CYGNA
ENERGY SERVICES
150 North Wacker Drive, Chicago, IL 60606
312/236-5701

October 19, 1984

Director of Nuclear Reactor Regulation
Attention: Mr. B.J. Youngblood, Chief
Licensing Branch No. 1
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Mr. William F. Colbert, General Supervisor
Nuclear Safety and Plant Engineering (342 NOC)
The Detroit Edison Company
Enrico Fermi-2 Nuclear Operations Center
64 North Dixie Highway
Newport, Michigan 48166

Subject: NRC Design Review Questions
Independent Design Verification Program
Detroit Edison - Enrico Fermi Unit 2
Docket #50-341

Dear Sirs:

Enclosed is Cygna's response to the NRC's request for additional information on the Independent Design Verification Program (IDVP) for Detroit Edison's Fermi-2 plant. This information was requested in a letter from Mr. B.J. Youngblood of the NRC to Dr. W. Jens of Detroit Edison and Mr. L. Kammerzell of Cygna Energy Services dated March 27, 1984.

Specifically, the enclosure contains Cygna's responses to the NRC questions presented in Enclosures 1, 2 and 3 to the NRC March 27, 1984 letter. In addition, Cygna is providing information regarding freezing in the RHR Complex contained in Enclosure 4. The protocol contained in Enclosure 5 of the NRC letter was followed in the course of preparing this submittal.

Our response has been assembled as Section 8.0 to the IDVP Final Report. The Information is responsive to the NRC's request and should satisfactorily resolve the remaining open issues. Cygna will continue to maintain its independence from Detroit Edison until Operating License is issued on Fermi-2 as directed by both the NRC and Detroit Edison.

B001
1/39

CYGNA ENERGY SERVICES

Director of Nuclear Reactor Regulation
Attention: Mr. B.J. Youngblood, Chief
U.S. Nuclear Regulatory Commission

Mr. William F. Colbert
The Detroit Edison Company

October 19, 1984

Please contact me if you require further assistance or clarifications on this matter.

Very truly yours,

David A. Ferg
Project Manager

DAF/mf
Enclosures (40 copies for NRC)
(20 copies for DECo)

cc: M.D. Lynch (NRC, NRR-DOL) with Enclosure (2 copies)
J.G. Keppler (NRC IE, Region III) with enclosure (2 copies)
O.K. Earle (DECo) w/o Enclosure

INSTRUCTION SHEET

To insert the enclosed printed material into CYGNA's Independent Design Verification Program Final Report on Detroit Edison's Fermi-2 plan (Docket #50-341), perform the following steps:

A. Remove from Volume 1 of the Table of Contents, pages iv and vi.

B. Insert into Volume 1 the attached revised Table of Contents, pages iv, vi, vii and viii.

C. Remove from Volume 4 the cover sheet dated November 15, 1983 and the Table of Contents, pages i and ii.

D. Insert into Volume 4 the attached revised cover sheet dated October 18, 1984 and the Table of Contents, pages i, ii, iii and iv.

TABLE OF CONTENTS (continued)

VOLUME 4

LIST OF EXHIBITS (continued)

LIST OF FIGURES

LIST OF TABLES

No.: TR-83021-1
Revision 1

VOLUME 4

Independent Design Verification Program
of
Enrico Fermi - Unit 2

Prepared for

The Detroit Edison Company
3331 West Big Beaver Road
Troy, Michigan 48084

Prepared by

Cygna Energy Services
150 North Wacker Drive
Chicago, Illinois 60606

Approved by David A. Ferg — Project Manager — 10/18/84 Date

Approved by [signature] — Senior Review Team — 10/18/84 Date

October 18, 1984

CYGNA

TABLE OF CONTENTS

VOLUME 4

LIST OF EXHIBITS

LIST OF FIGURES

LIST OF TABLES

INSTRUCTION SHEET

Insert the enclosed printed material in Volume 4 of CYGNA's Independent Design Verification Program Final Report on Detroit Edison's Fermi-2 plant (Docket #50-341) behind Section 7.7, Page 7.7-144.

8.0 ADDITIONAL NRC REVIEW INFORMATION

8.1 INTRODUCTION

In March, 1984, Cygna Energy Services received a letter from Mr. B.J. Youngblood of the NRC requesting additional review information on the Independent Design Verification Program (IDVP) for Fermi-2. The information was requested by the NRC to complete their review of Cygna's four-volume IDVP Final Report. The specific questions were contained in Enclosures 1, 2 and 3 to the NRC letter (dated March 27, 1984). This supplemental section to the IDVP Final Report contains the detailed Cygna responses to the NRC Enclosure items. In responding, Cygna is also providing further discussions to resolve general areas of NRC concern related to:

- Cygna's rationale for resolving specific observations (findings) related to deviations by Detroit Edison and its contractors from Fermi-2 design criteria and licensing commitments;
- Areas where the review scope was expanded to determine whether deviations were localized, one-time phenomenon or possibly indicative of generic concerns in the designs process;
- Any observations or findings which may point to short-comings in the implementation of Detroit Edison's QA/QC procedures for the design process;
- Cygna's basis for concluding that the overall design process was adequate for the technical disciplines reviewed and how the basis is documented in the IDVP Final Report.

Also, our comments are enclosed in response to NRC questions in Enclosure 4 regarding freezing in the Fermi-2 RHR Complex and the 10CFR50.55(e) report from Detroit Edison. The protocol contained in Enclosure 5 of the NRC letter was followed in the course of preparing this submittal to the NRC.

Overall, Cygna expended a considerable amount of time and effort (approximately 2,800 manhours) to assemble Section 8.0 to the IDVP Final Report. As a first step, Cygna prepared a Program Plan for the additional review activities required to respond to the NRC concerns. A subsequent meeting was held on May 11, 1984 with the NRC, Detroit Edison and Cygna to ensure the contents and actions outlined in our Program Plan were based on a sound, proper understanding and interpretation of the NRC questions. In preparing Section 8.0, the individual enclosure items were thoroughly examined and evaluated. In many cases, additional design documents and calculations were requested and reviewed indepth. Our activities extended basically to reviewing the entire IDVP Final Report documentation once again to confirm the basis for resolving the various observations and findings found in the course of Cygna's review.

As a result of this effort, Cygna was able to reconfirm the conclusions presented in Sections 1.6, 5.4 and 7.5 of the IDVP Final Report. In particular, Cygna found no basis for the general NRC concerns expressed in their letter dated March 27, 1984. Specifically, Cygna's rationale for resolving the Observations and Potential Finding Reports (PFRs) was that any deviations from design criteria and methodology in the Fermi-2 FSAR had, in the final analysis, an insignificant impact on the Fermi-2 design and no affect on plant safety. The basis for this determination is contained in the revised PFR writeups (Section 7.6 of IDVP Final Report), the Attachment A forms of the Observation Review Records (Section 7.5 of IDVP Final Report) and the expanded information contained in this transmittal in response to Enclosures 1, 2 and 3 of the March 27, 1984 NRC Letter (refer to Section 8.2). From an overview perspective, the results of the IDVP represent a collection of unique, diverse design problems which reflect no serious gaps or flaws in the Fermi-2 design information or persistent lapses or breakdowns in the Fermi-2 design control activities. For the scope-of-work reviewed, the engineering approaches and calculational techniques used by Detroit Edison and their design subcontractors (including Sargent & Lundy, Stone & Webster and GE) on Fermi-2 represent a consistent and acceptable design methodology to Cygna.

Over one-third of the valid observations in the IDVP required an expanded review to determine the impact on the Fermi-2 design. One purpose for expanding the review was to identify to what extent these observations may have impacted the overall design and design control process on Fermi-2. If the valid observations had generic implications, the review scope-of-work was expanded significantly. These scope expansions are described in Section 7.3 of the IDVP Final Report. In most cases, Cygna expanded the review scope to address the NRC Enclosure 1, 2 and 3 questions as indicated by our responses in Section 8.2. In particluar, the root cause discussions on extent in Section 8.2.1, Exhibit 8.2.1-1 and the information presented on the structural issues in Section 8.2.3 represents an expanded review effort well beyond that contained in the previous submittals of the IDVP Final Report. Overall, the expansion in the review effort for the original scope-of-work is significant if one considers that many of the observations were localized, one-time events having no design impact (Category D and E Observations in Section 8.2.1, Exhibit 8.2.1-2).

With respect to design control, Observations DC-01-08, DC-01-09 and DC-01-10 which resulted in Potential Finding Reports PFR-01, PFR-02 and PFR-03 respectively, indicated weaknesses in the implementation of QA/QC procedures by Detroit Edison. The weaknesses were in the areas of internal audits, vendor audits and corrective action on audit findings and surveillance reports primarily in the time frame prior to 1981. At the time Cygna performed its IDVP, the Detroit Edison QA/QC organization was functioning adequately and activities were being implemented effectively. Further information is available in Section 7.6 under PFR-01, PFR-02 and PFR-03. Previously, this information was provided in Section 7.2, Page 7.2-8 of the IDVP Final Report.

In the IDVP, Cygna reviewed a portion of the Fermi-2 design for the following technical disciplines:

- civil/structural
- mechanical
- electrical

The mechanical discipline included pipe and pipe support design and analysis as well as the equipment (seismic) qualification calculations. The initial scope-of-review for the three disciplines is outlined in Sections 2.4.1, 2.4.2 and 2.4.3 for the mechanical, structural and electrical disciplines. Overall, the review scope included design work by Sargent & Lundy who was the major civil/structural designer for Fermi-2 Category I buildings. It included pipe and pipe support design work by Sargent & Lundy and Stone & Webster, the major designer subcontractors in engineering mechanics for safety-related systems on Fermi-2. It also included design work by Detroit Edison who established electrical design criteria, performed final cable routings, prepared electrical equipment design specifications and developed power distribution single-lines for the RHR Complex. The scope of work offered an opportunity for an indepth review of the key technical disciplines along diverse elements involving multiple systems and a number of plant features (refer to Section 2.4).

Based on results of the review effort, ten observations were identified as having a potential impact on plant safety. Of these Potential Finding Reports (PFR's), three involved the Detroit Edison QA Organization, four were associated with stress analyses on Class I values by Wm. Powell Co. and on flued-heads by Tube Turns and Ralph Parsons Co., and three resulted from work performed by Sargent & Lundy. Two of the three PFR's related to Sargent & Lundy were in the structural discipline area and the other involved implementation of a project procedure for Design Change Requests.

In the mechanical area, the four PFRs involving Tube Turns, Parsons and Powell were for stress analysis work completed in the early 1970's. The PFR's covering the flued-heads were resolved by requiring the ASME Code Compliance Analysis to confirm stresses are acceptable for all Fermi-2 flued-heads as part of the overall as-built verification program. The PFR's on the Class I valves were resolved through a committed third-party review of the final design stress reports. This review would have to confirm that the deficiencies found in the preliminary Wm. Powell Co. design analyses had been eliminated for all safety-related valves.

The two PFRs involving Sargent & Lundy in the structural discipline were resolved by obtaining information confirming a) the soil loads were satisfactorily considered and, b) the errors in interpreting output from computer program SLSAP had been addressed and corrected. In the original submittal of the IDVP Final Report and again in preparing the root cause summaries in Section 8.2.1, Cygna noted approximately ten observations where design information was not reflected in the as-installed condition. This represented an expected or reasonable number of deviations between as-built conditions and design requirements for two reasons: a) the plant walkdown checked a substantial number of as-built conditions against the design drawings and stress report requirements, and b) the Detroit Edison "As-built Reconciliation of Pipe Stress Reports" program was just in its early stages of implementation. The resolution of the last PFR which involved Sargent & Lundy was based on this on-going, as-built piping reconciliation program within Detroit Edison which would ensure that field Design Change Notices (DCN's) are generated when required by the pipe stress analyses and design drawings.

Once an observation was identified and verified as being valid, the Project Review Team reviewed the deviation to assess design impact. In performing this review, the Project Review Team evaluated each observation for:

- design errors or flaws,
- procedural or programmatic breakdowns,
- nonconformances with industry codes/standards,
- nonconformance with project design criteria,
- nonconformance with licensing commitments.

Generally, if any design impact, extensive breakdown or significant nonconformance was identified for an observation, the observation was elevated to the status of a potential finding. The ten Potential Finding Reports were then evaluated in greater depth to determine whether any affected plant safety. All PFR's required an extensive evaluation with an expanded scope of review to identify if each was a localized, one-time phenomenon or indicative of a generic weakness in the design process. The review summaries presented in Section 7.6 indicate all PFR's were found to have potentially generic or programmatic implications. However, the subsequent review results provided sufficient justification and evidence for Cygna to conclude there was no impact on plant safety. The basis for this conclusion and the justification and supporting documentation for resolving the ten PFR's is contained in Appendix E and Sections 7.6 of the IDVP Final Report. From the results of Cygna's review, a limited number of field hardware modifications were required as described in Observations PS-01-05, PI-02-04, PI-02-06 and PS-02-02.

Cygna's response to the NRC's March 27, 1984 letter is contained in this supplemental Section 8.0 to the IDVP Final Report. Section 8.1 is organized to address the four general NRC questions and present Cygna's general comments and conclusions from review activities initiated to respond to NRC Enclosures 1, 2 and 3. Section 8.2 contains the specific information requested by the NRC in Enclosures 1, 2 and 3. It also contains additional Cygna comments on Enclosure 4 regarding design features of the RHR Complex to prevent freezing of the ultimate heat sink.

8.2 ENCLOSURE RESPONSES

This section contains the individual responses to each of the NRC Enclosures attachedto the March 27, 1984 letter. For clarity, the NRC questions are repeated and Cygna's responses follow for each of the items. It should be noted that Enclosure 2, Question 1 is not directed at Cygna, but requires a response from Detroit Edison.

8.2.1 ENCLOSURE 1, QUESTIONS 1 AND 2

NRC QUESTIONS

"In reviewing Cygna's IDVP report, we find it difficult to determine whether the identified design deficiencies are possible symptoms of a much broader design problem. Accordingly, we request that you instruct Cygna to respond to the following requests for additional information:

1)Describe in detail, Cygna's procedure(s) for determining the root causes of the identified deficiencies. Discuss the extent to which these causes could or could not impact on the acceptability of the design in those areas of the Fermi-2 facility other than the RHR complex.

2)Describe in detail, the root causes of each deficiency and Cygna's basis for determining whether a deficiency is or is not generic to those areas of the Fermi-2 facility other than the RHR complex. Do not respond on those deficiencies which are unique (i.e., one of a kind) and which do not have generic implications."

CYGNA RESPONSE:

In response to the NRC request, Cygna has made a determination for the root causes of the ninety-five (95) valid observations. The procedure for determining the root causes consisted basically of a two-step process. The first step involved preparing a brief statement for each valid observation describing the probable root cause. Each statement also includes an evaluation of the observation's significance and extent, as related to overall plant design. In the second step, Cygna categorized each of the observations into one of five possible categories based on their individual probable root causes. The root cause categories are as follows:

- Category A - Nonconformance with Design Criteria
- Category B - Nonconformance with Project Procedures
- Category C - Incorrect Design Method or Assumption
- Category D - Design Error or Procedural Oversight
- Category E - Incomplete Design Documentation

To accomplish the first step, Cygna developed a probable root cause summary for each of the valid observations. These summaries were prepared and reviewed by Project Review Team members. They represent an extension of the review activities performed by Cygna to resolve the ninety-five (95) valid observations and ten (10) Potential Finding Reports identified in the IDVP for Fermi-2. The individual root-cause summaries were based on the following:

- Indepth review of applicable information and associated documentation surrounding each observation;
- Comprehensive understanding of the impact on the design process for each valid observation;
- preparations of detailed Attachment A summaries to the individual Observation Review Records;
- Project Review Team agreement on Attachment A resolutions and Potential Finding Report conclusions;
- Senior Review Team review of the completed Observation Review Records and Potential Finding Reports.

To accomplish the second step, Cygna Project Review Team members segregated each valid observation into one of the five general root cause categories. To accomplish this, each individual root cause statement was subjectively evaluated and assigned to either Category A, B, C, D or E. If the Project Review Team had a concern or difficulty in choosing between any two or more categories, the category with the broader generic implications was chosen. Each assignment was based on a consideration of the definitions discussed below for each of the general root cause categories.

For Category A, observations must result from not fully satisfying or implementing stated design criteria, such as applicable industry codes and standards, PSAR/FSAR licensing commitments, NRC regulations and accepted engineering design practices. The potential root cause implications for Category A observations are that certain fundamental and basic design criteria were not followed in the design of Fermi-2. The generic implications are simply that these design criteria may have been inadequately documented, improperly understood, incorrectly applied or incompletely satisfied during the design process. Cygna's evaluation of any observations in Category A would consider a review scope expansion to determine to what extent the overall plant design was impacted or plant safety compromised.

Category B observations would generally result from a lack of implementing or following project design procedures. Project procedures would include engineering procedures, QA-related procedures, test procedures and, to a lesser extent, design instructions and system design review responsibilities. This category again has generic implications since the procedures could have potentially affected design activities across large cross-sections of the plant. Cygna's evaluation would examine to what extent these Category B observations may adversely affect the overall design of Fermi-2.

Observations assigned to Category C would imply the use of incorrect design methods or invalid, improper design assumptions. These might include nonconservative modeling techniques, incorrect interpretation of design information, inconsistent analytical assumptions, and improper use of computer programs. The generic implications are, in general, more restricted than the Category A and B observations since the correct design criteria and engineering procedures may have been specified for a given design activity, but its implementation could have been inconsistent or missing. It would be important in assessing the generic implications for Category C observations to determine to what extent the design methods or procedures in question were used in design activities on other Fermi-2 systems or structures.

Category D would include observations which were a result of localized errors in design calculations or minor inconsistencies in the implementation of procedural requirements. The root cause implication is one of a random and isolated nature or minor oversight in carrying out the design process. Category D observations should not have generic implications with respect to the overall design of Fermi-2.

Observations in Category E are a result of missing or incomplete documentation. Category E observations represent instances where the design information was incomplete on drawings, or in design specifications and calculations. The root cause implication here is one of a limited omission in the design documentation and would not have the generic implications of those observations in Category B. This category is particularly applicable to situations where the design calculations do not adequately state assumptions or contain sufficient justifications to support the assumptions or methodology followed.

In response to Item 2 in the NRC question, the probable root cause for each of the ninety-five valid observations are identified in Exhibit 8.2.1-1. The statements in Exhibit 8.2.1-1 represent Cygna's understanding of the underlying factors which led to each observation. The root causes are based on Cygna's review results and information obtained from Detroit Edison and their subcontractors during the course of the IDVP review. They were determined by Project Review Team discussions and supported by a Senior Review Team review.

The results of the categorization process to assess the generic implications of the valid observations are presented in Exhibit 8.2.1-2. The observations assigned to each category were based on Cygna's review and evaluation of the probable root causes contained in Exhibit 8.2.1-1. The extent to which the observations in Categories A, B and C could have impacted the acceptablility of the Fermi-2 design in areas other than the RHR Complex is discussed next. None of the observations in Categories D and E were considered to be generic to the design process on Fermi-2.

All of the observations assigned to Category A except Observations PI-01-11 and PS-01-03 received an expanded review by Cygna. Section 7.3, Exhibit 7-3 identifies to what extent the IDVP review was expanded. Observations PI-01-11 and PS-01-03 concerned the analysis of annulus pressurization (A/P) loads as a design requirement for Fermi-2. Since A/P loads were not originally considered by Cygna to be an actual design requirement on Fermi-2, the review was not expanded. Refer to Section 8.2.2 for further discussions concerning the A/P load issue. Observation EE-01-03 was by the nature of the observation expanded to review all safety-related loads which are sequenced on the diesel generator under accident conditions to ensure none would reduce the diesel generator voltage below 85%.

All of the observations assigned to Category B except Observations PS-01-04, PS-02-03 and ST-01-01 required an expanded review by Cygna. Again, Section 7.3, Exhibit 7-3 describes the scope expansion conducted by Cygna to resolve these Category B observations. Observation PS-01-04 concerned the comparison of piping design loads for Operational Basis Earthquake (OBE) and Safe-Shutdown Earthquake (SSE) ground motion accelerations. As such, the observation did not require an expanded review because it inherently covers the seismic characteristics of the entire Fermi-2 site. Observation PS-02-03 concerned a check to ensure seismic movements were within the working range of spring hangers. Again, since the seismic movements were small (1/10") in both the RHR Cooling and RHR Service Water Systems, no expansion in review scope was necessary since the two systems are representative of other plant systems. However, Cygna requested Detroit Edison to review the remaining spring hangers to verify adequacy. Finally, Observation ST-01-01 involved the use of design summary sheets to incorporate the structural design criteria into each structural calculation on the Fermi-2 project prior to 1981. Even though ST-01-01 was generic to all of S&L structural activities, it had no generic implications to the design process on Fermi-2 (refer to page 7.7-104 for further discussion).

Of the twenty-six (26) observations assigned to Category C, eleven (11) required an expanded review to determine to what extent, if any, each observations affected the Fermi-2 design. The scope expansions for Observations PI-01-03, PI-01-07, PI-01-08, PI-01-09, PI-03-05, PI-03-06, EQ-01-03, EQ-01-04, PS-00-04, ST-01-24 and ST-01-33 are described in Section 7.3, Exhibit 7-3.

