UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
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ARLINGTON, TEXAS 76011-4005

April 25, 2006

Randall K. Edington, Vice
President-Nuclear and CNO
Nebraska Public Power District
P.O. Box 98
Brownville, NE 68321

SUBJECT: COOPER NUCLEAR STATION - NRC SPECIAL INSPECTION REPORT 05000298/2005015

Dear Mr. Edington:

On March 14, 2006, the U.S. Nuclear Regulatory Commission (NRC) completed an inspection at your Cooper Nuclear Station. The enclosed inspection report documents the inspection findings which were discussed on November 23, 2005, with Mr. S. Minahan, General Manager of Plant Operations, and other members of your staff. Additional in-office reviews were conducted and the final inspection results were discussed with Mr. Minahan and your staff on March 14, 2006.

This 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. Specifically, the inspector reviewed the circumstances surrounding a service water system failure on October 20, 2005.

This report documents two NRC-identified findings that were evaluated under the risk significance determination process as having very low safety significance (Green). The NRC has also determined that a violation is associated with one of these issues. This violation is being treated as a noncited violation (NCV), consistent with Section VI.A of the Enforcement Policy. The NCV is described in the subject inspection report. If you contest the violation or significance of the NCV, 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 IV, 611 Ryan Plaza Drive, Suite 400, Arlington, Texas 76011-4005; the Director, Office of Enforcement, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555-0001; and the NRC Resident Inspector at the Cooper Nuclear Station facility.

In accordance with 10 CFR 2.390 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 component of NRC's document system (ADAMS). ADAMS is accessible from the NRC Web site at http://www.nrc.gov/readingrm/adams.html (the Public Electronic Reading Room).

Should you have any questions concerning this inspection, we will be pleased to discuss them with you.

Sincerely,

/RA/

Kriss M. Kennedy, Chief
Project Branch C
Division of Reactor Projects

Docket: 50-298
License: DPR-46

Enclosure:
NRC Inspection Report 05000298/2005015
w/attachments: Supplemental Information
Special Inspection Charter

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U.S. NUCLEAR REGULATORY COMMISSION

REGION IV

Docket:	50-298
License:	DPR-46
Report:	05000298/2005015
Licensee:	Nebraska Public Power District
Facility:	Cooper Nuclear Station
Location:	P.O. Box 98 Brownville, Nebraska
Dates:	November 7, 2005, to March 14, 2006
Inspector:	J. Hanna, Senior Resident Inspector, Fort Calhoun Station N. Taylor, Resident Inspector
Approved By:	K. Kennedy, Chief, Project Branch C, Division of Reactor Projects

SUMMARY OF FINDINGS

IR 05000298/2005015; 11/7/05 - 03/14/06; Cooper Nuclear Station. Other Activities.

The report documents special inspection activities conducted by a senior resident inspector and a resident inspector. One Green noncited violation and one Green finding were identified. The significance of the issues is indicated by their color (Green, White, Yellow, or Red) and was determined by the significance determination process in NRC Inspection Manual Chapter 0609. Findings for which the significance determination process does not apply are indicated by the severity level of the applicable violation. 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-Revealing Findings

Cornerstone: Mitigating Systems

- Green. The inspectors identified a noncited violation of 10 CFR Part 50, Appendix B, Criterion XVI, for failure of the licensee to take adequate and timely corrective action to prevent recurrence of a significant condition adverse to quality. Specifically, the licensee's corrective actions taken since a service water strainer clogging event in November 2004 did not preclude the event from occurring in October 2005. The effect of these events was to cause a loss of both trains of service water for a short period of time and potentially challenge the cooling function to downstream components.

  This finding affected the Initiating Events and Mitigating Systems Cornerstones since the loss of service water is an initiating event and the service water system is required to mitigate the consequences of an accident. The finding was more than minor since it could reasonably be viewed as a precursor to a significant event and it affected the cornerstone attribute of availability and reliability of mitigating equipment. Since two cornerstones were affected by the finding, a Significance Determination Process Phase 2 analysis was required. The finding was determined to be Green. Crosscutting aspects associated with problem identification and resolution were identified based on the fact that it was within the licensee's capability to have determined and corrected the problem prior to the failures in October 2005, yet they failed to do so. (Section 4OA5.3).

- Green. The inspectors identified a Green finding for failure of the licensee to implement a commitment made to the NRC. Specifically, the licensee did not carry out the programmatic service water intake bay inspections described in their response to NRC Generic Letter 89-13, "Service Water System Problems Affecting Safety-Related Equipment."

  The finding was more than minor since not performing the inspections could become a more significant safety concern if left uncorrected, as degraded conditions in the service water intake bay could affect the operability of the ultimate heat sink for the facility. This finding is not suitable for significance

determination process evaluation, but was reviewed by NRC management and determined to be of very low safety significance due to the fact that it did not result in an increase in the likelihood of an initiating event and did not result in the actual degradation of a mitigating system. The inspectors identified crosscutting aspects in problem identification and resolution in that this disparity was identified by the NRC in 1994 and again by the licensee in 2003 without any corrective actions being taken (Section 4OA5.9).

B. Licensee Identified Violations

None.

REPORT DETAILS

4. OTHER ACTIVITIES

4OA5 Other Activities

1. Description and Sequence of Events

On October 19, 2005, operator logs indicated a trend of degrading service water (SW) system performance. The symptoms included high sedimentation in the SW intake bay (Bay E) in excess of 3 feet, SW pump (SWP) gland water low flow alarms, and SW strainer high differential pressure (DP) alarms. In one shift, operators logged six occurrences where the SW strainer high DP alarm was received in the control room. Despite these mounting indications of a sedimentation problem, no actions were taken to protect the SW system.

