SHUTTLE CRITICAL ITEMS LIST - ORBITER

SUBSYSTEM :COMMUNICATION & TRACKING FMEA NO 05-2R -5300 -7 REV:06/27/88

ASSEMBLY :MIDBODY
P/N RI :MC405-0025-300X
P/N VENDOR:
QUANTITY :1
:ONE
:

CRIT. FUNC: 2
CRIT. HDW: 2

VEHICLE EFFECTIVITY:	102	103	104
	X	X	X

PHASE(S): PL LO OO X DO LS

REDUNDANCY SCREEN: A- B- C-

PREPARED BY:
DES H D HADDAD
REL 7-5-88 J Y HARADA
QE J T COURSEN

APPROVED BY:
DES 2/17/88
REL 7-25-88
QE

APPROVED BY (NASA):
SSM 9/7/88
REL 9/8/88
QE 9/8/88

ITEM:
DA-A, KU-BAND, DEPLOYED ASSEMBLY A (TEMPERATURE SENSOR)

FUNCTION:
PROVIDES TEMPERATURE MONITORING CAPABILITY (NOT PART OF HEATER CONTROL CIRCUIT) FOR THE FOLLOWING: TRANSMITTER HEATER, RECEIVER HEATER, BETA AXIS GIMBAL, ALPHA AXIS GIMBAL, GYRO, AND ANTENNA FEED. DA/40V74A33, TEMPERATURE SENSORS (INTERNAL): V74T2497A, V74T2961A, V74T2969A, V74T2965A, V74T2967A, V74T2963A.

FAILURE MODE:
LOSS OF TEMPERATURE MEASUREMENT

CAUSE(S):
VIBRATION, MECHANICAL SHOCK, CONTAMINATION, MISHANDLING, PIECE-PART STRUCTURAL FAILURE.

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

EFFECTS ON ABILITY TO CONTROL, POSITION, OR LOCK ANTENNA GIMBALS - 1R/3

(A) LOSS OF ABILITY TO MONITOR THE TEMPERATURES. POSSIBLE LOSS OF ABILITY TO LOCK GIMBALS IF TEMPERATURES EXCEED OPERATIONAL LIMITS.

(B) LOSS OF TEMPERATURE MEASUREMENTS TO TELEMETRY SYSTEM.

(C,D)POSSIBLE LOSS OF CREW/VEHICLE AFTER THREE FAILURES (LOSS OF MEASUREMENT, HEATER FAILURE, JETTISON) IF THE DEPLOYED ASSEMBLY CANNOT BE SECURED FOR REENTRY OR JETTISONED. REENTRY WITH GIMBALS UNLOCKED MAY CAUSE DAMAGE TO THE RADIATOR.

EFFECTS ON MISSIONS REQUIRING KU-BAND SYSTEM SUPPORT - 2/2

(A) LOSS OF ABILITY TO MONITOR THE MEASUREMENTS.

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(B) LOSS OF TEMPERATURE MEASUREMENTS TO TELEMETRY SYSTEM.

(C) POSSIBLE LOSS OF MISSION OBJECTIVES REQUIRING KU-BAND IF THE GIMBALS NEED TO BE LOCKED PRIOR TO COMPLETION OF THE MISSION.

(D) NO EFFECT.

EFFECTS ON PROVIDING DATA TO NSP FOR STATE VECTOR UPDATE - 1R/3

(A,B,C,D) LOSS OF ONE OF THREE REDUNDANT PATHS TO SUPPLY DATA TO THE NSP FOR STATE VECTOR UPDATE. UHF PROVIDES AN INDEPENDENT PATH FOR STATE VECTOR UPDATE. AFTER FOUR FAILURES POSSIBLE LOSS OF CREW/VEHICLE DUE TO LOSS OF STATE VECTOR UPDATE. NOTE- A SINGLE FAILURE OF A KU-BAND SPA DASH NUMBER -4001 CAN CAUSE THE LOSS OF POWER TO BOTH NSP'S, RESULTING IN ONLY ONE REMAINING PATH (UHF) TO UPDATE THE STATE VECTOR. THIS FAILURE CAN OCCUR DURING ANY MISSION PHASE. (KU-BAND POWERED ON OR OFF.)

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

(A) DESIGN
ALL EEE PARTS ARE SELECTED FROM OR IN ACCORDANCE WITH MF0004-400 (QPPL) REQUIREMENTS. SUBASSEMBLIES ARE QUALIFIED BY TEST OR USE OF EXISTING DESIGNS QUALIFIED FOR OTHER NASA & MILITARY PROGRAMS. THE DEA IS SEALED AND PRESSURIZED WITH NITROGEN/HELIUM GAS TO PROTECT CIRCUITS AND COMPONENTS FROM DIRECT EXPOSURE TO THE ENVIRONMENT. THE SYSTEM DESIGN INCLUDES A DEPLOYED ASSEMBLY JETTISON CAPABILITY WHICH CAN BE USED IF THE SYSTEM FAILS TO RESPOND TO LOCK OR STOW COMMANDS.