Cygna determined that it was standard practice for GE to use a default value for stress indices of 1.0 on small branch connections. Consequently Observation PI-01-06 required a generic resolution involving GE pipe stress analysis techniques. For Observation PI-03-02, Cygna reviewed all flued-heads to verify the omitted containment pressure stresses were negligible. Since thermal movements are small for both the RHR Cooling and RHR Service Water elements and since both systems were representative of other high temperature Fermi-2 systems, an expanded review for Observation PS-00-02 was not justified. In Observation PS-01-01, Cygna expanded the review until it was determined that GE had verified the shear lug design in the Class 1 pipe stress analyses. Review results were able to also demonstrate that Sargent & Lundy's method for calculating allowable loads on embedment plate stud bolts was sufficiently conservative to resolve Observation ST-01-26. Observations ST-01-03, ST-01-05, ST-01-06, ST-01-09, ST-01-12, ST-01-13, ST-01-15, ST-01-16 and ST-01-19 are in the structural discipline and are unique only to the RHR Complex. Additional information associated with the resolution of Observations ST-01-03, ST-01-06, ST-01-09, ST-01-13 and ST-01-16 are provided in Cygna's responses to NRC Enclosure 3 Questions (refer to Section 8.2.3).

THIS PAGE LEFT INTENTIONALLY BLANK

EXHIBIT 8.2.1-1
NRC ENCLOSURE 1, ITEM 2 RESPONSES

Observation/ PFR No.	Description	Reference (Page)
DC-01-01	**Root Cause:** There was insufficient guidance in contract procedures that specifically required precise standard QA terminology to be incorporated. **Significance:** There is no significance to this condition. Detroit Edison in both cases was able to demonstrate through correspondence and auditing that all safety-related work was performed under requirements of Appendix B, 10CFR50. **Extent:** Generic to all design activities performed by S&L and S&W on the Fermi-2 plant.	7.7-22
DC-01-02	**Root Cause:** Not applicable since observation was invalid.	7.7-23
DC-01-03	**Root Cause:** A lack of documentation which clearly established a requirement in the Detroit Edison Fermi-2 Design Control Program for verification and validation of computer codes. **Significance:** Without proper verification and validation of computer programs, confidence in the accuracy and conservatism of the design output would be weakened. Although the design control program of Detroit Edison was silent on the need to verify and validate computer programs, good engineering practice and detailed procedures ensured Detroit Edison computer programs were developed and utilized with sufficient verification and control. **Extent:** Generic to design activities outside the RHR Complex because the observation involves a limited number of Detroit Edison computer programs used to route cables, analyze motor control centers, perform cable tray calculations, etc. throughout the plant.	7.7-25
DC-01-04	**Root Cause:** Not applicable since observation was invalid.	7.7-27
DC-01-05	**Root Cause:** Incomplete or insufficient documentation in the Detroit Edison Project Procedure Manual, Edition 2. **Significance:** Although Edition 1 of the PPM adequately addressed the assignment of QA level designations to design documents, the subject should have been covered in Edition 2. Based on Cygna's review, the omission was not done consciously or under written direction, but appears to have been simply an oversight. The Detroit Edison PPM, Edition 2 was properly reviewed and approvals were provided by signature. **Extent:** Generic because the observation affects the Fermi-2 design and design control process across the entire plant if QA levels would not be designated properly within safety-related systems.	7.7-30

Observation/ PFR No.	Description	Reference (Page)
DC-01-06	**Root Cause:** An incomplete review of the subject specification since the revision did not have a P.E. certification. This was a random occurrence and appeared to be simply an oversight on behalf of Detroit Edison Engineering. **Extent:** No generic implications.	7.7-31
DC-01-07	**Root Cause:** Not applicable since observation was invalid.	7.7-32
DC-01-08 PFR-01	**Root Cause:** A lack of documented evidence that the Detroit Edison QA program with respect to internal audits was being effectively implemented. **Significance:** Without adequate assurance that the design control program was being effectively implemented, the quality and integrity of the Fermi-2 design could have been called into question. **Extent:** Generic implications for the entire plant to the extent the design process could have been of questionable quality and a lax internal audit system might never have identified the extent of any weaknesses.	7.7-33
DC-01-09 PFR-02	**Root Cause:** A lack of management attention and follow-up in reviewing audit results and taking appropriate action to correct the deficiencies. **Significance:** The Fermi-2 design could have been adversely or unnecessarily impacted without timely and proper corrective action on design control audit findings. **Extent:** Generic implications for the entire plant to the extent the design process could have been of questionable quality due to a continued lack of corrective action on internal audit and surveillance findings.	7.7-34
DC-01-10 PFR-03	**Root Cause:** A lack of documented evidence that the Detroit Edison QA program with respect to contractor and vendor audits was being effectively implemented. Also, an audit schedule of A/E's which appeared too infrequent for continuous monitoring of supplier QA program implementation. **Significance:** Basically, it is Detroit Edison's responsibility to perform frequent audits of architect/engineers and engineering consultants. They should maintain adequate documentation of checklists and audit findings to provide added assurances that design control programs are being effectively maintained and implemented. **Extent:** Generic implications to the extent the design information and design control process from A/E organizations to Fermi-2 could have been of questionable quality and an insufficient, infrequent vendor audit system might not have identified a weakness.	7.7-35

Observation/ PFR No.	Description	Reference (Page)
DC-01-11	**Root Cause:** Failure to implement procedures by updating the Mechanical Design Document Package for the RHR system. **Significance:** This observation had no significance since the Design Document Packages were not used in the design process. **Extent:** Localized to the one document.	7.7-36
DC-01-12	**Root Cause:** Incomplete documentation indicating lead auditors were certified to project requirements. **Significance:** Without proper auditor certification, the results of audits may be of questionable quality. All Fermi-2 lead auditors had sufficient education and experience plus training to be certified as lead auditors. **Extent:** Generic to the design control process on Fermi-2.	7.7-37

Observation/ PFR No.	Description	Reference (Page)
DC-02-01	**Root Cause:** Incomplete project design documentation. Computer programs were not referenced in a number of seismic stress reports. **Significance:** Without computer program references in the seismic stress calculations, it would be difficult to reconstruct the response spectra or reproduce the analysis for traceability purposes. The one report was revised to reference the applicable computer programs. **Extent:** Localized occurrence unique to Sargent & Lundy stress report, SL-3147.	7.7-38
DC-02-02	**Root Cause:** Incomplete project procedures and documentation. Sargent & Lundy did not issue project instructions identifying what computer programs the designers/analysts should use on the Fermi-2 project. **Significance:** Without some control or guidance on the use of computer programs for a particular design task, the design output could be in error or contain unconservative results. Further review determined a computer status listing of approved programs did exist and the designer/analyst has computer program manuals to define the proper and correct use for the programs. The reviewer of the calculation has the responsibility to ensure the correct program was used and that all applicable project design criteria was met. **Extent:** Generic to all Sargent & Lundy's design work on Fermi-2.	7.7-39
DC-02-03	**Root Cause:** Computer program validations were not available and user manuals were missing. **Significance:** Without computer program validations the calculations may produce nonconservative or inaccurate design results. Without computer program user manuals, the analyst may use the progams incorrectly or for the wrong application or design problem. Further review determined the program validation did exist and the user manuals were available for reference. **Extent:** Limited to four Sargent & Lundy computer programs used on the Fermi-2 project.	7.7-40
DC-02-04	**Root Cause:** Insufficient design reviews. Design reviews on Fermi-2 for the Sargent & Lundy Electrical and Mechanical Departments were not completed. **Significance:** Design reviews are an important function and activity to check the design process and provide assurances that the effort satisfies applicable industry codes/ standards, project design criteria, licensing commitments and good engineering practices. There was a directive issued prior to Cygna's IDVP review to initiate the subject reviews and in follow-up audits by Cygna, the design review reports were generated and appropriate actions were in place to resolve reviewer comments. **Extent:** Limited to design activities within Sargent & Lundy's Electrical and Mechanical Departments on the Fermi-2 project.	7.7-41

Observation/ PFR No.	Description	Reference (Page)
DC-02-05	**Root Cause:** Inadequate design documentation. Pipe support calculations by Sargent & Lundy had administrative errors and support load summary sheets from superceded stress analyses. **Significance:** Design bases are documented in the design calculations. Nonconservative design errors might exist if the calculations are not properly prepared. In this case, the administrative errors were minor and the referenced current and superceded stress analysis load summaries were identical. **Extent:** Localized and affected only certain calculation packages within Sargent & Lundy's mechanical pipe support design effort.	7.7-42
DC-02-06	**Root Cause:** Failure to comply with project procedures. Sargent & Lundy did not perform annual QA audits of all engineering activities used on Fermi-2. **Significance:** If the Sargent & Lundy design control program is not being effectively or adequately implemented, the quality of the design on Fermi-2 may be questioned. Those procedures not audited on an annual basis, however, were shown to either have been implemented adequately but on a less frequent audit schedule or found to be not applicable to the Fermi-2 project. In some cases, the procedures were inactive on the project at the time of the audit or used only for a brief time interval between audits. **Extent:** Generic to the Sargent & Lundy design control program on Fermi-2.	7.7-43
DC-02-07 PFR-09	**Root Cause:** Failure to implement design change documents to incorporate required component modifications. **Significance:** Design of Fermi-2 may be negatively impacted if the as-built piping configuration does not agree with the stress analysis models. This observation was elevated to a Potential Finding Report (PFR-09) and resolved by confirming that Detroit Edison had a committed, working program in place to reconcile the as-built piping against the pipe stress reports generated by Sargent & Lundy. **Extent:** Generic to all piping systems analyzed by Sargent & Lundy.	7.7-44
DC-02-08	**Root Cause:** Not applicable since this observation was invalid.	7.7-45

Observation/ PFR No.	Description	Reference (Page)
DC-02-09	**Root Cause:** Project correspondence from Detroit Edison to Sargent & Lundy was immediately retrievable. **Significance:** Design information must be controlled and retrievable to ensure the design process is not negatively impacted on Fermi-2. Further review of this observation determined that the correspondence sent to Sargent & Lundy was available. An additional sample was requested and all correspondence was produced by the Sargent & Lundy document control system. A check indicated the design information was also correctly transferred from the correspondence into the final design documentation. **Extent:** Localized, random occurrence with no generic implications.	7.7-46
DC-02-10	**Root Cause:** Failure to transfer pipe support design information to the field for as-built verification. **Significance:** The as-built walkdown verification is an important check to ensure the as-installed condition of pipe supports reflect the design assumptions required in the stress analyses. Without this check, some pipe supports may be installed in a condition which is not justified by the stress analysis results. Sargent & Lundy performed a review of all stress reports and requested the field to verify a number of as-built pipe supports. A procedure was in place for pipe supports under Detroit Edison's responsibility to ensure pipe support configurations are reconciled with stress analyses. **Extent:** Applicable to all Sargent & Lundy pipe and pipe support stress reports on the Fermi-2 project.	7.7-47

Observation/ PFR No.	Description	Reference (Page)
DC-03-01	**Root Cause:** Lack of a Responsible Engineer's signature on revisions to project drawings from subcontractors. **Significance:** Drawing signoffs are intended to ensure that responsible and cognizant engineers are reviewing and checking design information. If the proper reviews and checks are not being implemented, the design of Fermi-2 could be negatively impacted. For the drawings in question, the Lead Engineering Mechanics Division engineer assumed responsibilities for task leader and responsible engineer. Subsequent to Cygna's observation a responsible engineer was finally assigned and the drawings have been reissued with the proper signature. **Extent:** Applicable to a limited number of vendor drawings revised by Stone & Webster on the Fermi-2 project.	7.7-48
DC-03-02	**Root Cause:** Inadequate documentation on receipt of drawings transmitted to Detroit Edison. **Significance:** Drawings may be transmitted to Detroit Edison and, if the design information is not received, they would not be incorporated into the construction activities. An acknowledgement signature is a positive, direct method of confirming that the drawings or revisions to drawings have been received. Further review indicated that Stone & Webster had an alternate means of verifying that drawings issued to Detroit Edison were appropriately received. **Extent:** Applicable to all drawings transmitted from Stone & Webster to Detroit Edison on the Fermi-2 project.	7.7-49
DC-03-03	**Root Cause:** Incomplete and insufficient review of design documents. **Significance:** If review comments on design documents are not resolved, the design information could be negatively impacted. In this case, the comments were satisfactorily resolved by Detroit Edison, but Stone & Webster was never notified of the resolution. **Extent:** Isolated, one-time occurrence applicable to a single seismic report for a chlorine detector.	7.7-50
DC-03-04	**Root Cause:** Inadequate document control practices on closing-out field DCNs. **Significance:** If a dispositioned DCN is filed with the original transmittal of the DCN, it would be a positive, direct method to assure that Detroit Edison has responded to the action and an accounting process exists to accurately determine what DCNs are closed and which are open. Sargent & Lundy had an alternate filing system to keep track of DCNs requiring action to close-out. **Extent:** Applicable to all DCNs transmitted between Stone & Webster and Detroit Edison on the Fermi-2 project.	7.7-51

Observation/ PFR No.	Description	Reference (Page)
PI-01-01	**Root Cause:** An analysis oversight and a failure to confirm that the as-built drawings conform with the piping analysis. **Significance:** Modeling a long radius elbow as a short radius elbow has the following impact on design: • no significant effect on the overall system stresses • local stresses at the elbow will actually be less than those predicted by the model. **Extent:** Since the modeling error was conservative, there were no generic implications. This observation could have generic implications if a significant number of discrepancies are identified between the design condition and as-built configuration. PFR 09 addresses this generic concern.	7.7-52
PI-01-02	**Root Cause:** The analyst failed to confirm the piping analysis with the design drawings. **Significance:** These localized discrepancies have no impact on the hardware. Any increases in stress levels are less than the available design margins. **Extent:** Since similar geometry errors in the orientation of snubbers could have design impact, Cygna reviewed 10 other snubbers in the GE analysis. These other snubbers were modeled correctly. Therefore, the observed error is considered localized. This observation could have generic implications if a significant number of discrepancies are identified between the design condition and as-built configuration. PFR 09 addresses this generic concern.	7.7-53
PI-01-03	**Root Cause:** Standard method of analysis on Fermi-2. The analysis method assumed that a cutoff frequency of 33 cps, which is the Fermi-2 FSAR commitment, was adequate to define the seismic response of the system. However, this procedure does not satisfy standard industry practice that inclusion of additional modes shall not cause more than a 10% increase in response. The latter criteria is stated in the SRP and is presently incorporated in several standard piping programs, such as Arthur D. Little's ADLPIPE. **Significance:** One standard measure of the percent (%) response is mass participation. If at least 90% of the system mass has responded, it can be generally concluded that the SRP recommendations have been satisfied. Take, for example, a 1000 lb rigid steel block subjected to a 0.5 g acceleration. The design load for the block anchorage should be 150 lb. If the first natural frequency of the block is 40 cps and the analysis is cutoff at 33 cps, then the analysis will show that no force is transmitted to the block anchorage. For piping systems, this analogy applies particularly to concentrated masses, such as valves, located near supports or anchors. These "high frequency masses" may be missed when the analysis is cutoff at 33 cps.	7.7-55

Observation/ PFR No.	Description	Reference (Page)
PI-01-03 (cont.)	**Extent:** This was standard practice on Fermi-2 (see also Observation PI-02-02). Accordingly, Cygna evaluated the effect on the RHR supply line plus two of the four main steam lines analyzed by GE and the RHR service water lines analyzed by Sargent & Lundy. The results of Cygna's evaluation are as follows: • Missing seismic loads due to the 33 cps cutoff are small, largely due to the low site accelerations, (0.15 g, SSE, and 0.08 g, OBE). • Pipe supports had design margins greater than the added loads. Based on this review of representative lines, Cygna found no generic implications to the observation.	
PI-01-04	**Root Cause:** There is no technical procedure on the project that adequately addresses this particular modeling technique. **Significance:** In their piping analyses, GE included the stiffness of snubbers, but not the stiffness of support frames to which the snubbers are attached. Including the stiffness of these frames in the piping analyses could result in lower predicted system frequencies. **Extent:** To evaluate the effect on Fermi-2, Cygna reviewed the rigidity of frames supporting snubbers along the RHR supply line and found that they were sufficiently rigid to be omitted from the GE piping analyses. Based on this positive result within the RHR supply line, and on the fact that Cygna did not observe large, flexible support frames for snubbers during the walkdown activity, no further investigation was performed.	7.7-56
PI-01-05	**Root Cause:** Insufficient documentation in the pipe stress report. GE did not state that the valve weights had been revised subsequent to their analyses and that they judged the weight changes to be negligible. **Significance:** Cygna concurs with the GE conclusion that the revised valve weights would have insignificant effect on the design. **Extent:** Localized, unique situation with no generic implications.	7.7-57
PI-01-06	**Root Cause:** Standard GE practice for small connections. The GE stress analyst did not specify the stress indices for small branch connections. **Significance:** In the analysis, a default value of 1.0 was used for the stress indice. The ASME Code requires a larger value. After reviewing the system geometry and results, Cygna judged that the branch lines are located in low stress regions of the line and, therefore, would not control design. This judgement was confirmed by an analysis of the line. **Extent:** This procedure is standard GE practice and, therefore, generic to all Fermi-2 safety systems analyzed by GE.	7.7-58

Observation/ PFR No.	Description	Reference (Page)
PI-01-07	**Root Cause:** The technical verification package for GE computer program ANSI-7 does not adequately justify its selection of thermal stresses to be included in the ASME Code analysis. **Significance:** After a detailed evaluation of output from ANSI-7, Cygna concluded that the program produces conservative results. **Extent:** Generic since ANSI-7 was used by GE to analyze several Class 1 systems on Fermi-2.	7.7-59
PI-01-08	**Root Cause:** Analytical oversight. The GE stress analyst did not consider the effect of reinforced (thickened) regions in the computation of axial thermal gradients. **Significance:** This oversight would result in unconservative design stresses. Further review of the RHR analysis and design resulted in the following conclusions: • The increase in stress is extremely small. • The additional stresses are less than the available design margins. **Extent:** Cygna spot checked all Fermi-2 safety systems analyzed by GE, and concluded that there was no design impact. This is generic to piping systems analyzed by GE.	7.7-62
PI-01-09	**Root Cause:** GE computer program, ANSI-7, uses techniques that are not well documented. **Significance:** In the absence of complete documentation, ANSI-7 appears to calculate an insufficient number of loading conditions and to violat the ASME Code. After further review of the ANSI-7, Cygna concluded that the program produces conservative results for all applications. **Extent:** Generic since ANSI-7 was used by GE to analyze several Class 1 systems on Fermi-2.	7.7-63
PI-01-10	**Root Cause:** Analyst error. An incorrect value was input to the ANSI-7 analysis. **Significance:** The correct value is approximately 20% larger, but the design technique was sufficiently conservative to accommodate the increased load. **Extent:** Localized, unique situation. All the remaining lugs in the RHR supply line were analyzed correctly.	7.7-64

Observation/ PFR No.	Description	Reference (Page)
PI-01-11	**Root Cause:** Incomplete documentation. The Fermi-2 design specification was not updated to reflect the design basis commitments in the FSAR. **Significance:** Further review revealed that the requirement to analyze for faulted loads was unclear. (See Cygna's response to NRC Enclosure 2, Item 2 Question). **Extent:** This is a generic issue, which is being resolved between the NRC and the applicant.	7.7-65
PI-01-12	**Root Cause:** Standard practice on Fermi-2. The analyst failed to input a complete set of seismic displacements to the piping analysis. **Significance:** Only displacements at the anchorage points were input to the piping analysis. Displacements at intermediate support points were omitted. Standard industry practice is to input seismic displacements at all points of attachment to the structures or equipment. Further review of the seismic displacements produced by Category I structures on Fermi-2 revealed that the displacements were sufficiently small to be neglected in the piping analysis. As a result, this error has no significant impact on the design. **Extent:** As shown by this observation and Observation PI-02-03, both GE and Sargent & Lundy followed this practice on all Category I structures. Therefore, this observation applies to all Fermi-2 safety systems analyzed by either GE or Sargent & Lundy.	7.7-66

Observation/ PFR No.	Description	Reference (Page)
PI-02-01	**Root Cause:** Failure to confirm that the as-built drawings conform with the piping analysis. **Significance:** This error occurred at a branch connection. It has no impact on the run (RHR) piping, and minimal impact on the branch piping. **Extent:** This observation could only have generic implications if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR 09 addresses this generic concern.	7.7-67
PI-02-02	**Root Cause:** Standard method of analysis on Fermi-2. The analysis method assumed that a cutoff frequency of 33 cps, which is the Fermi-2 FSAR commitment, was adequate to define the seismic response of the system. However, this procedure does not satisfy standard industry practice that inclusion of additional modes shall not cause more than a 10% increase in response. The latter criteria is stated in the SRP and is presently incorporated in several standard piping programs, such as Arthur D. Little's ADLPIPE. **Significance:** One standard measure of the percent (%) response is mass participation. If at least 90% of the system mass has responded, it can be generally concluded that the SRP recommendations have been satisfied. Take, for example, a 1000 lb rigid steel block subjected to a 0.5 g acceleration. The design load for the block anchorage should be 150 lb. If the first natural frequency of the block is 40 cps and the analysis is cutoff at 33 cps, then the analysis will show that no force is transmitted to the block anchorage. For piping systems, this analogy applies particularly to concentrated masses, such as valves, located near supports or anchors. These "high frequency masses" may be missed when the analysis is cutoff at 33 cps. **Extent:** This was standard practice on Fermi-2 (see also Observation PI-01-03). Accordingly, Cygna evaluated the effect on the RHR supply line plus two of the four main steam lines analyzed by GE and the RHR service water lines analyzed by Sargent & Lundy. The results of Cygna's evaluation are as follows: • Missing seismic loads due to the 33 cps cutoff are small, largely due to the low site accelerations, (0.15 g, SSE, and 0.08 g, OBE). • Pipe supports had design margins greater than the added loads. Based on this review of representative lines, Cygna found no generic implications to the observation.	7.7-68
PI-02-03	**Root Cause:** Standard practice on Fermi-2. The analyst failed to input a complete set of seismic displacements to the piping analysis. **Significance:** Only displacements at the anchorage points were input to the piping analysis. Displacements at intermediate support points were omitted. Standard industry	7.7-69

