ERRATA SHEET

Replace Pages:	With Pages:
Cover sheet	Cover sheet
i through ii	i through ii
4 through 7	4 through 7
14	14
16	16
20	20
23	23
56 through 73	56 through 73
Table 5-1, 5 pages	Table 5-1, 5 pages
Appendix A, A-8	Appendix A, A-8 and A-9
Appendix B, Doc. DC-2, 11 pages	Appendix B, Doc. DC-2, 11 pages
Appendix D, PFR No. 009, Sheet 3 of 3	Appendix D, PFR No. 009, Sheet 3 of 3

NOTE: △ indicates changes from draft report.

Project No.: 82026

FINAL REPORT

Independent Design Review
of
Grand Gulf Nuclear Station - Unit 1

Prepared for

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Approved by [signature] — Senior Review Team — 8/25/82 Date

August 25, 1982

CYGNA

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review process, a Senior Review Team was formed to review the performance and the findings of the project team. This Senior Review Team was made up of Messrs. B. K. Kacyra, J. E. Ward, and E. F. Trainor. Mr. Kacyra, the Chief Executive Officer of Cygna Corporation, is a recognized expert with significant design experience in the field of structural design and dynamic analysis. Mr. Ward, Chief Executive Officer of Cygna Energy Serivces, is a recognized expert and industry spokesman in the regulatory requirments and systems design. Mr. Trainor, Vice President, Quality Assurance, offers extensive experience in the fields of quality assurance and management controls. This team, with assistance from in-house consultants, reviewed all phases of work performed by the project team and was the final authority within Cygna in the judgement of the safety impact of any potential finding.

1.3 Summary

The Observation Log in Table 1-1 summarizes the final status of all observations identified during the course of this review. It lists a total of eighty-four observations. Of these eighty-four, twenty-one have been invalidated as a result of further review. The sixty-three valid observations were categorized as follows: twenty-four (24) in Quality Assurance, thirty-seven (37) in Pipe Stress, and two (2) in Pipe Supports. Of these sixty-three valid observations, nine were identified as potential findings. All of the potential findings have been closed out as having no impact upon plant or public safety after undergoing further review by both the Project and the Senior Review Teams. Where necessary, this further review extended to other systems where a similar observation could indicate a generic design error. None were identified. There are no reportable findings.

The potential findings which were resolved as a result of further review included PFR-001 through and including PFR-009.

Based on this review, Cygna has reached the following conclusions regarding the design and design control activities on GGNS-1:

- The MP&L and Bechtel QA programs adequately address project commitments related to design control. This included design control activities in the areas of design input, design verification (including testing), drawings, specifications, internal and external interfaces, corrective action, audits and surveillances.

- The MP&L and Bechtel QA programs effectively controlled the design of piping and pipe supports in the RHR Train "A" during a period of extensive redesign effort.

- The piping and pipe supports in the Residual Heat Removal System, Train "A" have been designed to perform their intended safety function in accordance with the project commitments, the project design control process and the requirements of the New Loads Adequacy Evaluation Program.

- The pipe supports along the main flow path of RHR Train "A" have been physically installed in accordance with the design drawings.

Finally, we believe that this review provides significant assurance that the overall design activities on GGNS-1 have been properly performed. This general conclusion is based upon:

1. The QA and technical review of the design control and implementation process.

2. The fact that this review centered upon a complex system which underwent a major redesign effort involving major inter- and intra-organizational interfaces.

3. The interaction of the Cygna project team engineers with the GGNS-1 project management and design team.

4. Our own experience and engineering judgement.

Observation Log	Rev 2 / Date 8/21/82	Classification				
		Valid		Potential Finding		
Observation No.	Description	YES	NO	YES	NO	Remarks
QA-00-001	The Bechtel Quality Program is silent with respect to performing design verification by spot checking calculations and analyses.		X		X	Closed. All Bechtel calculations are verified.
QA-00-002	The Bechtel procedures do not address the QA Program statement that identical designs need not be verified.		X		X	Closed. All designs are verified. The "identical" option, which permits verifications to be waived, is not invoked.
QA-00-003	The procedures are silent with respect to design reviewer independence.		X		X	Closed. The design reviewer (or checker) is independent in accordance with the requirements of 10CFR50 App. B, Criterion III.
QA-00-004	The procedures are silent regarding design verification by testing.	X			X	Closed. Bechtel does not use testing to verify its designs on GGNS-1.
QA-00-005	The Bechtel QA Program does not specify that design verification be completed prior to fuel load.	X			X	Closed. Design verification is performed prior to design approval.
QA-00-006	The Bechtel QA program does not address corrective action for computer programs developed on-project.	X		*		PFR No. 001. Closed.

△2

* Further review has shown that this potential finding has no impact on plant safety.

Observation Log	Rev 2 Date 8/21/82	Classification				
		Valid		Potential Finding		
Observation No.	Description	YES	NO	YES	NO	Remarks
QA-01-020	One Bechtel Pipe Stress Group calculation did not make reference to design input data.	X			X	Closed. The calculation had been revised.
QA-01-021	No reference was made to the location of verification information for three (3) non-standard computer programs.	X			X	Closed. Documentation has been revised.
QA-01-022	Local stress calculations for civil group-designed restraints and anchors are not checked.	X		*		PFR No. 009. Closed.
QA-02-001	All aspects of the MP&L OQA Program are not audited on an annual basis.		X		X	Closed. Middle South Services audits the MP&L QA Auditing Dept. All remaining elements of the OQA Program are audited by MP&L QA Department.
QA-02-002	MP&L has not audited the Bechtel calculation program on a frequent basis.	X			X	Closed. MP&L has audited Criterion III in sufficient depth to assure proper design control implementation.

