UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

October 4, 2011

Mr. Anthony Vitale
Vice-President, Operations
Entergy Nuclear Operations, Inc.
Palisades Nuclear Plant
27780 Blue Star Memorial Highway
Covert, MI 49043-9530

SUBJECT: PALISADES NUCLEAR PLANT - NRC SPECIAL INSPECTION TEAM (SIT) REPORT 05000255/2011012

Dear Mr. Vitale:

On September 1, 2011, the United States Nuclear Regulatory Commission (NRC) completed a special inspection at your Palisades Nuclear Plant. The inspection was conducted in response to the circumstances surrounding the failure of the Service Water Pump P-7C, on August 9, 2011. Based on the risk and deterministic criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," a special inspection was initiated in accordance with Inspection Procedure 93812, "Special Inspection."

The special inspection charter (Attachment 2 of the enclosure) provides the basis and focus areas for the inspection.

The enclosed inspection report documents the inspection results, which were discussed with you and other members of your staff at the exit meeting on September 1, 2011. The determination that the special inspection would be conducted was made on August 15, 2011, and the on-site inspection commenced the same day.

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

Based on the results of this inspection, no findings of significance were identified.

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 and from the Publicly Available Records (PARS) component of NRC's document system, Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.qov/readinq-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Steven West, Director
Division of Reactor Projects

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

Enclosure: Inspection Report 05000255/2011012;
w/Attachments: 1. Supplemental Information
2. Memo to Jandovitz
3. Palisades Timeline

cc w/encl: Distribution via ListServ

U. S. NUCLEAR REGULATORY COMMISSION

REGION III

Docket No.:	50-255
License No.:	DPR-20
Report No.:	05000255/2011012
Licensee:	Entergy Nuclear Operations, Inc.
Facility:	Palisades Nuclear Plant
Location:	Covert, MI
Dates:	August 15, 2011 - September 1, 2011
Inspectors:	J. Jandovitz, Project Engineer (Lead) A. Shaikh, Reactor Inspector P. Smagacz, Reactor Engineer
Approved by:	John B. Giessner, Chief Branch 4 Division of Reactor Projects

Enclosure

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SUMMARY OF FINDINGS

IR 05000255/2010012; 08/15/2011 09/01/2011; Palisades Nuclear Plant; Inspection Procedure 93812, Special Inspection.

This report covers a 4-day period (August 15 -19, 2011) of on-site inspection and in-office review through September 1, 2011. A team, comprised of three regional inspectors, conducted this special inspection. The NRC's program for overseeing the safe operation of commercial nuclear power reactors is described in NUREG-1649, "Reactor Oversight Process," Revision 4, dated December 2006.

A. NRC-Identified and Self-Revealing Findings

No findings were identified.

B. Licensee-Identified Violations

No findings were identified.

REPORT DETAILS

Summary of the Degraded Condition

At 12:02 p.m. EDT on August 9, 2011, the licensee entered an unplanned 72-hour shutdown Technical Specification limiting condition for operation (LCO) action statement (TSAC) due to failure of service water (SW) pump P-7C. The SW system includes three motor-driven, vertical multistage deep draft pumps that provide cooling water to safety related equipment (component cooling water, containment air coolers, diesel generators, control room coolers, etc.). Each pump has 50 percent capacity; and two pumps are required to be in service; however, the technical specification requires all three pumps to be operable. All three pumps were running prior to the failure.

The licensee observed a low differential pressure condition and low pump amperage following the failure of the pump. The licensee disassembled pump P-7C and determined that the pump's first line shaft to second line shaft coupling, #6, had failed. The licensee replaced all of the pump P-7C couplings and two portions of the pump shaft. After completing the required maintenance and surveillance tests, the licensee returned pump P-7C to service on August 12, within the time allowed by the TSAC.

Pump P-7C had previously experienced another coupling failure in September 2009. The SW pump couplings in both cases were made of 416 Stainless Steel. Subsequent metallurgical analysis determined the coupling's hardness was significantly higher than the design specification; and the failure was caused by Intergranular Stress Corrosion Cracking (IGSCC). The licensee's corrective actions in 2009 included replacing all the SW pump P-7C couplings with couplings of the same design and hardness criteria. However, hardness test results of several couplings removed from pump P-7C on August 10, 2011, indicated that these couplings were not within the hardness specification. Specifically, three of the couplings had at least one test location where the hardness measurement was higher than the licensee's design specification criteria.

Inspection Scope

Based on the deterministic and conditional risk criteria specified in Management Directive 8.3, "NRC Incident Investigation Program," a special inspection was initiated in accordance with NRC Inspection Procedure 93812, "Special Inspection Team." The special inspection charter, dated August 15, 2011, is included as Attachment 2. The team reviewed technical and design documents, procedures, maintenance records, and corrective action documents; interviewed station personnel and consultants; and performed plant walkdowns of plant equipment. A list of specific documents reviewed is provided in Attachment 1.

4OA5 Other Activities – Special Inspection (93812)

In accordance with the Charter, the following items were reviewed.

.1 Establish a historical sequence of events related to service water pump coupling failures up to and including the most recent failure on August 9, 2011.

a. Inspection Scope

The inspectors reviewed corrective action documents, operating experience reports, technical literature, operation history, surveillance procedures and results, vendor procurement and manufacturing records, and interviewed plant personnel for information related to the use of 416 Stainless Steel (SS) material, and similar material such as 410SS, in power plant applications, particularly, SW pumps.

A detailed historical timeline of activities and information involving use and experience is contained in Attachment 3.

b. Findings and Observations

No findings were identified.

The inspectors were concerned that the licensee had not adequately evaluated operating experience to recognize the vulnerabilities of 416SS material to IGSCC based on material properties, particularly heat treatment. This concern is discussed further in the unresolved item (URI) in Section .07 of this report. However, the inspectors did not identify any operational or surveillance results or observations that may have predicted the failure of SW pump P-7C on August 9, 2011.

.2 Review the licensee's basis for operability of the service water pumps P-7A, P-7B, and P-7C. Determine whether the licensee had an adequately supported basis for operability of pumps P-7A and P-7B and for returning pump P-7C to service. Determine if additional corrective actions are required.

a. Inspection Scope

The inspectors reviewed the prompt operability basis for all three SW pumps contained in Engineering Change (EC) 31208 and EC 31218. The inspectors identified run times, service conditions and life, starts and stops, heats of materials, and differences in heat treatment for the in-service couplings.

b. Findings and Observations

No findings were identified.

