CYGNA
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83021.060

May 17, 1985

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, MI 48166

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

Reference: NRC Letter from B.J. Youngblood to Wayne J. Jens of Detroit Edison and L.L. Kammerzell of Cygna dated April 30, 1985

Dear Sirs:

Enclosed are Cygna's responses to the NRC questions contained in Enclosures 1, 2, and 3 to the referenced letter. Our response has been prepared in a format which will allow it to be inserted in the Final Report for the Detroit Edison Independent Design Verification Program on Fermi-2.

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

Very truly yours,

David A. Ferg
David A. Ferg
Project Manager

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PDR ADOCK 05000341
P PDR

DAF:od
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

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INSTRUCTION SHEET

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

a) Remove page 7.7-65 and insert new pages 7.7-65, 7.7-65a and 7.7-65b;

b) Remove pages 8.2-5 and 8.2-6 and insert attached pages 8.2-5, 8.2-5a, 8.2-6 and 8.2-6a;

c) Remove page 8.2-9 and insert new pages 8.2-9, 8.2-9a and 8.2-9b;

d) Remove pages 8.2-38 and 8.2-39 and insert new pages 8.2-38, 8.2-38a and 8.2-39;

e) Insert new pages 8.2-41a and 8.2-41b behind page 8.2-41;

f) Insert new page 8.2-46a behind page 8.2-46;

g) Insert new page 8.2-63a behind page 8.2-63;

h) Insert new page 8.2-67a and the attached nineteen (19) unnumbered pages from Dames & Moore behind page 8.2-67;

i) Insert new page 8.2-72a behind page 8.2-72.

Observation Record Review
Attachment A

Checklist No. PI-01	Revision No. 1
Observation No. PI-01-11	Sheet 2 of 4

	Yes	No
Valid Observation	X	
Potential Finding		X
(PFR No. N/A)		
Closed	X	

Comments

Further Cygna review has indicated that the postulated impingement and surge loads on the RHR system should not be considered since the source of the loads is the broken line to which the RHR line is attached. Detroit Edison will revise the design specification (3071-503) to reflect this. Cygna agrees with this evaluation, since the FSAR, Paragraph 3.6.5.1.1, states "Piping within the broken loop shall no longer be considered part of the RCPB (reactor coolant pressure boundary)."

In evaluating faulted conditions in general, Reference 3.2, Article 4.5 states "...LOCA does not create temperature or pressure surges in the piping systems of any significance and therefore it is not evaluated for this event." This reference also states in Article 4.7 that "pipe stress due to Annulus Pressurization is not required to be included in the Code analysis and stress report." 1

Based on this information, this observation does not warrant any further investigation.

Supplemental review has revealed that a separate report from the ASME Design Report was generated to assess the impact of annulus pressurization on piping and structures. This approach had been agreed to with the NRC because annulus pressurization was not in the original design basis for Fermi 2. Nevertheless, the piping supports are designed to accommodate the additional loads predicted by this analysis. The probable cause of this observation was the failure to update the DECo design specification to reflect the design basis commitments as stated above. 1

Approved By Project Manager: David A. Ferg — Date: 11/11/83

Checklist No. PI-01		Revision No.	1
Observation No. PI-01-11		Sheet 2 of 4	

	Yes	No
Valid Observation	X	
Potential Finding		X
(PFR No. N/A)		
Closed	X	

Comments

Subsequent information consisting of a) NRC letter to Detroit Edison, "Preliminary Evaluation of the IDVP Performed by Cygna Energy Services for the Fermi-2 Facility" dated March 27, 1984; b) meeting notes between the NRC, Detroit Edison and Cygna in Bethesda, Maryland on May 11, 1984; and c) Detroit Edison letter, EF2-72252 to the NRC dated September 27, 1984, indicates that the basis for resolving this observation was inadequate. There was a licensing commitment to the NRC by Detroit Edison to evaluate the Fermi-2 design for structural integrity under combined annulus pressurization and Design Basis Earthquake (DBE) loadings. (Detroit Edison Amendment 24 dated June, 1979, in response to NRC Question 110.11 in Appendix E.5 of the Fermi-2 FSAR).

As indicated in Section 8.2.2.2, Cygna proceeded with a review of the Detroit Edison pipe stress evaluation for faulted loads to determine if annulus pressurization was properly considered for the in-containment RHR shutdown suction cooling element. In the course of this review, Cygna reported sufficient differences between the piping geometry analyzed for A/P loads and the as-built configuration which precluded our establishing structural integrity for the RHR piping under faulted load conditions. Prior to the May 11, 1984 meeting in Bethesda, Md., Cygna's Project Team discussed elevating the observation to a Potential Finding Report in order to investigate further the significance of the differences. However, following the May meeting, the NRC, Detroit Edison and Cygna agreed that Cygna did not have enough information to proceed wit our review and Detroit Edison committed to re-analyze the portion of the RHR system .n question. The results of this re-analysis and a comparison of the as-built configuration of other large bore (NPS $\geq$ 4") reactor coolant pressure boundary piping systems with the original annulus pressurization analysis input were presented to the NRC with Detroit Edison's September 27, 1984 letter, EF2-72252. With minor weld size modifications, Detroit Edison was able to conclude that structural integrity would be maintained inthe Fermi-2 as-built configuration for faulted loads, including annulus pressurization. The April 30, 1985 letter from the NRC to Detroit Edison and Cygna indicates this issue has now been resolved without additional in-depth reviews by Cygna.

