ANALYSIS OF CHECK VALVE 578
FAILURE AND RECOMMENDATIONS

June 11, 1964

WANL-TME-821

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1. PROBLEM

During Experimental Plan I of the NRX-A1 test series, check valve 578 failed. The failure was first indicated by a high pressure drop across the check valve during a nitrogen flow test. An examination of the check valve by a re-entry team found that the disc stud had failed, freeing the disc (flapper) and allowing it to be lodged in the discharge port thus restricting flow. Inspection of the valve revealed that the failure occurred at the last thread as shown in the sketch.

The particular valve is identified as a Pacific Valve, Figure No. 680-12K-RJ, Trim No. 12K, 600 lb. cast steel, bolted bonnet, swing check valve, flanged ends, size 6".

An evaluation was requested by TCA Facilities Operations on the suitability of this type valve for the service for which it is intended. An identical valve, valve number 872 is installed upstream of the mixing chamber in the 8" LH_2 propellant line. A similar evaluation was requested for this valve.

2. ANALYSIS

Crane's Technical Paper No. 410, pp. 2 - 7, states that most of the difficulties encountered with swing check valves have been found to be due to oversizing which results in noisy operation and premature wear of the moving parts. This statement applies very well to valve 578.

From Crane's experience it has been found that swing check valves of good design will be in the full open position at about 1/2 psi. Pressure drop calculations, presented in Figures 1 and 2, through Pacific type check valves indicate that for the six (6) inch size valve the disc should be in the full open position at an ambient hydrogen mass flow rate of 1 lb m/sec. This same condition occurs in the four inch valve at a mass flow rate of 0.25 lb m/sec.

Conversation with Mr. Fred O'Brien of Pacific Valves, Long Beach, California, revealed that swing check valves of Pacific manufacture have an LID of approximately 80. Crane lists the following LID's that can be expected from other type check valves:

<u>Type Valve</u>	<u>LID</u>
Conventional Swing	135
Globe Lift	340
Angle Lift	145
In-Line Ball	150

Thus, it can be seen that the present valve provides very low resistance to flow.

Conversation with Test Cell A Operations personnel indicates that there was an audible chattering traceable to valve 578 with small gas flows. This was during facility checkouts when personnel were present in the FCR. This chattering is further substantiated by the excessive wear on the hinge pin which was evident upon inspection of the valve's internal parts.

Again, conversation with Mr. Fred O'Brien of Pacific Valves revealed that to his knowledge this is the first such reported failure of any of their check valves. A defect in the material that did not show up during Pacific non-destructive testing evidently caused the failure under the influence of cyclic loading.

Analysis of the fractured part was not possible because the upper part of the disc stud could not be found, and the lower part of the stud was destroyed in the process of making the disc usable for the remaining scheduled tests.

3. RECOMMENDATIONS

If the pressure drops attendant with the four (4) inch size valve are not objectionable, then the four (4) inch size Pacific valve is recommended to replace the present six (6) inch check valve.

The present check valve in the eight (8) inch LH_2 propellant line, valve 872, is considered acceptable.

GH₂ FLOW RATE
VS
VALVE PRESSURE DROP

FIG. 2

K&E LOGARITHMIC 358 120
 KEUFFEL & ESSER CO. MADE IN U.S.A.
 3 X 3 CYCLES

100.0
 9
 8
 7
 6
 5
 4
 3
 2
 1
 0.1
 0.01
 FLOW RATE
 PRESSURE

LEAK RATE
 VALVE DROPPING

VALVE

VALVE

$\Delta P \sim P$

FIG 1

PACIFIC-TYPE CHECK VALVE

HINGE PIN

LOCATION OF FAILURE

LOCATION OF FAILURE

REF:
PACIFIC VALVES INC
DWG. NO. 3-2119