

January 27, 2003

Dr. David K. Wehe, Director
Phoenix Memorial Laboratory
Ford Nuclear Reactor
University of Michigan
2301 Bonisteel Boulevard
Ann Arbor, MI 48109-2100

SUBJECT: NRC ANNOUNCED INSPECTION REPORT NO. 50-02/2002-201

Dear Dr. Wehe:

This letter refers to the inspection conducted on March 11 -12 and April 22 - 25, 2002, at the Ford Nuclear Reactor. The inspection included a review of activities authorized for your facility. The enclosed report presents the results of that inspection.

The root cause analysis and corrective actions for Reportable Occurrence No. 23, involving a reactor fuel element not properly seated on the core grid plate, were reviewed. Your prompt identification and prompt corrective action were considered in determining that this event constituted a Non-Cited Violation of your Technical Specifications. No reply to this letter is required. However, the disposition of violations in this manner does not eliminate the NRC's emphasis on compliance with requirements nor the importance of maintaining safety.

Additional areas examined during the inspection are identified in the report. Within these areas, the inspection consisted of selective examinations of procedures and representative records, interviews with personnel, and observations of activities in progress.

Based on the results of this inspection, no safety concern was identified. No response to this letter is required.

In accordance with 10 CFR 2.790 of the NRC's "Rules of Practice," a copy of this letter and its enclosure will be available electronically for public inspection in the NRC Public Document Room or from the Publicly Available Records (PARS) component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at (the Public Electronic Reading Room) <http://www.nrc.gov/reading-rm/adams.html>.

Dr. D. K. Wehe

-2-

Should you have any questions concerning this inspection, please contact Mr. Thomas Dragoun at 610-337-5373.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 50-02

License No.: R-28

Enclosure: NRC Inspection Report No. 50-02/2002-201

cc w/enclosure: Please see next page

University of Michigan

Docket No. 50-02

cc:

Special Assistant to the Governor
Office of the Governor
Room 1 - State Capitol
Lansing, MI 48909

Mr. C.W. Becker
Phoenix Memorial Laboratory
2301 Bonisteel Boulevard
University of Michigan
Ann Arbor, MI 48109

Michigan Department of Environmental Quality
Drinking Water and Radiological
Protection Division
P.O. Box 30630
Lansing, MI 48909-8130

Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

Dr. D. K. Wehe

-2-

January 27, 2003

Should you have any questions concerning this inspection, please contact Mr. Thomas Dragoun at 610-337-5373.

Sincerely,

/RA/

Patrick M. Madden, Section Chief
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

Docket No.: 50-02

License No.: R-28

Enclosure: NRC Inspection Report No. 50-02/2002-201

cc w/enclosure: Please see next page

Distribution

PUBLIC	RORP/R&TR r/f	AAdams	CBassett
WBeckner	LBerg	PDoyle	TDragoun
WEresian	FGillespie	SHolmes	DHughes
EHylton	PIsaac	PMadden	MMendonca

BDavis (Ltr. Only O5-A4)
NRR enforcement coordinator (Only for IRs with NOVs, O10-H14)

ACCESSION NO.: ML030210328

TEMPLATE No.: NRR-106

OFFICE	RORP:LA	RORP:RI	RORP:SC
NAME	EHylton:rdr	TDragoun	PMadden
DATE	01/ 24 /2003	01/ 22 /2003	01/ 24 /2003

C = COVER

**E = COVER & ENCLOSURE
OFFICIAL RECORD COPY**

N = NO COPY

U. S. NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION

Docket No: 50-02

License No: R-28

Report No: 50-02/2002-201

Licensee: University of Michigan

Facility: Ford Nuclear Reactor

Location: Ann Arbor, Michigan

Dates: March 11 - 12 and April 22 - 25, 2002

Inspector: Thomas F. Dragoun

Approved by: Patrick M. Madden, Section Chief
Research and Test Reactors Section
Operating Reactor Improvements Program
Division of Regulatory Improvement Programs
Office of Nuclear Reactor Regulation

EXECUTIVE SUMMARY

University of Michigan
Report No.: 50-02/2002-201

The primary focus of this announced inspection was the on-site review of actions related to Reportable Occurrence No. 23. This occurrence involved the misplacement of a fuel element resulting in an unoccupied grid position in the reactor core. This condition violates Technical Specification 3.4.3. Of concern was the adequacy of cooling of the misplaced element and the remainder of the core during a brief period of power operation prior to the discovery of the condition. In addition, selected aspects of the licensee's Class I research reactor radiation protection and ALARA programs were reviewed.

