October 14, 2004

Mr. David A. Christian, Sr. Vice President
and Chief Nuclear Officer
Dominion Resources
5000 Dominion Boulevard
Glen Allen, VA 23060-6711

SUBJECT: MILLSTONE POWER STATION UNIT 2 - SUPPLEMENTAL INSPECTION FOR WHITE PERFORMANCE INDICATOR REPORT NO. 05000336/2004015

Dear Mr. Christian:

By letter dated May 5, 2004, you were informed that the U.S. Nuclear Regulatory Commission (NRC) would conduct a supplemental inspection at your Millstone Power Station Unit 2 for a White performance indicator in the initiating events cornerstone. On August 27, 2004, the NRC completed this inspection. The enclosed report documents the inspection results, which were discussed on September 1, 2004, with Mr. J. Alan Price and other members of your staff.

The NRC performed this supplemental inspection to assess your activities that addressed the initiating events cornerstone White performance indicator, which involved crossing the threshold from Green to White for the Unplanned Scrams per 7,000 Critical Hours Performance Indicator in the first quarter of calendar year 2004. The purpose of this inspection was to examine your problem identification, root cause and extent of condition evaluation, and corrective actions. This supplemental inspection was performed in accordance with Inspection Procedure 95001, “Inspection For One Or Two White Inputs In A Strategic Performance Area.”

Based upon the results of this inspection, the NRC determined that the problem identification, root and contributing cause evaluation, extent of condition assessment, and corrective actions for the White performance indicator were adequate. 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 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 Website at http://www.nrc.gov/reading-rm/adams.html (the Public Electronic Reading Room).

Sincerely,

***/RA/***

Raymond K. Lorson, Chief
Performance Evaluation Branch
Division of Reactor Safety

Docket No. 50-336
License No: DPR-65

Enclosure: Inspection Report 05000336/2004015
w/Attachment: Supplemental Information

cc w/encl:
J. A. Price, Site Vice President - Millstone
C. L. Funderburk, Director, Nuclear Licensing and Operations Support
D. W. Dodson, Supervisor, Station Licensing
L. M. Cuoco, Senior Counsel
C. Brinkman, Manager, Washington Nuclear Operations
W. Meinert, Massachusetts Municipal Wholesale Electric Company
First Selectmen, Town of Waterford
V. Juliano, Waterford Library
J. Markowicz, Co-Chair, NEAC
E. Woollacott, Co-Chair, NEAC
E. Wilds, Director, State of Connecticut SLO Designee
J. Buckingham, Department of Public Utility Control
G. Proios, Suffolk County Planning Dept.
R. Shadis, New England Coalition Staff
G. Winslow, Citizens Regulatory Commission (CRC)
S. Comley, We The People
D. Katz, Citizens Awareness Network (CAN)
R. Bassilakis, CAN
J. M. Block, Attorney, CAN

Distribution w/encl **(VIA E-MAIL)**:
S. Collins, RA
J. Wiggins, DRA
J. Jolicoeur, RI OEDO
J. Clifford, NRR
V. Nerses, PM, NRR
S. Wall, Backup, NRR
S. Schneider, Senior Resident Inspector
E. Bartels, Resident OA
R. Bellamy, RI
K. Jenison, RI
T. Madden, OCA
T. Kim, Director, DOC
Region I Docket Room (with concurrences)
W. Lanning, DRS
R. Crlenjak, DRS
R. Lorson, DRS
S. Pindale, DRS

DOCUMENT NAME: C:\ORPCheckout\FileNET\ML042880365.wpd
After declaring this document "An Official Agency Record" it **will** be released to the Public.
**To receive a copy of this document, indicate in the box:** "**C**" = Copy without attachment/enclosure "**E**" = Copy with attachment/enclosure "**N**" = No copy

| OFFICE | RI/DRS | | RI/DRP | | RI/DRS | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NAME | SPindale | | RBellamy | | RLorson | | | | | |
| DATE | 09/21/04 | | 09/24/04 | | 10/14/04 | | 10/ /04 | | 10/ /04 | |