ACCEPTABILITY OF THE DA CERTIFICATION DEVIATIONS REGARDING NON-EXPLOSION PROOF GIMBAL MOTORS AND NON-STANDARD TERMINATIONS IS BASED ON THE FOLLOWING:

THE GIMBAL MOTORS ON THE DEPLOYED ASSEMBLY ARE NOT EXPLOSION PROOF. THESE MOTORS ARE DEACTIVATED WHEN THE GIMBAL IS LOCKED, EVEN WHEN THE KU-BAND EQUIPMENT IS "ON". DURING ON-ORBIT OPERATIONS, THE GIMBAL REMAINS LOCKED, AND THE MOTOR DRIVE INHIBITED UNTIL PAYLOAD DOORS HAVE BEEN FULLY OPENED AND THE DEPLOYED ASSEMBLY DEPLOYED TO ITS OPERATING POSITION, PLACING THE GIMBAL (AND MOTORS) OUTSIDE, AND FORWARD OF, THE PAYLOAD BAY. THE MOTORS, THEREFORE, REPRESENT NO POTENTIAL IGNITION SOURCE, FOR A COMBUSTIBLE ATMOSPHERE, EXCEPT DURING GROUND OPERATIONS WHERE A PRECAUTIONARY NOTE HAS BEEN ADDED TO KSC ORBITER GROUND TEST OMRSD AND KSC SHUTTLE GROUND TEST OMRSD.

THE "WHITE WIRE" FIX FOR THE "200 VOLT" CATHODE REGULATOR CIRCUIT LOCATED IN THE A9A1 PWB IS A "CUT AND JUMPER" FIX INVOLVING 15 CUTS OF COMPONENT LEADS AND ADDING 14 JUMPER WIRES UTILIZING PROCEDURES AND TECHNIQUES SIMILAR TO THOSE USED ELSEWHERE IN THE DEA, EXCEPT THAT COMPONENT LEADS ARE USED FOR SOLDER TERMINALS. THIS WORK INVOLVES "NON-STANDARD" TERMINATIONS PERFORMED DURING REWORK OF THE A9A1 BOARDS AND REQUIRE

QUALIFICATION IN ACCORDANCE WITH THE GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION STANDARD PARTS MOUNTING DESIGN REQUIREMENTS FOR SOLDERED PRINTED WIRING BOARD ASSEMBLIES, MSFC 136, PARAGRAPH 5.5. SINCE THIS TESTING WILL NOT BE PERFORMED, EDCP 168, DETAILING THE NON-STANDARD TERMINATIONS AND REWORK, WAS REVIEWED AND APPROVED BY THE JOINT ROCKWELL/NASA SOLDER WAIVER BOARD. EXTRA PRECAUTIONS AS DEFINED IN EDCP 168 AND THE ASSOCIATED PLANNING WERE EXERCISED DURING REWORK OF ALL UNITS TO INSURE THAT NO PROBLEMS WERE CREATED BY THE REWORK.

DEPLOYED ASSEMBLY S/N 101 WAS SUBSEQUENTLY SUBJECTED TO APPROXIMATELY 307 HOURS EXPOSURE TO THE THERMAL VACUUM ENVIRONMENT DURING SYSTEM TESTING AFTER INCORPORATION OR THE "WHITE WIRE" FIX. NO PROBLEMS RESULTED RELATING TO THE NON-STANDARD TERMINATIONS.

(B) TEST

ACCEPTANCE TESTING OF ALL UNITS INCLUDES EXAMINATION OF PRODUCT, AVT, ACCEPTANCE THERMAL VACUUM TEST (ATVT), LEAK AND FUNCTIONAL TEST. QUAL TEST INCLUDES POWER, EMC, LEAK, BONDING, THERMAL VACUUM, QAVT, QVT, LIFE, SHOCK, HUMIDITY, AND PERFORMANCE AT THE LRU LEVEL. AS A PART OF QUAL TESTING, A SYSTEM TEST WAS PERFORMED WITH THE DA EXPOSED TO A QUAL LEVEL THERMAL VACUUM ENVIRONMENT AND THE EA-1, EA-2, AND SPA COLD PLATE TEMPERATURES CYCLED AT QUAL LEVELS. CERTIFICATION DEVIATIONS ARE REQUIRED FOR THE FOLLOWING: NON-EXPLOSION PROOF GIMBAL MOTORS; HUMIDITY, SALT FOG, AND SAND AND DUST ENVIRONMENTS; AND NON-STANDARD TERMINATIONS (COMPONENT LEADS USED AS TERMINALS) FOR THE DEA TRANSMITTER A9A1 MODULE. INTEGRATED AND SUBSYSTEM VERIFICATION IS PERFORMED AT KSC. SYSTEM DESIGN VERIFICATION TESTS WERE PERFORMED BY THE HUGHES AIRCRAFT COMPANY AT THEIR FACILITY. NASA CONDUCTED INTEGRATED KU-BAND AND TDRSS VERIFICATION TESTS AT THE ESTL (JSC) AND SOFTWARE COMPATIBILITY TEST AT SAIL AND PASSIVE RADAR PERFORMANCE EVALUATION TEST AT WSMR.