Reportable Occurrence

- The noncompliant condition was identified during completion of routine shift turnover checklist that required a visual inspection of the core by the incoming operators.
- The reactor was promptly shut down and a comprehensive investigation of the root causes was begun by management and an independent consultant.

Radiation Protection Program

- Surveys were being completed and documented acceptably to permit evaluation of the radiation hazards present.
- Postings met the regulatory requirements specified in 10 CFR Parts 19 and 20.
- Personnel doses were well within the licensee's procedural action levels, and NRC's regulatory limits.
- Radiation monitoring equipment was being maintained and calibrated as required.
- The Radiation Protection being implemented by the licensee satisfied regulatory requirements.

REPORT DETAILS

Summary of Plant Status

The licensee's Ford Nuclear Reactor continues to be operated at 2 megawatts in support of laboratory experiments, reactor operator training, and various types of research. During the second portion of this inspection, the reactor was operated continuously at full power.

1. Reportable Occurrence

a. Inspection Scope (Inspection Procedure [IP] 60745)

On March 9, 2002, the licensee reported to the NRC that Technical Specification 3.4.3 was violated. This Technical Specification requires that all reactor grid positions be filled for operation above 100 kW. After a major refueling and ascent to 2 MW, a routine core visual inspection on March 7, 2002, found grid position 77 unoccupied and its fuel element (No. 304) upright and adjacent to, but outside of the grid, held there by the pneumatic tube bundle (rabbit system). The licensee's assessment of actual and potential safety consequences, root causes, short term, and long term corrective actions for this event were determined by a review of:

- Procedure AP-301, "Reactor Fuel" revision 23, effective June 28, 2000
- Procedure OP-201, "Building Checklist" revision 42, undated
- Temporary Operating Instructions, "Handling instructions for moving fuel element No. 304, located next to L77, to a safe storage location" approved by the Safety Review Committee on March 11, 2002
- reactor console log for March 5-7, 2002
- fuel movement records for March 5, 2002
- written statements concerning the event from all licensed reactor operators on staff
- Safety Review Committee meeting held March 11, 2002
- Calculation "Core Flow Rate with a Grid Location Vacant", calculation number CM-0100-2002-01, by C.W. Becker, technical review by A. Cook, undated
- Calculation "Thermal Evaluation of a Displaced Fuel Element", calculation number RX-0200-2002-01 revision 0, dated March 26, 2002, by Professor J. Lee, technical review by C.W. Becker
- Reportable Occurrence No. 14 (fuel cladding failure), dated November 6, 1991
- read-and-sign training records for the reactor staff
- Report "Root Cause Analysis of Improper Loading of Fuel Element MI-304", dated April 3, 2002

b. Observations and Findings

At approximately seven month intervals, three new fuel elements are added to the core and the remaining elements are shuffled to maintain the excess

reactivity needed for full power operation. This process was last completed on March 5, 2002, using procedure AP-301. Records indicated that all work was performed by experienced senior reactor operators with management oversight. Low power testing, including control rod worth and power range instrument calibration, was performed on March 5 and 6 and all parameters were normal. Visual inspections of the core, as specified by procedure OP-201 section 4.5(a), were performed and documented at each shift change. The reactor staff stated that several additional undocumented visual inspections of the core were also performed after the refueling. The reactor was started by the Swing Shift crew and power increased to 2 MW on March 6. The incoming Night Shift crew did not record any abnormalities during the shift turnover. On March 7, the incoming Day Shift operators conducting the OP-201 inspections reported that reactor core location No. 77 was vacant and the fuel element was upright alongside it. Location No. 77 is at the outer periphery of the grid plate. The reactor was promptly shut down. The Health Physicist initiated pool water sampling and analysis using lessons learned from a fuel failure event in 1991. No abnormal radioactivity was detected in the pool water. A lanyard was attached to the bail on the element to restrict movement. A temporary procedure was approved by the SRC for the movement of the element to a storage rack. After a practice run with a dummy element, the element was relocated in accordance with the procedure.

