July 21, 2006

Mr. Paul A. Harden
Site Vice President
Nuclear Management Company, LLC
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043-9530

SUBJECT: PALISADES NUCLEAR PLANT
NRC SPECIAL INSPECTION REPORT 05000255/2006008(DRS)

Dear Mr. Harden:

On June 14, 2006, the U. S. Nuclear Regulatory Commission (NRC) completed a Special Inspection at your Palisades Nuclear Plant to evaluate the facts and circumstances surrounding an event that occurred on April 19, 2006. In that event, a cask liner containing highly radioactive incore detectors became buoyant and floated to the surface of the reactor cavity pool, then filled with water and sank back down to the bottom of the pool. The enclosed report documents the inspection findings, which were discussed with you and members of your staff.

The inspection examined activities conducted under your license as they relate to safety and compliance with the Commission's rules and regulations and with the conditions of your license. The inspectors reviewed selected procedures and records, observed activities, and interviewed plant personnel.

During the back-shift on April 18-19, 2006, workers lowered a shipping cask and cask liner into the refueling cavity pool located in the Containment Building. The liner housed irradiated incore detector remnants which were loaded into the liner during previous refueling outages and had since been stored in one of the plant’s onsite storage buildings. Your staff intended to load additional irradiated detectors into the liner for storage as it had done during previous outages. At about 0200 hours on April 19, 2006, the cask was set on the reactor cavity pool floor and the cask lid was removed. At approximately 0230 hours, following attachment of rigging cables to the liner, the cask liner rose out of the cask due to its buoyancy up to the surface of the cavity pool. This created a transient elevated radiation condition at the 649' level of the Containment Building. While the cask floated on the pool surface for approximately 12 seconds, elevated radiation levels were generated in the area which caused area radiation monitor and electronic dosimetry worn by workers in the area to alarm. Workers evacuated the 649' level of the Containment Building as the liner sank back down to the bottom of the reactor cavity, ending the radiological transient.

Based on the deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," the incident was determined to warrant the establishment of a Special Inspection Team that was initiated in accordance with Inspection Procedure 93812, "Special Inspection." The inspection was chartered to evaluate the facts and circumstances surrounding the event including its causes, as well as the actions of your staff during the radiological transient. The inspection focused on nine areas as described in the enclosed Special Inspection Charter.

The NRC Special Inspection team concluded that this event could have been avoided had the job and procedure review processes identified that the liner was fabricated from carbon steel, would be repeatedly subjected to a boric acid environment, and was not intended for multiple uses due to the potential for corrosive degradation. When the liner reached the surface of the reactor cavity, elevated dose rates were generated which could have resulted in significant unnecessary exposure to workers. However, the NRC inspection team determined that your staff's response to the radiological transient was appropriate, which minimized worker radiation exposures.

Based on the results of this inspection, one finding of very low safety significance (Green) was identified, which involved a violation of NRC requirements. However, because of its very low safety significance and because the associated issues were entered into your corrective action program, the NRC is treating the violation as a Non-Cited Violation in accordance with Section VI.A.1 of the NRC Enforcement Policy.

If you contest the subject or severity of a Non-Cited Violation, you should provide a response within 30 days of the date of this inspection report, with the basis for your denial, to the U.S. Nuclear Regulatory Commission, ATTN: Document Control Desk, Washington, D.C. 20555-0001; with copies to the Regional Administrator, U.S. Nuclear Regulatory Commission - Region III, 2443 Warrenville Road, Suite 210, Lisle, IL 60532-4352; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001; and the NRC Resident Inspector at the Palisades facility.

In accordance with 10 CFR 2.390 of the NRC's "Rules of Practice," a copy of this letter, its enclosure, and your response (if any), 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), accessible from the NRC Web site at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA by Anne T. Boland Acting For/
Cynthia D. Pederson, Director
Division of Reactor Safety

Docket No. 50-255
License No. DPR-20

Enclosure: Inspection Report 05000255/2006008(DRS)
w/Attachments: 1. Supplemental Information
2. Special Inspection Charter

See Attached Distribution

cc w/encl: J. Cowan, Executive Vice President
and Chief Nuclear Officer
R. Fenech, Senior Vice President, Nuclear
Fossil and Hydro Operations
D. Cooper, Senior Vice President - Group Operations
L. Lahti, Manager, Regulatory Affairs
J. Rogoff, Vice President, Counsel and Secretary
A. Udrys, Esquire, Consumers Energy Company
S. Wawro, Director of Nuclear Assets, Consumers Energy Company
Supervisor, Covert Township
Office of the Governor
State Liaison Office, State of Michigan
L. Brandon, Michigan Department of Environmental Quality -
Waste and Hazardous Materials Division

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Docket No. 50-255
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Enclosure: Inspection Report 05000255/2006008(DRS)
w/Attachments: 1. Supplemental Information
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U.S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No:	50-255
License No:	DPR-20
Report No:	05000255/2006008
Licensee:	Nuclear Management Company, LLC
Facility:	Palisades Nuclear Plant
Location:	Covert, MI
Dates:	April 20 through June 14, 2006
Inspectors:	J. Cassidy, Radiation Specialist J. Ellegood, Senior Resident Inspector J. House, Senior Radiation Specialist (Lead Inspector) F. Ramirez, Reactor Engineer R. Walton, Operations Engineer
Approved by:	Wayne J. Slawinski, Acting Chief Plant Support Team Division of Reactor Safety

SUMMARY OF FINDINGS

IR 05000255/2006008; 04/20/2006 - 06/14/2006; Palisades Nuclear Plant; Special Inspection.

This report covered a 2-week onsite inspection period. The inspection was conducted by a Special Inspection Team of Region III inspectors and Resident inspectors. One Green finding was identified which had an associated Non-Cited Violation (NCV). The significance of most findings is indicated by their color (Green, White, Yellow, Red) using Inspection Manual Chapter (IMC) 0609, "Significance Determination Process (SDP)." Findings for which the SDP does not apply may be "Green" or be assigned a severity level after NRC management review. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 3, dated July 2000.

