U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Report No. 50-315/94004(DRP)
Docket No. 50-315 License Nos. DPR-58

Licensee: Indiana Michigan Power Company
1 Riverside Plaza
Columbus, OH 43216

Facility Name: Donald C. Cook Nuclear Power Plant, Unit 1

Inspection At: Donald C. Cook Site, Bridgman, MI

Inspection Conducted: February 16, 1994 through March 21, 1994

Inspectors: R. J. Leemon
J. A. Isom

Approved By: W. J. Kropp, Chief
Reactor Projects Section 2A

4/1/94
Date

Inspection Summary
Inspection from February 16, 1994 - March 21, 1994
(Report No. 50-315/94004(DRP)).

Areas Inspected: Special safety inspection in response to the reactor level perturbations between February 17 and 18, 1994, during the draining of the reactor coolant system (RCS) from normal operating level down to the reactor vessel flange.

Results: Based on the results of this inspection, there were three violations identified that pertained to procedures (paragraph 5.a); corrective actions to a previous event (5.c); and equipment status (5.d). There were three unresolved items identified that pertained to pre job briefings (5.a), training of operators for infrequently performed plant evolutions (5.b), and work scheduling and planning 5.e). One inspection followup item was identified that pertained to lack of level indication between the bottom of the pressurizer and the reactor vessel flange (5.d). The following is a summary of the licensee's performance during the draining of the RCS on February 16 through 18, 1994:

Operations

The performance of the operations department during the February 16 through 18, 1994, draining of the RCS was considered poor. The NRC staff is concerned with the failure of the control room operators to properly control a significant plant evolution such as the draining of the RCS. The staff is also concerned with the failure of the control room operators to understand

the importance of maintaining identical pressure throughout the RCS when draining, and also the effects on RCS level during rapid depressurization.

Maintenance

Overall, the work planning and scheduling performed for the draining of the RCS was poor. An outage schedule allowed an air eductor to be installed on the reactor vessel head vent with inappropriate plant conditions. This contributed to the perturbations in the RCS level during the draining of the RCS on February 17, 1994.

There were other concerns noted with work planning and scheduling that did not contribute to the event, but were indicative of poor work planning and scheduling. Both trains of reactor vessel level indication system (RVLIS) were taken out of service with the RCS level at 620 feet and 5 psig pressure, in preparation to remove the reactor vessel head. Other examples include:

- There was several hours of delay in venting sight glass NGG-100 and level instrument NLI-112 due to ALARA concerns, because the containment purge system was not in service and workers did not obtain enough portable tubing.

- There was a delay in testing the eductor after installation because the solenoid valve needed for the operation of the eductor was installed in a new location. This was not considered during the preparation of the work package.

Details

1. Persons Contacted

Consumer Company

* E. E. Fitzpatrick, Senior Vice President-Nuclear Generation
A. A. Blind, Plant Manager
K. R. Baker, Assistant Plant Manager-Production
L. S. Gibson, Assistant Plant Manager-Projects
* J. E. Rutkowski, Assistant Plant Manager-Technical Support
B. A. Svensson, Executive Staff Assistant
T. P. Beilman, Maintenance Superintendent
P. F. Carteaux, Training Superintendent
* D. L. Noble, Radiation Protection Superintendent
L. J. Matthias, Administrative Superintendent
T. K. Postlewait, Design Changes Superintendent
S. A. Richardson, Operations Superintendent
P. G. Schoepf, Project Engineering Superintendent
* J. S. Wiebe, Safety & Assessment Superintendent
* L. H. Vanginhoven, Site Design Superintendent
* G. A. Weber, Plant Engineering Superintendent
D. C. Loope, Chemistry Superintendent
M. L. Horvath, Quality Assurance Supervisor

* Denotes those attending the exit interview conducted on March 21, 1994.

The inspectors also had discussions with other licensee employees, including members of the technical and engineering staffs, reactor and auxiliary operators, shift engineers and foremen, and electrical, mechanical and instrument maintenance personnel, and contract security personnel.