Observation/ PFR No.	Description	Reference (Page)
PI-02-03 (cont.)	practice is to input seismic displacements at all points of attachment to the structures or equipment. Further review of the seismic displacements produced by Category I structures on Fermi-2 revealed that the displacements were sufficiently small to be neglected in the piping analysis. As a result, this error has no significant impact on the design. **Extent:** As shown by this observation and Observation PI-01-12, both GE and Sargent & Lundy followed this practice on Fermi-2. Therefore, this observation applies to all Fermi-2 safety systems analyzed by either GE or Sargent & Lundy.	
PI-02-04	**Root Cause:** Failure to confirm that the as-built drawings conform with the piping analysis. **Significance:** The support drawing indicates one additional direction of restraint as compared to the piping analysis. Such a discrepancy could result in a significant redistribution of stresses in the region of this pipe support. To resolve the discrepancy, a field change notice was issued to make the as-built condition consistent with the analysis. **Extent:** This observation could only have generic implications if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR-09 addresses this generic concern.	7.7-70
PI-02-05	**Root Cause:** Oversight during the reconciliation between the design condition, as-built drawing, and as-built configuration. **Significance:** No design significance because the design condition matched the as-built configuration. The as-built drawing was in error. **Extent:** This observation could only have generic implications if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR-09 addresses this generic concern.	7.7-71
PI-02-06	**Root Cause:** Analyst oversight. Failure to confirm that the piping analysis conforms with the as-built drawings. **Significance:** The piping analysis assumed that there would be insignificant loads at stanchions due to friction. Low friction devices, such as lubrite plates, were not installed. To resolve this discrepancy, a field change notice was issued to add lubrite plates at stanchions. **Extent:** This observation could only have generic implications if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR-09 addresses this generic concern. In response to this observation, the project reviewed all stanchions on safety systems located in the RHR Complex. The project further stated that there were no similar stanchions attached to the remaining Fermi-2 safety systems.	7.7-72

Observation/ PFR No.	Description	Reference (Page)
PI-03-01	**Root Cause:** Incomplete computer code verification for the program AUTOHEAD. The thermal transient analysis portion of the program had not been verified in the verification manual. **Significance:** Analysis results based on an unverified computer code could be in noncompliance with ASME Code requirements. To resolved this concern, Detroit Edison management has directed that all flued heads be checked for ASME Code Compliance as part of the Fermi-2 as-built verification program. **Extent:** Generic to all flued heads on Fermi-2 analyzed using the program AUTOHEAD.	7.7-73
PI-03-02	**Root Cause:** Incomplete documentation to support the design approach. **Significance:** Stresses due to axial load, shear load and containment pressure were not included in designing the flued heads. Based on further review, Cygna concluded that the missing stresses were insignificant. **Extent:** Generic to all flued heads on Fermi-2.	7.7-74
PI-03-03	**Root Cause:** Not applicable since the observation was determined to be invalid.	7.7-75
PI-03-04 PFR-06	**Root Cause:** Design oversight. The maximum stresses due to emergency loads were compared to an incorrect allowable. **Significance:** Use of an incorrect allowable stress could result in noncompliance with ASME Code requirements. **Extent:** Generic to all flued heads on Fermi-2. Detroit Edison management has directed that all flued heads be checked for ASME Code Compliance as part of the Fermi-2 as-built verification program.	7.7-76
PI-03-05	**Root Cause:** Incomplete documentation in the calculation package to support the selection of design stresses. **Significance:** The flued heads are designed for combined stresses based upon a selected time interval. Maximum design stresses throughout the flued head may not occur within that selected interval. Use of design stresses less than the maximum could result in noncompliance with ASME Code requirements. **Extent:** Generic to all flued heads on Fermi-2. Detroit Edison management has directed that all flued heads be checked for ASME Code Compliance as part of the Fermi-2 as-built verification program.	7.7-77

Observation/ PFR No.	Description	Reference (Page)
PI-03-06	**Root Cause:** Incomplete documentation in the calculation package to support selection of the design load combinations. **Significance:** Omitting controlling load combinations could result in noncompliance with ASME Code requirements. **Extent:** Generic to all flued heads on Fermi-2. Detroit Edison management has directed that all flued heads be checked for ASME Code Compliance as part of the Fermi-2 as-built verification program.	7.7-78

Observation/ PFR No.	Description	Reference (Page)
EQ-01-01	**Root Cause:** Not applicable since the observation was determined to be invalid. The load mechanism identified by Cygna could not develop.	7.7-79
EQ-01-02	**Root Cause:** Incomplete documentation in the calculation package. An overstress condition was identified, but not addressed and resolved. **Significance:** The load condition showing an overstress is not required by the ASME Code. Since this component is governed by the ASME Code requirements, there is no design significance. Further investigation revealed that this load condition was added by the designer in response to a request by Detroit Edison. Cygna evaluated the potential design impact on this added condition and found none. **Extent:** All licensing commitments and code requirements have been satisfied. An expanded review is not warranted. This was a localized, unique observation.	7.7-80
EQ-01-03 PFR-04	**Root Cause:** Design error. The Wm. Powell Co. designer used an incorrect pressure to determine whether or not stress reversal cycles could be excluded from the cyclic loading evaluation. **Significance:** An incorrect assessment of stress reversal effects could result in noncompliance with ASME Code requirements. **Extent:** Generic to all Class I valves analyzed by Wm. Powell Co. To address this concern, Detroit Edison management has directed that all Class I valves be checked for ASME Code Compliance as part of the Fermi-2 as-built verification program.	7.7-81
EQ-01-04 PFR-05	**Root Cause:** The calculation package did not provide justification for the calculated section properties of the valve yoke. **Significance:** The valve yoke consists of four legs which join the bonnet to the body. In the calculation package, the four legs were assumed to act as one. Alternatively, the four legs could be assumed to act independently. These two assumptions represent upper and lower bounds to the actual section properties. Based upon the shape of the Fermi-2 input spectra and the typical fundamental frequency of these valves, the most conservative assumption would have been to assume that the legs act independently. **Extent:** Generic to all Class I valves analyzed by Wm. Powell Co. To address this concern, Detroit Edison management has directed that the yoke section properties for all safety-related valves be checked as part of the Fermi-2 as-built verification program.	7.7-82

Observation/ PFR No.	Description	Reference (Page)
PS-00-01	**Root Cause:** The Stone & Webster design criteria states that pipe supports shall be designed to a maximum deflection of 1/16" in the restrained direction. There is no documentation to establish that this criterion is consistent with the piping analyses, which assumed rigid supports. **Significance:** The flexibility of supports attached to a piping system has an effect on the dynamic response of that system. In this case, the supports are more flexible than assumed in the analyses, which will tend to decrease the system response frequencies. Since piping is a multi-frequency system, the overall effect of decreased system frequencies depends upon the piping configuration and input spectra. Cygna evaluated the RHR System piping on Fermi-2 and concluded that the as-built stiffnesses are sufficiently close to the assumed stiffnesses to have no significant effect on the design. **Extent:** Generic to pipe supports designed by Stone & Webster. A detailed evaluation was performed for the RHR System, which confirmed that the specified maximum design deflection was adequate.	7.7-83
PS-00-02	**Root Cause:** Design inconsistency. One set of thermal movements was used to design spring hangers and another set was used to design snubbers. **Significance:** On Fermi-2 the thermal displacements are small for both of the RHR piping elements reviewed by Cygna. The difference between the thermal movements used for spring hangers and for snubbers is even smaller. The overall design impact is insignificant. **Extent:** Generic to the Fermi-2 plant. Cygna reviewed both the RHR supply and service water lines in conjunction with this observation. Based on the following, no further investigations were performed: (1) there was no significant design impact on the two systems reviewed, (2) thermal movements were considered, and (3) the difference between the two sets of thermal movements was small.	7.7-85
PS-00-03	**Root Cause:** Not applicable since this observation was determined to be invalid.	7.7-86
PS-00-04	**Root Cause:** Insufficient documentation in the calculation package to justify not including self-weight excitation in the design of snubbers and support assemblies. **Significance:** Self-weight excitation is the response of a snubber or support in the unloaded direction. This off-direction response could induce significant stress components. Further review of the RHR piping elements showed that (1) the self-excitation loads are small compared to the other pipe loads, and (2) there is a 33% safety factor in the support design which easily covers any added loads due to self-weight excitation. **Extent:** Generic to the Fermi-2 plant. Cygna confirmed that the 33% safety factor was contained in the design criteria, and therefore, applied across the plant.	7.7-87

Observation/ PFR No.	Description	Reference (Page)
PS-01-01	**Root Cause:** Incomplete documentation. The Stone & Webster pipe support calculations included an evaluation of lugs, which was superseded by GE pipe stress calculations. The lug evaluation portion of the pipe support calculations were not voided. **Significance:** No design significance since the proper lug evaluations were performed as part of the pipe stress calculations. **Extent:** Generic to all Fermi-2 piping systems analyzed by GE.	7.7-88
PS-01-02	**Root Cause:** Not applicable since the observation was invalid.	7.7-89
PS-01-03	**Root Cause:** See the Cygna response to NRC Enclosure 2, Item 2 Question.	7.7-90
PS-01-04	**Root Cause:** No justification was provided in the design calculation for deviating from the design specification. **Significance:** The design specification states that the maximum of either DBE or 1.875 x OBE shall be considered. Only the 1.875 x OBE case was considered. Based upon further review, Cygna concluded that DBE load combinations do not control design. In fact, as identified in Observation ST-01-23, there are many instances where the unfactored OBE load exceeds the DBE load. **Extent:** Generic to the Fermi-2 plant. In conjunction with this observation and Observation ST-01-23, Cygna reviewed the seismic design spectra for all Category I structures on Fermi-2.	7.7-91
PS-01-05	**Root Cause:** Failure to reconcile the as-built condition with the design calculations. **Significance:** If the design requirements from the calculations are not reflected in the as-built condition, the design may be non-conservative and negatively impacted. The under-sized weld on the support bracket was temporary at the time of the plant walkdown. Consequently, if the bracket would have been installed in its final configuration, it should have been attached to the support member with the required weld size of 5/16". **Extent:** Random occurence and isolated to support E11-2299-G21.	7.7-92

Observation/ PFR No.	Description	Reference (Page)
PS-02-01	**Root Cause:** Failure to confirm that the as-built drawings conform with the piping analysis. **Significance:** The support drawing indicates one additional direction of restraint as compared to the piping analysis. Such a discrepancy could result in a significant redistribution of stresses in the region of this pipe support. To resolve the discrepancy, a field change notice was issued to make the as-built condition consistent with the analysis. **Extent:** This observation could only have generic implications if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR-09 addresses this generic concern.	7.7-93
PS-02-02	**Root Cause:** Design judgement. At penetration SX-13, the gap between bearing lugs and the mating sleeve exceeds standard industry practice. **Significance:** The gaps observed in the as-built condition are consistent with those shown on the design drawings. These specified gaps, however, are greater than what is generally specified in the industry. Gaps larger than standard could lead to inconsistencies between the design and as-built configurations. To address this concern, Sargent & Lundy issued a corrective action document instructing the field to close the identified gaps using shims. **Extent:** Localized and unique to two penetrations. In response to this observation, Detroit Edison reviewed all safety-related penetrations on Fermi-2. Nonstandard gaps were noted on only one other penetration, SX-14, which is the mirror image of SX-13.	7.7-94
PS-02-03	**Root Cause:** Failure to consider dynamic movements in the spring hanger's setting. The working range of spring hanger E11-2184-G03 was not checked against the predicted seismic movements. **Significance:** Thermal movements were considered, seismic movements were not. Without a check of seismic movements, the spring hanger could bottom-out during a seismic event. Further evaluation revealed that seismic movements at Fermi-2 are small (less than 1/10"). Such small movements should have no impact on spring travel. **Extent:** Generic to the Fermi-2 plant. Cygna confirmed that seismic movements have negligible effect on spring settings within the RHR piping elements. Cygna also recommended that Detroit Edison perform a similar verification on the Fermi-2 remaining safety-related spring hangers.	7.7-95
PS-02-04	**Root Cause:** No justification was provided in the design calculation for deviating from the design specification.	7.7-96

Observation/ PFR No.	Description	Reference (Page)
PS-02-04 (cont.)	**Significance:** The design specification states that the maximum of either DBE or 1.875 x OBE shall be considered. Only the 1.875 x OBE case was considered. Based upon further review, Cygna concluded that DBE load combinations do not control design. In fact, as identified in Observation ST-01-23, there are many instances where the unfactored OBE load exceeds the DBE load. **Extent:** Generic to the Fermi-2 plant. In conjunction with this observation and Observation ST-01-23, Cygna reviewed the seismic design spectra for all Category I structures on Fermi-2.	
PS-02-05	**Root Cause:** Failure to reconcile differences between the design calculations and the as-built drawing. The design calculation required a brace that was not shown on the as-built drawing. **Significance:** Revised calculations in response to this observation showed that the brace is not needed. **Extent:** This discrepancy was observed on only one support and is, therefore, unique. There could be generic implications only if a significant number of discrepancies are identified between the analysis/design condition and the as-built drawings. PFR 09 addresses this generic concern.	7.7-97
PS-02-06	**Root Cause:** Construction oversight. The centerline of pipe to centerline of sleeve dimension measured during the Cygna walkdown do not match the design drawing. **Significance:** Further review revealed that this observation was associated with Observation PS-02-02, which addressed the sleeve/pipe gaps. Correcting the gaps resolved the sleeve centerline to pipe centerline discrepancy. Sargent & Lundy issued a corrective action document instructing the field to correct the observed gaps using shims. **Extent:** Localized and unique to only two penetrations. In response to this observation, Detroit Edison reviewed all safety-related penetrations on Fermi-2. Such gaps were noted on only one other penetration, SX-14, which is the mirror image of SX-13.	7.7-98

Observation/ PFR No.	Description	Reference (Page)
PS-03-01	**Root Cause:** Justification was not provided in the design calculation for an overstress condition under faulted loads. **Significance:** Further review revealed that the anchor structure need not be designed to faulted loads since it is attached to a moderate energy line. **Extent:** Localized and unique to a limited number of penetration anchor structures. In response to this observation, Detroit Edison reviewed the remaining stress reports for safety-related anchor structures on Fermi-2. Overstress conditions under faulted loads were noted three more times. In each of these cases, as in the first, the anchor was attached to a moderate energy line and was, therefore, acceptable. Cygna performed a spot check of the Detroit Edison findings and agreed with the conclusions.	7.7-99
PS-03-02 PFR-07	**Root Cause:** The design calculation did not justify selection of the design loading combinations. **Significance:** Many load combinations are possible. Without justification, it is not clear that the controlling load combinations have been considered. **Extent:** Generic to all flued-heads on Fermi-2. To address this concern, Detroit Edison issued a work instruction to be followed during the Fermi-2 design verification effort. All anchor structures supporting multiple flued heads will be verified in accordance with the work instruction. Cygna has reviewed and approved the work instruction.	7.7-100

Observation/ PFR No.	Description	Reference (Page)
ST-01-01	**Root Cause:** The lack of a central document containing all project structural design criteria. **Significance:** Without a documented design criteria for the RHR Complex, the design could potentially be inconsistent, unconservative and not in accordance with licensing commitments in the FSAR. **Extent:** Generic to the Fermi-2 design since all structural calculations prior to 12/1/81 had an attached sheet of design criteria and loading combinations. This sheet was adequate although not as comprehensive and complete as the "Project Structural Design Criteria" document issued 12/1/81.	7.7-101
ST-01-02 PFR-08	**Root Cause:** An improper and erroneous interpretation of the ACI code with respect to PFR-designing the foundation walls in the RHR complex and assigning the proper load factor for soil pressures. **Significance:** If the smaller load factor of 1.4 is used, the design of the RHR Complex foundation walls might be insufficient to withstand earthquake and pressure forces from the soil. **Extent:** Applicable to the RHR Complex only since the other Category I structures on the Fermi-2 site were designed using a proper load factor of 1.7. The design calculations contained an insufficient documentation of assumptions to justify the basis for using the 1.4 soil load factor in the RHR Complex.	7.7-102
ST-01-03	**Root Cause:** The calculation package did not clearly define the design loads and the approach to be followed in the analysis. **Significance:** Further investigation indicated that the actual analysis was more comprehensive than what was stated in the calculation package. The analysis was completed for the lateral soil loadings in accordance with the structural design criteria. **Extent:** Localized and specific to the RHR Complex only since it is restricted to structural loads and design analyses for that building.	7.7-103
ST-01-04	**Root Cause:** The calculation package did not justify the selected design thermal gradients for structures in the vicinity of the spray headers. **Significance:** These structures are designed for a maximum thermal gradient of 90°F (ΔT = 90°F). Ambient temperature range from -18°F (winter) to 70°F (summer). A preliminary investigation by Cygna indicated that these structures could be exposed to the spray header design temperature (125°F). If that occurred, the winter thermal gradient would be -18°F to 125°F (ΔT = 143°F). Further investigation revealed that the maximum expected temperature of the spray headers in winter is 70°F (ΔT = 88°F). In summer, the expected thermal gradient is even less. Therefore, the design thermal gradient is adequate.	7.7-104

Observation/ PFR No.	Description	Reference (Page)
ST-01-04 (cont.)	**Extent:** Localized and specific to the RHR Complex only. The root cause, however, was generic to the extent that a number of observations were a result of poorly documented design assumption(s) in the design calculations.	
ST-01-05	**Root Cause:** Insufficient documentation of assumptions by the designer/engineer. **Significance:** A simplified model was used to analyze a preliminary structural layout for defined design loads. The actual configuration underwent a number of refinements and alterations during the course of the Fermi-2 project. Despite these changes, the simplified model was still adequate to represent the final design configuration. **Extent:** Applicable only to the RHR Complex since it relates to the structural design of Frames B and D in that building.	7.7-105
ST-01-06	**Root Cause:** Incomplete documentation of the assumptions and requirements by the designer/engineer. **Significance:** Basically, the design calculations did not define the actual sections where high load moments existed although they did state that in those sections, additional rebar placement would occur. The design drawings located the additional rebar. **Extent:** Since the complete design package, calculations plus drawings was adequate for the RHR Complex, no further investigation was warranted or performed.	7.7-106
ST-01-07	**Root Cause:** Design oversight or incomplete documentation of the assumptions and requirements by the designer/engineer. **Significance:** Sargent & Lundy did not include thermal loads in the design loading combination. Their calculation packages did not address thermal loads and no justification was provided for omitting them. Although thermal stresses are only about 20% of the total allowable (54 ksi) they account for roughly 75% of the total applied stress in the reinforcement steel in the RHR Complex cooling towers. **Extent:** Sargent & Lundy designed two Category I buildings on Fermi-2, the RHR Complex and Reactor/Auxiliary Building. To determine the extent of this observation, Cygna surveyed Sargent & Lundy's calculations for the Reactor/Auxiliary Building and observed that thermal stress were considered. Cygna also ensured that Sargent & Lundy calculations for the RHR Complex were revised to include thermal stress effects.	7.7-107
ST-01-08	**Root Cause:** Design oversight or incomplete documentation of the assumptions and requirements by the designer/engineer. **Significance:** Sargent & Lundy did not include thermal loads in the design loading combination. Their calculation packages did not address thermal loads and no justification was provided for omitting them. Thermal stresses (5-10 ksi) are less than 20% of the total allowable stress (54 ksi), and about 25% of the total applied stress in the reinforcement steel in the cooling tower slab.	7.7-108

Observation/ PFR No.	Description	Reference (Page)
ST-01-08 (cont.)	**Extent:** Sargent & Lundy designed two Category I buildings on Fermi-2, the RHR Complex and Reactor/Auxiliary Building. To determine the extent of this observation, which is specific to the RHR complex, Cygna surveyed Sargent & Lundy calculations for the Reactor/Auxiliary Building and observed that thermal stress were considered. Cygna also ensured that Sargent & Lundy calculations for the RHR Complex were revised to include thermal stress effects.	
ST-01-09	**Root Cause:** Design oversight or incomplete documentation of the assumptions and requirements by the designer/engineer. Sargent & Lundy did not include thermal stresses in their design of the foundation wall. **Significance:** The design moment for the foundation wall is 19% below capacity when thermal effects are neglected and 7% below capacity when thermal effects are considered. **Extent:** Sargent & Lundy designed two Category I buildings on Fermi-2, the RHR Complex and Reactor/Auxiliary Building. To determine the extent of this observation, which is specific to the RHR Complex, Cygna surveyed Sargent & Lundy calculations for the Reactor/Auxiliary Building and observed that thermal stress were considered. Cygna also encured that Sargent & Lundy claculations for the RHR Complex were revised to include thermal stress effects.	7.7-109
ST-01-10	**Root Cause:** Conflicting values for the cooling tower in the analysis and calculations. **Significance:** The correct value was used in the analysis and design. The value calculated as input to the analysis was incorrect. This error has no impact on design. **Extent:** No generic implications since overall relatively few errors were found in reviewing the Sargent & Lundy design calculations. This one is considered random and isolated since the computer analysis used the correct value.	7.7-110
ST-01-11	**Root Cause:** Not applicable since the observation was invalid. Refer to Enclosure 4 response to the NRC Questions in Section 8.3.	7.7-111
ST-01-12	**Root Cause:** Incomplete documentation of the assumptions and design loading conditions used in the calculations for the RHR Complex basemat. **Significance:** The design loads on the RHR Complex basemat may not be conservative since certain foundation wall loads were not addressed (vertical, shear and overturning moments). Further review showed that the Sargent & Lundy design method was conservative and enveloped tne design loads identified by Cygna. **Extent:** No generic implications because the Sargent & Lundy design methods were conservative for structures on a rigid foundation, such as the Fermi-2 site.	7.7-112