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* Further review has shown that this potential finding has no impact on plant safety.

Observation Log	Rev 2 / Date 8/21/82	Classification				
		Valid		Potential Finding		Remarks
Observation No.	Description	YES	NO	YES	NO	
	GENERAL					
PI-00-007	There is no evidence that an evaluation of flanges has been made.	X			X	Closed. Flange calculations are maintained separately.
PI-00-008	A discrepancy exists in the use of Bechtel Program ME101 regarding the keyword "FLX".	X		*		PFR No. 008. Closed.
	PROBLEM NO. 96					
PI-01-001	The insulation weight used on line GBB-19 is 5% higher than the value in the insulation specification.	X			X	Closed. Line GBB-19 is a short piece of piping between the RHR head exchangers. A 5% change in the insulation weight does not significantly affect the design.
PI-01-002	A response spectra analysis for SSE loading is not run; instead, OBE values are multiplied by a factor of 2.3.	X			X	Closed. Cygna's check verifies that 2.3 x OBE envelopes SSE.
PI-01-003	The mass participation in the x, y and z directions is 45%, 61% and 71%, respectively, which is less than the target of 90%.	X			X	Closed. Based upon review of a rerun analysis which addressed the effect of the ZPA times the valve weight on system loads, there is negligible impact upon design. (2)

* Further review has shown that this potential finding has no impact on plant safety.

Observation Log		Rev 2 / Date 8/21/82	Classification				
Observation No.	Description		Valid YES	Valid NO	Potential Finding YES	Potential Finding NO	Remarks
	Problem No. 141						
PI-04-001	Several uninsulated lines are modeled as insulated.		X			X	Closed. This added insulation weight occurs on short lines near anchors, so the design impact is negligible.
PI-04-002	The direction cosines of lateral restraint S-22 are input incorrectly.		X			X	Closed. The design impact is negligible due to the size of the line and the proximity of anchors.
PI-04-003	The bend at data point 760 is incorrectly modeled.		X			X	Closed. Based upon review of revised analysis.
PI-04-004	The dynamic analysis for chugging and P.S.P.T. are cut off at a frequency of 62.7; no further static analyses are performed.		X			X	Closed. Review of spectra indicates no significant impact on design.
PI-04-005	Motor operated valve F028A-A is modeled with too heavy of an operator weight (671 vs. 475 lbs.).		X			X	Closed. Review of revised analysis shows that the design impact is negligible.
PI-04-006	There are several errors in unit weights and wall thicknesses.		X			X	Closed. Some errors were detected in the drawings, but were subsequently corrected. The correct values were used in design. The remaining instances do not significantly impact design. (2)

Observation Log	Rev 2 / Date 8/21/82	Classification				
		Valid		Potential Finding		
Observation No.	Description	YES	NO	YES	NO	Remarks
	FLUED HEAD REPORT					
PI-05-001	Primary plus secondary stress intensity exceeds 3 Sm.		X		X	Closed. Further review of an alternate linearization technique indicates stresses are within allowables.
PI-05-002	Radial thermal stresses at the inner surface are compressive and large (-22400 PSI). They should approach zero at this surface.	X			X	Closed. Stiffness matrix formulation used E_c while load vector formulation used E_h. However, this does not significantly affect stress intensity and does not impact conclusions.
PI-05-003	A. Specification is unclear with regard to where failure loads are applied and which load combinations are investigated. B. Interpretation of the specification by NEAT, which are results in load combinations inconsistent with possible system configurations.	X			X	A. Closed. Further review indicates that the location chosen is reasonable. B. Closed. Further review indicates that analysis conservatisms envelop any effect from other load combinations.

| 2

- Support and Restraint Types, Locations and Stiffness
- Fittings, Nozzles and Valves.
- Mass Point Spacing
- Cut-off Frequency / No. of Modes

4.5.3 Stress Related Calculations

The following calculations, which are necessary for completion of a piping stress analysis, were reviewed in detail:

- Stress Intensification Factors for Weldolets
- Seismic Anchor Movements
- Valve Natural Frequency Check
- Support, Restraint, Anchor, Penetration, and Equipment Nozzle Load Summaries

4.5.4 Results and Conclusions

After the above checks had been completed for each problem, the results and conclusions were reviewed in detail to assure reasonableness, consistency, and compliance with project criteria. The following items were given particular attention.

- Displacements, Stresses and Reactions
- Pipe Stress Code Check
- Equipment Nozzle Reactions
- Valve Acceleration Check
- Mass Participation
- Functionality Requirement Check
- Load Combinations

The following load combinations were reviewed:

Primary

Normal Operating Condition

A. Pressure + Weight

Upset Condition

B. Pressure + Weight + OBE

C. Pressure + Weight + OBE + Relief Valve Open/Closed Systems + SRV_{all} + Quencher Water Clearing

D. Load Case B + Relief Valve Open/Closed System + SRV_{all} + Quencher Air Clearing

E. Load Case B + RV Open/Closed System + SRV_{all} + Quencher Water Clearing

F. Load Case B + RV Open/Closed System + SRV_1 + Quencher Air Clearing

Faulted Condition

G. Load Case A + SSE

H. Load Case G + SRV_{all}

I. Load Case G + SRV_1

J. Load Case A + SRV_{ADS} + $(Chugging^2 + SSE^2)^{1/2}$

K. Load Case A + Poolswell + $[(Vent\ Air\ Clearing + PSPT)^2 + SSE^2]^{1/2}$

L. Load Case A + Fallback + $[Steam\ Cond./Chugging^2 + SSE^2]^{1/2}$

M. Load Case A + $[SSE^2 + AP^2]^{1/2}$

Secondary:

A. Thermal + SAM

Primary & Secondary:

A. Pressure + Weight + Thermal + SAM

NOTE: Loads were added by absolute sum except as indicated above.