Approved By Project Manager	Date
	11-11-83

CYGNA

Observation Record Review
Attachment A

Checklist No.	PI-01	Revision No.	1
Observation No.	PI-01-11	Sheet 2 of 4	

	Yes	No
Valid Observation	X	
Potential Finding		X
(PFR No. N/A)		
Closed	X	

Comments

(Cont.d)

In response to the recent April 30, 1985 request from the NRC, Cygna evaluated the information contained in the Detroit Edison letter dated September 27, 1984 and concurs with DECo's approach and conclusions. Observation PI-01-11 can therefore be closed on the basis of this information and the fact that the NRC and Detroit Edison have bi-laterally resolved the issue of A/P loads with the added assurances that Cygna considers this resolution to be acceptable.

Approved By Project Manager	Date
	11-11-83

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 DC-01-05, DC-01-12, DC-02-06, DC-02-07, DC-02-10, 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. To resolve Observation DC-01-05, all key design documents were reviewed by Cygna to ensure they had the proper QA level designation. A review of the personnel who acted as lead auditors since 1978 was performed to resolve Observation DC-01-12. Sargent & Lundy's internal audit program was reviewed in depth to determine that there was no design impact on Fermi-2 due to Observation DC-02-06. Observations DC-02-07 and DC-02-10 were resolved by requiring DECo to perform a complete as-built analysis for all flued-head anchor structures and Sargent & Lundy to review all Fermi-2 pipe stress reports and request the field to verify that as-built pipe supports are reconciled with the stress report results. 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 observation 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 review 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. To resolve Observation DC-02-02, Cygna examined Sargent & Lundy's method for specifying the use of computer programs on the Fermi-2 project and checked this method to ensure the correct and proper programs were utilized in the design process. 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)

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. A comprehensive review indicated all elements of the design control program were evaluated during the course of the project. However, Cygna performed a comprehensive review of the design control program elements including design input, design analysis, drawing control, procurement control, interface control, design verification, document control, design changes, corrective action and audits. Cygna found sufficient assurances that all key aspects of the design control program were evaluated during the Fermi-2 project duration and no potential impact on safety exists. **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. However, Cygna determined in the course of their review that the internal audit and review activities were sufficiently extensive and thorough to conclude the Fermi-2 design process was adequate and performed with the requisite quality and integrity. In addition, a DECO management directive was issued for a comprehensive review of all the less-formal surveillance QA reviews and special audit programs to assure any corrective action items were formally documented, tracked and closed.	7.7-33

Observation/ PFR No.	Description	Reference Page
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. However, a more formal, systematic system for tracking audit findings and QA remedial/corrective action items has been initiated. An "Open Item Status Report - Engineering Quality Assurance" has been periodically issued to responsible Project Engineering personnel down to and including the Group Supervising Engineers, which identifies individuals responsible for resolution along with expected dates of completion. Positive actions have been implemented and in progress to resolve outstanding open audit findings and surveillence items and therefore no impact on plant safety was found. **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. However, Cygna found that since Detroit Edison had implemented the tracking program for audit findings, significant progress had been made in resolving open items. The monthly meetings with the President of Detroit Edison involving corporate and Fermi-2 QA management provided for executive-level discussions on quality assurance matters and an appropriate forum to follow progress in closing the remaining open items. With continued follow-up and management attention, Cygna expects the remaining open items would be brought to a satisfactory, timely resolution without any impact on the design and safety of the Fermi-2 plant.	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 infrequently 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	7.7-35

Observation/ PFR No.	Description	Reference Page
DC-01-10 PFR-03 (cont'd)	of checklists and audit findings to provide added assurances that design control programs are being effectively maintained and implemented. With respect to architect/engineers, however, the combined audit activities by Detroit Edison, Sargent & Lundy and Stone & Webster were determined to provide sufficient assurances that the design control programs at S&L and S&W were effectively and adequately implemented. An expanded review by Cygna of Fermi-2 engineering service suppliers including NUS, Nutect, Teledyne, Bechtel, Parsons, Griffels Associates, Hopper & Associates and Multiple Dynamics Corporation, also disclosed that DECO performed the necessary audits to assure an effective implementation of each supplier design control program. Consequently, it was determined during the course of the review that this finding has an insignificant affect on the overall Fermi-2 design and design control process. **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. Further review again confirmed that, in addition to scheduled Detroit Edison audits of Stone & Webster and Sargent & Lundy, the Detroit Edison QA organization acted as an observer of internal audits conducted by the architect/engineer QA departments. This provided Detroit Edison QA with a first-hand assessment of the degree of compliance for the audited activity against the A/E's program commitments. Additionally, Detroit Edison QA routinely reviewed A/E and engineering consultant internal audit reports. Cygna was again able to confirm that this finding had no impact on the safety of the Fermi-2 plant.	

