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FINAL REPORT

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U.S. GOVERNMENT CONTRACT NAS 9-9027

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FOREWORD

This report covers a study conducted at the Aircraft Porous Media, Inc., Pall Corporation, Glen Cove, Long Island, New York (11542), under NASA Contract NAS 9-9027.

ABSTRACT

A study was conducted to determine the degree of microbial backcontamination which can be expected from the waste water to the potable water in the Command Module water system.

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1.0 INTRODUCTION

Due to Spaceflight contingency requirements, the spacecraft water system has been designed with a hardline interconnection between the potable water and the waste water portions of the system. These portions are separated by a check valve. For example, the water valve panel of the Apollo Environmental Control System is essentially a system closed to possible cross contamination from other system sources. Yet, there may be an exception due to the (5.2) check valves.

Considering the probability of the exact reseating to the sub-micronic tolerance required for no bacterial penetration it was felt that the most likely route of cross contamination would be via the (5.2) check valves.

For this reason tests were performed on two (2) 5.2 check valves in order to challenge their microbial integrity.

2.0 TEST PROCEDURES

- 2.1 The two (2) check valves (5.2) serial numbers 084163 and 084156 were installed in a water flow test set up and pressurized in their normal flow direction to ascertain correct function, as well as to flush clean the valve.

All lines of the water flow test set up were precleaned to prevent particulate contamination of the check valves and a 0.35 micron absolute filter was installed immediately upstream of the check valve under test.

- 2.2 Immediately following test procedure 2.1 each check valve in turn was reversed in the water flow setup and pressurized in its normal checking direction at pressures starting at 40 psig and reducing down to 2 psig. Pressure was maintained for 0.5 hours at each pressure increment.

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- 2.3 Both check valves were sterilized then installed in their normal checking direction into the sterile setup shown in Figure I.

Sufficient samples of the setup were taken to verify sterility, then the reservoir of the setup was charged with a concentration 10^7 /ml of *Pseudomonas diminuta* ATCC No. 19146, mean diameter 0.3 micron. This organism is stable in water; is motile and is easily cultured.

Valves (A) and (B) were opened and with all air purged from the system a system sample was taken from valve (b) to verify bacteria input.

The check valves were then pressurized in their normal checking direction for 72 hours. During and at the conclusion of the 72 hour test period, the nutrient solution was observed and analyzed as necessary for evidence of bacterial growth due to penetration of the test bacteria through the check valve.

- 2.4 The check valves and the setup were resterilized and the test procedures of paragraph 2.3 were repeated.
- 2.5 The check valves were again sterilized and subjected to the acceptance test procedures of para 2.1.
- 2.6 The check valves were then subjected to the test procedure of para 2.3 except that pressure was approximately zero (0) psi.
- 2.7 Tests per paras 2.5 and 2.6 were then repeated.

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3.0 TEST RESULTS AND DISCUSSION

- 3.1 The check valves in their normal flow direction were found to be functioning properly.

Actual Data Para 2.1 Test

<u>Check Valve</u>	<u>Flow</u>	<u>Pressure Drop</u>
Serial No.	cc/min	psid
084163	800	0.6
084156	800	0.6

- 3.2 Notwithstanding the leakage of s/n 084156 at (2) psig in checking direction this check valve was considered to be sufficiently representative of state of the art for check valves so that it was permitted to go on to the static bacterial penetration tests.

Actual Data Para 2.2 Test

<u>Check Valve</u>	<u>40 psig</u>	<u>25 psig</u>	<u>10 psig</u>	<u>2 psig</u>
<u>Serial No.</u>				
084163	'0' leakage	'0' leakage	'0' leakage	'0' psig
084156	'0' leakage	'0' leakage	'0' leakage	2 drops in 0.5 hours

- 3.3 At a pressure of 40 psig both check valves appeared to effectively prevent any bacterial penetration, while at (2) psig both check valves permitted bacteria to penetrate. In actual system use the result would be eventual bacterial contamination of the potable water.

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The fact that the check valves were bacteria tight at 40 psig, but not at (2) psig is considered normal in that the force acting at 40 psig pressure would naturally cause a tighter seal at this high-pressure barrier to bacterial penetration than at (2) psig.

Actual Data para 2.3 Test

Valve Serial No.	Pressure (psig)	Pseudomonas Downstream of Check Valve			
		0 hrs.	24 hrs.	48 hrs.	72 hrs.
084163	40 psig	-	-	-	-
084156	40 psig	-	-	-	-
084163	2 psig	-	+	+	+
084156	2 psig	-	+	+	+

- "No growth in brain heart infusion broth"

+ "Growth in brain heart infusion broth"

- 3.4 Test results of para 2.4 procedure compliments the results of para 2.3 discussion to the extent that check valves reliably prevented bacterial penetration at the high pressure 25-40 psig but allowed bacterial penetration in lower 2-10 psig range.

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Valve Serial No.	Pressure (psig)	Pseudomonas Downstream of Check Valve			
		0 hrs.	24 hrs.	48 hrs.	72 hrs.
084163	40	-	-	-	-
084156	40	-	-	-	-
084163	25	-	-	-	-
084156	25	-	-	-	-
084163	10	-	+	+	+
084156	10	-	-	-	-
084163	2	-	+	+	+
084156	2	-	+	+	+

- "Nogrowth in brain heart infusion broth"

+ "Growth in Brain heart infusion broth"

3.5 There was no significant change in functional performance of the check valves in either the checking or free flow direction as a result of repeated sterilizing.