2. Description of Event

On February 12, 1994, Unit 1 was shut down to begin a scheduled refueling outage. On February 17, 1994, preparations were made to vent and drain the reactor coolant system to approximately two feet below the reactor vessel flange to remove the reactor vessel head in preparation for core offload. The licensee also planned to install an air eductor on the reactor vessel vent line to facilitate the removal of conoseals. Due to inadequacies in the drain down procedure and ineffective planning and control by operations personnel, the reactor coolant system level was off sacle for approximately a five hour period.

The inspector concluded that the draindown of the RCS was not adequately performed since there was a period of five hours when RCS level instrumentation was off scale. Fortuitously, there was no safety significance to this event since, at all times, adequate decay heat removal for the reactor core remained available. However, considering

corrective action needs to be in place to prevent recurrence of these events.

3. Initial Conditions

Prior to the event, the residual heat removal (RHR) system was in service, maintaining desired RCS temperature. Two pressurizer power operated relief valves (PORV) were open to connect the pressurizer with the pressurizer relief tank and the RCS to maintain the entire RCS system at 5 psig.

The initial conditions prior to commencing the draining of the RCS was as follows:

- RVLIS train A was out of service (OOS).
- RVLIS train B wide range indication was in service.
- Pressurizer cold calibration level was at 85 percent.
- RCS was pressurized to 5 psig.

4. Sequence of Events

The sequence of events was determined by interviews with licensee personnel on shift at the time of the event, the review of logs, and the review of instrumentation strip chart recorders. The times noted in the following sequence of events labeled with an "(A)" were approximate times based mostly on personnel interviews.

Wednesday, February 16, 1993

Shift supervisor for the 1830 to 0630 shift calculates volume of water to be drained, including steam generator (SG) U-tubes. However, the calculation was not logged or communicated to subsequent shifts.

Thursday, February 17, 1993

0413	Shift supervisor authorized the start of the draindown of the RCS to the reactor water storage tank (RWST) from 82 percent pressurizer level with only the wide range of RVLIS in service.
0615	The RCS drained to 8 percent and stabilized.
0615	Shift change in progress.
0900 (A)	Opened bullseye flow indicator on reactor head vent line.
0930 (A)	Sight glass NGG-100 vented and in service.

0936		Started draindown from 8 percent at 5 to 10 gallons per minute (gpm).
1100	(A)	Pressurizer level at 0 percent. For approximately 20 minutes with no RCS level instrument available, draining was cautiously performed at 5 to 10 gpm..
1120	(A)	RVLIS upper plenum on scale at 100 to 99 percent and tracking.
1402		Stabilized RCS level at 620 feet (two feet below reactor vessel flange) and 5 psig.
1830	(A)	Bullseye was isolated which resulted in the reactor vessel head no longer in communication with the pressurizer and pressurizer relief tank (PRT).
1830	(A)	Started to isolate RVLIS for head removal.
1830		Shift change (1830 to 0630) in progress.
1830	(A)	Started installation of air eductor. The decision to isolate RVLIS and install eductor was the step in the sequence that led to the RCS level perturbations.
1900	(A)	Air eductor installed.
1900	(A)	RVLIS taken out of service.
1900		End of shift change with RCS level at the 620 feet elevation and 5 psig.
2030		When the air eductor was tested, a two foot decrease in level was indicated on NLI-112. By testing the eductor, the reactor vessel pressure was inadvertently vented to 0 psig with the PRT, pressurizer, and level instrumentation being maintained at 5 psig. Also, some draining of the SG U-tubes occurred.
2045	(A)	Air eductor tested again; a one foot decrease in level was indicated on NLI-112.
2100		Rapidly opened PRT vent valve RC-148 to vent RCS from 5 psig to 0 psig. This caused the Steam Generator (SG) U-tubes to drain, and level on sight glass NGG-100 and NLI-112 rapidly increased to off-scale high.
2100		Draining of RCS continues.
2230	(A)	2000 gallons drained from RCS based on a 0.5 percent increase in RWST. Draining was stopped since NGG-100 was still not back on-scale.

