UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF NUCLEAR REACTOR REGULATION
WASHINGTON, D.C. 20555-0001

January 5, 1996

NRC INFORMATION NOTICE 96-02: INOPERABILITY OF POWER-OPERATED RELIEF VALVES MASKED BY DOWNSTREAM INDICATIONS DURING TESTING

Addressees

All holders of operating licenses or construction permits for pressurized water reactors.

Purpose

The United States Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to a recent incident involving improper installation of power-operated relief valve (PORV) internals which rendered the PORVs inoperable, and inaccurate indications of the actuation of PORVs based upon tailpipe acoustic monitoring data during testing. The erroneous data led a licensee to conclude that two inoperable PORVs were functioning properly. It is expected that recipients will review the information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this notice do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On August 9, 1995, surveillance testing at Saint Lucie Plant, Unit 1, conducted in accordance with Section XI of the American Society of Mechanical Engineers Boiler and Pressure Vessel Code, indicated that the PORVs were not operating properly. The licensee cooled and depressurized the unit and removed and inspected the PORVs. Inspection of the internals of the valves revealed that a part required for proper operation of each of the two PORVs was installed backwards, thus rendering each valve inoperable. The valves had been in service since being rebuilt during a refueling outage approximately 10 months earlier.

In reviewing the methodology and acceptance criteria for PORV surveillances, the licensee found that the valve stroke time had been based upon the time lapse between the changing of a switch position and the receipt at the control room panel of acoustic indication from the detectors on the tailpipes of the subject valves. After this event, the licensee determined that flow through internal clearances within an inoperable valve could provide low-level acoustic responses in the tailpipes.

Updated 1/10/96

IDR-11c

Thus, without verifying that parameters were changing at the terminating point of the tailpipe (in the case of Saint Lucie, a quench tank), valve operation could not be determined based upon acoustic data alone.

Failure Mechanism

The PORVs used at Saint Lucie Unit 1 are Dresser Industries Model 31533VX-30 pilot-operated valves. The principles of valve operation are as follows:

- When PORV actuation is required, a signal is sent to an actuating solenoid within the pilot assembly, which strokes the pilot valve lever to open the pilot valve. A vent path is thus established from the main valve, through the bleed-off port and the pilot valve, to a low-pressure area.

- A differential pressure is established across the main disc when the valve pilot valve opens, thus venting a space inside the main disc (see Attachment 1) to a low-pressure area (in the case of Saint Lucie, the tailpipe) via the main valve bleed-off port. The differential pressure exists because the area above the main disc is pressurized to reactor coolant system pressure through internal passages in the main valve (not shown in Attachment 1).

- The main disc (responsible for actual reactor coolant system pressure relief) is opened by the force of water or steam acting on the main valve disc/seat interface. The main disc moves within a guide cylinder, and its movement is governed by the differential pressure established across the disc and spring force, which tends to move the disc into a closed position.

- When pressure relief is no longer required, the actuating solenoid closes the pilot valve and the space inside the main disc is pressurized by system pressure through the equalizing port. Differential pressure across the main disc is thus reduced, and the main disc is returned to the closed position under force of spring pressure.

In the case of the subject PORV inoperability, the licensee found that the main disc guide, a metal cylinder within which the main disc moves, was incorrectly oriented in the valve. One end of the guide contains a number of holes, which provide a vent path for the pilot valve of the PORV from the inner surfaces of the main disc. With the main disc guide incorrectly oriented upside down, the venting of the space within the main disc was severely restricted. This restriction resulted in insufficient venting of the space and a subsequent failure to create the differential pressure across the main disc necessary for the main disc to move and open the valve.

Although venting through the pilot valve was insufficient to result in a change of state in the main valve, subsequent testing revealed that internal clearances in the main valve are sufficient to pass water or steam through the pilot valve despite a failure of the main valve to lift. The tests the

licensee conducted in conjunction with Wyle Laboratories indicated that significant pressures can be developed at the discharge of the pilot valve (because of internal bypass flow paths) without movement of the main valve. Pilot valve discharge pressures ranging from 10.5 to 12.5 megapascals [1,500 to 1,800 pounds per square inch gage] were recorded when 16.7 megapascals [2,400 pounds per square inch gage] steam was applied to an incorrectly assembled PORV of the same manufacture as those on Saint Lucie Unit 1.