Observation/ PFR No.	Reference Description	(Page)
ST-01-13	**Root Cause:** Incomplete documentation of the assumptions and design loadings used in the design calculations for beams attached to the foundation walls. **Significance:** Beams (horizontal members) which attach to the foundation walls were not designed for the axial loads that would be induced by soil pressures. However, further investigation showed that the axial load contribution was negligible and, in fact, neglecting the axial load is actually conservative for the design. **Extent:** No generic implications since the loads are small and neglecting the load was conservative. No further investigation was warranted or performed.	7.7-113
ST-01-14	**Root Cause:** Incomplete documentation of the analyses for the deep beams design loadings. Specifically, horizontal shear loads were not included in the finite element analysis of the deep beams. **Significance:** If the analysis does not consider all loads on the deep beam, its capacity has not been confirmed. Further review showed that the deep beams were designed by Combining results from two separate analyses. The finite element model was used to predict stresses from vertical loads; and a separate seismic analysis was used to determine stresses from horizontal shear loads. The calculation has been revised by Sargent & Lundy to illustrate how the deep beams were evaluated for seismic shear loads. **Extent:** Localized and specific to the RHR Complex deep beam analysis technique. The technique is acceptable. The only possible generic implication is that the early Sargent & Lundy structural calculations needed more documentation with respect to assumptions and justification of design loading combinations.	7.7-114
ST-01-15	**Root Cause:** Design oversight or error on the designer/engineer's part to include the axial loads due to the seismic overturning moment. **Significance:** Since the seismic axial loads are less than 20% of the ultimate total loading, there is sufficient design margin to accommodate the additional axial loads. **Extent:** No design changes in the RHR Complex related to this observation. Therefore, no further investigations were warranted or performed.	7.7-115
ST-01-16	**Root Cause:** Failure to revise the original calculations for the maximum design moment in the RHR Complex foundation wall. **Significance:** The as-built reinforcing steel is in accordance with the design drawings. Preliminary calculations showed that the revised design moment (520 ft-k) exceeded the capacity (515 ft-k) by less than 1%. This small overage is acceptable. Subsequent to Cygna's review, Sargent & Lundy discovered an error in their load calculations which reduced the actual moment from 520 K-ft to 260 K-ft (a factor of 2 reduction). This resulted in a significant design margin. **Extent:** Localized and specific to the RHR Complex foundation wall since for all other RHR Complex calculations, the maximum design moments did not exceed the original design calculations. Cygna also checked to ensure the correct loading information was used for the RHR Complex frame analyses.	7.7-116

Observation/ PFR No.	Description	Reference (Page)
ST-01-17	**Root Cause:** Not applicable since the observation was invalid.	7.7-118
ST-01-18	**Root Cause:** Incomplete design analyses with respect to recommendations in the Dames and Moore soils report for the Fermi-2 site. **Significance:** Dames and Moore determined that the foundation rock was fractured and pressure grouting may be necessary to reduce seismic amplification at the Fermi-2 site. Cygna concluded that grouting would have been ineffective due to the small size and depth of the fracturing. In addition, the measured wave velocities in the fractured rock (7600 fps) is considerably greater than the value specified in Section 3.7 of the Standard Review Plan for rock siter (3500 fps), which shows that the rock is quite firm. **Extent:** Generic to the entire Fermi-2 site.	7.7-119
ST-01-19	**Root Cause:** Incomplete documentation indicating the designer/engineer considered the effects of water on the RHR Complex seismic analysis. **Significance:** If water mass had a significant effect on the reservoir walls due to lateral rigid loading and sloshing during a seismic event, the present analysis would not be sufficiently conservative. The mass of the water, however, has a very small effect on the natural frequency of the RHR Complex (less than a 3% change). Also, sloshing effects are not significant on the reservoir walls because they are below grade. Sargent & Lundy has revised the calculations to state that water mass has a negligible effect on the seismic analyses. **Extent:** Localized and unique to the RHR Complex since it concerns the water effect within the ultimate heat sink reservoir.	7.7-120
ST-01-20	**Root Cause:** Design oversight or incomplete documentation of the assumptions and design loading combinations by the designer/engineer. **Significance:** The RHR cooling towers were analyzed based on tornado loads controlling the design. If the natural frequency for the horizontal excitation of the cooling tower were significantly less than that for a rigid structure, the earthquake shear loads could exceed tornado loads. Further review showed that seismic loads do control design of the RHR cooling towers, but they are less than the tower design capacity. **Extent:** Localized and unique to the RHR Complex tower region since seismic loads were correctly assumed to control the remainder of the RHR Complex.	7.7-121
ST-01-21	**Root Cause:** Design oversight or incomplete documentation of the assumptions and design loading combinations by the designer/engineer.	7.7-122

Observation/ PFR No.	Description	Reference (Page)
ST-01-21 (cont.)	**Significance:** Slabs supporting the RHR cooling towers were analyzed based on tornado loads controlling the design. Further review showed that seismic loads were greater than the tornado loads, but they are within the slab capacity. Sargent & Lundy has revised the calculations to indicate earthquake loads were considered and determined to have no effect on the design. **Extent:** Unique to the RHR cooling tower region. Seismic loads were correctly assumed to control the remainder of the RHR Complex.	
ST-01-22	**Root Cause:** Not applicable since this observation was invalid.	7.7-123
ST-01-23	**Root Cause:** None. **Significance:** Cygna's review questioned whether the seismic analyses for the RHR Complex used the worst-case seismic response spectra. OBE accelerations are normally less than SSE accelerations. Consequently, Cygna was concerned that incorrect seismic loads were used to evaluate the design of the RHR Complex. Further review showed that the OBE and SSE accelerations are consistent with the FSAR commitments. In combination the ground spectra and sampling values specified in the FSAR could produce OBE acceleration which are greater than corresponding SSE accelerations. **Extent:** Unique within the RHR Complex, but the resolution is generic to the entire Fermi-2 site.	7.7-124
ST-01-24	**Root Cause:** Incomplete documentation to justify analytical assumptions made by the designer/engineer. **Significance:** Linearly extrapolating results from a non-linear analysis could result in a non-conservative embed plate design. There was no supporting justification in the calculations indicating why the analysis of embed plates were adequately and conservatively analyzed. See Cygna's response to NRC Question 3-7 for furher information. **Extent:** Generic to the Fermi-2 plant since it applies to all safety-related embeds designed by Sargent & Lundy.	7.7-125
ST-01-25	**Root Cause:** Not applicable since the observation was invalid.	7.7-126
ST-01-26	**Root Cause:** Incomplete documentation. Sargent & Lundy did not clearly document their evaluation of the embedment plate anchors. **Significance:** Further review by Cygna showed the Sargent & Lundy fully evaluated all loads on the embedment plate anchors, in accordance with ACI 349-76. Therefore, there is no design significance.	7.7-127

Observation/ PFR No.	Description	Reference (Page)
ST-01-26 (cont.)	**Extent:** Generic to Fermi-2 because Sargent & Lundy embedment plates are used throughout the plant.	
ST-01-27	**Root Cause:** Not applicable since the observation was invalid.	7.7-128
ST-01-28	**Root Cause:** Design analysis input error by the designer/engineer. **Significance:** In two separate analyses, Sargent & Lundy used different values for the cross-sectional area of a particular shear wall. Further review showed that the variation was small and had an insignificant effect on moments in the RHR Complex. **Extent:** Random and isolated occurrence. These types of errors were not found with any significant frequency in Cygna's review.	7.7-129
ST-01-29	**Root Cause:** Incomplete project documentation. **Significance:** Cygna determined that the fractured bedrock had no amplification effect on the seismic analysis results. It was determined further that grouting was injected in the bedrock, not to improve its seismic characteristics, but to provide a stronger base for rock anchors which were being considered at an earlier time to counter design flood buoyancy. The rock anchors were never installed because subsequently they were determined to be unnecessary. **Extent:** Generic to all Category I structures at the Fermi-2 site.	7.7-130
ST-01-30	**Root Cause:** Poor concrete workmanship. **Significance:** Further Cygna review indicates that Deviation Disposition Requests (DDR's) have documented the generally poor concrete workmanship (voids, honeycombing, patchwork, etc.) in the RHR complex. The DDRs, issued prior to the Cygna review, indicate corrective action was taken with subsequent verification of the completed disposition. Detroit Edison will also perform regular maintenance inspections of the RHR Complex in compliance with NRC Regulatory Guide 1.127. **Extent:** This observation has been addressed by the normal design/construction process. Therefore, further review was neither warranted or performed.	7.7-131
ST-01-31	**Root Cause:** Isolated oversight by field quality control inspectors. **Significance:** Detroit Edison prepared a Deviation Disposition Request to address the observed debris. An engineering evaluation of this debris showed that it was small and in	7.7-132

Observation/ PFR No.	Description	Reference (Page)
ST-01-31 (cont.)	a concrete tension zone where it would not affect design. Cygna's review indicated that other Deviation Disposition Requests had been created due to poor concrete workmanship in the RHR Complex. **Extent:** Localized and unique to one location in the RHR Complex.	
ST-01-32	**Root Cause:** Design error or oversight by the designer/engineer. **Significance:** The load induced by a cantilevered stairway along the east exterior wall of the RHR Complex was omitted from the design analyses. The load was significant enough to raise the resultant stresses in the east wall within 1% of the allowable stresses. **Extent:** This observation was specifically related to the RHR Complex and the cantilevered stairway. The design error or oversight was a random and isolated occurrence with no design consequences for the Fermi-2 plant.	7.7-138
ST-01-33 PFR-10	**Root Cause:** Misinterpretation of computer output results. **Significance:** Misinterpreting membrane shear stresses as membrane shear forces in the SLSAP computer analysis of shear walls could have resulted in an unconservative design of the RHR complex structure. Sargent & Lundy reviewed all Fermi-2 calculations wherever SLSAP plate element output was interpreted. Of the 42 calculations considered as potential candidates; 15 did not use membrane stress output, 22 interpreted membrane stress correctly and 5 were reanalyzed to correctthe misinterpretation of membrane stress output. **Extent:** Generic to all applications where SLSAP plate element output stresses were used on the Fermi-2 design. Cygna verified on a random sampling of 15 out of 42 calculations that the design output had been corrected by Sargent & Lundy.	7.7-139

Observation/ PFR No.	Description	Reference (Page)
EE-01-01	**Root Cause:** Incomplete design documentation. The interrupting rating for circuit breakers was not specified in the switchgear specifications. **Significance:** If the interrupting rating of the circuit breaker does not exceed the maximum value for fault current, extensive damage would likely result to the 480 V switchgear. Since the breaker which was actually installed in the switchgear has an interrupting rating of 30,000 amps, it can clear the maximum fault currents required by the design calculations. **Extent:** Applicable to the interrupting current breakers only on all 480 V safety-related switchgear on Fermi-2.	7.7-140
EE-01-02	**Root Cause:** Inconsistent design documentation. Disagreement in conduit sizes were noted on different drawings for the same conduit run. **Significance:** If the design information provided to the field construction effort is not consistent, the wrong design detail may be installed. The discrepancy occurred on the drawings which were not used to size the conduit in the field. **Extent:** Localized to the cable tray identification drawings on the Fermi-2 project within the electrical discipline.	7.7-141
EE-01-03	**Root Cause:** Failure to implement an FSAR requirement into a design specification. **Significance:** If the safety-related motors are purchased with a minimum starting voltage of 85% rated voltage and the minimum voltage on a safety-related electrical distribution feed such as emergency diesel generators could dip as low as 75% rated voltage, the safety-related motors could potentially fail to start under worst-case accident conditions. This had no significance on the design of Fermi-2 because the only motors potentially required to start on a voltage less than 85% rated voltage were on the RHR pumps. These RHR pump motors could start at rated voltage as low as 70%. **Extent:** Applicable to all safety-related motors rated at 460 VAC.	7.7-142
EE-01-04	**Root Cause:** Not applicable since this observation was determined to be invalid.	7.7-144

EXHIBIT 8.2.1-2
ROOT CAUSE CLASSIFICATIONS

Category	Observation	Comments
A	PI-01-11	Annulus pressurization piping loads
	PI-02-02	See Section 7.3, Exhibit 7.3
	PI-03-04	See Section 7.3, Exhibit 7.3
	PS-00-01	See Section 7.3, Exhibit 7.3
	PS-01-03	Annulus pressuriation suuport loads
	PS-03-01	See Section 7.3, Exhibit 7.3
	PS-03-02	See Section 7.3, Exhibit 7.3
	ST-01-02	See Section 7.3, Exhibit 7.3
	EE-01-03	FSAR requirement on minimum motor starting voltage
B	PI-01-12	See Section 7.3, Exhibit 7.3
	PI-02-03	See Section 7.3, Exhibit 7.3
	PI-03-01	See Section 7.3, Exhibit 7.3
	PS-01-04	Design specification revision required
	PS-02-03	Spring hanger seismic movements
	ST-01-01	S&L structural design criteria
	ST-01-30	See Section 7.3, Exhibit 7.3
	ST-01-31	Concrete voids and exposed rebar
C	PI-01-03	See Section 7.3, Exhibit 7.3
	PI-01-06	Branch connection stress indices
	PI-01-07	See Section 7.3, Exhibit 7.3
	PI-01-08	See Section 7.3, Exhibit 7.3
	PI-01-09	See Section 7.3, Exhibit 7.3
	PI-03-02	Flued-head load cases
	PI-03-05	See Section 7.3, Exhibit 7.3
	PI-03-06	See Section 7.3, Exhibit 7.3
	EQ-01-03	See Section 7.3, Exhibit 7.3
	EQ-01-04	See Section 7.3, Exhibit 7.3
	PS-00-02	RHR piping thermal movements
	PS-00-04	See Section 7.3, Exhibit 7.3
	PS-01-01	Shear lugs for Class I piping
	PS-02-04	Vce of OBE vs. DBE loads
	ST-01-03	RHR Complex design soil loading
	ST-01-05	Cooling tower frame analysis model
	ST-01-06	Basement reinforcing steel placement
	ST-01-09	Foundation wall rebar placement
	ST-01-12	Missing foundation walls loads
	ST-01-13	Reinforcing steel in beams

Exhibit 8.2.1-2 (Cont't)

Category	Observation	Comments
C (con't)	ST-01-15	Shear wall overturning moments
	ST-01-16	Foundation wall design moments
	ST-01-19	Reservoir water effects
	ST-01-24	See Section 7.3, Exhibit 7.3
	ST-01-26	Stud allowable load calculations
	ST-01-33	See Section 7.3, Exhibit 7.3
D	PI-01-01	Long vs. short radius elbows
	PI-01-02	Orientation of restraints S810 & G16
	PI-01-10	Shear lug input load error
	PI-02-01	Branch intensification factors
	PI-02-04	Restraint G01 geometry
	PI-02-05	Long vs. short radius elbows
	PI-02-06	Lubrite plates in stanchions
	PS-01-05	Weld size error
	PS-02-02	Penetration sleeve gaps
	PS-02-05	Hanger E11-2189-007 internal brace
	PS-02-06	See Section 7.3, Exhibit 7.3
	ST-01-10	Cooling tower slab load definition
	ST-01-28	Inconsistent section
	ST-01-32	Cantilevered slab loading
	EE-01-02	Conduit size drawing discrepancy
E	PI-01-04	Snubber supporting frame stiffness
	PI-01-05	Incorrect valve body weights
	EQ-01-02	Valve axial cyclic stresses
	PS-02-01	Support E11-2184-G01 gap size
	ST-01-04	RHR Complex thermal gradients
	ST-01-07	Cooling tower thermal gradients
	ST-01-08	Cooling tower slab thermal gradients
	ST-01-14	Shear loads on deep beam walls
	ST-01-18	Bedrock pressure grouting
	ST-01-20	Cooling tower seismic loadings
	ST-01-21	Cooling tower slab seismic loadings
	ST-01-23	DBE vs. OBE seismic design spectra
	ST-01-29	Bedrock pressure grouting
	EE-01-01	Circuit breaker interrupting rating

8.2.2.2 ENCLOSURE 2, QUESTION 2

NRC QUESTION

"We find that Cygna has not provided a reasonable basis for concluding that the reactor heat removal (RHR) piping has been properly evaluated for faulted loads (i.e., annulus pressurization loads). Our concern is that according to Cygna's review procedures as stated in Section 3.3 of the final report, all observations were to have been reviewed by a project team to determine their potential impact on plant safety. It appears from Cygna's resolution of this observation that Cygna did not evaluate the impact of the observation on plant safety but rather closed out the observation based on irrelevant statements extracted from a General Electric design specification. Accordingly, we cannot support Cygna's rationale for accepting a deviation from staff requirements and believe that further investigation is warranted to assure that the requirements of General Design Criterion 4 of Appendix A to 10 CFR Part 50 have been met.

To place this matter into proper perspective, note that the NRC staff met with Detroit Edison in February 1979 to discuss the topic of LOCA-related loads including annulus pressurization loads. This discussion was subsequently followed up by a question (Item 110.11 which is attached to this enclosure) and Detroit Edison responded in Amendment No. 24 to the FSAR (June 1979). This indicates that as early as February 1979, annulus pressurization loads resulting from a postulated LOCA were to be considered in the design of the Fermi-2 facility.

Additionally, we stated in Section 3.9.3 of our SER (page 3-25) that: "The design limits used by the applicant for these plant conditions are consistent with the criteria recommended in Regulatory Guide 1.48..." (Emphasis added). Accordingly, it is our position that Cygna's review effort on this particular observation should be oriented towards showing consistency with Regulatory Position C.1 (copy attached) of Regulatory Guide 1.48.

We request that you instruct Cygna to expand the scope of its review to determine whether other safety-related piping systems attached to the reactor coolant pressure boundary have considered faulted loads, including annulus pressurization, in the piping stress evaluation."

CYGNA RESPONSE

The NRC and Detroit Edison have requested Cygna to review the pipe stress evaluation for the in-containment RHR shutdown suction cooling element to determine whether faulted loads, including annulus pressurization (A/P), have been properly considered. To proceed with the review, Cygna examined a number of documents related to the analysis of A/P loads including:

- A/P model piping isometric
- As-built model piping isometric
- A/P model geometry with supports
- All A/P spectra
- GE Report TDEC-3714 output summary

Based on this review, Cygna found that the A/P analytical model for the in-containment piping near the flue-head is different than the actual istalled piping geometry and several pipe supports in the RHR shutdown cooling element are located and aligned differently in the as-built configuration. Cygna, therefore, finds there are sufficient differences between the piping geometry analyzed for A/P loads and the as-built configuration to preclude making a determination on structural integrity of the piping under faulted load conditions. Cygna recommends that the NRC and Detroit Edison reach a satisfactory resolution of this issue since Cygna does not have enough information to proceed further.

8.2.3.1 ENCLOSURE 3, QUESTION 1

NRC QUESTION

"Cygna states in Attachment A to Observation Record ST-01-01 which is contained in Section 7.7 (Volume 4) of its IDVP report that various design criteria have been used at different times. However, Cygna does not discuss the significance of the differences between these design criteria. We request that Detroit Edison instruct Cygna to indicate if any of these criteria are different from the criteria contained in the appropriate sections of the Standard Review Plan (SRP). If so, Cygna should identify these differences and provide a rationale for closing this observation in light of any of these differences."

CYGNA RESPONSE

Observation ST-01-01 was prepared primarily to record that a central design criteria document was not available for Sargent & Lundy's structural design effort in the mid-1970 time frame. The majority of the RHR structural calculations reviewed by Cygna were prepared before 1975. During that time period, the structural engineers/designers were guided by standardized design summary sheets contained in each calculation package. A project structural design criteria document (Sargent & Lundy Document DC-SE-01-EF) was prepared and issued in 1981.

Cygna concluded that even though the standardized design summary sheets were brief, they provided sufficient guidance to the engineers/designers prior to issuance of the structural criteria document.

In response to this NRC request, Cygna has performed a detailed comparison of the information contained in the design summary sheets, structural design criteria document and Fermi-2 FSAR. Since the design summary sheets primarily contain load combinations and stress criteria, those two areas formed the basis for the comparison. The other items contained in the design summary sheets are references and material types. Tables 8.2.3.1-1 through 8.2.3.1-4 summarize the load combinations and stress criteria for Category I concrete structures. A description of each table is provided on the following page.

Table 8.2.3.1-1 Design Summary Sheet Load Combinations for Category I Concrete Structures

This table lists the stress criteria and loading combinations contained in a typical S&L structural calculation for the RHR Complex. The stress criteria was in accordance with the ultimate strength design method specified in ACI 318-71. Regarding the loading combinations, there are two apparent exceptions to the FSAR: (1) crane loads are not combined with tornado loads, and (2) crane loads are not combined with the design flood.

