

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 05-2R-5300 -X

SUBSYSTEM NAME: COMMUNICATION & TRACKING

REVISION: 0 06/27/88

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
	: MIDBODY	
LRU	: KU-BAND DA-A	MC409-0025-300X

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

FOR 05-2R-5300-1, 05-2R-5300-2, 05-2R-5300-3, 05-2R-5300-4, AND 05-2R-5300-5:
 DA-A, KU-BAND, DEPLOYED ASSEMBLY A

FOR 05-2R-5300-6:
 DA-A, KU-BAND DEPLOYED ASSEMBLY A (THERMOSTATS)

FOR 05-2R-5300-7:
 DA-A, KU-BAND DEPLOYED ASSEMBLY A (TEMPERATURE SENSOR)

REFERENCE DESIGNATORS: 40V74A33

QUANTITY OF LIKE ITEMS: 1
 ONE

FUNCTION:

FOR 05-2R-5300-1, 05-2R-5300-2, 05-2R-5300-3, 05-2R-5300-4, AND 05-2R-5300-5:
 DOWN-CONVERTS TO "IF" SIGNAL, A RECEIVED TDRSS FORWARD LINK SIGNAL OR
 RETURNED SIGNAL FROM A RADAR TARGET AND PROVIDES FINAL FREQUENCY UP-
 CONVERSION AND RF AMPLIFICATION FOR ALL COMM & RADAR TRANSMISSIONS.
 PERFORMS RF SWITCHING FUNCTIONS RESPONDS TO ANTENNA DRIVE SIGNALS,
 PROVIDES OUTPUT DEFINING ANTENNA POSITION AND ANGULAR RATES OF CHANGE,
 AND SUPPORTS RADAR SELF-TEST. PROVIDES INDICATION THAT GIMBALS ARE
 LOCKED (BOOM STOW II).

FOR 05-2R-5300-6:
 PROVIDE TEMPERATURE CONTROL OF THE FOLLOWING: GYRO, ANTENNA FEED, BETA
 AXIS GIMBAL, ALPHA AXIS GIMBAL, TRANSMITTER HEATER, AND RECEIVER HEATER.

FOR 05-2R-5300-7:

**FAILURE MODES EFFECTS ANALYSIS (FMEA) --CIL HARDWARE
NUMBER: 05-2R-5300-X**

PROVIDES TEMPERATURE MONITORING CAPABILITY (NOT PART OF HEATER CONTROL CIRCUITS) 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.

SHUTTLE CRITICAL ITEMS LIST - ORBITER

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ASSEMBLY : MIDBODY				
P/N RI : MC409-0025-300X				CRIT. FUNC: 1R
P/N VENDOR:				CRIT. HDW: 2
QUANTITY : 1	VEHICLE	102	103	104
: ONE	EFFECTIVITY:	X	X	X
:	PHASE(S):	PL LQ	OO X DO	LS

REDUNDANCY SCREEN: A-PASS B-PASS C-PASS

PREPARED BY:	APPROVED BY:	APPROVED BY (NASA):
DES H D HADDAD	DES <i>[Signature]</i> 8/27/88	DES <i>[Signature]</i> 9/9/88
REL <i>[Signature]</i> 7-5-88 J Y HARADA	REL <i>[Signature]</i> 8-30-88	REL <i>[Signature]</i> 9/7/88
QE J T COURSEN	QE <i>[Signature]</i>	QE <i>[Signature]</i> 9/8/88

ITEM:
 DA-A, KU-BAND, DEPLOYED ASSEMBLY A

FUNCTION:
 DOWN-CONVERTS TO "IF" SIGNAL, A RECEIVED TDRSS FORWARD LINK SIGNAL OR A RETURNED SIGNAL FROM A RADAR TARGET AND PROVIDES FINAL FREQUENCY UP-CONVERSION AND RF AMPLIFICATION FOR ALL COMM & RADAR TRANSMISSIONS. PERFORMS RF SWITCHING FUNCTIONS, RESPONDS TO ANTENNA DRIVE SIGNALS, PROVIDES OUTPUTS DEFINING ANTENNA POSITION AND ANGULAR RATES OF CHANGE, AND SUPPORTS RADAR SELF-TEST. PROVIDES INDICATION THAT GIMBALS ARE LOCKED (BOOM STOW II). 40V74A33.

FAILURE MODE:
 LOSS OF OUTPUT, ERRATIC OPERATION, INADVERTENT OPERATION, ERRONEOUS OUTPUT

CAUSE(S):
 VIBRATION, TEMPERATURE, 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/2

(A,B) LOSS OF ABILITY TO LOCK GIMBALS, REAL-TIME DECISION REQUIRED TO PERFORM IN-FLIGHT MAINTENANCE PROCEDURE WITH EVA OR JETTISON THE DEPLOYED ASSEMBLY.

