

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : ORBITAL MANEUVER FMEA NO 03-3 -2006 -3 REV: 4/ 5/81

ASSEMBLY : PROPELLANT FEED CRIT. FUNC: 1
 P/N RI : MC621-0059 CRIT. HDW: 1
 P/N VENDOR: 73A740063
 QUANTITY : 4 VEHICLE 102 103 104
 EFFECTIVITY: X X X
 PHASE(S): PL LO X OO X DO X LS
 : TWO PER POD
 : ONE PER TANK

PREPARED BY: DES D W CARLSON
 REL C M AKERS
 QE W J SMITH

REDUNDANCY SCREEN: A- B- C-
 APPROVED BY: DES [Signature] APPROVED BY (NASA): [Signature]
 REL [Signature] SSM [Signature]
 QE [Signature] REL [Signature] 10-26-81

ITEM:
 COMMUNICATION SCREEN, PROPELLANT RETENTION AND ACQUISITION.

FUNCTION:
 THE MAIN BULKHEAD COMMUNICATION SCREEN RETAINS PROPELLANT WITHIN THE TRAP DURING ZERO OR LOW G AND ALLOWS PROPELLANT FLOW FROM THE FORWARD COMPARTMENT INTO THE TRAP DURING OMS BURNS. CAPILLARY WICKING CHANNELS INSURE SCREEN WETTING. THE COMMUNICATION SCREEN ENCLOSES THE FOUR STUR GALLERIES, CAPILLARY WICKING SCREENS IN THE BULKHEAD AND THE COLLECTOR MANIFOLD. THIS TRAP RESERVOIR PROVIDES GAS FREE PROPELLANT TO THE OMS & RCS DURING ADVERSE VEHICLE MANEUVERS. THE COMMUNICATION SCREEN ASSEMBLY IS COMPOSED OF 12 PACKS OF PLEATED 200 X 1400 TDDW MESH 304L CRES SCREEN WELDED INTO THE TITANIUM BULKHEAD. THE TOTAL EQUIVALENT FLAT SCREEN ARE IS 5093 SQUARE INCHES PLEATED INTO A PROJECTED AREA OF 926 SQUARE INCHES THE SCREENS ARE BACKED UP BY A 0.025 INCH THICK TITANIUM PLATE WHICH HAS A TOTAL OF 2028 0.5 INCH DIAMETER HOLES.

FAILURE MODE:
 STRUCTURAL FAILURE, LOSS IN RETENTION CAPABILITY, GAS BUBBLES IN PROPELLANT.

CAUSE(S):
 SCREEN COLLAPSE - RESIDUE, CORROSION, PROPELLANT SLOSH LOADS, HIGH DIFFERENTIAL PRESSURE, FASTENING HARDWARE FAILS. TANK ELASTIC DEFORMATION, VIBRATION, MANUFACTURING DEFECTS.

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EFFECT(S) ON:

(A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE

(A) SUBSYSTEM DEGRADATION - GAS BUBBLES IN PROPELLANT CAUSING REDUCED THRUST, HARD STARTS AND TRANSIENT COMBUSTION INSTABILITY.

(B) INTERFACE DEGRADATION - INABILITY TO PROVIDE PROPELLANT FOR RCS INTERCONNECT.

(C) LOSS OF MISSION OR SOME MISSION OBJECTIVES (MISSION EFFECTS ARE LIMITED TO ON-ORBIT MANEUVER CAPABILITY).

(D) POSSIBLE CREW/VEHICLE LOSS IF HARD STARTS OR COMBUSTION INSTABILITY RESULT IN ENGINE EXPLOSION AND FAILURE PROPAGATION EFFECTS TO SYSTEM, PC OR VEHICLE.

DISPOSITION & RATIONALE:

(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN

THE COMMUNICATION SCREEN IS DESIGNED TO WITHSTAND MAXIMUM SLOSH LOADS. ONLY PROPELLANT COMPATIBLE MATERIALS ARE USED IN THE DESIGN. THE STRUCTURAL DESIGN FACTOR OF SAFETY IS 1.4 WITH A MINIMUM MARGIN OF SAFETY OF 0.13 ON YIELD. THE SCREEN PERFORMANCE FACTOR OF SAFETY (PROPELLANT RETENTION) IS 3.1 FOR OXIDIZER AND 7.4 FOR FUEL. THE BACK UP PLATE PROVIDES AN ADDITIONAL STRUCTURAL SUPPORT. ON ORBIT, 20 MINUTES OF SUSTAINED LATERAL 0.04G ACCELERATION WOULD BE REQUIRED TO TRANSFER APPROXIMATELY 1500 POUNDS OF FUEL OR 2500 POUNDS OF OXIDIZER (AFT COMPARTMENT CAPACITY) FROM THE AFT TO THE FORWARD COMPARTMENT THROUGH A 0.5 INCH DIAMETER HOLE IN A SCREEN SEGMENT. SCREEN PERFORMANCE IS MONITORED BY THE AFT QUANTITY GAUGING PROBE OUTPUT FOR OMS FIRINGS OF GREATER THAN 14 SECONDS.