THE DA FAILED TO PASS THE HUMIDITY TEST AND WAS NOT SUBJECTED TO THE SALT FOG, AND SAND & DUST TESTS. CERTIFICATION DEVIATION RATIONALE INCLUDES:

1) THE HUMIDITY, SALT FOG, AND SAND & DUST TEST REQUIREMENTS, ARE MUCH MORE SEVERE THAN THE DA WILL BE SUBJECTED TO DURING TRANSPORTATION, INSTALLATION AND OPERATION, INCLUDING LAUNCH AND LANDING, BECAUSE OF ITS PROTECTED LOCATION IN THE PAYLOAD BAY.

2) PAINT PEELING/BLISTERING, AS OCCURRED DURING THE HUMIDITY TEST, CAN BE DETECTED BY NORMAL TURNAROUND INSPECTION IN TIME TO MAKE APPROPRIATE REPAIRS BEFORE ANY SIGNIFICANT DAMAGE CAN OCCUR.

3) WAVEGUIDE CORROSION, AND THE ATTENDANT "HANG-UPS" OF THE DMA WAVEGUIDE SWITCH AND THE POLARIZATION SWITCH, ARE NOT EXPECTED IN THE PAYLOAD BAY ENVIRONMENT. TURNAROUND TESTING WILL DETECT "HANG-UP" PROBLEMS SHOULD THEY OCCUR.

4) THE LOW POWER MONITOR READINGS DURING THE TEST WERE DUE TO MOISTURE IN THE WAVEGUIDE; THIS CONDITION WILL NEVER BE EXPERIENCED DURING TURNAROUND TESTING OR DURING ON-ORBIT OPERATIONS. THE FAILURE OF THE WIDE BEAM POWER MONITOR READING AFTER DRY-OUT WAS INDICATIVE OF EXCESSIVE LOSS IN THE WIDE BEAM ROTARY JOINT WHICH WAS DUE TO A DESIGN DEFICIENCY (LACK OF POWER HANDLING CAPABILITY) OF THE MDL RF ROTARY JOINTS. THE MDL ROTARY JOINTS HAVE BEEN REPLACED BY ITEMS MADE BY KEVLIN WHICH HAVE PASSED ALL QUALIFICATION TESTS INCLUDING HUMIDITY, SALT FOG AND SAND & DUST TESTS AT THE ROTARY JOINT LEVEL.

5) NO ENCODER MALFUNCTION WAS EXPERIENCED DURING THE HUMIDITY TEST BUT AN ANOMALY WAS EXPERIENCED DURING THE WSMR RADAR VERIFICATION TEST DUE TO DUST DEPOSITS ON THE OPTICAL DISK. THE PROBABILITY IS VERY LOW THAT SALT OR DUST DEPOSITS WILL OCCUR DURING ORBITER OPERATIONS DUE TO THE PROTECTED PAYLOAD BAY ENVIRONMENT OF THE DA. TURNAROUND TESTING WILL DETECT ENCODER PROBLEMS SHOULD THEY OCCUR.

6) THE SLIGHT MOTOR CORROSION OBSERVED AFTER THE DA HUMIDITY TEST DID NOT CAUSE A PERFORMANCE PROBLEM SO THE MUCH LESS SEVERE PAYLOAD BAY ENVIRONMENT IS NOT EXPECTED TO RESULT IN ANY PERFORMANCE PROBLEMS.

GROUND TURNAROUND TEST- VERIFY CORRECT HEATER ELEMENT OPERATION- PERFORMED EVERY FLIGHT.

(C) INSPECTION

RECEIVING INSPECTION
RECEIVING INSPECTION VERIFIES INCOMING MATERIALS.

CONTAMINATION CONTROL
CONTAMINATION CONTROL PROCESSES ARE MONITORED BY QE. PRECAUTIONS ARE TAKEN TO PREVENT CONTAMINATION (SMOCKS, GLOVES, HATS, BOOTIES AS REQUIRED ARE WORN, AND EATING & DRINKING ARE PROHIBITED). SIGNS ARE POSTED IDENTIFYING CLEANLINESS REQUIREMENTS IN WORK AREAS.

