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FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CRITICAL HARDWARE
NUMBER: 03-1-0242-X

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SUBSYSTEM NAME: MAIN PROPULSION

REVISION : 1 04/05/90

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
■ LRU :	HIGH PRESSURE FILTER	MC286-0056-0001

PART DATA

- EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FILTER (FL2,3,4,6,7,8), HIGH PRESSURE, ENGINE HELIUM SUPPLY SYSTEM
(0.375 INCH DIAMETER).
- QUANTITY OF LIKE ITEMS: 6
SIX
TWO PER ENGINE He SUPPLY
- FUNCTION:
THE FILTER TRAPS CONTAMINATION THAT MAY BE PRESENT IN THE SYSTEM FROM
THE GSE HELIUM SUPPLY AND/OR THE ENGINE HELIUM TANKS/LINES PRIOR TO
FLOW THROUGH THE ISOLATION SOLENOID VALVES (LV1,2,3,4,5,6) AND INTO THE
ENGINE SYSTEM. THERE IS A FILTER IN EACH INDIVIDUAL ENGINE SUPPLY LEG
(TWO PER ENGINE).

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SUBSYSTEM: MAIN PROPULSION
LRU :HIGH PRESSURE FILTER
ITEM NAME: HIGH PRESSURE FILTER

CRITICALITY OF THIS
FAILURE MODE:1R2

- FAILURE MODE:
RESTRICTED OR BLOCKED FLOW/CLOGGED

MISSION PHASE:
PL PRELAUNCH
LO LIFT-OFF

- VEHICLE/PAYLOAD/KIT EFFECTIVITY: 102 COLUMBIA
: 103 DISCOVERY
: 104 ATLANTIS

- CAUSE:
CONTAMINATION.

- CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

- REDUNDANCY SCREEN A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:

- A)

- B)

FAILS B SCREEN BECAUSE FAILURE OF ONE LEG CAN BE MASKED BY PRESSURE FROM THE OTHER LEG CLOSING THE CHECK VALVE DOWNSTREAM OF THE REGULATOR ON THE FAILED LEG.

- C)

- FAILURE EFFECTS -

- (A) SUBSYSTEM:
LOSS OF REDUNDANCY. REDUNDANT HELIUM SUPPLY LEG CAN PROVIDE ENGINE REQUIREMENTS.

- (B) INTERFACING SUBSYSTEM(S):
SAME AS A.

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- (C) MISSION:
NO EFFECT.
- (D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C.
- (E) FUNCTIONAL CRITICALITY EFFECTS:
1R/2, 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH/ASCENT.
1) FILTER CLOGS/LOW FLOW IN A SINGLE LEG.
2) LOSS OF REDUNDANT ENGINE HELIUM SUPPLY LEG.

RESULTS IN LOSS OF HELIUM SUPPLY TO THE AFFECTED ENGINE. INTERRUPTION OF FLOW TO HIGH PRESSURE OXIDIZER TURBOPUMP INTERMEDIATE SEAL MAY RESULT IN UNCONTAINED ENGINE FAILURE PRIOR TO SAFE REDLINE SHUTDOWN.

POSSIBLE LOSS OF CREW/VEHICLE.

- DISPOSITION RATIONALE -

- (A) DESIGN:
THE FILTER IS A 25 MICRON ABSOLUTE "OFF-THE-SHELF" ITEM. ITS ELEMENT IS OF ALL STAINLESS STEEL WELDED CONSTRUCTION. IT CONSISTS OF A PLEATED TWILLED DOUBLE DUTCH WIRE ELEMENT, A SUPPORT TUBE, AN END CAP, A FITTING AND TWO TEFLON O-RINGS.

THE FILTER ELEMENT IS REPLACEABLE WITHOUT REMOVAL OF THE FILTER FROM THE SYSTEM. IT IS DESIGNED (A) FOR A MINIMUM OF 210 HOURS BETWEEN CLEANING/REPLACEMENT; (B) TO FLOW 350,000 STANDARD CUBIC FEET OF HELIUM; AND (C) TO ABSORB TWO GRAMS OF STANDARD CONTAMINANT WITH LESS THAN A 20 PSID PRESSURE DROP. TWO UNITS TESTED DURING CERTIFICATION HAD LESS THAN 9 PSID PRESSURE DROP AFTER THE ADDITION OF TWO GRAMS OF STANDARD CONTAMINANT. BASED ON THIS DATA, SUPPLIER PROJECTIONS PREDICT THAT THE FILTER ELEMENT WILL REMOVE ABOUT SEVEN GRAMS OF STANDARD CONTAMINANT FROM THE FLUID SYSTEM BEFORE A PRESSURE DROP OF 20 PSID WOULD RESULT.

FILTERS OF SIMILAR CONFIGURATION HAVE BEEN USED IN THE VIKING PROGRAM. THERE HAS BEEN NO INCIDENT OF FLIGHT MALFUNCTION OR FAILURE ASSOCIATED WITH THE FILTERS USED IN THE VIKING PROGRAM.

