

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE

NUMBER: 03-1-0427 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 1 02/22/01

PART DATA

	PART NAME	PART NUMBER
	VENDOR NAME	VENDOR NUMBER
LRU	: SENSOR, ET LH2 BF GOODRICH	MC432-0205-0013 (OR EQUIVALENT ET P/N)
LRU	: SENSOR, ET LO2 BF GOODRICH	MC432-0205-0019 (OR EQUIVALENT ET P/N)
LRU	: ELECTRONICS BF GOODRICH	MC432-0205-0021
LRU	: SENSOR, ORBITER BF GOODRICH	MC432-0205-0027

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:

SENSORS AND ELECTRONICS, LO2/LH2 POINT LEVEL, ECO.

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1

FUNCTION:

THIS SYSTEM PROVIDES A MEANS OF MONITORING THE PROPELLANT LEVEL IN THE LO2/LH2 EXTERNAL TANKS DURING LOADING AND ASCENT. POINT SENSOR TRANSDUCERS ARE LOCATED IN THE ET AND ON THE ORBITER (LO2 17-INCH FEEDLINE) WITH SIGNAL CONDITIONING ELECTRONICS ON THE ORBITER TO MONITOR AND CONTROL LOADING AND DRAINING OF PROPELLANTS. SENSORS ARE REDUNDANT AT ALL CRITICAL LEVELS.

FOUR SENSORS IN THE ORBITER LO2 FEEDLINE AND FOUR IN THE BOTTOM OF THE ET LH2 TANK PROVIDE A SAFE BACKUP SSME CUTOFF SIGNAL TO PRECLUDE ENGINE PROPELLANT STARVATION, IN CASE A GUIDED (VELOCITY) MECO IS NOT ATTAINED. THE ECO LOGIC IS ARMED WHEN THE CALCULATED TOTAL PROPELLANT MASS REMAINING REACHES 32,000 LBS OR UPON SECOND ENGINE FAILURE FOLLOWING SRB SEPARATION. ANY TWO QUALIFIED LH2 OR LO2 DRY SENSORS WILL GENERATE A MECO COMMAND AFTER THE SYSTEM IS ARMED.

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LRU: LH2/LO2 LIQUID LEVEL SENSOR

ITEM NAME: LH2/LO2 LIQUID LEVEL SENSOR

CRITICALITY OF THIS

FAILURE MODE: 1/1

FAILURE MODE:

LOSS OF OUTPUT - FALSE WET LEVEL SENSOR SIGNALS (LCC DECEPTION).

MISSION PHASE:

PL PRE-LAUNCH

LO LIFT-OFF

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102 COLUMBIA

103 DISCOVERY

104 ATLANTIS

105 ENDEAVOUR

CAUSE:

OPEN/SHORT CIRCUIT IN LEVEL SENSOR CIRCUITS, FAILURE OF POINT SENSOR ELECTRONICS BOX

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN

A) N/A

B) N/A

C) N/A

PASS/FAIL RATIONALE:

A)

B)

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

THE GROUND SYSTEM INTEGRATES WET/DRY SIGNALS FROM THE CONTROL SENSOR (NORMALLY 100% NO. 1) TO GENERATE A PERCENT WET INDICATION WHICH IS USED TO CONTROL THE FACILITY REPLENISH FLOW RATE. A FALSE WET SIGNAL WOULD SHIFT THE PERCENT WET INDICATION MORE WET, CAUSING THE REPLENISH ALGORITHM TO REDUCE THE REPLENISH FLOW RATE.

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THE FLIGHT LEVEL LCC MONITORS FOR ONE OF TWO 100% SENSORS WITHIN THE REPLENISH CONTROL BAND, OR FOR THE 100+ SENSOR PERCENT WET MAXIMUM LIMIT AND 100- SENSOR PERCENT WET MINIMUM LIMIT AT TERMINATION OF REPLENISH TO VERIFY FLIGHT PROPELLANT LOAD. DETECTION OF A FAILED CONTROL SENSOR AND SWITCH IN OF THE BACKUP SENSOR IS A MANUAL OPERATION.

