

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : MAIN PROPULSION FMEA NO 03-1 -0435 -4 REV:04/21/88F

ASSEMBLY : ROCKWELL INTL.	VEHICLE	CRIT. FUNC:	1
P/N RI : V070-415430-004	EFFECTIVITY:	CRIT. HDW:	1
P/N VENDOR:	PHASE(S):	102	103 104
QUANTITY : 1	PL	X	X X
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PREPARED BY:	DES	J E OSLUND	APPROVED BY:	DES	<u>H.P. Rafferty</u>	REDUNDANCY SCREEN:	A-	B-	C-
REL	REL	L H FINEBERG	REL	REL	<u>L. S. Coe</u>	APPROVED BY (NASA):	SSM	<u>[Signature]</u>	
QE	QE	E M GUTIERREZ	QE	QE	<u>[Signature]</u>				

ITEM:  
FLAME ARRESTER, LH2 (FL1), 1.8 INCH DIAMETER.

FUNCTION:  
THE FLAME ARRESTER IS LOCATED AT THE LH2 VENT LINE OUTLET BETWEEN THE BASE OF THE VERTICAL STABILIZER AND THE LEFT OMS POD. THE DEVICE PREVENTS EXTERNAL FLAME (FROM RELIEF SYSTEM) FROM PROPAGATING BACK INTO THE LH2 VENT SYSTEM.

FOR NOMINAL, ATO, AOA, AND TAL MISSIONS, GH2 VENTING OCCURS AFTER MECO WHEN THE MANIFOLD RELIEF SHUTOFF VALVE (PVS) OPENS. AFTER COMPLETION OF PROPELLANT DUMP AND VACUUM INERTING NO ADDITIONAL VENTING IS EXPECTED FOR NOMINAL, AOA, AND ATO MISSIONS. FOR RTLS AND TAL MISSIONS GH2 VENTING WILL OCCUR AFTER COMPLETION OF PROPELLANT DUMP AND CONTINUES UNTIL BOILOFF OF LH2 RESIDUALS STOP (POST LANDING).

FAILURE MODE:  
RUPTURE/LEAKAGE OF THE FLAME ARRESTOR BODY POST MECO.

CAUSE(S):  
FATIGUE, MATERIAL DEFECT.

EFFECT(S) ON:  
(A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE:  
(A,B) LH2 LEAKAGE INTO THE AFT COMPARTMENT. VALVE INLET IS NOT EXPOSED TO LH2 UNTIL RELIEF SHUTOFF VALVE (PVS) IS OPENED AT MECO. POSSIBLE LOSS OF ADJACENT CRITICAL FUNCTIONS DUE TO CRYO EXPOSURE. POSSIBLE AFT COMPARTMENT OVERPRESSURIZATION AND FIRE HAZARD.  
(C,D) POSSIBLE LOSS OF CREW/VEHICLE.

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DISPOSITION & RATIONALE:

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

(A) DESIGN

THE ARRESTER CONSISTS OF FOUR PARTS: A HOUSING THAT CONTAINS TWO DISCS THAT ARE SEPARATED BY A SPACER. EACH DISC HAS A 1.750 INCH O.D., IS 0.500 INCHES THICK, AND CONTAINS APPROXIMATELY SIX THOUSAND 0.017 INCH DIAMETER HOLES THROUGH THE THICKNESS. THE HOUSING IS MACHINED FROM A SINGLE INCONEL 718 BAR AND HAS A MINIMUM 0.040 INCH WALL THICKNESS, THE DISCS ARE OF 304 CRES. THE SPACER IS CONSTRUCTED OF INCONEL X-750. THE TUBE IS CONSTRUCTED OF 21-6-9 CRES, 1 INCH DIAMETER BY 0.020 WALL THICKNESS. THE TUBE IS CONNECTED TO THE HOUSING BY INDUCTION BRAZING.

THE FLAME ARRESTOR ASSEMBLY WAS PROOF PRESSURE TESTED TO 300 PSIG. STRUCTURAL ANALYSIS INDICATES POSITIVE MARGIN OF SAFETY FOR ALL CONDITIONS OF FLAME ARRESTOR OPERATIONS.