- (B) TEST:
ATP

EXAMINATION OF PRODUCT

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BUBBLE POINT TEST (GREATER THAN 8.28 INCHES WATER)

PROOF PRESSURE TEST (9000 PSIG)

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LEAKAGE (0 TO 4500 PSIG)

CLEANLINESS (100A)

CERTIFICATION

RANDOM VIBRATION (DRY AND UNPRESSURIZED)
14 MINUTES IN X AND Y AXIS, 20 TO 2000 Hz, 22.3 grms
34 MINUTES IN X AND Y AXIS, 20 TO 2000 Hz, 20.2 grms

TRANSIENT VIBRATION (DRY AND UNPRESSURIZED)
IN X AND Y AXIS, 5 TO 35 Hz +/- 0.25 g PEAK

FLOW CAPACITY (464 SCFM (0.08 LBS/SEC) GHe AT 970 PSIG, +70 DEG F)
CLEAN FLOW (20 PSID MAX)
2 GRAMS OF AC COARSE DUST (20 PSID MAX)

ELEMENT BUBBLE POINT TEST (GREATER THAN 8.28 INCH WATER)
PROOF PRESSURE TEST (9000 PSIG)

EXTERNAL LEAKAGE (4500 PSIG)
AMBIENT (+70 DEG F)
LOW TEMP (-160 TO -200 DEG F)
HIGH TEMP (+160 DEG F)

LEAKAGE/THERMAL (970 PSIG)
+100 TO +350 TO +150 DEG F (1x10⁻⁴ SCC/SEC MAX LEAK RATE DURING CYCLE)
LEAKAGE CHECKED CONTINUOUSLY

ELEMENT PRESSURE
PLUG FILTER ELEMENT WITH A SLURRY OF AC COARSE DUST
PRESSURIZED TO 1125 PSID
CLEAN ELEMENT
ELEMENT BUBBLE POINT TEST

LIFE AND ENVIRONMENT REQUIREMENTS DEMONSTRATED BY ANALYSIS

BURST PRESSURE TEST (10,200 PSIG)

GROUND TURNAROUND TEST
V41BGO.080 PRI-3, 7-9 SSME HELIUM REGULATOR FUNCTIONAL TEST (EVERY
FLIGHT)
V41BZO.050 LV10 PNEUMATIC CROSSOVER VALVE FLOW PATH (PERFORM GROUND

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TURNAROUND TEST IF VALID VERIFICATION IS UNOBTAINABLE
DURING FLIGHT)
DV41BZD.050 LV10 PNEUMATIC CROSSOVER VALVE FLOW PATH (IN FLIGHT)

■ (C) INSPECTION:

RECEIVING INSPECTION
INSPECTION OF ALL CRITICAL DIMENSIONS. INCOMING MATERIALS ARE VERIFIED
BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
FILTERS ARE MAINTAINED TO CLEANLINESS LEVEL 100A. AFTER BUBBLE POINT
TEST AND PRIOR TO PACKAGING, FILTERS ARE DRIED IN VACUUM OVEN.

ASSEMBLY/INSTALLATION
SURFACE FINISHES ARE VERIFIED ON FILTER COMPONENTS SUCH AS END CAP,
FITTING, SUMP, AND TUBE. INSPECTION VERIFIES TORQUE APPLICATION TO
SUMP IS IN ACCORDANCE WITH REQUIREMENT. LUBRICATION OF SUMP THREADS
AND IDENTIFICATION MARKINGS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
PART PASSIVATION IS VERIFIED ON FILTER COMPONENTS SUCH AS TUBE, SUMP,
END CAP AND FITTING BY INSPECTION. TIG WELDS OF END CAP TO THE
ELEMENT ASSEMBLY ARE VERIFIED BY INSPECTION. FILTER MARKING PROCESS
BY CHEM-ETCH IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
HELIUM LEAK DETECTION IS CONDUCTED TO PREVENT ANY POSSIBLE LEAKAGE IN
THE ASSEMBLY.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
EACH FILTER OR FILTER ELEMENT END ITEM AND ITS SUPPORTING
DOCUMENTATION ARE VISUALLY CHECKED PRIOR TO SHIPMENT. FILTERS ARE
FIRST PRE-PACKAGED TO ASSURE MAINTENANCE OF CLEANLINESS LEVEL.
PACKAGING MATERIALS AND METHODS ARE UTILIZED IN ACCORDANCE WITH
REQUIREMENTS.

■ (D) FAILURE HISTORY:

THIS FAILURE MODE HAS NOT OCCURRED ON THIS COMPONENT DUE TO
CONTAMINATION. HOWEVER, GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED
WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE
(REFERENCE THE FOLLOWING PARAGRAPHS).

CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING
AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS

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CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 27 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR A02226). METHODS ARE BEING REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV-099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS340005, AC7912, A80530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. BRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE

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CARS 480529 AND 480530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

- (E) OPERATIONAL USE:
NO CREW ACTION CAN BE TAKEN.

- APPROVALS -

RELIABILITY ENGINEERING:	K. ANVARI	:	<u>OK</u> 5-24-90
DESIGN ENGINEERING	: H. P. BAFFORD	:	<u>H.P. Bafford</u> 4-16-90
QUALITY ENGINEERING	: O. J. BUTTNER	:	<u>O.J. Buttner</u> 5-24-90
NASA RELIABILITY	:	:	<u>W. J. ...</u> 10/12/90
NASA SUBSYSTEM MANAGER	:	:	<u>...</u> 10/12/90
NASA QUALITY ASSURANCE	:	:	<u>...</u> 10/12/90