Based on the information available, the inspectors did not disagree with the immediate or prompt operability evaluations. The prompt operability for SW pumps P-7B and P-7C was based on the higher confidence that the hardness of the couplings installed in the pumps were within the design specification range, and therefore less susceptible to

IGSCC. Operability for pump P-7A was based on the fact that couplings installed in that pump had been in operation the longest with no failures.

However, the inspectors noted that there was no discussion on temper embrittlement identified in the Structural Integrity (SI) report and in operating experience, as a factor that may affect the couplings' reliability. Therefore, it was recognized that the results from the metallurgy and root cause evaluation may impact the basis for current operability and the couplings' service life.

After the on-site SIT inspection was complete, the licensee received initial metallurgical results on the failed coupling and initiated a near-term replacement plan of the couplings in all three SW pumps with couplings of a different material, more resistant to IGSCC. At the time of the SIT exit, the couplings in pump P-7A had been replaced with the new material.

The NRC will continue to monitor results from the root cause investigation for impact on the operability basis for any pump that still has the 416SS couplings.

The residents will also evaluate the licensee's evaluation of past operability for all the SW pumps and the extent of condition evaluation for the 416SS components remaining in the pumps.

.3 Evaluate activities associated with the licensee's repair of service water pump P-7C for adequacy. Confirm that the repair complies with licensee and NRC requirements.

a. Inspection Scope

The inspectors reviewed the licensee's repair and replacement activities associated with the rebuild of pump P-7C following the 2011 pump coupling failure. This review included the document review of post-maintenance testing of the pump as well as documentation of pre-installation testing of pump and motor. Also reviewed was the completed work order for this repair and replacement, and the material specifications (heat treat curves, hardness results) of couplings that were installed in this rebuilt pump P-7C.

b. Findings and Observations

No findings were identified

The inspectors did not identify any issues relating to the 2011 pump P-7C repair.

.4 Review information and processes relied upon by Palisades to determine whether or not critical attributes of service water pump line shaft couplings, such as hardness, are acceptable prior to coupling installation.

a. Inspection Scope

The inspectors reviewed the information provided by the licensee regarding pump shaft couplings that included hardness measurements at time of procurement, independent lab results for coupling hardness measurements prior to coupling installation in the pumps, and the associated heat treatments for the couplings. Also reviewed were

industry reports and operating experience regarding use of 416 Martensitic SS for these couplings and the 2009 SW pump P-7C coupling failure root cause evaluation.

b. Findings and Observations

No findings were identified.

The inspectors identified a concern with the adequacy of specifying coupling hardness as the only critical material parameter. This was not a conservative approach given the collection of scientific literature and industry operating experience describing the vulnerability of 416/410 Martensitic SS to stress corrosion cracking; and suggested use of toughness measurements in addition to hardness values to determine acceptability of 416/410 Martensitic SS as coupling material. However, ensuring hardness that values are below a certain allowable maximum, reduces the vulnerability of the couplings to IGSCC; but hardness itself may not be sufficient to ensure critical parameters are met. This concern is captured as part of the URI included in Section .07 of this report.

In late 2007, an engineering change was initiated to replace the carbon steel components in the SW pumps with stainless steel components resistant to the erosion and corrosion issues the plant had experienced throughout its life. In 2008, couplings for the SW pumps were procured and fabricated from 416SS with specified criteria for material chemistry and a Rockwell C (Rc) hardness range of 28-32 Rc.

Information available from industry operating experience referenced that material, specifically water pump couplings, made from 410/416 SS were susceptible to IGSCC due to temper embrittlement and improper heat treatment.

The 2009 Palisades failure of SW pump P-7C coupling was attributed to IGSCC due to significantly high hardness, ranging from 37-41 Rc; and all couplings were replaced with the same material and design specification for hardness. No additional criteria were specified for tempering or heat treatment.

Results from a similar coupling failure at Prairie Island in 2010, showed that their coupling, supplied by same vendor as the Palisades pump couplings, failed due to IGSCC even though the hardness was near the specification criteria.

Absent any design criteria from the licensee, the heat treatment performed on the couplings was focused on the final product having a hardness value in the specified range of 28-32 Rc. There was no consideration of the effect of heat treatment on other material properties, such as toughness, that may affect susceptibility to IGSCC. The inspectors noted the heat treatments were different for couplings for each of the three pumps. Couplings for pumps P-7B and P-7C were double-tempered. Also, the procedure used by the heat treatment vendor allowed multiple heat treatments (tempering) to achieve the desired hardness, and did not consider the affect of this process on IGSCC resistance.

Because of the literature and industry operating experience of the vulnerability of 416/410 Martensitic SS to IGSCC, the plant requested Structural Integrity to evaluate their 416SS couplings. The report was received in March 2011, and suggested that the couplings were susceptible to temper embrittlement, but did not conclude that there was

an immediate operability concern. The plant was evaluating this information when the coupling failed on August 9.

.5 Evaluate the licensee's procedures and processes for evaluating/assessing the performance of vendors. Emphasis should be placed upon determining why couplings that were believed to be of an appropriate hardness were later found to be of an inappropriate hardness. Review any evaluations/assessments of HydroAire that were completed by the licensee following the September 2009 service water pump P-7C coupling failure. Also, review any actions taken or direction provided by the licensee to HydroAire in response to the recent hardness test results.

a. Inspection Scope

The inspectors reviewed procurement procedures for the licensee and vendor, the 2009 root cause evaluation, source surveillances completed since 2009, the industry audit of HydroAire, condition reports, corrective actions taken by the licensee and vendor after the 2009 coupling failure, purchase documents, and interviewed Quality Assurance personnel.

b. Findings and Observations

No findings were identified.

The inspectors identified a concern that the licensee may not have provided adequate vendor procurement control after the 2009 coupling failure, which may have contributed to the 2011 coupling failure. The inspectors found that adequate procurement procedures and processes existed, but were not fully utilized after the 2009 coupling failure. This concern is included in the URI discussion in Section .07 of this report.