(C,D) POSSIBLE LOSS OF CREW/VEHICLE AFTER TWO FAILURES IF DA 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,B,C) LOSS OF ALL MISSION OBJECTIVES REQUIRING KU-BAND COMM DATA

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PROCESSING OR RENDEZVOUS RADAR.

(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 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 DMF0004-400 (OPPL) 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

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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 OF THE "WHITE WIRE" FIX. NO PROBLEMS RESULTED RELATING TO THE NON-STANDARD TERMINATIONS.

CONFIGURATION - ALL LRU'S ARE OF THE LATEST DASH NUMBER CONFIGURATION WITH THE FOLLOWING EXCEPTIONS - S/N 105 (-3006 CONFIGURATION) HAS THE 56 WATT HEATERS AND DOES NOT HAVE ATOMIC OXYGEN PROTECTION FOR THE THERMAL BLANKETS. S/N 103 (-3006 CONFIGURATION) HAS THE 56 WATT HEATERS AND DOES NOT HAVE ATOMIC OXYGEN PROTECTION FOR EITHER THE THERMAL BLANKETS OR THE ANTENNA REFLECTOR.

(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, EK-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 DMG WAVEGUIDE SWITCH AND THE POLARIZATION SWITCH, ARE NOT EXPECTED IN THE

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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 - DEPLOY AND STOW ANTENNA TO VERIFY THAT GIMBALS UNLOCK/LOCK AND BSI AND BSII INDICATE CORRECTLY ON TM AND VERIFY ENCODERS INDICATE CORRECT STOP LOCATIONS. PERFORM RADAR SELF-TEST. VERIFY FORWARD LINK OPERATION BY RECEIVING GROUND COMMAND TO CHANGE STEERING MODE. VERIFY RETURN LINK OPERATION BY FRAME SYNC INDICATION OF 192 KBPS AT C&T STATION. VERIFY RADAR TRACKING OPERATION BY TRACKING CEILING OF OFF. IN COMM MODE MEASURE RF POWER AND IN RADAR MODE VERIFY THAT RF POWER RESPONDS CORRECTLY TO HIGH, MEDIUM AND LOW PANEL COMMANDS. VERIFY TWT TURNS OFF WHEN ENTERING OBSCURATION ZONE. VERIFY CORRECT HEATER ELEMENT OPERATION. INSPECT DA REFLECTOR & THERMAL BLANKET FOR ATOMIC OXYGEN DAMAGE - 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

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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.

(D) FAILURE HISTORY

POST-ATP FAILURE HISTORY - CAR 08F008-010, S/N 102, LOST ENCODER COUNTS - INSPECTION AND CLEANING PROCEDURES WERE IMPROVED. CAR 09F020-010, S/N 104, AND 11F003-010, S/N 103, TWT FAILED TO TURN ON - DESIGN CHANGED. CAR 09F021-010, S/N 104, GYRO HEATER STUCK ON; TRANSISTOR LEAD FOUND WITH NICKED CONFORMAL COATING, SHORT TO GROUND WOULD CAUSE CONDITION - REDESIGN USES 18 WATT HEATER (S/N 103 AND S/N 104 HAVE 56 WATT HEATERS). CAR 11F021-010 AND 13F101-010, S/N 103, FAILED TO ACQUIRE DUE TO EXTERNAL INTERFERENCE. CAR 17F007-010, S/N 103, LOST CONTROL OF BETA AXIS DUE TO SHORT CAUSED BY LOOSE SCREW - POSITIVE LOCKING ADDED. CAR 23F008-010, S/N 102, LOST CONTROL OF ANTENNA DUE TO SHORT OF LVPS CAUSED BY EXTRA WASHER - CONFORMAL COATING ADDED. AD0443-010, S/N 105 EXCESSIVE ALPHA AXIS LIMIT CYCLES (GROUND TEST AT KSC UNDER 1G CONDITION) - TEST AND ANALYSIS INDICATE THIS IS NOT A FLIGHT PROBLEM. CAR AD0236-010, S/N 101, LOST ENCODER COUNTS, DUE TO DUST ON OPTICAL DISK, ADDITIONAL TESTING AT KSC TO DETECT FAILURE. 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.

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(E) OPERATIONAL USE

WORKAROUND TO REGAIN ABILITY TO CONTROL, POSITION, OR LOCK ANTENNA
GIMBALS

REAL-TIME DECISION REQUIRED TO PERFORM THE GIMBAL LOCK IN-FLIGHT
MAINTENANCE PROCEDURE WITH EVA OR TO JETTISON THE DA.

WORKAROUND TO REGAIN SUPPORT OF MISSION OBJECTIVES

COMM: NONE. RADAR: ATTEMPT RENDEZVOUS WITH ALTERNATE SENSORS. USE BACK-
UP RENDEZVOUS PROCEDURES.

WORKAROUND TO PROVIDE THE STATE VECTOR UPDATE

THE STATE VECTOR CAN BE UPDATED VIA THE NORMAL S-BAND COMMUNICATIONS LINK
OR VIA UHF/AUDIO.