U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF SPECIAL PROJECTS

Comanche Peak Project Division

Report Numbers: 50-445/88-29, 50-446/88-25

Docket Numbers: 50-445, 50-446

Licensee: TU Electric
400 North Olive St., L. B. 81
Dallas, Texas 75201

Facility Name: Comanche Peak Steam Electric Station (CPSES)

Inspection At: Stone and Webster, Boston, Massachusetts and Cherry Hill, New Jersey
Ebasco, CPSES

Inspection Period: February 22 through March 29, 1988

Inspection Team: NRC
D. P. Norkin, OSP/CPPD - Team Leader
F. S. Ashe, OSP/CPPD - Electrical
Contractors
G. M. Aggarwal, Electrical
P. Fredricks, I&C
D. A. Mehta, Systems Interaction
F. R. Rosse, Mechanical Systems
G. E. Tuday, Systems Interaction
T. C. Yu, Systems Interaction

Donald P. Norkin 4-13-88
Donald P. Norkin Date
Team Leader
Office of Special Projects

Approved By: J. E. Lyons 4/13/88
James E. Lyons Date
Assistant Director for Technical Programs

Table of Contents

Individuals Participating in Inspection/Exit Meetings

J. S. Carty	Project Eng.	Stone & Webster Eng. Corp.
J. E. Woods	Audit Response Coord.	Stone & Webster Eng. Corp.
C. C. Zappile	EFE Program Mgr.	Stone & Webster Eng. Corp.
R. W. Twigg	EFE Team Leader	Stone & Webster Eng. Corp.
T. H. Hayes	Mech. Coordinator	Stone & Webster Eng. Corp.
W. A. Polin	Mech. Engineer	Stone & Webster Eng. Corp.
R. W. Card	Mech. Engineer	Stone & Webster Eng. Corp.
C. D. Nardella	Asst. Project Eng.	Stone & Webster Eng. Corp.
E. F. Heneberry	Lead Elec. Eng.	Stone & Webster Eng. Corp.
F. P. Walker	Asst. Lead Elec. Eng.	Stone & Webster Eng. Corp.
R. Shustrin	Electrical Eng.	Stone & Webster Eng. Corp.
M. A. Mellot	Electrical Eng.	Stone & Webster Eng. Corp.
K. R. Bedell	Electrical Eng.	Stone & Webster Eng. Corp.
R. G. Brunner	Electrical Eng.	Stone & Webster Eng. Corp.
K. J. Khunkhun	Electrical Eng.	Stone & Webster Eng. Corp.
J. H. Lash	Asst. QA Prog. Mgr.	Stone & Webster Eng. Corp.
J. C. Hicks	Licensing Eng.	TU Electric Company
H. A. Marvray	Licensing Eng.	TU Electric Company
J. W. Muffett	Mgr. Civil Eng.	TU Electric Company
J. J. LaMarca	Elec. Eng. Mgr.	TU Elctric Company
I. Ahmad	Elec. Sys. Supervisor	TU Electric Company
D. A. Lowrie	Mech. Eng. Srv. Mgr.	TU Electric Company
D. A. West	Sys. Interaction Spvsr.	TU Electric Company
S. L. Smith	Mech. Eng. - SIP	TU Electric Company
D. G. Patankar	Mech. Eng. - SIP	TU Electric Company
R. G. Leo	Program Mgr. - SIP	Ebasco Services
T. A. Flynn	Asst. Prog. Mgr. - SIP	Ebasco Services
J. Moores	Supervisor, Walkdown	Ebasco Services
T. Kosmopoulos	Supervisor, App. Mech.	Ebasco Services
S. Jung	Lead App. Mech.	Ebasco Services
L. K. Fernandez	Lead, Systems	Ebasco Services
P. L. Panasci	Lead, Walkdown	Ebasco Services
V. Thigarajan	Lead, Env. Analysis	Ebasco Services
A. Canbronero	Flooding Engineer	Ebasco Services
L. Barath	Systems Engineer	Ebasco Services
F. Bracy	Designer, Walkdown	Piping Design Serv. (PDS)
L. Schaefer	Walkdown Engineer	Piping Design Serv. (PDS)
J. Johnson	Vice President	Earthquake Eng. (EQE)
B. Benda	Principal Engineer	Earthquake Eng. (EQE)

Introduction and Summary

Background

Inspection Reports 50-445/87-19, 50-446/87-15 dated October 15, 1987 and 50-445/87-37, 50-446/87-28 dated February 8, 1988, document the results of NRC inspections of the Comanche Peak Design Validation Packages (DVPs) in the areas of mechanical systems, HVAC systems, civil/structural, electrical, instrumentation/controls, and systems interaction. The current inspection was intended to review important DVP work which was not completed in time to be included in the earlier inspections. These included implementation of the systems interaction Design Basis Documents (DBDs), electrical redesign for the 6.9Kv emergency power system, and analyses for certain operating modes for the component cooling water system.

Method of Review

The method of review was essentially identical to that of the previous reviews because the type of product reviewed was the same, i.e., the DVPs. The inspection focused on design criteria and their implementation. The team reviewed design criteria contained in DBDs and other documents, such as calculations, which demonstrated implementation of criteria. Open items were identified where the team could not conclude that the criteria were: (a) consistent with the FSAR and industry standards/practice, (b) adequate to ensure system functionality, (c) clear enough to ensure adequate implementation, or (d) implemented in the design.

The systems interaction inspection involved both document reviews and complementary field walkdowns. The team reviewed the development of zones of influence for interaction sources, documentation of source/target interactions, and documentation of actions taken to ensure that the interactions will not preclude safe shutdown of the reactor nor prevent mitigation of the consequences of the event. All three of these elements involved field walkdowns by the team. For the seismic/non-seismic interaction program, the field walkdowns identified non-seismic potential sources, developed zones of influence for these sources, identified safety-related targets within these zones, and evaluated the ability of targets to withstand impacts from sources. For the pipe break postulation/effects program, the field walkdowns were used to determine whether Ebasco walkdowns had identified all safety-related targets within the zones of influence for postulated pipe breaks.

Summary of Results

The remainder of this report contains a two-part section for each discipline. The initial part is a summary of (1) the rationale for the review sample and how it complemented that for the previous inspection of the DVPs and (2) open items. The second part documents the team's review of each design document in the review sample. This part identifies open items where further information or action is necessary for the team to conclude the document is adequate. For such documents, the team generally did not document all of the areas that were found acceptable; instead, the emphasis was on explaining the basis for the open items. For documents reviewed where no open items were identified, the report presents the team's rationale as to why the design criteria are adequate and the calculation or other design document demonstrates compliance with the design criteria.

As in the case of the previous inspections, the team generally found the DVP effort comprehensive and effective. Our final conclusions will depend upon the applicants' responses to open items identified in the three inspections. Since these inspections represented a small sample of the DVP effort, these responses need to address the significance and extent of conditions for each open item in order for the NRC to reach final conclusions on the entirety of the DVP process.

Some of the more significant open items identified in the current inspection were:

1. Systems Interaction

    (a) Not assuming failure of a single active component on systems and components required to mitigate the consequences of the pipe break and shut down the reactor (Open Items S-16 and S-17)

    (b) Not considering pipe whip restraints as jet impingement targets (Open Item S-18)

    (c) Lack of justification for deviation from SRP 3.6.2 and ANS 58.2 design limits for pipe whip restraints (Open Item S-21)

    (d) Lack of mass point spacing criteria in DBDs and pipe rupture calculations (Open Item S-22)

    (e) Need to complete analyses demonstrating ability to safely shut down the plant for cases where safety-related targets are impacted by pipe whip or jet impingement. (Open Item S-30)

2. Electrical

    (a) Lack of documented evidence of capability of diesel generator to accept current design step loads without exceeding specification limits. (Open Item E-32)

    (b) Need for the voltage profile calculation (down to 480Vac motor control centers) to address extreme voltage conditions (Open Item E-34)

3. Mechanical/Fluid Systems

    (a) Failure to assume worst case pipe break in CCW system analysis (Open Item F-44)

    (b) Need to address items pertinent to the effect on the CCW system of thermal barrier heat exchanger tube rupture (Open Items F-50 and 51)

SYSTEMS INTERACTION, PIPE BREAK POSTULATION AND EFFECTS - SUMMARY

1. Review Sample

Based upon the task description and the DBDs, it was noted that there were many similarities between the Pipe Break and Missile Postulation/Effects tasks. Both tasks generate zone of influence drawings through calculations and identification of sources. The zones of influence are walked down in the field and safety-related targets identified for further evaluation against a shutdown analysis. At the time of the inspection, no missile walkdowns had been completed. It was felt by the team that due to the similarities between the two tasks, a review of the implementation for the Pipe Break Postulation/Effects task would essentially cover the implementation of both tasks.

The Pipe Break Postulation/Effects task covers several subtasks for high and moderate energy line breaks (HELB and MELB):

- HELB Pipe Whip Evaluation
- HELB Jet Impingement Evaluation
- HELB Spray Evaluation
- HELB/MELB Flooding Analysis
- HELB Environmental Analysis

Each of these subtasks involves a calculational and field walkdown portion, followed by an evaluation phase. For the first four subtasks, the calculation phase establishes sources and determines zones of influence. The walkdown phase identifies safety-related targets in the zones of influence which are then evaluated against a shutdown analysis. The HELB Environmental Analysis calculates mass and energy releases into modeled areas to determine pressure and temperature transients following postulated piping ruptures. Walkdowns verify the compartment junctions and confirm any assumptions made regarding physical plant features.

a. Calculations

Flooding Analysis - The flooding analysis for the Safeguards Building was selected for review since this building has the most varied flooding inputs due to the large number of systems present. This building also houses most of the safety-related systems necessary to shut down the plant.

HELB System Analysis - Two calculations were reviewed that examined the detection and mitigation scenarios for breaks in the Safeguards Building as well as determining mass and energy releases. A third calculation was reviewed which modeled mass and energy releases for the 1.0 sq. ft. non-mechanistic break in the feedwater "superpipe" region.