2230 (A) Shift personnel caucused and calculated that approximately 13,000 gallons of water had drained from the SG U-tubes. This calculation was based on an assumption that 11.5 feet of water from the SG U-tubes was drained due to the venting of the RCS from 5 to 0 psig at 2030. The decision was made to slowly drain (40 to 60 gpm) until level was back on-scale on NGG-100.

February 18, 1994

0030 (A) Recommenced draining of the RCS to obtain an on scale reading for sight glass NGG-100.

0200 (A) Approximately 5 hours after going off-scale, level indication was back on scale on NLI-112 and sight glass NGG-100.

0330 (A) RCS level was stable at 620 feet and 0 psig with the SG U-tubes vented.

0455 Placed air eductor in service to remove conoseals.

5. Inspection Results

The inspector's review of the activities for the draining of the RCS on February 16 through 18, 1994, identified the following concerns in the areas of procedures, training, corrective actions to a previous event, equipment status, and work scheduling and planning.

a. Procedures

The inspector identified the following concerns with procedures 01-OHP 4021.002.005, "RCS Drain to One to Two Feet Below Reactor Vessel Flange with Fuel in Core"; PMI-4090, "Criteria for Conducting Infrequently Performed Tests or Evolutions"; and OHI-221 "Maintenance of Operations Department Logs,":

1) Procedure 01-OHP 4021.002.005, "RCS Drain to One to Two Feet Below Reactor Vessel Flange with Fuel in Core"

The inspector reviewed procedure 01-OHP 4021.002.005 to determine if the procedure was adequate to control the draining of the RCS. This review identified the following concerns:

- The draindown procedure allowed the shift supervisors to drain the RCS without having the RVLIS in service. RVLIS, if available, provided a mechanism for trending RCS level between the top the reactor vessel and the vessel flange. Shift supervisors invoked this option twice while draining the RCS. The first time, when commencing the draindown, train (A) of narrow level

RVLIS was out of service for the modification to convert the reactor protection system from analog to digital, and train (B) of RVLIS was out of service for breaker maintenance. The wide range indication for train (A) of RVLIS was available. Also, all of RVLIS was taken out of service with the RCS level at 620 feet and 5 psig pressure, in preparation to remove the reactor vessel head. This premature removal of both trains of RVLIS resulted in operators having no RCS level indication for a 5-hour period when the RCS was depressurized shortly after installing the eductor.

- The procedure did not provide the volume of RCS to be drained or the volume of water expected from the steam generator (SG) U-tubes when the RCS was vented from 5 psig to 0 psig. Therefore, when the RCS was vented, resulting in an off scale indication on sight glass NGG-100, the operators did not know the volume of water to be drained from the RCS to restore RCS level indication without performing calculations.

- The procedure did not contain adequate instructions to slowly vent the reactor coolant system from 5 psig to 0 psig in a controlled manner. This resulted in the rapid depressurization of the RCS and subsequent lost of level indication.

- The procedure did not contain any references between plant elevations and the various level instruments. Therefore, operating crews used personal notes from previous draindowns to determine RCS level based on wide range RVLIS.

- The procedure did not clearly define the plant conditions required (RCS at 0 psig) to isolate the bullseye and install the air eductor.

2) Log Keeping and Shift Turnovers

Procedure OHI-221 "Maintenance of Operations Department Logs," Revision 15, step 3.2.1.b for the control room log and step 3.3.1.b for the shift supervisor log book, requires that all significant shift activities and events, and all pertinent information that would assist in the reconstruction of a plant event be recorded. The logs were inadequate in that the following key plant evolutions were not properly logged:

- The calculated amount of water that was needed to be drained from the PRT to achieve a 5 percent level, the

volume of water actually drained, and the flow path used to the Reactor Coolant Drain Tank.

- The time when RCS level was no longer available from pressurizer level indication.
- The time when RCS level returned on scale on wide range RVLIS.
- The time that RCS level went off scale high on sight glass NGG-100 and the time RCS level returned on scale.