THIS FAILURE SCENARIO ASSUMES AN INTERMITTENT WET SIGNAL WHICH DRIVES THE PERCENT WET INDICATION HIGH (BUT UNDER THE MAXIMUM LCC LIMIT). IF THE FAILED SENSOR WERE LEFT IN CONTROL OF THE REPLENISH ALGORITHM INDEFINITELY, ACTUAL TANK PROPELLANT LEVEL WOULD DROP. ADDITIONALLY, THE SPURIOUS PERCENT WET INDICATION ERRONEOUSLY SATISFIES THE FLIGHT LEVEL LCC.

(B) INTERFACING SUBSYSTEM(S):

SAME AS A.

(C) MISSION:

UNDETECTED PROPELLANT UNDERLOAD COULD RESULT IN PREMATURE MECO PRIOR TO INTACT ABORT CAPABILITY. POSSIBLE LOSS OF CREW/VEHICLE.

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

SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:

NONE.

-DISPOSITION RATIONALE-

(A) DESIGN:

THE POINT SENSOR TRANSDUCERS UTILIZE 0.0005 INCH DIAMETER PLATINUM WIRE SENSING ELEMENTS MOUNTED ON A CERAMIC FRAME. THE ORBITER TRANSDUCER (LO2 ECO) HAS TWO SENSING ELEMENT ASSEMBLIES CONTAINED WITHIN A FLANGE- MOUNTED HOUSING (304 CRES) AND CONTAINS ONE ELECTRONIC CONNECTOR. THE ET TRANSDUCERS HAVE ONE SENSING ELEMENT ASSEMBLY IN A HOUSING WHICH IS MOUNTED ON MASTS AND ON THE LH2 SIPHON ASSEMBLY (BAFFLE) WITHIN THE LH2/LO2 TANKS. THE ET SENSOR USES A 356-T6 ALUMINUM INVESTMENT CASTING HOUSING WHICH IS TEFLON COATED ON THE INTERIOR TO ASSIST SYSTEM PERFORMANCE.

A SINGLE POINT SENSOR ELECTRONICS BOX IS HOUSED IN THE AFT AVIONICS BAY #5 ON A COLD PLATE. THE BOX HOUSING IS MADE OF DIP BRAZED 6061-T6 ALUMINUM. THE BOX CONTAINS A SERIES OF PRINTED CIRCUIT BOARDS WHICH ARE PLUGGED INTO A MOTHER BOARD. FLEX CIRCUITS INTERCONNECT THE PRINTED CIRCUIT BOARDS WITH THE INTERFACE ELECTRICAL CONNECTORS. THE BOX CONTAINS 14 SIGNAL CONDITIONING

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BOARDS, 2 POWER SUPPLY BOARDS, AND 1 CHECKOUT COMMAND ISOLATION BOARD. EACH SIGNAL CONDITIONING BOARD HAS ONE HYDROGEN AND ONE OXYGEN SIGNAL CONDITIONING CIRCUIT. PHYSICAL AND ELECTRICAL ISOLATION FOR EACH SIGNAL CONDITIONING CIRCUIT IS MAINTAINED.

EACH POWER SUPPLY BOARD HAS 2 SECTIONS. EACH SECTION CONVERTS VEHICLE 28 VDC POWER TO 14.5 VDC AND 12 VDC. VEHICLE POWER FROM THE THREE MAIN BUSES IS DISTRIBUTED TO THE POINT SENSOR ELECTRONICS POWER SUPPLIES. LOSS OF ANY ONE BUS WILL RESULT IN THE LOSS OF NO MORE THAN ONE POWER SUPPLY BOARD. EACH POWER SUPPLY POWERS A GROUP OF SIGNAL CONDITIONING BOARDS. POWER IS DISTRIBUTED WITHIN THE BOX SO THAT ADJACENT SENSORS UTILIZE DIFFERENT POWER SUPPLIES.

SIGNALS FOR GROUND CHECKOUT ARE DISTRIBUTED THROUGH OPTICAL ISOLATION CIRCUITS ON THE CHECKOUT COMMAND ISOLATION BOARD. GROUND CHECKOUTS ARE PERFORMED PRIOR TO AND DURING PROPELLANT LOADING OPERATIONS. SENSOR CABLE AND CONNECTOR RESISTANCES ARE VERIFIED DURING OPF CHECKS.