3.6 There was no evidence of growth in the brain heart infusion broth for either of the valves at zero (0) psig after two challenges.

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4.0 CONCLUSIONS AND RECOMMENDATIONS

To date no check valves have been found that are bacterially tight. Where possible, systems having the potential for cross or back contamination have found that valves designed with a contained air gap have provided an effective barrier system against cross contamination. While this type of valve may not be feasible for use in a Spacecraft, further development studies along this line may be warranted by soliciting such companies as Harco Scientific, Atco Manufacturing Company and Columbia Systems Company to propose new or existing designs suitable to prevent cross or back contamination in the CM Apollo water panel.

Study of the Apollo water system suggests a bacteria removal filter to be immediately upstream of the potable water tank or a bacteria removal filter to be immediately upstream of the potable water outlet or both.

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5.0 LITERATURE

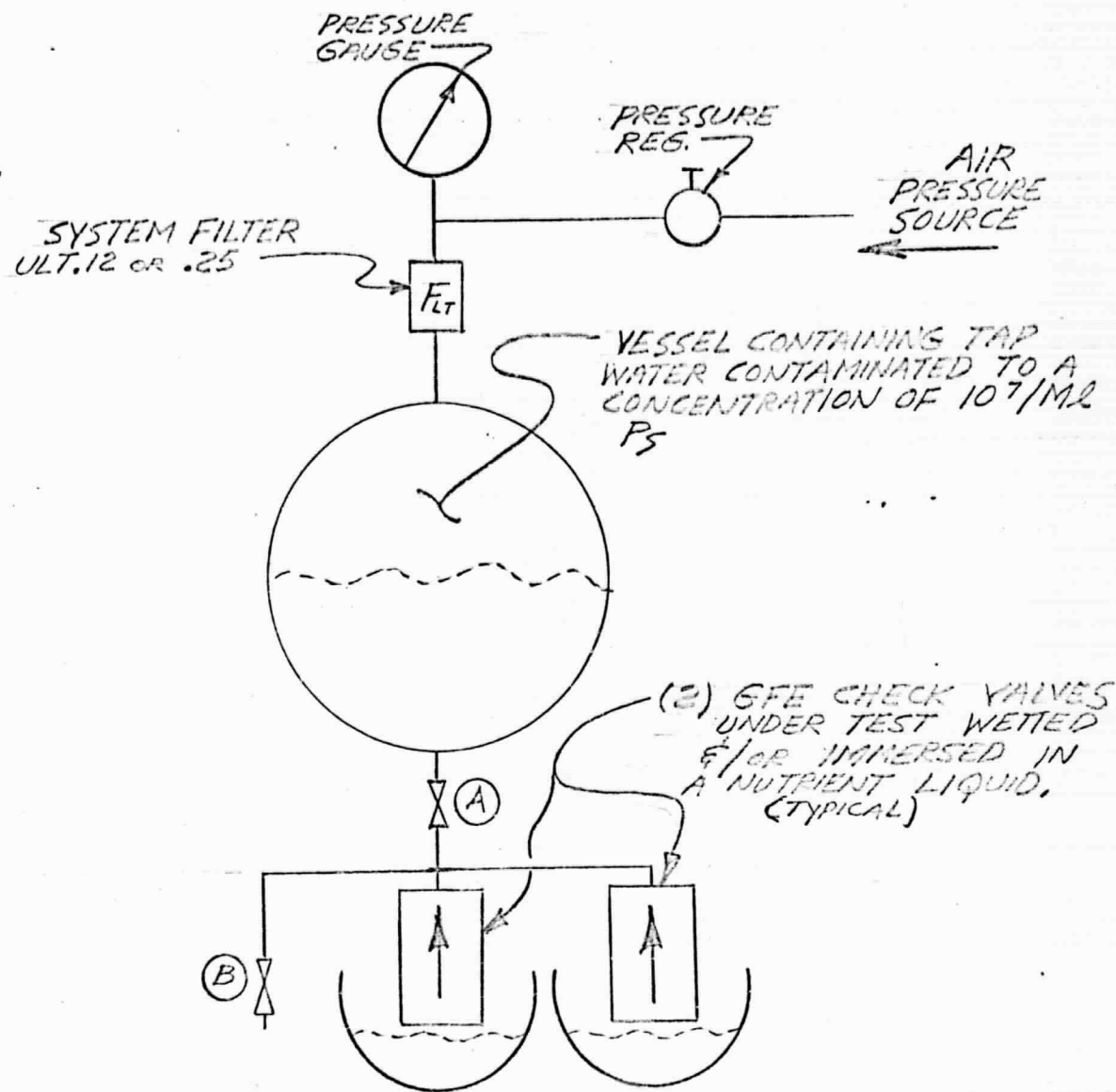
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NOTES:

1. LINE SIZES & LENGTHS, AS WELL AS DISTANCES BETWEEN COMPONENTS TO BE DETERMINED & RECORDED.
2. SIGNIFICANT SURFACES OF THE TEST SET-UP ARE TO BE STERILE AT THE START OF THE TEST.
3. VALVES (A) & (C) CLOSED AT START OF TEST.

FIGURE I