

SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM : ATMOSPHERIC REVIT. FMEA NO 06-1B -0640 -1 REV:08/22/88

ASSEMBLY : AIR DUCTS CRIT. FUNC: 2
P/N RI : V070-613XXX CRIT. HDW: 2
P/N RI : ME276-0024 VEHICLE 102 103 104
P/N VENDOR: EFFECTIVITY: X X X
QUANTITY : 1 SET PER VEHICLE PHASE(S): PL LO X OO X DO LS

PREPARED BY: DES N. K. DUONG
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REDUNDANCY SCREEN: A- B- C-
APPROVED BY: DES REL QE
[Handwritten signatures and initials]

ITEM:
DUCT SECTIONS, CABIN SUPPLY AIR

FUNCTION:
PROVIDE SUPPLY AIR FLOW PATH FROM THE OUTLET OF THE HUMIDITY CONTROL HEAT EXCHANGER UP THROUGH THE MIDDECK TO THE FLIGHT DECK DISTRIBUTION DUCTS FOR THE COMMANDER, PILOT, AFT FLIGHT DECK, AND SLEEP SECTIONS. P/N'S V070-613115, 116, 117, 118, 119, 430, 432, 605, 606, 607, 609, 611, 612, 613, 614, 615, 617, 618, 621, 751, 764, 765, 766, 793.

FAILURE MODE:
EXTERNAL LEAKAGE (DUCT PUNCTURE AS WORST CASE)

CAUSE(S):
PUNCTURE, ABRASION, MATERIAL DEFECT

EFFECT(S) ON:
(A) SUBSYSTEM (B) INTERFACES (C) MISSION (D) CREW/VEHICLE

(A) SLIGHT DECREASE IN CABIN FAN DELTA-P.

(B) EFFECT VARIES DEPENDING ON LOCATION AND MAGNITUDE OF THE LEAK. WORST CASE EFFECTS RESULT IN LOSS OF CABIN AVIONICS COOLING.

(C) POSSIBLE EARLY MISSION TERMINATION BASED UPON MAGNITUDE OF LEAK.

(D) NO EFFECT. EARLY MISSION TERMINATION WILL PRECLUDE LOSS OF CREW/VEHICLE.

DISPOSITION & RATIONALE:
(A) DESIGN (B) TEST (C) INSPECTION (D) FAILURE HISTORY (E) OPERATIONAL USE

(A) DESIGN
THE COLLECTION RETURN AND DISTRIBUTION SUPPLY DUCTS ARE RIGID EPOXY/ARAMID SECTIONS NOMINALLY ABOUT 15 INCHES LONG AND PREFORMED TO FIT THE CONTOUR OF THE VEHICLE AT THE INSTALLATION SITE. SECTIONS ARE HARD MOUNTED TO STRUCTURE BY A BRACKET/BAND CLAMP ASSEMBLY. A 0.50 INCH STRESS RELIEF GAP IS PROVIDED BETWEEN DUCT SECTIONS. THIS GAP IS BRIDGED BY FLEXIBLE SILICONE/FIBERGLASS SLEEVES HELD IN PLACE BY BAND CLAMPS AND GROOVES THAT ARE PREFORMED INTO EACH DUCT SEGMENT. DUCT BRANCHES LEADING TO AVIONICS BOXES ARE PREFORMED INTO THE MAIN DUCT SECTIONS OR MOUNTED TO

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THE MAIN DUCTS VIA PREFORMED INTERFACE FITTINGS. DUCTS ARE PROTECTED FROM DAMAGE BY CLOSEOUT PANELS.

FLEXIBLE DUCTS OF SILICONE/FIBERGLASS FABRIC OVER STEEL HELICAL SPRING WIRE ARE USED AS REQUIRED AT THE DUCT/AVIONICS BOX INTERFACE. BAND CLAMPS ARE USED TO HOLD FLEXIBLE DUCTS TO LRU AND RIGID DUCT INTERFACES. FLEXIBLE DUCTS ARE PROTECTED FROM DAMAGE BY CLOSEOUT PANELS.

(B) TEST

RIGID DUCTS:

QUALIFICATION TEST - TESTS OF SIMILAR MATERIAL SHOW THAT RIGID EPOXY/ARAMID DUCTS ARE UNAFFECTED BY HUMIDITY AND TEMPERATURE WITHIN THE LIMITS IMPOSED BY THE CABIN ATMOSPHERE. TENSILE STRENGTH (500 KSI) REMAINED UNCHANGED AFTER EXPOSURE TO 100 PHM OZONE AT 70 F FOR 1000 HOURS. TOLERANCE TO SALINITY WAS DEMONSTRATED BY ANALYSIS BASED ON TESTS OF SIMILAR MATERIAL IN SALT WATER FOR 125 DAYS. TRANSIENT VIBRATIONS, RANDOM VIBRATIONS, AND CRASH LOADS WERE CERTIFIED BY ANALYSIS.