4.6 Class 1 Stress Report

The Nuclear Class 1 Piping Stress Report for the RHR System, Bechtel Document No. 9645-SR42, was reviewed in detail to assure compliance with project criteria and Code requirements for Class 1 piping analysis. This review placed particular emphasis on the following areas of concern for a Class 1 analysis:

- Interpretation of pressure/temperature load histogram for use in thermal transient and fatigue analysis
- Piping discontinuity evaluation
- Calculation and use of stress indices
- Material parameters specific to Class 1 analyses
- ASME Code Class 1 acceptability check
- Analysis of welded attachments

4.7 Flued Head Analysis

The Nuclear Class 1 Stress Report for RHR Drywell Flued Head No. 313 and 314, Bechtel Document No. NEAT-81-9645-3, was reviewed in detail to assure compliance with project criteria and Code requirements for Class 1 analyses. This review placed particular emphasis on the following areas of concern:

- Interpretation of pressure/temperature load histogram for use in thermal transient and fatigue analysis
- Application of loads due to attached piping
- Application of pipe failure loads
- Use of finite element computer program "ANSYS"
- ASME Code Class 1 acceptability check

4.8 Pipe Support Design

The main flow path of RHR Train "A", as shown in Fig. 3-2, contains thirty-five pipe supports. The design of each of these supports was reviewed in detail to assure conformance with project design criteria and normal industry practice. This activity consisted of a review of the following items:

- Input data and load combinations considered
- Design calculations
- Drawings

Each of these items is described in detail below.

4.8.1 Input Data and Load Combinations

An in-depth inspection was made of the support guidance generated by the Bechtel Stress Group for use by the Support Group. This check was performed to assure that the following information was properly transmitted between the two groups:

- Support types and locations
- Piping deflections for all essential load cases
- Support loads generated for all essential load cases

4.8.2 Design Calculations

The following calculations and checks which are required for completion of the design of a pipe support were reviewed in detail:

- Support stiffness
- Weld calculations
- Stress allowables
- Vendor allowables for catalog hardware
- Proper modeling for computerized calculations
- Expansion bolt allowables and baseplate flexibility

4.8.3 Drawings

Due to the critical need for correct drawings to be forwarded to the site, a close comparison was made of the support drawings which were produced and the analytical results of the overall piping design process. To accomplish this, the following key elements were checked for each pipe support drawing issued:

- Correct type, orientation, and location
- Proper specification of clearances
- Sufficient structural and weld data
- Correct component sizes

4.8.4 Pipe Support Walkdown

To assure that the pipe supports and restraints will perform their intended functions in the installed condition, an as-built review was performed. This task was accomplished considering the overall assembly from a functional vantage point rather than inspecting detailed individual parts and components. Checks were made in the following key areas:

- Approximate location and orientation with respect to the piping system.

- Type, size and adjustment of components such as springs and snubbers.
- Approximate dimensions of critical members of the support assembly.
- Miscellaneous considerations such as clearance between pipe and restraint steel and gaps between baseplates and concrete surfaces.

In addition, during the course of the walkdown the orientation of the operator was checked for all motor operated valves along the main flow path.

5.0 SUMMARY AND CONCLUSIONS

Cygna has completed this independent design review. The review concentrated on the design and design control activities related to redesign of the RHR System, Train "A", to meet the requirements of the New Loads Adequacy Evaluation Program. Although this review concentrated on the New Loads era, which spanned from January 1978 to date, the piping between the RHR heat exchangers was unaffected by New Loads. That portion of the system design is controlled by seismic loads and was performed between 1975 and 1977. The technical review therefore considered designs developed as early as 1975.

Cygna has concluded that these design and design control activities were performed in accordance with the project commitments and standard practice. There were minor nonconformances, but none of these were determined to affect the safety of the plant or the public. The results of this review are tabulated below:

	OBSERVATIONS*	POTENTIAL FINDINGS
Number Valid	63	9
Number Invalid	21	0
Number Open	1	1
Number Closed	83	8
Number Reportable	0	0
TOTAL	84	9

* Includes the Potential Findings

"Observations" are any nonconformances to the review criteria. "Potential Findings" are those observations identified as having a potential impact on plant safety. After further review, a potential finding may be determined either to have no impact on plant safety or to be reportable under the guidelines the Code of Federal Regulations (10CFR21). The above tabulation shows that of the eighty-four (84) observations, nine (9) were identified as potential findings, none of which are reportable per 10CFR21. The following subsections address the resolution of each observation identified as a potential finding.

5.1 QA Review - Bechtel

5.1.1 QA Program Review

The review to determine the adequacy of the Bechtel QA Program in addressing the key design control elements as specified in ANSI-N45.2, and NUREG 75/087, resulted in six observations (QA-00-001 through QA-00-006 - see Appendix E). Of the six, five were satisfactorily resolved through further review and one PFR (PFR-001) was initiated.

PFR-001 The Bechtel QA GGNS-1 Program is silent with respect to establishing requirements governing the preparation, control, verification and documentation of non-standard computer programs.

The PFR has been closed, as the project provided evidence of satisfactory control over non-standard (project generated) computer programs. This has been accomplished by the project implementing the requirements of Bechtel Corporation Standard Procedure EDP 4.3.7. It is therefore concluded that the Bechtel QA Program as it applies to its GGNS-1 project during the NLAE program adequately addresses those key design control elements to which it has committed.

