

October 27, 2006

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,  
INSPECTION REPORT NO. 05000336/2006016

Dear Mr. Christian:

On September 14, 2006, the U.S. Nuclear Regulatory Commission (NRC) completed a supplemental inspection at your Millstone Power Station Unit 2. The enclosed report documents the inspection results, which were discussed on September 14, 2006, with Mr. A. Jordan and other members of your staff.

The NRC performed this supplemental inspection to assess your activities to address the Millstone Unit 2 Unplanned Scrams With Loss of Normal Heat Removal Performance Indicator crossing the Green-White threshold in the first quarter of calendar year 2006. The purpose of this inspection was to assure that the causes of the performance issues associated with this PI crossing the Green-White threshold were understood, the root cause and extent-of-condition were identified, and that corrective actions were sufficient. 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, no findings of significance were identified. 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. Therefore, consistent with NRC Inspection Manual Chapter 0305, "Operating Reactor Assessment Program," the performance indicator will only be considered in assessing plant performance until it crosses below the threshold, returning it to a Green characterization.

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Sincerely,

***/RA/***

Lawrence T. Doerflein, Chief  
Engineering Branch 2  
Division of Reactor Safety

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

Enclosure: Inspection Report 05000336/2006016  
w/Attachment

cc w/encl:

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**U.S. NUCLEAR REGULATORY COMMISSION**

**REGION I**

Docket No: 50-336

License No: DPR-65

Report No: 05000336/2006016

Licensee: Dominion Nuclear Connecticut, Inc.

Facility: Millstone Power Station, Unit 2

Location: P. O. Box 128  
Waterford, CT 06385

Dates: September 12, 2006 - September 14, 2006

Inspectors: S. M. Pindale, Senior Reactor Inspector  
M. P. Snell, Reactor Inspector

Approved by: Lawrence T. Doerflein, Chief  
Engineering Branch 2  
Division of Reactor Safety

Enclosure

## SUMMARY OF FINDINGS

IR 05000336/2006016; 09/12/2006 - 09/14/2006; Millstone Power Station, Unit 2; Supplemental Inspection for a white performance indicator in the initiating events cornerstone.

This inspection was conducted on September 12-14, 2006, by two region based reactor inspectors. 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 cause evaluation and corrective actions 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 with a Loss of Normal Heat Removal Performance Indicator (PI) in the first quarter of calendar year 2006. Specifically, Millstone 2 experienced reactor trips with a loss of normal heat removal on November 28, 2003; March 6, 2004; and February 23, 2006. The first trip (November 28, 2003) was manually initiated from about 10 percent reactor power during a plant startup from a refueling outage, and was the result of high turbine vibration following the installation of mono-block low pressure turbine rotors. Normal heat removal was lost when the main steam isolation valves were closed and condenser vacuum was broken due to the high turbine vibration. The second reactor trip (March 6, 2004) was manually initiated from 100 percent reactor power following a low steam generator level due to an unexpected trip of one of the two operating main feedwater pumps, and was related to an inadequate design change associated with the steam generator feedwater pump speed control. Normal heat removal was lost when the main steam isolation valves were closed and the main condenser vacuum was broken due to high turbine vibration. The third reactor trip (February 23, 2006) was manually initiated from 100 percent reactor power following a loss of instrument air in the turbine building. The loss of instrument air occurred during repairs to a structural support that resulted in a failure of a degraded downstream solder joint in the air line. The loss of instrument air resulted in an automatic trip of both operating steam generator feedwater pumps, which represented a loss of normal heat removal.

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

Given Dominion's acceptable performance in addressing the Unplanned Scrams with a Loss of Normal Heat Removal PI, consistent with the guidance in IMC 0305, "Operating Reactor Assessment Program," the white performance indicator associated with this issue will only be considered in assessing plant performance until it crosses below the threshold, returning it to a Green characterization. The implementation and effectiveness of Dominion's corrective actions will be reviewed during future inspections.

## REPORT DETAILS

### 01 **INSPECTION SCOPE (IP95001)**

The NRC performed this supplemental inspection to assess Dominion's problem identification, cause evaluation, and corrected actions 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 with a Loss of Normal Heat Removal performance indicator in the first quarter of calendar year 2006. Specifically, Millstone 2 experienced one reactor trip in the fourth quarter of 2003, one reactor trip in the first quarter of 2004, and one reactor trip in the first quarter of 2006, all with a loss of normal heat removal. A list of all documents reviewed is listed in the Attachment to this report.