There is no side plate on this quadrant of the grid plate. The licensee hypothesized that the tapered nose cone on the bottom of the fuel element, coupled with some sway of the element during insertion, allowed the bottom to deflect outside the grid plate. The shoulder at the transition from the tapered circular nose cone and the square fuel zone caught on the outer edge of the grid plate. This gave the fuel handler the "feel" that the element was properly "seated." The top of the element canted inward thus giving the visual appearance that location No. 77 was occupied when viewed from above. A combination of poor lighting, structural interferences, and naked eye observations (no binoculars) caused the problem to be undetected after several documented inspections by various operators. However, the clarity of the pool water was good. The reactor was operated for approximately 12 hours in this configuration. For an unknown reason, the fuel element assumed a vertical position and visually revealed the problem.

Licensee calculations show that the coolant flow through the core and the power level in the displaced element were within the safety envelope described in the safety analysis report. Facility management concluded that there was no actual or potential damage to the cladding of the fuel in the core or the displaced fuel element No. 304. This was confirmed by pool water radio analysis. However, fuel element No. 304 was permanently retired from service.

The licensee's immediate corrective action included:

- reactor shut down and prohibition on restart until approved by the SRC
- conduct of an independent review and recommendations by the reactor director from a nearby research reactor

- obtaining written statements from all licensed reactor operators on staff to document observations while the memories were still fresh
- quick calculations (later refined) to determine if any damage to the fuel occurred
- a review of console logs and records for any abnormalities including control rod worth calibrations, calorimetric data, control rod height at criticality, refueling logs, and building checks
- verification and inspection after any fuel moves at the west side of the core must be completed by the reactor manager and the assistant reactor manager.

Proposed long term corrective actions include:

- installation of a plate to the west side reactor grid, similar to the other three sides
- improved underwater lighting at the sides of the core
- require the use of binoculars when inspecting the core
- revise procedure AP-301 to include lessons learned from this event and include undocumented operator technique. For example, "An element is properly seated if you can fit one finger between the handle on the refueling tool and the pool bridge deck"
- redesign the pool bridge to eliminate visual obstructions and interferences during use of the fuel handling tool.

c. Conclusions

In consideration of the licensee's identification and corrective actions taken or to be taken for the non-compliance with Technical Specification No. 3.4.3, the NRC is exercising discretion in dispositioning this event as a Non-Cited Violation in accordance with NRC Enforcement Policy dated May 1, 2000.

2. Radiation Protection

a. Inspection Scope (IP 83743)

The inspector reviewed the following to verify compliance with 10 CFR Part 20 and Technical Specification Section 6 requirements:

- health physics organization and staffing
- Annual Radiation Safety Program Review conducted April 16, 18-19, 2002, by M. Driscoll and J. Miklos
- Letter to NRC dated March 1, 2002, "Reported Occupational Dose in Excess of 10 CFR 20.1201(a)(2)(ii)"
- Posting of NRC-3 Forms, warning signs, and labeling of radioactive material
- Memorandum from the Nuclear Reactor Laboratory (NRL) Manager to laboratory and health physics staff, "Lab Coats in the Ford Nuclear Reactor" dated October 1, 2001

- Memorandum from NRL Manager to laboratory and reactor users, "Dress and Personnel Protective Equipment Requirements", dated June 20, 2001
- personnel dosimetry reports for calendar year 2001
- Procedure HP-101, "Facility Contamination Survey", revision 4, effective August 5, 1998. Associated survey records for January 1, 2001, to-date
- Procedure HP-202, "Liquid Scintillation Counter Calibration", revision 7, dated July 28, 1998
- Procedure HP-102, "FNR-PML Area Radiation Surveys" revision 4, dated August 12, 1998. Associated records from January 25 to December 18, 2001
- Procedure HP-105, "FNR Pool Water Analysis", revision 6, dated August 5, 1998. Associated records for January 3 to April 18, 2002
- Procedure HP-203, "Calibration of Portable Ionization Chamber Survey Instruments" revision 3, dated July 9, 1998. Use of new Shepard calibrator for calibrating upper ranges on the instruments. Associated records for all instruments in use.