EXHIBIT 8.2.1-2
ROOT CAUSE CLASSIFICATIONS

Category	Observation	Comments
A	DC-01-01	See Section 7.3, Exhibit 7-3
	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 pressuriazation support 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	DC-01-05	QA level designations
	DC-01-08	See Section 7.3, Exhibit 7-3
	DC-01-09	See Section 7.3, Exhibit 7-3
	DC-01-10	See Section 7.3, Exhibit 7-3
	DC-01-12	Lead auditor qualifications
	DC-02-06	SRL internal audit files
	DC-02-07	Field design change requests
	DC-02-10	As-built field verification
	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	DC-01-03	See Section 7.3, Exhibit 7-3
	DC-02-02	Computer program user requirements
	PI-01-03	See Section 7.3, Exhibit 7-3
	PI-01-06	Branch connection stress
	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 indices
	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 pipng thermal movements
	PS-00-04	See Section 7.3, Exhibit 7-3
	PS-01-01	Shear lugs for Class I piping

EXHIBIT 8.2.1-2 (cont'd)
ROOT CAUSE CLASSIFICATIONS

Category	Observation	Comments
C	PS-02-04	Use of OBE vs. DBE loads
(cont'd)	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'd)
ROOT CAUSE CLASSIFICATIONS

Category	Observation	Comments
C (cont'd)	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 discrepency
E	DC-01-06	Missing PE certification
	DC-01-11	RHR Mechanical Design Document update
	DC-02-01	Seismic analysis report references
	DC-02-03	See Section 7.3, Exhibit 7-3
	DC-02-04	S & L design review schedule
	DC-02-05	S & L pipe support design calculations
	DC-02-09	See Section 7.3, Exhibit 7-3
	DC-03-01	Responsible engineer's signature
	DC-03-02	Receipt acknowledgement of drawings
	DC-03-03	Seismic report comment resolution
	DC-03-04	Filing of dispositioned DCN's
	PI-01-04	Snubber suppporting 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

ADDITIONAL NRC REVIEW COMMENT:

"In reviewing your resolution of Observation No. PI-01-11, we conclude that this observation should be dispositioned by you as a potential finding which had a strong probability for a potential impact on plant safety. We believe this disposition is in accordance with your criteria for your conduct of the Fermi-2 independent design verification program (IDVP). Accordingly, we find your resolution of PI-01-11 to be unacceptable.

To place this matter in proper perspective, we have found that your resolution of the other observations regarding the Fermi-2 piping systems reviewed in you IDVP, to be appropriate and acceptable. On this basis, we find that the inadequacy of your resolution of PI-01-11 to be an isolated matter which we attribute to the nature of the DECo commitments in its FSAR for annulus pressurization (AP) loads. Our re-review of these DECo commitments has indicated that they were somewhat ambiguous. Accordingly, we required DECo to address this matter of the AP loads in combination with other loads including seismic loads. DECo submitted a letter dated September 27, 1984, in which it resolved our technical concerns on this matter, including the question of whether there were any generic implications arising from this issue.

However, in the context of your IDVP, we cannot conclude that Cygna's rationale for originally accepting apparent deviations by DECo from its FSAR commitments regarding AP loads, is acceptable as noted above. Based on your evaluation of the AP issue discussed in DECo's letter dated September 27, 1984. While your response should touch on the matter of the original ambiguity, we require that you primarily focus on the acceptability of DECo's conclusions regarding the present method of analyzing the Fermi-2 piping systems subject to AP loads. Additionally, provide justification if you do not reclassify PI-01-11 as a potential finding."

CYGNA RESPONSE:

Within the strict context of a design requirement, this issue has been somewhat ambiguous with respect to whether Fermi-2 safety-related piping systems attached to the reactor coolant pressure boundary be designed to withstand faulted conditions including annulus pressurization loads. Cygna notes, however, that Detroit Edison did agree as an NRC licensing commitment, to evaluate whether the Fermi-2 design was able to maintain structural integrity under combined annulus pressurization and Design Basis Earthquake (DBE) loadings. (NRC Question 110.11 in Appendix E.5 of the Fermi-2 FSAR and subsequent Detroit Edison response via Amendment 24 to the FSAR submitted June, 1979).

CYGNA RESPONSE (Cont.d)

To address the matter at hand, it is now apparent based on a) information in the NRC letter to Detroit Edison, "Preliminary Evaluation of the IDVP Performed by Cygna Energy Services for the Fermi-2 Facility" dated March 27, 1984 (Reference 1); b) discussions in the subsequent meeting between the NRC, Detroit Edison and Cygna in Bethesda, Maryland on May 11, 1984; and c) results contained in the Detroit Edison letter to the NRC, "Annulus Pressurization Piping Load Re-evaluation" dated September 27, 1984 (Reference 2), that Cygna should have dispositioned Observation PI-01-11 (Page 7.7-65) as a potential finding. This would, in all probability, have been the action taken if Cygna had not stopped our review of this issue in May, 1984. (Refer to Cygna project letter 83021.058 dated November 30, 1984).

As indicated above in our response to NRC Question 2 in Enclosure 2 of Reference 1, Cygna proceeded in April 1984, to determine if the Detroit Edison pipe stress evaluation for faulted loads, including annulus pressurization, was properly considered for the in-containment RHR shutdown suction cooling element. Because of differences between the piping geometry analyzed for A/P loads and the as-built configuration, Cygna was unable to confirm structural integrity of the piping element under faulted load conditions. The NRC, Detroit Edison and Cygna agreed shortly after the May 20, 1984 meeting to resolve the issue without requiring an expanded review effort by Cygna. As an outcome of this agreement, Detroit Edison would confirm the validity of their previous assessment for structural integrity by re-analyzing the as-built recirculation and drywell RHR piping for combined A/P and DBE loads. Detroit Edison would also verify that the original analysis input was adequately represented in the as-built configuration for other large bore (NPS $\geq$ 4") reactor coolant pressure boundary piping systems. The confirmation for structural integrity was provided in Reference 2 (a copy of which was recently requested by Cygna via project letter 83021.059, dated May 7, 1985).