(B) TEST

ATP

DISC

FLOW TEST (19 PSIA IN AND 4 PSID MAXIMUM):  
AMBIENT: 0.28 LB/SEC GH2

ASSEMBLY

AMBIENT PROOF (300 PSIG)  
LEAK TEST (150 PSIG)

VERIFICATION

IGNITION TESTING

NINETY-THREE IGNITION TESTS SUCCESSFULLY CHARACTERIZED THE PERFORMANCE OF THE FLAME ARRESTER DESIGN DURING NORMAL AND ADVERSE CONDITIONS. FACTORS MONITORED DURING TESTING WERE PRESSURE DROP, FLAME ARRESTING CAPABILITIES, PLUME CHARACTERISTICS, AND GAS TEMPERATURE EFFECTS ON THE ARRESTER.

VARIED PARAMETERS:

GH2 FLOW (FROM .005 TO .022 LB/SEC)  
GH2/AIR FLOW-AIR/FUEL RATIO OF 40 (.005, .010, .020 LB/SEC GH2)  
GAS TEMPERATURE (-200 DEG F, AMBIENT, +200 DEG F)  
IGNITION ON (BEFORE AND AFTER FLOW INITIATION).  
WIND -  
NONE  
200 KNOTS @ 45 DEG TO FACE  
200 KNOTS NORMAL TO THE ARRESTER FACE)

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ICING TESTS

NASA/JSC CONDUCTED A SERIES OF TESTS TO DETERMINE IF THE ARRESTER COULD BE CLOGGED BY ICE DUE TO THE ORBITER LANDING IN RAIN. BOILOFF GAS FROM A LH2 DEWAR WAS VENTED THROUGH THE ARRESTER (MOUNTED WITH ITS CENTERLINE VERTICAL). AFTER THE ARRESTER WAS THOROUGHLY CHILLED, WATER WAS SPRAYED (THROUGH A MISTING NOZZLE) ONTO THE EXPOSED SURFACE OF THE OUTER DISC, AND THE SURFACE FROZE OVER.

TEST RESULTS WERE:

- FLOW STOPPED DUE TO THE ICING. DUE TO LACK OF CRYO FLOW, THE TEMPERATURE OF THE ARRESTER INCREASED TO THE MELTING TEMPERATURE OF THE ICE.
- MAXIMUM UPSTREAM PRESSURE INCREASE DUE TO THE STOPPED FLOW WAS APPROXIMATELY 60 PSID.
- UNDER THESE CONDITIONS, A PORTION OF THE ICE BLEW OFF, FLOW WAS REESTABLISHED, AND THE AREA ADJACENT TO THE FLOW RECHILLED. AFTER A FEW SECONDS, THE REMAINDER OF THE ICE BLEW OFF. IT WAS THEORIZED THAT THE REESTABLISHED FLOW CREATED A TEMPERATURE GRADIENT WITHIN THE ICE CAUSING IT TO FRACTURE.

OMRSD

V41AYO.020 LH2 EXTERNAL LEAK CHECK (15)

V41BUO.010 ORBITER MPS COMPONENT INSPECTIONS (EVERY FLIGHT)

V41BVO.022 LH2 FLAME ARRESTOR CLEANLINESS VERIFICATION (EVERY FLIGHT)

(C) INSPECTION

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION.

CONTAMINATION CONTROL

CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 400 IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

DETAIL PARTS ARE FABRICATED TO DRAWING SPECIFICATIONS AND VERIFIED BY INSPECTION. CORROSION PROTECTION AND SEALING SURFACES PROTECTION ARE VERIFIED. AT THE DETAIL LEVEL, THE DISCS ARE TESTED FOR FLOW, PRESSURE DROP, AND CLEANLINESS REQUIREMENTS. DIMENSIONS AND TOLERANCES ARE VERIFIED.

CRITICAL PROCESSES

HEAT TREATMENT, WELDING, AND BRAZING ARE VERIFIED. PARTS PASSIVATION AND ELECTROPOLISHING ARE VERIFIED BY INSPECTION. ELECTRICAL BONDING AND TEST (SYSTEM INSTALLATION) PER MA0113-306 CLASS L TYPE I IS VERIFIED BY INSPECTION.

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NONDESTRUCTIVE EVALUATION

RADIOGRAPHIC INSPECTION OF INDUCTION BRAZES IS VERIFIED BY INSPECTION.  
PENETRANT INSPECTION IS VERIFIED.

TESTING

ATP IS VERIFIED BY INSPECTION.

HANDLING/PACKAGING

PACKAGING FOR SHIPMENT IS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

THERE HAVE BEEN NO ACCEPTANCE TEST, QUALIFICATION TEST, FIELD OR FLIGHT  
FAILURES ASSOCIATED WITH THIS FAILURE MODE.

(E) OPERATIONAL USE

NO CREW ACTION CAN BE TAKEN.