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**ATR PRIMARY COOLANT SYSTEM CHECK VALVE
PROBLEM ANALYSIS AND CORRECTION
First Supplement**

by T. K. Burr

IDAHO NUCLEAR CORPORATION
NATIONAL REACTOR TESTING STATION
IDAHO FALLS, IDAHO

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Erratum for IN-1186 (First Supplement)

Page 3, Fig. 2:

Please substitute the illustration on this page for the one printed on page 3 (the caption is correct as printed).

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ATR PRIMARY COOLANT SYSTEM
CHECK VALVE PROBLEM ANALYSIS AND CORRECTION
First Supplement

BY

T. K. Burr

**ANALYSIS BRANCH
ENGINEERING DIVISION**

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Preparation of the tables and figures in this supplement and the original report, IN-1186, is credited to Mr. D. W. Elison and the Graphic Arts Branch.

ABSTRACT

Following successful performance tests of the modified ATR primary coolant system check valves as reported in IN-1186, a continuing surveillance program was established for the purpose of detecting a change in valve performance. In addition, an alternate bearing design was developed which could replace the existing bearings should the findings of the surveillance program indicate a change was necessary. This report discusses the bearing design and describes the surveillance program and the tests, inspections, and instrumentation required to implement it.

SUMMARY

To meet the hydraulic requirements of the ATR primary coolant system, it was necessary to make design changes to the 20-inch main primary system pump discharge check valves. Reference 1 issued in May, 1968, documents the events leading to the discovery of the check valve deficiencies, the resulting investigations, the solutions, and the performance tests conducted to verify the solutions.

Subsequent to the performance tests conducted in January, 1968, several projects were initiated by Idaho Nuclear Corporation to provide the data necessary to assess the condition of the check valves at any time. First was the design and installation of accurate, remote valve disc position indicators. Second was the completion of tests and inspections to establish a basis for a continuing check valve surveillance program. Third was the development of an alternate bearing design which is adaptable to the existing check valves. Fourth was the development of an analytical method which examines the check valve mechanics and bearing stresses.

The first three items are now complete and are discussed in this report. Check valve position indicators have been installed and operated successfully since September, 1968. Tests to evaluate valve response (signature) and provide surveillance data have indicated smooth valve operation since the initial performance tests in January, 1968. Inspection of the valve bearing surfaces have indicated virtually no change in appearance or dimension.

An alternate bearing design has been approved which employs a flame sprayed hard chrome surface. The design also includes better surface finishes than the existing bearings.

The analytical analysis which is reported under a separate cover (Reference 2) provides bearing stresses and indicates margins of safety.

It is suggested that bearing material tests be conducted to determine wear rates and bearing life. These tests would provide a direct reliability comparison of the existing check valve bearings and those of the alternate design. In addition, the tests would provide experimental validation of the analytical methods of Reference 2.

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ATR PRIMARY COOLANT SYSTEM

CHECK VALVE PROBLEM ANALYSIS AND CORRECTION

I. INTRODUCTION

In January, 1968, the ATR primary coolant system (PCS) 20-inch check valves were modified so that they would meet the system's hydraulic requirements without galling the valve bearing surfaces. Idaho Nuclear Corporation Report IN-1186 describes the PCS, the valves (before and after modification), the analytical establishment of design criteria, and the performance tests.

The work reported in IN-1186 was accomplished by a great many people in the shortest period of time to allow continuation (with minimum delay) of the ATR startup test program. The check valve performance tests of January 22 and 23, 1968, proved that the modified valves would close fast enough, under all pump failure situations, to prevent loss of required reactor core coolant and eliminate damaging waterhammer. Because of limited design data concerning wear rates of metal in pure water, additional data and monitoring of the valves were considered necessary. With the ATR startup testing continuing, Idaho Nuclear Corporation initiated the following projects:

- (1) Design and installation of permanent check valve disc position indicators.
- (2) Establishment of a surveillance program (based on valve tests and inspections) which would indicate the condition of the valve bearings and detect a reduction in the ability of the valves to meet the system's requirements.
- (3) Development of an alternate valve bearing design which could quickly and efficiently replace the existing bearings.
- (4) Provide a dynamic analysis of the check valve which will determine the bearing loads under the most severe operating situation, a one-of-three pump cutoff.

