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

August 31, 1989

NRC INFORMATION NOTICE NO. 89-62: MALFUNCTION OF BORG-WARNER PRESSURE SEAL BONNET CHECK VALVES CAUSED BY VERTICAL MISALIGNMENT OF DISK

Addressees:

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose:

This information notice is intended to alert addressees of the potential malfunctioning of Borg-Warner pressure seal bonnet check valves caused by the misalignment of the valve disk. 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 do not constitute NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances:

On April 23 and May 5, 1989, during hot functional testing at Comanche Peak Unit 1, a combination of procedural errors and malfunctioning check valves resulted in the backflow of high temperature water from the steam generators through the auxiliary feedwater system to the condensate storage tank. This flow caused abnormally high temperatures, thermal stresses in excess of the code allowable stresses, and damage to piping supports.

The procedural errors that occurred during testing on both dates involved simultaneously opening both an auxiliary feedwater pump discharge valve connecting the pump to the steam generators and an isolation valve in a test line leading back to the condensate storage tank. During the time period covering both dates, each of the eight 4-inch Borg-Warner check valves in the auxiliary feedwater supply lines leading to the steam generators was jammed partially open as a result of improper assembly. This combination of circumstances allowed water from the steam generators to flow back through the check valves, a pump discharge valve, and a test line isolation valve to the condensate storage tank.

In a separate incident on April 19, 1989, a 3-inch Borg-Warner check valve located in the motor-driven auxiliary feedwater pump miniflow recirculation line was found to be inoperable. On examination, the two remaining 3-inch miniflow recirculation valves in the auxiliary feedwater system also were found to be inoperable.

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Investigation revealed that the valve disks of these three 3-inch valves, as well as the eight inoperable 4-inch valves, were all positioned too low in the valve body relative to the valve seats. As a result, when the valve disk moved toward the seat, the outside upper edge of the disk was caught under the inside upper edge of the seat causing the disk to be jammed open with the plane of the disk at a large angle relative to the plane of the seat (Figure 1). All eleven of the inoperable valves were of the 900 psi pressure seal bonnet type.

Discussion:

During the two steam generator water backflow events, the operators made almost identical errors, although two different sets of valves were involved. On April 23 an auxiliary operator intended to realign valves associated with the turbine-driven auxiliary feedwater pump to permit recirculation flow to the condensate storage tank. The procedure required closing the normally open turbine pump discharge valve (1AF-041) before opening the turbine pump recirculation test line isolation valve (1AF-042). However, the valves were operated simultaneously and the recirculation valve which could be opened rapidly, was fully open while the discharge valve which took a half hour to close, was still open. In about 10 minutes the levels in steam generators 1, 2, and 4 were noticed to be decreasing rapidly. At about 20 minutes into the event, paint on the pipes in the turbine pump room was reported to be "bubbling and peeling" and the recirculation valve was closed, terminating the backflow.

On May 5 the operators were conducting an auxiliary feedwater system operability test. The motor-driven auxiliary feedwater pump recirculation test line isolation valve (1FA-055) was opened while the motor-driven pump discharge valve (1FA-054) was still open. Again, this was contrary to the procedure in use, which required closing the discharge valve prior to opening the test line isolation valve. During this event, only water from steam generator 1 is believed to have reached the auxiliary feedwater piping. The backflow was initially stopped when the discharge valve (-054) was fully closed. However, when the operators attempted to restore the valves to the original position to resume pumping to the steam generators, the test line isolation valve (-055) was inadvertently left partially open, reestablishing the backflow to the condensate storage tank. This backflow persisted for the next hour and a half, being interrupted intermittently by the operation of the two auxiliary feedwater motor-driven pumps. The operators observing inconsistencies in the flow to the steam generators finally realized that the test line isolation valve was open and closed it, terminating the backflow.