On October 20, 2005, during an extent of condition review for the failure of a motor-operated valve to close, operations personnel prepared to cycle residual heat removal (RHR) Heat Exchanger (HX) B SW Outlet SW-MOV-89B. In order to establish the plant conditions required to open this valve, operators planned to start a fourth SW pump (Pump D) to meet the additional flow demand as the RHR HX was placed in service. As required by the licensee's procedure, the SW intake bay spargers were cycled immediately prior to starting SWP D. (All four SW pumps take a suction on the SW intake bay, and the function of the spargers is to prevent debris buildup at the suction of the pumps.) Shortly after SWP D was started, SWP Strainers A and B became clogged and system low pressure alarms were received in the control room. The time line below describes the major events and the operator/system responses that occurred on October 20.

9:08 a.m. Operators started SWP D.

9:09 a.m. SW Discharge Strainer B high DP alarm received (5 psid).

9:11 a.m. SW Discharge Strainer A high DP alarm received (5 psid).

9:12 a.m. Control room operators noted that Division 1 SW booster pump suction pressure was at 39 psig and lowering.

9:12 a.m. SW Header A low pressure alarm received (17 psig). Valve SW-MOV-36 (noncritical SW header isolation valve) closed on low system pressure (38 psig).

9:12 a.m. SW Header A low pressure and SW Discharge Strainer A high DP alarms clear.

9:12 a.m. SWP B header low pressure alarm received. Valve SW-MOV-37 (noncritical SW header isolation valve) closed on low system pressure. Turbine equipment cooling was isolated.

9:13 a.m. Operators noted Division 1 SW pressure at 70 psig and reopened Valve SW-MOV-36. Operators attempted to reopen Valve SW-MOV-37, which immediately reclosed due to low pressure in Division 2 SW. Turbine equipment cooling was restored from Division 1 SW.

9:15 a.m. Operators began to bypass SW Strainer B.

9:24 a.m. SW Header B low pressure alarmed and SW Strainer B high DP alarm cleared.

The combination of elevated sediment levels in the SW intake bay, rotation of the SW intake bay spargers, and the starting of SWP D led to a simultaneous plugging of both SW strainers and a total loss of SW for a few seconds. During this short period of time, the automatic closing function of Valves SW-MOV-36 and SW-MOV-37 functioned properly and isolated all cooling to the noncritical SW loop (including the turbine equipment cooling system). The SW Strainer A successfully backwashed and Division 1 was restored approximately 5 minutes after the event began, precluding what would have been a manual scram of the reactor on prolonged loss of turbine equipment cooling water. The filtering function of SW Strainer B was overwhelmed by the inrush of sediment, and the automatic backwash function failed due to lack of any downstream pressure (the motive force for backwashing).

Based on system walkdowns, review of operating procedures, design basis documents, recorded data, and interviews with the station operators who were on watch during the transient, the inspectors concluded that all safety systems performed as designed with the exception of SW Strainer B. The SW Strainer B backwash feature was ineffective and required operators to bypass the strainer to restore pressure to Division 2 SW.

The inspectors reviewed standard operating procedures, emergency procedures, design documents, and recorded data and conducted interviews to evaluate the operators' response to the event. No discrepancies were noted in operator actions after the event began. The inspectors did note that various operators on watch when the event occurred had a different understanding of the entry conditions for System Operating Procedure 2.2.3.1, "Traveling Screen, Screen Wash, and Sparger System," which provided action levels for sanding conditions in the SW intake bay. The inspectors determined that this lack of a common understanding of the procedural requirements contributed to the operators' failure to respond to precursor alarms received immediately prior to the event.

The NRC evaluated these SW system failures in accordance with Management Directive 8.3, "NRC Incident Investigation Program," and determined the need to conduct a special inspection to evaluate the cause of the failures and to assess the licensee's corrective actions. The inspection charter is included as Attachment 2 to this report.

2. Similar SW System Challenges

The inspectors reviewed similar challenges to the SW system since January 2003 resulting from the introduction of debris into the SW system. The inspectors reviewed

these previous transients in order to better understand the frequency of the debris/sedimentation effects and the potential adverse effects. In particular the inspectors evaluated the more significant transients (e.g,. those where strainer DP exceeded 15 psid which results in inoperability of the component). The inspectors did not include events where the system responded properly and the condition was self-corrected (e.g., strainer DP reaches the setpoint and backwash is successful).

Condition Report	Date	Description of Event
2003-0046	1-6-03	Debris caused the thermal overloads on the SW Strainer B motor to trip. Strainer DP did not exceed 15 psid and the system safety function was maintained. The strainer was not manually bypassed.
2003-0271	1-21-03	SW Strainer B high DP (14.5 psid). Operators declared Division 2 SW inoperable due to erratic DP indications before and after strainer backwash.
2003-4936	8-27-03	High DP on SW Strainer A (< 15 psid). The subsequent drop in Division 1 SW pressure resulted in entry into SW Emergency Procedure 5.2. Pressure recovered and the system remained operable.
2004-4046	5-29-04	Shear pin broke on SW Strainer B. Strainer DP reached 15.2 psid. Operators declared SW Division 2 inoperable.
2004-7409	11-20-04	High DP on SW Strainer A (> 15 psid) after starting SWP D, followed by high DP on SW Strainer B (pegged high), which did not clear. Loss of SW pressure resulted in automatic system isolations. Operators declared both trains of SW inoperable and entered SW Emergency Procedure 5.2.
2004-5682	8-5-05	Following the start of J4-B2 spargers in the SW intake bay, a shear pin broke on the SW Strainer A causing a high DP condition for 38 seconds. Strainer DP exceeded 15 psid.
2004-7747	10-20-05	High DP on SW Strainer A (> 15 psid) after starting SWP D, followed by high DP on SW Strainer B (pegged high), which did not clear. Loss of SW pressure resulted in automatic system isolations. Operators declared both trains of SW declared inoperable and entered SW Emergency Procedure 5.2.