A. NRC-Identified and Self-Revealed Finding

Cornerstone: Occupational Radiation Safety

- Green. A self-revealing finding of very low safety significance and an associated Non-Cited Violation of Technical Specification 5.4 "Procedures," were identified. On April 19, 2006, while lowering a shielded cask and its liner into the reactor cavity in preparation for placing additional incore (irradiated) instruments into the liner, the liner failed to displace air and adequately flood-up with water. As a result, the liner, which housed highly radioactive irradiated incore detectors, floated up to the pool surface where it remained for about 12 seconds before sinking back down into the pool. The incident created transient elevated radiation levels on the refueling deck of the containment building resulting in radiological exposure to the workers in the area. The primary cause of this finding was an inadequate procedure for the work activity and the procedure change review process that failed to identify deficiencies with the procedure and with its development. The procedure allowed a carbon steel liner to be used on multiple occasions in a boric acid environment without properly accounting for its design, its material composition, and the manufacturer's intended use. Licensee corrective actions included a procedure revision to preclude the repeated use of carbon steel liners in harsh environments, and an action to evaluate the current procedure change review processes.

  The finding was more than minor because it was associated with the program and process attribute of the Occupational Radiation Safety Cornerstone, and adversely affected the Cornerstone objective of ensuring adequate protection of worker health and safety from exposure to radiation. The finding was of very low safety significance because it did not involve significant radiation exposure or a substantial potential for an overexposure, nor was the licensee's ability to assess worker dose associated with the event compromised. The issue was a Non-Cited Violation of Technical Specification 5.4 which required, in part, that procedures appropriate to the circumstances be developed (Section 4OA3.6).

B. Licensee-Identified Violations

None.

REPORT DETAILS

Summary of Plant Event

On April 19, 2006, at about 0230 (EST), a radiological incident occurred which created significantly elevated dose rates on the 649' level of the containment building (the refuel floor). The plant was in Mode 6 conducting a refueling outage, which included activities related to handling irradiated incore detectors. The licensee placed a shielded cask in the reactor cavity pool in preparation for cutting and storing the irradiated incore probes. The cask, which contained pieces of irradiated detectors from previous refuel outages, had been stored dry in the east radwaste building and had been moved into the containment building and lowered into the cavity pool to begin the work.

The cask consisted of a shielded outer cylinder with an inner liner which housed the irradiated in-core instrument remnants. The liner was constructed of carbon steel with an estimated weight of 700 lb, and was approximately 25 inches in diameter and 4-feet high. The outer cask was equipped with a bottom drain; the inner liner had two mesh areas on the bottom, each about 2.5 inches in diameter to allow for water ingress along with a vented lid. Once submerged on the floor of the reactor cavity pool, the outer cask lid was removed. Workers at the perimeter of the cavity then used long handled tools to remove straps attached to the inner liner. During this evolution, after the straps were loosened, the inner liner began to float upward toward the surface of the reactor cavity. A supervisor observed the liner rising and alerted the workers near the cavity to evacuate. The liner surfaced and floated atop the pool surface for approximately 12-seconds, which resulted in transient elevated dose rates on the refuel floor. The liner then sank to the bottom of the cavity. Area radiation monitors on the refuel floor measured dose rates of approximately 1200 millirem/hr causing them to alarm, which resulted in workers on the refuel floor evacuating the area. Work being conducted at the 649' elevation of the containment building was suspended by the licensee pending an investigation.

Using the electronic dosimetry (ED) worn by workers present in the area and their relative positions during the event, dose calculations indicated that the radiation exposures for the individuals involved ranged from 7 to 61 millirem deep dose equivalent. Licensee surveys disclosed no increased airborne or area contamination on the refuel floor as a result of this incident. Transient dose rates recorded by worker's EDs ranged from less than 1 millirem/hr to approximately 46,000 millirem/hr, with the dosimetry of most workers in the immediate area showing approximately 4,000 to 20,000 millirem/hr The significantly elevated dose rates existed for only a few seconds until the liner sank back into the pool. Electronic dosimetry worn by several workers present in the area alarmed from high radiation levels. Due to the rapid response of the workers to the transient radiological conditions and quick recognition of the problem by a supervisor that provided work oversight, worker accumulated doses were within the limits prescribed by their radiation work permits (RWPs).

The liner sank to the bottom of the reactor cavity landing on the 1" thick stainless steel support plate placed on the reactor cavity floor. Subsequent visual inspections completed by the licensee determined that there was no damage to either the liner or the support plate.

The NRC dispatched a Special Inspection Team to the Palisades station to investigate this event on April 20, 2006.

Inspection Scope

Based on deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," which involved concerns pertaining to licensee operational and equipment performance, a Special Inspection was initiated in accordance with Inspection Procedure 93812, "Special Inspection."

The inspection focused on the following charter items:

1. Establish a Sequence of Events including the sequence of the work planning, and job briefings, and the licensee's determination of the event classification.

2. Review the work planning including the application of operating experience, lessons learned, contingency and as-low-as-is-reasonably-achievable (ALARA) planning, and the interfaces among operations and work planning staff during the planning process.

3. Review the experience of the staff involved in the work activity and the management involvement/oversight of the actual work.

4. Evaluate the licensee's root cause evaluation and extent of cause/condition, as applicable.

5. Evaluate the engineering or operational factors that caused or contributed to the event including equipment design or use issues.

6. Evaluate the human performance impacts and contributing factors including procedure adequacy and adherence.

7. Evaluate the actual and potential radiological consequences.

8. Identify any unique characteristics which may have contributed to the event such as schedule pressure or work distractions.

9. Evaluate the impact of the fallen liner on the refuel cavity liner and associated structures.

4. OTHER ACTIVITIES (OA)

4OA3 Special Inspection (93812)

.1 Sequence of Events and Event Classification

a. Inspection Scope

On April 19, 2006, a cask liner containing pieces of highly radioactive (irradiated) incore detectors floated to the surface of the reactor cavity pool, then filled with water and sank back to the bottom of the pool. The inspectors reviewed licensee documents and video records, and interviewed licensee personnel in order to establish a sequence of events for this incident.

b. Findings and Observations

No findings of significance were identified

(1) Sequence of Events

Based on a review of the licensee's initial investigation, control room logs, interviews with plant personnel and observations of video recordings, the inspectors developed the following sequence of events associated with the incident.