Surveillance Testing

The licensee had performed surveillance testing twice on the subject valves before they were identified as inoperable, once in November 1994 (after installation in the system) and once in February 1995. The November 1994 test was performed at 1.69 megapascals [245 pounds per square inch absolute] reactor coolant system pressure and the February 1995 test was conducted at 12.1 megapascals [1,750 pounds per square inch absolute]. In both cases, stroke times, as measured using tailpipe acoustic data, were found to be satisfactory. At the time, reactor coolant system and surge tank parameters were not used to verify that the main valves of the PORVs had changed state. On August 9, 1995, surveillance testing results were unsatisfactory because threshold acoustic levels for control room indication were not achieved. Subsequent testing indicated that, although acoustic data were received, changes in reactor coolant system pressure and in quench tank parameters had not taken place. These anomalous indications led the licensee to perform the valve inspections previously described which, in turn, led to the subject findings.

The acoustic monitors employed in the PORV tailpipes register 10 discrete steps of 200 millivolts each. The surveillance test methodology involved timing of the interval by the operator from the moment a control switch was cycled until an acoustic monitor annunciator, used to indicate when the monitor exceeded the 400 millivolts output threshold, alarmed at the control panel. The acoustic level received in the erroneously accepted tests is not known; however, in the in-situ tests of the repaired valves on August 16, 1995, at approximately 1.72 megapascals [250 pounds per square inch absolute] reactor coolant system pressure, the valves reached the maximum design output of the monitors on opening. In addition, the licensee noted that the reactor coolant system pressure dropped by approximately 0.04 megapascals [6 pounds per square inch absolute] and the quench tank parameters indicated that energy had been introduced into the quench tank when the valves opened.

Discussion

The licensee determined that the test methodology used to verify PORV main valve actuation was inadequate. The licensee changed its maintenance procedure for the PORVs to verify that the main valve disc actuates when test pressure is applied at the valve lift setpoint. This verification will be performed during bench testing prior to installation of the valve. This functional testing will confirm that the PORVs have been assembled correctly. The licensee also changed the procedure for conducting inservice testing on the PORVs to provide more positive indication of PORV main valve actuation

by using quench tank and pressurizer parameters for confirmation of PORV main valve actuation during testing.

Acoustic monitors were added to the discharge piping of safety and relief valves in response to Action Item II.D.3 of NUREG-0737, "Clarification of TMI Action Plan Requirements." Some licensees of pressurized water reactors have attempted to use similar acoustic monitors for measuring stroke times of the atmospheric dump valves. However, the measurements have generally proven to be ineffective for determining if the valves have fully opened. Accordingly, alternative means of monitoring the power-operated function of the valves have been employed. Other types of acoustic monitoring equipment are used for testing the stroking of other types of valves, such as check valves, to verify movement.