5.1.2 Implementation Evaluation

The review to assess the effectiveness of the implementation of the established Bechtel QA program resulted in the identification of twenty-two (22) observations (QA-01-001 through QA-01-022 - See Appendix E). All but one (PFR-009) of these were resolved at the observation level. This PFR is discussed below:

PFR-009 Local stress calculations for restraints and anchors designed by the Civil Group are not checked.

This potential finding applies to 112 restraints and anchors in the GGNS-1 safety-related systems. As a result of this finding, Bechtel checked these local stress calculations. Upon completion of this checking activity, Cygna performed a review of 25% of these calculations. To assure compliance with applicable procedures a technical review of these calculations was performed to assure that proper engineering procedures were employed. Included among those calculations reviewed were the problems which had the highest primary stresses, the highest secondary stresses and the highest load to pipe size ratios. These reviews revealed that all calculations were properly checked and that there were no instances in which the stress allowables were exceeded. Based upon the above, it has been determined that there is no impact upon plant safety.

During the implementation evaluation of the Bechtel QA program, certain activities of an administrative nature were noted, which do not impact plant safety, but should nevertheless be addressed. These are:

A) Project calculations should be reviewed to assure that references to information or source data are specific to document revisions.

B) A consistent system for tracking of action items generated as a result of trip reports and conference notes should be established.

C) Calculation cover sheets should be revised to accommodate a listing of all calculation originators and checkers involved in the calculations as identified in calculation sheets.

5.2 QA Evaluation - MP&L

The evaluation of MP&L was concluded to be satisfactory. During the evaluation, two observations were identified (QA-02-001, QA-02-002 - See Appendix E). Both have been resolved.

5.3 Review of NRC Inspection Reports

The review of NRC Inspection Reports disclosed that several noncompliances were identified in the Bechtel design control program prior to and during the period of 1978. Of those identified, each was a separate, distinct problem indicating no discernable trend in the area of design control. Further, during the later part of 1978 through early 1979, all the earlier identified noncompliances had been resolved to the satisfaction of the NRC indicating a positive trend of corrective action by Bechtel in improving the design control program. The period of 1978 up to early 1982 disclosed only isolated non-compliances, none of which could be considered a degrading quality trend.

The Cygna review disclosed several observations, two of which were identified as a potential safety impact issue (QA-00-001, QA-01-001) which was subsequently resolved. Considered cumulatively, the results of this review and previous NRC inspections did not identify any degrative quality trends.

5.4 Review of Independent Verification of San Onofre Units 2 and 3 Seismic Design Interim Report

The review of the Torrey Pines Technology Independent Design Review Report on San Onofre Units 2 and 3 disclosed that no potential findings were identified regarding the Bechtel Design Control Program. It is therefore concluded that, after the Cygna review, no generic quality problem could be assigned to or inferred with the Bechtel Corporation Quality Program governing design control.

5.5 Review of Piping Stress Analyses

The review of the technical design associated with the four piping analyses from RHR Train "A" resulted in forty-four observations (PI-00-001 through PI-04-016). As a result of further review, eleven of these observations were invalidated, twenty-six were resolved and closed at the observation level, and seven warranted classification as potential findings (PFR). All of the PFRs were subsequently closed as a result of further review and corrective actions by Bechtel as needed. In all cases it was determined that there was no impact upon plant safety. These PFRs are contained in Appendix D and a discussion of each and its associated resolution follows:

PFR-002 Piping restraints were input to the piping analysis using an assumed stiffness value. After the pipe restraints were designed, the piping analysis was not revised to incorporate the actual restraint stiffnesses.

During the course of the pipe support review, the actual restraint stiffnesses for supports along the main flow path for RHR Train "A" were tabulated and compared to the assumed stiffness value. This, in conjunction with a previous Cygna study of the sensitivity of piping system response to changes in support stiffness, led to the determination that the maximum increase in loads and stresses which can be expected is within acceptable limits and the available design margin. Therefore, there is no impact upon plant safety.

PFR-003 The piping analysis used a cutoff frequency of 60 hertz. Since some hydrodynamic loads do not reach their zero period accelerations until nearly 100 hertz, this assumption may be unconservative.

Further review of the piping analyses from RHR Train "A", which are subjected to SRV loading and in which the analysis was cutoff at 60 HZ or less, indicates that there would not be any significant increase in loads and stresses due to the inclusion of the higher frequency modes. This is based upon calculations of the percentages of mass participation and strain energy. The latter was based upon the method shown in GE Document NEDE 25250, "Generic Criteria for High Frequency Cutoff of BWR Equipment", January 1980. As a result, it has been determined that there is no impact upon plant safety.

<u>PFR-004</u> The method which was used by the Bechtel Stress Group in the calculation of the Stress Intensification Factor (SIF) for a concentric reducer sometimes underestimates the SIF by as much as 100%. This method was employed on all piping systems analyzed for GGNS-1.

Cygna subsequently performed a review of 27% of the high temperature (greater than 350° F) safety related piping problems on GGNS-1. This, coupled with a random sampling performed by Bechtel of 10% of the "new loads" piping problems (both hot and cold), indicates that in many instances the increased stress at the reducers became the maximum system stress. However, in no case did this increase cause allowable stresses to be exceeded. Based upon the above it has been determined that there is no impact upon plant safety.

<u>PFR-005</u> In Problem No. 69C, the piping between the containment penetration and the RHR heat exchanger, a time history analysis was performed to analyze the hydrodynamic effects of relief valve blowdown. In developing the load summaries at restraints and anchors, the reactions were taken directly from the computer output which does not fully account for the high frequency response occuring along the line of action of a restraint or anchor. This resulted in an increase in load at one restraint (S28) of 81%.