HELB Environmental Analysis - Calculations for the pressure and temperature transients following pipe breaks were reviewed for the main steam and feedwater penetration area since they provide significant input to structural and equipment qualification programs. Another calculation evaluating the results of a postulated break in the Safeguards Building was reviewed for the reasons stated under flooding analysis, above.

Pipe Rupture Analysis - A sample of pipe rupture analyses was reviewed for breaks both inside and outside containment. These analyses evaluate the potential for pipe whipping and are used to develop the zone of influence drawing. There are two types of pipe rupture analyses: unrestrained and restrained. The unrestrained analysis uses a hand calculation to determine hinge points for pipe whip. The restrained analysis utilizes a computer code, such as PIPERUP, to determine the response of a restrained piping system, such as deflections and loads on whip restraints.

In addition, a representative jet impingement shield design calculation was reviewed.

b. Field Walkdown

As discussed previously, all of the subtasks have a field walkdown verification program. Since the HELB pipe whip and jet impingement walkdowns have the highest potential for impacting plant safety and all of the walkdown programs were conducted along similar lines, the team decided to review only the pipe whip and jet impingement walkdowns.

During the calculation review of the unrestrained rupture analyses (the restrained analyses were reviewed after the site inspection), specific break nodes were selected for site review. The objective of the team's site inspection was to recreate the Ebasco field walkdown and verify the targets contained on the HELB Interaction Form. In some of the cases, the selected break node was not reviewed because either the walkdown had not been completed, or the break had been deleted. In these cases, other breaks were selected for review.

2. Open Items:

Open Items S-16 and S-17 indicate that HELB system analyses did not assume a single active component failure on systems and components required to mitigate the consequences of the break and to shut down the reactor.

Open Item S-18 concerns a pipe whip restraint which was not considered as a target for jet impingement. Clear instructions were apparently not provided to the walkdown team for identification of targets.

Open Item S-19 on pipe rupture analysis concerns a revision to a calculation which deleted information needed elsewhere in the calculation to determine pipe whipping potential.

Open Item S-20 concerns two targets that were not entered on the HELB Interaction Record form.

Open Item S-21 on restrained pipe rupture analyses concerns the design limits for plastic deformation.

Open Item S-22 on restrained pipe rupture analyses concerns the mass spacing criteria for application of the PIPERUP Code.

Open Items S-23, S-24, and S-25 on specific restrained pipe rupture analyses concern items requiring clarification, either in the calculations reviewed or in the DBDs or procedures.

Open Item S-26 on the design of jet impingement shields concerns using design criteria for the wrong building.

Open Item S-30 concerns the need to complete analyses demonstrating the ability to safely shut down the plant for cases where safety-related targets are impacted by pipe whip or jet impingement.

Systems Interaction, Pipe Break Postulation and Effects -
Evaluation of Documents Reviewed

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-652, Rev. 0, dated 12/19/87, "Safeguards Building - Flooding Analysis"

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 0, dated 7/20/87, "Pipe Break Postulation and Effects"

Section 5.5 provides requirements for performing flooding evaluations from a variety of flood inputs.

b) EME-2.24-02, Rev. 1, dated 9/21/87 and EDCN-01, dated 10/27/87, "Flooding Analysis"

This technical procedure provides methodology for performing flooding analyses.

3. Compliance With Design Criteria:

The calculation determined expected flooding levels in the Safeguards Building. The events evaluated included:

High energy line break
Moderate energy line break
Non-seismically designed tank failure
Failure of non-seismically designed threaded connection
Inadvertent actuation of fire protection system
Backflow to/from other compartments

Proper allowances were made for areas where significant equipment would reduce net wetted floor areas. Cross-flooding of communicating areas was properly considered. Inventory contained in the piping after the break was also considered. Flow detection for all events was modeled as 30 minutes except for the RHR pump lines which were considered to be isolable from the Control Room in 10 minutes.

Ten open items were generated by Ebasco as a result of the calculation with regard to confirmation and verification of inputs and assumptions.

The calculation approached the problem in a very methodical manner and utilizes a checklist-type format to assure that all areas are addressed. The results appear reasonable based on the input and items requiring verification.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-666, Rev. 0, dated 12/2/87, "HELB System Analysis - Room 113"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Section 4.3 requires a single active failure to be assumed in any systems used to mitigate the consequences of a postulated piping failure and to shut down the reactor.

3. Compliance With Design Criteria:

The calculation reviews the pipe break detection and mitigation methods for the high energy lines in Room 113 of the Safeguards Building and calculates mass and energy releases for the breaks to be used in an environmental analysis.

The detection and mitigation schemes presented for the auxiliary steam system and the shell side of the SG Blowdown Heat Exchanger appear to be logical and reasonable, and will provide either redundant or diverse detection and isolation. Those valves that must be manually closed to isolate the break appear to be physically isolated from the break and will be accessible to personnel.

The mass and energy release values were reviewed and found to be calculated in accordance with industry accepted practice and appear to be reasonable in magnitude.

OPEN ITEM S-16

Sheet 7 of the calculation credits a single flow switch per train for mitigation of a steam generator blowdown (SGBD) break. Drawing ECE-M1-0202, Rev. CP4 and ICD-2323-M1-2202, Sht 06A, Rev. CP-2 indicate that the activation of any flow switch on the SGBD lines would close all 8 outboard isolation valves automatically. Failure of the flow switch to actuate the valves would prevent isolation of the break within the timeframe calculated. The calculation did not address the failure of the flow switch. The team does not consider this to be a technical problem because other switches would be activated and would perform the isolation function. However, the calculation did not indicate this.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-669, Rev. 0, "HELB System Analysis Break Room 80"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Breaks Postulation and Effects"

Section 4.3 requires that a single active failure be assumed in any systems used to mitigate the consequences of a postulated piping failure and to shut down the reactor.

3. Compliance With Design Criteria:

The calculation examines breaks in the letdown system at terminal ends both upstream and downstream of the Letdown Heat Exchanger in Room 80 of the Safeguards Building. The calculation indicated the following actions based on instrument indications:

Instrument	Indication	Action
PS-5385	Low pressure alarm UA-5385	Operator close isolation valves (UPS)
TE-130	Low temp readout on CB-06	Operator close isolation valves (UPS)
PI-131	Low line pressure on CB-06	PCV-131 automatically shuts (DNS)
FE-132	No flow on FI-132 on CB-06 (input into computer)	Operator close isolation valves (UPS)

All instrumentation is located downstream of the Letdown Heat Exchanger. The calculation concluded that the operator would be able to complete operations to isolate the break within 10 minutes.

OPEN ITEM S-17

The calculation credits a single non-redundant alarm (UA-5385) for detection, but it appears that single active failure of this alarm was not addressed. In addition, low readouts from TE-130, PI-131, and FE-132 apparently do not activate alarms on the control boards but, instead, an operator is required to monitor the actual process readout (temperature, pressure or flow). It appears unlikely that these gauges will be read often enough to support an isolation time of 10 minutes after the break. In addition, the assumption of an 11-minute blowdown time may be unrealistic.

It is noted that this is not the bounding break for Room 80, but may become bounding if the single failure criteria is properly addressed.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-672, Rev. 0, dated 10/15/87, "HELB System Analysis - Review of G&H Calculation #541, pages 53 through 71, Rooms 100 A1 through A8"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Section 5.5 of the DBD provides requirements for evaluation of environmental effects from postulated breaks.

3. Compliance With Design Criteria:

The calculation reviewed the mass and energy release from a 1.0 square foot break in the superpipe region of the feedwater system. The calculation concludes that the mass and energy releases (blowdown) calculated by Gibbs & Hill are conservative.

The assumptions used to model the system blowdown were reviewed by the team. The calculation assumes operating conditions such as full power temperature with no load condition pressure in order to provida maximized conditions for blowdown. The length of feedwater pipe used to develop inventory in the line was conservatively modeled, as was the time assumed to trip the feedwater pumps.

The team concluded, based on the above assumptions, that the subject calculation conservatively calculated blowdown from a 1.0 square foot break in the feedwater system.

1. Document Number:

Ebasco Calculation CPE-SI-CA-000-684, Rev. 0, dated 10/8/87, "Environmental Analysis - Break in Feedwater Penetration Area - Unit 1"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Section 5.5 provides requirements for evaluation of environmental effects from postulated breaks.

3. Compliance With Design Criteria:

This calculation determined the environmental response of the penetration area to a 1.0 sq. ft. break in the superpipe region of the feedwater lines. The mass and energy release was taken from calculation CPE-SI-CA-0000-672, Rev. 0, which was reviewed by the team and is discussed elsewhere in this report. The area model was taken from calculation CPE-SI-CA-0000-683, Rev. 0, which was also reviewed by the team for the area model only. Calculation -683 models the volumes and junctions based on field walkdown data. The resulting model appeared to be an accurate representation of the area. The physical model credits fire sprinkler system activation to help reduce long term temperature. The activation time delay is based upon test results of the sprinkler heads. The fact that the analyst did not utilize the heat transfer feature of the COMPARE-MODIA Code was conservative.

The subject calculation yields a peak pressure in Room 100A-8 that is bounding for both main steam and feedwater calculations; the main steam break as calculated in -683 provided the bounding temperature.

The peak compartment pressure differentials were transmitted to SWEC via letter No. EB-T-6127, SI-0269, dated 10/15/87 and to Impell via letter No. EB-T-6128, SI-0270, dated 10/15/87 for equipment qualification evaluation. At the time of the inspection, no response has been received from either organization.

It is concluded that the combined effects of conservative mass and energy release data from calculation -672 and not considering the heat transfer into the room concrete and steel structures results in conservative pressures and temperatures.

1. Document Number:

   Ebasco Calculation CPE-SI-CA-0000-699, Rev. 0, dated 12/14/87, "Environmental Analysis - Break Room 113"

2. Applicable Design Criteria:

   DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

   Section 5.5 of the DBD provides requirements for evaluation of environmental effects from postulated breaks.

