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September 11, 1986

Mr. J. J. Harrison, Chief
Engineering Branch, DRS
Region III
Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, IL 60137

Dear Mr. Harrison:

I spent the periods September 3-5 and September 9-12, 1986, at the Fermi Power Plant investigating whether the cracks in the Unit 2 base mat pose safety or operational hazards. On September 3, I met with representatives of Detroit Edison, Sargent and Lundy, Hopper and Associates, and the NRC. Thereafter, I made two inspections of the base mat, much of the top surface of which is accessible, and reviewed the extensive documentation which has accumulated relevant to this situation. Most of the pertinent documents were available in the Detroit Edison files. However, some were not. I requested and received additional documents from Sargent and Lundy. I reviewed the methodology for all the design and analysis calculations and checked many of the calculations in detail.

In order to evaluate the significance of the cracks, the following questions must be answered:

1. Do the cracks impair the structural performance of the base mat:

   a. under static loads?
   b. under the original design seismic loads?
   c. under subsequently revised seismic loads?
   d. under the Perry earthquake?

2. Does infiltration of ground water:

   a. pose safety or operational problems?
   b. permit corrosion of the reinforcing steel?

3. Is exfiltration of contaminated water from the plant into the ground water possible?

It is evident that the cracks were not caused by structural loads. The static loads for which the mat is designed include the dead weight of the mat, the uplift force of the ground water (which is four times as great as the dead weight), and the weight of the walls and components of the reactor building. The mat was placed during June and July, 1971. Reference to the cracks first appeared in the record on April 12, 1972. At that time, only about one-third of either the uplift load or the building load had been applied to the structure. The cracks had to be the result of restrained volume changes in the concrete.

Cracks in the reinforced concrete may occur in compression zones, tension zones, or zones of high shear stress. Cracks in compression zones are of no concern because they close under load. Concrete must crack in tensile zones in order for the steel to achieve any significant portion of its tensile strength. Normally, the cracks form as a result of load and are numerous and very narrow. But if pre-existing cracks exist, they serve the same purpose. Thus, pre-existing cracks in the tensile zone do not hinder the functioning of reinforced concrete. Their width may raise a question about steel corrosion. Cracks in zones of high shear stress are a potential source of concern. If such cracks, or the reinforcing steel passing through them, are unable to transmit the shear stress, there will be a relative displacement of the concrete on the two sides of the crack. I could detect no such displacement in checking the cracks with a straightedge. Thus, without making any calculations, it may be determined that the base mat is adequate for carrying its design static loads.

Calculations support the visual observations. Since the cracks are random and unrelated to critical stress locations, it would be a coincidence if any occurred in critical flexure or shear zones. Calculations demonstrate that none did. Calculations are the only feasible means for evaluating seismic response. A finite element analysis has demonstrated that the mat will successfully withstand both the original design earthquake and the subsequently developed site-specific earthquake under the assumption that the cracks extend completely through the mat and that there is no shear transfer other than by the shear friction phenomenon. No actual analysis was made in which the Perry earthquake was applied to the Fermi structure, but a comparison of the response spectra indicates that for the frequencies of interest, the displacements, velocities, and accelerations of the Perry earthquake are between 0.3 and 0.6 of those for the Fermi site-specific earthquake.

The cracks noted in 1972 were of the order of 0.03 inches in width. This is about twice the width recommended by the American Concrete Institute for corrosion control. The cracks were grouted in 1972 with a cement-fly ash grout. Such cracks as have been detected more recently are too narrow to be successfully treated with cement grout. They have been sealed with epoxy resin. There were 46 such cracks sealed in 1984 and 1985. The operation has been successful. The top of the mat is generally dry. Almost all the water present is from leaking mechanical systems or from wall cracks that have not yet been sealed. I observed seven floor cracks which are seeping some water, but there is no measurable flow. Thus, inflow of ground water is an almost non-existent problem and one that is well within the capability of the project water-handling facilities.

There is virtually no potential for steel corrosion. The width of the cracks in the repaired condition is well below American Concrete Institute recommendations. And since the cracks are either sealed or filled with water, there is no opportunity for oxygen to reach the steel. Without oxygen there can be no corrosion.

Exfiltration of water from the reactor building into the ground could occur only if a tremendous quantity of water poured into the building. Since the base mat is 35 feet below the water table, over 35 feet of water would have to accumulate. But the most severe pipe-break accident postulated in the FSAR puts only 8.6 feet of water in the torus room. The reactor would achieve a state of cold shutdown before the maximum water height is reached. The reactor building is flood-proofed to a level more than a foot above the flood level predicted for the probable maximum meteorlogical event. All doors and penetrations below this level are of watertight design. In the unlikely event that a door were left open during a flood, water could enter the reactor building, but it could not rise above the level of the outside water.