3. Corrective Actions for Previous Events

a. Inspection Scope

The inspectors reviewed the adequacy and timeliness of the licensee's corrective actions established prior to the event on October 20, 2005, to prevent recurrence of SW

strainer clogging and challenges to the operability of the service water system. The inspectors also examined the licensee's corrective actions following the event in an attempt to determine if those actions would be effective at preventing recurrence.

b. Findings

Introduction. The inspectors identified a Green noncited violation of 10 CFR Part 50, Appendix B, Criterion XVI, for the licensee's failure to take adequate and timely corrective action to prevent recurrence of a significant condition adverse to quality. Specifically, the licensee's corrective actions taken following a SW strainer clogging event in November 2004, did not preclude the event from occurring in October 2005. The effect of these events was to cause a loss of both trains of SW for a short period of time and potentially challenge the cooling function to downstream components.

Description. In response to the November 20, 2004, SW strainer clogging event, the licensee initiated Condition Report CR-CNS-2004-07409. The root cause analysis for this condition report identified that: (1) changing river conditions were causing higher levels of sediment being transported into the SW intake bay; and (2) monitoring, operation, design and maintenance of SW intake structure related equipment were not effective in mitigating sediment intrusion. The inspectors reviewed the corrective actions associated with these two causes.

Effectiveness of Prior Corrective Actions

Following the November 2004 SW strainer clogging event, the licensee identified corrective actions designed to prevent recurrence of the event. These actions included (but were not limited to):

- Implementing a calender-based SW strainer cleaning interval - The licensee had historically used a condition-based approach to cleaning the strainer (e.g., a high DP alarm would cause the licensee to clean the strainer). The licensee added a calendar based frequency (routine cleaning every 6 weeks) in conjunction with the condition based frequency. The intent of this change was to maintain the strainers as clean as possible to improve their performance in the event of a large influx of debris.

- Altering the SW pump operation cycle - The licensee increased the frequency at which the idle SW pump was started and a running pump was secured to daily. This action was intended to minimize the possibility of sediment buildup adjacent to an idle SW pump and decrease the probability of a significant influx of debris following the start of a pump that had been idle for a longer period of time.

- Determining SW intake bay sediment levels requiring increased monitoring and action - The licensee established alert/action levels for monitoring sediment levels in the SW intake bay and corresponding required actions. These actions included: (1) determining sediment levels in SW intake bay and increased monitoring if river level changed greater than 1 foot/day, (2) increased monitoring to every other day if SW intake bay levels were greater than 2.25 feet, and (3) removing sediment from the SW intake bay if levels were greater than 2.5 feet. The purpose of these

actions was to limit the amount of sediment in the SW intake bay and alert operators when conditions favorable to a SW strainer clogging event were present.

- Developing organizational lessons learned from the event, including effective communication, sense of urgency responding to issues, and operational focus.

The inspectors found that although the licensee had completed these corrective actions, they were inadequate in preventing the October 2005 event. For example, while detailed thresholds and specified actions were delineated based on SW intake bay debris levels, these limits and the procedurally required actions were unsuccessful at preventing a significant sediment event from occurring. Further, the inspectors found through interviews with the operating crew on watch at the time of the October 2005 event that there was a lack of common understanding of what indications to use and what actions were required to be taken. The inspectors determined that the expectations had not been communicated effectively to the operators.

The inspectors also observed that the licensee's root cause analysis for the October 20, 2005, event concluded that a human performance aspect of not responding to precursors was a factor. The inspectors noted this was similar to the "sense of urgency" or "operational focus," which were factors in the November 2004 event as described in CR-CNS-2004-7409. Prior to the October 2005 event, control room operators had indications that sediment levels in the SW intake bay were elevated (in excess of 2.0 feet), but did not take any action based on these indications. Additionally, the inspectors noted that there were approximately 12 instances in which strainer DP spiked high in the 24 hours prior to the October 2005 event.

Timeliness of Corrective Actions

In addition to the corrective actions listed above, the licensee identified other corrective actions following the November 2004 event. However, at the time of the October 2005 event, 11 months after the November 2004 event, the licensee had not completed these actions. The inspectors concluded that these actions were not completed in a timely manner. These actions included:

- Modifying the setpotint for automatic strainer backwash - The corrective action document specified changing the setpoint at which automatic strainer backwash occurred from 4.0 psid to 3.0 psid. The licensee believed that lowering the setpoint would reduce the amount of debris that might accumulate on the strainers immediately prior to an event and increase the likelihood that a strainer would automatically recover in the event of a large influx of sediment.

- Altering the frequency at which the strainers were periodically backwashed - The corrective action report required changing the frequency at which strainer backwash occurred from every 4 hours to every 2 hours to reduce the amount of debris that might accumulate on the strainers immediately prior to a large intrusion of sediment and increase the likelihood that a strainer would automatically recover during a large intrusion of sediment.

- Modifying the strainer DP alarm setpoint - The corrective action document recommended that if the strainer backwash setting was changed from 4.0 to 3.0 psid, that the alarm setpoint should be changed from 6.0 psid to 5.0 psid. The purpose of this change was to provide operators with earlier indication of the onset of a SW debris event.