Based upon further investigation, Cygna found that the loading combination in the design summary sheets reflect the actual loading conditions. This conclusion is supported by the following information:

- The standardized design summary sheets were used only for structural design of the RHR Complex.
- For the Reactor/Auxiliary Building, FSAR loading combinations were applied, including crane loads for all loading combinations.
- Design flood and tornado loads affect only exterior walls. There are no cranes in the RHR Complex supported on the exterior walls.
- Interior walls are controlled by seismic loads, which are combined with crane loads on the design summary sheets.

Table 8.2.3.1-2 Design Criteria Load Combinations for Category I Concrete Structures

The information contained on this table has been taken from the Sargent & Lundy structural design criteria document for Fermi-2, which was issued in 1981. For concrete structures, the stress criteria in ACI 318-71 is referenced.

Section 8.4.1.5 states, "Under design basis tornado condition the major cranes are considered locked in parked location and no lifted load is considered." There is no similar statement in the FSAR for major cranes other than the reactor building crane (FSAR Section 3.3.2.3.4).

Further investigation revealed that the statement in Section 8.4.1.5 of the structural criteria document is consistent with the FSAR. The only "major crane" located in Fermi-2 Category I structures is the reactor building crane.

Table 8.2.3.1-3: FSAR Load Combinations for Category I Concrete Structures

This information is from Table 3.8-19 of the Fermi-2 FSAR. Regarding stress criteria, FSAR Section 3.8.5.5 makes the following statement:

> "The allowable stresses and strains for the reinforced-concrete mat foundations and supports are in accordance with the provisions of ACI 318-71 for the RHR complex and ACI 318-63 and ACI-318-71 for the reactor/auxiliary building."

The loading combinations in the FSAR represent the project licensing commitments, and form the basis of comparison for determining the design adequacy.

Table 8.2.3.1-4: Standard Review Plan Load Combinations for Category I Concrete Structures

This information is provided for the convenience of comparison. Fermi-2 is not committed to the stress criteria or loading combinations presented in the Standard Review Plan.

Observations other than ST-01-01 addressed the application of load factors used in the design of various Category I concrete structural elements. Observation ST-01-02 noted that an incorrect load factor was employed for soil loads on the RHR Complex foundation walls. Observations ST-01-07, ST-01-08, and ST-01-09 stated that thermal loads had not been considered for certain structural elements. During the resolution process of several observations, it was noted that Sargent & Lundy had used a 0.75 reduction factor on the controlling OBE loading combination. To address the specific and generic implications of these deviations from the project criteria documents, Cygna performed a number of follow-up reviews.

During the IDVP report supplement phase, Cygna reviewed a sampling of safety-related structural calculations by Sargent & Lundy on Fermi-2 to determine whether or not thermal effects were considered in the structural analysis in accordance with the Fermi-2 design criteria. The following documents were selected:

- Calculation 7.01.00, Fuel Pool & Separator Design, dated 7/10/81 (walls and slabs).
- Calculation 5.04.01, Design of Drywell Shield and Penetration Analyses, dated 11/22/71 (biological shield wall).
- Calculation Vol. NO-03, Sacrificial Shield Analysis of Annulus Pressurization, dated 4/78.
- Calculation Book NO-01, Assessment of Pedestal & Stabilizer Truss for Safe End Break, dated 3/78 (RPV pedestal).
- Calculation 4.01.03, Reactor Building Frame Analysis - Bent 10, Computer Output, dated 6/72.

In all cases, temperature effects were considered in accordance with the project criteria.

In response to the recent NRC Staff's request for additional information, Cygna performed an additional review of Sargent & Lundy safety-related structural calculations on Fermi-2. This time Cygna reviewed final load verification calculations, to determine whether or not the current design process was consistent with the project criteria, relative to load combinations and thermal loads. Calculations were selected to obtain a cross-section of concrete structures. They were:

- Calculation SS-0002, Reactor Bldg. - Mat Foundation Review for SRV Loads, dated 7/1/84.
- Calculation SS-0005-DES, Design Control Summary for Reactor/Auxiliary Bldg. Final Load Verification and Processing of Cored Holes and Rebar Cuts (as related to Calculation SS-0007).
- Calculation SS-0007, Reactor Auxiliary Bldg. - Final Load Verification - Elevation 642'-6", dated 8/24/84.
- Calculation SS-0010, Final Load Check for Reactor/Auxiliary Bldg. Roof, dated 7/25/84.

- Calculation SS-0018, Selected Concrete Wall Final Load Check - Reactor Bldg., dated 8/24/84.
- Calculation 1.15.10, Shear Wall Design/Ice Loading, dated 9/19/84.
- Calculation 1.30.1, RHR Complex - Shear Wall - Seismic Reealuation, dated 8/24/84.

These seven calculations represent one-third of the final load verification packages on the project. No deviations from project criteria were observed in either load combinations or the application of thermal loads.

In conclusion, Cygna has performed several diverse reviews of Sargent & Lundy's structural design criteria on Fermi-2. These reviews have covered a wide span of the project life; they have covered all safety-related structures on the site; they have addressed adherence to licensing commitments; they have assessed application of the criteria; and, throughout the review process, they evaluated the significance of any deviations.

As a result of these reviews, Cygna has concluded that the standardized design summary sheets provided sufficient design guidance to the structural engineers/designers. Accordingly, Observation ST-01-01 remains satisfactorily resolved and closed.

Table 8.2.3.1-1

Design Summary Sheet Load Combinations for Category I Concrete Structures

Stress Criteria: Ultimate Strength Design (ACI 318-71)

Loading Combination	Load Factors
Construction	1.3(D+L+C+W+To)
Test	1.1(D+Ro) + 1.3(L+C+To)
Normal	1.4(D+Ro) + 1.7(L+C) + 1.3To
Severe Environmental	1.4(D+Ro) + 1.7(L+C+W) + 1.3To
	1.2(D+Ro) + 1.7W + 1.3To
	1.4(D+Ro) + 1.7(L+C) + 1.9Eo + 1.3To
	1.2(D+Ro) + 1.9Eo + 1.3To
	1.4(D+Ro) + 1.7(L+C+H) + 1.3To
Abnormal	1.0(D+L+C+Ra+Ta) + 1.5Pa
	1.0(D+L+C+Ro+To+M)
Extreme Environmental	1.0(D+L+C+Ro+Es+To)
	1.0(D+L+Ro+Wt+To)
	1.0(D+L+Ro+H+To)
Abnormal/Severe Environmental	1.0(D+L+C+Ra+Ta+Yr+Yj+Ym) + 1.25(Eo+Pa)
Abnormal/Extreme Environmental	1.0(D+L+C+Ra+Es+Ta+Pa+Yr+Yj+Ym)

Reference: Sargent & Lundy Calculation, Project 3988-12, Calculation Book No. 1.22.13, dated 11/6/71, page 5 of 7.

Table 8.2.3.1-2

Design Criteria Load Combinations Category 1 Concrete Structures

Stress Criteria: Ultimate Strength Design (ACI 318-71)

Loading Combination	Load Factors
Construction	1.3(D+L+C+W+To)
Test	1.1(D+Ro) + 1.3(L+C+To)
Normal	1.4(D+Ro) + 1.7(L+C) + 1.3To
Severe Environmental	1.4(D+Ro) + 1.7(L+C+W) + 1.3To
	1.2(D+Ro) + 1.7W + 1.3To
	1.4(D+Ro) + 1.7(L+C) + 1.9Eo + 1.3To
	1.2(D+Ro) + 1.9Eo + 1.3To
	1.4(D+Ro) + 1.7(L+C+H) + 1.3To
Abnormal	1.0(D+L+C+Ra+Ta) + 1.5Pa
	1.0(D+L+C+Ro+To+M)
Extreme Environmental	1.0(D+L+C+Ro+Es+To)
	1.0(D+L+C+Ro+Wt+To)
	1.0(D+L+C+Ro+H+To)
Abnormal/Severe Environmental	1.0(D+L+C+Ra+Ta+Yr+Yj+Ym) + 1.25(Eo+Pa)
Abnormal/Extreme Environmental	1.0(D+L+C+Ra+Es+Ta+Pa+Yr+Yj+Ym)

Reference: Sargent & Lundy Document, DC-SE-01-EF, "Project Structural Design Criteria, Enrico Fermi - Unit 2, Reactor/Auxiliary Building & RHR Complex," Revision 5, dated April 26, 1984.

Table 8.2.3.1-3

FSAR Load Combinations Category I Concrete Structures

Stress Criteria: Ultimate Strength Design (ACI 318-71)

Loading Combination	Load Factors
Construction	1.3(D+L+C+W+To)
Test	1.1(D+Ro) + 1.3(L+C+To)
Normal	1.4(D+Ro) + 1.7(L+C) + 1.3To
Severe Environmental	1.4(D+Ro) + 1.7(L+C+W) + 1.3To
	1.2(D+Ro) + 1.7W + 1.3To
	1.4(D+Ro) + 1.7(L+C) + 1.9Eo + 1.3To
	1.2(D+Ro) + 1.9Eo + 1.3To
	1.4(D+Ro) + 1.7(L+C+H) + 1.3To
Abnormal	1.0(D+L+C+Ra+Ta) + 1.5Pa
	1.0(D+L+C+Ro+To+M)
Extreme Environmental	1.0(D+L+C+Ro+Es+To)
	1.0(D+L+C+Ro+Wt+To)
	1.0(D+L+C+Ro+H+To)
Abnormal/Severe Environmental	1.0(D+L+C+Ra+Ta+Yr+Yj+Ym) + 1.25(Eo+Pa)
Abnormal/Extreme Environmental	1.0(D+L+C+Ra+Es+Ta+Pa+Yr+Yj+Ym)

Reference: Enrico Fermi - Unit 2 Final Safety Analysis Report (EF-2 FSAR), Table 3.8-19.

Table 8.2.3.1-4

Standard Review Plan Load Combinations Category I Concrete Structures

Stress Criteria: Ultimate Strength Design (ACI 349)

Loading Combination	Load Factors
Service	1.4D + 1.7L
	1.4D + 1.7L + 1.9Eo
	1.4D + 1.7L + 1.7W
	(0.75)(1.4D + 1.7L + 1.7To + 1.7Ro)
	(0.75)(1.4D + 1.7L + 1.9Eo + 1.7To + 1.7Ro)
	(0.75)(1.4D + 1.7L + 1.7W + 1.7To + 1.7Ro)
	1.2D + 1.9Eo
	1.2D + 1.7W
Abnormal/Extreme Environmental	1.0(D+L+To+Ro+Es)
	1.0(D+L+To+Ro+Wt)
	1.0(D+L+Ta+Ra) + 1.5Pa
	1.0(D+L+C+Ra+Ta+Yr+Yj+Ym) + 1.25(Eo+Pa)
	1.0(D+L+Ra+Es+Ta+Pa+Yr+Yj+Ym)

Reference: U.S. Nuclear Regulatory Commission, NUREG-800, Standard Review Plan, Section 2.8.4.II.3.b, Revision 1, July 1981.

Note: Enrico Fermi - Unit 2 is not committed to the Standard Review Plan.

8.2.3.2 ENCLOSURE 3, QUESTION 2

NRC QUESTION

"For Observations ST-01-03, ST-01-06, ST-01-09, ST-01-13 and ST-01-16, Cygna states that the as-built reinforcing steel provides the required structural capacity despite the apparent design deficiency. We request that Detroit Edison instruct Cygna to provide for each of the observations cited above, a simple sketch showing the location of the reinforcing steel bars as designed and as the bars are actually installed at the section for which the steel requirement was computed. Cygna should also indicate the development length of these bars. This addition to Cygna's report should also address the potential generic implication of these apparent design deficiencies on the design adequacy of the other safety-related structures of the Fermi-2 facility since the NRC staff has no assurance that the other safety-related structures will have the same structural margin which was the basis for Cygna's acceptance of the observed structural deficiencies."

CYGNA RESPONSE

In Cygna's IDVP final report, the resolution for Observations ST-01-03, ST-01-06, ST-01-09, ST-01-13 and ST-01-16 stated that these observations had no design impact because as-built reinforcement was adequate to resist any additional loads identified by the observations. The brief resolution statement in each observation should have clearly established that the reinforcement shown on the design drawings was consistent with the as-built reinforcement. The supplemental IDVP report attempted to clarify this fact. Objective evidence is provided below showing that there was consistency in the design process. The generic impact of each observation is also discussed, as well as the impact of these observations taken collectively.

None of the drawing revisions on Fermi-2 are specifically labeled "As-Built Drawing." During the course of the IDVP, Cygna assumed that the latest drawing revision was the best representation of the "as-built" condition.

Several figures and tables are enclosed to compare the reinforcing steel that was (a) required in the design calculations, (b) shown on the design drawings, and (c) provided in the field. Development lengths are also shown. In the following paragraphs, the information provided on these figures and tables is described in correlation to the Cygna observations.

Observations ST-01-03, ST-01-09 and ST-01-16

Sargent & Lundy Calculation Sets 1.2.1 and 1.15.10 determine the required reinforcement in the RHR basemat and walls. This information is reflected in design drawings B-293, B-294, B-297 and B-298. Relative to Observations ST-01-03, ST-01-09 and ST-01-16, Cygna treated the latest revisions of drawings B-287 through B-307 as the "as-built" drawings.

Figure 8.2.3.2-1 and Table 8.2.3.2-1 compare reinforcement details for the foundation wall/basemat joint, as specified in the various revisions of the calculation sets and drawings. In Revision 0 of the design calculations, the designers calculated only general reinforcement requirements. Details of the reinforcement were not specified. For more highly loaded regions the following statement was provided in the calculation:

> "For sections with moments bigger than the allowable 302 k-ft, the extra steel has been provided to increase the mat capacity (#11 @ 6" has been used for these sections)."

Revision B of the design drawings were released for construction at about the same time as the Revision 0 design calculations. These drawings located the reinforcing steel in accordance with the design drawings, including increased reinforcement (#11 @ 6") in the more highly loaded regions.

Revision 1 to the design calculation package refined the calculations and provided reinforcement details identical to the Revision B drawings. The latest revisions to the design drawings, which can be considered the "as-built" conditions, also have reinforcement details identical to Revision B of the design drawings.

Therefore, as shown in Figure 8.2.3.2-1 and Table 8.2.3.2-1, consistent reinforcement details were used throughout the design process. Figure 8.2.3.2-2 shows these reinforcement details.

Figure 8.2.3.2-3 also plots the moment capacity of the foundation wall versus the moment diagram due to the mechanical plus thermal loading combination. To develop the moment capacity plot, no credit was taken for development of splice lengths. This plot shows that the moment capacity diagram envelopes the moment diagram.

Regarding basemat reinforcement at the wall joint, #11 @ 6" were provided in the design drawings. The moment capacity, 567 k-ft/ft, significantly exceeds the maximum moment, 482 k-ft/ft.

Observation ST-01-13

Figure 8.2.3.2-4 and Table 8.2.3.2-2 compare the design and "as-built" longitudinal reinforcement for the 30' x 48" beams on grids B, C and D between grids 1-2, 4-5, 8-9 and 12-13. This figure and table confirm that the constructed reinforcement matches the reinforcement required by design.

In the final and supplemental IDVP reports, Cygna provided documentation indicating that, individually, these five observations have no impact on design. As part of the IDVP review process, Cygna also concluded that any generic implications had been satisfactorily addressed. The above discussion further supports these conclusions.

Considering these five observations collectively, there are basically three issues:

- Incomplete documentation in the calculation package regarding the specific locations for concentrated reinforcement (ST-01-03, ST-01-06 and ST-01-16).
- Omission of thermal loads (ST-01-09).

- Design of the beams below grade did not address the axial loads due to lateral soil pressure (ST-01-13).

Regarding project documentation, it is has been stated that specific reinforcement details were not provided in the original design calculation package (Revision 0). However, the design drawings issued during the same period properly detailed the reinforcement. The calculation packages were later updated to provide the same level of detail as the design drawings. Based on this information, Cygna has concluded that there are no generic implications related to Observations ST-01-03, ST-01-06 or ST-01-16. This conclusion holds when these observations are considered either individually or collectively.

Cygna's response to Enclosure 3, Question 1, fully discussed the Sargent & Lundy design process on Fermi-2 relative to thermal loads. Any potential generic design implications of Observation ST-01-09 have been addressed in that discussion.

Observation ST-01-13 has no effect on design. As stated in the IDVP report supplement, consideration of this small axial load in the design of these beams would actually result in a slightly increased design capacity.

In summary, Cygna has conclusively demonstrated that concrete reinforcement details have been consistent throughout the design process. It has also been demonstrated that Observations ST-01-03, ST-01-06, ST-01-13 and ST-01-16 have no generic implications. Cygna's response in Section 8.2.3.1 addresses the generic implications of Observation ST-01-09.

Table 8.2.3.2-1

REINFORCEMENT AT SHEAR WALL-TO-BASEMAT JOINT

Sargent & Lundy's Calculations or Drawings Job No. 3988-12	Dimensions A	B	C	D
Calculation No. 1115110 (Revision 0)*	N/A	N/A	N/A	N/A
Calculation No. 1.2.1 (Revision 0)*	N/A	N/A	N/A	N/A
Calculation No. 1.15.10 (Revision 1, Dated 6/22/83)	14'-6"	L_B	L_B	18'-0"
Calculation No. 1.2.1 (Revision 1, Dated 6/22/83)	14'-6"	L_B	L_B	18'-0"
Drawings B-287 to B-292, B-295, B-296, B-299 to B-307 (Revision B, Release for Construction)	N/A	N/A	N/A	N/A
Drawing B-293 (Revision B)	14'-6"	9'-0"	L_B	18'-0"
Drawings B-294, B-297, B-298 (Revision B)	14'-6"	L_B	L_B	18'-0"
Drawings B-287 to B-292, B-295, B-296, B-299 to B-307 (Latest Revision, As-Built)	N/A	N/A	N/A	N/A
Drawing B-293 (Latest Revision)	14'-6"	9'-0"	L_B	18'-0"
Drawings B-294, B-297, B-298 (Latest Revision)	14'-6"	L_B	L_B	18'-0"

* Specifies only #11 @ 6", but not the details of reinforcement.

Table 8.2.3.2-2

"AS-BUILT" REINFORCEMENT

Beam Mark	Floor Elevation	Bottom Bars "A"	Bottom Bars "B"	Top Bars End Location	Top Bars "C"	Top Bars "D"	Top Bars Cut Off
2RHRB-3	596'-4"	4, #10		S N	3, #11 3, #11	2, #11	9"-0"
2RHRB-4	596'-0"	4, #10			3, #11		
2RHRB-5	596'-0"	4, #10			3, #11		
2RHRB-6	596'-4"	4, #10			3, #11		
2RHRB-10	596'-4"	5, #9			5, #9		
2RHRB-13	596'-4"	5, #9			5, #9		
2RHRB-16	596'-4"	4, #10		S N	3, #11 3, #11	2, #11	9'-0"
2RHRB-17	596'-0"	4, #10			3, #11		
2RHRB-18	596'-0"	4, #10			3, #11		
2RHRB-19	596'-4"	4, #10			3, #11		

References: Drawing B-263, Revision U, dated April 30, 1984.
Drawing B-275, Revision H, dated May 7, 1984