Date and Time	Event Description
September 23, 2005	Work order approved. Instruction to perform cask movement per procedure requirements of RFL-V-3.
February 22, 2006	Palisades Procedure RFL-V-3, "Installation/Removal of Incore Cask and Liner" is approved. (Licensee used Westinghouse procedure CPAL-RFM-007 during the previous evolution in October 2004).
March 16, 2006	ALARA evaluation of hazards using Radiological Work Assessment Form QF-1203 completed.
March 29, 2006	Radiological Work Assessment was approved.
April 18, 2006	
7:00pm	Westinghouse 'C' crew received radiation protection (RP) and pre-job briefs.
10:00pm	Westinghouse 'D' crew received RP and pre-job briefs.
11:30pm (approx)	Truck transporting Cask 1-13C left east radwaste building.
11:49pm (approx)	Cask entered containment through the equipment hatch.
April 19, 2006	
2:10am	Cask was lowered to the reactor cavity pool floor and placed on the impact plate.
2:14am	Cask lid was removed and set on the impact plate next to the cask.
2:28am	Bound cask liner rigging released.
2:29:59am	Large release of bubbles and cask liner movement upward.
2:30:20am (approx)	Job supervisor noticed cask liner rising and alerted

	workers to exit the area.
2:30:26am	Cask liner breaches the water surface.
2:30:31am	Area Radiation Monitor alarm sounds. Control Room receives Plant Process Computer Urgent Alarm: Fuel handling area monitor No. 2
2:30:36am	Cask liner begins to sink.
2:30:59am	Cask liner landed on the cavity floor support plate.
2:31:20am	Containment refuel floor (El 649') was evacuated. Shift Manager reviewed the Emergency Implementation Plan and decided that no entry conditions were warranted. Operations Manager concurred.
6:49pm	Event Notification Report No. 42514 made to Headquarters Operations Officer

April 20, 2006

11:00am (approx)	Cask liner was lifted and inspected for damage and material condition including liner bottom and lid.
12:00pm (approx)	Cask liner was placed inside cask.

April 22, 2006

3:00am	Cask transported to east radwaste building.

(2) Event Classification:

The inspectors interviewed control room personnel and reviewed emergency preparedness documents.

When the liner floated to the surface, elevated radiation levels caused the containment building fuel handling area radiation monitors RIA 2316 and 2317 to alarm. The highest dose rate recorded was 1213 millirem/hr. The shift manager and operations supervisor in the control room reviewed the emergency conditions that might apply. With the normal background readings for containment being approximately 12 millirem/hr, the alarm of 1213 millirem/hr was a 100 fold increase in an area radiation monitor. Since this was less than the 1000 fold increase required for an area radiation monitor to meet an emergency classification, the shift manager determined that they did not meet an emergency classification. The operations manager, who was providing control room oversight, concurred with the decision.

About 16 hours later, emergency preparedness personnel reviewed this event. They considered dose rates from the dosimetry worn by personnel working around the edge of the reactor cavity pool. The maximum dose rate detected by personnel dosimetry was 46,000 millirem/hr. Since this was >1000 times background readings, the licensee reported this event to the NRC as “a potential event discovered after the fact.” The inspectors concluded that the control room personnel responded appropriately to the alarm and verified that the condition did not warrant an emergency declaration or a report to the NRC given the information known at that time. The inspectors noted that emergency preparedness personnel appropriately reviewed the condition and based on personnel dosimetry, conservatively reported the event to the NRC 16 hours later.

.2 Work Planning

a. Inspection Scope

The inspectors reviewed the planning for the incore detector loading activities including the application of operating experience, lessons learned, contingency and ALARA planning, and the interfaces among operations and work planning staff during the planning process. The inspectors also reviewed the applicable radiation work permits (RWPs), ALARA and job planning, and interviewed licensee personnel involved in the evolution to determine if radiological controls were adequately established given the anticipated radiological conditions.

b. Findings and Observations

No findings of significance were identified.

Discussion: The inspectors reviewed procedure RFL-V-3, Installation/Removal of Incore Cask and Liner, Revision 0, the RWP and ALARA work package for the evolution. The procedure did not contain guidance on vent time for the liner. However, since this evolution had been performed twice in the past, workers indicated that they did not expect this job to be any different from previous successful operations. Pre-job briefs for job steps and radiological conditions including high and locked high radiation area briefings were conducted with work crews. Following the incident, licensee discussions with the Institute for Nuclear Power Operations and the vendor indicated that neither organization had identified any similar operating experience.

The inspectors interviewed the individuals that completed the ALARA planning for the work activity. The ALARA planning included activities for moving the cask into the flooded reactor cavity, removing the cask lid from reactor cavity, replacing the lifting shackles on the cask lid, and cutting the in core detectors and placing them in the liner. The ALARA planning focused on the replacement of the shackles on the cask lid because that activity was identified to be the most radiologically risk significant aspect of the work due to the contamination levels on the lid. The highly contaminated lid would be transferred from the refueling cavity pool to an area accessible to the work crew. The plan also similarly focused on the control of hot particles that could be present on the threaded connections of the shackles. During the pre-job brief with the work crew, the shackling activities were a point of focus. The lowering of the cask and liner assembly into the cavity pool and measures to ensure the assembly was vented and water-filled before removal of the cask lid was not identified as a risk significant concern since this evolution had been successfully completed during previous outages.

The inspectors concluded that preparations for this job were similar to that for other routine outage work and that adequate coordination between the work crews and radiation protection had occurred. The inspectors concluded that job preparation appeared adequate given the information known at the time.

.3 Work Crew Experience and Management Involvement/Oversight

a. Inspection Scope

The inspectors interviewed the workers that participated in the job and evaluated their training and experience to determine if they were qualified to perform this evolution, and assessed management involvement/oversight of the actual work.

b. Findings and Observations

No findings of significance were identified.