Additionally, calculations for volume changes were performed on scratch paper and not passed from one crew to another during shift turnover. These calculations were not kept which resulted in some operators not knowing the quantity of coolant to be drained. For example, the evening shift on February 16, 1994, did calculations for the quantity of water needed to be drained from the RCS to reach the reactor vessel flange, including the water that would drain when from the SG U-tubes. During the event, when RCS level was off scale high on sight glass NG-100, the shift calculated that 13,000 gallons of water was needed to be drained to obtain an on scale reading on NGG-100. This calculation was written on scratch paper, and then selected information was entered into the log. Also, during this draindown, there were several late entries in the log relating to important information.

Based on the above, the failure to have an appropriate procedure to control the draining of the RCS, and the failure to record in the control room log or shift supervisor log book significant shift activities and events with other pertinent information that would assist in the reconstruction of the reactor coolant system draindown event is considered a violation of Title 10 of the Code of Federal Regulations, Part 50, Appendix B, Criterion V. (50-315/94004-01(DRP))

During the review of the event, the inspectors determined that a pre-job briefing for draining the RCS had not been performed by the licensee's management. Discussion with licensee's management determined that procedure, PMI-4090 "Criteria for Conducting Infrequently Performed Tests or Evolutions," did not require a pre-job briefing with plant management in attendance for each shift involved in the draining of the RCS. The procedure does allow management discretion to conduct a pre-job briefing for plant evolutions, but this discretion was not invoked for the draining of the RCS on February 16 through 18, 1994. The inspectors were concern that a pre job briefing was not conducted, and this matter is considered an unresolved item pending further NRC review (50-315/94004-02).

b. Training

The inspector reviewed the circumstances that led to the installation of the air eductor with RCS pressure at 5 psig. Through discussions with licensee personnel, the inspectors determined that the installation of the air eductor was placed on the schedule without adequate consideration of the plant status by the control room. The control room's decision to allow the installation of the air eductor was based on the refueling outage schedule, which identified the necessary plant condition to install the eductor as RCS level at 620 feet (approximately 1 foot below the flange). There was no consideration in the schedule for RCS pressure during the installation of the eductor. When the eductor was tested, the reactor vessel head was vented, which resulted in the reactor vessel being at a different pressure (0 psig) than the pressurizer, PRT, and the level instrumentation (5 psig). This resulted in an RCS level indication lower than actual level.

Also, shortly after testing the eductor, the control room directed operators in the containment to vent the RCS through a connection to the PRT. With the reactor vessel head at 0 psig; the rapid venting of the PRT and pressurizer resulted in an RCS level change due to the large volume of coolant drained from the SG U-tubes into the reactor vessel. The draining of the SG U-tubes to the reactor vessel resulted in RCS level going off scale on sight glass NGG-100 for approximately a 5-hour period with no other level indication available. The operators were not aware of the effects of rapidly depressurizing the RCS. This was evident because of the operators' subsequent action to drain 2000 gallons from the RCS in an attempt to restore RCS level indication. The operators proceeded in the face of uncertainty by not assessing the loss of level indication prior to draining the 2000 gallons.

Based on the above, the inspectors had a concern with the training of operators for infrequently performed plant evolutions. This matter is unresolved item pending further review by the licensee and the NRC (50-315/94004-03(DRP)). The licensee has agreed to respond to this item by August 1, 1994.

c) Previous Problems with the Draining of the RCS

During the draining of the RCS from the bottom of the pressurizer to the top of the reactor vessel head on February 17, 1994, no flow through the bullseye was observed by an operator and verified by a second operator. The bullseye was installed on the reactor vessel head vent to monitor the status of the RCS level between the bottom of the pressurizer and the top of the reactor vessel head during draining. If flow existed through the bullseye, the operators knew that the RCS level was between the bottom of the pressurizer and the top of the reactor vessel head.

head during draining. If flow existed through the bullseye, the operators knew that the RCS level was between the bottom of the pressurizer and the top of the reactor vessel head.

The failure to see flow through the bullseye also occurred during the draindown of the RCS on August 5, 1993, when the reactor coolant system was being drained to repair a reactor head conoseal. As a result, the reactor was drained to a lower level than anticipated prior to valving in sight glass NGG-100. The shift's explanation in August, 1993, was that when the bullseye was monitored for flow, the level had already been drained below the bullseye connection on the reactor vessel vent line.