3. Compliance With Design Criteria:

   The calculation takes mass and energy release data from calculation CPE-SI-CA-0000-666, Rev. 0, and calculates the pressure and temperature response of Room 113 and connected rooms.

   Modeling of the volumes and interconnecting junction inertias is based on standard industry practice and was taken from walkdown data.

   Assumptions were made regarding plant features and their ability to prevent the transport of hot gases. SIPG Open Item Log No. 171 was written to highlight the need to verify these assumptions. Letter EB-T-6856, dated February 12, 1988 from Ebasco to SWEC requested that SWEC confirm the assumptions and implement any necessary modifications to validate them.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-714, Rev. 0, dated 10/26/87, "Pipe Rupture Analysis - Auxiliary Feedwater System Outside Containment Problem 10B&C Unrestrained"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break. Open Item S-7 discussed the review of this design criterion.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the auxiliary feedwater lines outside containment for use in determining zones of influence. The calculation reviews the unrestrained portions of the piping for whipping.

Calculation of the whipping potential of all breaks contained in Problems 1-10 B&C was found to be correctly accomplished utilizing the design criteria in Attachment 4 of the DBD.

OPEN ITEM S-18

During the team's field walkdown to verify the HELB interaction record for Problem 1-10C, Break 593C, it was found that pipe whip restraint AF-1-096-901-S57W was not listed as a target of the jet from the downstream portion of the break. Based on the team's discussions with Ebasco, it appeared that the walkdown documentation excluded the restraint from consideration as a jet target. The restraint was either considered to be a structure (which is exempt from jet and pipe whip consideration for source sizes under 6" diameter) or a moment restraint (which is also exempt by design).

The team's concern is that pipe whip restraints are devices engineered to withstand a given pipe whip load. If the restraint experiences a jet load from the non-restrained portion of the break concurrently with the whip load, as is the case here, the restraint must be evaluated to assess both loads. The procedure covering the HELB target identification does not provide sufficient guidance for proper identification of pipe whip restraints as jet targets.

The walkdown interaction record was reviewed for the adjacent room 100A-2, also shown on zone-of-influence (Z of I) drawing 1ZI 100A, Sheet 2 of 3. This room is essentially a mirror image of the room reviewed above. It was found that jet loading on the similar restraint AF-1-098-901-S-57W was also not identified; thus, this is not an isolated case. Pipe whip restraints were identified as jet targets on other non-related cases that were walked down as part of this inspection.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-751, Rev. 0, "Pipe Rupture Analysis, Problem #1-40"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the letdown system inside containment for use in determining zones of influence. In particular, this review examined break 67C on line 3" CS-1-077-2501R-2.

Pipe break locations are derived from SWEC calculation #15454-NM(E)-CS-1-40-PB, Rev. 0, from which pertinent pages were attached as Attachment B to this subject calculation. The data contained in the SWEC calculation appeared to be reasonable and was presented in a manner that could be clearly understood.

The plastic hinge lengths and elastic limit lengths were calculated in accordance with the guidelines of Attachment 4 of the DBD.

Break 67C was selected for field review. Zone of Influence Sketch 1Z19 Rev. CP-2 was reviewed for break 67C. The Z of I appeared to correctly apply the guidelines provided in the DBD.

At the time of the field inspection, the walkdown of this break had not been completed and therefore was not available for review.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-588, Rev. 0, dated 12/2/87, "Pipe Rupture Analysis, CVC System, Problem 1-4A"

2. Applicable Design Criteria:

DBD-ME-077, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the letdown portion of the Chemical and Volume Control System in containment for use in determining zones of influence.

Calculation of whipping potential of all of the breaks contained in Problem 1-42A was found to be correctly accomplished utilizing the design criteria in Attachment 4 of the DBD. The design criteria were accurately interpreted and the results are presented such that they may be clearly understood.

Break 693C was selected for site review. Zone of influence drawing 1ZI 31, 34 Revision CP-2 was reviewed for break 693C. The Z of I appeared to correctly apply the guidelines provided in the DBD.

Calculation Change Notice No. 1 to Calculation CS-1-042A-PB, Rev. 1 (the SWEC pipe stress calculation) was reviewed at the site and showed that Break 693C was deleted during an update of the stress analysis.

1. Document Number:

Ebasco Calculation TNE-DS-CA-0000-615, Rev. 0, dated 11/24/87, "Pipe Rupture Analysis - Steam Generation Systems - Problem 1-079E&F"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the steam generator blowdown system outside containment for the purpose of determining zones of influence. The calculations addressed both circumferential and longitudinal breaks in piping. Calculation of the whipping potential of the circumferential breaks was found to be in accordance with the criteria of Attachment 4 of the DBD. The criteria were correctly interpreted and the results clearly presented. There are no criteria in the DBD regarding the calculation of plastic hinges due to longitudinal breaks; however, the assumptions made were reasonable and the methodology appeared to conform with industry standards.

Break 702C was selected for field review. Zone of influence drawing 1ZI 88, Rev. CP-3 was reviewed for the break. The Z of I drawing appeared to correctly apply the guidelines of the DBD.

The HELB Interaction Record Form for Problem 1-79E, break 702C dated 2/18/88, was reviewed during a field walkdown. The HELB Interaction walkdown is performed in accordance with procedure CPE-EB-FVM-SI-34, Rev. 1 dated 6/11/87, including ICN-03, "Field Verification Method, High Energy Line Break Target Identification." Utilizing the Zone of Influence Drawing 1ZI 88, Rev. CP-3, it was concluded that the above HELB Interaction Record was accurately completed.

OPEN ITEM S-30:

At the time of the review, the evaluation of targets identified in the HELB Interaction Record had not been performed. This is a generic comment which applies to all cases where the team performed a walkdown to validate Ebasco target identification. Resolution of this item will require the team's inspection of a sample of target evaluations, preferably for the cases addressed in this report (see the succeeding calculations).

1. Document Number:

Ebasco Calculation TNE-DS-CA-0000-567, Rev. 1, dated 2/22/88, "Pipe Rupture Analysis - Auxiliary Feedwater System Outside Containment - Problem 1-12A, B, D, and E

2. Applicable Design Criteria:

DBD-ME-007, Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the auxiliary feedwater lines serving the motor driven auxiliary feedwater pumps outside containment for use in determining zones of influence.

Calculation of the whipping potential for all of the breaks contained in Problems 1-12A, B, D, and E was found to be correctly accomplished utilizing the design criteria in Attachment 4 of the DBD, as well as additional computer analysis using the ABAQUS" Dynamic Analysis Code. The design criteria were accurately interpreted and the results are presented such that they may be clearly understood.

Break 781C was selected for site review. Zone of influence drawing 1ZI-72, Revision CP-2 was reviewed for break 781C. The Z of I appeared to correctly apply the guidelines provided in the DBD. Break 781C was not available for field review since the HELB interaction record was not complete.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-733, Rev. 0, dated 12/2/87, "Pipe Rupture Analysis - RHR Inside Containment, Problem 1-26A&B (unrestrained)"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the PHR system inside containment for use in determining zone of influence. This calculation reviews the unrestrained portions of the pipe for whipping.

Calculation of the pipe whip potential for the breaks of Problem 1-26A&B was found to be correctly accomplished utilizing the criteria of Attachment 4 of the DBD. The criteria were correctly interpreted and the results clearly presented.

Several of the breaks in Problem 1-26A&B are prevented from free whipping by the use of bumper restraints. The loads on these restraints were calculated in Calculation No. CPE-DS-CA-0000-610, Rev. 1, dated 2/22/88. This calculation developed restraint loads utilizing the PIPERUP computer code. The calculation was not reviewed in detail; however, the input data preparation appeared to conform to industry standards and output loads appeared reasonable. The team reviewed PIPERUP implementation in more detail for other calculations covered in this report.

1. Document Number:

Ebasco Calculation TNE-DA-CA-0000-542, Rev. 0, dated 12/16/87, "Pipe Rupture Analysis Problem #1-77"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Break Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

This calculation references an Ebasco procedure for determining the plastic hinge locations, as the DBD was not issued at the time the calculation was performed. The referenced procedure was reviewed and found to be equivalent to the DBD procedure.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the steam generator blowdown system serving steam generator #3, inside Containment for use in determining zones of influence.

The calculation of the pipe whip potential and plastic hinge location for all given break points evaluated in the calculation set was found to be correctly accomplished utilizing the criteria provided in the referenced procedure. The criteria were accurately interpreted and the results clearly presented.

Break 45C was selected for field review. Zone of influence drawing 1ZI 35, Rev. CP-2 was reviewed for the break. The Z of I drawing appeared to correctly apply the guidelines of the DBD.

The HELB Interaction Record Form for problem 1-77, break 45C, dated 2/26/88, was reviewed during a field walkdown. The HELB interaction walkdown is performed in accordance with procedures CPE-EB-FVM-SI-34, Rev. 1, dated 6/11/87, including ICN-03, "Field Verification Method, High Energy Line Break Target Identification." Utilizing the Z of I drawing, the team concluded that the above HELB Interaction Record was accurately completed.

At the time of the inspection, the evaluation of targets identified in the HELB Interaction Record had not been performed.

1. Document Number:

Ebasco Calculation CPE-SI-CA-0000-501, Rev. 1, dated 2/22/88, "Pipe Rupture Analysis - Reactor Coolant and Safety Injection System - Problem 1-13A&B"

2. Applicable Design Criteria:

DBD-ME-007, Rev. 0, dated July 20, 1987, "Pipe Postulation and Effects"

Attachment 4 provides a procedure for locating the plastic hinge (i.e., the point about which a pipe begins to whip) following a pipe break.

3. Compliance With Design Criteria:

This calculation provides the location of plastic hinges for breaks in the hot leg safety injection lines serving Loops 1 & 4 inside Containment for use in determining zones of influence.