VEHICLE CABLING/CONNECTORS ROUTING MAINTAINS CIRCUIT ISOLATION. SIX INTERFACE ELECTRICAL CONNECTORS ARE INSTALLED ON THE HOUSING. TWO ARE USED FOR ATP CHECKOUT AND THE REMAINING FOUR ARE USED FOR OPERATIONAL FUNCTIONS. THE SYSTEM IS DESIGNED TO PROVIDE A WET SIGNAL FOR THE PREDOMINANT FAILURE MODES (PREVENT OVERFILLING OF ET TANKS AND PREMATURE MECO). EACH CRITICAL SENSING LOCATION HAS TRANSDUCERS LOCATED TO PROVIDE EITHER VERTICAL OR HORIZONTAL REDUNDANCY (BY LOCATION).

THE POINT SENSOR ELECTRONICS BOX IS BUILT USING EEE COMPONENTS SCREENED TO MIL-STD-883 LEVEL B REQUIREMENTS. ALL EEE COMPONENTS WERE SELECTED SO THAT THEIR USAGE MEETS THE SHUTTLE DERATING REQUIREMENTS.

(B) TEST:

ATP - ELECTRONICS BOX

EXAMINATION OF PRODUCT
DIMENSIONAL
WEIGHT
TRACEABILITY RECORDS

ELECTRICAL CHARACTERISTICS
DIELECTRIC STRENGTH
INSULATION RESISTANCE

PERFORMANCE @ 28 VDC, 24 VDC, AND 32 VDC INPUT POWER
INVERSE VOLTAGE PROTECTION
CURRENT CONTROLLERS
WET/DRY TRIGGER LEVEL
POWER CONSUMPTION
OUTPUT SIGNAL PERFORMANCE
BUILT IN TEST EQUIPMENT (BITE) - OPERATION

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THERMAL CYCLE

+70 DEG F TO -60 DEG F TO +160 DEG F TO +70 DEG F
REPEAT PERFORMANCE TEST AT EACH TEMPERATURE

VIBRATION

RANDOM - FOR 30 SECONDS IN EACH OF THREE AXES

LEAKAGE - 15PSIG GHE

ATP - SENSORS

EXAMINATION OF PRODUCT

DIMENSIONS
WEIGHT
TRACEABILITY RECORDS

ELECTRICAL CHARACTERISTICS

DIELECTRIC STRENGTH
INSULATION RESISTANCE

THERMAL SHOCK (7 CYCLES)

AMBIENT (DRY GN2) TO LN2 TO AMBIENT

PERFORMANCE - LN2

RESPONSE (WET TO DRY) REPEAT 5 TIMES

PROOF PRESSURE (ORBITER UNIT; FLANGE AND CONNECTOR)

390 PSIG FOR 5 MINUTES

LEAKAGE (ORBITER UNIT; FLANGE AND CONNECTOR)

CRYO: 200 PSIG GHE @ -320 DEG F

D.C. RESISTANCE (SENSOR ELEMENT)

CERTIFICATION

RANDOM VIBRATION (POWER ON)

ELECTRONICS BOX - 48 MINUTES IN EACH OF 3 AXES
ET SENSORS - 3 MINUTES IN EACH OF 3 AXES IN LHE
- 3 MINUTES IN EACH OF 3 AXES IN LN2
ORBITER SENSOR - 48 MINUTES IN EACH OF 3 AXES IN LN2
ELECTRONICS BOX (QAVT) - 5 MINUTES IN EACH OF 3 AXES

RANDOM VIBRATION (POWER OFF)

ET SENSORS - LH2 3 MINUTES IN EACH OF 3 AXES @ 360 DEG F
- LO2 3 MINUTES IN EACH OF 3 AXES @ 500 DEG F

SINUSOIDAL (ELECTRONICS BOX AND ORBITER SENSOR)

5 TO 35 HZ

MECHANICAL SHOCK (MIL-STD-810)

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DESIGN

ELECTROMAGNETIC COMPATIBILITY (ELECTRONICS BOX ONLY)
CONDUCTED AND RADIATED INTERFERENCE AND SUSCEPTIBILITY PER MIL-STD-462

THERMAL CYCLE (ELECTRONICS BOX ONLY) - 40 CYCLES
AMBIENT TO +165 DEG F TO -65 DEG F TO +165 DEG F TO AMBIENT
PERFORM ATP PERFORMANCE TEST @ EACH TEMPERATURE EVERY 10 CYCLES

