulated Pipe Break Outside Containment at Diablo Canyon Unit 1," PGE-01-27, Revision 1 (e.g., certain doors were open or closed and certain penetrations were open) were still valid in view of plant design changes.

- EOI File 7005 was issued by RFR because NSC could not provide documented evidence that calculations were performed for compartments outside containment.

- EOI File 8003 was issued because the enthalpy value used for calculation of the temperature environments in the turbine building was too low.

- EOI File 8006 was issued because documentation necessary to verify the analysis methods and inputs for the turbine building could not be provided.

- EOI File 8033 was issued because it was determined that an inappropriate method was used to model the steam generator for calculation of mass and energy release data.

- EOI File 8034 was issued because the methods used to calculate the pressure and temperature transients in area GE of the auxiliary building did not consider the effects of adjacent compartments.

No EOI files were issued as a result of the additional verification reported in this ITR.

3.2 SCOPE OF ADDITIONAL VERIFICATION

The IDVP developed a scope of work to determine if the concerns identified in the EOI files had been addressed by the PG&E reanalyses. This scope of work is described in ITR No. 34 and is summarized below:

- Perform a computer program sensitivity analysis
- Perform a review of inputs, methodology, and results of sample analyses
- Perform a review of implementation and completeness of remaining analyses.

SECTION 4

ANALYSIS

The IDVP verification of the PG&E reanalyses was accomplished by a review of PG&E calculation methodology and results for a sample analysis; independent calculations of the pressure and temperature transients in area GE of the auxiliary building and the turbine building; a computer program sensitivity analysis; and a review of the calculations for the remaining areas of the auxiliary building. The following subsections describe the verification work performed by the IDVP and the results of the analysis and review.

4.1 COMPUTER PROGRAM SENSITIVITY ANALYSIS

A computer program sensitivity calculation was performed to determine the differences in calculated pressure and temperature transients which could be attributed solely to the use of different computer programs. The analysis was performed using inputs and results for area GE of the auxiliary building at elevation 115 feet-0 inch for a main steam line rupture in area GW at elevation 115 feet-0 inch.

The SWEC computer program THREED was run utilizing, to the maximum extent possible, identical input data used by PG&E in the computer program FLUD. The model and geometric input data developed by PG&E for areas GE and GW were used for the computer program comparison. The input data were obtained from the computer input echo print supplied by PG&E. The Westinghouse mass

and energy release data for a limited displacement double-ended rupture with the reactor at 0 percent power and assuming failure of the main steam isolation valve (MSIV) to close were used to calculate the environments. The mass and energy release data were taken from the computer input echo print supplied by PG&E.

The values of the peak pressure and temperature calculated by each computer program are presented in Table 4-1.

The magnitude of the differences presented in Table 4-1 was used as a guide for comparison of the results between the PG&E analyses and the IDVP independent calculations performed in area GE at elevation 115 feet-0 inch and the turbine building at elevation 140 feet-0 inch.

4.2 REVIEW OF INPUTS, METHODOLOGY, AND RESULTS OF SAMPLE ANALYSIS

An IDVP review was performed of the PG&E documents and analyses listed in Section 4.5 which calculated the pressure and temperature transients in areas GE and GW of the auxiliary building and the turbine building. In addition, the pressure and temperature transients calculated by PG&E in these areas were compared with the results obtained from independent calculations performed by the IDVP. The results of the reviews are summarized below:

- PG&E utilized the Bechtel computer program FLUD. FLUD is designed to predict general pressure and temperature transients in a system of interconnected compartments following postulated pipe breaks.

- Multiple node models were developed by PG&E to calculate the environments in areas GE, GW, and the turbine building. The nodalization of these areas and the resulting models are appropriate. This IDVP conclusion was based on the review of drawings, IDVP field inspection, and comparison with IDVP developed models.

- The position of doors (i.e., open or closed) was selected by PG&E to maximize the pressure and temperature transients in areas GE and GW of the auxiliary building and the turbine building. The doors which would allow venting out of these areas and the doors which would allow venting into certain vital areas of the turbine building were assumed closed, except for the door in area GW at elevation 100 feet-0 inch. This door was assumed to open and provide a vent path if the door design pressure was exceeded. The assumptions concerning closed doors are conservative for areas in which PG&E has calculated pressure and temperature effects due to pipe ruptures; however, for areas assumed isolated, justification for the doors remaining closed will be addressed by PG&E. PG&E has committed in its Iterative Design Process to address the results of the postulated pipe rupture pressure and temperature

reanalysis to verify that the doors are able to withstand the resulting pressure transients and remain closed or be modified as required.

- The methodology utilized by PG&E to calculate the required input data (e.g., loss coefficients, inertia terms, vent areas) was appropriate. This conclusion was based on a comparison with the IDVP's methods, as well as the methods described in NUREG/CR-1199, LA-8169-MS, Subcompartment Analysis Procedures.