The reason that the disk assemblies of the malfunctioning check valves were positioned too low in the valve bodies was that an essential step was missing from the vendor's reassembly procedure. The disk assembly, as well as the valve bonnet and seal, is suspended from and positioned vertically by a threaded ring that is screwed into the top of the valve neck, called the retainer ring (Figure 1). The prescribed assembly procedure for the 3- and 4-inch valves (Borg-Warner Operation and Maintenance Manual, OMM 1003) was to install and bottom out the retainer ring. This had the effect of locating the disk assembly too low in the valve. The original factory assembly process included the backing

out of the retainer ring while observing the disk through the valve ports until the disk had been raised to the correct height. However, the necessary step of backing out the retainer ring to its original factory assembly height was not included in the reassembly procedure provided with the 3- and 4-inch valves. All of the auxiliary feedwater check valves had been disassembled and inspected in 1983 because of a concern about the adequacy of the disk stud fillet welds. During the following reassembly using the incorrect procedure, all of the 3- and 4-inch valve disks were positioned lower than the original factory adjusted position. Larger Borg-Warner check valves (6, 8 and 10-inch) could also be affected by this error.

The April 23 backflow of high temperature water caused a significant amount of blistering and flaking of the paint on the auxiliary feedwater supply lines as well as some unusual stressing of the auxiliary feedwater piping. However, the May 5 backflow is believed to have caused the most damage. Several areas in the piping are known to have experienced thermal stresses that exceeded the code allowable stresses. In addition, one of the piping supports failed and had to be replaced. As a result, an extensive analysis of the piping, the piping supports, and the penetrations had to be made to ensure the continued reliability of the auxiliary feedwater system.

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Charles E. Rossi, Director
Division of Operational Events Assessment
Office of Nuclear Reactor Regulation