Figure 8.2.3.2-1

Reinforcement at Shear Wall to Base Mat Joint

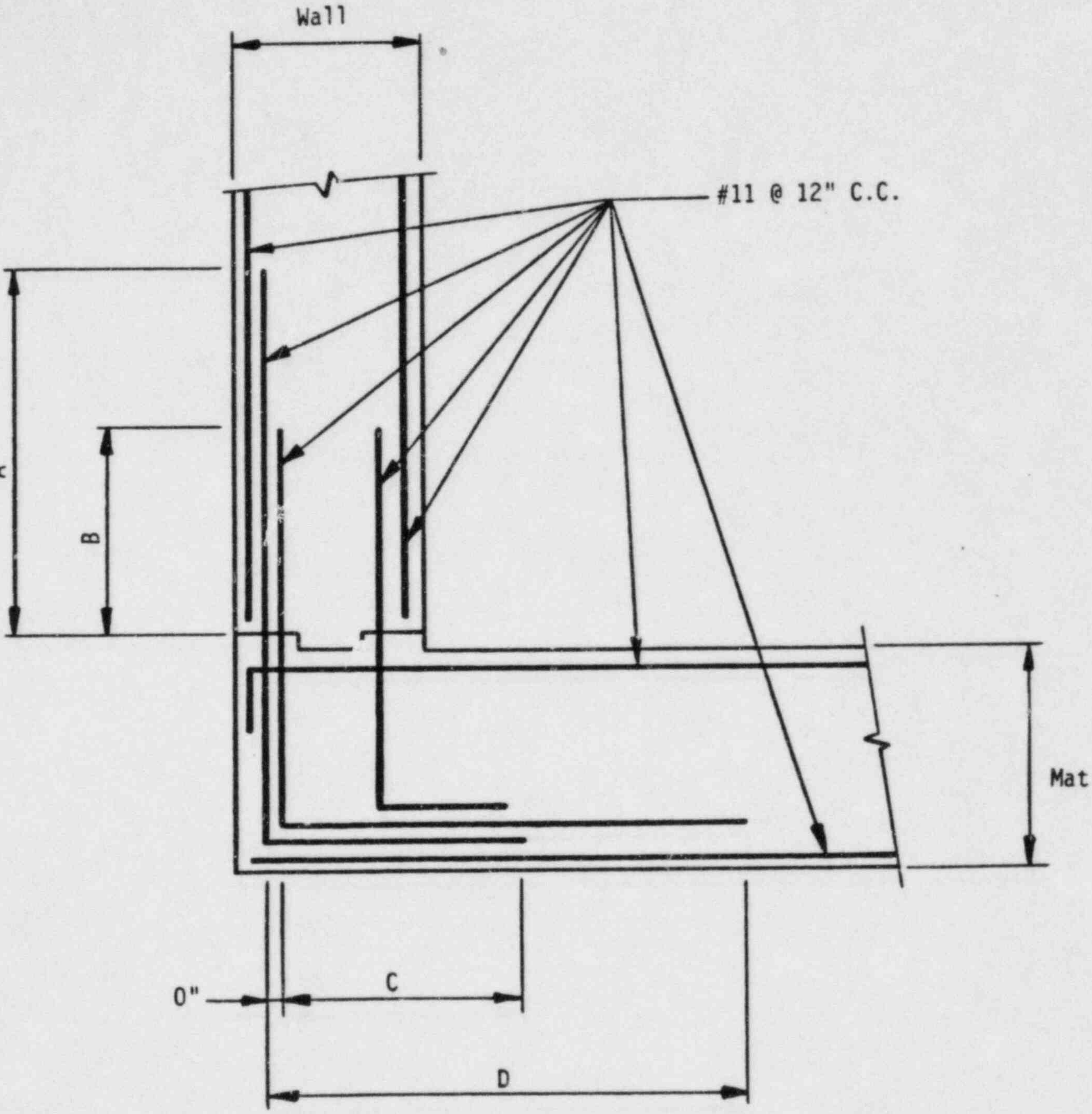
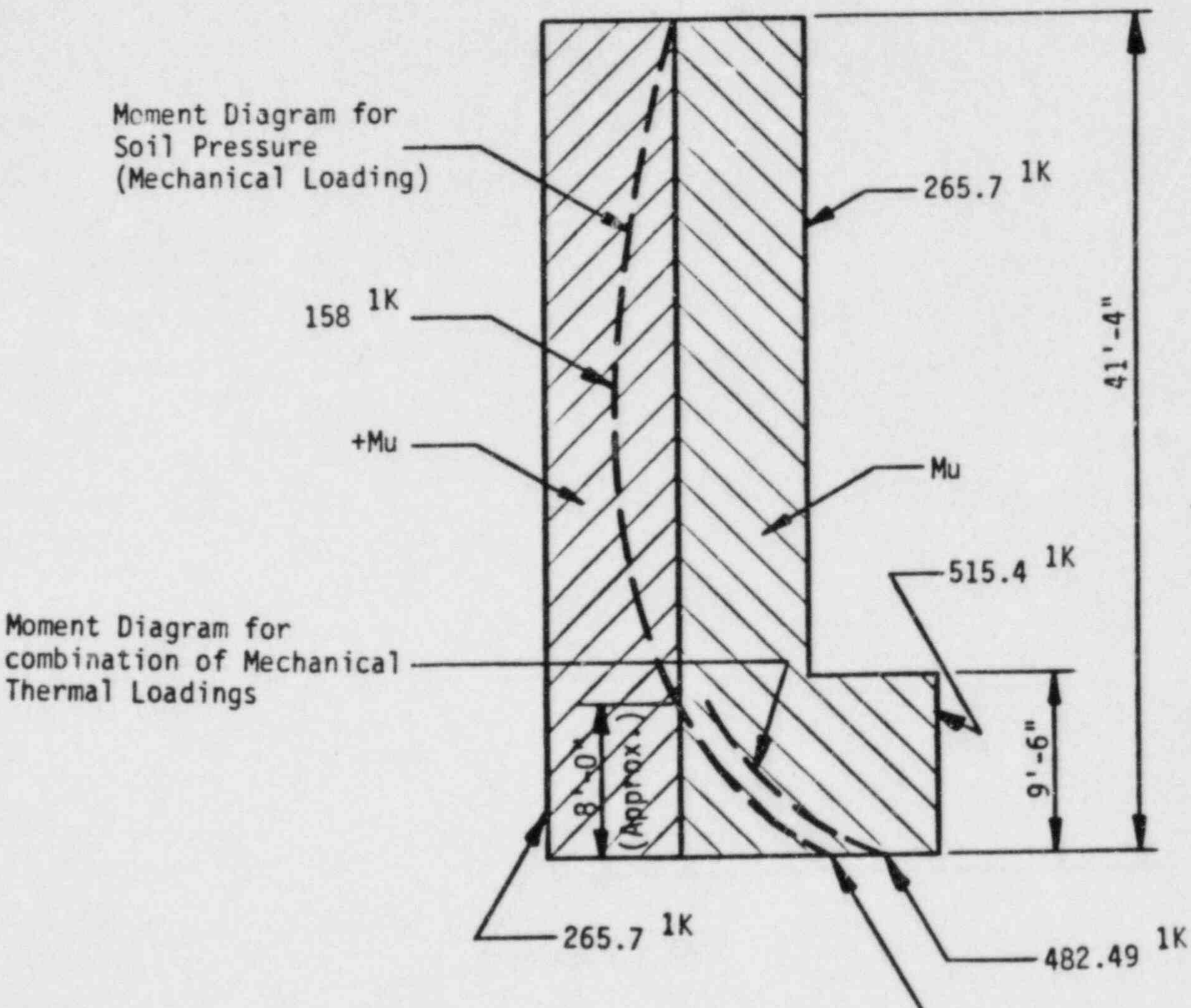


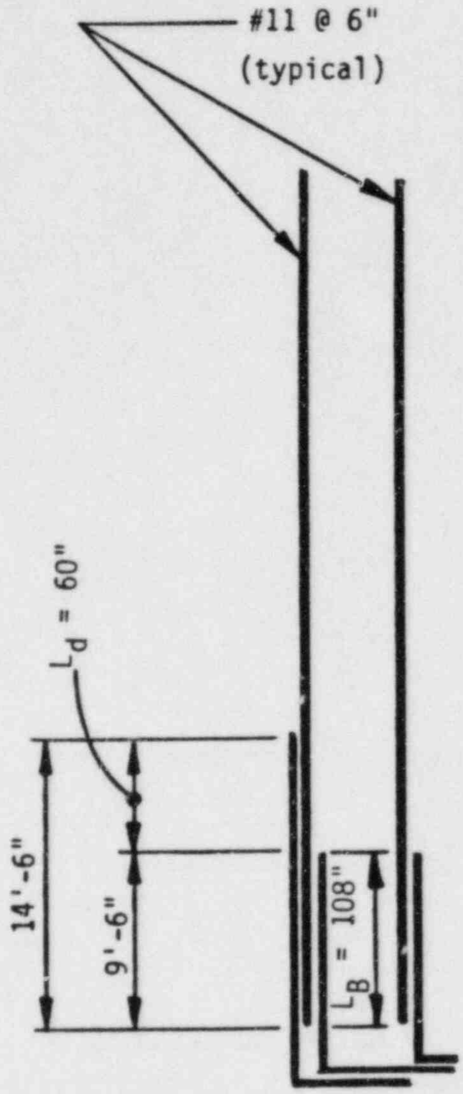
Figure 8.2.3.2-2

Moment-Diagrams at Shear Wall to Base Mat Joint



Moment Diagrams

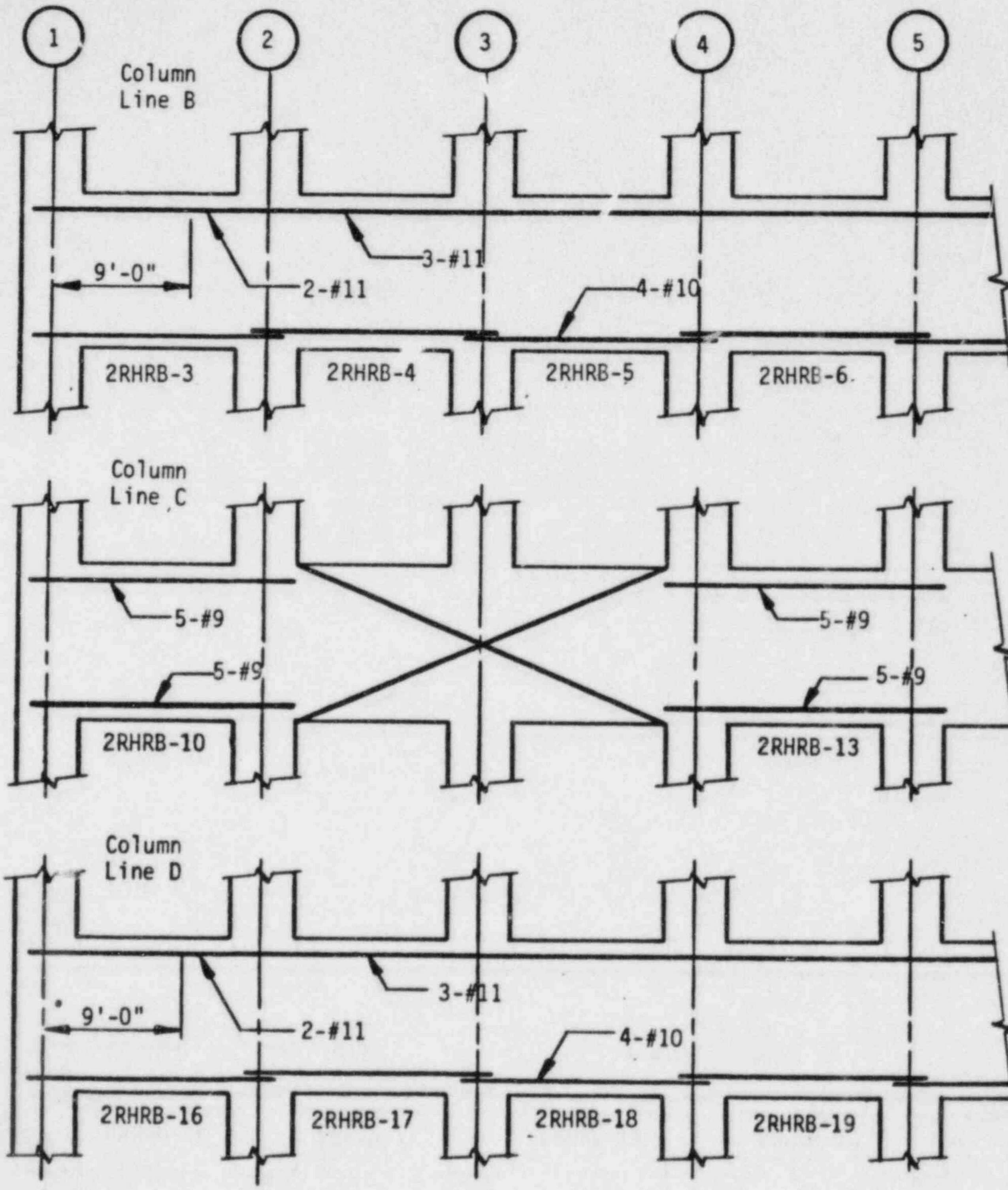
Figure 8.2.3.2-3
Reinforcement Diagram for Shear Wall to Base Mat Joint



Reinforcement Diagram

Figure 8.2.3.2-4

Reinforcement Specified in the Design Calculation



8.2.3.3 ENCLOSURE 3, QUESTION 3

NRC QUESTION

"In Potential Finding Report (PFR) No. 10, it appears there is an inconsistency in the approach used for the shear wall analysis of the Fermi-2 facility by Sargent & Lundy. Cygna stated in PFR No. 10 that the shear walls were analyzed as deep beams despite the fact that the computer program which was used, SLSAP, analyzes plate and shell elements and that the results of this analysis were misinterpreted. We request that DECo instruct Cygna to provide a justification for resolving this dificiency."

With regard to this misinterpretation of the SLSAP Code, Cygna should state why the 15 calculations cited on Page 2 of PFR No. 10 did not use the membrane stresses calculated by the computer code. Cygna should also indicate the nature of the additional refined analyses which were performed for two of the five shear walls analyzed as deep beams; i.e., those five calculations which correctly used the membrane stress calculated by SLSAP.

CYGNA RESPONSE

Potential Finding Report (PFR) No. 10 addressed the misinterpretation of SLSAP output for Element Type 6, which is a two-dimensional finite element. Only the membrane shear stresses were misinterpreted. In response to this finding, Sargent & Lundy performed an extensive review of Fermi-2 calculations to identify any calculations affected by the misinterpretation. Forty-two calculations were identified. Of these, twenty-two used the membrane stresses correctly, fifteen did not use membrane stress output and five used the membrane stress output incorrectly. Of the five, two required reanalyses using a refined evaluation. Cygna randomly spot checked the Sargent & Lundy results and concurred that no structural modifications were required.

In response to this NRC request for additional information, the following questions will be addressed:

1) Was the model adequate to define the structural deformations of a loaded deep beam?

2) Why were some membrane stresses calculated by SLSAP not used for design?

3) How were the refined evaluations performed for two of the deep beams?

The deep beams in the RHR Complex are about 73 feet long and 27 feet deep. The thickness varies from 1'-6" to 2'-11". Sargent & Lundy developed SLSAP models of these deep beams to evaluate in-plane shear stresses due to seismic and vertical (dead plus live) loads. The characteristics of SLSAP Element Type 6 are appropriate for such a model. Cygna also reviewed the deep beam models and confirmed that a properly sized finite element mesh was used. One hundred and forty (140), nearly square, elements were used to model the beams. Therefore, the SLSAP models of the deep beams were adequate for their purpose.

Again a total of forty-two (42) SLSAP models were used on the Fermi-2 project. As indicated in PFR 10, the membrane shear stresses calculated for fifteen (15) of these models were not included in the structural design of the modeled element. That was appropriate for these 15 models for the following reasons:

- The structures modeled were mats, slabs and embedded plates. Finite element models were prepared for these structures to determine their out-of-plane bending characteristics.
- The in-plane shear stresses predicted by these SLSAP models were very small and insignificant to design.
- Other stress components not in the plane of the beam, such as flexural shear and punching shear, were calculated manually and then combined with the SLSAP results (see Sargent & Lundy Calculation 1.2.1) .

When Sargent & Lundy evaluated the effect of this misinterpretation on Fermi-2 design, no changes were made to the original analyses. Only the design methods were refined. Two design methods were employed for this evaluation:

a. Original design method. The shear capacity was calculated based on only the concrete strength. No credit was taken for the shear strength contributed by the reinforcement.

b. Refined design method. The shear capacity was calculated as the sum of the concrete strength and the shear friction contribution from the reinforcement. In addition, the current configuration of wall openings was used. Specifically, an opening had been assumed in the analysis of the wall on grid line E in the RHR Complex, which was not shown on the design drawings. The shear stresses were revised accordingly in that region and then compared to the shear capacity.

Each of the above design methods is consistent with the structural design code, ACI 318-71.

Using the original design method, only two of the structural designs were shown to be unsatisfactory for the revised shear loads. For these two structural designs, the revised shear loads were evaluated using the refined design method. Both were found to be satisfactorily designed.

In summary, Cygna has stated that the analytical models for the deep beams were appropriate for the design application. Cygna has also stated that certain membrane stresses calculated by SLSAP were neglected in the design because those stresses were insignificant. And finally, Cygna has described the refined evaluation for the two shear walls, and has shown that the methodology was consistent with both the design code and the design drawings.

8.2.3.4 ENCLOSURE 3, QUESTION 4

NRC QUESTION

"Cygna's explanation for the use of a 1.4 load factor as given in the Attachment to PFR No. 8 (Page 7.6-44 of Volume 4) is unacceptable to the NRC for the following reasons:

a. Cygna states on Page 7.6-44 of its IDVP report that a less conservative load factor of 1.4 is balanced by a conservative soil pressure of 2.47 kips per square foot (ksf) and on this basis considers the less conservative load factor of 1.4 to be proper. However, for the load combinations which include seismic loads, a value of 2.39 ksf is indicated as the static earth pressure. Based on this discussion, it appears there may not be any conservatism in the soil pressure, especially if the dynamic earth pressure increment is to be included.

b. For the load combinations which include seismic loads, the use of a dynamic water pressure increment of only 0.35 ksf apparently is used to justify a load reduction factor of 0.75 which is indiscriminately applied to the load combination as a whole. In accordance with Section 3.8.4 of the SRP, the use of the reduction factor of 0.75 is not allowed for this particular load combination.

c. There is no discussion of the strength of the structural member.

In view of the staff concerns listed above, we cannot agree with Cygna's conclusion regarding adequacy of the particular design method under consideration. We request that DECo instruct Cygna to address our concerns in this matter and to provide a discussion of the extent to which these observed deficiencies affect those safety-related structures which were not included in the IDVP. Specifically, Cygna should provide a discussion of the potential generic implication of applying this same design logic to other safety-related structures of the Fermi-2 facility."

CYGNA RESPONSE

Potential Finding Report (PFR) No. 8 stated that the ultimate load factor used for soil loading on the RHR Complex foundation walls was not consistent with the required loading combinations. Specifically, a 1.4 factor was applied to the soil load rather than the required 1.7 factor.

In response to this NRC request for clarifications, the following issues will be addressed:

- conservatisms in the soil loading,
- load factors used to develop the design soil pressure,
- adequacy of the foundation wall,
- generic implications.

Soil pressures for the Fermi-2 site are based on the Dames & Moore Report entitled, "Static and Dynamic Soil and Rock Studies, Fermi II Nuclear Power Plant," dated February 3, 1970. Table 7.8-1 in that report recommends the following values for lateral pressures:

Laterial Pressure ($lb/ft^2/ft$)	Fill
Static - Rigid Wall Above Water	96 (a)
Static - Rigid Wall Submerged	122 (a)
Static - Cantilever Wall Above Water	32 (a)
Static - Cantilever Wall Submerged	80 (a)
Dynamic - Rigid Wall Above Water	320 (b)
Dynamic - Rigid Wall Below Water	280 (b)

(a) A factor of 1.5 is recommended in the use of these values.

(b) A factor of 1.1 is recommended in the use of these values.

Regarding conservatisms in the soil loading, the most significant conservatism is that two factors of safety are applied to the soil loads on foundation walls. First the factor of safety recommended by Dames & Moore in the above table is applied. Then an additional factor of safety is applied in accordance with the ultimate strength design requirements summarized on FSAR Table 3.8-19. This duplication of safety factors results in an effective safety factor of up to 2.55 (1.5 x 1.7). Sargent & Lundy and Detroit Edison have recently reevaluted the practice of applying multiple load factors to the soil loading, and they have concluded that the practice is too conservative. As a result, they have proposed a revision to the structural design criteria in the FSAR. The proposed revision would eliminate the load factors recommended by Dames & Moore.

Remaining discussions in this section assume that this revision to the FSAR criteria for soil loads will be issued and accepted.

Design calculations for the RHR Complex foundation walls have been updated by Sargent & Lundy to remove the load factors recommended in the soils report. Load combinations and load factors used in the updated calculation are consistent with the FSAR. The controlling loading combination is:

$$U = 1.4\ D + 1.7\ L + 1.3\ T_o + 1.9\ E_o$$

where U = ultimate design load

D = dead load

L = live load, including soil loads

T_o = operating temperature loads

E_o = OBE loads.

Cygna has performed a general review of this updated calculation package and concurs with the conclusion that the foundation walls in the RHR Complex adequately support the applied loads, including dynamic effects and thermal loads. The maximum design loads are within the foundation wall capacity, as shown below:

Description	Load	Capacity
Moment	429 k-ft/ft	515 k-ft/ft
Shear	50.3 k/ft	51.7 k/ft

In the resolution to PFR No. 8, the IDVP Section 7.6 (Page 7.6-41) write-up addressed generic implications of this finding by stating, "Furthermore, Cygna has reviewed the calculations for the following structures and confirmed that a 1.7 load factor was used: RHR Mat Foundation (Book #4.1), Reactor/Auxiliary Building Substructure (Book #3.08.00), and Reactor/Auxiliary Building Mat Foundation Review for SRV Loads (Book #SF-0002)." In addition, Cygna has reviewed the loading combinations used in the Reactor/Auxiliary Building mat foundation calculation package, and confirmed that the FSAR loading combinations were considered. The Reactor/Auxiliary Building and RHR Complex are the only Category I structures on the Fermi-2 site. Therefore, Cygna can state that all generic implications of PFR No. 8 have been addressed and satisfactorily resolved.

8.2.3.5 ENCLOSURE 3, QUESTION 5

NRC QUESTION

"Cygna states in its additional comments on Observation No. ST-01-20 (Page 7.7-121 of Volume 4) that since the acceleration corresponding to a frequency of 27.6 Hz is almost equal to the acceleration corresponding to a rigid structure, the shear forces are insignificant. This reasoning is not clear to us. Accordingly, we request DECo to instruct Cygna to provide an explanation of this assumption."

CYGNA RESPONSE

Observation ST-01-20 refers to the lateral seismic response of the RHR cooling towers. Cygna prepared this observation to address an assumption in the design calculation package that the lateral fundamental frequency of the cooling tower was in the rigid range, i.e., greater than 33 Hz. Based upon supporting evaluations provided by Sargent & Lundy, Cygna concluded that the calculated frequency (27.6 Hz) was sufficiently rigid to justify the original assumption. It was also concluded that the small change in frequency did not affect the seismic shear forces.