Cygna has evaluated the information contained in Reference 2 and supports the conclusion that structural integrity of the as-built recirculation and drywell piping would be maintained provided the stresses resultant from a combined annulus pressurization and DBE loading were within $3S_m$ of ASME code allowable values and all supports were within their Level D component ratings. Cygna also agrees that the results of the original analyses submitted in response to NRC Question 110.11 from Appendix E.5 of the Fermi-2 FSAR for other reactor coolant pressure boundary piping systems would remain valid as long as the analysis input was reflected in the as-built configurations.

In summary, Cygna concurs with Detroit Edison's conclusions contained in Reference 2. We also support the NRC position that there are no generic safety implications on Fermi-2 resulting from the issue of annulus pressurization loads. The Attachment A to Observation PI-01-11 (page 7.7-65) has been revised to indicated that Detroit Edison and the NRC resolved this issue without requiring an expanded review by Cygna.

ADDITIONAL NRC REVIEW COMMENT:

"In the first sentence of the last paragraph on Page 8.2-62, you stated that the shear capacity was calculated as the sum of the concrete strength and the shear friction contribution from the reinforcement. Your basis for this approach is not clear. Accordingly, provide justification for this approach. "

CYGNA RESPONSE:

In response to a Cygna observation, Sargent & Lundy re-evaluated the shear wall along column row E in the RHR Complex (see Sargent & Lundy Calculation 1.20.9, Rev. 2, dated 5-30-84). Maximum shear stresses were taken from a finite element analysis of the shear wall. For design purposes, the most highly stressed element in the shear was selected. Then, the shear strength was calculated as a combination of concrete and reinforcement strengths, with the latter determined using the shear friction provisions in Section 11 of ACI Standard 318.

Cygna considered the use of localized maximum stresses to be over conservative. Also, Cygna did not support the application of shear friction to a potential diagonal tension crack. As a result, Cygna performed an independent check of this wall prior to issuing the IDVP report supplement. In our evaluation, the overall shear strength of the wall was based upon ACI 318, Section 11, "Special Provisions for Walls". Cygna concluded that the shear strength of the concrete alone was greater than the applied shear. Therefore, the wall satisfactorily withstands the design shear loading using conventional design methods, without consideration of shear friction.

ADDITIONAL NRC REVIEW COMMENT

"Although there are differences in the load combinations listed in Tables 8.2.3.1-1, -2, -3, and -4, we believe that these differences should have no significant effect on the final design of most of the seismic Category I structures. Our basis for this position is the assumption that these structures were designed in accordance with the load combinations described in the FSAR which DECo committed to follow. However, we note in the attachment to Potential Finding Report (PFR) No. 8 and in Observation No. ST-10-21, that a reduction factor of 0.75 has been used for load combinations involving seismic loads. This is not in conformances with any of the load combinations listed in Tables 8.2.3.1-1, -2 and -3. Accordingly, provide an explanation why the 0.75 reduction factor was used in the structural design."

CYGNA RESPONSE:

As stated in the IDVP report supplement above, Cygna performed several follow-up reviews of structural calculations to ensure that appropriate load combinations were being used. One of the follow-up review items was the 0.75 reduction factor which was employed during an intermediate design phase. Cygna reviewed one-third of the final load reconciliation calculations and found all structural load combinations to be in accordance with FSAR. The 0.75 reduction factor was not applied in any of these final design packages.

Based on this large sample, Cygna has concluded that the final design of seismic Category I structures is in conformance with the FSAR load combinations.

ADDITIONAL NRC REVIEW COMMENT:

"You indicate that a factor of 1.5 is recommended in a Dames & Moore report. Provide that portion of this report which discusses the bases for such a factor."

CYGNA RESPONSE:

Please find enclosed a portion of Dames & Moore report, "Static and Dynamic Soil and Rock Studies, Fermi II Nuclear Power Plant, for the Detroit Edison Company", dated February 3, 1970. This enclosure contains the cover letter, pages 1 - 16, and a list of references.

The factor of safety of 1.5 for static conditions is shown on Table 1 (page 7) and explained in the third paragraph on page 12. A factor of safety of 1.1 is also recommended for dynamic conditions. As explained in the report, these safety factors are recommended to allow for variations in compaction of backfill and for residual pressure that may result from compaction operations.

DAMES & MOORE

CONSULTING ENGINEERS IN THE APPLIED EARTH SCIENCES

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February 3, 1970

The Detroit Edison Company
2000 Second Avenue
Detroit, Michigan 48226

Attention: Mr. Leonard Johnson,
Design Engineer

Gentlemen:

Ten copies of our "Report, Static and Dynamic Soil and Rock Studies, Fermi II Nuclear Power Plant, for The Detroit Edison Company" are herewith submitted.

The studies reported herein were planned in collaboration with Messrs. Leonard Johnson and Joe Funston of The Detroit Edison Company and Mr. Glen Chauvin of Sargent & Lundy. The scope of work was outlined in our confirming proposal to The Detroit Edison Company dated December 18, 1969.

The data presented in this report has been developed primarily to provide appropriate soil, rock and fill parameters for use in the structural design of the Reactor and Auxiliary Building structures. Data presented for the $1\frac{1}{2}$ inch and smaller crusher-run fill material is applicable only to this material placed and compacted to a density equivalent to that of the test area investigated.