The above four projects have been completed and the first three are documented in the following paragraphs. The dynamic analysis is reported under a separate cover[2]. The surveillance program is in effect, and a feasibility study is recommended to determine if bearing tests can be made which will establish the fatigue life of the existing and alternate bearing materials. Should the bearing tests be feasible, a second supplement will be issued describing this work.

Figures 1 and 2, from IN-1186, have been included with this supplement for reference.

Fig. 1 Flow diagram of ATR primary coolant system.

Fig. 2 Section view of modified 20-inch check valve.

II. CHECK VALVE DISC POSITION INDICATORS

Design Alternatives

The check valve disc position indicators used during the initial valve tests were not meant for permanent service and required the use of portable instrumentation. To provide the reactor operator with a continuous indication of disc position and to provide the accuracy necessary for the planned valve surveillance program, a new position indicator system was required. This system had to be dependable, accurate, and of a permanent nature. Several methods of sensing disc position were considered and are discussed below.

- (1) Gamma source located in the dashpot piston and a G-M detector in the bonnet. As the distance between source and detector varies, the gamma current as seen by the detector varies as a function of $[\exp(-K)(\text{distance})]/(\text{distance})^2$. Thus, the G-M output will change proportionally. Considerable amount of research has been done; however a commercial unit was not available. The development would have to be a research program.
- (2) Permanent magnet located in the piston which closes a series of reed switches as the piston moves in the vertical direction. To define the signature clearly, the distance between switches must approach zero. Yet as the distance approaches zero, random closure of the switches occur. This results in poor repeatability. In discussions with various manufactures, it was found that commercially available systems were in "position limit" applications only.
- (3) A piston rod attached to the check valve damping piston which protrudes through the bonnet and is directly connected to a linear potentiometer.

Final Design

Method 3 was chosen for the final design because of the low cost involved, and reliability. The mechanical design of the indicator and its attachment to the check valve are shown in Figure 3; the electrical circuit schematic is shown in Figure 4. The sensing device, a linear potentiometer, is attached directly to the damping piston and supplies a continuous signal, which is calibrated in degrees, to the operating control room. This signal can also be recorded during transient periods through the galvanometer jack indicated on Figure 4. The indicators have been in service since September, 1968.

Fig. 3 ATR-PCS 20-inch check valve disc position indicator assembly.

Fig. 4 Schematic of electrical circuit for check valve position indicator.

III. SURVEILLANCE PROGRAM

General

The primary function of the surveillance program is to detect deterioration of the valve bearing surfaces which, if allowed to continue, would result in the inability of the valve to meet the system hydraulic requirements. The requirements imposed on the check valves by the primary coolant system are:

- (1) In the event of pump failure or loss of commercial power, limit backflow through the pump(s) so that reactor cooling requirements are maintained.
- (2) Should a one-pump failure occur, the valve of the stopped pump must close such that the piping system is not subjected to severe waterhammer.

The surveillance program now in effect consists of periodic tests to record valve response (signature) during a one-of-one pump cutoff. The tests will be conducted semiannually during the first year of operation and annually thereafter. An evaluation of the signature tests results will determine the necessity of an immediate disassembly inspection. Further action would depend on measurements and observations made during the valve inspection.

Each test will be conducted in accordance with written standard procedures. These are presented in Appendix A. A one-of-one pump cutoff was selected over the more severe one-of-three pump cutoff for the following reasons:

- (1) The large closing force generated by a one-of-three pump cutoff would not be affected significantly by minor galling of bearing surfaces, thereby making this deficiency more difficult to detect.
- (2) The closing time of approximately 11 seconds for the one-of-one cutoff is five times greater than the one-of-three cutoff, and would:
  - (a) be least effected by instrument error and
  - (b) simplify curve plotting.
- (3) Procedures, test setup, and equipment operating are minimized with the operation of a single pump.
- (4) The one-of-one cutoff most nearly represents a normal pump shutdown which is accomplished with the pump discharge valve closed or nearly closed.