Cygna used the seismic response spectra at the base of the cooling tower to quantitatively evaluate the effect of this small change in frequency on shear forces. OBE and SSE accelerations from the seismic spectra are tabulated below for the assumed and calculated structural frequencies.

Earthquake	33 Hz	27.6 Hz
OBE	0.17 g	0.18 g
SSE	0.25 g	0.26 g

This tabulation shows that there is negligble difference in design accelerations associated with the assumed and calculated frequencies. Since shear forces and accelerations are proportional in this case, the difference in shear forces is also negligible.

For better clarity, the resolution to Observation ST-01-20 should have stated that there was no significant change in the seismic shear forces due to a horizontal earthquake. Further discussions related to the seismic analysis of the cooling towers are provided in Section 8.2.3.6.

8.2.3.6 ENCLOSURE 3, QUESTION 6

NRC QUESTION

"In Observation ST-10-21, Cygna states its concerns that the shear forces resulting from the horizontal component of seismic loads were checked. In Attachment A to this observation record (Page 7.7-122 of Volume 4), calculations of the moments instead of shears due to tornado and seismic loads are given. We request DECo to instruct Cygna to provide an explanation of the resolution of this observation. Additionally, the use of a 0.75 resuction factor for seismic loads is not consistent with the acceptance criteria in Section 3.8.4 of the SRP."

CYGNA RESPONSE

Observation ST-01-21 dealt with the design of the roof slab supporting the RHR cooling towers. The original design calculation package did not address the significance of seismic shear forces. In a later revision to the calculation package, Sargent & Lundy stated that seismic loads had been considered and were judged to have no effect on the results of the original design calculations. Cygna concurred that the consideration of seismic shear forces would result in no changes to the design details, and therefore closed the observation.

In response to this NRC request for additional information, Cygna performed an independent structural verification of the slabs supporting the RHR cooling towers. One of the four cooling towers, which are placed in each corner of the roof, was analyzed. Figure 8.2.3.6-1 illustrates a typical tower/slab configuration.

The finite element model shown on Figure 8.2.3.6-2 was used to perform an elastic analysis. Based on symmetry and the applied loads, a 180 degree model was prepared which included the significant structural elements: cooling tower, roof slab and shear walls. Since the objective of the analysis was to determine slab loads, a refined element mesh was provided for the roof slab. Modeling of the tower and shear walls was sufficiently detailed to ensure proper load transfer and structural response. The tower and roof slab were modeled with plate/shell elements located along the mid-plane of each structure. The radial dimension of the first row of slab elements was set equal to the thickness of the roof slab, 2'-6". Coincidentally, the tower and slab have the same thickness at their point of intersection. This model was not used to evaluate lateral dynamic responses. Loads due to lateral dynamic response were separately determined and then applied statically to the model.

This model was input to the computer program ANSYS. The analyses were based on uncracked sections, except for the thermal load case. Design loads were produced at the midpoint of each element. Loads were then developed in the most highly stress element(s) and compared to the slab design capacity.

The following loading combinations were considered, in accordance with the Fermi-2 FSAR:

LC1: $U = 1.0\,(D + L + T_o + W_t)$

LC2: $U = 1.4\,D + 1.7\,L + 1.3\,T_o + 1.9\,E_o$

LC3: $U = 1.0\,(D + L + T_o + E_s)$

where U = ultimate design loads

D = dead load

L = live load

T_o = operating thermal load

W_t = design basis tornado load

E_o = OBE load

E_s = SSE load

Both summer and winter conditions were considered for the operating thermal load.

Table 8.2.3.6-1 summarizes the results for both moment and shear loads. It shows that al' but one maximum load is within the design capacity, and that load exceeds the capacity by an acceptably small amount, 3%. The maximum loads occur, as expected, in the row of elements adjacent to the cooling tower. These results verify the original resolution to Observation ST-01-21.

TABLE 8.2.3.6-1

FINITE-ELEMENT ANALYSIS SUMMARY OF RESULTS

Load Combinations[1]		Maximum M_x ft-k/ft	M_y ft-k/ft	N_x[3] k/ft	N_y k/ft
I	$1.0D + 1.0L + 1.0W_t + 1.0T_o(W)$	23.7	56.7	6.65	5.44
I	$1.0D + 1.0L + 1.0W_t + 1.0T_o(S)$	26.0	59.1	5.67	5.24
II	$1.4D + 1.7L + 1.9OBE + 1.3T_o(W)$	38.7	93.7	10.35	8.90
II	$1.4D + 1.7L + 1.9OBE + 1.3T_o(S)$	41.7	96.9[2]	9.13	8.65
III	$1.0D + 1.0L + 1.)DBE + 1.0T_o(W)$	26.7	65.1	7.28	6.08
III	$1.0D + 1.0L + 1.)DBE + 1.0T_o(S)$	29.0	67.5	6.34	5.89

1 D = Dead Load, L = Live Load, W_t = Tornado Load, $T_o(W)$ = Winter Thermal Load, and T(S) =Summer Thermal Load.

2 Exceeds the ultimate moment capacity of the slab, 93.9 ft-k/ft.

3 $N_x = \frac{(M_x)_J - (M_x)_I}{\ell_{IJ}}$ where $(M_x)_I$ and $(M_x)_J$ are the M_x of Elements I and J, respectively, and ℓ_{IJ} is the distance between the center of these two elements.

Figure 8.2.3.6-1 RHR Complex Cooling Tower

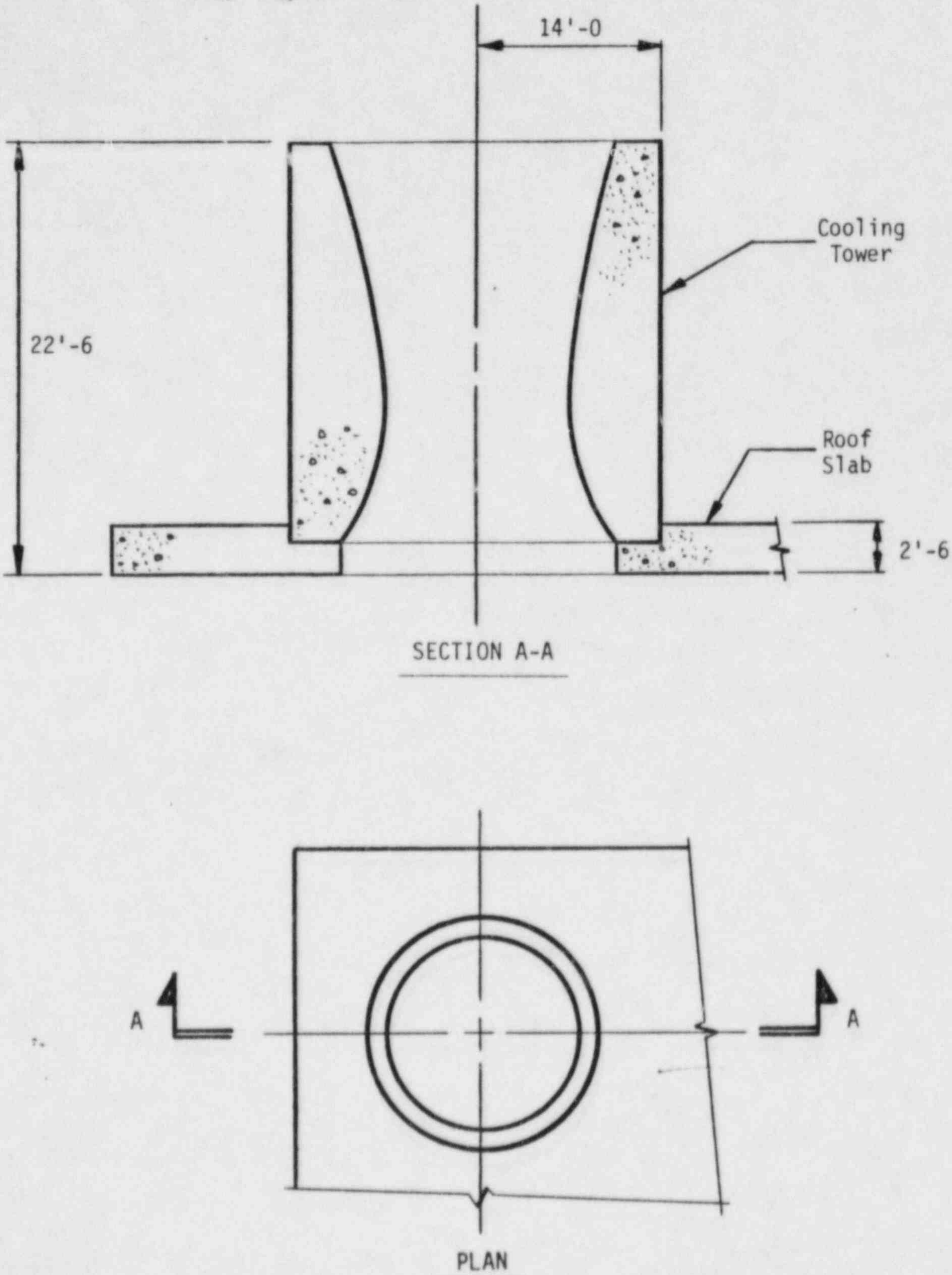
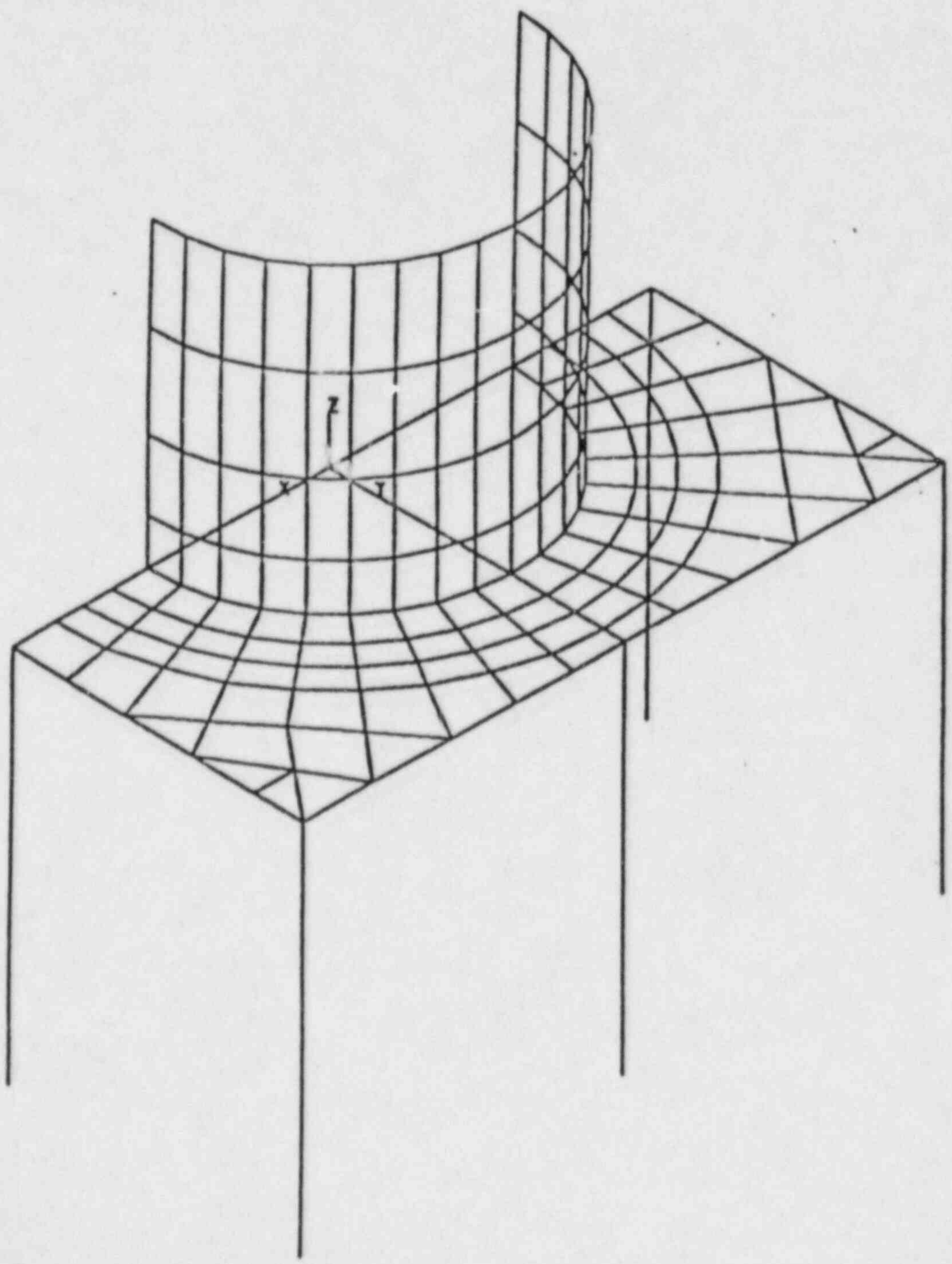


Figure 8.2.3.6-2

Finite Element Model for RHR Complex
Cooling Tower and Floor Slab



8.2.3.7 ENCLOSURE 3, QUESTION 7

NRC QUESTION

"In Attachment A to Observation No. ST-01-24 (page 7.7-125 of Volume 4), Cygna indicates that its in-house program, EPLATE, was used to verify the non-linear analysis done by Sargent & Lundy and that there is reasonable agreement between these two methodologies. However, since a non-linear analysis is sensitive to: (1) the assumed boundary conditions; (2) the material properties; and (3) the various assumptions used, we request DECo to instruct Cygna to state what level of confidence it has in basing its conclusion on one verification of the non-linear analysis."

CYGNA RESPONSE

Observation ST-01-24 addresses the boundary conditions assumed by Sargent & Lundy for the generic embedment plate analysis. Sargent & Lundy performed the generic analysis to develop an interaction equation which was then applied throughout the plant to evaluate embedment load capacities. As described below, Cygna resolved this observation by performing three worst-case analyses which showed that the Sargent & Lundy boundary condition assumptions were satisfactory.

Sargent & Lundy determined the maximum embedment plate capacity based on a "unit load approach." In this method, the maximum allowable load (P_a) was determined by linearly extrapolating the results from a lesser load. Expressed in equation form:

$$P_a = P * (S_a/S)$$

where P = applied load

S = stress at load P

S_a = allowable stress

In order for this linear expression to be accurate, the analysis must also be linear. Cygna was concerned that the unit load approach overlooked nonlinear stress effects caused by shifts in the contact surface between the structural concrete and the embedment plate. Figure 8.2.3.7-1 illustrates the Cygna concern. As the magnitude of the applied loads change, the corresponding "gap region" also changes. The relationship between the location of this gap region and the magnitude of the applied load is nonlinear. There was no other significant nonlinearities in the S&L analyses.

Sargent & Lundy developed the following generic interaction equation using the unit load approach:

$$\frac{T}{T_a} + \frac{V}{V_a} + \frac{M_x}{M_{xa}} + \frac{M_y}{M_{ya}} \leq 1.0$$

where T = applied maximum tensile force

M_x = applied moment in the x-direction

M_y = applied moment in the y-direction

V = applied shear force

T_a = allowable maximum tensile force

M_{xa} = allowable moment in the x-direction

M_{ya} = allowable moment in the y-direction

V_a = allowable shear force.

As previously mentioned, this interaction equation was used throughout Fermi-2 to determine the adequacy of embedment plate attachments. To test the adequacy of the interaction equation, Cygna performed several independent analyses using a set of "worst-case" loads. Figure 8.2.3.7-2 illustrates how the worst-case loads were selected. The greatest deviation between actual and extrapolated loads occurs at S_a, the maximum allowable stress. Therefore, Cygna tested the validity of the interaction equation by using the maximum allowable loads predicted by the Sargent & Lundy analysis method as input. Comparing the maximum stress levels predicted by the Cygna and S&L analyses would be a conclusive test of the generic interaction equation. A comparison at loads less then these worst-case values would show smaller deviations.

The adequacy of the interaction equation was evaluated based on the following logic:

- If the maximum plate stress calculated by the Cygna analysis significantly exceeded the allowable stress predicted by Sargent & Lundy, then the Sargent & Lundy approach was inadequate.
- If the maximum plate stress calculated by Cygna was equivalent to or less that the allowable stress predicted by Sargent & Lundy, then the Sargent & Lundy approach was adequate.

Due to differences in analysis techniques and computer programs, any correlation within ±10% was considered at the outset to be excellent.

Boundary conditions assumed for both the Sargent & Lundy and Cygna analyses are illustrated in Figure 8.2.3.7-3. The concrete was assumed to be a compression-only boundary with a stiffness calculated by half-space theory. The anchors were modeled as truss elements with the appropriate axial length and stiffness. The attachment was modeled as a rigid block such that nodal points along the attachment-to-plate boundary would remain in the same plane when loaded.

The following material properties were used:

Embedment Plate and Anchor

Young's Modulus = 29,000 ksi @ room temperature
Poisson's Ratio = 0.3 @ room temperature.

Concrete

Compressive Strength = 4 ksi

Cygna's analyses for the tensile and moments loading conditions resulted in maximum stress levels within 5-10% of the stress levels predicted by Sargent & Lundy. Since Cygna used worst-case loads, the Sargent & Lundy approach has been verified. In these analyses, the only non-linearity considered, was the contact surface between the concrete and embedment plate. Observation ST-01-24 and the above discussion demonstrate that this non-linearity is not significant.

Cygna has a high level of confidence that the conclusions in Observation ST-01-24 are accurate. This confidence is based on the following:

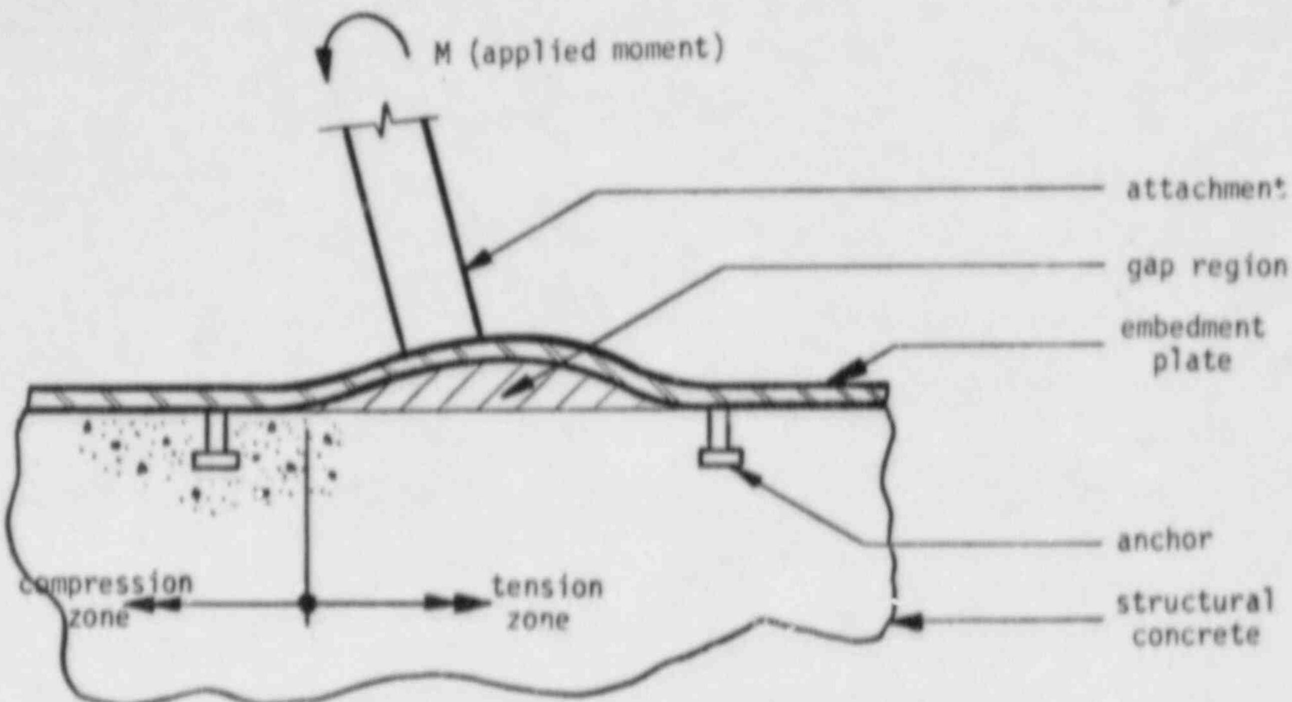
- Cygna verified the Sargent & Lundy results by performing several independent analyses, which addressed both the tensile and moment loading conditions.

- Cygna's analyses focused on the interaction equation, which was employed for embedment plates throughout the plant.