Discussion

Staff Experience: The four Westinghouse contractors (‘C’ Crew) were experienced in containment and refueling activities. The ‘C’ crew supervisor had participated in the lift of the same cask and liner during the previous outage in October 2004 without incident. The supervisor stated he used the same process as the previous lift, but could not explain the different outcomes. Another Westinghouse contractor stated that he had worked with cask and liners housing irradiated detectors since 1979, but did not ever load a liner that had been reused.

The four Westinghouse contractors, the polar crane operator, two radiation protection technicians, and a former radiation protection supervisor that served in a field oversight role all participated in the RWP briefing and had discussed the details of the cask and liner move into containment and into the reactor cavity. The field supervisor supplemented the pre-job brief with additional information since this individual was familiar with containers being opened underwater and associated radiological hazards.

The Westinghouse job supervisor directed the task of moving the cask and liner and removing the cask lid underwater. The radiation protection field supervisor was in a position to observe the liner rise out of the cask and move towards the surface of the pool and immediately alerted the workers to evacuate the area. The video recording of this event was reviewed by the inspectors and it revealed workers moving quickly out of the area as the liner floated to the surface of the reactor cavity.

The workers at the edge of the reactor cavity heard a containment area radiation alarm (RIA-2317 peaked at 1213 millirem/hr with an alarm set to 80 millirem/hr), and exited the 649' level of containment expeditiously.

Management Involvement:

There were no site managers involved with this activity. The licensee had previously determined that moving the cask and liner through containment and into the reactor cavity was not an evolution that warranted direct management oversight. The radiation protection field supervisor provided adequate job oversight and ensured proper worker response to the radiological transient.

The inspectors concluded that the work crew was experienced and the workers responded to the transient properly.

.4 Review of Root Cause Evaluation, Extent of Condition and Extent of Cause

a. Inspection Scope

The inspectors reviewed the licensee's Root Cause Investigation (RCI) Report No. 01024794 to assess its adequacy including a determination of whether the licensee identified the root and contributing causes, and completed Extent of Condition and Extent of Cause reviews consistent with NRC inspection procedure guidance.

b. Findings and Observations

No findings of significance were identified

Discussion: The licensee's root cause investigation of the event was sufficient in scope and appeared to correctly identify the root and contributing causes of the event. The inspectors also concluded that the licensee's Incident Investigation Report was accurate and provided the necessary information to preclude this event from occurring in the future. The licensee's RCI analysis determined that there was an Equipment Root Cause, an Organizational Root Cause and one Contributing Cause:

Equipment Root Cause: This portion of the RCI identified that the flow paths for the cask drain line and liner drains were blocked with debris (corrosion products and paint chips) which prevented the cask and liner from being able to properly vent and fill with water.

Organizational Root Cause: This portion of the RCI addressed the fact that plant personnel did not recognize the consequences or potential problems associated with the effects of multiple uses of a carbon steel liner in a boric acid environment.

Contributing Cause: This portion of the RCI identified that the procedure used in this evolution was inadequate and lacked proper guidance to verify that the liner was not buoyant prior to lifting the cask lid from the cask and did not verify that the cask drain line was not plugged prior to use.

Corrective Action Synopsis: The RCI identified three principal actions to prevent recurrence. Those actions consisted of: (1) a study to design, fabricate and deliver a storage basket for irradiated incore detectors in the spent fuel pool; (2) development of plans to determine how incore detectors currently in dry storage will be handled including methods to prevent future buoyancy problems; and (3) procedure revisions which preclude reuse of any carbon steel liners in borated water environments.

The NRC staff's review of the Root Cause Investigation Report determined that the overall investigation was sufficient in scope and correctly identified the root and contributing causes. However, the NRC staff found that the licensee's investigation had not fully explored generic and potentially more fundamental aspects of the organizational root cause. Specifically, while the organizational root cause identified by the licensee focused on personnel failures to recognize the consequences of using carbon steel products multiple times in harsh environments, the investigation did not explore a potentially generic organizational cause associated with procedure change review and 10 CFR 50.59 design change review processes. For example, the licensee did not determine what, if any, link existed between the procedure development, the procedure change review process, and the resulting inadequate procedure. In particular, the root cause investigation had not determined whether the licensee's current procedure change review process ensured that: (1) equipment manufacturers were consulted during the development of new procedures; (2) equipment design documentation were reviewed, if applicable; and (3) industry benchmarking was performed to determine if equipment and tools would be utilized consistent with industry practices and as intended by the manufacturer. As a result, corrective actions were not formulated to address this potentially more fundamental, generic issue associated with the organizational cause. Additionally, the inspectors review identified concerns with the rigor of the licensee's Extent of Condition review.

However, following the exit meeting on June 14, 2006, the inspectors learned that the licensee's root cause investigation team had previously recognized that the organizational root cause and extent of condition reviews were not complete, and that generic implications had not yet been fully evaluated. This was not clearly documented in the licensee's RCI report. The inspectors also learned that a corrective action document was generated by the licensee as part of its root cause investigation to perform a more comprehensive review of the organizational root cause and complete an expanded extent of condition review (AR-01024794; dated April 19, 2006).

.5 Evaluation of Engineering or Operational Factors

a. Inspection Scope

The inspectors reviewed the licensee's Incident Response Report (CAP 01024794), the video of the job evolution, drawings and dimensions of the cask and liner, and interviewed licensee representatives to ascertain if the licensee's investigation adequately determined the factors that caused or contributed to the event including equipment design or use issues.

b. Findings and Observations

No findings of significance were identified

Discussion: Following the incident on April 19, 2006, the licensee established an incident investigation team. The team determined that air did not properly vent from the liner due to either blocked vent holes on the top of the liner and/or blocked drain holes on the bottom of the liner thus providing the buoyancy necessary for the liner to rise.

However, the liner did not float to the surface upon removal of the cask lid and was believed to have been wedged into the cask by 3/8" steel wire rigging located in the annular space between the outside of the liner and the inside of the cask. When workers pulled on the steel wire rigging in preparation for removing the liner from the cask, the liner was freed and floated to the surface.

Subsequent remote camera inspections of the liner, the cask and the 1" thick stainless steel support plate placed on the reactor cavity floor, identified the presence of small piles of rust-colored particles on the support plate and inside the cask. Similarly, the bottom resting surface border of the liner was orange in color indicating the presence of corrosion.

