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UNITED STATES
NUCLEAR REGULATORY COMMISSION
OFFICE OF INSPECTION AND ENFORCEMENT
WASHINGTON, D. C. 20555

March 10, 1983

IE BULLETIN NO. 83-03: CHECK VALVE FAILURES IN RAW WATER COOLING SYSTEMS OF DIESEL GENERATORS

Addressees:

All nuclear power reactor facilities holding an operating license (OL) for action and all those holding construction permits for information.

Purpose:

The purpose of this bulletin is to (1) notify licensees and construction permit holders about numerous incidents of failed check valves in systems important to safety; (2) inform licensees of a significant generic matter for which additional NRC action is anticipated; (3) to require appropriate surveillance and testing of check valves in raw water cooling systems for diesel generators. A response to this bulletin is required from all nuclear power reactors holding an OL as discussed below.

Description of Circumstances

A review of available operating experience, data and licensee event reports (LERs) shows that numerous check valve failures have occurred in systems important to safety in nuclear power plants. A series of IE generic communications (listed in Table 1) has been issued which describes a broad range of check valve failures involving various designs, causes, and applications. The NRC has evaluated check valve failures in consideration of the need to request generic action by licensees. The focus of this bulletin is directed primarily at the failure mode of disassembly or partial disassembly of check valve internals. For example, the check valve disc becomes separated from the hinge.

Title 10 of the Code of Federal Regulation, Section 50.55a(g) requires testing of valves whose function is required for safety. This is implemented by application of Section XI of the ASME Boiler and Pressure Vessel Code and Addenda. However, our analysis of operating experience with check valves has shown that disassembly and partial disassembly of check valve internals is not effectively found by Section XI testing as it is implemented at this time. Tests performed for Section XI or Technical Specifications usually require only forward flow through check valves. These tests may not detect internal check valve failures unless the disassembled parts move to block flow during the test.

This bulletin is expected to be part of a generic response to check valve failures which will result in improved testing to ensure operability and to improve reliability of check valves. In addition to the generic

communications issued by IE, the NRC Office of Nuclear Reactor Regulation requires that licensees consider all check valves in systems important to safety for inclusion in the ASME Section XI Pump and Valve Inservice Testing Programs. Although most check valves in systems important to safety are included in current IST program reviews, most are not required to be reverse flow tested or disassembled to detect gross internal failure because licensees have identified each of these valves as having a single safety function: the open position. However, forward flow tests to verify the open position are inadequate for detecting internal disassembly. Effective check valve testing techniques are necessary to the development of a more meaningful and productive IST program. Operating experience provides a basis for determination of what areas of IST check valve surveillance need to be improved.

The specific requirements of this bulletin stem from analysis of check valve failures in the raw cooling water supply to the diesel generators at the Dresden and Quad-Cities nuclear power stations and other events which are described in Table 1. At Dresden and Quad-Cities, it was found that six of six check valves in the raw cooling water systems for the diesel generators had failed with the disc becoming detached from the pivot arm. Many of the failures described in the generic communications listed in Table 1 also involved detached discs. The Dresden event is described in detail in IE Information Notice No. 82-08. In summary, the event involved failure of the check valves in the raw water cooling systems for the diesel generators which resulted in interruption of cooling water flow to the diesel generator heat exchangers and subsequent inoperability of the diesel generators. The Dresden check valve failures rendered two diesels inoperable at the same time when the valve discs moved to the valve outlets and blocked flow. However, the true cause of flow blockage was not determined until almost one month later. All three Diesel Generator Cooling Water Pump (DGCWP) systems at Dresden Units 2 and 3 involved check valve failures which were discovered during a short period of time. These failures were not identified by operator observations and instrument readings during diesel generator surveillance tests, but were discovered by direct inspection of the internals of the valves. It is not known how long these check valves were broken before their condition was detected. The broken valve discs were found to be free to move within the valve bodies and may have been that way for some time before coming to rest in a position which restricted flow enough to cause the diesels to trip on high engine temperature. The subject check valves are horizontally mounted Crane 8-inch, cast iron swing check valves, Type 373, and have a pressure rating of 125 psi.

Because of the similarity between the Dresden Units and Quad-Cities Units, NRC Region III requested that Commonwealth Edison inspect the DGCWP discharge check valves on the Quad-Cities Units on a schedule consistent with the availability of valve parts and the availability of the DG units. The DGCWP systems at Quad-Cities were inspected and all three DGCWP discharge check valves were found with the discs separated from the pivot arms.