- Implementing weir wall modifications and installing river turning vanes - The licensee completed installing turning vanes in the river bed on September 1, 2005. However, the licensee also planned to alter the weir wall profile. The inspectors noted that, in order for the turning vanes to be effective at minimizing sedimentation transported into the intake structure, they had to work in conjunction with the weir wall modification. The licensee planned to complete this modification during Refueling Outage 1R23 in October 2006.

Analysis. The inspectors concluded that the licensee failed to take effective and timely corrective actions to prevent recurrence of debris clogging of both trains of SW strainers. Successfully completing these actions was reasonably within the licensee's ability to do so, based on the history of SW debris events, the time since the last significant debris event, the precursors to the debris events, and the availability of applicable industry operating experience. Therefore, the inadequate and untimely corrective actions, which resulted in the clogging of the SW strainers, was determined to be a performance deficiency. This finding affected the Initiating Events and Mitigating Systems Cornerstones since the loss of SW is an initiating event and the SW system is required to mitigate the consequences of an accident. The finding was more than minor since it could reasonably be viewed as a precursor to a significant event and it affected the cornerstone attribute of availability and reliability of mitigating equipment.

A modified Phase 2 significance determination process (SDP) analysis was performed by a senior reactor analyst. Key assumptions used in this analysis included:

- The exposure time used in Table 1 of the Risk-Informed Inspection Notebook for Cooper Nuclear Station (SDP Phase 2 Notebook, Revision 2) was 3-30 days. This was based on the number of days prior to the November 2004 event that degraded conditions existed in the SW intake bay (5 days) and the number of days prior to the October 2005 event that degraded conditions existed in the SW intake bay (1 day).

- The applicable initiating event scenario evaluated for this finding was loss of SW (LOSW).

- The initiating event likelihood was increased to 1 based on the occurrence of the November 2004 and October 2005 events.

- Full mitigation capability credit was assumed for the reactor core isolation and high pressure core injection since these systems can operate for some period of time without SW.

- Recovery of SW flow in a loop with a clogged strainer can be accomplished by opening the associated strainer bypass valve.

- A clogged strainer can be cleaned and returned to service in less than 8 hours.

- A Recovery Credit of 4 was used based on the probability that the bypass valve fails to open (6E-6) and the probability that operators fail to open the valve (Human Error Probability = 1.16E-4).

Using the above assumptions, the results of evaluating the most dominant core damage sequences for the LOSW initiator worksheet are shown below.

SEQUENCE	IEL	REMAINING MITIGATION CAPABILITY RATING	RECOVERY CREDIT	RESULTS
LOSW - RECSW24 - LI	1	1 + 2	4	8
LOSW - RECSW24 - CV	1	1 + 2	4	8
LOSW - RCIC - LI	1	1 + 2	4	8
LOSW - RCIC - CV	1	1 + 2	4	8

The analyst determined that external initiating events did not contribute significantly to the overall significance of the finding. The analyst also determined that any change in large early release frequency did not contribute to the significance of the finding.

Using the above assumptions in the Modified SDP Phase 2 Analysis, the finding was determined to be of very low safety significance (Green).

This finding had crosscutting aspects associated with problem identification and resolution. The failure to implement effective and timely corrective actions contributed to the SW strainer clogging event in October 2005.

Enforcement. Title 10 CFR Part 50, Appendix B, Criterion XVI, requires that measures shall be established to assure that conditions adverse to quality are promptly identified and corrected. In the case of significant conditions adverse to quality, the measures shall assure that the cause of the condition is determined and corrective action taken to preclude repetition. Contrary to this requirement, Cooper Nuclear Station failed to correct and preclude repetition of a significant condition adverse to quality. Specifically, on October 20, 2005, both trains of SW strainers became clogged due to ingestion of sediment/debris. Cooper Nuclear Station experienced a similar clogging event approximately 11 months earlier, but failed to take timely and effective corrective actions to prevent further failures.

Because this finding is of very low safety significance and has been entered in the licensee's corrective action program as Condition Report CR-CNS-2005-7772, this violation is being treated as a noncited violation consistent with Section VI.A of the NRC Enforcement Policy (NCV 05000298/2005015-01, Inadequate Corrective Actions for Service Water Strainer Clogging Event).

Unresolved Item (URI) 05000298/2005002-09, Both SW Discharge Strainers Clogged Due to Silt Intrusion, is being closed to this violation.

4. Corrective Actions Implemented Following the October 2005 Event

Following the October 2005 event, the licensee instituted a number of interim corrective actions including:

- Cleaned and inspected SW Strainers A and B.

- Limited the number of running circulating water pumps to three during continuous operation. The licensee believed that this would minimize the amount of turbulence outside the SW intake bay and minimize the amount of sand/debris being transported into the intake structure.

- Established a limit of 2.5 feet of sediment in the SW intake bay downstream of the traveling water screen. The licensee believed that this would minimize the amount of debris accumulation available for transport into the SW system.

- Established a rotation frequency for SW intake bay spargers of approximately every 3 hours. If the SW intake bay spargers cannot be rotated every 3 hours or are out of service, the intake Bay D to SW intake bay crosstie valve may be used to supply water to the SW pumps through the circulating water intake Bay D. The licensee believed that the more frequent rotation of the spargers would minimize the amount of sand accumulation.

- Changed the operation of the SW strainers such that the strainers would be maintained in continuous operation for 10 minutes after and until strainer DPs are stable following any SW intake bay evolution, including SW intake bay sparger or SW pump swaps, starts or stops. The licensee believed that this would ensure that the SW strainers would have time to backwash additional debris entrained in the SW flow.

The inspectors found that these actions appeared to be technically acceptable and appropriate. Though the inspectors were unable to predict with certainty the effectiveness of the current compensatory measures, the inspectors verified that they are being performed and/or have been incorporated into the licensee's procedures.