The liner was a 1/4" carbon steel container with two 2½" screened drains on the bottom and four 1/4" holes in the top of the container. The liner was coated with two layers of epoxy paint to minimize corrosion. The cask and liner had been used during the previous two refueling outages to store cut up irradiated and spent incore instrument remnants. The cask was used to provide shielding from the irradiated incore instruments which were highly radioactive. The process of cutting the incore instruments and placing them in the liner was accomplished under about 22 feet of borated water in the bottom of the refuel cavity during the refuel outages. Towards the end of each outage both the cask and internal liner were removed from the reactor cavity, drained and stored in the east radwaste storage facility.

The incident investigation team identified that the reuse of the liner was not a standard industry practice. The licensee determined from discussions with the cask and liner vendor that the carbon steel liner was intended for a single use. The licensee's team also determined that storing the incore instruments in a shielded cask outside of the spent fuel pool was not consistent with industry practices.

The licensee's investigation identified several issues including:

- Corrosion debris blocking the two drain holes on the bottom of the liner.
- Corrosion causing partial occlusion of the four vent holes on the top of the liner.
- Multiple use of a liner designed for a single use.
- Inadequate engineering evaluation for reuse of the liner.
- Failure to follow industry practices for storage of highly irradiated components in the spent fuel pool.

The inspectors concluded that the licensee's event follow-up and incident response investigation was adequate in determining and evaluating the engineering and operational factors that caused and contributed to the event.

.6 Evaluation of Human Performance and Licensee Process Impacts and Contributing Factors

a. Inspection Scope

The inspectors reviewed procedures, interviewed operators, contractor workers, and radiological protection workers including the field oversight supervisor. The inspectors also reviewed videos from the event and operator logs. These reviews were performed in order to evaluate the human performance aspects of this incident, including procedure adequacy and adherence.

b. Findings and Observations

Introduction: A self-revealing finding of very low safety significance (Green) and associated Non-Cited Violation of Technical Specification 5.4.1.a, “Procedures,” was identified. Specifically, on April 19, 2006, during the setup of an incore instrument cask and liner in the reactor cavity pool. This cask and liner were used for the storage of used incore instrumentation that had been removed from the reactor vessel. The licensee’s failure to have an adequate procedure for the installation and removal of an incore cask and liner resulted in the cask liner becoming buoyant and floating to the reactor cavity pool surface resulting in unanticipated radiation exposure to workers in the area.

Description: On April 19, 2006, while the plant was shutdown for a refueling outage, Palisades workers were preparing to place a cask inside the reactor cavity pool in accordance with procedure RFL-V-3, Revision 0, “Installation/Removal of Incore Cask and Liner.” The shielded cask with its carbon steel liner was placed in the reactor cavity pool in preparation for placing used incore instruments inside the cask liner for storage. When not in use, the cask and liner were stored at the east radwaste building. Since this was the third time this cask and liner were used, the liner already contained used incore (highly irradiated) instruments. When the licensee removed the cask lid, the liner which was to flood-up and remain in the cask at the bottom of the spent fuel pool, floated to the pool surface for approximately 12-seconds. The liner floating on the pool surface created transient elevated radiation levels on the refueling deck of containment (649' level) and caused area radiation monitors to alarm. In addition, it resulted in unanticipated radiation exposures to workers in the area. The liner then filled with water and settled to the bottom of the pool, resting on the stainless steel plate next to the cask.

Subsequent to the event, the cask vendor informed the licensee that the cask was not designed for long term storage of radioactive waste, but rather for the transportation and burial of it. Additionally, the vendor indicated that since the liner was constructed of carbon steel, it was designed for one-time use incident to disposal at a radwaste burial site. During the licensee’s subsequent review and inspections, it was concluded that the carbon steel liner failed to vent because the vent paths on the top and bottom of the liner were blocked with corrosion product debris and paint chips. Since the liner had previously been loaded with incore instruments on two separate occasions prior to this use and stored for more than two refueling cycles in the east radwaste building, it developed corrosion that prevented the liner from properly venting by restricting the flow paths with debris. As a consequence, the air trapped in the liner caused it to become buoyant and float to the surface of the reactor cavity pool.

The inspectors noted that procedure RFL-V-3, “Installation/Removal of Incore Cask and Liner” did not account for the design of the cask and liner. Specifically, the procedure did not address the fact that the cask and liner were not designed for long term storage or repeated use, and as such, failed to provide adequate precautions and limitations to allow for its proper usage. Furthermore, the procedure failed to anticipate the effects of liner corrosion and failed to ensure that the liner properly vented and flooded when it was placed in the reactor cavity pool. Additionally, the procedure did not establish the proper controls for a carbon steel liner containing residues of borated water.

Analysis: The inspectors determined that the failure to account for the design and intended use of the carbon steel incore cask liner was a licensee performance deficiency that warranted review in accordance with the Significant Determination Process. The inspectors concluded that the finding was greater than minor in accordance with IMC 0612 "Power Reactor Inspection Reports," Appendix B, "Issue Disposition Screening," dated September 30, 2005, because the issue was associated with the program and process attribute of the Occupational Radiation Safety Cornerstone, and adversely affected the Cornerstone objective of ensuring the adequate protection of worker health and safety from exposure to radiation.

To assess significance of the finding, the inspectors used IMC 0609, Appendix C, “Occupational Radiation Safety Significance Determination Process.” The inspectors determined that the finding did not involve ALARA planning. The highest dose received by an individual involved in the work was 61 millirem and thus there was no overexposure. Also, given the transient radiological conditions and the workers response to those conditions, no substantial potential for an overexposure existed. Information was available to define the transient radiological conditions and through primary and secondary (electronic) dosimetry results the licensee was able to accurately determine worker dose. Consequently the licensee's ability to assess worker dose was not compromised. Therefore, the inspectors concluded that the SDP assessment for the finding was of very low safety significance (Green).