OPEN ITEM S-19:

Page 13 of the calculation discusses the whip point for break 667CB. This discussion utilizes the plastic hinge length and elastic limit values from break 661CB & 662CB that were calculated on page 9 of the calculation. Page 9 from the Rev. 0 calculation appears to adequately address whipping potential. Revision 1 to this calculation deleted page 9 because it contained breaks, such as arbitrary intermediate breaks, that were no longer applicable. However, this action resulted in deleting documentation for break 661CB which is still applicable. In addition, this deleted cross-reference interfaces with break 667CB, as noted above.

Calculation of the whipping potential of the balance of the breaks was found to be correctly accomplished utilizing the design criteria in Attachment 4 of the DBD. The results are presented such that they may be clearly interpreted.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-96A, dated 9/28/87

Zone of Influence Sketch 1ZI 108, Rev. CP-2

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

Attachment 1 provides guidance in determing jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03, dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The zone of influence (Z of I) drawing was reviewed for this area. This Z of I was handled differently than most others. Since the area of concern was small and there was Class 5 high energy piping in the area, for which breaks are postulated at every fitting and valve weld, it was assumed that the entire area is subject to pipe whip and jet effects. Since all of the piping subject to breaks is close to the floor (within 2 feet) and in a single flat plane, a "zone of total destruction" was assumed by determining the resultant maximum flashing jet diameter, and considering as targets all safety related components below a level based on this diameter.

The team's field review of the targets within the "zone of total destruction" was compared with the HELB Interaction Record Form. It was found that 4 of the flexible conduits serving valve 1HV-2409, which were targets, were not listed on the HELB Walkdown Record Form. The SIP Walkdown Engineer was aware of a Design Change Authorization (DCA) that replaced the existing flex conduits on valve 1HV-2409 with new environmentally qualified flex conduits.

DCA 42105, Rev. 3, dated 2/12/88, was reviewed and revealed that a total of 4 flexible conduits were being changed on valve 1HV2409. The deleted conduits shown on page 34 of the DCA match the 4 conduits on the HELB interaction record form that could not be found during the walkdown inspection.

System Interaction Review Forms for Revs. 0, 1, & 2 of DCA 42015 were reviewed; all committed to a followup walkdown by the SIP group.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-46A, Break 305C, dated 1/22/88

Zone of Influence Sketch 1ZI 80, CP-20

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

   Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03 dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

   This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The zone of influence drawing was reviewed for break 305C, a break in the CVCS letdown subsystem outside containment.

The pipe was postulated to whip about a hinge formed at a tee connection which is the second change in direction. Although the pipe rupture calculation was not reviewed for this break, the hinge point selected was typical of unrestrained pipes that were reviewed. The Z of I also portrays a flashing jet, which would be expected based on letdown system conditions.

The team's field review of the targets in the pipe whip and jet paths determined that targets documented on the HELB Interaction Record Form were correct.

At the time of the inspection, the evaluation of the targets identified in the HELB Interaction Record had not been performed.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-52Z, Break 166C, dated 1/29/88

Zone of Influence Sketch 1ZI 77N, Rev. CP-2

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03, dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The zone of influence drawing was reviewed for break 166C, a break in the CVCS seal injection header outside containment.

The pipe was postulated to whip primarily about the second elbow from the break, with secondary hinges formed at the ends of long branch connections onto the line. The proposed whip paths appeared realistic based on the piping configuration. The Z of I indicated that the jet from the break was of the non-expanding cylindrical type, in accordance with the DBD.

The team performed a field review of the targets in the pipe whip and jet paths relative to the HELB Interaction Record Form.

OPEN ITEM S-20:

The walkdown review for break 166C revealed two targets that were not entered on the HELB Interaction Record Form. These targets are a) snubber support SI-1-079-007-S42K for line 10" SI-1-079-601R-2 and b) line 3-CS-1-074-2501R-2, both of which were found in the pipe whip path shown on the Z of I Sketch 1ZI 77N, Rev. CP-2.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-52Z, Break 684C, dated 1/19/88

Zone of Influence Sketch 1ZI 77N, Rev. CP-2

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Postulation and Effects"

Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03 dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The Zone of Influence drawing was reviewed for break 684C, a break in the CVCS seal injection line to RC pump #3 at the outboard moment restraint near the containment penetration.

The pipe was postulated to whip about a hinge formed at the second elbow from the break. Although the pipe rupture calculation was not reviewed for this break, the hinge point selected was typical of unrestrained pipe that were reviewed. The Z of I portrays a cylindrical, non-expanding jet for this cold water discharge, which meets the criteria in the DBD.

A field review of the targets in the pipe whip and jet paths indicated that the HELB Interaction Record Form was accurate.

At the time of the inspection, the evaluation of the targets identified in the HELB Interaction Record had not been performed.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-46A, Break 303C, dated 1/14/88

Zone of Influence Sketch 1ZI 81, CP-2

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03, dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets. These requirements are implemented by means of an as-built walkdown.

3. Compliance With Design Criteria:

The Zone of Influence drawing was reviewed for break 303C, a break in the CVCS letdown line at the letdown heat exchanger outside containment. The pipe was considered to whip about a hinge formed at the second elbow. Although the pipe rupture calculation was not reviewed for this break, a hinge at the second elbow was typical of unrestrained pipes that were reviewed. The Z of I also portrays a flashing jet, which is to be expected for the CVCS letdown subsystem.

The results of the team's field review of the targets in the pipe whip and jet paths matched those on the HELB Interaction Record Form.

At the time of the inspection, the evaluation of targets identified in the HELB Interaction Record had not been performed.

1. Document Number:

Ebasco HELB Interaction Form, Problem 1-12E, Break 582C, dated 12/14/87

Zone of Influence Sketch 1ZI 100A, Rev. CP-3

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03, dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The Zone of Influence sketch was reviewed for break 582C, a break in the auxiliary feedwater supply from the Train B pump to Steam Generator #3. The pipe was postulated to whip about a hinge formed at the second elbow. This is consistent with the conclusions of pipe rupture analysis calculation TNE-DS-CA-0000-567, Rev. 1, which is discussed elsewhere in this report. The Z of I presents a flashing jet from the upstream portion of the break and a non-flashing as well as a flashing jet from the downstream portion of the jet.

The team performed a field review of the targets in the pipe whip and jet paths relative to the HELB Interaction Record Forms. It was noted that a total of nine flexible conduits serving valve 1-HV-2136, which were targets, were not included on the HELB Interaction Record Form. The SIP Walkdown Engineer was cognizant of a Design Change Authorization (DCA) that replaced the existing flexible conduits on valve 1-HV-2136 with environmentally qualified flex conduits. The new conduits have been given new conduit numbers. With regard to why the old conduit numbers did not appear on the HELB Interaction Record, the Ebasco walkdown engineer stated that it was possible that the old conduits had been removed at the time of the SIP walkdown. The team noted that the installation of the new qualified conduits was in various stages of completion in each of the four feedwater penetration rooms.

DCA 42402, Rev. 3, dated 1/25/88, revealed that a total of 11 flexible conduits were being changed on valve 1HV-2136. Systems Interaction Review Forms for Revisions 0, 1, and 2 of DCA 42402 all committed to a followup walkdown. The team considers that review of all DCAs by the Systems Interaction Group will ensure proper evaluation of modifications.

1. Document Number:

Ebasco HELB Interaction Record Form, Problem 1-75, Break 202C, dated 2/26/88.

Zone of Influence Sketch 1ZI 38, Rev. CP-2.

2. Applicable Design Criteria:

a) DBD-ME-007, Rev. 1, dated 1/8/88, "Pipe Break Postulation and Effects"

Attachment 1 provides guidance in determining jet geometry. Attachment 3 and Section 5.1 provide guidance in determining pipe whip potential and subsequent whip paths.

b) CPE-EB-FVM-SI-34, Rev. 1, dated 7/11/87, including ICN-03, dated 12/16/87, "Field Verification Method, High Energy Line Break Target Identification"

This procedure provides requirements for identification and documentation of interactions between HELB sources and safety related component targets by means of an as-built walkdown.

3. Compliance With Design Criteria:

The Zone of Influence sketch was reviewed for Break 202C, a break in the steam generator blowdown system serving Steam Generator #1 inside containment.

The pipe was postulated to whip about the second elbow from the break. The plastic hinge points assumed appear realistic based upon other similar breaks reviewed and the Zones of Influence appear to be correctly presented.

Results of the team's field review of the targets in the pipe whip and jet paths corresponded with the HELB Interaction Record Form. It was concluded that the HELB Interaction walkdown was accurately performed.

At the time of the inspection, the evaluation of the targets identified in the HELB Interaction Record had not been performed.

1. Document Numbers:

a) Ebasco Calculation No. CPE-SI-CA-0000-604, Rev. 0, dated 1/11/88, "Pipe Rupture Analysis - CVC System Inside Containment"

b) Ebasco Calculation No. CPE-SI-CA-0000-599, Rev. 1, dated 2/24/88, "Pipe Rupture Analysis - Safety Injection System Inside Containment"

c) Ebasco Calculation No. CPE-SI-CA-0000-611, Rev. 1, dated 2/1/88, "Pipe Rupture Analysis - Reactor Coolant System"

d) Ebasco Calculation No. CPE-SI-CA-0000-603, Rev. 1, dated 2/5/88, "Pipe Rupture Analysis - Feedwater System Inside Containment"

2. Applicable Design Criteria:

a) NUREG-0800, Standard Review Plan Section 3.6.2, Rev. 1, July 1981

b) American National Standard ANS-58.2, 1980, Design Basis for Protection of Light Water Nuclear Power Plants Against Effects of Postulated Pipe Rupture

c) EME 2.24-05, Rev. 0, dated 7/21/87, Comanche Peak Engineering Mechanical Engineering Technical Procedure - Pipe Rupture Books

d) DBD-CS-088, Rev. 1, dated March 1988, TU Electric Comanche Peak Steam Electric Station, Units 1 & 2 - Design Basis Document Pipe Whip Gap Restraints Design and Analysis

3. Compliance With Design Criteria:

The calculations, in general, are in compliance with the design criteria, industry standard practice, and TU CPSES technical procedures. Also, the contents of the calculations are comprehensive.

