FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER:03-1-0145 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 3 07/25/00

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	:HIGH PRESSURE GHE FILTER WINTEC	ME286-0056-0001 24228-626

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
FILTER (FL5), HIGH PRESSURE HELIUM, PNEUMATIC HELIUM SUPPLY SYSTEM (0.375 INCH DIA).

REFERENCE DESIGNATORS: FL5

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
THE FILTER TRAPS CONTAMINATION THAT MAY BE PRESENT IN HELIUM FROM THE GROUND SUPPORT EQUIPMENT SUPPLY AND/OR THE PNEUMATIC HELIUM TANK PRIOR TO FLOW THROUGH THE ISOLATION SOLENOID VALVES (LV7,8) AND INTO THE PNEUMATIC SUPPLY DISTRIBUTION SYSTEM.

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LRU: GHE FILTER
ITEM NAME: MPS PNEU GHE SUPPLY FILTER (FL5)

CRITICALITY OF THIS FAILURE MODE: 1R2

FAILURE MODE:
RESTRICTED OR BLOCKED FLOW/CLOGGED.

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF

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

CAUSE:
CONTAMINATION.

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) PASS
C) PASS

PASS/FAIL RATIONALE:
A)

B)
RESTRICTED OR BLOCKED FLOWPATH IS DETECTABLE BY DOWNSTREAM PRESSURE MEASUREMENT

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF REDUNDANCY. REDUNDANT HELIUM SUPPLY THROUGH LV10 AT MECO CAN PROVIDE PNEUMATIC ACTUATION SYSTEM 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 (FL5) CLOGGED
2) CROSSOVER VALVE (LV10) FAILS TO OPEN/REMAIN OPEN.

THE HELIUM REGULATOR AND ACCUMULATOR PRESSURES ARE MONITORED BY THE LCC PRIOR TO T-31 SECONDS. FAILURE SUBSEQUENT TO COMPLETION OF OUTBOARD FILL AND DRAIN VALVE (PV9, 11) CLOSURES WILL NOT PREVENT LAUNCH. THERE SHOULD BE SUFFICIENT HELIUM REMAINING IN THE ACCUMULATOR LEG TO OPERATE THE LH2 PREVALVES PRIOR TO ENGINE START AND THEIR VALVE OPEN INDICATIONS WILL PASS THEIR LCC CHECKS AT T-7 SECONDS. ACTUATION OF VALVES PRIOR TO LIFT-OFF REDUCES THE PRESSURE OF THE GAS REMAINING IN THE ACCUMULATOR. AT MECO, IF LV10 DOES NOT REPLENISH THE ACCUMULATOR PRESSURE, THE REDUCED PRESSURE WILL NOT CLOSE THE LO2 PREVALVES WITHIN THE TIME REQUIRED BY THE ENGINE (0.95 +/- 0.20 SECONDS) AND UNCONTAINED ENGINE DAMAGE MAY RESULT.

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.

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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

BUBBLE POINT TEST (GREATER THAN 8.28 INCHES WATER)

PROOF PRESSURE TEST (9000 PSIG)

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

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BURST PRESSURE TEST (18,200 PSIG)

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:
RECEIVING INSPECTION
ALL CRITICAL DIMENSIONS ARE VERIFIED. INCOMING MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL
FILTERS ARE MAINTAINED TO CLEANLINESS LEVEL 100A. BUBBLE POINT TEST IS VERIFIED.

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

CRITICAL PROCESSES
PART PASSIVATION IS VERIFIED ON 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 ON THE FILTER ASSEMBLY IS VERIFIED.

TESTING
ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING
COMPONENT, SUBASSEMBLY AND FINAL ASSEMBLY HANDLING AND PACKAGING ARE VERIFIED TO MEET SPECIFICATION REQUIREMENTS.

(D) FAILURE HISTORY:
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 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 17 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.

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METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WERE MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR AD2226). 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. BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES HAVE BEEN 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, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES HAVE BEEN 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 CARS AB0529 AND AB0530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORESCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

PNEUMATIC TANK, REGULATOR, AND ACCUMULATOR PRESSURE ARE ON S/M ALERT FDA SYSTEM AND THE BFS SYSTEM SUMMARY DISPLAY. THIS ALLOWS THE FLIGHT CREW TO RESPOND TO A PNEUMATIC HELIUM SYSTEM LEAK INDEPENDENT OF GROUND CONTROL.

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- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	:/S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	:/S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: CHARLES EBERHART	:/S/ CHARLES EBERHART
MPS SUBSYSTEM MGR.	: TIM REITH	:/S/ TIM REITH
MOD	: JEFF MUSLER	:/S/ JEFF MUSLER
USA SAM	: MIKE SNYDER	:/S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: BILL PRINCE	:/S/ BILL PRINCE