The inspectors reviewed a vendor surveillance performed in March 2010 on parts for a spare SW pump. The surveillance noted that one pump part was heat-treated, and the hardness readings taken by the pump vendor and the heat treatment vendor were both out of the specified range. Therefore, the part was again heat-treated, resulting in acceptable hardness values obtained by both vendors. The part was then identified as acceptable. This demonstrated that as late as 2010, there were still issues with the controls on heat treatment for SW pump parts.

Implementation of the corrective actions from the 2009 coupling failure resulted in some improvements to the vendor procurement processes and additional oversight. This was based on:

- frequent vendor surveillance activities were conducted on new parts that found vendor performance was satisfactory;
- procedure EN-MP-100, "Critical Procurements," was implemented for procurements after 2009; and
- a NUPIC [Nuclear Procurement Issues Committee] audit conducted in April 2011 found that HydroAire was implementing an effective quality assurance (QA) program.

This is not concluding the design criteria supplied to the vendor was correct, as discussed earlier, only that the parts supplied by the vendor appeared to meet licensee criteria.

No additional actions were taken by or required of the vendor after the 2011 coupling failure, since the licensee considered this failure the result of activities that occurred in 2009, and that corrective actions implemented by the vendor then were effective.

.6 Evaluate the licensee's operating experience program with an emphasis on operating experience related to pump components manufactured by HydroAire. Specific attention should be given to the licensee's evaluation of a 2010 service water pump coupling failure at Prairie Island and the evaluation of a March 2011 report from Structural Integrity regarding the potential for coupling failure due to temper embrittlement.

a. Inspection Scope

Operating experience regarding failures of couplings using 410/416 Martensitic SS was reviewed along with generic technical reports and metallurgical reports. The report of most interest were the Prairie Island coupling failure in 2010, the Structural Integrity report which was issued to address the 2009 coupling failure at Palisades, and the 2009 Palisades coupling failure root cause evaluation.

b. Findings and Observations

No findings were identified.

The inspectors identified a concern that operating experience and industry information may not have been incorporated into the design of the pump nor addressed adequately in the 2009 coupling failure replacement and root cause evaluation. Further discussion of this concern is included in the URI discussion in section .07.

Operating experience that existed as early as 1991 discussed failures of pump couplings attributed to embrittlement of 410SS and 416SS due to improper tempering temperatures and heat treatment. In addition, industry and NRC reports were available prior to 2009 and discussed the effect of temper embrittlement on 410/416SS material.

The SI report was issued in March 2011, but the licensee did not accept the report until August. This report discussed temper embrittlement as an issue that could affect coupling reliability. The licensee had not yet evaluated nor initiated corrective actions based on the report.

The inspectors found the licensee did identify pertinent operating experience in development of the 2011 coupling failure root cause evaluation, although the root cause report was not issued by the completion of this SIT report.

.7 Review the licensee's root cause evaluation plan and schedule. Include the schedule for performing testing of any components removed from pump P-7C. Evaluate whether the root cause evaluation plan is of sufficient depth and breadth. Confirm that the time allowed to perform the root cause evaluation is commensurate with the safety significance of this issue. Communicate to the licensee that the NRC will inspect the

completed root cause evaluation and the associated corrective actions as part of our normal inspection activities.

a. Inspection Scope

The inspectors reviewed the root cause charter, schedule, team make-up and action plan; and discussed actions with root cause team.

b. Observations

The inspectors found the root cause team was comprised of individuals dedicated solely to the root cause investigation; they had no additional responsibilities. Most members had not been involved in the root cause for the 2009 failure. Team members included consultants, including an independent pump manufacturer and the metallurgical lab contracted to perform the metallurgical analysis. The pump supplier, HydroAire, provided input to the root cause but was not a member.

The root cause timeline started August 16, and was scheduled to be completed within 30 days in accordance with procedures.

The root cause investigation was determined to be of adequate depth and breadth to be successful in determining the actual root cause. The action plan included the following aspects:

- improper hardness;
- improper material;
- over-torque from foreign material;
- shaft misalignment;
- Stress Corrosion Cracking;
- incorrect clearances in coupling to shaft;
- shaft faces not square;
- pump alignment;
- shaft wobble;
- reverse rotation;
- coupling defects;
- operation at critical speed;
- operation loads;
- strainer blockage;
- maintenance practices; and
- fatigue failure.

The inspectors reviewed the draft metallurgical plan and considered the metallurgical analysis plan for selected coupling to be thorough, although the licensee had not yet finalized the plan or determined which couplings would be included in the plan. The NRC will continue to inspect the metallurgical results and root cause report under the normal baseline procedures.

Unresolved Item: Adequacy of SW Pump Couplings

Introduction: A URI was identified by the inspectors during review of the SW pump P-7C coupling failure in 2011. Specifically, the inspectors were concerned with the adequacy of the procurement of the replacement couplings after the 2009 coupling failure on the same pump; whether operating experience was adequately incorporated into design specifications; and whether the corrective actions taken after the 2009 failure were adequate to prevent recurrence.

Description: Palisades has three safety-related SW pumps that draw water from Lake Michigan to provide cooling to safety-related and non-safety-related components. Each pump has eight couplings to connect shaft sections. In 2009, the plant began a material change for the couplings and shafts from carbon steel to 416 Martensitic SS due to erosion issues of the carbon steel material. The material would be changed in series in of pumps P-7A, P-7C, and P-7B respectively. The timeline (Attachment 3) includes specific dates.

In 2009, SW pump P-7C failed due to cracked coupling #7, resulting into entry a TSAC, requiring the plant to shut down if the pump was not returned to service within 72 hours. Metallurgical data on the failed coupling revealed the coupling hardness was significantly higher than the design specification. The specified hardness range was Rockwell C value of 28-32 Rc. Hardness readings on the failed coupling ranged from 37-41 Rc. The vendor, HydroAire, had supplied the couplings with certifications that the couplings were within the specified hardness.

This failure was entered into the licensee's corrective action program and identified as a significant condition adverse to quality (SCAQ).