ASSEMBLY/INSTALLATION
INSPECTION WITNESSES CONTAMINATION CONTROL, SOLDERING, BONDING AND TORQUE OPERATIONS. QE ENSURES WORK TICKETS REFLECT DRAWING AND SPEC REQUIREMENTS. DETAILED INSPECTION IS PERFORMED ON ALL ASSEMBLY AND DETAIL PARTS PRIOR TO NEXT OPERATION PER PROGRAM QUALITY REQUIREMENT AND WORK TRANSFER QUALITY REQUIREMENTS. INSPECTION REQUIREMENTS ARE TRANSMITTED TO OUTSIDE VENDORS, AND COMPLIANCE IS VERIFIED BY SOURCE INSPECTION AND VENDOR SURVEILLANCE. A FORMAL CONNECTOR ASSEMBLY/HANDLING TRAINING COURSE FOR ALL TECHNICIANS AND INSPECTORS WAS IMPLEMENTED IN NOVEMBER, 1986.

CRITICAL PROCESSES
CRITICAL PROCESSES, SUCH AS, SOLDERING AND CRIMPING, ARE CERTIFIED. THE FORMAL CERTIFICATION OF ALL TECHNICIANS AND INSPECTORS FOR CRIMPING OPERATIONS WAS IMPLEMENTED IN NOVEMBER, 1986. ANNUAL VISION TESTS ARE

GIVEN TO INSPECTORS. ALL CRITICAL PROCESSES ARE MONITORED AND VERIFIED BY QC PER PROGRAM QUALITY REQUIREMENT INSTRUCTIONS.

TESTING
INSPECTION VERIFIES ATT/AVT, LEAK AND INSULATION RESISTANCE/DIELECTRIC STRENGTH TESTS. GIMBAL AND DEA RECEIVE THERMAL AND VIBRATION TESTS BEFORE THEY ARE INTEGRATED INTO THE DA WHERE FORMAL ATT/AVT ARE PERFORMED. USE OF NON-SKID TEST PROBES TO MINIMIZE SLIPPAGE WAS IMPLEMENTED IN SEPTEMBER, 1986.

HANDLING/PACKAGING
ALL KITTING, ASSEMBLY, TEST, INSPECTION, TROUBLESHOOTING, AND REWORK OPERATIONS ON STATIC-SENSITIVE DEVICES ARE PERFORMED AT STATIC-SAFE WORK STATIONS AND IN ACCORDANCE WITH PROGRAM INSTRUCTION. HARDWARE ITEMS ARE PACKAGED, PROTECTED, AND INSPECTED PER ENGINEERING DRAWING REQUIREMENTS AND PROGRAM QUALITY REQUIREMENT INSTRUCTIONS.

GROUND TURNAROUND TEST - VERIFY CORRECT HEATER ELEMENT OPERATION-PERFORMED EVERY FLIGHT.

(D) FAILURE HISTORY
POST-ATP FAILURE HISTORY - CAR AD0800-010, S/N 102, DA TEMPERATURE FLUCTUATION CAUSED BY FLEXING OF SOFT COPPER WIRE AND INCORRECT CRIMP-HARDWARE AT KSC, POTTED BACK OF CONNECTOR. FOR ADDITIONAL HARDWARE, SOFT COPPER WIRE REPLACED AND FORMAL CERTIFICATION OF CRIMPING OPERATIONS IMPLEMENTED.

(E) OPERATIONAL USE

WORKAROUND TO REGAIN ABILITY TO CONTROL, POSITION, OR LOCK ANTENNA GIMBALS
IF THE TEMPERATURE MEASUREMENTS ARE LOST, THE ANTENNA GIMBALS WILL BE LOCKED AND THE DA WILL BE STOWED IN ACCORDANCE WITH THE FLIGHT RULE ANNEX.

WORKAROUND TO REGAIN SUPPORT OF MISSION OBJECTIVES
COMM: NONE. RADAR: IF THE TEMPERATURE MEASUREMENTS ARE LOST, THE ANTENNA GIMBALS WILL BE LOCKED AND THE DA WILL BE STOWED IN ACCORDANCE WITH THE FLIGHT RULE ANNEX. IF THE GIMBALS MUST BE LOCKED, ATTEMPT RENDEZVOUS WITH ALTERNATE SENSORS. USE BACK-UP RENDEZVOUS PROCEDURES.

WORKAROUND TO PROVIDE THE STATE VECTOR UPDATE
IF THE TEMPERATURE MEASUREMENTS ARE LOST, THE ANTENNA GIMBALS WILL BE LOCKED AND THE DA WILL BE STOWED IN ACCORDANCE WITH THE FLIGHT RULE ANNEX. IF THE GIMBALS MUST BE LOCKED, THE STATE VECTOR CAN BE UPDATED VIA THE NORMAL S-BAND COMMUNICATIONS LINK OR VIA UHF/AUDIO.