Subsequently, Cygna performed a review of other systems which require a time history analysis (main steam, main steam bypass, and main steam relief valve discharge). This review confirmed that this situation was isolated to the RHR Relief Valve Discharge Piping. In addition, restraint S28 was found to be able to withstand the increase in load. Therefore, plant safety is not impacted.

PFR-006 The Stress Intensification Factor (SIF) for a weldolet was not considered for the run pipe wherever the ratio of run pipe section modulus to branch pipe section modulus exceeded 10. This criteria was applied to all piping systems analyzed for GGNS-1.

Subsequently, Cygna performed a review of 27% of the high temperature (greater than 350° F) safety related problems on GGNS-1. This, coupled with an evaluation of the piping problems for RHR Train "A", indicates that there are no instances in which the increase at a branch connection causes allowables to be exceeded. Therefore plant safety is not impacted.

PFR-007 Inspection of the output for Problem No. 141 (piping between the drywell and containment), which was rerun due to Observations PI-04-005 and PI-04-008, shows that valve FO37A-A exceeded the allowable acceleration by 25%. This was the only valve in RHR Train "A" where this problem was noted.

Subsequently, Problem No. 141 was rerun with a revised, less conservative envelope of the SRVA Response Spectra. Review of this rerun analysis showed that the acceleration of valve FO37A-A was below the allowable for both upset and faulted conditions. Therefore plant safety is not impacted.

PFR-008 As a result of Observation PI-04-003 it was determined that a discrepancy exists in the documentation for Bechtel Computer Program "ME101". When using the keyword "FLX" for specifying the flexibility factor for an elbow or bend, the documentation does not indicate that the bend radius must also be specified.

As a result of the additional reviews performed by Cygna during the resolution of PFR-004 and PFR-006 and additional investigation performed by Bechtel, it has been determined that the use of this keyword was isolated to only one piping problem and that there is no impact upon plant safety. Bechtel has issued an internal memorandum to ME101 users providing directions for using the "FLX" key word.

5.6 Review of Class 1 Stress Report

The review of Bechtel's Class 1 Stress Report for the LPCI System, No. 9645-SR-12, Rev. 0, resulted in no deficiencies of a nature which warranted a written observation. However, there were several items where it is felt that a correction or clarification might aid any future reviewer.

1) It is probably not useful to incorporate the entire TRHEAT theoretical manual in the stress report. In terms of balance it would be more useful to describe in general the operation, format, and verification of all computer programs used in the analysis. This would include TRHEAT, ME913, and any others.

2) A more detailed discussion of special functional capability requirements would be helpful.

3) All nomenclature used for complete description of NB3650 code equations was listed on Page viii of the report, yet, code equations were not noted.

4) No mention of type of seismic analysis done, computer programs used or USNRC Regulatory guides incorporated was in the report. Similarly, there was no mention of how building earthquake anchor movements were considered.

5) No mention was made of qualifying methods for ASME Code Class 1 small bore piping.

6) A separate isometric drawn specifically for the Class 1 report would have been much simpler and more understandable than the multipurpose drawing attached to the report. Also, the data point designation on the isometric did not match that of the stress report. There were no clear ASME Class 1/2 boundaries noted.

5.7 Review of Flued Head Analysis

The review of Bechtel's Nuclear Class 1 Stress Report for RHR Drywell Flued Head Nos. 313 and 314, No. NEAT-81-9645-3, Rev. 1 resulted in seven observations (PI-05-001 through PI-05-007). As a result of further review, three of these observations were invalidated and the remaining four were resolved. None of these observations resulted in a PFR. However, as noted in the Observation Record Reviews, for at least four of these observations the review could have been accomplished much more efficiently if the documentation provided in the report had been more detailed.

In addition, a brief review of Bechtel's Nuclear Class 1 Stress Report for Main Steam Flued Head Nos. 5, 6, 7, and 8, No. NEAT-81-9645-17, Rev. 1, was performed to assure that the areas questioned in the RHR Flued Head Review were adequately addressed in the Main Steam Flued Head. This revealed no deficiencies and, as in the case of the RHR Flued Head, resulted in the conclusion that there is no impact on plant safety.

5.8 Review of Pipe Support Design

The review of the technical design associated with the thirty-five pipe supports located along the main flow path of RHR Train "A" resulted in three observations (PS-00-001, PS-08-001, and PS-34-001). As a result of further review, PS-00-001 was invalidated and the remaining two observations were closed due to their insignificant design impact. There were no deficiencies of a nature which warranted a PFR or affected plant safety.
In addition, this review noted further conservatism in the pipe support designs due to a 27% margin in fillet weld allowables when compared to the 1980 code.

5.9 Pipe Support Walkdown

The as-built verification of the thirty-five pipe supports located along the main flow path of RHR Train "A" is summarized in Table 5-1. Of the thirty-five, three were inaccessible. The remaining thirty-two were found to be within allowable tolerances and were determined to be acceptable. The model numbers and load ratings of nine Bergen-Patterson spring hangers were partially obscured by stick-on labels showing hot and cold settings. A review of controlled documentation provided by MP&L provided acceptable verification for these hangers. In addition, no discrepancies were noted in the orientation of motor operated valves.

