

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

January 18, 1996

NRC INFORMATION NOTICE 96-05: PARTIAL BYPASS OF SHUTDOWN COOLING FLOW FROM  
THE REACTOR VESSEL

Addressees

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

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert addressees to potential problems associated with monitoring reactor coolant temperature while operating in the shutdown cooling mode of the residual heat removal system. 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 information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On July 8-9, 1995, partial bypass of shutdown cooling flow from the reactor vessel occurred at the Hope Creek Nuclear Station. With residual heat removal pump B running, the recirculation pump discharge valves for both A and B recirculation loops were ~~closed~~ to prevent thermal binding (Figure 1, which for clarity shows only recirculation and residual heat removal loops B). However, the A discharge valve still became thermally bound. To prevent the B discharge valve from thermally binding, the licensee partially opened the B discharge valve. Because recirculation pump discharge valve B was open, some of the shutdown cooling flow bypassed the reactor vessel and went through recirculation loop B. This reduced shutdown cooling flow through the core and increased core temperature until boiling occurred and the reactor vessel started to pressurize. Plant operators were unaware of the heatup because the bypass flow caused indicated water temperature, measured at the inlet to the residual heat removal heat exchanger, to be less than the unmeasured reactor vessel exit water temperature at the recirculation outlet nozzle. The temperature of water exiting the reactor vessel is normally lower than the core exit temperature at the top of the active fuel due to internal bypass flows. The reduced shutdown cooling flow exacerbated this condition. Two transitions from cold to hot shutdown occurred without being recognized by the operating crew. The event was terminated when the licensee closed recirculation pump discharge valve B and restarted residual heat removal pump B.

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## Discussion

To prevent thermal binding during plant cooldowns, Hope Creek operating procedures specified that the recirculation pump discharge valves be alternately opened and closed. When the recirculation pump discharge valve is stroked open and then closed in a short time, the effect on shutdown cooling is negligible. During this event, however, plant operators deviated from the operating procedure and left the recirculation pump discharge valve partially open. As a result, part of the shutdown cooling flow was diverted away from the reactor vessel, significantly reducing core flow. After this event, the licensee decided not to stroke the recirculation pump discharge valves and removed this step from the operating procedures.

The reactor vessel level during shutdown operation is important in maintaining cold shutdown conditions. Hope Creek operating procedures specified that reactor vessel water level be maintained about 4.6 m [15 ft] above the top of the active fuel, a level corresponding to the water spillover elevation in the steam separators. The significant flow reduction through the core allowed the coolant in the core region to heat up and the reactor vessel to pressurize. The licensee later determined that reactor vessel level should be maintained above the elevation of the steam separator spillover point to ensure adequate core cooling during shutdown conditions. Maintaining this level would allow natural circulation within the reactor vessel if the shutdown cooling system was not available. The licensee revised the operating procedures to specify that reactor vessel water level be maintained above the bottom of the predryers on the steam separators, about 6.1 m [20 ft] above the top of the active fuel, during cold shutdown operation.


Valid core outlet temperature information was not available during most of this event. During the event, the residual heat removal system pumps were stopped some of the time for surveillance testing of the residual heat removal system valves. During such times, measurements were not available to indicate the temperature of water exiting from the reactor vessel, normally taken as the temperature of water at the residual heat exchanger. At other times, the bypass flow through the open recirculation pump discharge valve caused the measured water temperature to be lower than the temperature of water exiting the reactor vessel. Finally, significant bypass flow via inactive jet pumps inside the reactor vessel meant that the temperature of water exiting the reactor vessel was not representative of the temperature of water exiting the core. (The last is true even during normal shutdown operation unless all jet pumps are active.) Other temperature indications, such as the reactor vessel metal and reactor water cleanup system inlet temperature, do not represent water temperature exiting the core. As a consequence, water in the core apparently reached saturation temperature faster than anticipated when the residual heat removal system pumps were stopped because the core was initially hotter than shown by available instrumentation. At times when a residual heat removal pump was running, the jet pump bypass flows led to a temperature indication lower than the core exit temperature. Both situations led to unanticipated and initially unrecognized pressurization.

The licensee revised operating procedures to provide additional guidance for monitoring reactor vessel pressure and vessel metal temperature when the shutdown cooling system is not in service. This guidance includes considering pressurization of the reactor vessel as a transition to the hot shutdown condition.

Related Generic Communication

Information Notice 93-45, "Degradation of Shutdown Cooling System Performance," June 16, 1993

This information notice requires no specific action or written response. If you have any questions about the information in this notice, please contact one of the technical contacts listed below or the appropriate Office of Nuclear Reactor Regulation (NRR) project manager.