### 02 **EVALUATION OF INSPECTION REQUIREMENTS**

#### 02.01 Problem Identification

##### a. Determination of who identified the issue and under what conditions

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

The November 28, 2003, a manual reactor trip from about 10 percent reactor power during a plant startup from a refueling outage was the result of 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 recently installed mono-block low pressure turbine rotors. Dominion had anticipated high turbine vibration with the new turbine mono-block rotors based on published industry operating experience and vendor information. Normal heat removal was lost when the main steam isolation valves were closed and condenser vacuum was broken due to the high turbine vibration, in accordance with operating procedures.

The March 6, 2004, a manual reactor trip from 100 percent 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 operating steam generator feed pumps [RxT 2]. The steam generator feed pump trip was primarily related to an inadequate design change associated with the steam generator feed pump governor. Normal heat removal was lost when the main steam isolation valves were closed and the main condenser vacuum was broken due to high turbine vibration.

The February 23, 2006, a manual reactor trip from 100 percent reactor power occurred following a loss of instrument air to the turbine building [RxT 3]. The loss of instrument air occurred during repairs to structural support (hanger) that resulted in a failure of a degraded downstream solder joint in the air line. The loss of instrument air resulted in an automatic trip of both operating steam generator feedwater pumps, which represented a loss of normal heat removal. During this transient, turbine bearing

vibration increased to the procedural limit where operators were directed to break condenser vacuum, but decreased below procedural limits before operators finished actions required for higher priority reactor trip complications.

- b. Determination of how long the issue existed, 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 with a Loss of Normal Heat Removal Performance Indicator, occurred in the first quarter of calendar year 2006. The three reactor trips constituted self-revealing events. In their analysis of the three reactor trips, Dominion self-identified that narrowly focused cause evaluations for prior individual and similar trips represented missed opportunities to address the turbine vibration issue in a more comprehensive and timely manner (see Section 02.02.a below).

- c. Determination of the plant-specific risk consequences and compliance concerns associated with the issue

Dominion's evaluation assigned a change in core damage frequency of  $1.70E-7$  to the three reactor trips. The inspectors reviewed Dominion's evaluation and assumptions, and confirmed their validity. No compliance or regulatory concerns were identified.

## 02.02 Root Cause and Extent of Condition Evaluation

- a. Evaluation of methods used to identify root causes and contributing causes

Dominion used a collective significance analysis (CSA) technique to evaluate the reactor trips, and reviewed the details of the previously completed individual evaluations associated with each of the three reactor trips. In addition, Dominion included several other relevant and significant plant events over a six-year period in the evaluation. The goal of the analysis was to identify common aspects of the individual events, and included a focus on potential common equipment reliability, human performance, programmatic, and organizational issues.

Dominion's CSA identified that there was not a common cause associated with the three reactor trips. However, they identified that high turbine vibration was a common issue for the loss of normal heat removal aspect of the reactor trips due to a high sensitivity to main condenser backpressure.

Further, the CSA identified two notable contributing issues, as follows:

- (Contributing Issue 1) Narrow focus of five previous cause evaluations resulted in missed opportunities to address the turbine vibration issue. For the condenser vacuum range associated with cold water conditions, Unit 2 is still vulnerable to loss of normal heat removal during reactor trips from 100 percent power.

- (Contributing Issue 2) Due to some complacency in accepting turbine vibration as 'expected,' corrective actions to address turbine vibration have been incremental, untimely, and unsuccessful in preventing recurrence of reactor and turbine trips as well as the loss of normal heat removal (i.e., condenser path).

The inspectors determined that Dominion's CSA methodology represented an appropriate root cause and extent of condition evaluation for the reactor trip issues.

b. Level of detail of the root cause evaluation

Overall, the inspectors found the level of detail of the CSA root cause evaluation to be acceptable. Dominion appropriately considered operating experience, including vendor, user and owner groups, as well as Unit 2 to Unit 3 internal operating experience. Their evaluation was sufficiently self-critical and appropriately identified missed opportunities and some weaknesses related to use of and quality of industry and vendor information.

c. Consideration of prior occurrences of the problem and knowledge of operating experience

Overall, the CSA and the several condition reports associated with the individual events considered prior occurrences and similar problems as applicable. Consistent with Dominion's evaluation, the inspectors concluded the first of the two mono-block turbine rotor related trips discussed in this report (RxT 1) along with industry, vendor, and Unit 2 unique design information could have been utilized more effectively to potentially prevent or minimize the high turbine vibrations that were experienced with subsequent transients.