The fundamental cause of this finding was an inadequate procedure change review process that failed to identify deficiencies with the procedure and with its development. The procedure allowed a carbon steel liner to be used on multiple occasions in a boric acid environment without properly accounting for its design, its material composition, and the manufacturer’s intended use. Licensee corrective actions included a procedure revision to preclude the repeated use of carbon steel liners and an action to evaluate the current procedure change review processes.

Enforcement: Technical Specification 5.4.1.a, “Procedures,” requires that written procedures shall be established, implemented, and maintained as recommended in Regulatory Guide 1.33, Revision 2, Appendix A, February 1978. Regulatory Guide 1.33, Appendix A, Section 7, “Procedures for Control of Radioactivity,” specifically addresses the need to have appropriate procedures for solid waste drum handling and storage. The licensee developed procedure RFL-V-3, Revision 0, “Installation/Removal of Incore Cask and Liner” to implement that requirement. Contrary to the above, procedure RFL-V-3, was not appropriate to the circumstances, in that it did not provide adequate precautionary guidance to account for the design and use of the liner. Consequently, on April 19, 2006, the cask liner failed to vent and flood, floated to the surface of the spent fuel pool and produced unanticipated radiation dose to the workers on the refueling deck of containment. Since this finding was determined to be of very low safety significance and has been entered into the licensee’s Corrective Action Program (AR 01024794), this violation is being treated as a Non-Cited Violation, consistent with Section VI.A.1 of the NRC Enforcement Policy. (NCV 05000255/2006008-01).

Discussion

Human performance/procedure adherence: The procedure in use during the last refuel outage for loading and removal of the incore cask and liner system was developed by licensee contractors. However, since the last refuel outage, the licensee had rewritten the contractor procedures to the licensee's standards. These new licensee procedures were virtually identical to the previous procedures and were reviewed by the licensee for technical and administrative adequacy. These procedures were used by the same contractor work crew that removed and installed the cask and liner during the two previous outages. The workers did not identify any differences in the cask and liner operation between the two outages. The inspectors determined that the workers had followed their procedures and met the licensee's expectations for procedure place-keeping. In addition, the inspectors concluded that there were no indications of schedule pressures or human fatigue issues that would have caused or contributed to this event.

.7 Evaluation of Radiological Consequences

a. Inspection Scope

The inspectors interviewed plant staff that were present on the refueling deck during the event and reviewed the radiation exposure records including ED histograms of those workers. The review was conducted to evaluate the actual and potential radiological impact of the event including if the circumstances coupled with the transient radiological conditions could have presented a substantial potential for an overexposure.

b. Findings and Observations

No findings of significance were identified

Discussion: The actual radiological dose consequences of the cask liner rising to the surface of the reactor cavity pool were minimal. The highest dose rate observed on the area radiation monitors and recorded on the plant process computer was approximately 1213 millirem per hour. During the 12-seconds that the liner floated atop the pool surface, the highest transient dose rate recorded on a workers electronic dosimetry was approximately 46 rem/hour. The highest assigned dose to a worker was 61 millirem. The workers electronic dosimeters recorded dose rates ranging from 0.59 millirem/hr to 46,000 millirem/hr with most of the involved workers exposed to transitory dose rates of approximately 4,000 - 20,000 millirem/hr. The dose rate spike existed for only a few seconds duration as noted on ED histograms but was sufficient to cause the electronic dosimeters to alarm.

The potential radiological consequences were bounded by the licensee's radiation protection system of area radiation monitors, alarming electronic dosimeters worn by the workers, the short duration (12-second) of the transient and the quick response by the radiation protection field supervisor and the radiation workers and RP technicians involved. Consequently, the event did not represent a substantial potential for an overexposure as provided in the NRC Enforcement Manual (NUREG/BR-0195, subsection 8.4.1). Specifically:

C The supervisor, upon seeing the liner moving upwards immediately ordered the workers to evacuate the refueling floor.

C The area radiation monitor alarmed as designed which alerted workers to the radiological transient.

C The workers electronic dosimeters alarmed as designed.

C The RP job coverage technicians would have evacuated the workers based on any of the alarms had the workers not exited the area following the field supervisors instructions.

The inspectors concluded that the licensee's radiation monitoring systems (area radiation monitors and electronic dosimetry) functioned as designed, that worker response was timely and appropriate, and that dose to the workers was minimal.

.8 <u>Evaluation of Other Event Contributors</u>

a. <u>Inspection Scope</u>

The inspectors interviewed control room operators, contractor personnel, the RP field supervisor for the job, and RP technicians assigned job coverage to determine if there were any job related conditions existed that could have contributed to the event.

b. <u>Findings and Observations</u>

No findings of significance were identified

<u>Discussion</u>: Although the Westinghouse crew worked seven 10-hour shifts per week, fatigue did not appear to be a contributing factor to this event. There were no other control room tasks occurring at the time of this event that would have distracted the workers. Other workers also indicated there was no schedule pressure or other work distractions interfering with the task of preparing the cask and liner for cutting and receiving the spent incore instruments. The inspectors concluded that no schedule pressures or other work distractions existed at the time of the event.

.9 <u>Evaluation of the Impact of the Fallen Liner on the Refuel Cavity and Structures.</u>

a. <u>Inspection Scope</u>

The inspectors reviewed the event, the licensee's remote camera inspections of the reactor cavity liner and cask liner, and interviewed licensee and contractor personnel. The review was conducted to determine if the cask liner was damaged or if it had damaged the stainless steel support plate or the reactor cavity pool liner when it settled to the bottom of the pool.

b. Findings and Observations

No findings of significance were identified

Discussion: The inspectors noted that the cask and liner lay down area in the reactor cavity pool was not in close proximity to any spent fuel, the reactor vessel or near any other equipment. The lay down area was under about 22 feet of water. The cask was positioned on a stainless steel support plate that measured approximately 10 feet X 5 feet X 1 inch thick. This support plate was placed on the cavity floor in order to provide additional weight support and to distribute the loads of the cask, and to protect the 3/16" stainless steel reactor cavity pool liner.

After the event, the licensee performed a remote camera inspection of the liner and support plate. This inspection did not reveal any deformation of either the liner or the support plate. Additionally, the rate of water flowing from the reactor cavity leak detection system did not change. The licensee determined that neither the liner nor the support plate was adversely impacted by the liner as it sank back down into the cavity pool. No other equipment was adversely affected. The inspectors concluded that the licensee's investigation was adequate.