  
Dennis M. Crutchfield, Director  
Division of Reactor Program Management  
Office of Nuclear Reactor Regulation

Technical contacts: Robert Summers, Region I  
(609) 935-5373  
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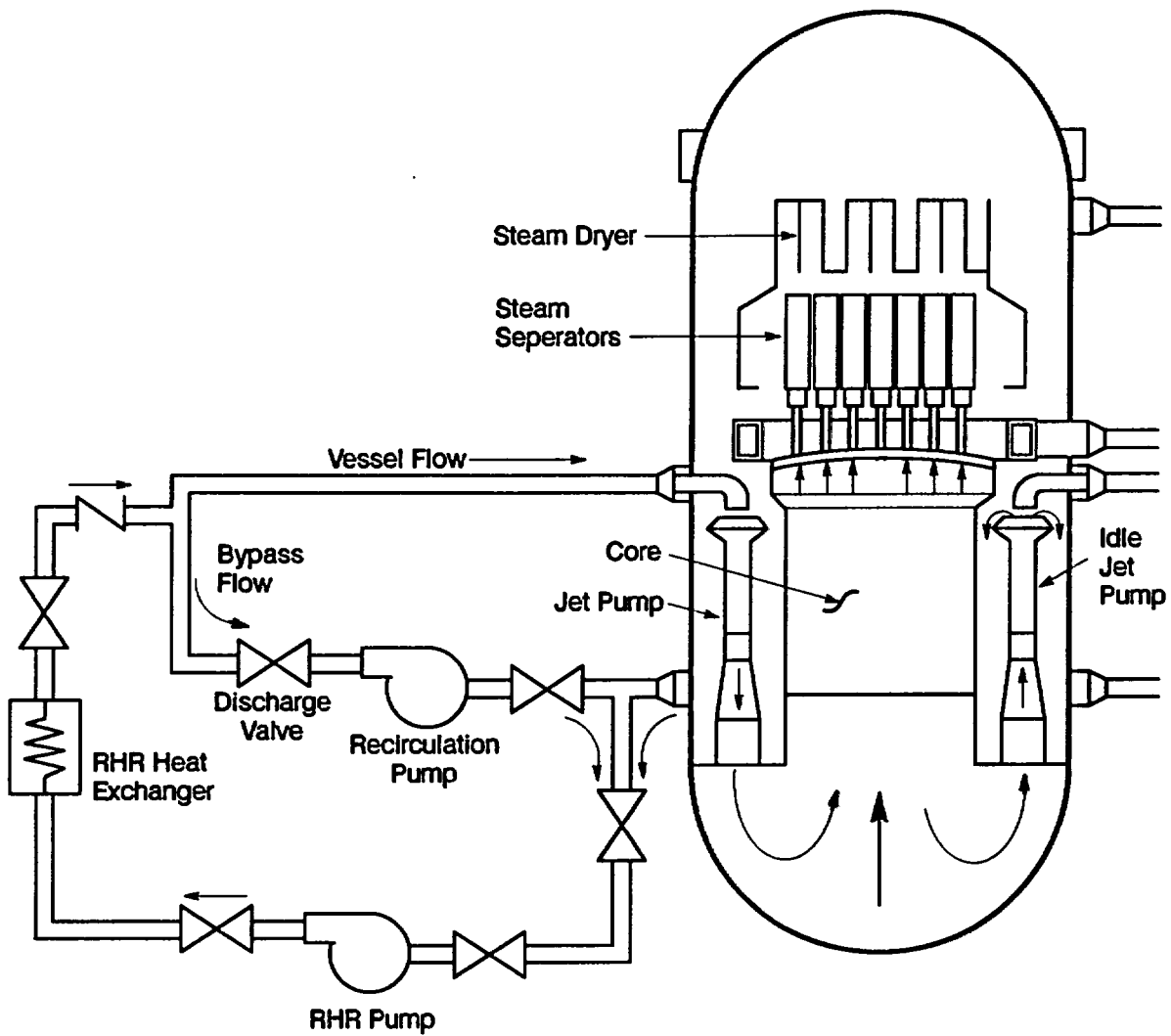
Scott Morris, Region I  
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Attachments:

1. Figure 1. Hope Creek Shutdown Cooling System with Open Recirculation Pump Discharge Valve
2. List of Recently Issued NRC Information Notices

*Attachments Filed in Jacket*



Shutdown Cooling System  
(1 of 2 Loops)

Figure 1 Hope Creek Shutdown Cooling System with Open Recirculation Pump Discharge Valve

LIST OF RECENTLY ISSUED  
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
96-04	Incident Reporting Requirements for Radiography Licensees		All radiography licensees and manufacturers of radiography equipment
96-03	Main Steam Safety Valve Setpoint Variation as a Result of Thermal Effects	01/05/96	All holders of OLs or CPs for nuclear power reactors
96-02	Inoperability of Power-Operated Relief Valves Masked by Downstream Indications During Testing	01/05/96	All holders of OLs or CPs for PWRs
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 or 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.

OL = Operating License  
 CP = Construction Permit

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original signed by

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2. List of Recently Issued NRC Information Notices

DOCUMENT NAME: 96-05.IN

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DATE	11/20/95	12/11/95	12/14/95	01/11/96

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CVHodge	JTWiggins	GMHolahan	AEC <sup>ms</sup> haffee	DMCrutchfield
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Related Generic Communications

1. Generic Letter 95-07, "Pressure Locking and Thermal Binding of Safety-Related Power-Operated Gate Valves," August 17, 1995
2. Information Notice 93-45, "Degradation of Shutdown Cooling System Performance," June 16, 1993

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