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

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

The extent of condition review in the CSA included evaluating the three in-scope reactor trips with a loss of normal heat removal, as well as one additional Unit 2 reactor trip outside the 12 quarter performance indicator time period and two Unit 3 reactor trips with a loss of normal heat removal. The review also considered four other Unit 2 and Unit 3 turbine vibration issues since 2000 (that were outside the 12 quarter time period).

e. Consideration of safety culture components in root cause, extent of condition, and extent of cause

The CSA adequately considered the components of safety culture and determined complacency in accepting equipment issues as one of the contributing causes.

### 02.03 Corrective Actions

#### a. Appropriateness of corrective actions

The inspectors found that corrective actions were generally appropriate, however, some weaknesses were identified related to actions to address the two contributing causes. Based upon reviews of the individual reactor trip condition reports, the inspectors found that Dominion had taken appropriate actions following each trip. Some of these actions included procedure changes and operator training and communication. The inspectors found that, while Dominion's CSA identified two specific contributing causes associated with the three reactor trips with a loss of normal heat removal, the CSA did not identify explicit and corresponding corrective actions to resolve each contributing cause. A recently completed Nuclear Oversight assessment of the CSA similarly identified this concern, and initiated a condition report and additional assignments to address the narrow focus contributing cause.

Regarding the lack of explicit and corresponding corrective actions to resolve each contributing cause in the CSA, the inspectors determined that Dominion had in fact taken several actions that addressed the content of each contributing cause. For example, Root Cause Evaluation 06-01330, a separate evaluation associated with Equipment Reliability Issues, contained several corrective actions that addressed the complacency issues, some of the turbine vibration issues, and included actions consistent with operating and vendor guidance. The inspectors determined that the necessary actions to address the CSA's contributing causes were adequately addressed.

Further, while Dominion had taken reasonable corrective actions based upon existing industry, vendor, and technical guidance to minimize the likelihood of increased turbine vibration, there is a continued vulnerability for increased turbine vibrations following a plant transient. In particular, operator intervention may be required on the secondary plant, to intentionally degrade condenser vacuum, during a reactor trip. This action is expected to minimize the elevated turbine vibration. While the appropriate guidance for this intervention exists in current procedures, the inspectors noted that reactor trips with complications (such as the February 23, 2006 trip) may be particularly challenging to operators due to competing and high priority actions.

While the inspectors concluded that Dominion's corrective actions were reasonable, continued management attention is warranted to ensure all related causes and corrective actions for the high turbine vibration phenomena are identified, understood, and corrected (including continued vendor interaction). These actions include currently proposed plans to upgrade the existing turbine vibration monitoring system, possible turbine vibration setpoint changes, and developing and implementing any necessary turbine control system modifications.

b. Prioritization of corrective actions

The inspectors found that the corrective actions were properly prioritized.

c. Establishment of a schedule for implementing and completing the corrective actions

The inspectors 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. Establishment of quantitative or qualitative measures to determine the effectiveness of corrective actions to prevent recurrence

The inspectors determined that the CSA recommended that an effectiveness review be performed for the white performance indicator. The due date for that review is December 29, 2006.

03 **MANAGEMENT MEETINGS**

The results of this inspection were discussed with Mr. A. Jordan and other members of Dominion management and staff at the conclusion of the inspection on September 14, 2006. No proprietary information was provided or examined during the inspection.

