

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE**NUMBER:03-1-1517 -X****SUBSYSTEM NAME:** MAIN PROPULSION**REVISION:** 1

07/27/00

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
ASSY	: FILTER ASSEMBLY (TYPE I) VACCO INDUSTRIES	MC286-0097-0011
ASSY	: FILTER ASSEMBLY (TYPE II) VACCO INDUSTRIES	MC286-0097-0012
LRU	: FILTER HOUSING (TYPE I) VACCO INDUSTRIES	MC286-0097-0003
LRU	: FILTER HOUSING (TYPE II) VACCO INDUSTRIES	MC286-0097-0004

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

FILTER HOUSING, GH2 PREPRESS/PRESSURIZATION SYSTEM. THE THREE ENGINE LEG GH2 FILTERS USE 5/8" DIA, TYPE I HOUSINGS (MC286-0097-0003). THE GROUND SUPPLIED GHE PREPRESS FILTER USES A 1" DIA, TYPE II HOUSING (MC286-0097-0004).

NOTE: BOTH FILTER HOUSINGS USE THE SAME MODEL FILTER ELEMENT. ALTHOUGH THE FILTER HOUSINGS AND ELEMENTS ARE USUALLY PROCURED AS SEPARATE PART NUMBERS, THEY CAN BE PROCURED AS A FILTER ASSEMBLY. THE ENGINE LEG FILTER ASSEMBLIES (MC286-0097-0011) ARE COMPRISED OF FILTER ELEMENT AND TYPE I FILTER HOUSING. THE GROUND SUPPLIED GHE PREPRESS FILTER ASSEMBLY (MC286-0097-0012) IS COMPRISED OF FILTER ELEMENT AND TYPE II FILTER HOUSING.

REFERENCE DESIGNATORS: FL10 (PREPRESS)
FL11 (ENGINE 1)
FL12 (ENGINE 2)
FL13 (ENGINE 3)

QUANTITY OF LIKE ITEMS: 4
ONE FILTER ON EACH OF THREE ENGINE LEGS, AND ONE ON THE PREPRESS SYSTEM

FUNCTION:

THE FILTER TRAPS CONTAMINATION THAT MAY BE PRESENT IN EITHER THE HELIUM PREPRESS SYSTEM FROM THE GROUND SUPPORT EQUIPMENT SUPPLY OR IN THE GH2 PRESSURIZATION SYSTEM ORIGINATING FROM THE LH2 FEED SYSTEM, THE SSME'S, OR THE EXTERNAL TANK.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) --CIL HARDWARE
NUMBER: 03-1-1517-X**

REFERENCE DOCUMENTS: VS70-415007 (MAIN PROPULSION SYS SCHEMATIC)
NSTS-12820 (SPACE SHUTTLE OP FLIGHT RULES)

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-1517-01

REVISION#: 1 07/27/00

SUBSYSTEM NAME: MAIN PROPULSION

LRU: FILTER ASSEMBLY, GH2/GHE

ITEM NAME: GH2 FILTER HOUSING

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

RUPTURE/EXTERNAL LEAKAGE

MISSION PHASE:

PL PRE-LAUNCH

LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA

103 DISCOVERY

104 ATLANTIS

105 ENDEAVOUR

CAUSE:

MATERIAL DEFECT, FATIGUE, INTERFACE SEAL DAMAGE, MISHANDLING

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) N/A

B) N/A

C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

DURING ASCENT, A LEAK IN ANY ONE OF THE FOUR (4) PREPRESS/ PRESSURIZATION FILTERS WILL DUMP GH2 INTO THE AFT COMPARTMENT FROM THE GH2 PRESSURIZATION SYSTEM. THIS MAY RESULT IN:

1. FIRE/EXPLOSION HAZARD IN AFT COMPARTMENT
2. POSSIBLE OVERPRESSURIZATION OF THE AFT COMPARTMENT

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-1517-01**

LEAKAGE OF A FILTER DURING MANIFOLD REPRESS RESULTS IN POSSIBLE LOSS OF HELIUM SUPPLY FOR AFT COMPARTMENT PURGE. RTLS/TAL ABORT CRITICAL.

(B) INTERFACING SUBSYSTEM(S):
SEE A.