The establishment of the interval between signature tests was somewhat arbitrary due to sporadic operating periods of the ATR during its initial start-up. Several additional tests and inspections have been made since IN-1186 which have helped form a basis for the surveillance program. These are discussed in the following paragraphs.

Inspection of Valve CK-A-1-2 Top Works

On July 29, 1968, the dashpot cylinder head and cylinder were removed from check valve CK-A-1-2 for observation of its nitrided surfaces. The nitrided areas observed were the dashpot piston and piston rod, which had been nitrided in December, 1967. A 109 cycle inspection, made on February 27, 1968, was reported in IN-1186. Since then, this valve had accumulated 36 additional open-close operating cycles, and its components had been immersed in water for approximately five months. Figures 5 through 8 provide a visual record of this inspection. General observations were:

- (1) The nitrided wear surfaces of the piston and piston rod are virtually free of corrosion.
- (2) Rust which could be seen in several spots was not serious and would not reduce the reliability of the valve.

Further dismantling and inspection of the link pins or hinge pins of this valve or the components of the remaining three check valves were considered unnecessary at that time.

Fig. 5 Photograph of CK-A-1-2, piston and piston rod.

Fig. 6 Photograph of CK-A-1-2, piston and spring retainer.

Fig. 7 Photograph of CK-A-1-2, dashpot cylinder head.

Fig. 8 Photograph of CK-A-1-2, dashpot cylinder.

September-October, 1968 Signature Tests

On September 27, 1968, signature tests were conducted in accordance with the procedures in Appendix A. These tests were considered to be the first of the semiannual tests of the surveillance program. The characteristic or signature to be investigated was the relationship of check valve disc position with time during the closing action resulting from a one-of-one pump cutoff. The new check valve position indicators were used for the first time in this capacity.

The results of these tests were compared with test data obtained from tests conducted March 15, 1968, under similar test conditions and procedures. The closing characteristic for each valve compares favorably with the March results, indicating a smooth closure. However, the total closing time, from motor trip to seating of the valve disc, increased for each valve since the March tests by the following amounts:

<u>Pump</u>	<u>Valve</u>	<u>Increase (Sec)</u>	<u>% Increase</u>
M6	CK-A-1-2	2.5	25
M7	CK-A-1-5	0.64	5
M8	CK-A-1-8	0.95	9.5
M9	CK-A-1-11	1.01	10.3

A review of the March and September test data and a check of the test equipment used offered no plausible explanation for the increased closing times. Inspection of the bearing areas of Valve CK-A-1-2 (discussed below) revealed nothing unusual. The position indicators (linear potentiometers) of Valves CK-A-1-2 and CK-A-1-5 were interchanged, and the signature test of these two valves was repeated on October 17, 1968.

Table I shows the results (closing times) for all tests; Table II provides a test comparison and a tabulation of accumulated valve open-close cycles. Figures 9 through 20 are curves which show the signature of each valve.

The repeatability of Valves CK-A-1-5, 8 and 11 was very good during the September 27 test, ie, the closing time for each of these valves differed by no more than 0.04 second for the two runs of each test. The repeatability of Valve CK-A-1-2 was not as good, since the closing times for its two runs differed by 0.19 seconds. This poorer repeatability followed the linear potentiometer from Valve CK-A-1-2 to Valve CK-A-1-5 as indicated by the repeated tests of October 16. Valve CK-A-1-5 indicated a difference of 1.6 seconds between its two runs while CK-A-1-2 had only a 0.06 second difference.

The suspect potentiometer was replaced and tested and inspected in the laboratory. Other than a slight roughness at one position in its stroke, no deficiencies were discovered.