PERFORMANCE

ELECTRONICS BOX - REPEAT ATP PERFORMANCE TEST
ET SENSORS

LO2 UNIT - REPEAT ATP PERFORMANCE IN LO2
LH2 UNIT - REPEAT ATP PERFORMANCE IN LH2

ORBITER SENSORS

PERFORM RESPONSE FLOW TEST IN 6 INCH DIAMETER PIPE WITH
LO2 - REPEAT 5 TIMES

SENSOR

VERIFY UNIT RESISTANCES
EXPOSURE TO HIGH VELOCITY FLUID

ORBITER - 27 FT/SEC LN2

ET - 3 FT/SEC LN2

EXPOSURE TO HIGH PRESSURE

ORBITER (LO2) - 260 PSIA

ET (LO2) - 75 PSIA

ET (LH2) - 50 PSIA

SENSOR INTEGRATED SYSTEMS TEST (IN LH2/LO2)

RAISE AND LOWER FLUID PAST SENSOR CLUSTERS TO SIMULATE ET
FILLING AND DRAINING OPERATIONS

ORBITER SENSORS

TERMINAL DRAIN FLOW TEST IN LO2 USING 17 INCH O.D. LINE AND
SIMULATED VEHICLE (ET/ORB) CONFIGURATION. VERIFY SENSORS
PERFORMANCE

EXPLOSIVE ATMOSPHERE (SENSORS)

LH2 UNIT - GH2/AIR MIXTURE @ 160 DEG F FOR 2 MINUTES USING 12 VDC

LO2 UNIT - (ET) GO2 @ 500 DEG F AND 25 PSIG

(ORB) GO2 @ 200 DEG F AND 25 PSIG

SENSING ELEMENTS POWERED WITH 14.5 VDC

OPERATING LIFE

ORBITER ELECTRONICS BOX

600 HOURS TOTAL (POWER ON)

300 CYCLES - 2 HOURS POWER ON; 1 HOUR POWER OFF

50 CYCLES - AMBIENT TO VACUUM

PERFORM POST TEST BOX CHECKOUT WITH CHECKOUT
COMMANDS ONCE EACH DAY

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ET SENSORS (TEST FLUID: LN2/LH2)
19 HOURS OF 1 MINUTE WET AND 1 MINUTE DRY CYCLES; WARM UP
TO AMBIENT EVERY 6 HOURS. LAST CYCLE WARM UP TO 500 DEG F
(LO2 UNIT), 360 DEG F (LH2 UNIT)
ORBITER SENSORS (TEST FLUID LN2)
62.5 HOURS OF 1 MINUTE WET AND 1 MINUTE DRY CYCLES; WARM
UP TO AMBIENT EVERY 6 HOURS. LAST CYCLE WARM UP TO 200
DEG F.

BURST (ORBITER SENSOR - FLANGE AND CONNECTOR)
440 PSIG

OMRSD
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION

RAW MATERIALS ARE VERIFIED FOR MATERIALS AND PROCESS CERTIFICATION.
CERTIFICATES AND RECEIVING RECORDS ARE MAINTAINED FOR VERIFICATION. SAMPLING
TESTS ARE PERFORMED ON ELECTRONIC PARTS PER DRAWING REQUIREMENTS.

CONTAMINATION CONTROL

CLEANLINESS LEVELS OF SENSORS ARE VERIFIED TO 400 FOR LH2 UNITS AND 800A FOR
LO2 ET UNITS AND THE WETTED PORTION OF THE ORBITER LO2 ECO SENSORS.

ASSEMBLY/INSTALLATION

ALL SOLDERING IS INSPECTED TO NHB5300.4 (3A) REQUIREMENTS. ALL DIMENSIONAL,
FINISHES AND TORQUE INSTALLATION REQUIREMENTS ARE VERIFIED. ALL SENSOR
ELEMENT WELDS ARE INSPECTED WITH 7.5X MAGNIFICATION; SAMPLE WELDS ARE
VERIFIED BY PULL TESTS. THE WELD ATTACHMENTS TO THE ELECTRICAL CONNECTOR
PINS ON THE ORBITER SENSOR ARE 100% PULL TESTED. CONTINUITY OF SENSOR
SUBSTRATE ELEMENT GOLD PATHS IS VERIFIED. WIRE TO TERMINAL POST WRAP IS
CHECKED WITH 7.5X MAGNIFICATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN
THE ASSEMBLY PROCEDURE.