At the time of the failure, no spare couplings were available. Immediate discussions with HydroAire ensued to obtain replacement couplings within the 72-hour timeframe. Based on the hardness data received on the failed coupling, which conflicted with the certification received from the vendor, the licensee verbally imposed additional requirements to obtain independent laboratory hardness checks on the replacement couplings. The requirement for independent hardness checks on the replacement couplings was not incorporated into the procurement process. Procurement documents were not updated with this additional requirement, and procurement personnel, such as the licensee procurement manager at the vendor site or the plant receipt inspection personnel, were not made aware of the additional requirement. Procedure EN-MP-100, "Critical Procurements," was not implemented even though criteria in the procedure, such as previous vendor issues, how critical the couplings were on plant operation, and the short procurement timeframe, appear to have been satisfied.

Eight replacement couplings were received and immediately installed in the pump; the pump was returned to service within the 72-hour requirement. Soon after the pump was returned to service, the licensee discovered that independent hardness checks were not performed. The vendor did provide certifications indicating that the couplings had hardness values in the specified range. An additional ten couplings were ordered and received soon after the pump was returned to service. Independent hardness checks completed on these spare couplings agreed with vendor hardness results, thus providing

some assurance to the licensee that the couplings currently installed in pump P-7C were of the correct hardness.

On August 9, 2011, SW pump P-7C was declared inoperable due to the failure of coupling #6. This failure was entered into the licensee corrective action program and identified as a SCAQ. The cause of the failure had not been determined at the time this SIT report was completed. However, hardness results obtained from an independent metallurgical lab from four of the in-service couplings, including the coupling that failed, were found to have at least one spot of higher hardness than specified, greater than Rockwell Hardness value of 32 Rc. No hardness values approached the 37-41 Rc observed in the 2009 failure (the values were less than 34Rc). Therefore, the inspectors were concerned that the licensee did not ensure the vendor-supplied couplings with correct hardness values in 2009. Pending final results and conclusions from the metallurgical analysis and root cause analysis, the licensee may have failed to take measures in 2009 to assure that purchased material and equipment conform to the procurement documents, including provisions for, as appropriate, objective evidence of quality furnished by the contractor as required by Appendix B.

Operating experience available to the licensee from 1991 through 2009, identified that Martensitic 416SS could be more susceptible to IGSCC, dependant on the heat treating process. Some of the previous operating experience is listed below:

- September 12, 1991 – Beaver Valley Unit 1 experienced a coupling failure of a Byron-Jackson centrifugal pump as a result of embrittlement of 410SS due to improper tempering temperatures and potential impurities. The failure mechanism was IGSCC;
- September 1, 1993 – NRC Information Notice 93-68, “Failure of Pump Shaft Coupling Caused by Temper Embrittlement During Manufacture,” is issued informing licensees of problems stemming from temper embrittlement of 410SS supplied by Byron-Jackson (referring to the 1991 Beaver Valley event); the document noted in the material analysis that the toughness of the failed component was extremely low;
- September 22, 1993 – Indian Point Unit 2 experienced a pump failure due to a failed coupling attributed to a non-ductile fracture because of temper embrittlement of the 410SST used; the failure mechanism was IGSCC;
- September 1, 2003 – Perry Unit 1 experienced a coupling disassembly event on their emergency SW pump A. The failure mechanism was by IGSCC and no performance effects were noticed before the failure of the coupling;
- May 21, 2004 – Perry Unit 1 experienced another emergency SW pump coupling failure; the failure mechanism was by IGSCC, similar to the 2003 event;
- 2006 – INPO Operating Experience Digest 2006-02 – INPO released a document that discusses SW pump (shaft, coupling and impeller) failures occurring in the industry. The report noted that 12 failures occurred between 1998 and 2006, with the most frequent including corrosion causing coupling separation. One of the common causes identified was improper heat treatment of the material during manufacturing; and
- February 9, 2007 – NRC Information Notice 2007-05, “Vertical Deep Draft Pump Shaft and Coupling Failures,” was issued and referenced the coupling failures from IGSCC that occurred at Columbia Generating Station. The couplings were

410 Martensitic SS and were susceptible to tempering embrittlement. The operating experience review identified at least 23 essential SW pump shaft and coupling failures since 1983 involving more than six different manufacturers.

The 2009 coupling failure root cause evaluation was focused on the material hardness. It did not fully evaluate the effect of other material properties, such as toughness which is discussed in the operating experience, nor the change of material properties from heat treatment on the susceptibility of the couplings to IGSCC. Corrective actions after the 2009 failure did not address the heat treatment process. The inspectors were concerned that the licensee may not have adequately addressed operating experience in the design of the original 416SS couplings or the 2009 replacement couplings as required by Appendix B, Criteria III. And the corrective actions taken after the 2009 failure may not have prevented recurrence of this SCAQ as required by Appendix B, Criteria XVI. These concerns will be further evaluated as part of the NRC baseline inspection program, after the final metallurgical results are issued and the licensee root cause evaluation is completed. (URI 05000255/2011012-01; Adequacy of SW Pump Couplings).

4OA6 Meetings, Including Exit

On September 1, 2011, the special inspection team leader presented the preliminary inspection results to Mr. Anthony Vitale and members of his staff. No proprietary information is included in this inspection report.

ATTACHMENT: SUPPLEMENTAL INFORMATION

SUPPLEMENTAL INFORMATION

KEY POINTS OF CONTACT

Licensee Personnel

T. Vitale, Entergy/Site Vice President
J. Haumersen, Entergy/System Engineering Manager
B. Kemp, Entergy/Design Engineering Manager
D. MacMaster, Entergy/Acting Design Engineering Manager
D. Hamilton, Entergy/General Manager Plant Operations
A. Blind, Entergy/Engineering Director
D.Malone, Entergy/Acting Nuclear Safety Assurance Dir.
J. C. Plachta, Entergy/Quality Assurance Manager
P. Deniston, Entergy/Sr. Engineer
J. Forehand, Entergy/Engineering Supervisor
B. Dotson, Entergy/Licensing
J.Pennington, Entergy/Corporate MP&C

NRC Personnel

J Ellegood, Senior Resident Inspector, Palisades
J. Giessner, Branch Chief
K. Stoedter, Acting Branch Chief