During the review of calculation CPE-SI-CA-0000-604, Rev. 0, it was noted that two additional (non-existing) bumpers were added in the analysis model to contain the broken pipe during the pipe rupture event. SIPG Open Item No. 238 addresses the requirement to resolve the need for the additional bumpers. In addition, DCA-66765, Rev. 6, also deals with the necessity to review this and other cases where the need for additional pipe whip restraint hardware has been identified. The team feels that there is good control over resolution of this issue.

There are certain technical open items of generic and specific nature identified.

OPEN ITEM S-21

Standard Review Plan 3.6.2, Section III.2.a states that the inelastic behavior of the piping and restraint system should stay within the design limits of 50% of the ultimate uniform strain. ANS 58.2, Section 6.6.2 also addresses the same design limits concerning plastic deformation designs for piping and pipe whip restraints. The acceptance criteria for the process pipe, ($M_{max}/M_{ult} \leq 0.8$) being used in the Ebasco calculations deviates from the standards. Technical justification provided by Ebasco to show that the criteria ($M_{max}/M_{ult} \leq 0.8$) meets the intent of the standards was based on selected pipe sizes and materials at temperature. The approach and methodology being used in this technical justification appears to be acceptable. However, a wider range of pipe sizes and materials should be considered to make the justification generic to CPSES pipe rupture calculations.

OPEN ITEM S-22:

Mass point spacing criteria was not mentioned in the design basis document or in the calculations being reviewed. To ensure that the piping and pipe whip restraint system are modeled in sufficient detail to reflect its dynamic characteristics under thrust and wave forces during the pipe rupture event, mass point spacing criteria should be incorporated into the design basis document and be followed through the applicable calculations.

Ebasco provided the team with criteria on mass point spacing which are judged acceptable for straight runs of pipe. Mass point spacing criteria should also address the components and fittings. Mass point spacing criteria should be incorporated in the DBDs and assurance should be provided that the criteria have been correctly implemented in pipe rupture calculations.

OPEN ITEM S-23:

Calculation No. CPE-SI-CA-0000-603, Rev. 1 - By reviewing the piping response curve at selected points on the pipe, it cannot be concluded that the run time is sufficient enough to show that the dynamic response of the piping system has stabilized and that the peak response was enveloped.

OPEN ITEM S-24:

Calculation No. CPE-SI-CA-0000-611, Rev. 1 - Clarify the statement on page 53, "There is no requirement to arrest the pipe after break and consequently no limits for the displacements."

OPEN ITEM S-25:

Calculation No. CPE-SI-CA-0000-599, Rev. 1 - Restraint No. SI-1-181-902-C47W listed on page 4 is not included in the analysis model on page 14; restraint No. SI-1-091-903-C47W in the analysis model on page 14 is missing from the list on page 4.

1. Document Number:

   a) SWEC Calculation No. 16345-EM(B)-030, Revision 1, 12/5/87, "Supplement to Calculation SSB-134C, Set 2, Design of Jet Shield"

   b) Gibbs & Hill Calculation No. SSB-134C, Set 2, Revision 2, 3/28/84

2. Applicable Design Criteria

OPEN ITEM S-26:

FSAR Sections 3.8.3.3 and 3.8.3.5 provide loads and load combinations and acceptance criteria for structural steel members for Containment - Internal Structures. The loads were used for the subject jet shield which is located in the Safeguards Building.

3. Compliance With Design Criteria:

SWEC Calculation 16345-EM(B)-030 provides a supplementary calculation to validate the original Gibbs and Hill calculation SSB-134C for the revised jet shield loads. The jet shield JS-77-16 is provided to protect valve 1HV-4175, located in the Safeguards Building. The jet shield load was generated by Ebasco and documented via letter DSG-0056, dated 10/8/86. The SWEC STRUDL Program is used to analyze the shield support structure. The structural frame consisting of channels, structural tubes, plates and the anchorage are validated for their structural adequacy for the received loading. The validation was adequate based on the applied design criteria which, as noted above, were for the Containment - Internal Structures.

Systems Interaction Seismic/Non-Seismic Interaction - Summary

1. Review Sample

The seismic/non-seismic interaction program, the II/I review program, provides a review of Non-Seismic Category I items relative to the requirements of USNRC Regulatory Guide 1.29 to ensure that the physical failure of Non-Seismic Category I components during a safe shutdown earthquake (SSE) does not compromise the safety functions of essential systems and components located in the vicinity. To prevent such seismic interactions, the Non-Seismic Category I systems and components (sources of interaction) are either seismically qualified or an analysis is performed to assure that the sources are located at sufficient distance from essential components (targets) to preclude adverse interactions. The overall seismic/non-seismic interaction review process at CPSES is being carried out by various organizations. Responsibility for systems, components and structural elements is shown below:

SEISMIC/NON-SEISMIC INTERACTION REVIEW

Organizations	Items Covered
Ebasco	All Non-Seismic Category I systems and components, except small bore piping and conduits and plant architectural features, using Design Basis Document DBD-ME-005
Stone & Webster Engineering	Architectural features (such as doors, security barriers, handrails, grating, checkered plates, Control Room ceiling, and sheet rock walls), using Specific Technical Issue Reports CPRT-S-006, 007, 011, and 012
TU Electric PSE Group/EQE Inc.	Small bore Class 5 piping less than 2 inches in diameter, using Project Plans EQE 526006.01-P-001 and 002
Impell Corporation	Small bore Train "C" conduits less than 2 inches in diameter, using Design Basis Document DBD-CS-093

This inspection concerns the Ebasco Seismic/Non-Seismic Systems Interaction Program, which is being conducted by an integrated team of engineers from TU Electric, Ebasco, and EQE, Inc., under Ebasco's overall direction. This program consists of (1) field walkdowns of each area (room) of all Seismic Category I buildings and (2) resolution of unacceptable interactions. At the time of the inspection, analyses were completed for establishing zones of influence for all buildings. However, field walkdowns to document seismic interactions were completed only for the Safeguards Building and part of the Containment. The team concluded that (1) review of the zone of influence calculations, (2) field inspection of the Safeguards and Containment Buildings, and (3) review of target resolutions would provide a representative sample of the program.

For the zone of influence calculations, the team addressed the assumptions, references, application of engineering analysis and design, and conclusions. Review of the arrangement drawings was done on a selected basis to confirm consistency with the calculations. The field inspection of selected areas was performed to evaluate the adequacy of identifying safety-related targets and resolving unacceptable source/target interactions.

2. Open Items

The Ebasco Seismic/Non-Seismic Interaction Program provides a systematic and thorough review of all areas of safety-related buildings. The analytical methods used in determining the zones of influence for the falling Non-Seismic Category I objects are well implemented using design basis amplified response spectra for the building and elevation. The field walkdowns performed for each area (room) of the safety-related building provided documentation identifying potential adverse interactions postulated during the SSE. The resolutions of these interactions are documented with respect to acceptance criteria which includes use of experience data.

Open Item S-27 concerns the fact that seismic interaction between adjacent seismic/non-seismic components, resulting from the insufficient physical clearance (seismic gap) between these items, is not addressed in the Design Basis Document for the Seismic/Non-Seismic Interaction Program. It is noted that interactions due to insufficient seismic gap between Seismic Category I components are being addressed by SWEC's commodity clearance review program per SWEC Specification CPES-S-1021.

Open Item S-28 indicates that 1 1/2-inch chilled water system piping was not recorded as a target for the non-safety related speaker P-8 in Safeguards Building Room No. 54 at El. 773'-0.

For Auxiliary Feedwater Pump Room No. 73, Ebasco documentation noted that the security cabinet TC-207 could be a potential source hitting a long vertical cantilevered conduit support for conduit marked C13G07225. The acceptance of this interaction needs additional justification (Open Item S-29).

Systems Interaction, Seismic/Non-Seismic Interaction - Evaluation of Documents Reviewed

1. Document Number:

   a) Ebasco Calculation No. CPE-DS-CA-0000-640, Revision 0, "Interaction Zone of Non-Seismic Components in Containment Building"

   b) Ebasco Calculation No. CPE-DS-CA-0000-642, Revision 0, "Interaction Zone of Non-Seismic Components in Other Category I Buildings"

2. Applicable Design Criteria:

   a) DBD-ME-005, Revision 1, Seismic/Non-Seismic Interaction Program"

   b) USNRC Regulatory Guide 1.29, February 1976, "Seismic Design Classification"

   DBD-ME-005 discusses the evaluation process for Non-Seismic Category I items (sources) which either fail or become loose from their supports during a seismic event and hit Seismic Category I essential systems or components (targets).

OPEN ITEM S-27

The seismic interaction resulting from insufficient physical clearance (seismic gap) between adjacent seismic/non-seismic components is not addressed in the above DBD. The team noted that such interactions between adjacent Seismic Category I components are to be reviewed per SWEC Specification CPSES-S-1021, "Commodity Clearance," and SWEC Field Verification Method for Commodity Clearance, CPE-SWEC-FVM-CS-068.

3. Compliance With Design Criteria:

   The zone of influence is a three dimensional volume within which the impact of a non-seismic component on Seismic Category I systems and components is reviewed for seismic interaction. These calculations determine the zones of influence for non-seismic components in the Containment and other Seismic Category I buildings by determining the range that the components would move as projectiles during a safe shutdown earthquake. This determination factors in the building amplified response spectra, a 2% damping value, and the component elevation. Using a simplified equation of motion, distance travelled by a falling object in two horizontal directions is calculated and an enveloped projectile path is developed for the zone of influence. The team's numerical check of a selected sample area indicated that the calculations were correct and consistent with the DBD.