In order to evaluate the safety of the structure, it is not necessary to pinpoint the exact cause of the cracks. However, it is almost certainly the result of thermal cracking associated with the high temperature rise of the very strong concrete. The concrete was much stronger than it needed to be. Although the use of fly ash reduces rate of strength gain somewhat, almost all the concrete reached its required 28 day strength in less than seven days, and the one 90-day test that was made resulted in a strength over twice that required. While a maximum temperature limit was imposed which required the use of ice, there was probably a temperature rise in

this massive structure of over 100°F. In cooling 100° to ambient temperature, concrete must inevitably crack. In carrying out such placements, cracking can be minimized by following the advice in ACI 207.2R, "Effects of Restraint, Volume Change, and Reinforcement on Cracking of Massive Concrete." The search for an improved concrete, suggested in the correspondence, has not materialized because Detroit Edison has not undertaken any nuclear reactor construction since Fermi 2.

In summary, the base mat will safely carry the design static and seismic loads, infiltration of ground water is very small and easily manageable, corrosion of reinforcing steel is essentially impossible, and exfiltration of water to the ground is impossible either in a pipe-break accident or a flood.

Sincerely yours,

Robert E. Philleo

Robert E. Philleo, P.E.

REP/jj

U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report of Construction Inspection

IE Inspection Report No. 050-341/75-01

Licensee: Detroit Edison Company
2000 Second Avenue
Detroit, Michigan 48226

Enrico Fermi Unit 2
Monroe, Michigan

License No. CPPR-87
Category: A

Type of Licensee: BWR (GE) - 1150 MWe

Type of Inspection: Routine, Unannounced

Dates of Inspection: March 5-6, 1975

Dates of Previous Inspection: November 25-26, 1974 (Construction)

Principal Inspector: T. E. Vandel — 4-7-75 (Date)

Accompanying Inspectors: C. E. Jones — 4-7-75 (Date)

E. W. K. Lee — 4/7/75 (Date)

Other Accompanying Personnel: None

Reviewed By: D. W. Hayes, Senior Reactor Inspector
Construction Projects — 4/7/75 (Date)

2. Storage and Identification of Spring Hangers and Supports (RO Inspection Report No. 050-341/74-08)

As previously reported, pipe hangers and supports were apparently not being properly stored and protected.

During this inspection, the inspector noted that several spring hangers and supports stored outdoors were badly rusted, and the identifying paint was fading. This matter is now considered to be in noncompliance with NRC rules and regulations. (Report Details, Section I, Paragraph 2)

3. Reactor Building Wall and Floor Slab Cracking (RO Inspection Report No. 050-341/74-08, and Inquiry Report No. 050-341/72-02)

The inspectors observed the area of the floor and walls where cracking had been identified. In addition, they reviewed the licensee's final report, EF-2-29-537, submitted pursuant to 10 CFR Part 50.55(e), and informed the licensee they had no further questions in regard to this matter. (Report Details, Section II, Paragraph 5)

Management Interview

A. The following persons attended the management interview at the close of the inspection.

Detroit Edison Company (Edison)

T. A. Alessi, Quality Assurance Division Director
A. Alexiou, Project Quality Assurance Director
T. G. Byrd, Field Quality Assurance Engineer
W. E. Everett, Assistant Construction Supervisor
J. Ferguson, Supervisor - Major Projects
A. B. Harris, Project Manager
F. A. Reed, Field Quality Assurance Engineer
E. G. Sliper, Project Engineer

B. Matters discussed and comments, on the part of management personnel, were as follows:

1. The inspector stated that it appears that the following activities were not conducted in full compliance with NRC rules and regulations and Edison procedures.

a. The equipment, maintenance, and record control (EM&RC) file was not maintained properly. Consequently, the RCIC system steam turbine periodic inspection was overdue. (Report Details, Section I, Paragraph 1)

Spray Pumps, identification No. E-21-01-C-001B and No. E-21-01-C-001A. The inspector verified that procedure WP-M-019 was being followed to provide storage protection and to perform surveillance inspections.

4. Exposed Building Structures

The inspector stated his observations of the wall, where construction terminated in the reactor building, (about 660' elevation) that ice had gathered in the construction joint and appeared to have damaged the concrete. The licensee stated that the area would be cleaned of loose concrete and the reinforcing bars cleaned, prior to resumption of construction.

The licensee was also asked about imbedments left in the equipment mounting pedestals. Ice was observed in the recess and in the sleeves around the anchor bolts. The licensee stated these would be cleaned and inspected prior to resumption of construction.