CRITICAL PROCESS

BRAZED AND WELDED SENSING WIRE TERMINATIONS ARE INSPECTED IN COMPLIANCE
WITH DRAWING REQUIREMENTS. SWAGED TERMINAL POSTS OVER TERMINAL WASHERS
ARE VERIFIED PER REQUIREMENT. ELECTRON BEAM WELDING IS VERIFIED ON ORBITER
SENSOR HOUSING. ELECTRO CHEM-ETCH PROCESS IS VERIFIED.

NONDESTRUCTIVE EVALUATION

HELIUM LEAK DETECTION IS CONDUCTED ON ELECTRONICS BOX AND ORBITER SENSOR
HOUSINGS. RADIOGRAPHIC AND DYE PENETRANT OF EB WELDS ARE VERIFIED.

TESTING

ATP IS PERFORMED AND VERIFIED BY INSPECTION.

HANDLING/PACKAGING

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PARTS PACKAGED AND PROTECTED TO APPLICABLE REQUIREMENTS ARE VERIFIED. SPECIAL HANDLING PER DOCUMENTED INSTRUCTIONS IS VERIFIED TO PRECLUDE DAMAGE, SHOCK AND CONTAMINATION DURING HANDLING/SHIPPING/PACKAGING BETWEEN WORK STATIONS.

(D) FAILURE HISTORY:

EARLY PRODUCTION VERSIONS OF POINT SENSOR TRANSDUCERS SUFFERED OPEN CIRCUITS DUE TO WELDING PROBLEMS. FOUR FAILURES OCCURRED AT THE SENSING WIRE WELD JUNCTIONS (REFERENCE CAR A5872 AND A5838 AT THE SUPPLIER; CAR AB6152 AT MPTA AND CAR AC4210 AT MARTIN MARIETTA). TWO OTHER FAILURES OCCURRED AT THE SUPPLIER ON THE LOX ECO SENSOR NICKEL RIBBON WELD ATTACHMENT (REFERENCE CAR AB7600 AND AB8336). CORRECTIVE ACTION TAKEN ON LATER SENSOR CONFIGURATIONS FOR ALL VEHICLES INCLUDED IMPROVED WELDING TECHNIQUES, WELD EQUIPMENT, SCREENING AND WELD SAMPLING.

EARLY SUPPLIER PRODUCTION UNITS HAD FALSE WET SIGNALS DUE TO USE OF INCORRECTLY SIZED CURRENT CONTROLLER CIRCUIT RESISTORS FOR LOW TEMPERATURE (REFERENCE CAR A5498). THE CIRCUIT RESISTORS WERE MODIFIED ON ALL UNITS.

EARLY PRODUCTION SENSORS HAD ENCOUNTERED A SERIES OF BROKEN SENSING ELEMENTS DUE TO EXCESSIVE WIRE TENSION (REFERENCE CAR A9753 AND AB0195 DURING QUALIFICATION TESTS; A5179 AT SUPPLIER; AB7231, AB7230 MPTA; AND AB8051 AT MCC). ALL VEHICLES' SENSORS WERE CHANGED TO UTILIZE LOWER WIRE TENSION.

ONE FALSE WET SIGNAL OCCURRED DURING THE SUPPLIER ATP VIBRATION TEST DUE TO A COLD SOLDER JOINT IN A POINT SENSOR ELECTRONICS BOX (REFERENCE CAR AC5955). THIS PROBLEM IS NOT ALWAYS DETECTABLE DURING VISUAL INSPECTION; HOWEVER, THE ATP SCREENING TEST IS USED TO IDENTIFY THIS OCCURRENCE. NO CORRECTIVE ACTION WAS TAKEN OTHER THAN PRECAUTIONARY OPERATOR NOTIFICATION.