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for Dennis M. Crutchfield, Director
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Eric J. Benner, NRR
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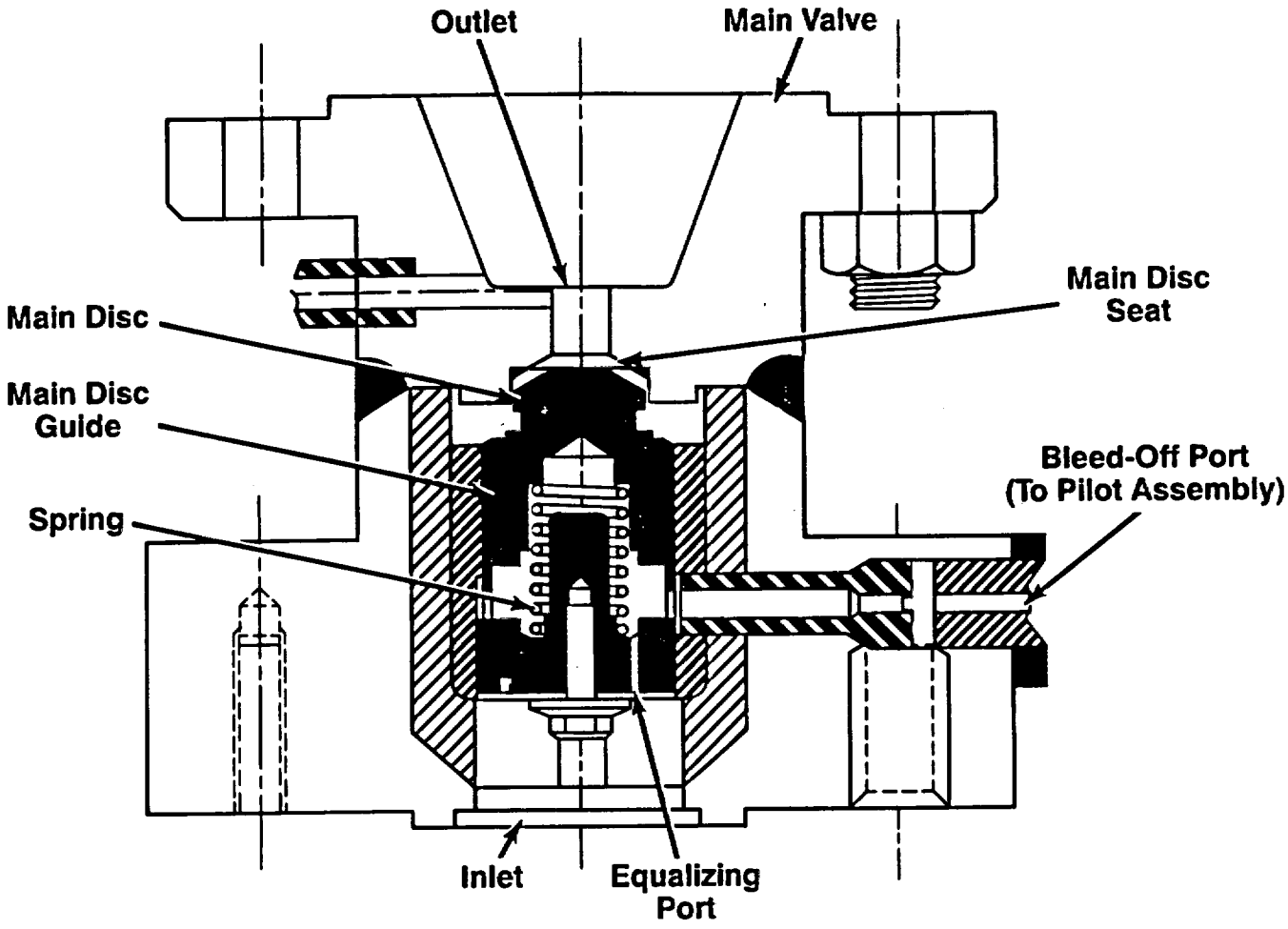
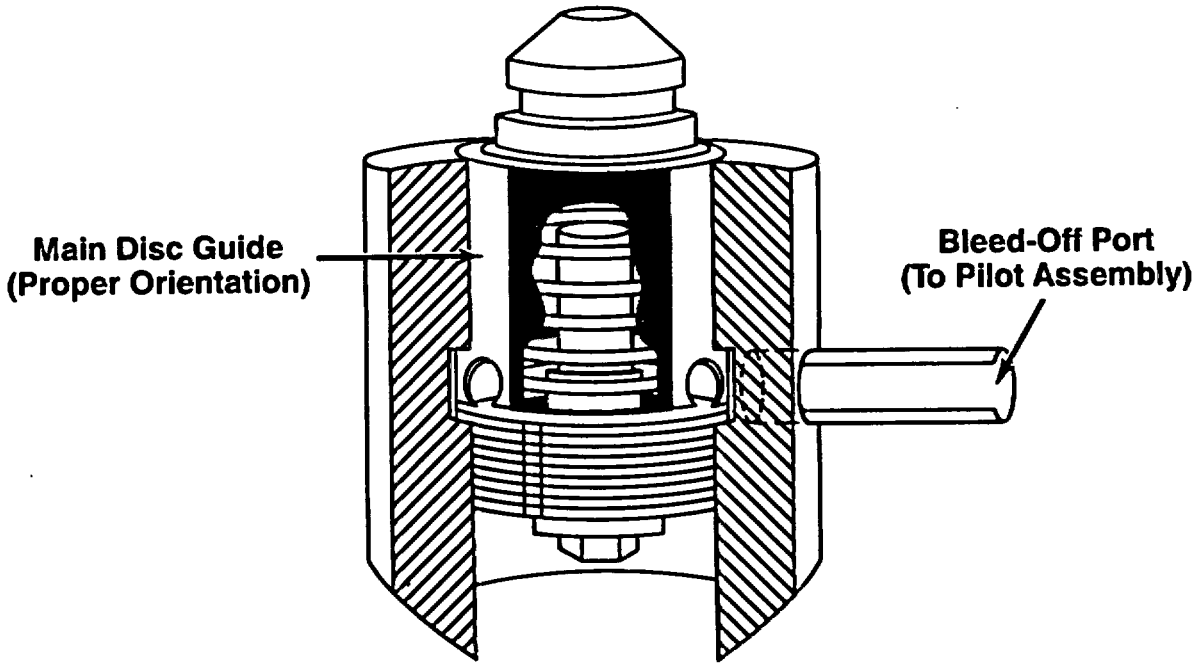
Attachments:
1. Partial Section View of Power-Operated Relief Valve
2. List of Recently Issued NRC Information Notices