At Quad-Cities, the failures remained latent; although the discs were lying free in the valve body, they did not move to the outlet and block flow. The DGCWP discharge check valves at Quad-Cities were also Crane, 8-inch, swing check valves, Type 373. However, the Quad-Cities valves and the Dresden valves were not identical. The Quad-Cities valves had larger, more bulbous valve bodies and slightly different internals.

For all valves, the most dominant failure mode was due to a combination of abrasive and corrosive wear of valve internals. In particular, the valve disc was held to the pivot arm by a stud with washer and nut. Apparently, flow conditions at the valves were such that the discs vibrated (fluttered) causing local abrasive wear at the arm bore of the hinge where it joins the disc. This same action also resulted in severe degradation of the washer used to retain the disc on the hinge, and once the degree of degradation at the hinge bore and washer was sufficient, the two components separated. The stud and nut wore such that the stud and nut assembly pulled through the enlarged hole in the pivot arm and became detached.

In the case of the Dresden Unit 2 valve, the valve disc remained barely attached to the pivot arm and the arm had broken at its hinge to the valve hinge pin. In this case, abrasive/corrosive wear was found to have occurred at the hinge pin bore. All of the failed valves showed wear at this location. The degree of degradation varied from very slight in the Quad-Cities 1/2 hinge to extreme in the Dresden Unit 2 hinge which had fractured at this location. As plants age, failure modes of these types may be expected to become more prevalent.

The bulletin focuses on check valve failures in the raw water cooling system of diesel generators for the following reasons:

(1) Six of six check valves in these systems at Dresden and Quad-Cities failed with the potential for interrupting flow of cooling water to the diesel generators.

(2) Both diesels on Dresden Unit 3 tripped on overtemperature due to lack of cooling water flow and the unit was without emergency power.

(3) The cause of the lack of raw cooling water flow to the Dresden Unit 3 dedicated diesel (failed check valves) was not discovered for almost one month following the event despite numerous test and surveillance procedures and was attributed to other causes. The condition of the swing diesel and the unit 2 dedicated diesel check valves at Dresden was not discovered until more than one month after the initial event.

(4) None of these check valves was included in the plant IST program at the time of the event. Since the event, the NRC Office of Nuclear Reactor Regulation has added these valves to IST requirements for plants currently being reviewed.

(5) Even if the valves had been in the IST program, it is doubtful if the normal forward flow test would have discovered these latent failures except by chance, as occurred at Dresden. The failures were finally discovered by direct inspection of valve internals.

It should be noted that the popular use of swing check valves in safety related plant fluid systems considerably expands the scope of concern for check valve maintenance and testing beyond diesel cooling systems. Licensee event reports indicate that other systems important to safety have experienced failures of check valves which are not included in the IST program and have not been

discovered during testing. Other licensee event reports indicate that for those valves which are not leak tested, both the type and frequency of testing may not be adequate to detect valve failure. Maintenance and IST programs should be reconsidered in light of detecting and preventing gross and multiple check valve failures that can defeat functions of systems important to safety. This includes concerns both for check valve opening and closure.

Required Actions For Holders Of Operating Licenses:

1. Licensees are requested to review the plant Pump and Valve In-Service Test (IST) program required by Section XI of the ASME Boiler and Pressure Vessel Code and modify it if necessary to include check valves in the flow path of cooling water for the diesel generators from the intake to the discharge. Those portions of the cooling water system which do not directly supply the diesel may be excluded from this review. For example, if the cooling water to the diesel is supplied by the normally operating service water system, the loop of piping to the diesel from the service water piping and back must be considered, but not the complete service water system. For those cooling water systems which come into operation only upon demand for diesel cooling, all portions of the system which are required to change state must be reviewed.

2. For the valves described in (1) above, licensees are requested to examine the IST program and modify it if necessary to include verification procedures that confirm the integrity of the valve internals. This may be accomplished by using both a forward flow and a back flow test or by valve disassembly and inspection. Other equally effective means of assuring integrity of the valves may be used. A reasonable schedule for the test of these valves shall also be included in the IST program.

3. Licensees are requested to perform initial valve integrity verification procedures for the valves identified in (1) above using the methods described in (2) above, to be completed by the end of the next refueling outage commencing after April 1, 1983.