DURING SUPPLIER ATP TESTING, LOW RESISTANCE BETWEEN THE SENSING CIRCUIT AND THE TRANSDUCER HOUSING OCCURRED DUE TO OPERATOR ERROR, MANUFACTURING DEFECTS AND EXCESSIVE MOISTURE IN THE TEST FIXTURE (REFERENCE CAR A6328, A7564, A6163, A8619 AND AC4846). CORRECTIVE ACTION INCORPORATED IMPROVED MANUFACTURING, SCREENING AND TEST PROCEDURES.

TWO SENSORS ENCOUNTERED TEFLON DEBONDING ON THE HOUSINGS (REFERENCE CAR AB6854 AT MPTA AND AB7544 (ET) AT KSC). CORRECTIVE ACTION TAKEN FOR ALL VEHICLES INCLUDED REMOVAL OF THE TEFLON COATING ON THE ORBITER LOX ECO SENSORS AND USE OF A DIFFERENT PROCESS SUPPLIER FOR THE ET SENSOR TEFLON COATINGS PLUS IMPROVED QUALITY CONTROL.

OPEN CIRCUITS OF THE LOX ECO POINT SENSOR TRANSDUCERS OCCURRED DUE TO USE OF MOLYBDENUM/RHENIUM SENSING WIRE WHICH OXIDIZED IN AN OXYGEN ATMOSPHERE (REFERENCE CAR'S AB6852 AND AB6853 AT MPTA AND AB5397, AB6613 AT KSC). CORRECTIVE ACTION FOR ALL VEHICLES CHANGED THE SENSING ELEMENTS TO PLATINUM.

DURING CHECKOUT OF POINT SENSOR ELECTRONICS BOX ON OV-102 (STS-2) AT KSC, FALSE LOX ECO WET SIGNALS OCCURRED DUE TO USE OF RESISTORS SIZED FOR

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MOLYBDENUM/RHENIUM SENSING WIRE (REFERENCE CAR AB8685). ALL BOXES WERE MODIFIED TO UTILIZE RESISTORS SIZED FOR USE WITH PLATINUM SENSING WIRES.

TEST INDUCED/OPERATOR ERROR PROBLEMS

SIX TRANSDUCER OPEN CIRCUITS OCCURRED DURING EARLY SUPPLIER ATP TESTING DUE TO THE OCCURRENCE OF ICE IN LN2 TEST FIXTURE (REFERENCE CAR A5138, A5160, A5708, A5142 AND A6182). CORRECTIVE ACTION CHANGED THE TEST PROCEDURE AND EQUIPMENT TO PREVENT ICE OCCURRENCE.

DURING QUALIFICATION TESTS, EXCESSIVE VOLTAGE WAS INADVERTENTLY INDUCED ON THE POINT SENSOR ELECTRONICS BOX. ONE POWER SUPPLY WAS DAMAGED (REFERENCE CAR A8679). THE TEST SETUP WAS MODIFIED TO PROTECT THE BOX FOR FUTURE TESTS.

FOUR SENSORS WERE DAMAGED DUE TO OPERATOR ERROR. ONE SENSOR WAS DAMAGED DURING QUALIFICATION TESTING (REFERENCE CAR A8619) AND ONE DURING MPTA TESTING (REFERENCE CAR AB1820) DUE TO EXCESSIVE VOLTAGE. OTHER UNITS WERE PHYSICALLY DAMAGED ON THE NSTL ENGINE TEST STAND (REFERENCE CAR AB8503) AND ON MPTA (REFERENCE CAR A7983). NO CORRECTIVE ACTION WAS TAKEN DUE TO THE UNKNOWN SOURCE OF THE PROBLEMS.

FALSE WET SIGNALS OCCURRED ON THE ELECTRONICS BOX DUE TO OPERATOR ERROR (REFERENCE CAR A9384 DURING QUALIFICATION TESTS; AD1694, AB0705, A9627, AD1623 AT THE SUPPLIER). PRECAUTIONARY OPERATOR INSTRUCTIONS WERE ISSUED.

ON OV-099 CHECKOUT AT KSC, THE POINT SENSOR ELECTRONICS BOX GENERATED FALSE WET SIGNALS DUE TO A STRUCTURAL FAILURE OF THE BOX HOUSING CAR 13F006). ONE POWER SUPPLY PRINTED CIRCUIT BOARD FAILED DUE TO SUSPECTED BOX OVERPRESSURIZATION DURING SUPPLIER LEAK CHECK WHICH ALLOWED THE BOARD TO FALL OUT OF THE CARD GUIDE. THE DAMAGED HOUSING AND BOARD WERE REPLACED.