Attachments filed in Jacket

Partial Section View of Power-Operated Relief Valve





Detail of Main Disc & Main Disc Guide Assembly

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-01	Potential for High Post-Accident Closed-Cycle Cooling Water Temperatures to Disable Equipment Important to Safety	01/03/96	All holders of OLs for CPs for PWRs
95-58	10 CFR 34.20; Final Effective Date	12/18/95	Industrial Radiography Licensees
95-57	Risk Impact Study Regarding Maintenance During Low-Power Operation and Shutdown	12/18/95	All holders of OLs or CPs for nuclear power reactors.
95-56	Shielding Deficiency in Spent Fuel Transfer Canal at a Boiling-Water Reactor	12/11/95	All holders of OLs or CPs for nuclear power reactors.
95-55	Handling Uncontained Yellowcake Outside of a Facility Processing Circuit	12/06/95	All Uranium Recovery Licensees.
95-54	Decay Heat Management Practices during Refueling Outages	12/01/95	All holders of OLs or CPs for nuclear power reactors.
95-53	Failures of Main Steam Isolation Valves as a Result of Sticking Solenoid Pilot Valves	12/01/95	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

by using quench tank and pressurizer parameters for confirmation of PORV main valve actuation during testing.

Acoustic monitors were added to the discharge piping of safety and relief valves in response to Action Item II.D.3 of NUREG-0737, "Clarification of TMI Action Plan Requirements." Some licensees of pressurized water reactors have attempted to use similar acoustic monitors for measuring stroke times of the atmospheric dump valves. However, the measurements have generally proven to be ineffective for determining if the valves have fully opened. Accordingly, alternative means of monitoring the power-operated function of the valves have been employed. Other types of acoustic monitoring equipment are used for testing the stroking of other types of valves, such as check valves, to verify movement.

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original signed by B.K. Grimes

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Attachments:
1. Partial Section View of Power-Operated Relief Valve
2. List of Recently Issued NRC Information Notices

Tech Editor reviewed and concurred on 9/8/95

DOCUMENT NAME: 96-02.IN *See previous concurrence

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Surveillance Testing

The licensee had performed surveillance testing twice on the subject valves before they were identified as inoperable: once in November 1994 (after post-outage installation in the system) and once in February 1995. The November 1994 test was performed at 245-psia RCS pressure and the February 1995 test was conducted at 1,750 psia. In both cases, stroke times, as evidenced by tailpipe acoustic data, were found to be satisfactory. At the time, RCS and surge tank parameters were not used to verify that the main valves of the PORVs had changed state. On August 9, 1995, surveillance testing results were unsatisfactory because threshold acoustic levels for control room indication were not achieved. Subsequent testing indicated that, although acoustic data were received, changes in RCS pressure and in quench tank parameters had not taken place. These anomalous indications led the licensee to perform the valve inspections previously described which, in turn, led to the subject findings.

The acoustic monitors employed in the PORV tailpipes were TEC Model 914, and they registered a 0-to-2V output in 10 discrete steps of 200mV each. The surveillance test methodology involved timing of the interval by the operator from the moment a control switch was cycled until an acoustic monitor annunciator, used to indicate when the monitor exceeded the 400mV output threshold, alarmed at the control panel. As a result, the acoustic level received in the erroneously accepted tests is not known; however, in the in situ tests of the repaired valves on August 16, 1995, at approximately 250-psia RCS pressure, the valves reached the design output of the monitors. Additionally, the licensee noted that the RCS pressure dropped by approximately 6 psia and the quench tank parameters indicated that energy had been introduced into the quench tank.

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