THE ET LH2 TANK ULLAGE PRESSURE COULD FALL BELOW THE REQUIRED CONTROL BAND (32-34 PSIG) DURING MAIN ENGINE OPERATIONS, RESULTING IN POSSIBLE VIOLATION OF TANK STRUCTURAL CAPABILITIES AND NET POSITIVE SUCTION PRESSURE (NPSP) BELOW REQUIREMENT. THIS COULD RESULT IN STRUCTURAL FAILURE OF LH2 TANK OR UNCONTAINED MAIN ENGINE SHUTDOWN.

(C) MISSION:
POSSIBLE LOSS OF MISSION DUE TO LOSS OF CREW/VEHICLE, SEE A.

POSSIBLE LAUNCH SCRUB (CRITICALITY 3/3) DUE TO GHE LEAKAGE THROUGH A RUPTURE OF ANY PREPRESS/PRESSURIZATION SYSTEM FILTER. GHE LEAKAGE FROM ANTI-ICING PURGE DURING GROUND OPERATIONS WOULD BE DETECTED UP TO T-9 MINUTES BY THE HAZARDOUS GAS DETECTION SYSTEM (HGDS). GHE LEAKAGE DURING PREPRESSURIZATION OPERATIONS WOULD BE DETECTED AS THE INABILITY TO PRESSURIZE THE LH2 TANK TO PREPRESSURIZATION LEVELS.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE, SEE (A) AND (B).

(E) FUNCTIONAL CRITICALITY EFFECTS:
POSSIBLE LOSS OF CREW/VEHICLE, SEE (A) AND (B).

-DISPOSITION RATIONALE-

(A) DESIGN:
THE FILTER HAS A FILTRATION RATING OF 14 ± 3 MICRONS (17 MICRON ABSOLUTE). IT USES A STAINLESS STEEL ETCHED DISC FILTER ELEMENT. THE .002 INCH THICK FILTER ELEMENT DISCS HAVE SHALLOW RADIAL GROOVES ETCHED IN THEM TO A DEPTH OF 14 ± 3 MICRONS. WHEN THE DISCS ARE STACKED TOGETHER, THE GROOVES FORM RECTANGULAR PASSAGES THAT ALLOW FLOW TO PASS THROUGH BUT RESTRICT THE SIZE OF PARTICLES THAT CAN PASS THROUGH. THE 6 INCH FILTER ELEMENT CONTAINS APPROXIMATELY 3000 OF THESE DISCS.

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-1517-01**

THE FILTER ELEMENT IS DESIGNED TO BE 100% CLEANABLE THROUGH BACKFLUSHING WHICH MUST BE ACCOMPLISHED WITH THE ELEMENT REMOVED FROM THE HOUSING. THE FILTER HOUSING IS FLANGED. THE LOWER HALF OF THE HOUSING MAY BE REMOVED FOR REMOVAL OF THE FILTER ELEMENT WITHOUT REMOVAL OF THE COMPLETE HOUSING FROM THE SYSTEM. THE FILTER ELEMENT IS DESIGNED TO ACCEPT 15 GRAMS OF STANDARD ALUMINUM CONTAMINANT WITH AN INCREASE IN PRESSURE DROP OF LESS THAN 50 PSID. THIS IS PROJECTED TO BE EQUIVALENT TO AT LEAST 5 MISSIONS OF SERVICE. BOTH THE TYPE I AND TYPE II FILTERS HAVE A FACTOR OF SAFETY OF 1.5 FOR PROOF AND BURST PRESSURE.

THE TYPE I FILTER USED IN THE ENGINE LEGS OF THE PRESSURIZATION SYSTEM HAS PROVISIONS FOR A TRIM ORIFICE TO BE INTERNALLY INSTALLED IN ITS INLET LINE. THE ORIFICE CAN BE USED TO MAKE SMALL ADJUSTMENTS TO PRESSURIZATION SYSTEM FLOWRATE BY ADJUSTING FLOW CONTROL VALVE INLET PRESSURE.

(B) TEST:

ATP

EXAMINATION OF PRODUCT

BUBBLE POINT TEST EQUIVALENT TO 17 MICRON ABSOLUTE FILTRATION RATING.

BOIL POINT TEST EQUIVALENT TO 14 MICRON NOMINAL FILTRATION RATING.