.10 Storage of In-Core Detectors In The East Radwaste Storage Building

a. Inspection Scope

The inspectors reviewed the licensee's practices for the storage of irradiated incore detector remnants and evaluated those practices relative to the descriptions in the Updated Final Safety Analysis Report (UFSAR) and the guidance provided in NRC Generic Letter (GL) No. 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites."

b. Findings and Observations

No findings of significance were identified

Discussion: The East Radwaste Storage Facility was designed and constructed as an interim storage facility incident to packaging and preparation of low level radioactive waste prior to shipment to a disposal or processing facility. As described in Section 11.4.2.3 of the licensee's UFSAR, "Radioactive Waste Storage Facilities" the east radwaste building was not intended for long term storage of radioactive waste provided licensed burial sites were available.

The UFSAR specified that 2500 Ci/yr could be generated from irradiated hardware and would be stored on-site in 36-inch thick concrete vaults. However, over the last four years, the licensee had stored irradiated incore remnants in the east radwaste facility in the same shipping cask and liner that was involved in the event rather than in the concrete vaults. The licensee had previously performed a 10 CFR 50.59 required evaluation including a site boundary (10 CFR 100) dose calculation for storage of irradiated incore detectors in the concrete vaults located in the east radwaste building; however, that evaluation did not bound the storage of incore detectors in the shipping cask and liner. During the course of this special inspection, the inspectors informed the licensee that its storage practice for irradiated incore detectors was inconsistent with its UFSAR and that its prior 10 CFR 50.59 evaluations did not bound the current storage conditions. Following the inspection exit meeting, the licensee completed a 10 CFR 50.59 required evaluation of its current storage conditions, consistent with the guidance in GL 81-38. That evaluation determined that the change in the licensee's storage facility and storage practices did not represent an unreviewed safety question; therefore, prior NRC approval of the facility changes would not have been required. The inspectors reviewed the licensee's evaluation, its assumptions and dose calculations, and agreed with the licensee's conclusions.

The licensee's failure to perform a timely 10 CFR 50.59 evaluation for changes made to its radioactive waste storage facility/practices as described in the UFSAR was evaluated utilizing NRC Enforcement Guidance, Supplement I of the NRC Enforcement Manual, and the SDP for the Public Radiation Safety Cornerstone. Given the results of the licensee's post inspection 10 CFR 50.59 evaluation including 10 CFR Part 100 dose calculations for design basis events, the inspectors concluded that the 10 CFR 50.59 (and corresponding 10 CFR 50.71(e)) violations were of minor safety significance. In particular, the licensee's bounding dose calculations showed that the storage of irradiated incore detector remnants in the shipping cask and liner did not adversely affect the cornerstone objective to ensure adequate protection of the public from exposure to radiation.

Generic Letter 81-38 provided guidance to power reactor licensee's for interim storage of low level radioactive waste as a result of reduction in waste disposal site availability in the 1980s. The licensee's practices for the storage of irradiated incore detectors was reviewed relative to the GL guidance and was discussed with the licensee. While the licensee's irradiated detector storage practices did not violate regulatory requirements, the inspectors found that some of the licensee's storage activities were inconsistent with NRC guidance and with industry practices. These inconsistencies were discussed with the licensee during the exit meeting and involved: (1) the dry storage of incore detectors; (2) storage container selection based on corrosive potential; (3) periodic container inspection; and (4) issues associated with disposal options complicated by the waste classification these highly radioactive incore detectors presented.

4OA6 <u>Meetings</u>

<u>Exit Meetings</u>

The inspection team met with Mr. P. Harden and members of licensee management on April 26, 2006 to discuss the preliminary results of the onsite inspection effort. Following additional in-office review, on June 14, 2006, the inspection team leader and a member of NRC Region III management presented the inspection results to Mr. P. Harden and other members of licensee management. The licensee acknowledged the findings presented. The inspectors asked the licensee whether any materials examined during the inspection should be considered proprietary. No proprietary information was identified.

ATTACHMENTS:
1. SUPPLEMENTAL INFORMATION
2. SPECIAL INSPECTION TEAM CHARTER

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee

B. Dotson, Regulatory Compliance Analyst
P. Harden, Site Vice President
D. Malone, Regulatory Compliance Supervisor
D. Mims, Site Director
D. Nestle, Health Physicist
B. Patrick, Radiation Protection Manager
S. Pierce, Engineering Supervisor
P. Rhodes, Senior Reactor Operator

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened and Closed

05000255/2006008-01	NCV	Failure to Develop an Adequate Procedure For Reuse of Cask Liner. (Section 4OA3.6)

LIST OF DOCUMENTS REVIEWED

The following is a list of documents reviewed during the inspection. Inclusion on this list does not imply that the NRC inspectors reviewed the documents in their entirety but rather that selected sections of portions of the documents were evaluated as part of the overall inspection effort. Inclusion of a document on this list does not imply NRC acceptance of the document or any part of it, unless this is stated in the body of the inspection report.

<u>Work Orders:</u>

00026786-01, "Fuel Handling Monitor Adjustments;" dated April, 14, 2006

<u>Procedures:</u>

EI-1, "Emergency Classification and Actions;" Revision 47
RFL-V-3, "Installation/Removal of incore cask and liner;" Revision 0

<u>Other Documents</u>:

Palisades Nuclear Plant Technical Specifications and Bases

Palisades Nuclear Plant Updated Final Safety Analysis Report; Revision 25

Event Notification Worksheet EN No. 42514; dated April 19, 2006

Operations Logs; dated April 19, 2005
NMC Incident Investigation Report AR01024794; "Unanticipated Radiation Exposure to Workers During Installation of Incore Instrument Liner in Reactor Cavity"; dated April 21, 2006

