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PRINT DATE: 10/19/94

FAILURE MODES EFFECTS ANALYSIS (FMEA) - CRITICAL HARDWARE

NUMBER: 03-2F-111110 -X

SUBSYSTEM NAME: FORWARD REACTION CONTROL SYSTEM (RCS)

REVISION: 3 10/18/94

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: TANK ASSEMBLY, PROPELLANT MARTIN MARIETTA	MC282-0061-0601 855C3320000-029
LRU	: TANK ASSEMBLY, PROPELLANT MARTIN MARIETTA	MC282-0061-0602 855C3320000-030

PART DATA

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

TANK ASSEMBLY, PROPELLANT, INCLUDING ACQUISITION DEVICE

QUANTITY OF LIKE ITEMS: 2

ONE REQUIRED PER PROPELLANT

FUNCTION:

TO STORE/SUPPLY PROPELLANT FOR REACTION CONTROL THRUSTERS. ACQUISITION DEVICE RETAINS PROPELLANTS FOR ADEQUATE FEED DURING 1"G", 0"G" AND HIGH "G" CONDITIONS. REGULATED HELIUM IS SUPPLIED TO THE ULLAGE TO FORCE PROPELLANT TO THE THRUSTERS AS REQUIRED. (243 + OR -4 PSIA) (17.95 CUBIC FEET). ACQUISITION DEVICE CONSISTS OF UPPER AND LOWER COMPARTMENT CHANNELS, SCREENS, FEEDOUT TUBE, PLENUM, BULKHEAD, BARRIER AND COLLECTOR.

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FAILURE MODES EFFECTS ANALYSIS (FMEA) NUMBER: 03-2F-111110-03

SUBSYSTEM: FORWARD REACTION CONTROL SYSTEM (RCS) REVISION: 0 11/21/88 W

LRU :TANK ASSY, PROPELLANT

CRITICALITY OF THIS FAILURE MODE: 1 1

ITEM NAME: TANK ASSY, PROPELLANT

FAILURE MODE:

STRUCTURAL FAILURE. FAILS TO FEED PROPELLANT DUE TO RETENTION DEVICE FAILURE, GAS BUBBLES IN PROPELLANT, SCREEN DRY OUT.

MISSION PHASE:

LO LIFT-OFF
OO ON-ORBIT
DO DE-ORBIT

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

CAUSE:

FATIGUE, CONTAMINATED PROPELLANT, CONTAMINATION, VIB, MECH SHOCK, SCREEN COLLAPSE OR DRY OUT, FROZEN PROP, PROP SLOSH LOADS, FASTENING HARDWARE FAILS, HIGH FLOW RESULTING FROM SERVICING OR PROCEDURAL ERRORS, INSTALLATION/ASSEMBLY DAMAGE.

CRITICALITY 1/1 DURING ANY MISSION PHASE OR ABORT? Y

DO DE-ORBIT
LO LIFT-OFF
OO ON-ORBIT

REDUNDANCY SCREEN A) N/A
B) N/A
C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

METHOD OF FAULT DETECTION:

- FAILURE EFFECTS -

(A) SUBSYSTEM:

SUBSYSTEM DEGRADATION, REDUCED PROPELLANT FLOW, GAS BUBBLES IN PROPELLANT CAUSING REDUCED THRUST, O/F RATIO SHIFT OR COMBUSTION

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INSTABILITY.

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

(C) MISSION:
POSSIBLE EARLY MISSION TERMINATION DUE TO INABILITY TO USE PROPELLANT FROM THAT TANK.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE IF FAILURE OCCURS PRIOR TO ET-SEP. FAILURE OF ACQUISITION DEVICE SCREENS COULD CAUSE PREMATURE GAS INGESTION INTO THE THRUSTER MANIFOLDS DURING MATED COAST/ET SEP, CAUSING LOSS OF VEHICLE CONTROL.

Criticality/
Required Fault Tolerance/Achieved Fault Tolerance: 1/1/0

RATIONALE FOR CRITICALITY:

TIME FROM FAILURE TO CRITICAL EFFECT: IMMEDIATE

TIME FROM FAILURE OCCURRENCE TO DETECTION: IMMEDIATE

TIME FROM DETECTION TO COMPLETED CORRECTIVE ACTION: IMMEDIATE

TIME REQUIRED TO IMPLEMENT CORRECTIVE ACTION LESS THAN TIME TO EFFECT? YES

- DISPOSITION RATIONALE -

(A) DESIGN:
SAFETY FACTORS OF 1.4 (MINIMUM) IN SCREEN WILL MINIMIZE FAILURE POTENTIAL. SAFETY FACTOR OF 1.5 ON THE PRESSURE VESSEL.

THE TANK IS MADE OF ALL STAINLESS STEEL MATERIALS THAT ARE COMPATIBLE WITH PROPELLANT. A SWIRL DIFFUSER HAS BEEN INSTALLED TO PRECLUDE SCREEN DRYOUT.

BLEED PORTS ARE INSTALLED TO BLEED ALL GAS PREVENTING SCREEN DRYOUT. THE TANK IS A TOTAL PASSIVE SYSTEM HAVING NO MOVING PARTS.

(B) TEST:
THE QUALIFICATION TEST PROGRAM INCLUDES EXPULSION CYCLES (188,000 FLOW TRANSIENTS OVER 200 EXPULSION CYCLES), PRESSURE CYCLES (800 CYCLES), BOOST RANDOM VIBRATION (48 MIN/AXIS), ACCELERATION, EXTERNAL PRESSURE, PROPELLANT EXPOSURE, PRESSURE HOLD CREEP, BURST (>525 PSIG), FUNCTIONAL TEST, HANDLING SHOCK, SHIPPING CONTAINER SHOCK, 100 MISSION LIFT-OFF

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VIBRATION.