A condition report (CR 93-1267) was issued for the August 5, 1993, draindown event. The corrective action consisted of a revision to procedure, 01-OHP 4021.002.005, "RCS Drain to One to Two Feet Below Reactor Vessel Flange with Fuel in Core." The revision required that sight glass NGG-100 be placed in service at a level of 5 percent in the pressurizer. The corrective action was narrow in scope and did not adequately resolve the problem, since two operators did not observe flow through the bullseye during the February 16 through 18, 1994, draining of the RCS. The failure to provide adequate corrective action to preclude the inability to use the bullseye during the draining of the RCS is considered a violation of 10 CFR Part 50, Appendix B, Criterion XVI (50-315/94004-04(DRP)).

d. Equipment Status

The inspectors identified that the currently installed RCS level instrumentation did not cover the full span from the top of the pressurizer down to the reactor vessel flange. There was approximately a three foot area below the pressurizer and above the top of the reactor vessel where there was no installed level instrumentation. In addition, the licensee used RVLIS instrumentation, if available, as a trending device to monitor RCS level between the top of the reactor vessel and the vessel flange. At the vessel flange, the level fell within the scale of the NGG-100 gauge glass. The inspector noted that 01-OHP 4021.002.005 did not require that RVLIS be available during the draindown evolution. The matter regarding full span level coverage is considered an Inspection Followup Item pending further NRC review (50-315/94004-04(DRP)).

Also, the inspectors were concerned with the operators' use of pressurizer relief tank (PRT) level instrument indicator, 1-NLA-351, that had a "defective" tag which had been placed on the instrument on November 18, 1992. This PRT level indication was required to be used during the drain down because the drain down procedure, 01-OHP 4021.002.005, required PRT level to be less than 5 percent prior to commencing the draining of the RCS. The operating crew drained the PRT to the reactor coolant drain tank

appeared to track, the use of an instrument that was known to have accuracy outside of necessary limits to monitor level in the PRT, is considered a violation of 10 CFR Part 50, Appendix B, Criterion XII (50-315-94004-05(DRP)).

e) Schedule and Planning

Poor work scheduling and planning contributed to the perturbations in the RCS level during the draining of the RCS on February 17 and 18, 1994. The following were examples of poor work scheduling and planning:

- Both trains of RVLIS were taken out of service with the RCS level at 620 feet and 5 psig pressure in preparation to remove the reactor vessel head.

- The air eductor was installed when plant conditions were not appropriate for the activity. The schedule identified that the eductor was to be installed when the RCS level was at 620 feet elevation, without requiring the RCS to be depressurized to 0 psig. As a result, when the RCS level was at 620 feet, maintenance workers were staged in containment to install the air eductor. Expediters repeatedly telephoned the control room requesting authorization to install the air eductor. This external pressure was a contributing factor in the operators' decision to install the air eductor with the wrong plant conditions.

- There was several hours of delay in venting sight glass NGG-100 and level instrument NLI-112 due to ALARA concerns, because the containment purge system was not in service and workers did not obtain enough portable tubing. The total delay in putting these instruments into service was approximately five hours. However, this delay did not impact the draining of the RCS, since level was still in the pressurizer during this time.

- There was a delay in testing the eductor after installation, because the solenoid valve needed for the operation of the eductor was installed in a new location. This new location resulted in maintenance workers not having enough air line to test the eductor. This change in location of the solenoid was not considered during the preparation of the work package. The licensee issued Condition Report 94-290 to evaluate this inadequate work planning .

Based on the above, concerns with work scheduling and planning are considered an Unresolved Item pending further review by the NRC (50-315/94004-06(DRP)).

6. Root Cause Analysis

The inspectors determined that the major casual factors for the RCS level perturbation event that resulted in the loss of level indication for five hours on February 17, 1994 were:

- A draindown procedure that did not provide adequate instructions to vent the reactor coolant system from 5 psig to 0 psig in a controlled manner. This resulted in the rapid depressurization of the RCS and subsequent lost of level indication.