OFFICIAL RECORD COPY

**U.S. NUCLEAR REGULATORY COMMISSION**

**REGION I**

| | |
|---|---|
| Docket No: | 50-336 |
| License No: | DPR-65 |
| Report No: | 05000336/2004015 |
| Licensee: | Dominion Nuclear Connecticut, Inc. |
| Facility: | Millstone Power Station, Unit 2 |
| Location: | P. O. Box 128<br>Waterford, CT 06385 |
| Dates: | August 23, 2004 - August 27, 2004 |
| Inspector: | S. M. Pindale, Senior Reactor Inspector |
| Approved by: | Raymond K. Lorson, Chief<br>Performance Evaluation Branch<br>Division of Reactor Safety |

Enclosure

## SUMMARY OF FINDINGS

IR 05000336/2004015; 08/23/2004 - 08/27/2004; Millstone Power Station, Unit 2; Supplemental Inspection for a White performance indicator in the initiating events cornerstone.

This inspection was conducted by a senior reactor inspector. No findings of significance were identified. 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.

Cornerstone: Initiating Events

This supplemental inspection was conducted to assess Dominion's evaluation performed in response to a White performance indicator in the initiating events cornerstone. Millstone Unit 2 crossed the threshold from Green to White for the Unplanned Scrams per 7,000 Critical Hours Performance Indicator in the first quarter of calendar year 2004. Specifically, Millstone 2 experienced two reactor trips in the fourth quarter of 2003 and two reactor trips in the first quarter of 2004. The first two trips, which occurred on November 27 and 28, 2003, were manually initiated by operators from about 20% and 11% reactor power, respectively, during plant startup from a refueling outage and were in response to high and increasing turbine vibration following the installation of a low pressure turbine rotor modification. The third reactor trip was manually initiated from 100% reactor power following an unexpected trip of one of the two steam generator feed pumps, and was related to an inadequate design change associated with the steam generator feed pump governor. The fourth reactor trip was an automatic reactor trip from 100% reactor power that occurred while testing a steam generator feed pump overspeed lockout feature, and was the result of a combination of human performance error and a problematic design of the test switch.

Dominion's problem identification, root and contributing cause evaluation, extent of condition assessment, and corrective actions for the four reactor trips were adequate, and no findings were identified.

Report Details

## 01 INSPECTION SCOPE (95001)

The NRC performed this supplemental inspection to assess Dominion's evaluation associated with a White performance indicator in the initiating events cornerstone. The White performance indicator involved crossing the threshold from Green to White for the Unplanned Scrams per 7,000 Critical Hours performance indicator in the first quarter of calendar year 2004. Specifically, Millstone 2 experienced two reactor trips in the fourth quarter of 2003 and two reactor trips in the first quarter of 2004. Dominion's activities included document reviews and personnel interviews. A list of all documents reviewed is listed in the Attachment to this report.

## 02 EVALUATION OF INSPECTION REQUIREMENTS

02.01 Problem Identification

a. How Issue was Identified

The four reactor trips were self-revealing events which occurred during the course of normal operational conditions.

The November 27, 2003, manual reactor trip from about 20% reactor power during plant startup from a refueling outage occurred in response to high and increasing turbine vibration [hereafter referred to as reactor trip No. 1, or RxT 1]. Dominion determined that the high turbine vibration was caused by rubbing between the turbine casing and the newly installed monoblock low pressure turbine rotors. Dominion had anticipated high turbine vibration with the new turbine monoblock rotors based on published industry operating experience.

The November 28, 2003, manual reactor trip from about 11% reactor power similarly occurred in response to high and increasing turbine vibration [RxT 2]. This trip was nearly identical to the November 27 trip with the exception that operators were required to close the main steam isolation valves and break main condenser vacuum. This action resulted in a loss of normal heat removal.

The March 6, 2004, manual reactor trip from 100% reactor power resulted as operators anticipated reaching the steam generator low level automatic reactor trip setpoint following an unexpected trip of one of the two steam generator feed pumps [RxT 3]. The steam generator feed pump trip was primarily related to an inadequate design change associated with the steam generator feed pump governor.