FLEXIBLE DUCTS:

QUALIFICATION TEST - THE SILICONE/FIBERGLASS FLEX DUCTS WERE CERTIFIED BY SIMILARITY AND WERE SHOWN TO WITHSTAND TEMPERATURES FROM -60 F TO 600 F WITHOUT PROBLEMS. NON-NUTRIENT TO FUNGUS DEMONSTRATED BY TEST. SALINITY TOLERANCE DEMONSTRATED BY TEST OF IDENTICAL MATERIAL EXPOSED TO A 20% SALT SOLUTION AT 95 F AND 85% RELATIVE HUMIDITY FOR 50 HOURS WITH NO EFFECT. BURST PRESSURE DEMONSTRATED BY TEST TO BE GREATER THAN 200 PSIG. TRANSIENT AND RANDOM VIBRATIONS WERE CERTIFIED BY TEST OF THE SIMILAR DUCTS AND CRASH LOADS BY ANALYSIS.

ACCEPTANCE TEST - EXTERNAL LEAK TEST AT 0.5 PSIG FOR 5 MINUTES. MAX LEAKAGE 0.005 CFM/INCH DIAMETER/FT LENGTH. PROOF TEST AT 1.0 PSIG FOR 5 MINUTES.

IN-VEHICLE TESTING - SUPPLY AIR FLOW DISTRIBUTION IS MEASURED USING A HOT WIRE ANEMOMETER AT COMPLETION OF ASSEMBLY OF EACH VEHICLE. CABIN FAN DELTA-P IS MONITORED DURING THIS TEST AND THE DELTA-P CAN BE USED AS A REFERENCE POINT TO DETECT MAJOR FLOW RESISTANCE CHANGES IN THE DUCT SYSTEM. DUCT INSTALLATION IS INSPECTED FOR DAMAGE PRIOR TO INSTALLATION OF CLOSEOUT PANELS.

OMRSD - CABIN FAN DELTA-P IS MONITORED DURING EVERY TURNAROUND AND SERVES AS AN INDICATION OF SYSTEM PERFORMANCE/EXTERNAL LEAKAGE.

FLEXIBLE AND HARD DUCTS ARE BEING COMPLETELY INSPECTED PRIOR TO FIRST REFLIGHT OF EACH ORBITER AND ARE ALSO INSPECTED AS AVAILABLE IN CONJUNCTION WITH REMOVAL OF PANELS/LRU'S. DUCTS ARE ALSO INSPECTED DURING PERIODIC PERFORMANAL INSPECTIONS.

OMRSD CHANGE IN WORK TO PERFORM A NEGATIVE PRESSURE TEST ON FLIGHT DECK AVIONICS TO VERIFY MINIMUM PRESSURE REQUIREMENTS.

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(C) INSPECTION

RECEIVING INSPECTION

CERTIFICATION OF MATERIALS AND PROCESSES IS VERIFIED BY INSPECTION.

CONTAMINATION CONTROL

CLEANLINESS REQUIREMENTS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION

INSPECTION VERIFIES THE FOLLOWING: PROCESS REQUIREMENTS RELATIVE TO MATERIALS PREPARATION, FABRICATION OF DUCT SECTIONS (INCLUDING DUCT LENGTH AND WALL THICKNESS) AND CURE CYCLES IN ACCORDANCE WITH REQUIREMENTS, INSTALLATION OF CURED SECTIONS INTO THE DUCT SYSTEM (BONDING, SPLICING, SEAL COATING, INSTALLATION OF CLAMPS, FASTENERS, TAPE AND INSULATION) IN ACCORDANCE WITH DRAWING AND SPECIFICATION REQUIREMENTS.

CRITICAL PROCESSES

CURING IS VERIFIED BY INSPECTION.

TESTING

THE ATP, WHICH INCLUDES LEAK AND PROOF TESTING, EXAMINATION FOR WORKMANSHIP, FINISH AND DIMENSIONAL FEATURES IS VERIFIED BY INSPECTION.

PACKAGING AND HANDLING

PARTS PROTECTION AND HANDLING REQUIREMENTS ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY

THERE IS NO FAILURE HISTORY OF THE RIGID DUCT. THE FLEXIBLE DUCTS HAVE DEVELOPED MINOR LEAKS THAT HAVE BEEN CAUSED BY ABRASION AND PUNCTURE DUE TO INTERFERING WITH THE SURROUNDING STRUCTURE. NONE OF THE LEAKAGE TO DATE HAS RESULTED IN SIGNIFICANT AIR FLOW REDUCTION TO CAUSE OVERHEATING AND SUBSEQUENT FAILURE OF AVIONICS EQUIPMENT. A REDESIGN IS IN PROGRESS WHICH WILL REPLACE THE STEEL SPRING IN THE DUCT WITH A NYLON SPRING AND THE FIBERGLASS SILICON SHEATH WITH ARAMID/SILICON FABRIC. CAR A03187-010, DATED 7/15/87, WAS OPENED AGAINST DUCTS REMOVED DURING COMPLETE INSPECTION OF QV-103 DUCTS. IT REMAINS OPEN PENDING REDESIGN.

(E) OPERATIONAL USE

TBS.