- The air eductor was installed when plant conditions were not appropriate for the activity. The schedule identified that the eductor was to be installed when the RCS was at the 620 feet elevation, without requiring the RCS to be depressurized to 0 psig.

- The operating crew did not maintain adequate control when expediters repeatedly telephoned the control room requesting authorization to install the air eductor

7. Licensee Immediate Corrective Actions

The licensee performed an excellent sequence of events root cause analysis for this event. The inspector performed an independent sequence of events and root cause assessment of this event, then discussed the licensee's sequence of events and root cause assessment which is still ongoing. The licensee's root cause assessment agreed with the inspector's conclusions. The immediate concerns were identified and the licensee initiated immediate corrective actions that included:

- Operating procedures 01(02)-OHP 4021.002.001, "Filling and Venting the Reactor Coolant System" will be revised to incorporate lessons learned from this event. The procedure revisions will also incorporate all applicable standards that apply to operation under "reduced inventory" conditions. These procedure enhancements will be completed prior to replacing the Unit 1 reactor vessel head on the vessel with fuel in the core and, for Unit 2, prior to the next procedure usage.

- Operating procedures 01(02)-OHP 4021.002.005, "RCS Draining", will be revised to incorporate lessons learned from this event. The procedure revisions will also incorporate all applicable standards that currently applied to operation under "reduced inventory" conditions. These procedure enhancements will be completed for Unit 1 prior to any draindown of the RCS after the system is filled and vented following core reload. These same enhancements will be in place for Unit 2 prior to the next procedure usage.

- Administrative controls for reactor coolant system operation at "reduced inventory" will be reviewed against lessons learned from

this event and will be continuously reviewed against industry operating experience information. Enhancements will be made to reduced inventory standards, as appropriate, prior to operation at reduced inventory levels with fuel in the core (applies to both Units).

- Both units will be provided full-range temporary RCS level instrumentation prior to the next draindown of the reactor coolant system with fuel in the core. The instrumentation will meet the Generic Letter 88-17 criteria, as committed.

- An engineering program will be established to evaluate the feasibility and usefulness of the RVLIS system as a reactor coolant system level indicator during draindown evolutions. Data will be gathered as a part of this program during the post-refueling outage vessel floodup on Unit 1.

- A study will be performed to identify and evaluate full-range reactor coolant system level indication system, considering the criteria specified in Generic Letter 88-17. The study will be completed by the end of 1994, and a document will be available to the NRC that describes the results and conclusions of the study.

- A review of management effectiveness will be performed. The review will be completed by July 15, 1994, which is prior to the scheduled Unit 2 outage. A document will be available to the NRC that describes the results and conclusions of this review.

- Reactor coolant system draindown evolutions will be evaluated against the requirements specified in PMI-4090, "Criteria for Conducting Infrequently Performed Tests or Evolutions".

- The site management staff, production facilitation teams, and operating crew management have received an initial briefing on the February 16 through 18 reactor coolant system level perturbation event, including generic implications.

- Plant Management has historically emphasized that safety (nuclear, radiation, and personnel safety) was the "number one" priority during outage periods, as well as during normal plant operation. Management will continue to stress this commitment to safety during management meetings and at other opportunities.

8. Inspection Followup Items

Inspection followup items are matters which have been discussed with the licensee, which will be reviewed by the inspector and which involve some action on the part of the NRC or licensee or both. An Inspection Followup Open Item disclosed during the inspection is discussed in Paragraph 5.d.

9. Unresolved Items

Unresolved items are matters about which more information is required in order to ascertain whether they are acceptable items, violations, or deviations. Unresolved items disclosed during the inspection are discussed in paragraphs 5.a, 5.b, and 5.e.

10. Exit Interview (30703)

The inspectors met with the licensee representatives denoted in paragraph 1 during the inspection period and at the conclusion of the inspection on March 21, 1994. The inspectors summarized the scope and results of the inspection and discussed the likely content of this inspection report. The licensee acknowledged the information and did not indicate that any of the information disclosed during the inspection could be considered proprietary in nature.