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PRINT DATE: 11/07/88

SHUTTLE CRITICAL ITEMS LIST - ORBITER NUMBER: 06-1B1-0301-X

SUBSYSTEM NAME: AHS COOLING

REVISION : 11/07/88

CLASSIFICATION	NAME	PART NUMBER
LRU :	CABIN FAN & DEBRIS TRAP	MC621-0008-0311
SRU :	FAN	SV755527

QUANTITY OF LIKE ITEMS: 2

DESCRIPTION/FUNCTION:

FAN AND DEBRIS TRAP ASSY - CABIN AIR REVITALIZATION

TWO INDEPENDENTLY CONTROLLED FANS LOCATED IN A COMMON FAN PACKAGE TO CIRCULATE CREW CABIN AIR FOR CO2 AND HUMIDITY REMOVAL, TEMPERATURE CONTROL AND FLIGHT DECK AVIONICS COOLING DURING GROUND AND ORBITAL OPERATIONS. ONE FAN PROVIDES THE REQUIRED FLOW DURING NORMAL OPERATIONS.

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NUMBER: 06-1B1-0301-01

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SUBSYSTEM: ARS COOLING
LRU : CABIN FAN & DEBRIS TRAP
ITEM NAME: FAN

CRITICALITY OF THIS
FAILURE MODE: 1R2

FAILURE MODE:
LOSS OF OUTPUT AIR FLOW, INCLUDING REDUCED FLOW

MISSION PHASE:

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

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

CAUSE:
PHYSICAL BINDING/JAMMING, LOSS OF ELECTRICAL POWER, CONTAMINATION

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

REDUNDANCY SCREEN A) PASS

B) N/A

C) PASS

A)

B)
SCREEN B IS N/A BECAUSE REDUNDANT FAN IS IN STANDBY.

C)

- FAILURE EFFECTS -

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(A) SUBSYSTEM:

LOSS OF ONE REDUNDANT FAN. INTERRUPTION OF AIR FLOW.

(B) INTERFACING SUBSYSTEM(S):

UNTIL CORRECTING ACTION IS IMPLEMENTED, AIR FLOW LOSS RESULTS IN AIR QUALITY DEGRADATION (INCREASED CABIN TEMP, REDUCED CO2 AND WATER REMOVAL), LOSS OF FLIGHT DECK AVIONICS COOLING, AND POSSIBLE LOSS OF SMOKE DETECTION CAPABILITY.

(C) MISSION:

POSSIBLE EARLY MISSION TERMINATION.

(D) CREW, VEHICLE, AND ELEMENT(S):

NO EFFECT.

RATIONALE FOR CRITICALITY:

FUNCTIONAL CRITICALITY EFFECT - SECOND ASSOCIATED FAILURE (LOSS OF REDUNDANT FAN) WILL CAUSE LOSS OF AVIONICS COOLING AND MAY RESULT IN OVERHEATING AND FAILURE OF FLIGHT DECK AVIONICS, POTENTIALLY CAUSING LOSS OF CREW/VEHICLE.

- DISPOSITION RATIONALE -
-----**(A) DESIGN:**

FAN IS AXIAL FLOW TYPE DRIVEN BY A 3 PHASE, 400 HZ, 115 VOLTS/PHASE INDUCTION TYPE ELECTRIC MOTOR. FAN HAS A CYLINDRICAL ALUMINUM HOUSING AND ALUMINUM IMPELLER. THE DESIGN OPERATING LIFE IS 20,000 HOURS MINIMUM. THE FANS ARE RUN TO FAILURE. BEARINGS ARE PRECISION BALL BEARINGS OF THE DEEP GROOVE TYPE AND ARE PRELOADED IN SUCH A MANNER AS TO MINIMIZE THE EFFECTS OF INDUCED ENVIRONMENTS UPON PERFORMANCE OF THE FAN. THE BINDING OF ROTATING PARTS FAILURE CAUSE IS MINIMIZED BY BEARING SELECTION, UPSTREAM FILTRATION AND CLEARANCES BETWEEN ROTATING AND STATIONARY PARTS. THE BEARINGS SELECTED ARE FROM A FAMILY OF BEARINGS WHICH HAVE BEEN OPERATED FOR 120,000 HOURS AND 90% WERE STILL OPERATING AT THE END OF THE TEST (B10 LIFE). BEARING WEAR IS MINIMIZED BY BALANCING THE ROTATING ASSEMBLY ON ITS OWN BEARING TO A REQUIREMENT OF 200 MICRO OUNCE INCHES AND USE OF HIGH LUBRICITY, HIGH TEMPERATURE TOLERANT GREASE, KRYTOX 240AC. THE UPSTREAM FILTER IS 40/70 MICRON WHILE CLEARANCES BETWEEN ROTATING AND STATIONARY PARTS ARE 0.004 INCHES (127 MICRONS). THE MOTOR IS DESIGNED TO MEET A 55C TEMPERATURE RISE. MOTOR WILL CONTINUE TO OPERATE ON TWO PHASES. THE ELECTRICAL DISTRIBUTION SYSTEM DYNAMIC COMPONENTS ARE DERATED SEE PARTS. THE CONNECTORS ARE PER MIL-C-38999.