PROOF PRESSURE TEST (4950 PSIG, TYPE I; 1045 PSIG, TYPE II)

LEAKAGE (0 TO 4500 PSIG, TYPE I; 0 TO 950 PSIG, TYPE II)

CLEANLINESS LEVEL 100 (PER MA0110-301)

CERTIFICATION (TYPE I QUAL UNIT)

1. PROOF TEST (4950 PSIG)
FAILURE OF PRIMARY SEAL SIMULATED, SECONDARY SEAL FULLY PRESSURIZED.
2. FLOW TEST (1.5 LBS/SEC GHE @ 3050±50 PSIG, 50°±50° F)
CLEAN PRESSURE DROP (160 PSID)
CONTAMINATED PRESSURE DROP (50 PSI INCREASE IN ΔP OVER CLEAN VALUE WITH 15 GRAMS OF STANDARD ALUMINUM CONTAMINANT, 0 TO 1000 MICRONS IN SIZE, WITH TEST SEQUENCE REPEATED TWICE)
3. ELEMENT REUSE DEMONSTRATION
RECLEAN FILTER ELEMENT
BUBBLE POINT TEST ELEMENT - EQUIVALENT TO 17 MICRON ABSOLUTE FILTRATION RATING
BOIL POINT TEST ELEMENT - EQUIVALENT TO 14 MICRON NOMINAL FILTRATION RATING
REASSEMBLE FILTER
LEAK CHECK (2 SCCM OF GHE @ 4500 PSIG)

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-1517-01**

4. RANDOM VIBRATION (PRESSURIZED TO 4500 PSIG)
52 MINUTES IN Y-AXIS, 20 TO 2000 HZ, 10.5 GRMS (ASCENT ENVIRONMENT)
52 MINUTES IN X AND Z AXES, 20 TO 2000 HZ, 5.7 GRMS (ASCENT ENVIRONMENT)
3.3 MINUTES IN X AND Z AXES, 20 TO 2000 HZ, 10.5 GRMS (MAIN ENGINE IGNITION ENVIRONMENT)
5. THERMAL CYCLES (400 CYCLES, +80°F TO -300°F)
6. HYDROGEN COMPATIBILITY (13.5 HRS, 4500 PSIG GH₂)
7. PRESSURE CYCLES (400 CYCLES, AMBIENT, 10 PSIG TO 4500 PSIG)
8. ELEMENT PRESSURE
PLUG ELEMENT WITH A SLURRY OF AC COARSE DUST
PRESSURIZE TO 1000 PSID IN EACH DIRECTION INDEPENDENTLY
CLEAN ELEMENT AND PERFORM BUBBLE POINT TEST
9. LRU DEMONSTRATION
DISASSEMBLE/REASSEMBLE FILTER 20 TIMES
LEAK CHECK AND BUBBLE POINT TEST
10. GH₂ FLOW TEST (1.1 LBS/SEC GH₂ @ 3050±50 PSIG, 50°±50°F)
CLEAN PRESSURE DROP (160 PSID)
11. BURST TEST (6750 PSIG)

OMRSD

ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION:

INCOMING MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL TYPE AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL:

FILTER INTERNAL SURFACES ARE MAINTAINED TO LEVEL 100 (PER MA0110-301).
CORROSION PROTECTION IS IMPLEMENTED AND VERIFIED.

ASSEMBLY/INSTALLATION:

CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION.
MANUFACTURING PROCESSES AND INSTALLATION AND ASSEMBLY OPERATIONS ARE VERIFIED BY INSPECTION. TORQUE FORCES APPLIED TO PARTS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES:

INLET AND OUTLET TUBE WELDS ARE INSPECTED PER SPECIFICATION REQUIREMENTS.

NONDESTRUCTIVE EVALUATION:

**FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
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DYE PENETRANT INSPECTION OF HOUSING AND SUMP AFTER MACHINING AND CHEMICAL ETCHING AND X-RAY OF INLET/OUTLET TUBE WELDS WITNESSED BY INSPECTION.

TESTING:

TESTING IS WITNESSED TO VERIFY COMPLIANCE WITH REQUIREMENTS OF ATP.

HANDLING/PACKAGING:

WORKMANSHIP IS INSPECTED. FINAL ASSEMBLY, HANDLING, AND PACKAGING ARE VERIFIED TO MEET REQUIREMENTS OF PROCEDURE.

(D) FAILURE HISTORY:

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

(E) OPERATIONAL USE:

NONE

- 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	: MICHAEL SNYDER	:/S/ MICHAEL SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	:/S/ SUZANNE LITTLE
NASA SR&QA	: BILL PRINCE	:/S/ BILL PRINCE