LIST OF ITEMS OPENED, CLOSED, AND DISCUSSED

Opened and Closed
None

Closed
None

Opened

05000255/2011012-01	URI	Adequacy of SW Pump Couplings

LIST OF DOCUMENTS REVIEWED

Condition Reports	Title	Date/Revision No.
CR 04-02598	Root Cause Report for Perry Emergency Service Water Pump A Upper Shaft Coupling Sleeve Repeat Failure.	
CR 2011-03975	Relevant OE Not Considered in CR-PLP-2009-4519 (Root Cause Evaluation for the 2009 Service Water Pump P-7C coupling Failure)	August 12, 2011
CR-PLP-2009-04519	Root Cause Evaluation Report for Service Water Pump P-7C Failure to Provide Discharge Pressure	March 4, 2009
CR-PLP-2009-04542	Evaluate Early Station Response to Failure of P-7C	September 30, 2009
CR-PLP-2009-04547	Inadequate FME Postings and Boundaries for Initial Disassembly of P-7C	September 30, 2009
CR-PLP-2009-04561	Job Safety Hazard Analysis Not at Job Location for P-7C	September 30, 2009
CR-PLP-2009-04571	Station in Event Response for Unexpected Loss of Service Water Pump P-7C	September 30, 2009
CR-PLP-2009-04593	Steps Not Followed Within WI-SWS-M-04 for Reassembly of P-7C	October 1, 2009
CR-PLP-2009-04613	Administrative Issues Involving Work Scheduling in Response to Emergent Equipment Issues	October 2, 2009
CR-PLP-2009-04616	Procedure Not In-Hand for Packing Adjustments for P-7C Pump Shaft	October 2, 2009
CR-PLP-2009-04659	Initial CR for CR-PLP-2009-04806	October 6, 2009
CR-PLP-2009-04806	Apparent Cause Evaluation to Evaluate Miscommunication of Independent Testing	October 15, 2009
CR-PLP-2009-04877	Service Water Pump P-7C Exceeds Maintenance Rule Unavailability	October 21, 2009
CR-PLP-2009-05647	Documentation of HydroAire Root Cause Evaluation of Failed Line Shaft Coupling on P-7C	December 9, 2009
CR-PLP-2009-05874	Evaluation of Past Operability Issues of P-7C Prior to the Event on 09/29/2009	December 22, 2009
CR-PLP-2010-01015	Error Identified in Licensee Event Report 2010-001, Potential Loss of Safety Function Due to a Service Water Pump Shaft Coupling Failure	March 10, 2010

CR-PLP-2011-03902	Root Cause Report Service Water Pump 7-C Line Shaft Coupling Failure	September 8, 2011
CR-PLP-2011-03920	Non-covered Worker Has Exceeded Limits of EN-FAP-OM-006	August 10, 2011
CR-PLP-2011-03921	A-Frame Designated for Lifting P-7C Service Water Pump Missing	August 10, 2011
CR-PLP-2011-03929	Non-Conforming Components Removed from P-7C	August 10, 2011
CR-PLP-2011-03938	Outside Diameter Value and/or Tolerance in Error	August 10, 2011
CR-PLP-2011-03939	Degradation of Coating with Blisters on the Discharge Head of P-7C	August 10, 2011
CR-PLP-2011-03942	Non-covered Worker Has Exceeded Limits of EN-FAP-OM-006	August 11, 2011
CR-PLP-2011-03944	Personnel Pulled from Training for Plant Event Response	August 11, 2011
CR-PLP-2011-03946	P-7C Work Temporarily Stopped Due to Non-Tethered Tools in FME Zone 1	August 11, 2011
CR-PLP-2011-03947	Hardhat Lost During P-7C Disassembly	August 11, 2011
CR-PLP-2011-03948	Issues with Licensed Operator Training Identified	August 11, 2011
CR-PLP-2011-03952	Chlorination Deferment without Potential Adverse Effect	August 11, 2011
CR-PLP-2011-03959	Violation of Protected Equipment Boundary	August 11, 2011
CR-PLP-2011-03961	Potential Extent of Condition on Service Water Pumps P-7A and P-7B	August 11, 2011
CR-PLP-2011-03963	Reverse Rotation Noticed of P-7C During Breaker Opening	August 11, 2011
CR-PLP-2011-03965	Engineer Exceeds Overtime Limit	August 11, 2011
CR-PLP-2011-03966	Removed Couplings from P-7C 2011 Failure Show Out-of-Spec Hardness	August 12, 2011
CR-PLP-2011-03966	Results of 4 Couplings Sent to Consumers Energy Laboratory Services for Hardness Testing	August 12, 2011
CR-PLP-2011-03967	Service Water Pump P-7C Lift Setting Not Validated Correctly	August 12, 2011
CR-PLP-2011-03967	Final Pump Lift Setting Not Validated Correctly	August 11, 2011
CR-PLP-2011-03968	Questioning of Pump Run in Dead Headed Condition	August 11, 2011
CR-PLP-2011-03975	Relevant OE not Considered in CR-PLP-2009-04519	August 12, 2011
LO-CAR-2009-00103	Nonconformance of Parts from HydroAire	October 5, 2009

LO-PLPLO-2009-00065	Implementation of Effectiveness Review Plan for RCE CR-PLP-2009-04519	October 16, 2009

Documents	Title	Date/Revision No.
LER 2004-001-01	Emergency Service Water Pump Failure	September 18, 2004
Certificate of Conformance	Certificate of Conformance for PO 10237148, Job# NQ5832	June 9, 2009
CP-PLP-2009-002	P-7C Service Water Pump Refurbishment Procurement Plan	May 18, 2009
EC 31208	Engineering Basis for Service Water Pump P-7C to be Considered Fully Operable Post-Repair (August 2011 Coupling Failure)	August 12, 2011
EC 31218	Engineering Basis for Service Water Pump P-7A and P-7B to be Considered Operable Considering P-7C Coupling Failure (August 2011 Coupling Failure)	August 10, 2011
Examination Report 00286627	VT-2 (Pressure Test) of Service Water Pump P-7C Prior to Return to Service	August 12, 2011
HydroAire NDR	Nonconformance and Discrepancy Report 09-55	October 2, 2009
LO-WTHQN-2011-00439	Source Activity for Entergy Palisades PO10262979* Rev 000	March 4, 2011
LO-WTHQN-2011-00920	Source Activity for Entergy Palisades PO10262979, HydroAire Job No. NQ 5940	July 20, 2011
MAT Project 0900609	Consumers Energy Palisades Pump P7C Shaft Coupling Failure Analysis	October 5, 2009
NDR No. QANC-09 97	HydroAire Nonconformance & Discrepancy Report and Part 21 Notification	December 16, 2009
NUPIC Audit Report VA11-011	NUPIC Audit of HydroAire, Inc.	June 1, 2011
Purchase Order 10190242	Procurement Documents for Pump P-7A Couplings for 2009 Pump Refurbishment	Revision 003
Purchase Order 10237148	Procurement Documents for Service Water Pump Refurbishment	June 9, 2009
Purchase Order 10246213	Procurement Documents for Pump P-7B Couplings for 2009 Pump Refurbishment	Revision 004
Purchase Order 10253715	Procurement Documents for Pump P-7C Couplings Following 2009 Coupling Failure	Revision 003
Report No. 1100112.401	Structural Integrity Additional Review of Palisades Service Water Pump Couplings	Revision 0