TABLE I

SIGNATURE TESTS OF SEPTEMBER 27 AND OCTOBER 28, 1968

SIGNATURE TESTS OF SEPTEMBER 27, 1968:

<u>TEST No.</u>	<u>Run No.</u>	<u>Pump No.</u>	<u>CHECK VALVE No.</u>	<u>CLOSING TIME, Sec.</u>	<u>AVG. TIME</u>
1	1	M-6	CK-A-1-2	12.40	12.5
1	2	M-6	CK-A-1-2	12.59	
2	1	M-7	CK-A-1-5	11.96	11.94
2	2	M-7	CK-A-1-5	11.92	
3	1	M-8	CK-A-1-8	10.94	10.95
3	2	M-8	CK-A-1-8	10.96	
4	1	M-9	CK-A-1-11	10.82	10.81
4	2	M-9	CK-A-1-11	10.80	

SIGNATURE TESTS OF OCTOBER 16, 1968 :

<u>TEST No.</u>	<u>RUN No.</u>	<u>PUMP No.</u>	<u>CHECK VALVE No.</u>	<u>CLOSING TIME, Sec.</u>	<u>AVG. TIME</u>
1	1	M-6	CK-A-1-2 ⁽¹⁾	12.46	12.43
1	2	M-6	CK-A-1-2 ⁽¹⁾	12.40	
2	1	M-7	CK-A-1-5 ⁽¹⁾	11.36	12.16
2	2	M-7	CK-A-1-5 ⁽¹⁾	12.96	
3	1	M-6	CK-A-1-2	2.04 ⁽²⁾	—

Note (1) Linear potentiometers interchanged

(2) 1-of-3 Pump cutoff - all others, 1-of-1 Pump cutoffs

TABLE II

CHECK VALVE CLOSING TIMES AND ACCUMULATED CYCLES

<u>1-OF-1 PUMP CUTOFF CLOSING TIMES, sec</u>			
<u>TEST DATE</u> →	3-15-68	9-27-68	10-16-68
<u>VALVE:</u>			
CK-A-1-2	10.0	12.5	12.43
CK-A-1-5	11.3	11.94	12.16
CK-A-1-8	10.0	10.95	—
CK-A-1-11	9.8	10.81	—

<u>1-OF-3 PUMP CUTOFF CLOSING TIMES, sec</u>		
<u>TEST DATE</u> →	3-15-68	10-16-68
<u>VALVE:</u>		
CK-A-1-2	1.9	2.04
CK-A-1-5	1.9	—
CK-A-1-8	1.7	—
CK-A-1-11	1.8	—

} 1-of-3 Pump
Cutoff was not
performed.

<u>ACCUMULATED OPEN-CLOSE CYCLES</u>		
<u>DATE</u> →	3-15-68	9-27-68
<u>VALVE:</u>		
CK-A-1-2	109	156
CK-A-1-5	96	138
CK-A-1-8	99	132
CK-A-1-11	21	66

Fig. 9 ATR-PCS, 20-inch check valve signature.

Fig. 10 ATR-PCS, 20-inch check valve signature.

Fig. 11 ATR-PCS, 20-inch check valve signature.

Fig. 12 ATR-PCS, 20-inch check valve signature.

INC - B - 13492

Fig. 13 ATR-PCS, 20-inch check valve signature.

INC - B-13493

Fig. 14 ATR-PCS. 20-inch check valve signature.

INC-B-13494

Fig. 15 ATR-PCS, 20-inch check valve signature.

INC-B-13495

Fig. 16 ATR-PCS, 20-inch check valve signature.

INC-B-13496

Fig. 17 ATR-PCS, 20-inch check valve signature.

INC-B-13497

Fig. 18 ATR-PCS, 20-inch check valve signature.

INC-B-13498

Fig. 19 ATR-PCS, 20-inch check valve signature.

INC - B - 13499

Fig. 20 ATR-PCS, 20-inch check valve signature.