b. Observations and Findings

Safety precautions taken during extraction of an Ar-Ar sample from the reactor by the Health Physics Assistant on April 24, 2002, were satisfactory. The construction, interlocks, and ALARA precautions for the new neutron radiography apparatus installed at a beam port satisfied the requirements of 10 CFR 20.1601. The replacement of charcoal cartridges in all the sampling skids for the ventilation and exhaust systems was accomplished with adequate attention to contamination controls.

The HP Technician left in February 2002. A replacement is expected onboard by the end of May 2002. In the interim, a HP Assistant was completing the duties of the Technician. The Health Physicist and HP Technician have collateral duties for all use of radioactive materials on North Campus. However, loss of the technician has not negatively impacted the conduct of the radiation protection program. An annual review of the radiation protection program was completed on April 19, 2002, and documented as required by 10 CFR 20.1101. Dosimetry records for 2001 indicated that personnel exposures were below NRC limits. Records for January 25 to December 18, 2001, demonstrated that dose rate surveys were completed in accordance with procedural requirements and reviewed by the Health Physicist. Similarly, records of surface contamination surveys from January 2001 to April 2002 were satisfactory. Records of the analysis of pool water performed biweekly as required from January 3 to April 18, 2002 did not reveal any abnormalities. A spot check of portable ionization chamber instruments in use found that they had been calibrated annually and response checked quarterly in accordance with procedural requirements. A tour of the reactor building and laboratory spaces found warning signs, postings, NRC 3 forms, and radioactive material labels used as specified in 10 CFR Part 20.

During inspection 2001-201, conducted on April 30 to May 4, 2001, the reactor manager stated that certain HP procedures would be updated by April 2002, and the remainder by April 2003. During this inspection, the reactor manager stated that this project was several months behind schedule due to actions taken in response to the 9/11 terrorist attack. Drafts were available for some procedures. Assistance was obtained from health physicists in the Occupational Safety and Environmental Health office on the main campus. No new date was set due to the efforts required to upgrade the safeguards barriers. Inspector Follow-up Item 50-02/2001-201-01 remains open.

Additional pancake probe friskers were placed at laboratory exits. A sensitive automated frisker (Eberline PCM) was obtained to replace the hand and foot monitor in the building hallway leading to the laboratories. This equipment required some repair but will provide improved frisking once it is operational.

c. Conclusions

The inspector determined that, because: 1) surveys were being completed and documented acceptably to permit evaluation of the radiation hazards that might exist; 2) postings met regulatory requirements; 3) personnel doses were within the NRC's regulatory limits; and, 4) radiation monitoring equipment was being maintained and calibrated as required; the Radiation Protection Program being implemented by the licensee satisfied regulatory requirements.

3. Exit Interview

The inspection scope and results were summarized on April 25, 2002, with members of licensee management. The inspector described the areas inspected and discussed in detail the inspection findings. No dissenting comments were received from the licensee.

PARTIAL LIST OF PERSONS CONTACTED

Licensee

C. Becker, Ford Nuclear Reactor Manager
A. Cook, Reactor Engineer
H. Downey, Reactor Health Physicist
M. Driscoll, Director, Radiation Safety
B. DuChamp, Assistant Manager, Reactor Operations
J. Lee, Chair, Safety Review Committee
J. Miklos, Senior Health Physicist
D. Wehe, Director, Michigan Memorial Phoenix Project

INSPECTION PROCEDURES USED

IP 60745	Class I Non-Power Reactor Fuel Movement
IP 83743	Class I Non-Power Reactors Radiation Protection

ITEMS OPENED, CLOSED, AND DISCUSSED

Updated

50-02/2001-201-01	IFI	Update health physics procedures
-------------------	-----	----------------------------------

Opened

none

Closed

none

LIST OF ACRONYMS USED

CFR	Code of Federal Regulations
HP	Health Physics
IFI	Inspector Follow-up Item
IP	Inspection procedure
NRC	Nuclear Regulatory Commission
TS	Technical Specification