THE TANK WAS ALSO QUALIFIED AS PART OF THE POD IN THE VIBRO-ACOUSTIC TEST AT JSC (131 EQUIVALENT MISSIONS) AND THE HOT FIRE TEST AT WSTF (24 EQUIVALENT MISSION DUTY CYCLES AND APPROX 7 YEARS OF PROPELLANT EXPOSURE).

THE ACCEPTANCE TEST PROGRAM INCLUDES SUBASSEMBLY BUBBLE POINT VERIFICATION, PAD SUBASSEMBLY VISUAL INSPECTION, PROOF PRESSURE (470 PSIG), BUBBLE POINT RETENTION, OUTFLOW DELTA PRESSURE PERFORMANCE, INTERNAL CLEANLINESS, HOT N2 FORGE WITH SAMPLES FOR IPA.

OMRSD PERFORMS THE FOLLOWING: PROPELLANT TANK ACQUISITION VERIFICATION ON LEAD TANKS EVERY TEN FLIGHTS. SCREEN BUBBLE POINT VERIFICATION SHALL BE PERFORMED ON ONE FUEL AND ONE OXIDIZER LEAD TANK FOR EACH 10 FLIGHT INTERVAL. PROPELLANT SAMPLING ON FLIGHT #2 AND THEN ON A CONTINGENCY. PROPELLANT LOADING FOR EVERY FLIGHT. PROPELLANT OFF LOADING IN THE HORIZONTAL POSITION ON A CONTINGENCY BASIS TO OFFLOAD WHEN A SYSTEM OR AN ISOLATED PART OF A SYSTEM MUST BE FREE OF PROPELLANT. PROPELLANT OFFLOADING IN THE VERTICAL POSITION ON A CONTINGENCY BASIS WHEN OFFLOAD TO GAS BREAK IS REQUIRED WITH VEHICLE ON THE PAD. A PROP TANK EVALUATION FOR THE FIFTH FLIGHT AND EVERY FIVE FLIGHTS THEREAFTER AND ON A CONTINGENCY BASIS. CONTINGENCY FOR LRU RETEST PER OMRSD TABLE. CONTROL OF FLOW LIMITS. LOADED PROPELLANT MEET THE REQUIREMENTS OF SE-S-0073.

(C) INSPECTION:

RECEIVING INSPECTION
CHEMICAL AND PHYSICAL PROPERTIES TESTS REPORTS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

HEMISPHERE CLEANLINESS IS VERIFIED BY INSPECTION PRIOR TO WELDING GIRTH WELDS PENETRANT AND RADIOGRAPHICALLY INSPECTED. SCREEN MATERIAL CLEANLINESS IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

TANK HEMISPHERES ARE DIMENSIONALLY INSPECTED.

NONDESTRUCTIVE EVALUATION

FORGINGS ARE ULTRASONICALLY INSPECTED. AFT TANK GIRTH WELDS ARE ULTRASONICALLY INSPECTED IN THE COLLECTOR DOME AREA. WELD START AND STOP POINTS ARE INSPECTED WITH FIBER OPTICS.

CRITICAL PROCESSES

WELDING IS VERIFIED BY INSPECTION.

TESTING

ATP IS WITNESSED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

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PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:

CAR'S AB3554 AND AB5965:

TWO AFT QUAL TANKS (TA7, TA10) FAILED BUBBLE POINT TEST AFTER BOOST VIBRATION TESTING WITH OFF LOADED PROPELLANT LOADS A COLLECTOR SCREEN DEFICIENCY WAS IDENTIFIED AS THE CAUSE. CORRECTIVE ACTION WAS TO USE AS-RECEIVED (COLD WORKED) WIRE CLOTH INSTEAD OF ANNEALED CLOTH. ALSO, ALL MISSIONS ARE FLOWN WITH FULLY LOADED TANKS WHICH ELIMINATES THE SOURCE OF THIS FAILURE.

CAR AB8528:

CORRODED SOLDER REPAIR OF SCREENS WERE REPORTED. THE CORROSION WAS CAUSED BY EXPOSURE TO MMH WHICH WAS CONTAMINATED WITH FRECN. CORRECTIVE ACTION WAS TO TEST ALL MMH PRIOR TO USE TO ASSURE NO CORROSIVE AGENTS ARE PRESENT.

CAR AB4002:

ONE TANK FAILED BUBBLE POINT TEST AFTER PRESSURE CYCLING. THIS WAS CAUSED BY RAPID COLLAPSE OF VAPOR BUBBLE IN THE L/C WHICH ALLOWED THE TANK PRESSURE TO FALL BELOW THE PROPELLANT'S VAPOR PRESSURE. DURING OPERATION, THE TANK PRESSURE IS ALWAYS MAINTAINED ABOVE VAPOR PRESSURE WHICH PRECLUDES THIS FAILURE.

CAR A8639:

ONE TANK FAILED BUBBLE POINT DUE TO AN OILY FILM ON THE SCREEN CORRECTIVE ACTION IS TO INSPECT FOR OILY SURFACE AND CLEAN IF PRESENT. TANKS ARE DELIVERED CLEAN AND THE SYSTEM IS KEPT CLEAN.

(E) OPERATIONAL USE:

INHIBIT FWD RCS IF GAS INGESTION IS SUSPECTED.

- APPROVALS -

RELIABILITY ENGINEERING: R. P. DIEHL
DESIGN ENGINEERING : R. PIEDRA
QUALITY ENGINEERING : W. J. SMITH
NASA RELIABILITY :
NASA SUBSYSTEM MANAGER :
NASA QUALITY ASSURANCE :

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