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(B) TEST:

DURING MANUFACTURING BUILDUP DIELECTRIC WITHSTANDING TEST IS PERFORMED.

ACCEPTANCE TEST - EACH FAN IS BURNED-IN FOR AT LEAST SIX HOURS. DURING ATP THE POWER DRAIN AND POWER FACTOR ARE MEASURED. INSULATION RESISTANCE 100 MEGOHM MINIMUM WITH 500 VDC APPLIED. FAN PERFORMANCE IS VERIFIED FOR AIRFLOW AND DELTA-P WITH THREE PHASE AND TWO PHASE POWER SUPPLY.

QUALIFICATION TEST - FAN PACKAGE ASSEMBLY SUBJECTED TO RANDOM VIBRATION SPECTRUM ENVELOPE OF 20 TO 150 HZ INCREASING AT 6 DB/OCTAVE TO 0.09 G**2/HZ AT 150 HZ, CONSTANT AT 0.09 G**2/HZ FROM 150 TO 900 HZ, DECREASING AT 9 DB/OCTAVE FROM 900-2000 HZ FOR 48 MINUTES PER AXIS IN THREE ORTHOGONAL AXES. DESIGN SHOCK - THREE TERMINAL SAWTOOTH PULSES OF 20 G PEAK AMPLITUDE AND 11 MS DURATION APPLIED IN BOTH DIRECTIONS ALONG EACH OF THREE ORTHOGONAL AXES. SALT SPRAY TEST WITH SOLUTION OF FIVE PARTS OF SALT BY WEIGHT AND 80% RH FOR 120 HOURS, CYCLED BETWEEN 60 AND 120F.

IN-VEHICLE TESTING - FAN PERFORMANCE (ON/OFF) IS VERIFIED IN BOTH MANUAL AND REMOTE MODES, AND DELTA-P IS VERIFIED. THREE PHASE OPERATION IS VERIFIED. FAN WITH LOWER FLOW RATE IS USED TO VERIFY SUPPLY DUCT AIR-FLOW. DELTA-P IS CONTINUALLY MONITORED WHEN VEHICLE IS POWERED UP.

OMRSD - PERFORMANCE OF THE CABIN FANS IS VERIFIED DURING EACH TURNAROUND. THE CABIN FAN DEBRIS TRAP IS INSTALLED ANYTIME THE CABIN FANS ARE OPERATED AND IS CLEANED DURING EVERY TURNAROUND.

(C) INSPECTION:

RECEIVING INSPECTION
RAW MATERIAL VERIFIED.

CONTAMINATION CONTROL
CORROSION PROTECTION PROVISIONS AND CONTAMINATION CONTROL PLAN
VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
PARTS PROTECTION, MANUFACTURING PROCESS, INSTALLATION AND ASSEMBLY
VERIFIED BY INSPECTION. TORQUE VERIFIED BY INSPECTION. LUBRICANT
APPLICATION VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
DYE PENETRANT AND X-RAY OF WELDS IS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
ELECTRICAL TERMINATION VERIFIED BY INSPECTION. WELDING IS VERIFIED BY

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INSPECTION.

TESTING
PERFORMANCE TEST AND CLEANLINESS VERIFICATION CONDUCTED.