It has been a pleasure to undertake this program and we appreciate your continued confidence in our firm. Please contact us if you should have any questions or comments regarding this report.

Yours very truly,

DAMES & MOORE

George D. Leal

George D. Leal

GDL:MFE:aw
Ten Copies Submitted
cc: (5) Sargent & Lundy, Engineers
Attention: Mr. Glen Chauvin

REPORT

STATIC AND DYNAMIC SOIL AND ROCK STUDIES

FERMI II NUCLEAR POWER PLANT

FOR

THE DETROIT EDISON COMPANY

INTRODUCTION

This report presents the results of our static and dynamic soil and rock studies at the Fermi II Nuclear Power Plant and collates related data previously presented in the Preliminary Safety Analysis Report (PSAR) and its Amendment (References 1 and 2). The purpose of this study was primarily to provide design parameters for the structural analyses of the proposed Reactor and Auxiliary Buildings.

The combined Reactor and Auxiliary Building structure area has plan dimensions of 154 feet by 205 feet. We understand that the structure excavation will extend to elevation 534, approximately 18 feet into bedrock. The ground surface level throughout the area of the proposed structures is presently at elevation 564 to 567 feet, which is at or near the proposed foundation level for the Turbine Building, Radwaste Building and Service Building. It is assumed that, at completion, the final surface grade throughout the plant area will be at elevation 585 feet.

SCOPE

The specific scope of work for this study was as follows:

1 - Determination of the in-situ density of compacted fill material which consisted of $1\frac{1}{2}$ inch and smaller crusher-run dolomite rock material.

2 - Determination of the static modulus of elasticity of the fill material.

3 - Determination of the static modulus of elasticity of the in-situ glacial till.

4 - Determination of the dynamic modulus of elasticity, shear modulus, Poisson's ratio, damping factors, and shear and compression wave velocities for the proposed fill material.

5 - Determination of the variation of the modulus of elasticity with depth for the in-situ rock under both static and dynamic loading.

6 - Determination of the soil lateral pressure parameters for both the in-situ rock and the rock fill under the static and dynamic conditions.

During the course of our study, Mr. Glen Chauvin referred us to the Sargent & Lundy letter to The Detroit Edison Company dated November 22, 1968 and requested that our scope be extended as follows:

7 - Confirmation of previously submitted values of density, wave velocities, Poisson's ratio, shear modulus, and damping for the in-situ rock.

8 - Determination of representative values of density, wave velocities, Poisson's ratio, dynamic modulus of elasticity, shear modulus and damping for the in-situ glacial till.

9 - Confirmation of bearing capacity and settlement for structures founded on bedrock.

10 - Discussion of problem areas that may exist in construction of future units.

In connection with this investigation, a test stockpile of controlled compacted fill was constructed at the direction of The Detroit Edison Company. We understand that this test area was placed and compacted in a manner similar to that which will be used during final placement. Soil and Foundations Associates assisted The Detroit Edison Company in quality control during construction of the test area. The approximate location of the test area is indicated on the Plot Plan, Plate I.

SOIL AND ROCK CONDITIONS

GENERAL:

A complete description of the geologic and hydrologic features of the region and the site area is presented in Reference (1). Based on the results of recent investigations in the immediate plant area, Reference (2) was submitted to The Detroit Edison Company as an Amendment to Reference (1). The information contained in this section is largely condensed and extracted from the two referenced documents.

SURFICIAL DEPOSITS:

Subsurface conditions within the proposed plant area were investigated by drilling test borings at the locations shown on Plate I, Plot Plan. Approximately five feet of lacustrine peaty silts to clay had been removed from the site area at the time of our most recent investigation in November 1969. This exposed the surface of the glacial till deposit at an average elevation of 566; this is approximately six feet below the surface of the adjacent Lake Erie. The till consisted of nearly impermeable silty to sandy clays with varying amounts of gravel and cobbles. Occasional boulders, up to 18 inches in diameter, were encountered within the till near the bedrock surface. At random locations throughout the site, the lower one to five feet of till graded to a clayey silt with some gravel and occasional boulders.

In addition to test borings reported in References (1) and (2), three additional borings, 12 to 13 feet in depth, were drilled to recover undisturbed samples of the glacial till. Logs of these borings are presented in the Appendix of this report. The till exposed at the present surface of the excavation is hard in consistency and grades very hard within several feet of the bedrock surface.

BEDROCK:

A complete description of the bedrock is presented in Reference (1) and (2). Briefly, the bedrock consists of the Bass Islands Group of Sediments (predominantly dolomite) underlain by the Salina Group (shales and dolomites). Throughout the proposed plant area the surface of the Bass Islands Group is at elevation 557 to 549 and the contact between the Bass Islands Group and the Salina Group is at elevation 488 to 457 feet.

Prior to foundation installation for the Reactor and Auxiliary Buildings, the bedrock throughout the foundation area will be pressure grouted from foundation level (elevation 534) down to elevation 485 feet in accordance with procedures outlined in Reference (2).

FILL MATERIAL:

Crusher-run rock material, $1\frac{1}{2}$ inch and smaller in size, will be used as backfill adjacent to the proposed Reactor and Auxiliary structures. This fill material will be predominantly dolomite and will be quarried on-site. We understand that the backfill material will be similar to the presently produced $1\frac{1}{2}$ inch and smaller crusher-run rock. Approximately 60 percent of this material is less than one inch in size and it contains up to 20 percent fines (materials passing the standard U.S. No. 200 Sieve).