WIRING PROBLEMS

FOUR OCCURRENCES OF OPEN CIRCUITS DUE TO VEHICLE WIRING PROBLEMS (REFERENCE CAR AB1742, AB5217 AT MPTA, CAR AC4828 AT KSC OV-099, CAR AC6930 AT KSC OV-102). NO CORRECTIVE ACTIONS WERE TAKEN, OTHER THAN TO REPAIR THE VEHICLE WIRING (ET AND ORB).

DURING MPTA TESTING, LOW RESISTANCE IN THE SENSOR CIRCUIT CREATED FALSE WET SIGNALS DUE TO SUSPECTED EXCESSIVE CABLE/CONNECTOR MOISTURE (LEAKAGE TO GROUND). CORRECTIVE ACTIONS INCLUDED THE INSTALLATION OF DRAIN HOLES ON THE ET WIRING CONDUITS AND DRYING OF CABLE CONNECTIONS (REFERENCE CAR'S AC0940 AND AC1761).

RANDOM ELECTRICAL FAILURES

AT KSC ON OV-099, STS-8 CHECKOUT, A FALSE WET SIGNAL OCCURRED DUE TO A DEFECTIVE RESISTOR (REFERENCE CAR AC6567). THE FAULTY RESISTOR WAS REPLACED. THIS WAS CONSIDERED A RANDOM FAILURE.

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VARIOUS FALSE DRY OR WET SIGNALS HAVE OCCURRED DUE TO DEFECTIVE HYBRID INTEGRATED CIRCUITS (REFERENCE CAR AB6709 AT KSC AND CAR'S A6390, A7100, A9315, AB0132 AT SUPPLIER). CORRECTIVE ACTION CONSISTED OF USE OF NEW HYBRID MANUFACTURER PLUS USE OF IMPROVED MANUFACTURING TECHNIQUES, TESTING AND SCREENING.

UNRESOLVED FAILURES

DURING LAUNCH OPERATIONS OF OV-102 (STS-1, 2 AND 6), ONE SENSOR ON EACH OF THE ET'S (DIFFERENT LOCATIONS) FAILED TO PROVIDE THE PROPER DRY SIGNAL. A BROKEN SENSING ELEMENT IN THE TRANSDUCER IS SUSPECTED TO BE THE CAUSE OF THE FAILURE (REFERENCE CAR 06F036 AND AC0934). POST FLIGHT FAILURE ANALYSIS WAS NOT POSSIBLE DUE TO UNAVAILABILITY OF THE ET.

CURRENT DATA ON TEST FAILURE, FLIGHT FAILURE, UNEXPLAINED ANOMALIES, AND OTHER FAILURES EXPERIENCED DURING GROUND PROCESSING ACTIVITY CAN BE FOUND IN THE PRACA DATABASE.

(E) OPERATIONAL USE:

ERRONEOUS PERCENT WET INDICATIONS FROM THE 100% NO. 1 CONTROL SENSOR RESULTING IN A PROPELLANT UNDERLOAD WILL BE READILY DETECTABLE BY THE GROUND CREW. THE INDICATION WILL NOT TRACK THE NO. 2 SENSOR PERCENT WET INDICATION. ADDITIONALLY, THE 100- AND 98% SENSOR PERCENT WET INDICATIONS MAY BE ANOMALOUS.

UPON DETECTION, THE GROUND CREW WILL SWITCH CONTROL OF THE REPLENISH ALGORITHM TO THE NO. 2 CONTROL SENSOR.

- APPROVALS -

S&R ENGINEERING	: W.P. MUSTY	: /S/ W. P. MUSTY
S&R ENGINEERING ITM	: P. A. STENGER-NGUYEN	: /S/ P. A. STENGER-NGUYEN
DESIGN ENGINEERING	: HERB WOLFSON	: /S/ HERB WOLFSON
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: JEFF MUSLER	: /S/ JEFF MUSLER
USA SAM	: MIKE SNYDER	: /S/ MIKE SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: ERICH BASS	: /S/ ERICH BASS