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March 28, 1991

U.S. Nuclear Regulatory Commission
Office of Nuclear Reactor Regulation
Washington, D.C. 20555

Attention: Mr. R. L. Pettis

Subject: Broken Swing Check Valve Arm

Dear Mr. Pettis:

Enclosed is the final technical service bulletin prepared to report this component failure to the industry. As we discussed by phone, there have been no changes to the front page. The second side summarizes the results of metallurgical examinations performed by consultants under contract to Texas Utilities.

The bulletin has been sent directly to all BW/IP customers with our swing check valves products. To inform utilities which have purchased BW/IP valves from cancelled plant surplus, a copy has been mailed to the Institute for Nuclear Power Operations (INPO) with a request that it be distributed in the "Significant by Others" report.

Distribution of this bulletin concludes BW/IP, International, Inc. reporting of this incident.

Very truly yours,

Kent A. Huber, Ph.D.
Section Head, Special Projects

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TECHNICAL DISCUSSION

The swing check valve arm is a standard BW/IP part cast from 17-4 PH material. All swing arms were procured in accordance with industry standards in effect at the time of manufacture (circa 1974-76).

The fracture planes of the failed arm were in the collar region where arm attaches to the disc (see Figure). Corrosion products were found on the fracture faces. Failure analyses, performed by third parties under utility funding, included metallurgical examinations of five similar arms removed from valves in service that had not failed.

Examination showed a poor material condition in the failed arm consisting of casting defects, inadequate heat treatment and minor chemistry deviations. The significant casting defects were the presence of microcracks and shrinkage cavities formed during solidification of the casting and its subsequent cooling. These microcracks were not detectable using normal LP, MP and RT techniques. No microcracks were present in the other arms inspected.

Inadequate heat treatment in the failed arm and one other arm was evidenced by material hardness greater than Rc 35. Materials in this hardness range are more susceptible to hydrogen assisted cracking. The material microstructure showed the existence of well defined dendrites which also indicates the arm did not receive either a homogenization treatment or a double solution anneal.

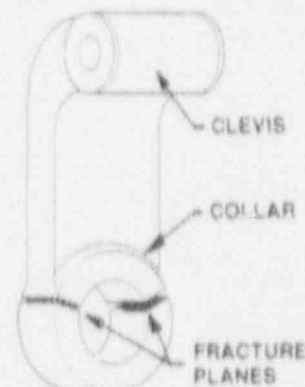
Chemistry of the failed arm material was in accordance with specifications except for a marginal silicon and chromium content. The lower amount of silicon decreased the fluidity of the molten metal during casting and contributed to the formation of hot cracks and voids. One other arm exhibited similar chemistry deviations.

It is hypothesized that the failure initiated at the surface connected casting defects which provided preferential sites for crevice corrosion. The simultaneous presence of corrosion sites and a microstructure susceptible to hydrogen assisted cracking enabled stress corrosion cracking to occur when the material was exposed to the relatively high chloride content service water. The cracks propagated along the dendrite grain boundaries which were not broken up by a sufficient heat treatment until failure occurred.

Based on the metallurgical tests and analyses, the dominant cause is considered to be the casting quality. Poor material properties were also contributory in the corrosive service water environment. Casting quality and material chemistry of the other swing arms examined were good. The failure of the swing arm is thus considered to be an isolated event.

This Technical Service Bulletin applies to all Borg-Warner swing check valves.

For additional information, contact Mr. Kent Huber at BW/IP International, Inc., Pump Division.



SWING ARM

EFFECTED INSTALLATIONS



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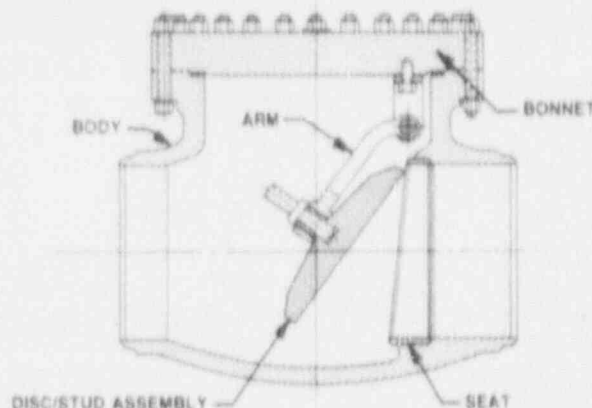
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Swing Check Valves

... Inspection of internal components recommended ...



PROBLEM

A single occurrence of a swing arm failure has been experienced in a 4-inch 150 lb valve installed in a service water system. The failure occurred during hot functional testing and consisted of radial fractures, in two places, of the collar holding the disc/stud assembly to the valve arm.

EVALUATION

Examination of the failed arm and five other swing arms removed from service indicate this failure to be an isolated event resulting from a synergistic combination of surface defects and corrosive service environment. Over one thousand similar valves have been supplied to the nuclear power industry. A review of INPO NPRDS data identified over 500 of these valves in service with no failures of the swing arm reported.

RECOMMENDATION

Although this failure is considered to be an isolated occurrence, BW/IP International, Inc., considers it prudent to inspect all swing arm check valves at the next opportunity. Valves installed in systems with a high chloride content should receive special attention.

- Perform visual inspection of valve internal components.
- Perform PT/MT examinations if indicated by visual inspection.
- Replace any defective components.