We understand that the fill material will be placed in loose horizontal lifts approximately 10 inches in thickness and that each lift will be compacted by approximately 10 passes with a vibratory roller similar to that used to compact the test area constructed during the course of this study. A description of the test fill area is presented in the Appendix.

FIELD AND LABORATORY STUDIES

Field and laboratory studies undertaken for this investigation consisted of the following:

(a) Drilling three borings through the glacial till to recover undisturbed samples;

(b) Laboratory tests on undisturbed samples;

(c) Construction of a test fill area;

(d) Plate load tests on the glacial till and rock fill; and,

(e) Field seismic studies.

Descriptions of these studies are presented in the Appendix to this report.

Some bedrock test data developed during prior investigations is also repeated in the Appendix to provide a collated summary of test data used for the development of soil and rock parameters.

DISCUSSION AND RECOMMENDATIONS

SUMMARY:

Based on our analysis of the results of field and laboratory testing, together with a review of published data, recommended design parameters for soil, rock and fill materials have been developed and are summarized in Table I, Static and Dynamic Soil and Rock Values. A discussion of these values is presented in subsequent paragraphs.

As outlined in Reference (2), the ultimate bearing capacity of the foundation bedrock is estimated to be on the order of 300,000 pounds per square foot. The total settlement of the Reactor and Auxiliary Buildings is conservatively estimated to be on the order of 0.3 to 0.5 inches for an assumed applied pressure of 25,000 pounds per square foot.

Consideration has been given to construction difficulties that may occur in the design and construction of future units. Major problem areas would be associated with rock excavation by blasting, and possibly with dewatering. It is recommended that the feasibility of performing rock excavation for future units prior to the operations of Unit II be evaluated further. Similarly, it is recommended that records of blasting, grouting, dewatering, and other pertinent construction operations for Fermi II be collated and condensed into a post-construction report that would deal specifically with future construction problems.

TABLE I
STATIC AND DYNAMIC SOIL AND ROCK PROPERTIES

	CRUSHED ROCK FILL	IN-SITU GLACIAL TILL	BASS ISLANDS BEDROCK
DENSITY (PCF)			
Dry Density	139 ± 4%	125 ± 4%	150 ± 10%
Wet Density	144 ± 5%	140 ± 5%	-
Submerged Density	90 ± 3%	80 ± 3%	110 ± 10%
WAVE VELOCITIES (FT./SEC.)			
Compression Wave	2500 ± 15%	7700 ± 7%	13000 ± 10%
Shear Wave	900 ± 25%	2200 ± 15%	7600 ± 15%
POISSONS RATIO			
Static or Dynamic	0.4 ± 10%	0.45 ± 10%	0.24 ± 10%
MODULUS OF ELASTICITY (PSF)			
Static	$1.2 \times 10^6 \pm 25\%$	$0.5 \times 10^6 \pm 20\%$	$120 \times 10^6 \pm 50\%$
Dynamic	$4.0 \times 10^6 \pm 30\%$	$1.2 \times 10^6 \pm 30\%$	$180 \times 10^6 \pm 50\%$
Increase Per Foot of Depth	$0.48 \times 10^6 \pm 25\%$	$0.48 \times 10^6 \pm 20\%$	0
SHEAR MODULUS (PSF)			
Dynamic	$1.4 \times 10^6 \pm 30\%$	$0.4 \times 10^6 \pm 30\%$	$72 \times 10^6 \pm 50\%$
Increase Per Foot of Depth	$0.17 \times 10^6 \pm 25\%$	$0.17 \times 10^6 \pm 20\%$	0
DAMPING VALUES (PERCENT OF CRITICAL DAMPING)			
Within Earthquake Levels	7% to 10%	5% to 8%	1%
LATERAL PRESSURE (PSF/FT.)			
Static-Rigid Wall Above Water	96*	-	0
Static-Rigid Wall Submerged	122*	-	63
Static-Cantilever Wall Above Water	32*	-	0
Static-Cantilever Wall Submerged	80*	-	63
Dynamic-Rigid Wall Above Water	320**	-	0
Dynamic-Rigid Wall Below Water	280**	-	-

*A factor of safety of 1.5 is recommended in the use of these values

**A factor of safety of 1.1 is recommended in the use of these values

STATIC AND DYNAMIC SOIL AND ROCK PROPERTIES:

Each of the parameters presented in Table I is discussed below. A brief description of the method of determining the values is given, and the range of variation is discussed.

Density - The densities given for the rock fill material were determined from six relatively large scale density tests performed by Soil and Foundations Associates in the compacted test fill. The individual test results are presented in the Appendix. In determining the submerged density, the rock fill material was assumed to have a specific gravity equivalent to that of dolomite. The range of variation given is considered appropriate for a controlled compacted fill of 1½ inch and smaller crusher-run rock.

The densities for the in-situ glacial till and their range of variation were assessed from the moisture-density tests performed on undisturbed samples. An appropriate specific gravity was used to determine the submerged density.

Bedrock density and its range of variation were determined from the results of measured densities of representative rock cores.