1. Document Number:

Field Walkdown Seismic/Non-Seismic Interaction Matrix Sheet 1 of 1, dated 11/17/87, Area No. 54, Safeguards Building El. 773'-0

2. Applicable Design Criteria:

a) DBD-ME-005, Revision 1, dated 12/30/87, "Seismic/Non-Seismic Interaction Program"

b) CPE-EB-FVM-SI-40, Revision 1, dated 10/1/87, Field Verification Method - Seismic/Non-Seismic Walkdowns - System Interaction Program"

3. Compliance With Design Criteria:

This matrix sheet provides the results of the field walkdown review of non-safety related components located in the Safeguards Building Containment Spray Pump Room No. 54 at El-773'-0. A walkdown team identified five non-safety related components as potential sources of seismic interaction with fifteen safety-related systems and components. The source identification was performed in accordance with DBD-ME-005 and CPE-EB-FVM-SI-40. The targets were identified with respect to their proximity to the sources within the zone of influence matrix per Attachment C to CPE-EB-FVM-SI-40 for the Safeguards Building. Each of the fifteen targets was subsequently reviewed for the ability to withstand the impact in accordance with the Dynamic Impact Criteria of DBD-ME-005, Paragraph 4.3.4. The seismic interaction resolution for each source is documented in the Seismic/Non-Seismic Interaction Walkdown Evaluation Form. Further evaluation regarding the structural integrity and the anchorage of the sources of interaction is documented in the experience data base evaluation sheet.

The team reviewed the seismic/non-seismic interaction package and performed a field walkdown in order to determine whether all targets had been identified and whether appropriate actions had been taken concerning identified interactions. The team found that the walkdown and resultant resolutions had been correctly implemented, except as noted below.

OPEN ITEM S-28:

1 1/2-inch diameter piping for the chilled water system located near P-A Speaker P-8 was not identified as a target, as required by the zone of influence walkdown criteria of Ebasco Procedure CPE-EB-FVM-SI-40, Attachment C, Table 5.

1. Document Number:

Field Walkdown Seismic/Non-Seismic Interaction Matrix Sheets 1, 2, and 3, dated 11/17/87, Area No. 73, Safeguards Building El. 790'-6".

2. Applicable Design Criteria:

a) DBD-ME-005, Revision 1, dated "Seismic/Non-Seismic Interaction Program"

b) CPE-EB-FVM-SI-40, Revision 1, dated 10/1/87, "Field Verification Method - Seismic/Non-Seismic Walkdowns - System Interaction Program"

3. Compliance With Design Criteria:

The auxiliary feedwater pump room located in the Safeguards Building at El. 790'-6 was reviewed for the potential impact of non-safety related components on safety-related systems and components. This review identified 23 sources with 58 possible interactions with 39 targets. Thirty-three interactions were resolved using the Dynamic Impact Criteria of DBD-ME-005. The other 25 interactions required further evaluation using the experience data base or more detailed analysis.

Field walkdown of this area was performed by the team with TU/Ebasco/EQE engineers to evaluate the above implementation of the design criteria. Security cabinet TC-207 had been identified as a source of impact on four safety related components. The team reviewed the resolution for each of these targets.

OPEN ITEM S-29:

Seismic/Non-Seismic Interaction Evaluation Sheet 14 (of 47) showed that the wall mounted security cabinet TC-207 could impact the long vertical cantilevered support for conduit C13G07225. The interaction was resolved per dynamic impact criterion No. 8 of Paragraph 4.3.4 of DBD-ME-005, but requires additional justification or analytical calculations to show that the impact load on the conduit support is acceptable.

The team agreed in other respects with the identification of targets and resolution of source/target interactions for the area.

1. Document Number:

Seismic/Non-Seismic Interaction Evaluation Form and Structural Integrity Evaluation Form, both dated 12/3/87, ~ea No. 103, Source No. 67a, Hoist and Trolley in the Electrical Equipment Room, El. 852'-6 in the Safeguards Building.

2. Applicable Design Criteria:

   a) DBD-ME-005, Revision 1, "Seismic/Non-Seismic Interaction Program"

   b) CPE-EB-FVM-SI-40, Revision 1, "Field Verification Method - Seismic/Non-Seismic Walkdown - System Interaction Program"

3. Compliance With Design Criteria:

This review provides an evaluation of a possible unacceptable interaction that can be caused by the hoist and trolley located above the safety related components in the Electrical Equipment Room. The resolution is performed by verifying the structural integrity of the hoist and trolley by the experience data base, i.e., by enveloping the seismic acceleration and reviewing the anchorage of the hoist and trolley system.

The team performed a walkdown of the area and reviewed the evaluation form, and agreed with the document's conclusion that the hoist and trolley would remain in place during a seismic event.

1. Document Number:

Seismic/Non-Seismic Evaluation Form and Structural Integrity Evaluation Form, both dated 12/3/87, Area No. 103, Source Radiation Monitor IRE-6296 in Electrical Room, El. 852'-6 in the Safeguards Building

2. Applicable Design Criteria:

a) DBD-ME-005, Revision 1, "Seismic/Non-Seismic Interaction Program"

b) CPE-EB-FVM-SI-40, Revision 1, "Field Verification Method - Seismic/Non-Seismic Walkdown - System Interaction Program"

3. Compliance With Design Criteria:

This evaluation identifies the need to perform a structural integrity evaluation to assure that the subject radiation monitor does not fall from its support to become a loose object, thereby hitting the safety related components located in the vicinity.

The review, using the experience data base, provides resolution by enveloping the seismic acceleration and performing an anchorage review of the Hilti expansion anchors. The equipment bolting to surface mounted plates by means of 1/2-inch Nelson studs has also been verified. The team agreed with the document's conclusion that the radiation monitor would remain in place during a seismic event.

Electrical - Summary

1. Review Sample

Inspection Report 50-445/87-37, 50-446/87-28 stated the following:

> "The review of all the selected design document samples was not completed because of a major redesign effort involving 6.9 Kv electrical power system. In addition, some other items selected were not available at this time. Significant items where the review is incomplete are as follows:
>
> a. 6.9-Kv electrical power system design, drawings, and calculations;
>
> b. DG loading capability verification;
>
> c. Electrical penetration protection;
>
> d. Justification for separation deviations; and
>
> e. Associated circuit analyses for control and instrumentation circuits."

The purpose of this inspection was to review the above items.

2. Open Items:

Open Item E-31 concerns the schematic drawing for the 6.9 Kv switchgear bus which does not show contacts from lockout relays 86-1/ST1 and 86-2/ST1 in the tripping circuit of breaker 1EA2-2.

Open Item E-32 concerns the lack of documented evidence of the capability of the diesel generator to accept current design step loads without exceeding specification limits.

Open Item E-33 concerns the need to establish a technical basis for acceptability of a curve which provides motor starting capability of the diesel generator.

Open Item E-34 concerns SWEC Calculation 16345-EE(B)-73, Rev. 1, "Station Service Study-Voltage Profiles of Class 1E Systems Down to 480 Vac MCC." This is an important calculation which was not complete at the time of the inspection. However, based on its review of preliminary work, the team stressed the need for the calculation to address both high and low extreme voltages on the 138 Kv and 345 Kv grids.

Electrical - Evaluation of Documents Reviewed

1. Document Number:

SWEC Calculation 16345-EE(B)-017, Rev. 1, dated 12/19/87, "Electrical Penetration Short Circuits"

2. Applicable Design Criteria:

DBD-EE-062, Containment Electrical Penetration Assemblies, Rev. 1, dated 12/31/87. See Calculation 16345-EE(B)-048 for detail on the DBD.

3. Compliance With Design Criteria:

This calculation utilized design cable lengths to calculate the short circuit currents at the electrical penetrations. The objective of this calculation was to find the maximum credible short circuit current at each containment electrical penetration so as to determine the adequacy of the penetration module momentary current rating and to provide data for the overcurrent device coordination study. The maximum available fault current at the inboard end of the penetration module is calculated based on the power source impedance, cable impedance, and the source voltage. The calculation addresses each penetration circuit except circuits using triax, coax, thermocouple or No. 16 AWG conductors. These circuits were not analyzed because they are low energy circuits.

The calculation utilizes a computer program "Wire Z BA" to determine cable resistances and reactances and another computer program "LUCID" to calculate the fault currents. The calculation also includes data to show the validity of these computer programs.

The calculation is based on conservative assumptions and utilizes the equipment short circuit ratings. This results in conservative values of the available short circuit currents at the penetrations.

In general, the calculated available short circuit currents at the penetrations are below the module ratings. In some cases, where the calculated currents exceed the module short circuit ratings, corrective actions will be required; SWEC has a process for ensuring completion of these actions.

Based on this review, we conclude that this calculation meets its objective.

1. Document Number:

SWEC DBD-EE-040, Rev. 1, dated 12/31/87, "6.9 kV Electrical Power System"

2. Applicable Design Criteria:

Revision 1 of the design basis document incorporates changes due to addition of new station service startup transformers. Only Sections 1.0 through 4.3.8 have been updated to reflect the changes. The revisions to these sections adequately address the changes. Our current review of these sections did not result in any new open items. Open items for this document, as detailed in NRC Inspection Report No. 50-445/87-37, 50-446/87-28, are still applicable.

1. Document Number:

SWEC Dwg. 2323-E1-0031, Sheet 7, Rev. #CP-3. "6.9 kV Switchgear Bus 1EA2 Breaker #1EA2-2, Schematic Drawings"

2. Applicable Design Criteria:

SWEC DBD-EE-040, "6.9 kV Electric Power System

SWEC DBD-EE-051, "Protection Philosophy". This DBD describes the functions, design requirements, modes of operation, arrangement, performance characteristics, and limitations for the plant electrical distribution protection system.

3. Compliance With Design Criteria:

We reviewed the schematic drawing for compliance with SWEC design criteria, industry practice, and for acceptable circuit operation. Our review resulted in the following open item.

OPEN ITEM E-31

The drawing does not show the contacts from the lockout relays 86-1/ST1 and 86-2/ST1 in the tripping circuit of breaker 1EA2-2. These lockout relays are actuated by the transformer XST1 primary and backup protective relaying schemes. As such, for a fault on this transformer or its associated cables, the breaker 1EA2-2 must be tripped to isolate the faulted section. Also, permissives from the relays 86-1/ST1 and 86-2/ST1 must be provided in the breaker 1EA2-2 closing circuit to prevent its closing onto a faulted section.