TABLE 5-1

INDEPENDENT DESIGN REVIEW
PIPE SUPPORT WALKDOWN SUMMARY

Hanger/Support	Location	Dimension	Angle	Weld	Manufacture Hardware	Base Plate and Anchor Bolt	Remarks
QIE12G015 R21	A	A	A	A	C	-	As-Built Acceptable
QIE12G015 H04	A	A	-	A	C	-	"
QIE12G015 R37	A	A	-	A	A	-	"
QIE12G015 R01	-	-	-	-	-	-	Inaccessible
QIE12G015 R02	-	-	-	-	-	-	Inaccessible
QIE12G015 H01	-	-	-	-	-	-	Inaccessible
QIE12G015 C09	A	A	A	A	-	-	As-Built Acceptable
QIE12G015 R03	A	A	A	A	-	-	As-Built Acceptable
QIE12G015 R25	A	-	-	A	-	-	"

TABLE 5-1

INDEPENDENT DESIGN REVIEW
PIPE SUPPORT WALKDOWN SUMMARY

Hanger/Support	Location	Dimension	Angle	Weld	Manufacture Hardware	Base Plate and Anchor Bolt	Remarks
QIE12G015 R26	A	-	-	A	-	-	As-Built Acceptable
QIE12G009 R01	A	A	A	-	-	A	"
QIE12G009 H01	A	A	-	-	C	A	"
QIE12G009 R03	A	A	-	B	A	-	"
QIE12G009 H02	A	-	-	B	C	-	"
QIE12G009 R04	A	B	-	A	A	-	"
QIE12G012 H16	A	A	-	-	C	-	"
QIE12G012 R01	A	A	A	A	-	A	"
QIE12G012 H15A	A	A	-	A	C	A	"

TABLE 5-1

INDEPENDENT DESIGN REVIEW
PIPE SUPPORT WALKDOWN SUMMARY

Hanger/Support	Location	Dimension	Angle	Weld	Manufacture Hardware	Base Plate and Anchor Bolt	Remarks
QIE12G012 H01	A	A	-	A	-	A	As-Built Acceptable
QIE12G012 R02	A	A	A	A	A	-	"
QIE12G012 R03	A	A	A	-	-	B	"
QIE12G012 H02	A	A	A	A	C	-	"
QIE12G012 R04	A	A	-	A	A	-	"
QIE12G012 R05	A	-	-	-	A	A	"
QIE12G012 H03	A	A	A	-	C	A	"
QIE12G012 R06	-	-	-	A	-	A	"
QIE12G013 H01	D	A	-	A	-	-	"

TABLE 5-1

INDEPENDENT DESIGN REVIEW
PIPE SUPPORT WALKDOWN SUMMARY

Hanger/Support	Location	Dimension	Angle	Weld	Manufacture Hardware	Base Plate and Anchor Bolt	Remarks
QIE12G013 H02	A	A	-	A	C	-	As-Built Acceptable
QIE12G013 H03	A	-	-	A	C	-	"
QIE12G013 R02	D	A	A	A	A	-	"
QIE12G013 R03	A	-	-	A	-	A	"
QIE12G013 R04	A	A	-	A	A	-	"
QIE12G013 R05	A	A	A	A	A	A	"
QIE12G013 R06	A	A	-	A	A	-	"
QIE12G013 R07	A	A	-	A	A	-	"

TABLE 5-1

INDEPENDENT DESIGN REVIEW

PIPE SUPPORT WALKDOWN SUMMARY

NOTES:

(A) As-built agrees with the design or has a minor discrepancy.

(B) Inaccessible. No safety impact due to large design margin.

(C) Spring hanger. Unable to determine model and rating.

(D) Inaccessible for exact measurement.

58.0 MP&L Operational Quality Assurance Manual, Title: Corrective Action, Rev. 2.

59.0 MP&L Operational Quality Assurance Manual, Title: Audits, Rev. 2.

60.0 MP&L Internal Procedures Manual, Section 8, Rev. 13.

61.0 Piping and Instrumentation Diagrams - RHR System M-1085A, Rev. 19 and M1085B, Rev. 17.

62.0 Area Piping Composite Drawings (M Drawings).

63.0 GE Drawing No. 794E858, Rev. 1, Class 1 Piping Cycles - LPCI.

64.0 Bechtel Drawing No. SK-M-2034, Rev. 7, Flued Head Details.

65.0 Penetration Schedule and Detail Drawings (C Drawings).

66.0 Vendor Valve Drawings.

67.0 I.E. Bulleton 79-14 Walkdown Checklist for:
QIE12G013H03
QIE12G013H02
QIE12G012H16
QIE12G012H15
QIE12G012H03
QIE12G012H02
QIE12G009H02
QIE12G009H01
QIE12G015H04

68.0 Bechtel Calculations Nos.:

Q1B21G022R03	Q1E12G018A01	Q1E12G013R05
Q1B21G023H04	Q1G41G016A01	Q1E12G013R06
Q1B21G024C01	Q1P45G812A01	Q1B21GO23R05
Q1B21G024R14	Q1E12G025A03	
Q1B21G025H01	Q1P41G008A02	
Q1B21G032A01	Q1P41G008A03	
Q1E12G021A01	Q1P41G009A03	
Q1P44G003A01	Q1P66G003A01	
Q1P53G003A02	Q1B21G024R11	
Q1E51G004A02	Q1B21G023R20	
Q1G41G009A01	Q1B21G022R13	
Q1E12G014A01	Q1B21G023R04	
Q1E12G014A02		

Job No. 82026
Doc. No. DC-2
Rev. 1

INDEPENDENT DESIGN REVIEW

PIPE SUPPORT DESIGN REVIEW CRITERIA

FOR

GRAND GULF NUCLEAR STATION UNIT 1

MISSISSIPPI POWER & LIGHT

Prepared by Chuan Liu 8/20/82
C. Liu Date

Independent Review by L. Chiu 8/20/82
L. Chiu Date

Approved by [signature] 8/20/82
R. Hamati Date
Division Manager

CYGNA ENERGY SERVICES
141 Battery Street, Suite 400
San Francisco, CA 94111

August, 1982

CYGNA

1.0 SCOPE

1.1 This criterion is intended to establish general guidelines for an independent design review of supporting components, hangers, restraints and shock suppressors in the RHR, train "A" piping system.