Wave Velocities - The compression and shear wave velocities presented in Table I for the compacted fill and the glacial till are the values measured during this investigation. The in-situ rock velocities are the values measured during prior studies and previously reported in Reference (1). The tabulated glacial till velocities (V_c=7700 ft./sec., V_s=2200 ft./sec.) differ from the previously measured compression wave velocity (V_c=6500 ft./sec.) and computed shear wave velocity (V_s=2650 ft./sec.) which were reported in Reference (1). In our opinion, the currently developed values are more applicable in that they were measured in the specific plant area.

The range of variation of wave velocities presented in Table I has been estimated from consideration of inherent uncertainties in methods of measurement, and variation in grain size, density, and/or strength of the various materials.

Poisson's Ratio - The tabulated values of Poisson's ratio for the compacted rock fill and glacial till were computed from the measured shear and compression wave velocities. Where possible, the load-settlement data from plate load tests were compared to provide a further check on the values computed from the wave velocities. Values for in-situ rock were previously estimated from the seismic investigation reported in Reference (1).

The range of variation of Poisson's ratio were estimated from consideration of probable variations in wave velocities, probable variations in grain size, density and/or strength of the materials being considered.

Static Modulus of Elasticity.- The tabulated static moduli of elasticity for the rock fill and glacial till were determined from the load-settlement behavior recorded during plate load testing, with interpretation of these data by the methods outlined in Reference (5). Computed values were compared with published data (References 3, 4, 6, 13, 17, 18) and minor adjustments were made as necessary.

The variations of moduli with depth were determined from the test results using the methods of Reference (5). The tabulated variations with depth should not be used for depths of more than 50 feet. Based on research of published data and a comparison of results with moduli values determined for glacial till at other nuclear power plant sites, it is recommended that the depth taken in computing the modulus of elasticity of the till be the depth from the lowest adjacent ground surface to the till layer being considered.

The modulus of elasticity of the bedrock was computed using the elastic moduli information developed during testing but modifying the measured values on the basis of experience, RQD, vugs, discontinuities, clay seams, and proposed grouting, to produce a modulus appropriate for the in-situ rock. The tabulated value is applicable to the Bass Islands Group of sediments and the range indicated covers variations that may result from variations within this bedrock group. No marked variation of modulus with depth or overburden pressure is expected for the bedrock.

The indicated range of values reflect the inherent errors of testing and analyses together with anticipated variations in properties of the various materials.

Dynamic Modulus of Elasticity - The dynamic moduli for the compacted rock fill and glacial till were determined from elastic analysis of the results of the field seismic investigation. The computed values were adjusted to give values which would be applicable for the anticipated strain levels which will be developed by the adopted earthquake levels. The results of the elastic analysis were also compared with the moduli computed by the methods of Reference (5) using the rebound portions of the load-settlement curves. When adjusted for strain level and confinement, the elastic analysis results and rebound values compared well; thus the anticipated variation with depth computed by Reference (5) methods are considered appropriate.

The dynamic modulus of elasticity of the bedrock was determined by elastic analysis of the results of the seismic investigation. Computed values were adjusted for strain level to give a value appropriate for the grouted in-situ rock within the adopted earthquake levels. In our opinion, the modulus will not vary markedly with depth or confining pressure.

The range of values given reflects the accuracy of field measurement and analysis together with the anticipated variations in grain size, density and/or strength of the various materials.

Shear Moduli - The shear moduli were computed using the elastic relationship between shear modulus, modulus of elasticity and Poisson's ratio. The tabulated values of modulus of elasticity and Poisson's ratio were used and thus the shear moduli as tabulated are appropriate for the adopted earthquake levels. Similarly, the range of values reflects inherent uncertainties in methods of analysis and anticipated variations in grain size density and/or strength of the various materials.

Damping Values - For the compacted rock fill and the glacial till, an attempt was made to determine damping from the behavior of load-unload cycles of the plate load tests. Similarly, the energy losses of wave trains developed in the seismic investigation were studied. Although these studies gave an indication of the relative damping capacity of the two materials, a precise assessment of damping was not possible by these methods. The tabulated values of damping are based largely on a review of available published data.

The damping capacity of the bedrock was developed during prior studies reported in Reference (1).

All of the tabulated damping values are expressed as a percentage of critical damping.

Lateral Pressures - In computing lateral pressures appropriate for the compacted rock fill, it was necessary to estimate the probable angle of internal friction of this material. Based on observations of the material placed in the field and based on research of available published data, the angle of interval friction was assumed equal to 40 degrees.

All static lateral pressure data presented in Table I are expressed as equivalent fluid pressures. For rigid walls, the tabulated values of lateral pressure are derived for the case of earth pressure "at rest." For cantilever walls, the tabulated values are derived for the case of "active" earth pressure.

Dynamic lateral pressures for the rock fill and glacial till were determined from "passive" earth pressure theory allowing for the possible increases in pressure which could result from seismic accelerations. The tabulated pressures will occur only for that portion of the substructure which is out of phase with the adjacent backfill during movement due to earthquake motion. These pressures need not be considered to act over the entire height of the substructure.

For static conditions, a factor of safety on the order of 1.5 is recommended in the use of the recommended design values. This is to allow for variations in compaction of backfill and for residual pressures that may result from compaction operations. For dynamic conditions, a factor of safety on the order of 1.1 is recommended for similar reasons.