5. Additional Actions Planned

The inspectors also noted that the following corrective actions related to the SW strainer clogging events:

- Conduct visual inspections for macroscopic biofouling and corrosion of the intake structure once per refueling cycle. The inspectors noted that the licensee did not plan to assess the conditions below the surface of the water. Refer to Section 4OA5.9 of this report.

- Perform an annual depth survey in the area between the trash rack and the weir wall.

- Dredge the front of the intake structure to ensure sand build-up in front of the intake is not excessive. Recent low river levels have resulted in a frequency of once/cycle for this activity.

- Modify and replace the circulating water and SW intake bays' traveling screens with a new design. The inspectors noted that, though the mesh size of the new screens was smaller than the previous design, the openings were still larger than those on the SW strainers. Consequently, debris plugging events were still possible.

- Form a cross-discipline team to evaluate the design challenges to the SW system to preclude future events.

6. SW Licensing and Design Basis Requirements

a. Inspection Scope

The inspectors reviewed the evaluation performed by the licensee to verify the ability of the SW system to continue to meet design requirements. The inspectors compared the results of the licensee's evaluation with the Cooper Nuclear Station licensing and design basis.

b. Findings

Introduction. The inspectors identified an unresolved item regarding the potential deposition of sediment to the reactor equipment cooling (REC) HXs by the SW system during design basis accidents. This finding is unresolved pending the NRC's review of licensee calculations.

Description. During a design basis accident (e.g., a loss-of-coolant accident) the SW system provides cooling to safety-related equipment, including the REC system HXs. The REC system is a closed system which provides cooling to various equipment rooms and the residual heat removal pumps seals.

The inspectors reviewed a licensee analysis, "Determination of the Sedimentation Characteristics in the Service Water System," dated October 31, 2000. The inspectors noted that the median particle size of 0.4 mm assumed in this analysis was based on data gathered at the traveling screens in front of the SW intake structure in 1999. The inspectors considered the material withdrawn from the SW strainers following the recent plugging events to be more representative of the sediment that would be present in the system. The material removed from the strainers following the November 2004 and October 2005 events was characterized as "torpedo gravel . . . wedge[d] into the openings (1/8") of the strainer basket." This meant that the upper bound of the sediment size was approximately 3.0 mm. In the event that operators bypassed the SW strainers, this sediment would be transported through the SW system to the components cooled by the system.

To assess the potential adverse effects of bypassing the SW strainers on safety-related equipment, the inspectors reviewed data for normal and postaccident SW flow rates to

various systems. For the REC system piping (14-inch diameter), the normal SW flow rate was 3500 gpm and the normal flow velocity was 8.3 feet/second. The SW flow rate through the REC system following an accident was 400 gpm (as specified in the Updated Final Safety Analysis Report), and the accident flow velocity was 0.9 feet/second. The inspectors noted that the flow velocity of SW to the REC system was less than the flow velocity above which significant accumulation of sand due to settling should not occur. The SW sedimentation study concluded that "a flow velocity of 1.1 feet/second or more will prevent significant accumulation from occurring." Thus, the calculated postaccident SW flow velocity through the REC system was less than the flow velocity at which sediment typically found at Cooper Nuclear Station would no longer be entrained. Additionally, the sediment found within the SW system was known to be greater than a median size of 0.4 mm and, consequently, the potential for deposition in the system was greater. The inspectors also reviewed REC HX performance test data for SWP A REC HX since 1999 and found evidence that the REC HXs had a relatively low amount of margin to withstand sedimentation buildup. Data reviewed for 33 quarterly tests performed on the SWP A REC HX since 1999 indicated that the HX fouling limit of 0.006 hr•ft^2•F/BTU had been exceeded twice, and that the fouling criteria exceeded 0.005 hr•ft^2•F/BTU on five occasions. This data indicated that the performance margin for the REC HXs may be relatively low and could be adversely affected by the deposition of sediment in the HX.

In response to the inspectors' concern, the licensee completed an analysis, NEDC 94-021, "REC-HX-A & REC-HX-B Maximum Allowable Case Fouling," in an attempt to bound the adverse effects of the potential buildup of sediment in the REC HXs following an accident. At the end of the inspection period, the licensee was still evaluating the results of the analysis. The results are scheduled to be published in an engineering evaluation in June 2006.

Analysis. The inspectors determined that further inspection was required to review the licensee's engineering evaluation and evaluate the potential impact of this issue on the performance of the REC HXs.

Enforcement. This issue was identified as unresolved item pending the NRC's review of the licensee's evaluation: URI 05000298/2005015-02, Potential for Plugging of REC Heat Exchangers During a Design Basis Accident.

7. Potential Adverse Impact from Debris Loading and Bypassing SW Strainers

The inspectors assessed the impact that the increased debris loading, and operation of SW with one or more strainers bypassed, has had on safety-related components cooled by the system. In order to assess the potential effects of silt/sand/debris on downstream components the inspectors:

- Reviewed a list of condition reports over a 5-year time frame with a word search on sand, silt, or sediment. The inspectors reviewed the empirical data and selected 15-20 instances where components were apparently adversely affected. The safety function for the components identified in the list was then reviewed for potential impact.

- Assessed whether SW flow would entrain and/or deposit material within the system.

- Evaluated whether transported sediment/debris could adversely effect downstream components, especially those components not known to have been previously affected. The inspectors reviewed a list of critical tolerances in the SW system against known debris size.

- Compared a list of strainer bypassing evolutions over the past 5 years with HX fouling factors to determine if there was a relationship between bypassing the strainer and a reduction in HX performance (e.g., higher HX fouling factors).