Radiological Survey Sheet for Containment 649' Level; dated April 17, 2006

PPC Printout of RIA-2316/2317 Radiation Monitor Alarms; dated April 19, 2006

Various Personnel Qualification Records of Workers Involved with Event

Palisades Nuclear Plant Root Cause Investigation Report No. 01024794

10CFR50.59 Safety Review For EA-E-PAL-91-030-03; Revision 0

10CFR50.59 Safety Review For EA-E-PAL-91-030-01; Revision 1

10 CFR 50.59 Screening Evaluation (No. 06-0125); Revision 0

Calculation No. EA-EC8423-01; Revision 0

Calculation No. EA-E-PAL-91-030-02; Revision 0A

Calculation No. EA-E-PAL-91-030-03; Revision 1

LIST OF ACRONYMS USED

ALARA	As-Low-As-Is-Reasonably-Achievable
ED	Electronic Dosimeter
IMC	Inspection Manual Chapter
NCV	Non-Cited Violation
NRC	Nuclear Regulatory Commission
OA	Other Activities
RCI	Root Cause Investigation
RWP	Radiation Work Permit
SDP	Significance Determination Process
TS	Technical Specification

April 21, 2006

MEMORANDUM TO: John House, Senior Radiation Specialist, Plant Support Team
Division of Reactor Safety

FROM: Cynthia Pederson, Director **/RA/**
Division of Reactor Safety

SUBJECT: SPECIAL INSPECTION CHARTER FOR THE RADIOLOGICAL EVENT AT THE PALISADES PLANT DURING PREPARATION FOR INCORE DETECTOR REMOVAL ON APRIL 19, 2006

On April 19, 2006, at about 0225 (EST), a radiological incident occurred at the Palisades Nuclear Plant, which created significantly elevated dose rates on the refuel floor. The plant was in Mode 6 conducting refuel outages activities, which included activities related to handling incore detectors.

The licensee placed a shielded incore cask in the refuel cavity pool in preparation for cutting of the incore probes. The cask had been stored in a radioactive waste storage area in another building and contained pieces of irradiated detectors from previous refuel outages. The cast was moved into the Containment Building and lowered into the cavity to begin the work. The incore cask consisted of a shielded outer cylinder and an inner liner used to house the irradiated incore instrument remnants. The outer cask was equipped with a bottom drain and the inner cask with a mesh bottom and vented lid. A bolted lid on the outer shielded cask was loosened prior to lowering the cask into the refueling cavity, to allow air to escape. Once submerged on the floor of the refuel cavity, the outer cask lid was removed. Workers at the perimeter of the cavity then used long handled tools to remove straps attached to the inner cask During this evolution, the inner cask began to float upward toward the surface of the refuel cavity. A worker observed the liner rising and alerted the workers near the cavity of the problem. The inner cask rose to the top of the cavity pool creating dose rates in excess of 10 R/hour in areas occupied by several workers involved in the work activity. Shortly thereafter, the inner cask then sank back to the bottom of the cavity. An area radiation monitor on the refuel floor measured dose rates of approximately 1200 mrem/hour. Workers on the refuel floor evacuated the area, and all work in the Containment Building was suspended by the licensee pending an investigation. Electronic dosimetry worn by workers present in the area showed that the maximum accumulated exposure to a worker was less than 50 mrem. Preliminary licensee surveys disclosed no increased airborne or area contamination on the refuel floor as a result of this incident.

CONTACT: W.J. Slawinski, DRS
(630) 829-9820

The sequence of events and the cause of the problem are being investigated by the licensee. Based on the deterministic criteria provided in Management Directive 8.3, "NRC Incident Investigation Program, " the incident was determined to warrant the establishment of a special inspection team (SIT). Specifically, the incident involved potential adverse generic implications and questions and concerns pertaining to the licensee's operational performance (Part 1 of MD 8.3, deterministic criteria (e, h)) consistent with the characteristics for an SIT. Based on these critera and as provided in Regional Procedure 8.31, "Special Inspections at Licensed Facility," a special inspection will commence on April 20, 2006. The inspection will be led by John House with radiological inspection assistance from John Cassidy and operational/engineering assistance from Keith Walton and Frances Ramirez.

The special inspection will determine the sequence of events, and will evaluate the facts, circumstances, and the licensee's actions surrounding the April 19, 2006 incident. The inspection will focus on the planning and preparations associated with the work activity, the execution of the work plan, and the actual and potential radiological consequences. Additionally, the team will examine the cause of the liner to become buoyant along with any associated engineering or operational issues, including implementation of Emergency Action Levels. The potential impact of outage schedule pressure, human performance and procedure adequacy will also be evaluated. An entrance meeting will be conducted at 1300 (EST) on Thursday April 20, 2006.

The special inspection will be conducted in accordance with Inspection Procedure 93812, "Special Inspection," and Divisional Instruction DI-IP-93812, "Evaluation of Radiological Incidents," and will include, but not be limited to the following items:

1. Establish a Sequence of Events including the sequence of the work planning and job briefings and the licensee's determination of event classification.

2. Review the work planning, including the application of operating experience, lessons learned, contingency and ALARA planning, and the interfaces among operations and work planning staff during the planning process.

3. Review the experience of the staff involved in the work activity and the management involvement/oversight of the actual work.

4. Evaluate the licensee's root cause evaluation and extent of cause, as applicable.

5. Evaluate the engineering or operational factors that caused or contributed to the event including equipment design or use issues.

6. Evaluate the human performance impacts, and contributing factors, including procedure adequacy and adherence.

7. Evaluate the actual and potential radiological consequences.

8. Identify any unique characteristics which may have contributed to the event such as schedule pressure or work distractions.

9. Evaluate the impact of the fallen liner on the refuel cavity liner and associated structures.

cc w/att: J. Cassidy, DRS, Radiation Specialist
M. Satorius, DRP, Division Director
J. Caldwell, Regional Administrator, Region III
G. Grant, Deputy Regional Administrator, Region III
S. Orth, DRS, Plant Support Team Leader
H. Peterson, DRS, Chief Operator Licensing Branch
C. Lipa, DRP, Chief, Reactor Projects Branch 4
J. Ellegood, SRI
K. Walton, DRS, Operations Engineer
E. Hackett, NRR
P. Hiland, NRR
F. Ramirez, Branch 4 DRP
L. Mark Padovan, NRR - Palisades PM