Some operating variables were not controlled during these and the March tests which would have an effect on the test results and a comparison analysis. These are:

- (1) Calibration and accuracy of PCS flow indicator.
- (2) Surge tank level.
- (3) PCS pump motor voltage.

Although it appeared that the new instrumentation and, to some extent, the uncontrolled variables were responsible for the difference in closing times, a one-of-three pump cutoff was made on Valve CK-A-1-2- for assurance that the PCS requirements mentioned above could be met under the most severe shutdown situation. The valve closure was smooth and well within the 2.5 second limit established in IN-1186. Closure time for this situation had increased 7% since the March tests.

October Disassembly Inspection of Valve CK-A-1-2

During the period October 8 through 10, 1968, Valve CK-A-1-2 was removed from the piping system, disassembled, and inspected. Previously, CK-A-1-2 had been completely disassembled and inspected in February, 1968 after 109 open-close operating cycles. The following was observed:

- (1) The solid film lubricant, electrofilm No. 4396, had been removed from the surface.
- (2) There was no new galling or surface deterioration.
- (3) A dimensional check of all components indicated virtually no change from the measurements made in February, 1968.

Figures 21 through 30 are photographs taken during the inspection of the major valve components.

Fig. 21 Photograph of CK-A-1-2, link pins and link.

Fig. 22 Photograph of CK-A-1-2, link pins and link (pins rotated 180 degrees).

Fig. 23 Photograph of CK-A-1-2, hinge pins.

Fig. 24 Photograph of CK-A-1-2, hinge pins (rotated 180 degrees).

Fig. 25 Photograph of CK-A-1-2, piston assembly.

Fig. 26 Photograph of CK-A-1-2, lower piston.

Fig. 27 Phtograph of CK-A-1-2, lower piston rod (rotated 180 degrees).

Fig. 28 Photograph of CK-A-1-2, upper piston rod.

Fig. 29 Photograph of CK-A-1-2, upper piston rod (rotated 180 degrees).

May, 1969 Signature Tests

The second of the semiannual signature tests was performed in May, 1969, and the cause of the valve closing time variance was discovered. Prior to testing, the operators were specifically instructed to set the required primary coolant system flow rate as close as possible to 18,000 gpm by opening the motor operated butterfly valve, BF-A-14, but not to overshoot 18,000 gpm and then close the valve to get 18,000 gpm. This was accomplished for all test runs of valves CK-A-1-2, 5 and 11 with very good repeatability of valve closing time. For the second run of valve CK-A-1-8, the operator accidentally went to 21,000 gpm and had to close BF-A-14 to obtain the established test flow of 17,800 gpm. This resulted in a new indicated valve position. The butterfly valve position indicator now placed BF-A-14 at 7/32 open instead of 9/32 open as recorded for all other runs. The test run was continued, and valve closing times differed by 18% between run 1 and 2. See Table III.

This phenomenon of two valve positions for the same flow rate was noted during the September-October, 1968 tests, but was assumed to be the result of linkage clearance. A review of the September-October test data indicates that when two identical test runs differed greatly in closing time, the indicated valve position also differed by 7/32 open and 9/32 open. It is also observed that when BF-A-14 is 7/32 open for 18,000 gpm, the check valve closing time is faster than when BF-A-14 is 9/32 open for 18,000 gpm. It is reasoned that when BF-A-14 is 7/32 open, it offers more resistance to the emergency pump flow, forces more water through the closing check valve, and results in a faster closing time.

Table III represents the results of the May, 1969 tests. Valve CK-A-1-2 shows a slight decrease in closing time whereas the other three valves show small increases in closing times. Figures 30 through 38 show the most recent valve signatures. Table IV represents the check valve closing times and accumulated open-close cycles for the two semiannual tests of the continuing surveillance program. This data will be used as a basis for future yearly check valve analyses.