5. Reactor Building Walls and Floor Slab Cracking

The Edison final report number EF2-29,537 issued November 8, 1974 was discussed with Licensee personnel. In response to questioning the licensee indicated that the grouting repairs are complete and that although some slight leakage (0.13 gal per minute maximum) may still occur it is fully expected that any leakage will seal itself off in time. In addition, the inspectors were assured that any minimal leakage would be handled through the radwaste system, and that, the containment building negative pressure inside and the ground water hydostatic pressure on the outside, would prevent any outleakage.

The inspector stated he had no further questions in regard to this matter.

6. Buildings and Installed Equipment As-builts

Information was requested relative to as built plant conditions records and plans to develop such documents. The inspectors were informed that a computer oriented Nuclear Power System (NPS) has been developed as a status system and that the accuracy of the information is being checked by actual plant survey and documentation. The installation status of other mechanical equipment, piping etc., is also being manually recorded on drawings or by lists.

The licensee added that a system type of bar charts are being developed and expanded that will provide a method for commencing construction again once the shutdown period is over.

U.S. NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT

REGION III

Report No. 50-341/79-04

Docket No. 50-341 License No. CPPR-87

Licensee: Detroit Edison Company
2000 Second Avenue
Detroit, MI 48226

Facility Name: Enrico Fermi 2

Investigation At: Enrico Fermi 2

Investigation Conducted: February 15-March 2, 1979

Investigators: R.C. Knop for F. C. Hawkins, Reactor Inspector — 7/27/79 (date)

C.E. Norelius for R. J. Marsh, Investigator — 7/27/79 (date)

R.C. Knop for H. S. Phillips, Reactor Inspector — 7/27/79 (date)

H.M. Wescott H. M. Wescott, Reactor Inspector — 7/27/79 (date)

Reviewed By: C.E. Norelius C. E. Norelius
Assistant to the Director — 7/27/79 (date)

R C Knop R. C. Knop, Chief
Projects Section 1 — 7/27/79 (date)

Investigative Summary

Investigation on February 15 - March 2, 1979 (Report No. 50-341/79-04)
Areas Inspected: Twenty allegations were made relative to management and construction practice. In many instances these allegations pertained to non-safety related equipment or work. This inspection involved 146 inspector-hours which includes 80 hours on site and 50 hours of investigation time meeting with several allegers at appointed meeting places.

SUMMARY OF FACT

On February 8 and 9, 1979, Mr. Frank Kuron was interviewed by Messrs. Robert Marsh (NRC Investigator, Region III), and Shannon Phillips (NRC Reactor Inspector, Region III), regarding his earlier statements before the Fermi 2 Prehearing Conference.

Mr. Kuron provided the NRC representatives with information on twelve areas which he considered as potential health and safety concerns regarding the construction and future operational capabilities of the Fermi 2 site. Through both question and answer and in narrative statements it was disclosed that Mr. Kuron's concerns covered broad areas and in several cases were dated or were of a nonspecific nature. Mr. Kuron indicated much of his information was second or third hand and/or founded solely on heresay. Mr. Kuron agreed to review his own records and contact his "sources" in an attempt to provide the NRC more definitive information. At the close of the interview, twelve (12) potential areas of investigation were identified. Following a review of Mr. Kuron's allegations, an investigation was initiated on February 15, 1979.

On February 20, 1979, the investigation was continued at the Fermi 2 site. On February 21, 1979, Mr. Kuron was brought on site and in a walking tour of the facility, further defined his allegations.

The orginal list of twelve allegations/areas of concern resulting from the February 8 and 9, 1979, interview of Mr. Kuron was expanded to twenty (20) items and additional detail was aquired from Mr. Kuron and other sources. The areas investigated and the conclusions reached are summarized as follows:

1. Lack of Quality Control - No evidence to support or substantiate this allegation was identified.

2. Destruction of two trailer loads of quality control records - In 1974, documents from two trailers that contained personal records and copies of working drawings, specifications, and milestone charts were burned. No permanent QA records were destroyed. The investigation was unable to substantiate this allegation.

3. A recent fire in Building 45A was more extensive than reported to the NRC - No evidence to support or substantiate this allegation was identified. Continued as open item (341/79-04-02) pending licensee identification of records burned.

4. Interference fit of a 24" Globe Valve - No evidence to substantiate this allegation or concern regarding improper construction practice was identified.

5. Poor housekeeping in the drywell area - The investigation was unable to substantiate that overall housekeeping (drywell area included) was unacceptable at the time of this investigation.

6. Improper installation of reflective shielding - The investigation substantiated that this shielding is nonsafety related and therefore it is not a safety concern.

7. Pipe hangers improperly installed - Allegation determined to be valid and previously identified by the NRC. Corrective action is continuing.

8. Reactor Feed Pump Turbine damaged in early fire not properly repaired - Investigation disclosed concerned equipment to be QA Level II, nonsafety related. Allegation considered a nonsafety construction issue.