Technical Contacts: H. H. Livermore, NRR
(817) 897-1500

M. F. Runyan, NRR
(817) 897-1500

Attachments:
1. Figure 1, Check Valve Shown with Disk Jammed in Open Position

2. List of Recently Issued NRC Information Notices

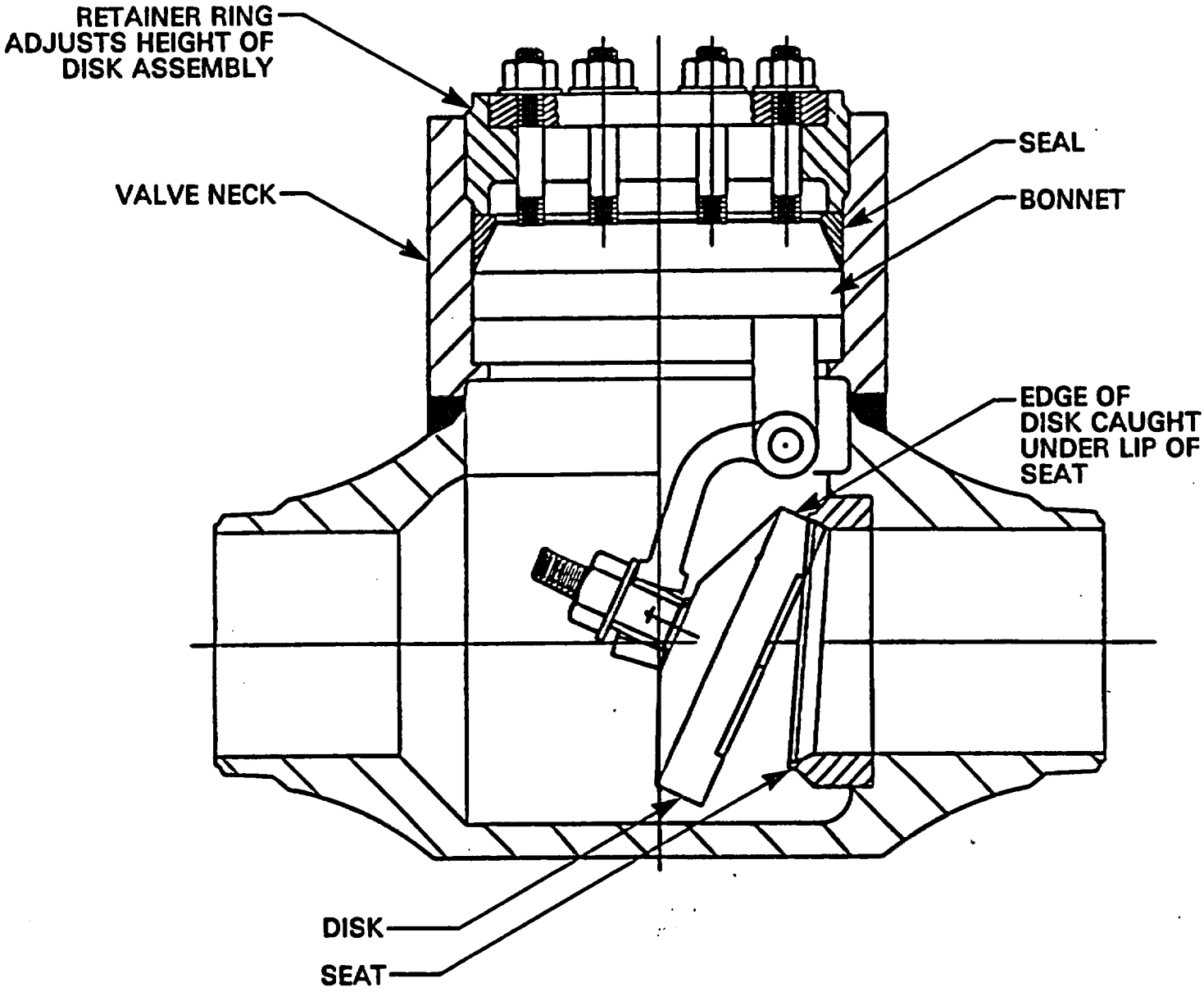

Figure 1. CHECK VALVE SHOWN WITH DISK JAMMED IN OPEN POSITION

LIST OF RECENTLY ISSUED NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
89-61	Failure of Borg-Warner Gate Valves to Close Against Differential Pressure	8/30/89	All holders of OLs or CPs for nuclear power reactors.
88-48, Supp. 2	Licensee Report of Defective Refurbished Valves	8/22/89	All holders of OLs or CPs for nuclear power reactors.
89-60	Maintenance of Teletherapy Units	8/18/89	All NRC Medical Teletherapy Licensees.
89-59	Suppliers of Potentially Misrepresented Fasteners	8/16/89	All holders of OLs or CPs for nuclear power reactors.
89-58	Disablement of Turbine-Driven Auxiliary Feedwater Pump Due to Closure of One of the Parallel Steam Supply Valves	8/3/89	All holders of OLs or CPs for PWRs.
89-57	Unqualified Electrical Splices in Vendor-Supplied Environmentally Qualified Equipment	7/26/89	All holders of OLs or CPs for nuclear power reactors.
89-56	Questionable Certification of Material Supplied to the Defense Department by Nuclear Suppliers	7/20/89	All holders of OLs or CPs for nuclear power reactors.
89-45, Supp. 1	Metalclad, Low-Voltage Power Circuit Breakers Refurbished With Substandard Parts	7/6/89	All holders of OLs or CPs for nuclear power reactors.
89-55	Degradation of Containment Isolation Capability by a High-Energy Line Break	6/30/89	All holders of OLs or CPs for nuclear power reactors.
89-54	Potential Overpressurization of the Component Cooling Water System	6/23/89	All holders of OLs or CPs for nuclear power reactors.

OL = Operating License
CP = Construction Permit

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2. List of Recently Issued NRC Information Notices

*See previous concurrence

D/DOEA:NRR
CERossi
08/24/89

OGCB:DOEA:NRR*	*NRR	*NRR	RPB:ARM*	*C/OGCB:DOEA:NRR
DCKirkpatrick	HHLivermore	MRRunyan	TechEd	CHBerlinger
08/14/89	08/21/89	08/21/89	08/18/89	08/23/89

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C/OGCB:DOEA:NRR
CHBerlinger
08/23/89 CHB

factory assembly process included the backing out of the retainer ring while observing the disk through the valve ports until the disk had been raised to the correct height. However, the necessary step of backing out the retainer ring to its original factory assembly height was not included in the reassembly procedure provided with the 3- and 4-inch valves. All of the auxiliary feedwater check valves had been disassembled and inspected in 1983 because of a concern about the adequacy of the disk stud fillet welds. During the following reassembly using the incorrect procedure, all of the 3- and 4-inch valves disks were positioned too low in the valve body.

Larger Borg-Warner check valves were not affected by this error. The manual instructions for the Borg-Warner 6-inch valves correctly identified the need to set the bonnet elevation (and consequently the disk elevation) by adjusting the retainer ring to the proper height.

The lack of an adequate procedure apparently also resulted in maintenance personnel being unaware of the need to establish the correct retainer ring height during the disassembly of the valves so that they could reassemble the valves correctly. As a consequence, the Comanche Peak personnel found it necessary to go through a complex dimensional analysis process in order to establish the correct positions of the retainer rings.

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