Other schematic drawings should be reviewed for similar problems.

1. Document Number:

Pre-Operational Test Procedure, 1CP-PT-29-04, RT-1, Rev. 0, "Diesel Generator Sequencing and Operational Stability Test - Retest"

2. Applicable Design Criteria:

SWEC DBD-ME-011, Rev. 0, dated 7/31/87, "Diesel Generator Sets" and RG 1.9 "Selection, Design, and Qualification of Diesel Generator Units Used As Standby (onsite) Electric Power Systems at Nuclear Power Plants" contain the principal design criteria and requirements for this test.

In summary, the criteria require that the diesel generator sets be capable of attaining the required frequency and voltage within 10 seconds after receiving a start signal. Also, they must be able to accept and accelerate the design step loads in the required sequence while keeping the frequency and voltage dips within specified limits. The criteria documents further impose specific requirements for the recovery of voltage and frequency during each step loading interval.

3. Compliance With Design Criteria:

The document 1CP-PT-29-04 RT-1 provides the results of preoperational testing performed at the site. The oscillograms provided as part of this test report were mostly illegible. The scale used to obtain the voltage profile to ascertain the voltage dips during step loading was inadequate. The selected scale (i.e. 6.9 kV = 1 9/32") was unsuitable to read voltage dips even to an accuracy of 100 volts. The step loads connected to the diesel generator during this testing were considerably less than the current design loads.

OPEN ITEM E-32

The test report does not show how the test objectives were met. Actual step loading was considerably below the current design step loading. This report does not show how the capability of the diesel generator to accept the current design loads without exceeding the specification limits has been proven.

1. Document Number:

G & H Calculation V-5, Rev. 9, "Emergency Diesel Generator Sizing"

2. Applicable Design Criteria:

SWEC DBD-ME-011, Rev. 0, dated 7/31/87, "Diesel Generator Sets" and RG 1.9, "Selection, Design, and Qualification of Diesel Generator Units Used As Standby (onsite) Electric Power Systems at Nuclear Power Plants" contain the principal design criteria and requirements for this document.

In summary, the criteria require that the diesel generator sets be capable of attaining the required frequency and voltage within 10 seconds after receiving a start signal. Also, they must be able to accept and accelerate the design step loads in the required sequence while keeping the frequency and voltage dips within the specified limits. The criteria documents further impose specific requirements for the recovery of voltage and frequency during each step loading interval.

3. Compliance With Design Criteria:

The objective of this calculation is to confirm the adequacy of the emergency diesel generator to safely shut down the plant during a design basis accident and/or a power blackout. The calculation provides the loading for the diesel generator at each load step. In addition, the diesel generator capability to accept these loads has been verified. The team concluded that the calculation complied with the design criteria, except as noted below.

OPEN ITEM E-33

On sheet 44A of this calculation, a curve providing motor starting capability of the diesel generator has been included. This curve forms the basis for proving the diesel generator adequacy. However, the basis of acceptability of this curve has not been established, e.g., based on test data.

1. Document Number:

FSAR Fig. 8.3-1, dated 2/5/88, "Plant One Line Diagram"

FSAR Fig. 8.3.2, Sh. 1, dated 2/5/88, "Main One Line Meter and Relay Diagram"

FSAR Fig. 8.3-6, Sh. 1 & 2, dated 2/5/88, "6.9 kV Auxiliary One Line Diagram, Safeguard Buses"

2. Applicable Design Criteria:

SWEC DBD-EE-040, "6.9 kV Medium Voltage System"

SWEC DBD-EE-051, "Protection Philosophy"

3. Compliance With Design Criteria:

The team reviewed the above one line diagrams and the meter and relay diagram for changes due to modifications to the 6.9 kV emergency power system.The preferred power source (offsite) of the two redundant safety buses 1EA1 and 1EA2 is from the "Y" winding of the startup transformer XST2. The alternate offsite power source for these buses is from the "X" winding of startup transformer XST1.

The team discussed with SWEC if, for any bus fault on bus 1EA1 or 1EA2, the overcurrent protective relays (51) and lockout relays (86) of both the safeguard buses could actuate. SWEC has performed coordination studies to ensure that for such a fault only the affected bus will be locked out, while the other safeguard bus will still be available to provide power to the safety loads.

The team reviewed the potential for conductor circulating currents since the connections from the startup transformers to the safety buses consist of a number of electrical cables connected in parallel. Design and installation provisions addressing conductor lengths and spacings preclude significant conductor circulating currents.

The above items indicate compliance with aspects of the design criteria addressed by the team.

1. Document Number:

SWEC Calculation 16345-EE(B)-048, Rev. 1, dated 12/23/87, "Protection and Ampacity of Electrical Containment Penetration"

2. Applicable Design Criteria:

The objectives of this calculation are:

a) to verify the adequacy of the electrical penetration assembly ampacity for normal, overload, and short circuit conditions, and

b) to verify that the primary and the backup protection requirements of NRC RG 1.63 are met.

The criteria applicable to this calculation are defined in the SWEC design basis document, DBD-EE-062, Rev. 1, dated 12/31/87, "Containment Electrical Penetration Assemblies." Major requirements are:

a) Each penetration circuit should be provided with two independent means (primary and backup) of electrical protection.

b) The penetration is considered protected if both of the protective devices operate before the thermal limit of the penetration is exceeded.

c) When a containment electric penetration can safely withstand the maximum possible current due to a fault, the penetration is considered self-protected.

d) The maximum heat load per foot at the nozzle interface must be equal to or less than the manufacturer's data.

e) Continuous load current through penetration conductors should be equal to or less than the 90° continuous rated current of the penetration conductor.

f) The maximum half-cycle peak short circuit current through the penetration conductor should be less than the allowable peak current.

3. Compliance With Design Criteria:

Calculation 16345-EE(B)-048, Rev. 1 has addressed each of the required criteria for all the penetration circuits. The adequacy of the penetration protection has been checked by plotting the protective device's time current characteristics against the thermal limit curves of the penetration conductors. Also, the maximum half-cycle peak currents were compared with the manufacturer's allowable peak currents. The current values were corrected for the actual X/R ratios.

The calculation also provides proposed solutions for the potential problem circuits. Revisions 0 and 1 of this calculation identified 616 penetration circuits requiring corrective actions. Typical corrective actions include changing of breaker sizes, addition of breakers, addition of fuses and fuse holders, use of parallel or different size penetration conductors, increasing the circuit cable lengths, and additional analysis of the Conax penetration test data.

Revision 0 to this calculation was reviewed in the previous inspection (Inspection Report 50-445/87-37, 50-446/87-28). The team identified Open Item E-30 for Revision 0. The current inspection found Revision 1 to indicate compliance with the above design criteria.

1. Document Number:

SWEC Calculation 16345-EE(B)-73, Rev. 1, "Station Service Study-Voltage Profiles of Class 1E Systems Down to 480 Vac MCC"

2. Applicable Design Criteria:

SWEC DBD-EE-040, "6.9 Kv Electric Power Systems"
SWEC DBD-EE-041, "480 Vac and 120 Vac Electric Power System"

3. Compliance With Design Criteria:

This study was still in-process during our review. We reviewed some of the computer printouts from the in-process work The following open item addresses areas the team will review when this calculation is completed.

OPEN ITEM E-34

FSAR Section 8.2.2, page 8.2-14, states that "Operating voltage for the respective grids has been calculated to be within the range of 340.17 kV to 352.74 kV and 135.53 kV to 140.70 kV for normal and credible contingency conditions.

The maximum limits are 363 kV and 144 kV and the minimum limits are 325 kV and 130 kV for the offsite power grid... No transmission contingencies are anticipated wherein the extreme voltages, either high or low, would exist for more than one or two hours..."

In discussions with the SWEC personnel, the team was told that the degraded grid protection will be actuated for voltages lower than that used in the calculation (i.e., 340.17 kV and 135.53 kV). The degraded grid relay setting calculations should address the lower voltages. For higher voltages (i.e., 363 kV and 144 kV), analyses should be performed to show that, under extreme conditions, the connected equipment voltage rating is not exceeded.

Mechanical/Fluids Systems - Summary

1. Review Sample

Flow balance calculations for the relatively complex component cooling water system were incomplete at the time of the previous inspection (Inspection Report 50-445/87-37, 50-446/87-28). Therefore, evaluation of some operating modes for this system were reserved for the current inspection.

2. Open Items

a. Calculation 16345-ME(B)-196

° Open Item F-44 indicates that the worst case non-seismic pipe break may not have been assumed for a calculation of surge tank capacity and available NPSH.

° Open Item F-45 indicates that when the hydraulic energy grade line is lower than the break elevation, air infiltration may delay the surge tank "empty" signal and affect pump and heat exchanger performance.

° Open Item F-46 concerns the need to account for friction loss in the surge tank legs.

° Open Item F-47 concerns the need to examine a partial pipe break just downstream of the vent chiller condenser if the pipe pressure could be subatmospheric.

b. Calculation 103-45-ME(B)-255

° Open Item F-48 concerns the need to account for very large system flow rates during the transient phase of system switchover from one operating mode to another.

c. Calculation 16345-ME(B)-267

° Open Item F-49 addresses controls to establish and maintain manual valve settings commensurate with "Selected K" values which correct for low hydraulic resistance in CCW system flow distribution calculations.

d. Calculation 16345-ME(B)-166

° Open Items F-50 and F-51 raise questions concerning rupture to a thermal barrier heat exchanger tube and the effect of the resultant hot primary coolant on the CCW system.

Mechanical/Fluids Systems - Evaluation of Documents Reviewed

1. Document Number:

Calculation 16345-ME(B)-196, Rev. 0, dated 12/31/87, "CCW Worst Case Non-Seismic Pipe Break"

2. Applicable Design Criteria:

a) DBD-ME-0229, "Component Cooling Water System," Rev. 1, December 31, 1987.