TABLE III

SIGNATURE TESTS OF MAY, 1969

Test Date : 5-2-69

Valve / Pump	Run No	Closing Time (sec)
CK-A-1-2 / M6	1	12:05
CK-A-1-2 / M6	2	12:19
CK-A-1-5 / M7	1	12:40
CK-A-1-5 / M7	2	12:45
CK-A-1-8 / M8	1	11:85
CK-A-1-8 / M8	2	10:03
CK-A-1-8 / M8	3	11:83
CK-A-1-11 / M9	1	11:36
CK-A-1-11 / M9	2	11:61

Valve / Pump	CK A 1 2/M6		CK-A-1-5/M7		CK-A-1-8 / M8			CK-A-1-11/M9	
Run No.	1	2	1	2	1	2	3	1	2
PCS Flow, gpm	17,800	17,800	17,800	17,800	17,800	17,800	17,800	17,800	18,000
Pump Discharge Pressure, psig	368	368	368	366	366	374	372	370	367
Pump Suction Pressure, psig	215	205	205	205	205	205	205	205	205
PCS Temperature, °F	60	62	64	64	65	66	70	68	69
PCV-1-1 Flow, gpm	300	300	300	300	300	300	300	300	300
Reactor Δp , psi	24	24	24	24	24	24.5	24	24	24
BF-A-14 (fraction open)	9/32	9/32	9/32	9/32	9/32	7/32	9/32	9/32	9/32 +
Reactor Inlet Pressure, psig	248	248	248	247	247	247	247	247	247

TABLE IV

CURRENT CHECK VALVE CLOSING TIMES AND ACCUMULATED CYCLES

Valve / Pump	Test Date	Open-Close Cycles *	Avg. Closing Time seconds	% Time Change since 9 - 68
CK-A-1-2 / M6	Sep-Oct, 68	156	12.43	
	May, 69	241	12.12	-2.5
CK-A-1-5 / M7	Sep-Oct, 68	138	11.94	
	May, 69	205	12.42	+4.0
CK-A-1-8 / M8	Sep-Oct, 68	132	10.95	
	May, 69	184	11.84	+8.1
CK-A-1-11 / M9	Sep-Oct, 68	66	10.81	
	May, 69	107	11.48	+6.2

---

* As of September 27, 1968 and May 5, 1969

Fig. 30 Present ATR-PCS, 20-inch check valve signature.

Fig. 31 Present ATR-PCS, 20-inch check valve signature.

Fig. 32 Present ATR-PCS, 20-inch check valve signature.

Fig. 33 Present ATR-PCS, 20-inch check valve signature.

Fig. 34 Present ATR-PCS, 20-inch check valve signature.

Fig. 35 Present ATR-PCS, 20-inch check valve signature.

Fig. 36 Present ATR-PCS, 20-inch check valve signature.

Fig. 37 Present ATR-PCS, 20-inch check valve signature.

Fig. 38 Present ATR-PCS, 20-inch check valve signature.

IV. ALTERNATE BEARING DESIGN

1. Design

The alternate design of the wear and bearing surfaces of the ATR PCS check valves was prepared as a precautionary measure in the event there is any sign of significant deterioration of the nitrided surfaces presently in the check valves. The wear surfaces considered were hinge pins and bushings, piston rod and bushings, link pins and clevis.

The alternate design was prepared to the following requirements:

- (1) Parts shall be compatible with existing check valves, if possible. If not possible, alteration to the check valves shall be kept to a minimum.
- (2) Material combinations must have anti-galling properties sufficient to withstand maximum contact stresses encountered during operation of the check valves, approximately 30,000 psi. Material combinations must have a coefficient of friction of 0.6 or less to provide adequate sliding surfaces.
- (3) Materials chosen for wear and bearing surfaces must not be adversely affected by radiation.
- (4) Materials chosen shall have a corrosion classification of Class II as defined by the "Corrosion and Wear Handbook for Water Cooled Reactors". These are materials with corrosion resistance approximately equivalent to that of type 304 stainless steel.
- (5) The materials chosen must be such that the corrosion by-products released into the PCS can be removed from the PCS by the bypass demineralizer system. The corrosion by-products must not present an activation problem within the PCS system. The use of copper bearing alloys is prohibited.
- (6) Redesign of wear and bearing surfaces shall not degrade the hydraulic and time response characteristics of the check valves.