The March 15, 2004, automatic reactor trip from 100% reactor power occurred following the unexpected trip of one of the two steam generator feed pumps while conducting the quarterly overspeed lockout test associated with that feed pump [RxT 4]. The steam generator feed pump apparently tripped due to a combination of human performance error (failure to hold the lockout test switch in position) and a problematic design of the test switch.

b. Issue Duration and Prior Opportunities for Identification

There was no specific duration associated with this issue. The initiating events cornerstone White performance indicator, which involved crossing the threshold from Green to White for the Unplanned Scrams per 7,000 Critical Hours Performance Indicator, occurred in the first quarter of calendar year 2004. The four reactor trips constituted self-revealing events.

c. Plant-Specific Risk Consequences and Compliance Concerns

Dominion's evaluation assigned a change in core damage frequency of 1.72E-7 to the four reactor trips. The inspector reviewed Dominion's evaluation and assumptions, and confirmed their validity. No compliance concerns were identified.

02.02 Root Cause and Extent of Condition Evaluation

a. Methods Used to Identify Root and Contributing Causes

Dominion used a collective significance analysis (CSA) technique to evaluate this issue, and reviewed the details of the previously completed individual evaluations associated with each of the four reactor trips. In addition, Dominion included in their CSA several other relevant and significant plant events over a three-year period. The goal of the analysis was to identify common aspects of the multiple individual events. The CSA focused primarily on equipment reliability issues, although Dominion stated that other equipment issues (i.e., human performance, programmatic, or organizational) were considered.

Dominion's CSA identified three contributing issues, as follows:

- (Contributing Issue 1) Failure to identify and respond to leading indicators of potential equipment failure. Individual equipment malfunctions were being identified at the component level but the corrective actions were not timely to prevent equipment failure;

- (Contributing Issue 2) Lack of an aggregate equipment reliability assessment. A recent focus on equipment reliability was evident but had not yet resulted in leading indicators that could be utilized to respond proactively to the potential consequences of system level failure; and

- (Contributing Issue 3) Inadequate initial design change and/or post modification/maintenance testing (PMT). New modifications were being installed or maintenance was being performed with latent equipment deficiencies, which were not identified and corrected during the PMT process.

The CSA identified specific assignments associated with each of the three above contributing issues. These assignments are discussed in Section 02.03.a of this report.

b. Level of Detail of the Root Cause Evaluation

Overall, the inspector found the level of detail of the CSA root cause evaluation to be acceptable. However, there were several observations and weaknesses associated with the root cause evaluation level of detail.

The CSA identified and reviewed the details and conclusions associated with the previously completed individual condition reports (CR), and analyzed that information without verifying the individual CR root cause evaluations were correct. This approach did not evaluate the adequacy or effectiveness of the corrective action program, including the adequacy of previously performed root cause analyses. Therefore, weaknesses that may have existed with the individual root cause evaluations would not be identified because they were neither verified nor challenged by the CSA. While the inspector did not identify significant problems relative to the corrective action program during this inspection, several weaknesses were identified associated with the individual evaluations and/or conclusions, as described below.

- The RxT1 and RxT2 events occurred one day apart (November 27 and 28, 2003), whose proximate cause was related to recently installed low pressure turbine monoblock rotors. While operating/industry experience indicated that some increased turbine vibration may be anticipated (along with a resulting turbine trip), the inspector concluded that the second turbine trip potentially could have been prevented with a more timely and effective review of 1) operating experience, 2) several additional Millstone Unit 2 turbine trips due to high vibration that occurred without accompanying reactor trips, 3) the first turbine/reactor trip (RxT1), and 4) unique design and operating characteristics of the Millstone 2 turbine unit. Specifically, the unique Unit 2 turbine and steam dump system design and interface contributed largely to uneven heating of the turbine rotor, which was subsequently determined to have made the turbine more susceptible to high vibration under these operating conditions. Neither the CSA nor the individual RxT1 or RxT2 CRs addressed this unique Unit 2 vulnerability. Subsequent actions (operational and procedure changes) to address this vulnerability following RxT2 were effective in preventing additional increased turbine vibration and plant transients.