ATTACHMENT

Persons Contacted

S. Baker, Unit 2 Shift Manager  
W. Bartron, Engineer III, Station Nuclear Licensing  
A. Briggs, Unit 2 System Engineer  
D. Dodson, Supervisor - Licensing  
R. Griffin, Director - Nuclear Safety and Licensing  
W. Hoffner, Manager - Nuclear Operations  
A. Jordan, Director - Operations and Maintenance  
W. Koste, Nuclear Engineer III  
R. MacManus, Director - Engineering  
M. O'Connor, Unit 3 Shift Manager  
T. Raetz, Nuclear Technical Specialist III  
R. Rogozinski, Engineer  
M. Turner, Unit 3 System Engineer  
L. Salyards, Nuclear Engineer III  
D. Smith, Manager of Procedures and Records  
W. Spahn, Supervisor - Nuclear Engineering, Secondary  
S. Stricker, Supervisor Nuclear Engineering - Electrical/I&C  
B. Walsh, Unit 3 Control Room Operator

Documents Reviewed

Condition Reports (CR)

CR-03-12035, CR-03-12076, CR-04-02121, CR-05-12137, CR-05-13354, CR-05-13356,  
CR-06-01796, CR-06-02598, CR-06-08198

Action Requests

03003962, 03006562, 03008227, 04000031, 04001454, 05000046, 05007054, 05007645,  
05007645, 06000233, 06001020, 06001398

Work Orders

M20602234, M20603895, M20603896, M20603898

Procedures

AOP 2575, Unit 2 - Rapid Downpower, Rev. 003  
AOP 3575, Unit 3 - Rapid Downpower, Rev. 013  
ARP 2590E-173, Alarm Response Procedure - Unit 2 Turbine Vibration Hi  
ARP 2590E-174, Alarm Response Procedure - Unit 2 Turbine Vibration Hi-Hi  
OP 2323A, Turbine - Unit 2  
OP 3323A, Main Turbine - Unit 3  
OP 3353.MB7A, Alarm Response Procedure - Unit 3 Turbine Vibration Hi  
OP 3353.MB7A, Alarm Response Procedure - Unit 3 Turbine Vibration Hi-Hi

Other Documents

25203-ER-04-0006, MP2 LP Turbine Rotor Replacement - Lessons Learned, Rev. 0  
25212-ER-04-0006, MP3 LP Turbine Rotor Replacement - Engineering Recommendations for Startup, Rev. 1  
Effectiveness Review of CR-04-02121, Unit 2 Plant Trip as a Result of SGFP 'B' Trip  
GEK 107588, Operation to Maintain Radial and Axial Clearances, March 2001  
GEK 46385A, Starting and Loading (Nuclear Units) - Reheat Partial Arc, March 2004  
GEK 46387A, Starting and Loading (Nuclear Units) - Reheat Full-Throttling, January 2004  
M-05-13354, Root Cause Evaluation - Unacceptably High Turbine Bearing Vibration During Rapid Downpower on 12/1/05 - Millstone Unit 3  
M-06-01330, Root Cause Evaluation - Ineffective Resolution of Some Equipment Reliability Issues, 4/13/06  
M-06-01796, Root Cause Evaluation - Reactor Trip Due to Instrument Air Loss  
M-06-02172, Collective Significance Analysis - The NRC Performance Indicator for Unplanned SCRAMS With a Loss of Normal Heat Removal Changed From a 'Green' to 'White' Status for Millstone Unit 2, 4/13/06  
M-06-44, Nuclear Oversight Assessment - Review of the Millstone Organization Response to Exceeding the NRC Performance Criteria for Plant Trips with a Loss of Normal Heat Sink, 9/7/06  
Millstone Unit 2 Maintenance Rule (a)(1) Evaluation for the Instrument Air System, 5/8/06  
NOD-GL-2, Nuclear Oversight Assessment Methodology, Rev. 6  
NRC Inspection Report 05000336/2004015, Millstone Power Station Unit 2 - Supplemental Inspection for White Performance Indicator, 10/14/04  
SCRAMs With a Loss of Normal Heat Removal (NRC Indicator) - Unit 3 Data Sheet, September 2005 to August 2006  
USFAR, Section 9.11, Compressed Air System  
UFSAR, Section 10.2, Turbine Generator  
Unplanned SCRAMs/7000 Hours Critical (NRC Indicator) - Unit 3 Data Sheet, September 2005 to August 2006

Acronyms

CR	Condition Report
CSA	Collective Significance Analysis
NRC	Nuclear Regulatory Commission
RxT1	Reactor Trip - first event; November 28, 2003
RxT2	Reactor Trip - second event; March 6, 2004
RxT3	Reactor Trip - third event; February 23, 2006