Report PO 10324017	Consumers Energy Rockwell Hardness Test Report for Couplings Removed from Failed Pump P-7C	August 10, 2011
SQA2010-00131	HydroAire Source Surveillance Report SS010-016	March 16, 2010
SQA2010-00561	HydroAire Source Surveillance Report SS010-158	November 2, 2010
WO 00190235	P-7C, Reduced Flow>RO-144; Replace Pump Assembly per EC-14577	June 10, 2009
WO 00208591	P-7C: Motor Shaft Broke. Repair Pump	October 28, 2009
WO 00209551	RO-216 Service Water Pump Flow Verification	September 15, 2010
WO 00286627	Test Spare P-7C Motor IAW EN-MA-134 Offline Motor Electrical Testing	August 11, 2011
WO 52211728	P-7C IST Service Water Pump	October 1, 2009

Procedures	**Title**	**Date/Revision No.**
ARP-7	Auxiliary Systems Scheme EK-11	Revision 80
BMS-WI 09.15.03	Bodycote Heat Treatment of Martensitic Corrosion Resistant Steels Procedure	July 10, 2006
BMS-WI-09-00-02	Bodycote Determination of Heat Treat Process Time Procedure	November 17, 2006
EN-DC-115	Engineering Change Process	Revision 11
EN-DC-313	Procurement Engineering Process	Revision 6
EN-LI-102	Corrective Action Process	Revision 16
EN-LI-118	Root Cause Evaluation Process	Revision 14
EN-LI-118-01	Event & Causal Factor Charting	Revision 0
EN-LI-118-02	Change Analysis	Revision 0
EN-LI-118-03	Barrier Analysis	Revision 0
EN-LI-118-04	Task Analysis	Revision 0
EN-LI-118-05	Fault Tree Analysis	Revision 0
EN-LI-118-06	Common Cause Analysis	Revision 1
EN-LI-118-07	Behavioral Analysis	Revision 0
EN-LI-118-08	Failure Modes Analysis	Revision 0
EN-MA-118	Foreign Material Exclusion	Revision 5
EN-MP-100	Critical Procurements	Revision 8
EN-MP-101	Materials, Purchasing and Contracts Process	Revision 5
EN-MP-111	Inventory Control	Revision 3
EN-MP-117	Standardized Purchasing Process	Revision 2
EN-MP-120	Material Receipt	Revision 4
EN-MP-123	Term and Definitions	Revision 4
EN-MP-125	Control of Material	Revision 7

EN-QV-119	Corrective Action Requests, Supplier Stop Work Orders, and Recommendations	Revision 7
EN-QV-120	Planning, Performing, and Reporting Source Activities	Revision 7
EN-QV-121	Supplier Qualification/Maintenance of Qualifications	Revision 5
EN-QV-122	Qualified Suppliers List	Revision 4
EN-QV-123	Supplier Audits/Surveys	Revision 4
EN-WM-100	Work Request (WR) Generation, Screening and Classification	Revision 6
Procedure No QO-14	Palisades Inservice Testing Procedure for Service Water Pumps	May 25, 2011
Procedure No RO-144	Comprehensive Pump Test Procedure Service Water Pumps P-7A, P-7B and P-7C	Revision 4, (4/10/09)
Procedure No.F11358-P-001	LPI Procedure for Metallurgical Examination of SW Pump P-7C Coupling Components	August, 2011
SOP-15	Service Water System	Revision 51
SOP-5	Containment Air Cooling	Revision 28
WI-MSM-M-26	Palisades Compression Fitting Installation and Inspection	Revision 1
WI-SWS-M-04	Service Water Pump P-7B and P-7C Removal, Inspection, and Reinstallation	Revision 7

Drawings	**Title**	**Date/Revision No.**
M0011-SH-0055	Palisades Service Water Pump Coupling Drawing.	
M-398	Level Setting Diagram Service Water and Dilution Water Pump	Revision 2
VEN-M11	Service Water Pump Rotating Element Assembly for Pumps P-7A, 7B and 7C	Revision 2

LIST OF ACRONYMS USED

ADAMS	Agencywide Document Access Management System
EC	Engineering Change
IGSCC	Intergranular Stress Corrosion Cracking
IMC	Inspection Manual Chapter
IP	Inspection Procedure
IR	Inspection Report
LCO	Limiting Condition of Operation
LPI	Lucius Pitkin, Inc
NRC	U.S. Nuclear Regulatory Commission
NUPIC	Nuclear Procurement Issues Committee
PARS	Publicly Available Records System
QA	Quality Assurance
Rc	Rockwell C
ROP	Reactor Oversight Process RS Reactor Safety SBO Station Blackout
SCAQ	Significant Condition Adverse to Quality
SI	Structural Integrity
SS	Stainless Steel
SW	Service Water
TS	Technical Specification
TSAC	Technical Specification Action Statement
URI	Unresolved Item
WR	Work Request

ATTACHMENT 2

UNITED STATES
NUCLEAR REGULATORY COMMISSION
REGION III
2443 WARRENVILLE ROAD, SUITE 210
LISLE, IL 60532-4352

August 15, 2011

MEMORANDUM TO: John Jandovitz, Project Engineer
Branch 5
Division of Reactor Projects

FROM: Steven West, Director **/RA/**
Division of Reactor Projects

SUBJECT: SPECIAL INSPECTION CHARTER FOR PALISADES NUCLEAR PLANT FAILURE OF P-7C SERVICE WATER PUMP COUPLING ON AUGUST 9, 2011

A potential repetitive failure of a coupling on the Palisades P-7C service water pump was recently self-revealed. The coupling failure is the subject of a Special Inspection that you have been identified to lead. A short discussion of the event follows.