9. Nozzles in main condenser improperly welded - Insufficient detail available to identify specific piping involved. Investigation disclosed no safety related piping in area designated by alleger.

10. Improper storage of turbine parts - Determined to be nonsafety construction issue.

11. Inadequate posting of work areas as required by 10 CFR 21 (Paragraph 21.6) - Allegation not substantiated.

12. Improper welding of Main Steam Line spool piece - No evidence to support or substantiate this allegation was identified.

13. Use of improper weld rod - Allegation not substantiated. System involved determined to be nonsafety related.

14. Improper pipe whip restraint weld - Allegation was determined to be unsubstantiated.

15. Improper installation of concrete anchors (Red Heads) - The investigation was unable to substantiate this allegation. Continued as open item (341/79-04-03) pending additional testing by licensee.

16. Voids in grout of sacrificial shield wall - Allegation substantiated. Two void areas identified by investigation and licensee DDR 1187 found to have been inadequately completed (incomplete repair). These items cited as items of noncompliance (341/79-04-04).

17. Improper cadweld sleeves in Reactor Building - No evidence found to support or substantiate this allegation.

18. Hairline cracks in Reactor Building structural steel - No evidence found to support or substantiate this allegation.

19. Surplus structural steel from RHR Building considered by alleger to represent construction "short cuts" - No evidence to support or substantiate this allegation was identified.

20. Cracks in the concrete of the base slab of the Reactor Building - The investigation revealed that an early history of cracking had existed with the base slab but that this previously addressed matter had been satisfactorily resolved by licensee action.

CONCLUSIONS

One item of noncompliance (341/79-04-04) was identified as a result of this investigation of Mr. Kuron's allegations. In the other nineteen (19) instances, the allegations/areas of concern were found to be either unfounded, previously identified, or addressing nonsafety related areas. In the latter case, the available details of the allegation and findings of the investigative team were provided to the licensee for their information and corrective action as deemed appropriate.

In the identified item of noncompliance (allegation No. 16) the identified voids in the grouting of the sacrificial shield and incomplete corrective action previously initiated by the licensee under DDR 1186 were cited as examples of noncompliance with 10 CFR 50, Appendix B, Criterion XVI.

The investigation associated with this allegation did not reveal any evidence that would lead to the conclusion that reinforcing steel was omitted from the RHR Building. No items of noncompliance or deviations were identified.

Allegation No. 20: Cracks in the concrete base mat of the Reactor Building.

Mr. Kuron expressed his concern of the concrete cracks which developed in the reactor building base mat at elevation 540'. He felt that the cracking might "allow radiation to leak out of the reactor building" and that the structural integrity of the base mat may have been impaired.

Finding: DECo had previously identified the cracks in the reactor building base slab in accordance with 10 CFR 50, Paragraph 50.55(e)(3). The final technical report from DECo was dated November 8, 1974, No. EFZ-29,537.

DECo summarized the reactor building base mat cracking problem as being one of ground water, which was seeping through the radial and circumferential cracks present in the base slab. Evaluation and disposition of the cracking problem by the licensee included the following actions:

- Building Outleakage - In the case of a pipe rupture in the Reactor Building, there would be no outward leakage of radioactive water through the cracks in the floor of the building unless the basement areas became flooded to such a depth that the head of water inside was equal to or higher than that of the ground water outside. Under normal plant operation conditions, this would require flooding in the basement to a depth of approximately 30 feet before reaching the same head at the normal external ground water. If this flooding began to occur, the reactor would be brought to a safe shutdown and the water contained within the building would be processed through the radwaste system. It should be noted that this case is only valid if the cracks were not repaired.

- Sargent and Lundy, the structural designers for the reactor building, performed a thorough anlysis and concluded that the observed cracks did not impair the structural strength of the base slab.

- A program was initiated to monitor the width and length of selected cracks for an increase in length or width and to identify any new cracks which might develop.

- Crack width and the penetration into the base slab was determined by taking random concrete cores at various specified locations.

- Developed, approved and execute procedures for the drilling, pressure testing and grouting of all cracks present in the base mat.

As of the date of this investigation, DECo personnel indicated that they felt the grouting program had effectively sealed the cracks in the base slab due to the lack of infiltrating ground water. The NRC team toured the elevation 540 base slab on February 22, 1979, and found no evidence of continued water seepage. No items of noncompliance or deviations were noted.

6. Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items, items of noncompliance, or deviations. Unresolved items disclosed during the investigation are discussed on pages 12 and 13 (Allegations 2 and 3), and on page 22 (Allegation No. 15) of this report.

7. Exit Interview

The investigators met with site staff representatives (denoted in the Persons Contacted paragraph) at the conclusion of the investigation on March 2, 1979. The investigators summarized the scope and findings of the investigation, including the apparent items of noncompliance identified in the Results section of this report. The licensee acknowledged the findings.