- The mass and energy release data utilized to calculate the environments in areas GE of the auxiliary building and the turbine building were appropriate. PG&E used Westinghouse developed mass and energy release data without liquid entrainment. A spectrum of break sizes with various plant operating conditions was analyzed by PG&E to determine the most limiting environments in these areas. The main steam line double-ended rupture with the reactor power level of 0 percent was determined by PG&E to produce the peak compartment pressures in area GE and GW of the auxiliary building and the turbine building. The peak temperatures in these areas resulted from analyzing a 0.908 foot^2 main steam line split rupture.

Independent calculations of the pressure and temperature transients due to a main steam line rupture were performed by the IDVP. The independent cal-

culations were performed in the area GE of the auxiliary building and the turbine building. The SWEC computer program THREED was used to calculate the environments. The IDVP models for these areas were developed based on the review of drawings and field inspection. The mass and energy release data for two break sizes, a main steam line double-ended rupture and a 0.908 foot^2 main steam line split rupture, were developed by the IDVP to determine the environments.

The peak pressure and temperature calculated by the IDVP in area GE at elevation 115 feet-0 inch and the turbine building at elevation 140 feet-0 inch were compared against the results calculated by PG&E in the same areas. The comparisons between the results are shown in Table 4-2. The differences between the results are explained below:

- The higher peak temperature calculated in area GE by PG&E was due to differences in mass and energy release data. The mass and energy release data PG&E utilized was developed by Westinghouse for the PG&E reanalysis work outside containment. The IDVP utilized Westinghouse mass and energy release data previously supplied by PG&E that was developed for a main steam line split rupture inside containment and modified by the IDVP for use outside containment. This modification consisted of utilizing the Westinghouse mass and energy release data from 0 to 94.5 seconds as provided. The mass and energy release data were held constant from 94.5 seconds until 600 seconds when operator action was assumed to have

isolated flow. This resulted in a minor difference in peak enthalpy values that were utilized, 1,205 Btu/lbm used by PG&E and 1,203 Btu/lbm used by the IDVP.

- The higher peak pressure calculated in area GE by PG&E was due to differences between the computer program and minor differences between the geometric input data.

- The higher peak temperature calculated in the turbine building by PG&E was due to a difference in mass and energy release data. The differences between the mass and energy release data were the different peak enthalpy values utilized in the long term as explained previously.

- The higher peak pressure calculated in the turbine building by PG&E was due to the differences between the computer program and minor differences between the geometric input data.

The review of the PG&E reanalysis and the independent calculation of pressure and temperature transients in area GE of the auxiliary building and the turbine building revealed that appropriate pressure and temperature transients were developed. Differences between the pressure and temperature environments calculated by PG&E and the IDVP are attributed to variations of input parameters (e.g., mass and energy release data) and computer programs that have been explained in this section.

4.3 REVIEW OF THE IMPLEMENTATION AND COMPLETENESS OF REMAINING AREAS

The IDVP reviewed the PG&E documents and analyses (identified in Section 4.5 as the Auxiliary Building Analysis) which calculated the pressure and temperature transients in the remaining areas of the auxiliary building. The review was performed to ensure that the calculational methods verified by the IDVP in Section 4.2 for area GE and the turbine building were employed by PG&E in the remaining areas of the auxiliary building. The results of the review are summarized as follows:

- The models for the remainder of the auxiliary building were developed by PG&E utilizing the following procedures:

  1. The identification and tracing of high energy lines, as well the identification of pipe break locations.

  2. The identification of compartments containing Class I equipment to ensure that the compartments are analyzed.

  3. The development of the building model by the review of drawing and plant walkdown to verify the as-built conditions.

  4. The models were developed assuming fire and security doors were closed; however, once the design pressures for the doors were exceeded, the doors were assumed to open and provide vent paths.

Based on the methods previously described, the procedure utilized by PG&E to develop the models for the remainder of the auxiliary building is consistent with that used in the reanalysis reviewed in Section 4.2.

- The mass and energy release data were developed by PG&E. Two types of breaks were considered: double-ended pipe ruptures and pipe cracks. The determination of the type of break considered in each high energy line was based on the criteria taken from the Giambusso letter, dated December 18, 1972. This letter is the DCNPP-1 licensing criteria for evaluation of the effects associated with pipe ruptures outside of containment.

PG&E utilized the following two methods to calculate the mass and energy release data:

1. Hand calculations based on the Moody Steady Slip Model which calculated a maximum flow rate for one point in time. The constant flow rate was assumed to continue until the break was isolated. This method was used for compressed water lines and saturated steam lines.

2. The use of the computer program RELAP4 MOD5 for the calculation of the transient mass and energy release data. This

method was used to analyze circumferential pipe breaks in the main steam supply line to the turbine-driven auxiliary feedwater pump.

The mass and energy release data was assumed to continue for 30 minutes after detection when operator action was assumed to isolate the break flow. Based on the methods described previously, appropriate methods were utilized to calculate the mass and energy release data.

- The assumptions (e.g., door positions) selected by PG&E are consistent with those previously reviewed in areas GE, GW, and the turbine building. Justification of assumptions will have to be addressed by PG&E in its Iterative Design Process for new pressure and temperature results.