1.2 Pipe supports shall be capable of supporting a piping system during all conditions of operation by transmitting the loads from the pipe to structural members in the building.

2.0 CODES, STANDARDS AND REFERENCE DOCUMENTS

The following codes shall be used for the design review of pipe supports:

2.1 ASME Boiler and Pressure Vessel Code Section III, Subsection NF, 1977 edition.

2.2 ANSI B31.1, Power Piping Code, 1977.

2.3 American Institute of Steel Construction, Inc., AISC Steel Construction Manual, 8th edition.

2.4 Bergen-Paterson Pipe Supports Catalog No. 66R

3.0 PHYSICAL REQUIREMENTS

3.1 Natural Frequency

a. The natural frequency of a seismic restraint with its tributary pipe mass must be greater than 33 Hertz in the pipe's restrained direction. The mass used to calculate the natural frequency shall include the weight of the restraint, restrained pipe, pipe insulation, fluid, pipe attachments, and valves. Any rational analysis may be used to calculate the natural frequency. The natural frequency calculations of pipe restraints do not have to include the flexibility of the building structure.

b. The natural frequency of a support in its unrestrained direction shall be considered for the purposes of computing loads and stresses. Only the weight of the hanger applied uniformly along its length needs to be considered.

c. For the purpose of determining the natural frequency of snubbers and their frames, consider the snubber to exhibit stiffness qualities which would make them a rigid link between the pipe and the supporting structure. The supporting structure, from the building's frame to the snubber, shall be designed such that the natural frequency is at least 33 Hertz.

3.2 Gaps

A gap shall be provided to accommodate radial expansion and construction tolerances. The maximum total gap allowed in the restrained direction is 1/8". In non-restrained directions, the support design shall allow clearance for the most severe thermal plus seismic movements of the pipe. Proper installation tolerances shall be provided where thermal movement cannot be accommodated within the specified gap minus 1/16".

3.3 Deviations

3.3.1 The design location of the supports in a straight run of the pipe may deviate by from the theoretical location ± 2 inches for Nuclear Class 1 and ± 6 for Nuclear Class 2 and 3. 1

3.3.2 The distance between centerline of piping and structural attachment may deviate by 10%.

3.4 Spring Supports

Spring supports shall be capable of exerting a supporting force equal to the load, as determined by weight-balance calculations, plus the weight of all hanger parts, such as clamps, and rods, that will be supported by a spring at the point of attachment to a pressure-retaining component or to an integral attachment. The design shall be such as to prevent complete release of the component load in the event of spring failure or misalignment. Any variability of a supporting spring force resulting from movement of the component shall be considered in the loadings used in the stress analysis of the component. The spring's available travel will be checked against the thermal and seismic movements.

3.5 Hanger Rods

Hanger rods shall be subjected to tensile loading only unless specific gapping instructions are indicated on the drawings. Rod hanger assemblies shall be designed to allow anticipated thermal horizontal movement without subjecting the pipe to extraneous loads. The maximum swing angle due to horizontal pipe movement should be less than 4°. If the swing angle of the rod is in excess of 4° and/or the total movement is in excess of two inches, the hanger shall be offset two-thirds of the thermal movement towards the direction of movement.

3.6 Snubbers

The snubber assembly shall be offset two-thirds of the thermal movement in the cold position if the swing angle exceeds 5° and/or the total movement of the point of attachment on the pipe is in excess of two inches. The midpoint of thermal travel for snubber strokes shall be set at the midpoint of the total travel with hot and cold settings established accordingly.

3.7 Structural details shall conform to the requirement of the AISC Manual of Steel Construction.

3.8 All seismic supports shall be two way restraints. Regardless of other imposed loads, the pipe must be physically restrained in each direction along the restraining axis.

4.0 RESTRAINT

4.1 The loadings that shall be taken into account in designing a component support are, but not limited to, the following:

a. Weight of the component, insulation, and normal contents (DL). Pipe and component weights from manufacturer's data.

b. Loads induced by the actuation of safety/relief valves associated with automatic depressurization system (SRV_{ADS}).

c. Loads generated by restrained thermal expansion. These include temperatures at normal operating conditions (TH).

d. Loads induced by the steam condensing/chugging (SC/CH).

e. Seismic Loads - Safe Shutdown Earthquake (SSE).

5.0 LOADING COMBINATIONS

The following loading combination shall be used for the design review of pipe supports:

$$DL + TH + SSE + SRV_{ADS} + SC/CH$$

This is a faulted loading condition.

6.0 ALLOWABLE STRESS

Stress		Normal & Upset Value	Normal & Upset KSI	Faulted
Tension		$0.6\ F_y$	21.6	As per ASME Appendix F-1370
Shear		$0.4\ F_y$	14.4	
Web Crippling		$0.75\ F_y$	27.0	
		F_a per Table 1-36 AISC		
Bending		$0.6\ F_y$	21.6	
Bearing		$0.9\ F_y$	32.4	
Bolts 307	Tension	Allowable Tension per AISC		
	Shear	Allowable Shear per AISC		
Anchor Bolt		TABLE A		
Welds (Fillet, Full or Partial Penetration)	Shear	$0.3\ F_v$ (Weld Metal)	21.0	
	Tension	$0.6\ F_y$ (Base Metal)	21.6	
Combined Stress		Per AISC		
Catalog Items		Catalog Values		

APPENDIX A

DESIGN (Anchor Bolt)

A.1.0 APPLICATIONS

A.1.1 Concrete expansion anchors should not be used indiscriminately. For important work, bolts should preferably be cast-in-place, welded, or grouted in drilled holes or in cast-in-place sleeves. Where those types of installation are for good reason impractical, expansion anchors may be used.