The inspectors did not identify instances in which safety-related equipment was adversely impacted by the introduction of larger debris into the SW system due to operating with the SW strainers bypassed. However, the inspectors noted that large rocks approximately 4 inches in diameter were removed from one of the strainers during the week of November 7, 2005. Given the presence of the large rocks found in the SW strainer, and the history of debris in the SW intake bay, the inspectors did note that the potential for adverse effects on downstream components remained.

8. Causes of Increased Debris Loading

The inspectors reviewed trends associated with changing conditions in the Missouri River in order to determine if there was a correlation between the changing conditions and the increase in SW system debris loading at Cooper Nuclear Station in recent years.

The inspectors noted that the river level was approximately 877 feet mean sea level (MSL) in 2004 and 2005 when both of the SW debris events occurred. The inspectors also observed that the time frames during which these sedimentation events occurred were following the end of the navigation season (14 days in the case of the October 2005 event). The inspectors also noted that a significant majority (29 of 40) of the SW strainer high DP events occurred at night. The inspectors could not attribute this fact to any particular factor (lower river temperature, cycling of the spargers, etc.).

The inspectors could not definitively attribute the cause of the increased sedimentation to be the lower river levels. However, the inspectors observed that, due to the construction of the weir wall in front of the intake structure, more river water must make a sharp turn in order to enter the intake structure when river level is low. Below a river level of 885 feet MSL, more water must go around the wall versus over it, and at 867.5 feet MSL, all of the water must go around the weir wall. This larger volume of water “turning the corner” resulted in a higher fluid velocity in front of the intake structure and appeared to cause greater entrainment of sand/sediment. This observation was confirmed by the Computational Fluid Dynamic studies that the licensee had performed and Section B-2, 1973 CNS Silting Study - Part III of Final Safety Analysis Report Amendment 31. A primary cause of the lower river level has been the drought conditions in the Missouri River valley.

Following the November 2004 event, the licensee cleaned the SW intake bay to remove the sediment. Sediment levels downstream of the traveling screen were then measured every other day to evaluate the effectiveness of the cleaning. The sediment levels returned to an equilibrium state after 16 days. The sediment pattern was similar to previous trends: the highest sediment levels were at the traveling screen and decreased to near zero levels at the J4B and J4C sparger header locations.

9. Industry Operating Experience

a. Inspection Scope

The inspectors reviewed various NRC generic communications and operating experience from other licensees relevant to SW and intake structure challenges. Specifically, the inspectors reviewed Generic Letter (GL) 89-13, "Service Water System Problems Affecting Safety-Related Equipment," and the licensee's associated response letter for actions related to the accumulation of sediment/debris in the intake structure.

b. Findings

Introduction. The inspectors identified a Green finding for the licensee's failure to implement a commitment made to the NRC. Specifically, the licensee did not carry out the programmatic SW intake bay inspections described in their response to NRC GL 89-13 "Service Water System Problems Affecting Safety-Related Equipment."

Description. The NRC issued GL 89-13, "Service Water System Problems Affecting Safety-Related Equipment," on July 18, 1989. The GL was written to require licensees to supply information about their respective SW systems to assure compliance with the General Design Criteria (GDC) of 10 CFR Part 50, Appendix A. Specifically, licensee responses were evaluated against GDC 44, "Cooling Water;" GDC 45, "Inspection of Cooling Water System;" and GDC 46, "Testing of Cooling Water System." GL 89-13 requested licensees to implement controls in five recommended topical areas to ensure compliance with the GDCs and required licensees to advise the NRC whether the recommendations in each of the five areas had been implemented and provide a schedule for completion for those actions still being implemented.

Recommendation III of GL 89-13 required licensees to "ensure by establishing a routine inspection program . . . that corrosion, erosion, protective coating failure, silting, and biofouling cannot degrade the performance of the safety-related systems supplied by service water." In their response to the GL dated January 29, 1990, the licensee stated that "The present intake structure inspection includes examination of the basin for silt, debris and deterioration (including corrosion) and frequent monitoring of silt levels. The deterioration inspection is performed by using divers or dewatering the bay."

In 1994 the NRC Service Water System Operational Performance Inspection team noted that the inspections had not been performed but that the licensee intended to implement modifications to the plant to allow such inspections to be conducted in the future. The NRC inspection team documented in NRC Inspection Report 05000298/1994-004 the licensee's intent to make changes to the plant to allow direct inspections of the SW intake bay by divers. In September 1995, the licensee proposed

five alternatives to modification and the plant modification was subsequently cancelled. The licensee instead relied upon direct inspections of the circulating water bays to make educated assessments of the conditions that may be expected in the SW bay. The licensee did not implement an inspection program for the SW intake bay as described in their response to GL 89-13.

In September 2003 a licensee self-assessment of the "Heat Exchanger GL 89-13 Program" identified that the "basis for cancelling the implementation of a planned modification" was "not clearly documented." The condition report written at that time incorrectly concluded that the statement in the licensee's GL 89-13 response was not in fact a commitment. The condition report was closed without any corrective action being proposed.

The inspectors verified that no diving or dewatering of the SW intake bay downstream of the traveling water screens had ever been performed. The inspectors reviewed records of the limited inspections that had been performed upstream of the traveling water screens and downstream of the screens in the area above the waterline. These inspections were limited in scope and did not meet the full intent of GL 89-13. Additionally, the inspectors were unable to identify any correspondence to the NRC that showed that the licensee had changed or cancelled the commitment contained in the January 29, 1990, response to GL 89-13.