On August 9, 2011, Palisades Nuclear Plant experienced a sudden loss of the P-7C service water pump while it was in service. This failure resulted in the licensee entering a 72 hour Limiting Condition for Operation due to the inoperability of one service water train. The licensee disassembled the P-7C pump and determined that the pump's first line shaft to second line shaft coupling had failed. The licensee replaced all of the P-7C pump's couplings and two portions of the pump shaft. After completing the required maintenance, the licensee returned pump P-7C to service on August 12, 2011

Based upon our initial review, we are concerned that the licensee may not have taken effective corrective actions following a P-7C service water pump coupling failure that occurred in September 2009. Following the September 2009 event, the licensee determined that the pump coupling failed due to improper heat treatment. The improper heat treatment resulted in the coupling's hardness being too high. The licensee's corrective actions included replacing the P-7C SW pump's couplings with couplings of appropriate hardness. Recent hardness test

Attachment

results of several couplings removed from the P-7C pump on August 10, 2011, indicate that these couplings were of an inappropriate hardness. Specifically, each coupling had at least one test location where the hardness measurement exceeded the licensee's acceptance criteria. In addition, one coupling had multiple test locations that exceeded the acceptance criteria. Testing of the failed coupling produced hardness results that were within specifications. Based upon the hardness test results and a March 2011 report provided to the licensee by Structural Integrity, another metallurgical failure mechanism may be contributing to the coupling failures. Lastly, this event raises questions about the effectiveness of the licensee's program for assessing and applying operating experience and its oversight of vendor activities.

The NRC has also learned that the remaining service water pumps, P-7A and P-7B, have the same type of coupling installed. As a result, these pumps may also be susceptible to a coupling failure.

The sequence of events and the root and contributing causes for this issue are being investigated by the licensee.

Based on the deterministic and risk-based criteria in Management Directive 8.3, a Special Inspection at Palisades will commence on August 15, 2011. The Special Inspection Team, which is being led by you, will include Atif Shaikh. Other members may be assigned if specific needs are identified.

The special inspection will determine the sequence of events, and will evaluate the facts, circumstances, and the licensee's actions surrounding this issue. The Special Inspection Charter for you and your team is enclosed.

Enclosure: As Stated

cc w/encl:
M. Satorius
C. Pederson
G. Shear
S. Reynolds
K. O'Brien
D. Roberts, RI
J. Clifford, RI
P. Wilson, RI
S. Weerakkody, RI
R. Croteau, RII
W. Jones, RII
J. Munday, RII
H. Christensen, RII
K. Kennedy, RIV
T. Pruett, RIV
A. Vegel, RIV
J. Lara, RIII
V. Mitlying
P. Chandrathil

Attachment

N. Valos
D. Merzke
A. Barker
A. Shaikh
RidsNrrPMPalisadesResource
NRR Reactive Inspection@nrc.gov

Attachment

The NRC has also learned that the remaining service water pumps, P-7A and P-7B, have the same type of coupling installed. As a result, these pumps may also be susceptible to a coupling failure.

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RidsNrrPMPalisadesResource
NRR Reactive Inspection@nrc.gov
DOCUMENT NAME: G:\DRPIII\PALI\Palisades Special Inspection Charter for P7C coupling failure.docx **See Previous Concurrence**

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PALISADES SPECIAL INSPECTION CHARTER

This Special Inspection Team is chartered to assess the circumstances surrounding the failure of a coupling on the P-7C service water pump on August 9, 2011. The Special Inspection will be conducted in accordance with Inspection Procedure 93812, "Special Inspection." The special inspection will include, but not be limited to, the items listed below. This charter may be revised based on the results and findings of the inspection.

1. Establish a historical sequence of events related to service water pump coupling failures up to and including the most recent failure on August 9, 2011.

2. In light of the failure of the P-7C service water pump, review the licensee's basis for operability of the P-7A, P-7B, and P-7C service water pumps. Determine whether the licensee has an adequately supported basis for operability of the P-7A and P-7B pumps and for returning the P-7C pump to service. Determine if additional corrective actions are required.

3. Evaluate activities associated with the licensee's repair of the P-7C pump for adequacy. Confirm that the repair complies with licensee and NRC requirements.

4. Review information and processes relied upon by Palisades to determine whether or not critical attributes of service water pump line shaft couplings, such as hardness, are acceptable prior to coupling installation.

5. Evaluate the licensee's procedures and processes for evaluating/assessing the performance of vendors. Emphasis should be placed upon determining why couplings that were believed to be of an appropriate hardness were later found to be of an inappropriate hardness. Review any evaluations/assessments of HydroAire that were completed by the licensee following the September 2009 P-7C coupling failure. Also, review any actions taken or direction provided by the licensee to HydroAire in response to the recent hardness test results.

6. Evaluate the licensee's operating experience program with an emphasis on operating experience related to pump components manufactured by Hyrdo-Aire. Specific attention should be given to the licensee's evaluation of a 2010 service water pump coupling failure at Prairie Island and the evaluation of a March 2011 report from Structural Integrity regarding the potential for coupling failure due to temper embrittlement.

Review the licensee's root cause evaluation plan and schedule. Include the schedule for performing testing of any components removed from the P-7C pump. Evaluate whether the root cause evaluation plan is of sufficient depth and breadth. Confirm that the time allowed to perform the root cause evaluation is commensurate with the safety significance of this issue. Communicate to the licensee that the NRC will inspect the completed root cause evaluation and the associated corrective actions as part of our normal inspection activities.