(B) TEST

QUALIFICATION TESTS

KC-135 ZERO-G TESTS WERE CONDUCTED DURING DEVELOPMENT. A LUCITE TANK WAS USED IN ORDER TO ALLOW VISUAL OBSERVATION OF DYNAMIC PERFORMANCE DURING ZERO-G. TESTS ARE ALSO CONDUCTED USING A FULL SCALE TANK. TESTING OF THE OMS ENGINE AT WSTF DEMONSTRATED THE CAPABILITY OF THE ENGINE TO FUNCTION PROPERLY AND MEET THE REQUIREMENT FOR INDUCED GAS INGESTION OF 48 CUBIC INCHES. (INADVERTENT INTRODUCTION OF GAS INTO THE SYSTEM DURING THIS TEST PROGRAM INDICATED THAT THE OMS ENGINE COULD ACTUALLY ACCOMMODATE A MUCH GREATER VOLUME OF GAS INGESTION). BUBBLE POINT TESTS ARE CONDUCTED ON FLIGHT UNITS. RANDOM VIBRATION AT ANTICIPATED MISSION LEVELS, PROPELLANT EXPOSURE AND PRESSURE CYCLING WERE PERFORMED DURING QUALIFICATION OF THE TANK ASSEMBLY. ALSO QUALIFIED AS PART OF THE POD ASSEMBLY - VIBRO-ACOUSTIC TESTING AT JSC, 100 EQUIVALENT MISSIONS. HOT-FIRE TEST PROGRAM AT WSTF, 517 TESTS (24 EQUIVALENT MISSION DUTY CYCLES). APPROX. 7 YEARS PROPELLANT EXPOSURE.

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ACCEPTANCE TESTS

(EACH UNIT) - EXAMINATION OF PRODUCT, WELD TESTS, BUBBLE POINTS ON EACH SCREEN AND AS ASSEMBLED UNIT.

GROUND TURNAROUND

V43CBO.120 PERFORMS IN-TANK BUBBLE POINT TESTS ON OMS SCREENS. EFFECTIVITY IS EVERY 10 FLIGHTS FOR LEAD TANKS AND CONTINGENCY. FLIGHT PERFORMANCE IS MONITORED FOR EVIDENCE OF SCREEN DETERIORATION.

(C) INSPECTION

RECEIVING INSPECTION

MATERIALS AND PROCESSES CERTIFICATIONS ARE VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS TO LEVEL 200 FOR MMH AND 200A FOR NTO AND CORROSION PROTECTION PROVISIONS ARE VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

MANUFACTURING, ASSEMBLY AND INSTALLATION PROCEDURES ARE VERIFIED BY INSPECTION. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. BUBBLE POINT TESTS AFTER CUTTING AND AFTER WELDING ARE VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION

FENETRANT AND RADIOGRAPHIC INSPECTION OF WELDS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

THE WELDING PROCESS AND VERIFICATION THAT WELDS MEET SPECIFICATION REQUIREMENTS ARE VERIFIED BY INSPECTION.

TESTING

TEST EQUIPMENT AND TOOL CALIBRATION ARE VERIFIED BY INSPECTION. ACCEPTANCE TEST IS VERIFIED BY INSPECTION. BUBBLE POINT TEST AFTER INSTALLATION INTO THE TANK IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

HANDLING, PACKAGING, STORAGE AND SHIPPING REQUIREMENT ARE VERIFIED BY INSPECTION.

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(D) FAILURE HISTORY

CAR ACSS34 RECORDS AN INSTANCE OF WELD CRACKS IN THE FRAME TO PANEL WEL OF THE COMMUNICATION SCREEN OF A UNIT SCHEDULED FOR THE LEFT POD OF OV-104 DURING SUPPLIER PROCESSING. THIS WAS DUE TO LACK OF FUSION BETWEEN THE FILLER WIRE AND FRAME. IMPROVED FIT UP ASSEMBLY AND A NEW WELD PROCEDURE WERE INSTITUTED. THE RATIONAL FOR FLYING UNITS THAT DID NOT SEE THIS CORRECTIVE ACTION IS THAT THEY SUCCESSFULLY PASSED BUBBLE POINT TEST AND ANALYSIS INDICATES THAT FLIGHT STRESSES ARE NOT HIGH ENOUGH TO INDUCE FAILURE. ADDITIONALLY THE FLAWS OBSERVED WOULD NOT RESULT IN AN ADVERSE EFFECT ON SYSTEM PERFORMANCE

(E) OPERATIONAL USE

NO ACTION POSSIBLE FOR CATASTROPHIC FAILURE, IF FAILURE DETECTED DURING PREVIOUS OMS MANEUVER, TERMINATE INTERCONNECT OPERATIONS UPON EVIDENCE OF GAS INGESTION. PRECEDE REMAINING OMS BURNS BY RCS PROPELLANT SETTling MANEUVER. IF FAILURE DETECTED DURING OMS ENGINE START (LOW P_c AND DELTA V) SHUTDOWN ENGINE AND TREAT AS OMS ENGINE FAIL.