The inspectors noted that numerous foreign objects have been identified in the intake bay and/or ingested into the SW system that could have been identified and removed during physical inspections. These items have included large rocks and pieces of corroded metal that have migrated into the SW system.

Analysis. The inspectors considered the failure to meet a commitment as a performance deficiency. The finding was more than minor since the failure to perform inspections could become a more significant safety concern if left uncorrected. Degraded conditions in the SW intake bay could affect the operability of the ultimate heat sink for the facility. This finding is not suitable for significance determination process evaluation, but was reviewed by NRC management and determined to be of very low safety significance due to the fact it did not result in an increase in the likelihood of an initiating event and did not result in the actual degradation of a mitigating system. The inspectors identified crosscutting aspects in problem identification and resolution, in that this issue was identified by the NRC in 1994 and again by the licensee in 2003 without any corrective actions being taken.

Enforcement. No violation of NRC requirements was identified. The licensee entered this finding into their corrective action program as CR-CNS-2005-8576. This finding is identified as FIN 05000298/2005015-03, Failure to Implement Commitment in Response to Generic Letter 89-13.

10. Potential Generic Issues

The inspectors did not identify any potentially generic issues related to the SW event.

4OA6 Meetings, Including Exit

On March 14, 2006, the results of this inspection were presented to Mr. S. Minahan and other members of his staff who acknowledged the findings. The inspector confirmed that the supporting details in this report contained no proprietary information.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

D. Buman, Assistant System Engineering Manager
R. Edington, Vice President
R. Estrada, Corrective Actions Manager
J. Flaherty, Site Regulatory Liaison
P. Fleming, Licensing Manager
G. Kline, Director, Engineering
S. Minahan, General Manager of Plant Operations
J. Roberts, Director, Nuclear Safety Assurance
D. Vorpahl, Engineer, Service Water System

NRC Personnel

S. Schwind, Senior Resident Inspector

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened

05000298/2005015-02	URI	Potential for Plugging of REC Heat Exchangers During a Design Basis Accident (Section 4OA5.6)

Closed

05000298/2005002-09	URI	Both SW Discharge Strainers Clogged Due to Silt Intrusion (Section 4OA5.3)

Opened and Closed

05000298/2005015-01	NCV	Inadequate Corrective Actions for SW Strainer Clogging Events (Section 4OA5.3)
05000298/2005015-03	FIN	Failure to Implement Commitment in Response to Generic Letter 89-13 (Section 4OA5.9)

LIST OF ACRONYMS

DP	differential pressure
CFR	*Code of Federal Regulations*
FIN	finding
GDC	General Design Criteria
GL	generic letter
HX	heat exchanger
LOSW	loss of service water
MSL	mean sea level
NCV	noncited violation
NRC	U.S. Nuclear Regulatory Commission
psid	pounds per square inch differential
psig	pounds per square inch gage
REC	reactor equipment cooling
RHR	residual heat removal
SW	service water
SWP	service water pump
URI	unresolved item

LIST OF DOCUMENTS REVIEWED

System Operating Procedure 2.2.3.1, “Traveling Screen, Screen Wash, and Sparger System”

Missouri River Level Trend Data from 1994 to 2005

Plots of Service Water Differential Pressure on August 5, 2005, and October 18 to October 21, 2005

Sounding Level Information for SW Intake Bay from November 15, 2004, until November 18, 2005

“The Evaluation of Thermal Effects in the Missouri River Near Cooper Nuclear Station,” dated April 1972 - March 1973

Records of Heat Exchanger Testing and Maintenance from 1999 - 2005, for Both Trains of Diesel Generator Jacket Water, Diesel Generator Lube Oil, Diesel Generator Intercooler, Residual Heat Removal, Reactor Equipment Cooling, and Turbine Equipment Cooling Heat Exchangers

Engineering Evaluation 03-003, “Reconstitute and Define the Design Basis of the Service Water Pump Discharge Strainers,” Revision 2

Updated Safety Analysis Report, Sections 4.0, 8.0

Technical Specification 3.7.2

Control Room Log Entries, Queried for “Zurn,” “Sedimentation,” and Debris

Condition Reports

CR-CNS-2001-2541	CR-CNS-2002-3018	CR-CNS-2003-5062	CR-CNS-2004-7464
CR-CNS-2001-5373	CR-CNS-2002-3901	CR-CNS-2004-1615	CR-CNS-2005-5138
CR-CNS-2001-6337	CR-CNS-2002-4467	CR-CNS-2004-4046	CR-CNS-2005-6714
CR-CNS-2002-0373	CR-CNS-2003-0046	CR-CNS-2005-5682	CR-CNS-2005-7772
CR-CNS-2002-1376	CR-CNS-2003-0271	CR-CNS-2004-7408	CR-CNS-2005-7747
CR-CNS-2002-1387	CR-CNS-2003-2488	CR-CNS-2004-7409	CR-CNS-2005-8227
CR-CNS-2002-2467	CR-CNS-2003-4936	CR-CNS-2004-7415	CR-CNS-2005-8576

NPPD Letter to the NRC, “Generic Letter 89-13 Recommended Inspection Program,” dated October 15, 1990

Operational Experience

Operational Experience-15108, Silt Levels in Main Intake Structure Exceed Allowable Values

Operational Experience-16024, Excessive Buildup of River Sediment Results in Reduced Water Depth Outside Plant Intake Structure

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION IV
611 RYAN PLAZA DRIVE, SUITE 400
ARLINGTON, TEXAS 76011-4005

November 2, 2005

MEMORANDUM TO: John Hanna, Senior Resident Inspector
Division of Reactor Projects

FROM: Kriss M. Kennedy, Chief, Projects Branch C
Division of Reactor Projects

SUBJECT: SPECIAL INSPECTION CHARTER TO EVALUATE SERVICE WATER EVENT AT COOPER NUCLEAR STATION

In response to an event that led to the inoperability of the service water system at Cooper Nuclear Station on October 20, 2005, a Special Inspection is being chartered. You are hereby assigned to conduct the Special Inspection. Nick Taylor, Resident Inspector, Cooper Nuclear Station, has been assigned to assist you during this inspection.