- The individual evaluation (Licensee Event Report, LER, 2004-001) associated with the RxT3 manual reactor trip did not specifically state inadequate design as a primary cause. Rather, it stated the apparent cause to be relay agitation and it broadened the root cause to be onsite and industry inexperience with interfacing control grade devices with digital microprocessors. However, the inspectors' review of this event and associated documentation indicated the primary cause to be inadequate design.

- Dominion's documented evaluation (LER 2004-002) of the RxT4 event stated the lockout control switch for feed pump governor testing was problematic, but failed to identify human performance error as a cause. The inspector agreed that the switch's unique operating and design characteristics may have contributed to this

event, however, the inspector viewed Dominion's characterization as weak since the periodic test had been performed successfully many times in the past.

In addition to the above weaknesses, the inspector noted that the individual CR and associated cause evaluation associated with RxT4 had not yet been completed at the time of the CSA, and therefore, very little of RxT4 was considered in the CSA. Subsequent review of this event by the inspector determined, however, that the root and contributing causes ultimately linked to RxT4 were captured in the CSA corrective actions by virtue of its similarity to other events.

c. Prior Occurrences and Operating Experience

Overall, the CSA and the several condition reports associated with the individual events considered prior occurrences and similar problems where applicable. As stated earlier, the inspector concluded the first of the two monoblock turbine rotor related trips (RxT1), along with industry, vendor and Unit 2 design information, could have been utilized more effectively and potentially prevented the subsequent RxT2 event.

d. Consideration of potential common causes and extent of condition of the problem

The CSA appropriately evaluated the potential for common causes for the four reactor trips. The CSA concluded there was no common significant issue resulting from the investigation.

The extent of condition review in the CSA was primarily based on an evaluation performed by another nuclear facility that similarly crossed the Green to White threshold associated with the same reactor trip performance indicator. The inspector identified a minor weakness in that some of the investigation items appeared to be applicable to Millstone Unit 2, but were not assessed or discussed the CSA.

02.03 Corrective Actions

a. Appropriateness of Corrective Actions

Dominion took prompt corrective actions to repair the equipment deficiencies associated with each of the four reactor trips. Acceptable actions to correct the three contributing causes were performed or scheduled to be performed.

To address Contributing Issue 1, Dominion 1) developed a tool (repeat issues list) to identify the number of times that CRs are written against plant equipment, and 2) communicated to personnel regarding the expectations and acceptable thresholds for questioning component operability following repeat equipment problems. Specific emphasis was placed on the potential for repeat equipment problems to adversely effect component and system operability. Dominion plans to perform a systematic review to identify critical components and evaluate internal and external operating experience as well as the preventive maintenance plans. Also, Dominion plans to re-evaluate the

Millstone instrumentation obsolescence strategy for the Unit 2 reactor protection system and other instrumentation systems for both Unit 2 and Unit 3.

For Contributing Issue 2, Dominion was establishing management expectations and assigning responsibilities for monitoring and trending component performance across system boundaries as a measure of system health in an effort to identify common issues not readily apparent in individual system health reports. Dominion was also developing a procedure to define condition monitoring/run to failure and provide guidance in applying detailed condition monitoring.

To address Contributing Issue 3, engineering reinforced expectations by the establishment of a design change challenge board, consisting of representatives from engineering, maintenance and operations. This board will provide increased emphasis on PMT and pre-operational testing to verify that modifications can acceptably perform their intended design function after installation, and that no new problems were created by the modification activity. In addition, Dominion conducted training for engineers and supervisors responsible for plant modifications to reinforce expectations regarding 1) rigorous implementation of the existing Design Control Manual for PMT and the qualification, verification and validation of design inputs, and 2) the roles and responsibilities for performing independent technical reviews of design documents.