Based on the requirements, the alternate design consisted of:

- (1) Hinge pins, piston rod, and link pins -- 304 SST hard-surfaced with Colmonoy-8^[a], spray welded and bonded.
- (2) Bushings -- 17-4Ph SST heat-treated to condition H-1100.

Complete details are shown in Figure 31.

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[a] Hard Surfacing Manual No. 80, Wall Colmonoy Corporation, 12521 South Shoemaker Avenue, Santa Fe Springs, California.

Fig. 39 ATR-PCS 20-inch check valve details alternate design.

2. Bearing Tests

Since there is very little information available concerning bearing life in pure water, there is a need for tests which would determine the wear rates of the existing and alternate check valve bearing designs. With experimental wear rate values, the life of the bearings could be predicted. The results of such tests would provide a performance comparison between the existing and alternate bearing designs. These tests would also provide experimental validation for the method employed in Reference 2.

The feasibility of such tests is being considered. In the event they are performed, an additional supplement to IN-1186 will be issued covering this work.

V. CONCLUSIONS AND RECOMMENDATIONS

The tests and inspections conducted to date on the 20-inch check valves indicate that the design changes made in January, 1968 have resulted in a valve capable of satisfactory performance under operating conditions. Although there appears to be a slight trend toward slower valve closures, there is as yet insufficient data to draw a definite conclusion.

The following recommendations have been made:

- (1) The unusual effect of the Butterfly valve position should be investigated to determine if this is indeed a hydraulic phenomenon, or a mechanical or instrumentation problem.
- (2) Consideration should be given to a series of tests designed to determine the wear rates of the bearing materials used in the existing valves and the alternate bearing design.

VI. REFERENCES

1. T. L. Bridges and T. K. Burr, ATR Primary Coolant System Check Valve Problem Analysis and Correction, IN-1186 (May, 1968).
2. N. R. Byers, Evaluation of Bearing Loads and Contact Stresses in the primary Coolant Check Valve of the Advanced Test Reactor, IN-1338 (To be published).

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APPENDIX A

SIGNATURE TESTS

OF

ATR-PCS 20-INCH CHECK VALVES

PURPOSE: To provide data which will indicate long-term changes in valve operation resulting from deterioration of valve components.

SCOPE: One-of-one pump cutoff tests are to be conducted periodically, under identical system conditions on each 20-inch check valve, namely CK-A-1-2, CK-A-1-5, CK-A-1-8, and CK-A-1-11.

OBJECTIVE: To obtain a record for each valve which indicates valve disc position versus time from primary pump motor trip.

PROCEDURE:

- (1) Prior to pump tests, provide a recording oscilloscope to record the primary pump motor trip signal and the 0 to 50 micro amps (μ A) output from the check valve disc position indicator.

See Figures 3 and 4.

- (2) When instrumentation has been completed, complete the following steps:

- (1) Pressurize PCS according to normal startup procedures.
- (2) Start one (1) primary coolant pump.
- (3) Start one (1) emergency coolant pump.
- (4) Establish and record the following PCS operating parameters:

Pump Discharge Pressure -- Normal Pressure, not to exceed 250 psig at the pump suction.

Reactor Inlet Temperature -- $85^{\circ} \pm 50^{\circ}\text{F}$.

Total PCS Flow -- 18,00 gpm^[a].

- (5) Allow five (5) minutes for above conditions to stabilize.

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[a] Until the flow-position phenomenon of the PCS Butterfly control valve is understood, the test flow rate will be approached by opening Butterfly valve.

- (6) Start recording oscilloscope. Set chart speed at 1 inch/sec.
- (7) Without shutting primary pump discharge valve, secure power to pump.
- (8) Operate oscilloscope recorder for one (1) minute after motor trip.
- (9) Repeat Steps 1 through 8, once.
- (10) Steps 1 through 9 above are to be performed for each pump.