Design events listed in the DBD require the CCW system to remain operational during the following events:

° Failure of a non-seismic component in the non-safeguards loop

° A moderate energy crack in any CCW system piping.

The DBD requires that the CCW surge tank contain sufficient water volume so that during the time period between a worst case non-seismic piping failure and closure of the non-safeguards loop isolation valves total depletion of the tank water volume will not occur.

3. Compliance With Design Criteria:

OPEN ITEM F-44

The calculation assumes two guillotine breaks in 10-inch non-seismic piping to and from ventilation chillers. The breaks are downstream of a butterfly valve that is assumed to be only 32° open. Since the valve is the main point restricting the flow and is also in non-seismic piping, the postulated break does not represent the "worst case." A "worst case" break should be postulated just downstream of the class break from class 3 to class 5 pipe. Non-seismically designed components may fail during a seismic event. Therefore, any non-seismic piping connected to seismic portions of the CCW system should be assumed to fail next to the class break point. For a single Comanche Peak unit, this represents four places in the CCW system, i.e., the entrance to and exit from the non-seismic portions servicing the ventilation chillers and the instrument air compressors. The surge tank capacity and available NPSH should be calculated for the larger flows.

The currently calculated maximum leak rate for this scenario is about 3000 gpm, whereas it appears that leak rates of about three times this value are possible if no artificial restrictions are assumed within the system.

OPEN ITEM F-45

The calculation states, "Where the pipe centerline elevation exceeds the EGL (hydraulic energy grade line) at connected nodes, the breaks are represented by dead-end segments." This method may be non-conservative with respect to air voids entering into the system.

When the EGL (hydraulic energy grade line) is less than the elevation of the break, air infiltration could be significant, could delay the surge tank "empty" signal from being activated, and could severely disrupt pump and heat exchanger performances after the break is finally isolated.

The effect of air infiltration on the system operation following the worst case pipe break scenario should be fully examined, including the recovery phase after non-safety loops have been isolated if it is judged that a significant amount of air has entered the system. The effect of the air should be considered on:

- pump operation
- heat exchanger performance (from air entrapment at the tube sheets)
- surge tank and standpipe leg operation

The venting scenario should also be identified and evaluated.

OPEN ITEM F-46

For the calculation of available pump NPSH, friction loss in the surge tank legs was calculated to be almost negligible. Yet, the flow out of the bottom of the surge tank was assumed to be equal to the flow out of the double-ended 10-inch pipe break. The calculation should be reworked to show the effect of the friction on the available pressure at the pump suction during this postulated event.

OPEN ITEM F-47

A partial pipe break just downstream of the vent chiller condenser should be examined if the pipe pressure could be subatmospheric. The resulting inflow of air would not be detected either by a CCW flow increase to the vent chiller condenser or by a decrease in level of the surge tank to the "empty" level. The effect of massive air infiltration into the system should be evaluated to determine if it would degrade the operation of critical components.

1. Document Number:

Calculation 16345-ME(B)-255, dated November 25, 1987, "Effects of Residual Heat Removal and Spent Fuel Pool Operation on Component Cooling Water Pump Performance"

2. Applicable Design Criteria:

a) DBD-ME-229, Component Cooling Water System, Rev. 1, dated December 31,

b) Accepted fluid system design practice dictates that system pumps be operated only within their allowable flowrate band, as defined by the pump manufacturer. Operation outside the allowable flow range may cause pump damage or failure due to excessive vibration, radial or axial bearing loads, shaft whip, or cavitation conditions.

3. Compliance With Design Criteria:

This calculation addresses pump "Runout" and "Runup" (operation at maximum and minimum flowrates).

The calculation addresses maximum runout flowrate which can occur during automatic switchover from various operating scenarios into new conditions, usually initiated by accident signals.

Nominal pump flowrates are in the vicinity of 14,000 gpm, and the maximum runout flowrate is determined to be about 20,000 gpm. The pump manufacturer has projected pump performance out to 22,000 gpm; therefore, the calculation determines that calculated flowrates are not excessive.

OPEN ITEM F-48

The calculation addresses only the steady state flowrates existing before and after the switchover from one flow alignment to another. On examining flow resistances and valve operating times, it appears that there is a possibility of very large system flow rates occurring during the transient phase of system switchover from one operating mode to another. For the case of transition from normal operation to a LOCA alignment with a single component cooling water pump, flowrates approaching 25,000 gpm may occur. This is far in excess of presently defined maximum runout conditions.

Manufacturers of large pumps typically recommend that pump discharge valves be brought to a restricted (partly closed) position before startup to avoid undesirable flow conditions. For some plants, the sequencing times for motor operated valves have been coordinated to avoid runout conditions during these transient conditions.

1. Document Number:

Calculation 16345-ME(B)-267, Rev. 0, dated 12/10/87, "Component Cooling Water System Flow Distributions"

2. Applicable Design Criteria:

a) DBD ME-229, "Component Cooling Water System," Rev. 1, dated December 31, 1987

b) Required system water flowrates are delineated within the DBD.

3. Compliance With Design Criteria:

The component cooling water system consists of a large and complex piping system which provides cooling water to dozens of components. Water is provided to selected components according to the flow alignments required by normal, refueling, cooldown, emergency, and accident conditions. For each of these flow alignments, a hydraulic network flow analysis is performed to demonstrate the capability to provide minimum required flowrates. The analysis method used by SWEC provides an acceptable technique to address all flow situations modeled. Various calculation packages provide detailed inputs of the system's hydraulic characteristics for every flow path. This data is then consistently used for computer flow network analysis.

OPEN ITEM F-49

To correct for low hydraulic flow resistance, the hydraulic losses are increased by (a) installing fixed orifices to restrict flow to some cooled components, or (b) by assuming a throttled position of valves which carry flow into or out of various heat exchangers.

To accomplish this task of throttling a valve to some desired preset position, the computer model is modified by utilizing a "Selected K" for various flow paths ("K" is the universally used symbol representing hydraulic resistance in a piping circuit). All of the "Selected K" values must be greater than the K value existing before the assumed throttling of the valve.

The two major technical concerns for these flow evaluations are:

a) How the "Selected K" values are established by actual manual valve settings at the plant.

b) What controls assure that the as-modeled "Selected K" values remain consistent with the as-built CCW system configuration for all future operation.

The setting of fixed throttle valves should include a plan which considers errors and tolerances in those parameters which provide guidance for obtaining "Selected K" values. Additional tolerance should be considered to account for variations in manual settings, in accordance with accepted error analysis. Criteria should be established to verify valve positions.

Once throttle valves have been set in their desired positions, controls are necessary to preclude radical changes in these setpoints. This situation may occur if a cooled component requires more than its rated (normal maximum) flowrate due to any number of malfunctions. Operators may attempt to attain extra cooling by opening up preset throttle valves, thus changing the system's hydraulic configuration.

A significant change in the cooling system's hydraulic character may not show any anomalies for the normal alignments of the system. However, if the system is called upon to provide extra cooling associated with emergency or accident conditions, the hydraulic computerized model may not accurately represent parameters for the system.

1. Document Number:

16345-ME(B)-166, Rev. 2, dated 2/25/88, "Effect on Component Cooling Water System of a Thermal Barrier Tube Rupture"

2. Applicable Design Criteria:

DBD-ME-229, "Component Cooling Water System," Rev. 1, dated December 31, 1987

3. Compliance With Design Criteria:

This calculation evaluates the thermal-hydraulic conditions existing within the component cooling water system if a thermal barrier heat exchanger tube rupture allows hot/high pressure primary reactor coolant to enter this cooling circuit. This postulated event is of particular interest because the blowdown flow may completely bypass containment and, therefore, represents a small break LOCA without containment isolation.

Component cooling water is supplied to cool each of the plant's reactor coolant pumps by a single header which penetrates containment. A check valve (8") is provided to prevent reverse flow. This header then divides to feed each of the four reactor coolant pumps; additional branches feed each thermal barrier through individually checked lines. After providing required cooling services, the four thermal barrier flows are headered together and exit containment through a 4-inch pipe. Other reactor coolant pump coolers are separately headered together and exit containment through an 8-inch pipe. These two pipes are connected outside containment, and this junction forms the endpoint of this analysis.

The calculation shows that the hot primary coolant blowdown rapidly passes through the thermal barrier cooling return line, and at each junction where the other undamaged thermal barriers join the return header, the blowdown flow pressure and temperature is so great as to arrest the cooling flowrate returning from other thermal barriers. Because these lines each contain check valves, the flow merely stops, and reverse flow is precluded. The blow-down flow finally exits containment and joins the 8-inch return line for other reactor coolant pump services. It is assumed that (1) this junction is an infinite reservoir at a fixed pressure of 45 psi, and (2) cooling flows throughout the remainder of the system are virtually unchanged.

OPEN ITEM F-50

This analysis shows more than 65 cubic feet per second of hot steam/water mixture entering the 8-inch pipe with virtually no effect on this piping. The following questions should be addressed for this scenario:

a) Since the blowdown flow arrests the flow from connected intact thermal barrier pipes, is it possible that flow in the 8-inch pipe is also arrested?

b) Could pressures/temperatures within the 8-inch pipe be higher than current piping ratings?

c) It is assumed that the blowdown flow is quenched by the component cooling water in the 8-inch pipe. How much of a steam bubble must enter the 8-inch pipe in order to satisfy transport (energy transfer) equations? Could waterhammer/steamhammer conditions be cause for concern?

d) If the blowdown steam/water flow pervades further into the component cooling water system, what is the effect of this void formation on surge tank piping frictional losses, surge tank pressure, and system pressures?

OPEN Item F-51

In this calculation, certain portions of the component cooling water piping were determined to be experiencing pressure and temperature above rated design conditions (150 psig/200°F design vs approximately 300 psig/420°F for the thermal barrier rupture). SWEC provided calculation 16345-ME(B)-194 which addresses this condition. It is noted that the 194 calculation only addresses pipe wall thickness, and does not address thermal expansion considerations, which may cause pipe stresses higher than allowable for some piping configurations.