A.1.2 Provisions of this standard shall apply to the shell or stud type expansion anchors.

A.1.3 Anchors must be at least 1/2" diameter when used for structural connections or for anchorage of pipes greater than 2" diameter.

A.1.4 Embedded length of anchor shall be exclusive of thickness of grout pad or other overlay.

A.2.0 ALLOWABLE LOADS

A.2.1 Allowable loads shown in Table A, as modified by the provisions of this standard, shall apply to anchors installed in ordinary concrete.

A.2.2 For concrete strength between 2 ksi and 6 ksi, linear interpolation in Table A may be used. For concrete strength greater than 6 ksi, use 6 ksi allowable values. For sound concrete of unknown strength, use 2 ksi values.

A.2.3 Allowable load values given in this standard shall not be increased because of short duration of loading (e.g., for wind or seismic loads).

A.2.4 For anchors subjected to continuous or frequent (more than 500 times per year) reversal of loading, allowable loads shall be 1/3 of the allowable values given in this standard.

A.2.5 Allowable loads given in this standard are intended for use at "working load" levels. For "ultimate" or "limit" load design purposes, twice these values may be used.

A.2.6 Anchors installed in lightweight aggregate concrete shall have allowable loads equal to those provided for anchors in ordinary concrete with $f'_c = 2$ ksi .

A.2.7 If center-to-center spacing of anchors is less than 12 diameters and/or if distance from edges of concrete to center of anchor is less than 6 diameters, the allowable loads shall be reduced in accordance with the following formulae:

$$P_D = 2.25\ P_A \frac{N}{N+6} \frac{E}{E+3}$$

$$S_D = 1.5\ S_A \frac{E}{E+3}$$

where:

P_D = allowable pullout load reduced for edge distance and/or spacing

P_A = allowable pullout load from Table A

S_D = allowable shear load reduced for edge distance

S_A = allowable shear load from Table A

N = number of diameters of anchor spacing $(6<N<12)$: if $N>12$, use $N=12$

E = number of diameters of edge distance $(3<E<6)$: if $E>6$, use $E=6$

Anchor spacing shall be not less than 6 times nominal diameter of anchor. Edge distance shall be not less than 3 times nominal diameter nor less than 3 inches. If edge of concrete is chamfered, edge distance shall be measured from nearest edge of chamber.

A.2.8 For anchors which will be subjected simultaneously to pullout and shear forces, the allowable load values used must satisfy the following formula:

$$\left(\frac{P_C}{P_D}\right)^{5/3} + \left(\frac{S_C}{S_D}\right)^{5/3} < 1$$

where: P_D, S_D = allowable loads (pullout, shear), reduced for spacing or edge distance if appropriate.

P_C, S_C = design loads to be used in cases where pullout and shear loads may occur simultaneously.

Note: For convenience in calculation, exponents in the above formula may, conservatively, be reduced to 1.0.

TABLE A

ALLOWABLE LOAD (KIPS) ON EXPANSION ANCHORS

NOMINAL DIAMETER (inch)	CONCRETE STRENGTH, f'_c 2 ksi		3 ksi		4 ksi		5 ksi		6 ksi	
	P	S	P	S	P	S	P	S	P	S
1/4	.25	.30	.275	.30	.30	.30	.325	.30	.35	.30
3/8	.40	.54	.50	.60	.60	.67	.70	.73	.80	.80
1/2	.70	.74	.87	.89	1.05	1.04	1.23	1.19	1.40	1.34
5/8	1.20	1.00	1.50	1.25	1.80	1.50	2.10	1.75	2.40	2.00
3/4	1.80	1.50	2.35	1.80	2.90	2.10	3.45	2.40	4.00	2.70
7/8	2.50	2.00	3.35	2.35	4.20	2.70	5.05	3.05	5.90	3.40
1	3.30	2.50	4.30	2.90	5.50	3.30	6.60	3.70	7.70	4.10
1-1/4	5.30	3.40	6.65	3.95	8.00	4.50	9.35	5.10	10.70	5.70

NOTE: P, PULLOUT; S, SHEAR
For expansion anchors installed in lightweight aggregate concrete, assume F'_c = 2 ksi. See par. A.2.6.

Potential Finding Report	
PFR No.	009
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II. Senior Review

	YES	NO
Further Review Required	☐	☒
Valid Observation	☒	☐
Potential Safety Impact	☐	☒

Comments:

Subsequent to the initial issuance of this Finding, Bechtel checked the local stress calculations for all 112 safety-related supports and anchors which were designed by the Bechtel Civil Group. After the completion of this checking activity, Cygna performed a review of 25% of these calculations. In addition to the QA Review to assure compliance with applicable procedures, a technical review of these calculations was performed to assure that proper engineering procedures were employed. Included among those calculations which were reviewed were the problems which contained the highest primary stresses, the highest secondary stresses and the highest load to pipe size ratios. These reviews revealed that all calculations were properly checked and that there were no instances in which the stress allowables were exceeded. Based upon the above, it has been determined that there is no impact upon plant safety.

Approved by [signature] Cognizant Senior Reviewer — Date 8/23/82

III. Project Manager

Comments:

None.

Approved by T. Wittig Project Manager — Date 8-23-82