The inspector determined that Dominion's proposed and completed corrective actions were acceptable overall. However, the inspector identified some minor weaknesses associated with some of the actions. Examples included 1) the operations brief that was credited for expressing management's expectations and thresholds for questioning component operability was narrowly focused (it appeared to be related only to service water system corrosion/erosion); and 2) based upon interviews with plant staff, the inspector noted that the challenge board appeared to have performed a limited review of some modification tests.

b. Prioritization of Corrective Actions

The inspector found that the corrective actions were properly prioritized.

c. Corrective Action Schedule

The inspector verified that the actions to correct the contributing issues as identified in the CSA were incorporated and tracked in the corrective action program via specific action request numbers.

d. Measures to Determine the Effectiveness of Corrective Actions to Prevent Recurrence

The inspector determined that the CSA recommended that an effectiveness review be performed for the White performance indicator. The due date for that review is February 25, 2005.

## 03 MANAGEMENT MEETINGS

03.01 Exit Meeting Summary

The results of this inspection were discussed with Mr. J. Alan Price and other members of Dominion management and staff at the conclusion of the inspection on September 1, 2004. No proprietary information was provided or examined during the inspection.

# ATTACHMENTS

Persons Contacted

T. Cleary, Senior Engineer
D. Dakers, Project Manager
D. Dodson, Licensing Manager
C. Gladding, Manager, Design Engineering
A. House, Outage Planner
A. Jordan, Director, Nuclear Engineering
P. Parulis, Manager, Nuclear Oversight
A. Price, Site Vice President - Millstone
V. Wessling, Supervisor, Nuclear Corrective Action
B. Wilkens, Manager, Nuclear Organizational Effectiveness

Documents Reviewed

Condition Reports

| | | |
|---|---|---|
| CR-01-03081 | CR-02-08189 | CR-03-12035 |
| CR-01-04614 | CR-02-08761 | CR-03-12076 |
| CR-01-04910 | CR-03-02300 | CR-04-02121 |
| CR-01-06690 | CR-03-02416 | CR-04-02446 |
| CR-02-04632 | CR-03-09580 | CR-04-02532 |

Action Requests

03006174 07
03006174 09
03006174 10

Miscellaneous Documents

Effectiveness Review of CR 02-08189, "Automatic Reactor Trip Due to Low Steam Generator Level During Power Ascension (AR 03001372-04)," June 9, 2004

Effectiveness Review of CR 03-02300, Unit Trip While Performing SP 2401D, RPS Matrix Logic and Trip Path and Relay Test," July 29, 2004

Effectiveness Review of CR 01-04614, "Unit 2 Reactor Trip Resulting From Loss of 'C' Circulating Water Pump," July 23, 2003

Effectiveness Review of CR 01-04910, Unit 2 Manual Reactor Trip Due to Loss of Circulating Water Pumps in One Condenser (AR #01003786-13)," September 3, 2002

"Today's Repeat Equipment Issues (3 Year History)" August 23, 2004

Maintenance Rule Functional Failure Evaluation (Feedwater Control System), August 25, 2004

Millstone Unit 2 Maintenance Rule (a)(1) Evaluation for the Feedwater Control System, June 30, 2004

Millstone Station Open List of System Equipment Reliability, August 23, 2004

| | |
|---|---|
| LER 2003-006 | Two Manual Reactor Trips Due to Turbine Trips Caused by Turbine Vibrations |
| LER 2004-001 | Manual Reactor Trip on Low Steam Generator Level Resulting From a Feedwater Pump Spurious Relay Operation |
| LER 2004-002 | Automatic Reactor Trip on Low Steam Generator Level Resulted From a Feedwater Pump Trip During Test |

Acronyms

| | |
|---|---|
| CR | Condition Report |
| CSA | Collective Significance Analysis |
| LER | Licensee Event Report |
| NRC | Nuclear Regulatory Commission |
| PMT | post modification/maintenance testing |
| RxT1 | Reactor Trip - first event; November 27, 2003 |
| RxT2 | Reactor Trip - second event; November 28, 2003 |
| RxT3 | Reactor Trip - third event; March 6, 2004 |
| RxT4 | Reactor Trip - fourth event; March 15, 2004 |