- The pressure and temperature results were developed utilizing the Bechtel computer program FLUD.

- The pressure and temperature transient results were reviewed by the IDVP. PG&E stated that these results are conservative for the break compartment only and that these results may not be conservative for compartments that are downstream of the break compartment due to the low driving pressure in the break compartment. The IDVP agrees with this assessment of the results. When small mass

and energy releases in the break compartment result in low differential pressure between compartments, other effects such as ventilation flows and convection mixing due to density differences must be considered. PG&E has stated that a future revision to these calculations will include the heating and ventilation system operation, and under these conditions, the mass transfer between compartments will be significantly enhanced. This assumption will be addressed by PG&E as part of the Iterative Design Process, discussed in Section 5.

The IDVP has concluded that the methodology used by PG&E in the reanalysis of the remaining areas in the auxiliary building was consistent with that used in areas GE, GW, and in the turbine building.

4.4 ACCEPTANCE CRITERIA

The PG&E reanalyses of the environmental consequences due to pipe ruptures outside containment are acceptable if the IDVP concurs that all appropriate areas have been considered and if the concerns listed below are addressed:

- Assumptions concerning door positions,
- All areas containing safety-related equipment,
- Use of an appropriate multiple node computer program,
- Appropriate enthalpy values of release,

- Appropriate calculation for steam generator releases or use of Westinghouse supplied data, and

- Consideration of adjacent compartments.

4.5 DOCUMENTATION USED

The following PG&E information was used by the IDVP to review the PG&E reanalysis of the consequences of postulated pipe ruptures outside containment:

General Information

FLUD Code Description

Turbine Building Analysis

Physical Characteristics of Compartments

FLUD Input-Physical Data

FLUD Input-Blowdown Data

Temperature Response above El. 140 Ft

Temperature Response El. 85 Ft

Pressure Response above El. 140 Ft

Pressure Response El. 85 Ft

GE/GW Areas Analysis

Physical Characteristics of Compartments

Physical Characteristics of Compartments-Supplement

FLUD Input-Physical Data

FLUD Input-Split Break Blowdown Data

FLUD Input-Limited DER Blowdown Data

Temperature Responses

Pressure Responses

Auxiliary Buildings Analysis

Physical Characteristics of Compartments

Worst Pipe, Worst Break, Deletion of Vent Paths

Input-Blowdown Data

FLUD Input-Physical Data

Temperature Responses

Pressure Responses

TABLE 4-1

RESULTS OF THE COMPUTER PROGRAM SENSITIVITY ANALYSIS

Computer Program	Area GE Peak Pressure (psia)	Area GE Peak Temperature (°F)
THREED (IDVP)	21.04	322.16
FLUD (PG&E)	24.07	321.34

TABLE 4-2

COMPARISON BETWEEN IDVP RESULTS AND PG&E RESULTS

	IDVP Results		PG&E Results	
Area	Peak Pressure (psia)	Peak Temperature (°F)	Peak Pressure (psia)	Peak Temperature (°F)
GE	20.73	323.34	24.07	326.6
Turbine	15.3	303.45	16.09	310

SECTION 5

CONCLUSIONS

The review of the PG&E reanalysis of the consequences of postulated pipe rupture outside containment has been completed. The review was performed to ensure that the IDVP's concerns identified in Section 3.1 have been addressed by PG&E in its reanalyses. The conclusion of the review is that the PG&E reanalyses are proper. This conclusion is based on the IDVP's review as described in Section 4; therefore, no additional verification is required in this area.

The original concerns identified the inappropriate use of the computer program CONTEMPT and other analytical errors. PG&E has performed a reanalysis of the environmental consequences of postulated pipe rupture outside containment to address the IDVP concerns. In addition, PG&E has described an Iterative Design Process which will be utilized to incorporate the new pressure and temperature results into the plant design. Revisions to pressure and temperature calculations reviewed by the IDVP may also occur as part of the Iterative Design Process. These revisions do not require verification based on the positive results of the IDVP review described in Section 4.

APPENDIX A

PROGRAM MANAGER'S ASSESSMENT

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PROGRAM MANAGER'S ASSESSMENT

Independent review by TES of the tasks performed by SWEC to verify the Diablo Canyon Project (DCP) efforts was done in accordance with the IDVP Phase II Program Management Plan and ITR-34.

ITR-34, Revision 1, issued on March 24, 1983, identified five (5) areas of concern which required additional verification. The work was performed by the DCP and the conclusions were verified by SWEC.

This ITR describes the work performed by the DCP for the concern of environmental consequences of postulated pipe ruptures outside containment. The results are reported herein.

The DCP performed a reanalysis of the environmental consequences of postulated pipe ruptures in areas outside the containment. The IDVP verification and independent calculations concluded that the reanalysis adequately addressed the original concerns.

Accordingly, no further additional verification is required.

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REVISION 0

ADDITIONAL VERIFICATION OF CIRCUIT SEPARATION AND SINGLE FAILURE REVIEW OF SAFETY-RELATED ELECTRICAL EQUIPMENT

STONE & WEBSTER ENGINEERING CORPORATION