4. Licensees are requested to submit a report to the NRC within 90 days of the date of this bulletin, which lists the valves identified in (1) above and describes the valve integrity verification procedure methods and schedule identified in (2) above. This report should include the history of any known previous failures of these valves at your plant.

5. Licensees are requested to submit a report to the NRC within 90 days of completion of the results of the initial valve integrity verification procedure performed in accordance with (3) above. For those valves which are found to have undergone either partial or complete disassembly of valve internals, a description of the failure mode should be included.

6. The written reports required shall be submitted to the appropriate Regional Administrator under oath or affirmation under provisions of Section 182a, Atomic Energy Act of 1954, as amended. The original copy of the cover

letters and a copy of the reports shall be transmitted to the U. S. Nuclear Regulatory Commission, Document Control Desk, Washington, D. C. 20555 for reproduction and distribution.

Required Actions for Holders of Construction Permits:

None. This information is provided to holders of Construction Permits to provide guidance in preparing their proposed IST programs. These programs will be reviewed during the licensing process.

Although no specific request or requirement is intended, the following information would help the NRC evaluate the cost of implementing this bulletin:

- Staff time to perform requested valve integrity verification procedures
- Staff time to prepare written responses

This rquest for information was approved by the Office of Management and Budget under clearance number 3150-0097 which expires on November 1985. Comments on burden and duplication should be directed to the Office of Management and Budget, Reports Management, Room 3208, New Executive Office Building, Washington, D.C. 20503.

If you have any questions regarding this matter, please contact the Regional Administrator of the NRC Regional Office or the technical contact listed below.

Richard C. DeYoung, Director
Office of Inspection and Enforcement

Technical Contact: George F. Lanik, IE
(301) 492-9636

Attachment:
1. Table 1 - IE Generic Communications
2. List of Recently Issued IE Bulletins

TABLE 1. IE GENERIC COMMUNICATIONS

ON CHECK VALVES

IE Circular 78-15 "Tilting Disc Check Valves Fail to Close"

IE Bulletin 79-04 "Incorrect Weights for Swing Check Valves Manufactured by Velan Engineering Corporation

IE Bulletin 80-02 "Operability of ADS Valve Pneumatic Supply"

IE Information Notices:

80-41 "Failure of Swing Check Valve in the Decay Heat Removal System at Davis-Besse Unit No. 1"

81-30 "Velan Swing Check Valves"

81-35 "Check Valve Failures"

82-08 "Check Valve Failures in Diesel Generator Engine Cooling System

82-20 "Check Valve Problems"

82-35 "Failure of Three Check Valves in High Pressure Injection Lines to Pass Flow"

Attachment 2
IEB 83-03
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LIST OF RECENTLY ISSUED IE BULLETINS

Bulletin No.	Subject	Date of Issue	Issued to
83-02	Stress Corrosion Cracking in Large-Diameter Stainless Steel Recirculation System Piping at BWR Plants	03/04/83	Table 1 BWRs an for action and all other licensees and holders of a CP
83-01	Failure of Reactor Trip Breakers (Westinghouse DB-50) to Open on Automatic Trip Signal	02/25/83	All PWR facilities holding an OL and other power reactor facilities for information
82-04	Deficiencies in Primary Containment Electrical Penetration Assemblies	12/03/82	All power reactor facilities holding an OL or CP
82-03 Rev. 1	Stress Corrosion Cracking in Thick-Wall Large-Diameter Stainless Steel, Recirculation System Piping at BWR Plants	10/28/82	Operating BWRs in Table 1 for action and other OLs and CPs for information
82-03	Stress Corrosion Cracking in Thick-Wall Large-Diameter, Stainless Steel, Recirculation System Piping at BWR Plants	10/14/82	Operating BWRs in Table 1 for action and other OLs and CPs for information
82-01 Rev 1, Supp 1	Alteration of Radiographs of Welds in Piping Subassemblies	08/18/82	All power reactor facilities with an OL or CP
82-02	Degradation of Threaded Fasteners in the Reactor Coolant Pressure Boundary of PWR plants	06/02/82	All PWR facilities with an OL for action and all other OLs or CPs for information
82-01 Rev. 1	Alteration of Radiographs of Welds in Piping Subassemblies	05/07/82	All power reactor facilities with an OL or CP

OL = Operating License
CP = Construction Permit