HANDLING/PACKAGING
HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
THREE FAN FAILURES HAVE OCCURRED:

(1) CAR A2886-010, 4-6-76. ONE FAN DID NOT START DURING OV101 ALT CHECKOUT. TWO OF THE THREE CIRCUIT BREAKERS IN THE POWER DISTRIBUTION SYSTEM WERE FOUND TO HAVE TRIPPED. THE MALFUNCTION WAS ATTRIBUTED TO SOME PROBLEM WHICH CAUSED ONE POWER PHASE TO TRIP. THEN WHEN THE FAN WAS ACTIVATED THE TWO CIRCUIT BREAKERS RECEIVING POWER TRIPPED. THE ANOMALY DISAPPEARED DURING TROUBLESHOOTING AND THE FAN SUBSEQUENTLY OPERATED PROPERLY. NO CORRECTIVE ACTION; UNEXPLAINED ANOMALY.

(2) CAR AC3235-010, 6-4-82. DURING A CABIN NOISE SURVEY ON OV-102 AFTER STS-3, FAN B WAS FOUND TO BE NOISY. DEBRIS WAS FOUND IN THE FAN HOUSING, NICKS WERE FOUND IN THE IMPELLER BLADE TIPS. THE BEARING ON THE IMPELLER END OF THE SHAFT WAS LIGHTLY BRINELLED. BEARING GREASE WAS ADEQUATE IN AMOUNT AND CONSISTENCY. CAUSE OF THE BRINELLING WAS CONSIDERED TO BE ASSEMBLY DAMAGE AND SHOCK LOADING ON THE BEARING WHEN SOLID DEBRIS PASSED THROUGH THE FAN. BRINELLING OF THE BEARING AND UNBALANCE CAUSED BY DEBRIS BUILDUP ON THE ROTATING PARTS RESULTED IN THE INCREASE IN FAN NOISE, WHICH WAS AMPLIFIED BY THE EFFECTS OF AIR DUCTS AND MOUNTINGS. CORRECTIVE ACTION - NONE; EXISTING FAN MOTOR ASSEMBLY PROCEDURES WERE CONSIDERED ADEQUATE, AND DEBRIS TRAP CLEANING PROCEDURE WAS ADEQUATE. AFTER CAR CLOSEOUT, FILTERS WERE RESIZED (FROM 100 MICRON TO 40/70 MICRON), PRECLUDING CONTAMINATION.

(3) CAR AD0353-010, 10-10-85. DURING OV-099 CHECKOUT, FAN B EXHIBITED ABNORMAL NOISE AND VIBRATION THROUGH ADJACENT STRUCTURE. INVESTIGATION REVEALED IMPELLER BLADE DAMAGE CAUSED BY THE INTRODUCTION OF A FOREIGN OBJECT INTO THE FAN HOUSING. THE OBJECT WAS NEVER FOUND. THE IMPELLER HAD RUBBED A 90 DEGREE ARC ON THE HOUSING. AN ACCUMULATION OF LINT AND OTHER MATERIALS WAS FOUND ON THE INSIDE OF THE IMPELLER BLADE HUB. CORRECTIVE ACTION - NCR 11258 WAS ISSUED TO ESTABLISH CONTAMINATION CONTROL PRACTICE AND PROCEDURES.

(E) OPERATIONAL USE:

1. CREW ACTION
FAN PERFORMANCE DEGRADATION TROUBLESHOOTING AND APPROPRIATE FOLLOW ON PROCEDURES (POWERDOWN).
2. TRAINING
A. CURRENT ECLSS TRAINING COVERS THE GENERIC EFFECT OF THIS FAILURE.

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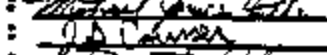
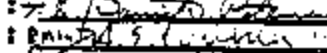
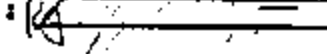

B. CURRENT FDP CONTAINS APPLICABLE CONTINGENCY PROCEDURES FOR THE EFFECT OF THE FAILURE.

3. OPERATIONAL CONSIDERATIONS

- A. REAL TIME DATA SYSTEM ALLOWS FOR GROUND MONITORING.
- B. REFERENCE CURRENT LOSS/FAILURE FLIGHT RULES.
- C. POTENTIAL LOSS OF CO2 CONTROL; USE OF LES MAY BE REQUIRED.

REMARKS:

- APPROVALS -

RELIABILITY ENGINEERING:	W. L. STEISSLINGER:	⁷¹⁸ 
DESIGN ENGINEERING	: N. K. DUONG	
QUALITY ENGINEERING	: D. R. STOICA	
NASA RELIABILITY	:	
NASA DESIGN	:	
NASA QUALITY ASSURANCE	:	