It is our opinion that static pressures imposed by rock on rigid or cantilever walls above the ground water level will be negligible. The lateral pressure in rock cuts below the water table will be limited to hydrostatic water pressure. This assumes that the walls will be poured directly against the blast-excavated rock face. To assure applicability of these criteria, it is recommended that the exposed rock wall be inspected by a qualified geologist to insure that any rock masses which are loose or highly fractured are removed or stabilized.

Dynamic lateral pressures in the bedrock will be controlled by the rock-structure interaction during earthquake loading. To determine stress levels during seismic interaction, it is customary to construct a model and analyze the seismic behavior of the ground-structure system by finite element analysis. We assume that such a model can be constructed using various rock parameters previously provided in this report. If this is not the case, we would be pleased to provide any additional data that might be required.

ROCK BEARING CAPACITY:

Data on the rock bearing capacity has been presented in Reference (2) and is repeated herein.

The ultimate bearing capacity of the foundation bedrock was evaluated, on a conservative basis, in accordance with methods described in References (9) and (16). No consideration was given to the increase in bearing capacity which will result from the grouting operations.

The strength of the foundation rock was evaluated by means of rock compression tests. Considering this value to be appropriate for rock with an RQD (Rock Quality Designation) of 100, a reduction factor was selected based on an assessment of the measured RQD values, information on vug volume and size, fracture orientation and spacing, and presence of clay and shale seams. Application of this reduction factor produced a modified value approximating the in-situ strength of the rock mass. On this basis, the minimum ultimate bearing capacity of the rock mass in the plant area is considered to be on the order of 300,000 pounds per square foot. Assuming a combined static and dynamic maximum loading as high as 25,000 pounds per square foot, the factor of safety against foundation failure would exceed 12. Considering the rock strengthening by grouting operations, the factor of safety would be considerably in excess of 12.

SETTLEMENT:

Settlement data were also presented in Reference (2) and are repeated below.

Detailed design loads for the Reactor and Auxiliary Buildings are presently not available. If the maximum unit pressure were to be as high as 25,000 pounds per square foot, it is estimated that the Reactor and Auxiliary Buildings would undergo a maximum total settlement on the order of 0.3 to 0.5 inches. This estimate has been computed using the elastic moduli information developed during testing but modifying the measured values on the basis of experience, RQD, vugs, discontinuities, and clay seams to produce conservative deformation moduli appropriate for the in-situ rock.

If applied unit pressures for the Reactor and Auxiliary Buildings are less than 25,000 pounds per square foot, actual settlements would be reduced proportionately.

FUTURE UNITS:

Construction of future units will be affected by the Fermi II unit particularly with respect to rock excavation by blasting. Prior studies of vibrations from blasting (References 7 and 8) established tentative criteria for shot-load versus distance from Fermi I. It was tentatively established that not more than a 25 pound per delay shot load should be used at a minimum distance of 400 feet from Fermi I and that the total shot load for delayed detonation be limited to 1,000 pounds per shot. These limits are subject to review and confirmation or possible revision during production blasting for Fermi II.

If a future unit is to be constructed immediately adjacent to Fermi II, careful consideration should be given to the planning of excavating operations. If possible, rock excavation for the future unit might be conducted concurrently with that for Unit II. If this is not feasible, further studies will be required to establish blasting load limits and other blasting criteria.

Planning for a future unit should also consider the resulting unbalanced lateral pressures occurring due to backfill on one side of Unit II, and open cut on the opposite side. As a preliminary guide, it is estimated that the coefficient of friction preventing sliding of the Reactor foundation on the grouted bedrock will be on the order of 0.6. This estimated value should be checked when the grouted bedrock is exposed throughout the Fermi II foundation area.

The affect of dewatering for future units should also be studied, with particular attention given to lateral pressure variations from submerged to non-submerged conditions. Similarly, in the design of appurtenant earth-supported buildings, possible settlement which may result from dewatering should be analyzed.

It is recommended that accurate records of grouting, dewatering, blasting and construction operations be kept during construction of Fermi II. A post-construction report collating these data would contribute significantly to an assessment of possible future construction problems.

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The following Plates and Appendix are attached and complete this report:

Plate I - Plot Plan

Appendix - Field and Laboratory Explorations

Respectfully submitted,

DAMES & MOORE

George D. Leal

George D. Leal

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ADDITIONAL NRC REVIEW COMMENT:

"In the original Observation No. ST-01-21, values of Mt equal to 2134.9 kip-feet and MEQ equal to 1255 kip-feet, are shown. Indicate how these values are related to the values shown in Table 8.2.3.6-1.

CYGNA RESPONSE:

The values for Mt and MEQ, contained in the original Observation No. ST-01-21, represent the total applied overturning moments due to tornado and OBE loadings, respectively. Sargent & Lundy used these values in their analysis of the cooling towers.

The values shown in Table 8.2.3.6-1 summarize Cygna's finite element analysis of the cooling towers. The moments tabluated are the maximum moments (kip-feet/ft) developed within various elements in the finite element model. These moments should be considered local resulting moments. Of course, such local moments have much smaller magnitudes than the total applied overturning moments.

To show that the Sargent & Lundy and Cygna results are consistent, we have calculated the total overturning moments for tornado and OBE loadings using a) our more detailed analysis input and b) Sargent & Lundy's analysis approach. The resulting overturning moments are as follows:

Tornado: 2135 kip-feet
OBE : 1237 kip-feet

The primary reason for the minimal (< 2%) difference in OBE moment is due to Cygna's more detailed calculation of the cooling tower mass.