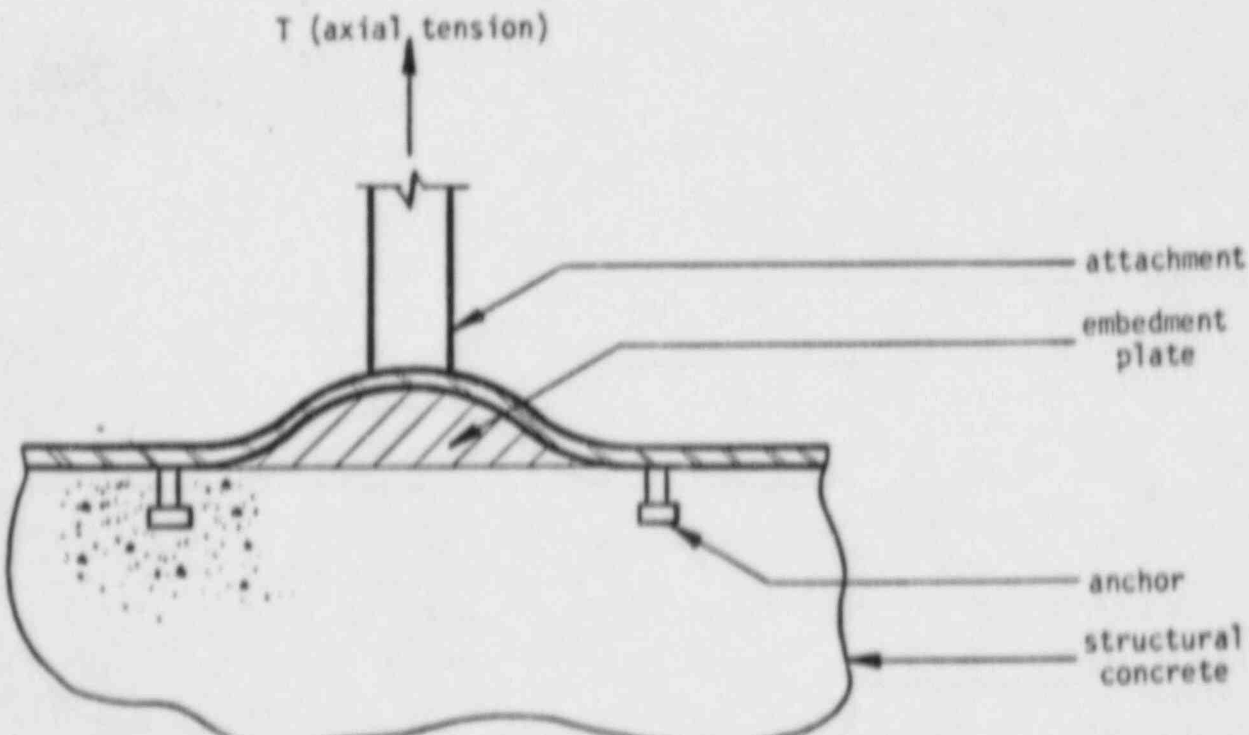
- Cygna performed enveloping analyses for the load components of the interaction equation. These analyses showed conclusivelv that the design was satisfactory.

Figure 8.2.3.7-1

Embedment - Plate Deformation



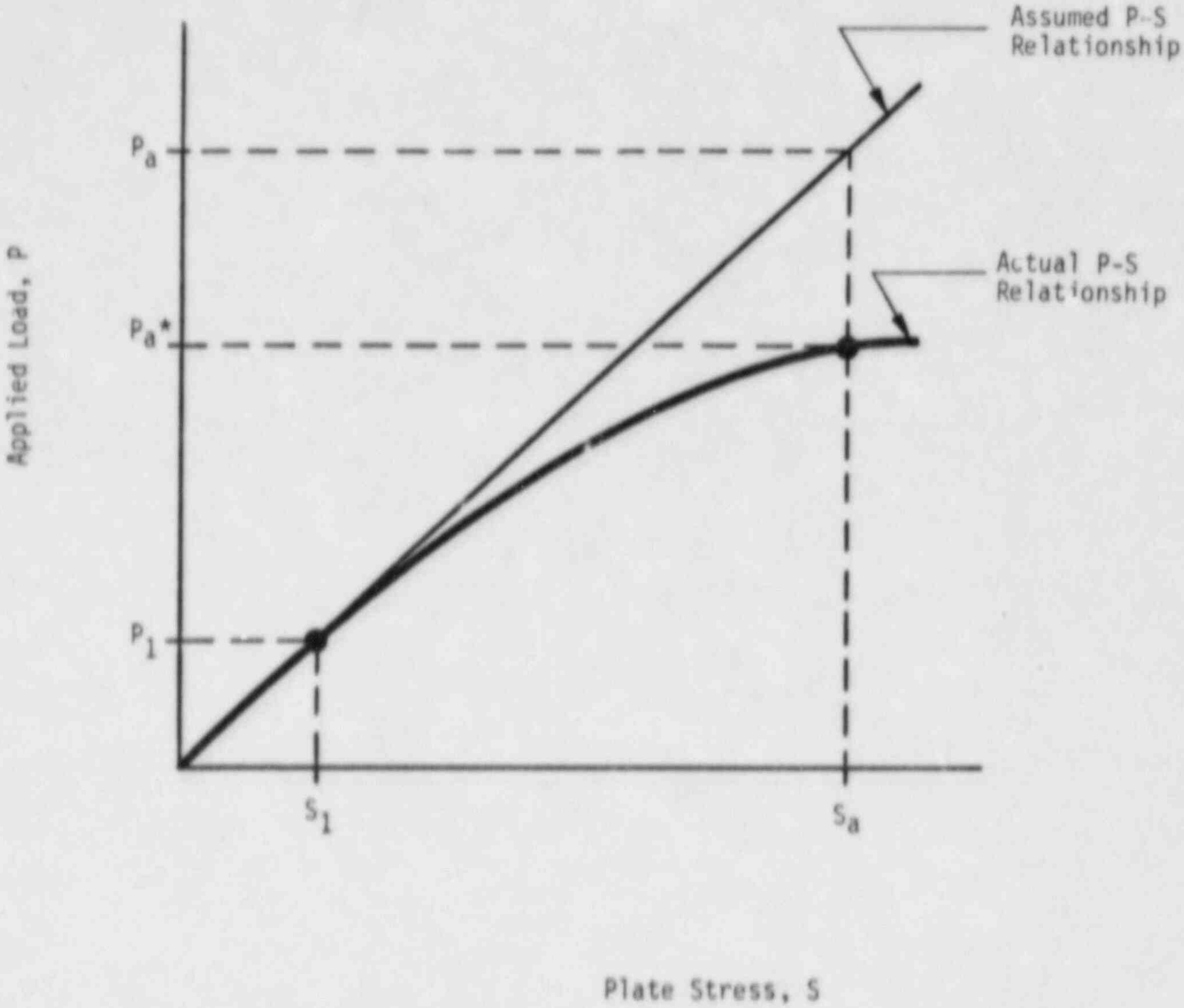
a. Applied Bending Moment



b. Applied Tension

Figure 8.2.3.7-2

Load Stress Relationship



P_1 = unit applied load

S_1 = stress due to P_1

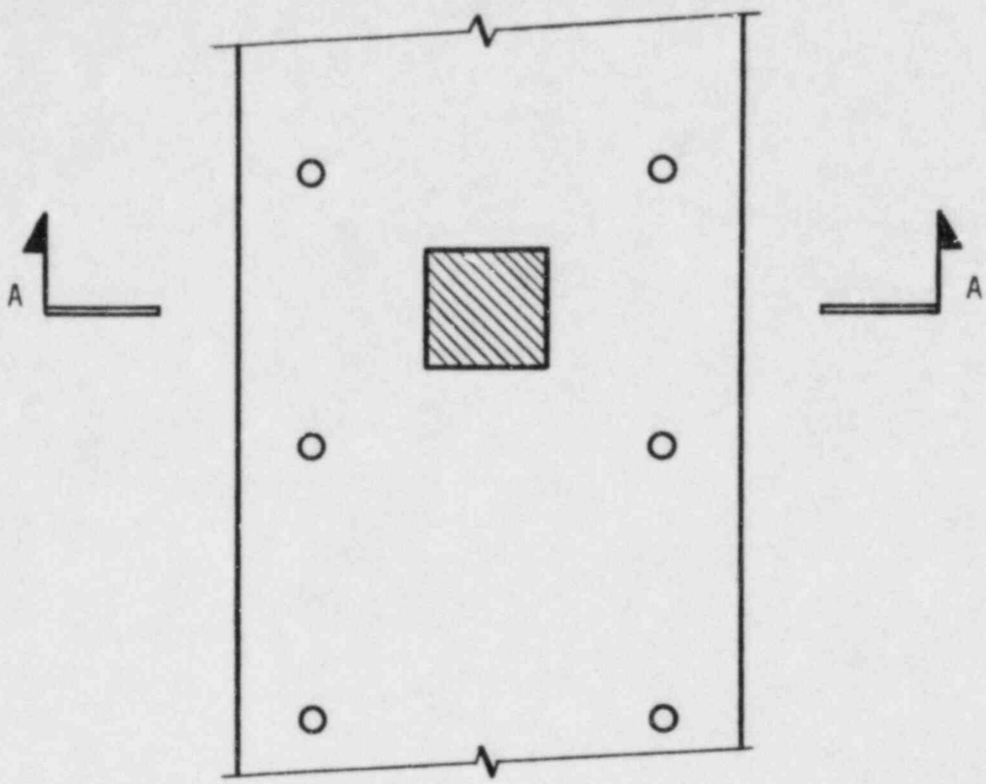
S_a = allowable stress

P_a = assumed allowable load, $P_a = P_1 * (S_a/S_1)$

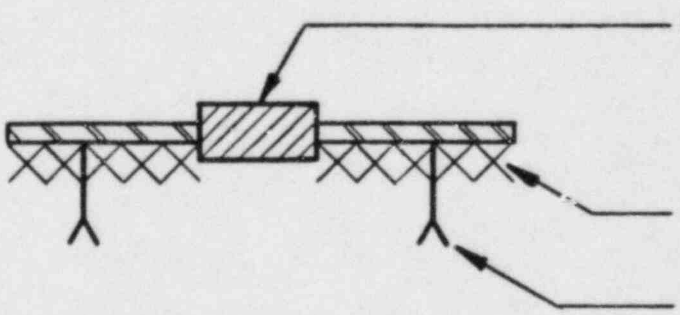
P_a^* = actual allowable load, considering non-linear boundary condition

Figure 8.2.3.7-3

Boundary Conditions



PLAN



SECTION A-A

8.2.3.8 ENCLOSURE 3, QUESTION 8

NRC QUESTION

"In Observations No. ST-01-30 and ST-01-31, Cygna indicates that poor workmanship (e.g., poor formwork, exposed rebar, exposed aggregate and plywood cast into the concrete beam), has been observed in the structural walkdown. Cygna states that as a result of this observation, corrective action was taken and verified. We request that Detroit Edison instruct Cygna to indicate how it can be sure that those structural members thus repaired: (1) can fulfill their design function; (2) have no voids or other debris in those portions of the structural members which are not visible. Cygna should also indicate why this observed deficiency has no generic implication."

CYGNA RESPONSE

Observation ST-01-30 states that several examples of poor workmanship were visually noted during the IDVP walkdown. These were resolved with the finding they had no impact on the adequacy of the design or construction process. The basis for resolution was that the significance of the visually poor workmanship, including voids, honeycombing, and patchwork, had previously been identified and evaluated in appropriate project documentation.

Observation ST-01-31 noted an isolated occurrence of exposed plywood and steel. This was concluded to have no impact on design due to the size and location of the debris. The plywood was triangular in shape and measured no more than 7" along the longest side. The steel was a rebar support, 24" long and 1/4" diameter. Both the plywood and steel were located in the tension zone of a concrete beam, and therefore, had no impact on the beam's strength. Detroit Edison has removed this debris and patched the concrete. Refer to IDVP Section 7.7, page 7.7-132 for the documentation and inspection report closing out this item.

For both of these observations the design process has been verified to be adequate.

In order to address this NRC request for additional verification, Cygna performed a follow-up walkdown of the RHR Complex on May 9-10, 1984. The walkdown team consisted of two structural engineers from Cygna and one from the NRC staff. This team performed visual inspection of the structural concrete, checked selected quality control documents, and reviewed the concrete patching procedures. During the visual inspection activity, the team (1) estimated the amount of patchwork; (2) looked for evidence of debris or honeycombing; and (3) determined the probable cause of the patchwork. Project documentation was reviewed to confirm that appropriate engineering evaluations had been performed relative to concrete workmanship. Table 8.2.3.8-1 summarizes the results of key walkdown activities. The scope of this followup walkdown was specifically selected to address the following NRC questions:

- How can Cygna be sure that repaired structural elements will perform their design function? This question has been addressed by determining the amount and cause of patchwork, and by confirming that project engineering evaluated the design effects.
- How can Cygna be sure that repaired structural elements have no hidden voids or debris? This question has been addressed by reviewing the project documentation.

The Cygna/NRC walkdown team visually inspected both the exterior and interior of the RHR Complex. The exterior inspection included the walls, roof slab (Elevation 583'). The interior inspection covered rooms and compartments between the first floor (Elevation 590') and roof slab. All rooms and compartments in Divisions I and II of the RHR Complex were inspected. Results and conclusions of the visual inspection are provided below:

a) Amount of patchwork
Cygna estimated that less than 5% of the concrete surface area in the RHR Complex has been patched.

b) Evidence of debris or honeycombing
As noted in Table 8.2.3.8-1, the walkdown team observed one instance of debris and another instance of honeycombing. Both were isolated and small with no impact on design. Each of these instances was documented, evaluated and repaired by Detroit Edison in accordance with project procedures.

c) Probable cause of the patchwork
Shifting of formwork was observed in several walls, as exhibited by overpours. Steps as large as 1/2" were noted along the concrete surface at construction joints. Some patchwork was related to those steps. Cygna has concluded that the remaining patchwork resulted from incomplete vibration of the concrete. Based upon this walkdown and documentation review activity, Cygna is convinced that the observed patchwork was cosmetic and has no generic impact on the structural adequacy.

After completing the visual inspection, the Cygna walkdown team reviewed project documentation related to patchwork and grouting. Seventeen Deviation Disposition Requests (DDR) were identified. Of these seventeen, four were selected for a detailed review. Two of the four were selected randomly (Walls R13GD and R16GD). The other two were selected based on the walkdown (Walls R15FG and R310B). Detroit Edison was unable to retrieve the documentation package for Wall R310B for several weeks. The delay was attributed to misfiling. Cygna reviewed the trail of documentation for the remaining three walls from beginning to end, and found the implementation to be satisfactory.

In conclusion, Cygna has provided the following additional evidence to support the resolutions reached in Observation ST-01-30 and ST-01-31 (refer to IDVP Section 7.7, pages 7.7-131 and -132):

- An additional visual inspection was performed by a team of NRC and Cygna representatives. This team identified several minor concerns, but found no indications of any deficiencies nor did they observe significant occurrences of honeycombing in the RHR Complex structure.

- An evaluation of the project documentation trail confirmed that concrete repairs related to patching and grouting were properly reviewed, assigned to the field, completed and closed-out. This was verified during the visual walkdown.

- Identified several instances over the course of the project in which voiding has been documented, evaluated and repaired in accordance with project procedures. Examples include DDR (C)1213 dated 10/3/77, DDR (C)1510 dated 3/28/78, and DDR (C)1733 dated 5/31/78.

- The amount of patchwork visible during a walkdown of the RHR Complex covers less than 5% of the total concrete surface.

The above information provides substantial evidence that a) occurrences of concrete voids and construction debris have been detected and properly corrected during the course of the normal construction process, and b) concrete repairs due to poor workmanship have been accomplished without impacting the design function. In addition, Cygna's review of the concrete patching procedures confirmed that satisfactory controls were in place during the construction phase and these were properly implemented. As a result, Cygna has found no evidence that there are unresolved generic implications related to poor concrete workmanship within the RHR Complex.

TABLE 8.2.3.8-1

FOLLOW-UP WALKDOWN SUMMARY

Item	Notes
1. Confirm repairs related to the debris in Observation ST-01-31 (plywood and rebar support).	The location is satisfactorily patched.
2. Quantify the degree of surface patching in the RHR Complex.	Less than 5% of the concrete surface.
3. Exposed rebar was observed at one location near grid lines 8 and B.	The rebar was exposed by a small honeycomb measuring 7" wide by 4" high by the depth depth of concrete cover (about 1-1/2"). Detroit Edison prepared Nonconformance Report 84-0749 to address this item.
4. Hairline cracks were observed in the roof slab adjacent to each side of grid lines C between the cooling towers.	Detroit Edison made the following measurements of the cracks: Length = 40 ft Surface opening = 0.011 inches in general = 0.035 inches locally Detroit Edison prepared DCN 10739 to water-seal the cracks. Cygna calculated an expected crack width of 0.0075 inches due to service loads ($1.0D + 1.0L + 1.0T_o$). This is very close to the observed general crack width.
5. Debris was observed in a construction joint along the exterior wall near grid line A.	Detroit Edison prepared Nonconformance Report (NCR) 84-1392 to address this item. The construction joint was excavated for a length of approximately 12" to a maximum depth of 4-1/2". The construction joint was excavated in four places over a distance of approximately 15 feet to search for other debris. None was found. The opposite side of the construction joint was visually inspected and showed no indication of debris. In addition, the construction joint along grid line G was excavated. All that was found was a nail, cigarette and 1-1/2" wood shaving. The depth to sound concrete in this location was 1". Based on the following, Cygna has concluded that there is no significance: • The observed debris is very localized • There is no impact on design.

8.2.4.1 ENCLOSURE 4, QUESTION 1

NRC QUESTION

"Did Cygna in its IDVP consider all design criteria which are applicable to the RHR complex complex with particular emphasis on those criteria directly related to the functioning of the RHR complex? In responding, Cygna should specify which design criteria for the RHR complex were investigated and which were not."

CYGNA RESPONSE:

Program Plan describing the design criteria documents evaluated by Cygna Energy Services is provided in Cygna's Proposal C84-003, "Independent Design Verification Program, Detroit Edison Company - Fermi 2", dated December 14, 1982. Staff approval of this Program Plan was transmitted by NRC letter, D. G. Eisenhut to H. Tauber, DECo, "Acceptance of the Proposed Fermi 2 Design Verification Program", received December 27, 1982. As illustrated by the following excerpts from the Program Plan, Cygna evaluated design criteria for the RHR Complex in the areas of piping, electrical, and structural:

Piping (Program Plan, Section 4.2.1.1.a)

"In order to obtain an independent assessment of the methodologies and approaches implemented in the piping analyses performed by Detroit Edison, the Cygna team will review the applicable design criteria documents. Based on Cygna's own expertise in piping design and analyses, a determination will be made as to the validity of the criteria encountered. As a minimum, the appropriate sections fo the following documents will be reviewed:

- Design Specification for Piping Systems for Nuclear Service
- Design Specification for Supports and Restraints for Nuclear Service
- Field Fabrication and Installation Specification for Piping for Nuclear Service
- Final Safety Analysis Report"

Electrical (Program Plan, Section 4.2.3)

"We will review the SAR commitments and preliminary design information including the functional system requirements, design instructions and general motor and cable design specifications to obtain review criteria."

Structural (Program Plan, Section 4.2.2)

"To verify the adequacy of the RHR cooling tower foundation, the following activities will be performed.

- Review criteria documents
- Select controlling load combination
- Review seismic analysis
- Select major structural elements
- Review structural analysis
- Review design
- Review results and conclusions
- Review design drawings"

In each of these general technical areas, evaluation of the design criteria was limited to the review scope defined in the program plan. The piping criteria covered pipe stress, pipe supports, anchors and loads transferred to the structure. The electrical criteria focused on a RHR cooling tower fan motor and its electrical power from the 480V Class 1E bus. The structural criteria addressed the structural analysis and design of the RHR Complex. Appendix C of the Enrico Fermi - Unit 2, IDVP, Final Report contains a compilation of the essential design criteria within each technical area. None of these review criteria documents included checking design features which could prevent freezing.

As part of the structural review, Cygna documented (Observation No. ST-01-11) that ice loadings were not addressed in the foundation wall design. This observation was subsequently invalidated due to the following statement in the Enrico Fermi - Unit 2 Final Safety Analysis Report:

> "9.2.5.3.1.3 Freezing
>
> The design of the ultimate heat sink being enclosed by the RHR complex building will prevent the reservoir water from freezing. The rooms above the reservoir will be kept at a minimum of 60 F. In addition, 80-90 percent of the reservoir water is below the frost line. If icing should occur no structural damage would occur to the reservoir. Since all the pumps have bottom suction, the safety-related pumps will not be affected."

Verifying whether or not the above commitment was implemented in the Fermi-2 design is outside the technical review scope defined in both the Program Plan and Final Report. Consequently, Cygna accepted the FSAR commitment to prevent freezing of the reservoir as a satisfactory resolution to Observation ST-01-11.

It is also noteworthy that the NRC accepted this FSAR commitment with the following statement from Section 9.2.2 of the Enrico Fermi - Unit 2 Safety Evaluation Report, dated July 1981:

> "Freezing of reservoirs is precluded by its location within the residual heat removal complex structure with most of the inventory below the frost line. Additionally, the rooms located above the reservoirs will be kept at a minimum temperature of 60 degrees Fahrenheit."

8.2.4.2 ENCLOSURE 4, QUESTION 2

If Cygna did consider the design criterion that no freezing be permitted in the water lines leading to the RHR complex and the ultimate heat sink, what questions did Cygna ask DECO or what independent evaluations did Cygna perform?

CYGNA RESPONSE:

There is a detailed description of the design criteria evaluated by Cygna during the IDVP in the response to NRC Request No. 1, Enclosure 4. That description shows that the design details related to prevention of freezing in the RHR Complex reservoir were outside the IDVP scope of review, which was well defined in both the Program Plan and Final Report. Accordingly, Cygna performed no independent evaluations to verify whether or not the design would adequately prevent freezing.

Cygna did, however, confirm that ice loadings were not a design basis for the RHR Complex structures and piping. This was confirmed by statements in both the FSAR (Section 9.2.5.3.1.3) and SER (Section 9.2.2).