Attachment

Additional Inspection Requirements

1. Determine if there are any lessons learned from this Special Inspection.

Charter Approval

/RA by Karla Stoedter for/ 8/15/11 John Giessner, Chief
Branch 4
Division of Reactor Projects

/RA/ 8/15/11 Steven West, Director
Division of Reactor Projects

Attachment

ATTACHMENT 3

Palisades P-7C Service Water Pump Timeline

September 12, 1991	Beaver Valley Unit 1 experiences a coupling failure of a Byron-Jackson centrifugal pump as a result of embrittlement of 410 SST due to improper tempering temperatures and potential impurities. The failure mechanism was IGSCC.
September 1, 1993	NRC Information Notice 93-68, "Failure of Pump Shaft Coupling Caused by Temper Embrittlement During Manufacture" is issued informing licensees of problems stemming from temper embrittlement of 410 SS supplied by Byron-Jackson (referring to the 1991 Beaver Valley event).
September 22, 1993	Indian Point Unit 2 experiences a pump failure via a failed coupling attributed to a non-ductile fracture because of temper embrittlement of the 410 SST used. The failure mechanism was IGSCC.
September 1, 2003	Perry Unit 1 experienced a coupling disassembly event on their Emergency Service Water 'A' pump. The failure mechanism was by IGSCC and no performance effects were noticed before the failure of the coupling. The shafts were 416SS.
May 21, 2004	Perry experiences additional failures of Emergency Service Water pump shafts composed of 416 SS. The failure mechanism was by IGSCC.
2006	INPO Operating Experience Digest 2006-02 – INPO releases a document that discusses service water pump (shaft, coupling and impeller) failures occurring in the industry. The report notes that 12 failures occurred between 1998 and 2006 with the most frequent including corrosion causing coupling separation. One of the common causes identified was improper heat treatment of the material during manufacturing.
February 9, 2007	NRC Information Notice 2007-05, "Vertical Deep Draft Pump Shaft and Coupling Failures" is issued that references the coupling failures from IGSCC that occurred at Columbia Generating Station. The couplings were TP410 martensitic stainless steel and were susceptible to tempering embrittlement. The operating experience review identified at least 23 essential SW pump shaft and coupling failures since 1983 involving more than six different manufacturers.
December, 2007	EC-5000121762 was initiated to change the SW pump internal components, in including the shaft couplings, from carbon steel to 416 SS.
April 4, 2009	P-7A couplings and shafts were changed to 416 SS from carbon steel under WO 51637416 (Heat Number 49293)

April 10, 2009	P-7C fails Technical Specification Surveillance Test RO-144, "Comprehensive Pump Test Procedure Service Water Pumps P-7A, P-7B and P-7C," via a low flow condition and the pump is declared inoperable (test performed during refueling outage)
April 25, 2009	P-7C declared Operable with Compensatory Measures due to Op Eval showing that P-7C would demonstrate its 30 day mission time with degraded flow prior to startup from outage
May 19, 2009	Purchase Order #10237148 issued to HydroAire to re-build Layne and Bowler pump to replace P-7C
May 21-22, 2009	Pump P-7C couplings were heat treated once and then received a second heat treatment.
June 12, 2009	P-7C couplings and shaft changed to 416 SS from carbon steel under WO 190235
September 29, 2009	P-7C pump failed due to coupling #7 failure from IGSCC. The pump had a total run time of 2414.44 hours with 13 starts/stops.
October 1, 2009	First two couplings from HydroAire arrive (Heat Order #20163) early. Remaining six couplings arrive later in day (Heat Order #20166) and installed.
October 2, 2009	P-7C restored to operation
May 13, 2010	P-7B couplings and shaft changed to 416 SS from carbon steel under WO 213444 (Heat Number W2464-B50)
July, 2010	Prairie Island experienced a failure of 410 SS couplings from IGSCC. These couplings were also supplied by HydroAire.
March, 2011	Structural Integrity (SI) report received at Palisades concerning failure mechanisms of 416 SS.
August, 2011	SI report accepted by Licensee.
August 9, 2011 0700	All 3 SW pumps in-service with differential pressures of 1/2/1 psid, respectively and header pressure is 73 psig and stable. P-7C operated for a total of 14,114.86 hours with a total of 95 starts/stops and had passed all surveillances

Attachment

1202	Control room receives following alarms: EK-1163 “Critical Service Water Header ‘B’ LO Pressure;” EK-1164 “Critical Service Water Header ‘A’ LO Pressure;” EK-1165 “Non-Critical Service Water LO Press;” EK-0557 “Diesel Gen No. 1-2 Trouble;” and EK-1132 “Service Water Pump P7A Basket STR HI DP. Operators enter Off Normal Procedure 6.1 for Loss of Service Water and enter TS LCO 3.7.8.A1 (restore SW pump P-7C to operable in 72 hours)
1203	Nuclear Plant Operator reports that P-7C has no discharge pressure and a loud banging noise from the pump. Operators stop pump P-7C. Header pressure is stable at 64 psig. All alarms except EK-1132 clear.
1246	CR-PLP-2011-03902 created to document failure of P-7C and initiates root cause investigation and identified as significant condition adverse to quality
1303	Operators exit ONP 6.1
1530	BS-1320 completed identifying only zebra mussel shells in strainer
August 10, 2011	
0107	P-7C motor and pump uncoupled
0215	P-7C motor removed
1325	All P-7C shafts removed. P-7C pump failed due to coupling #6 failure.
August 10, 2011	Jackson Labs independently performs hardness tests on 4 couplings and identifies that three couplings have at least one hardness value out-of-specification high.
August 11, 2011	
0135	P-7C shaft reassembly commenced with couplings from Traveler 27797 (Heat Order 20170).
1059	P-7C pump reassembly completed.
1215	P-7C motor reinstallation completed.
August 12, 2011	P-7C declared Operable after completion of Post Maintenance Testing (WO 286627) and return-to-service Surveillance Testing (WO 286774).
August 16-17, 2011	All P-7C couplings sent to Lucius Pitkin Inc (LPI). Metallurgical plan is still in draft form.

Attachment

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 and from the Publicly Available Records (PARS) component of NRC's document system, Agencywide Documents Access and Management System (ADAMS). ADAMS is accessible from the NRC Website at http://www.nrc.qov/readinq-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

/RA/

Steven West, Director
Division of Reactor Projects

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

Enclosure: Inspection Report 05000255/2011012;
w/Attachments: 1. Supplemental Information
2. Memo to Jandovitz
3. Palisades Timeline

cc w/encl: Distribution via ListServ

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DATE	09/29/11		10/04/11		09/29/11			

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Letter to A. Vitale from S. West dated October 4, 2011.

SUBJECT: PALISADES NUCLEAR PLANT - NRC SPECIAL INSPECTION TEAM (SIT) REPORT 05000255/2011012

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