A. Basis

On October 20, at 0909 with Service Water Pumps A, B, and C running, operators started Service Water Pump D. Following the start of Service Water Pump D, at 0910, the control room operators received a high differential pressure alarm on Service Water Strainer B followed by a high differential pressure alarm on Service Water Strainer A. Both service water cross-connect valves (SW-MO-36/37) closed on low service water header pressure. Operators observed that the service water header pressure in Loop A was approximately 42 psig and 15-20 psig in Loop B. The differential pressure across Service Water Strainer A peaked at 20 psid and recovered in approximately 3 minutes following the automatic initiation of strainer backwash. The differential pressure across Service Water Strainer B peaked at 20.9 psid, however, the automatic initiation of backwash did not result in a sufficient decrease in differential pressure and operators bypassed the strainer. Following these actions, the service water system header pressures returned to normal. During the event, operators declared both loops of service water inoperable due to exceeding the strainer differential pressure structural integrity limit of 15 psid. With both loops of service water inoperable, operators declared both emergency diesel generators inoperable.

The high differential pressure across the strainers was the result of debris (small rocks) which was introduced into the service water system following the start of Service Water Pump D. The high debris loading clogged the strainers. Cooper Nuclear Station experienced a similar event in November 2004, and has experienced other challenges to the proper operation of the service water system resulting from debris over the last several years.

Management Directive 8.3, “NRC Incident Investigation Program,” was used to evaluate the level of NRC response for this event. In evaluating the deterministic criteria of MD 8.3, it was determined that introduction of debris into the service water system: (1) led to the loss of a safety function or multiple failures in systems used to mitigate an actual event, and (2) involved repetitive failures or events involving safety-related equipment or

deficiencies in operations. Since the deterministic criteria was met, the service water event was event was evaluated for risk. The preliminary Estimated Conditional Core Damage Probability was determined to be between 2.0E-6 and 2.0E-5. In accordance with MD 8.3, the results of the risk assessment indicates that NRC response to this event falls between the overlap region to conduct a Special Inspection and no additional inspection, and the region that requires a Special Inspection.

Region IV has reviewed the results of the MD 8.3 evaluation and determined that a Special Inspection is warranted. Based on previous inspections of these issues, and inspection that has occurred since the October 20 event, the following specific concerns have been identified that warrant further inspection and assessment:

- The timeliness and adequacy of corrective actions that Cooper Nuclear Station has already implemented or plans to implement to correct the cause of these events
- The adequacy of Cooper Nuclear Station's interim compensatory measures to prevent challenges to the service water system while the longer term corrective actions are being implemented
- The assumptions and basis used by the licensee to evaluate the ability of the service water system to continue to meet design requirements

This Special Inspection is chartered to identify the circumstances surrounding this event, determine if the licensee's long-term corrective actions are timely and adequate, and to determine if the licensee's interim compensatory actions are adequate.

B. Scope

The inspection is expected to perform data gathering and fact-finding in order to address the following:

14. Develop a complete description of the service water event that occurred on October 20, 2005, and a complete sequence of events, including operator and system response, related to the event.

15. Develop a list of similar challenges to the service water system resulting from debris and actions taken by the licensee to correct the problem.

16. Identify and evaluate the adequacy and timeliness of the licensee's long-term corrective actions established prior to the event on October 20, 2005, and any changes following the event, to address the adverse impact of debris on the service water system.

17. Identify and evaluate the adequacy of the licensee's compensatory measures established prior to the event on October 20, 2005, and following the event, to address the adverse impact of debris on the service water system.

18. Identify and assess additional actions planned by the licensee in response to this event, including the timeline for their completion of these actions.

19. Evaluate the assumptions and basis used by the licensee to determine the ability of the service water system to continue to meet design requirements.

20. Assess the impact that the increased debris loading, and operation of the service water system with one or more strainers bypassed, has had on safety-related equipment cooled by service water.

21. Identify the changing conditions that have resulted in the increase in service water system debris loading in recent years.

22. Compare the results of your inspection with the licensing and design basis for Cooper Nuclear Station.

23. Evaluate pertinent industry operating experience to the event, including the effectiveness of any action taken in response to the operating experience.

24. Determine if there are any generic issues related to the service water event. Promptly communicate any potential generic issues to regional management.

25. Assess the safety significance of any inspection findings.

C. Guidance

Inspection Procedure 93812, "Special Inspection," provides additional guidance to be used by the Special Inspection Team. Your duties will be as described in Inspection Procedure 93812. The inspection should emphasize fact-finding in its review of the circumstances surrounding the event. It is not the responsibility of the team to examine the regulatory process. Safety concerns identified that are not directly related to the event should be reported to the Region IV office for appropriate action.

You will formally begin the special inspection with an entrance meeting to be conducted no later than November 7, 2005. The inspection will include a review of the results of the licensee's root cause analysis. You should brief Region IV management during the course of your inspections and prior to your exit meeting. A report documenting the results of the inspection should be issued within 30 days of the completion of the inspection.

This Charter may be modified should you develop significant new information that warrants review. Should you have any questions concerning this Charter, contact me at (817) 860-8144.

cc via E-mail:
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T. Gwynn
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A. Howell

D. Chamberlain
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