FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 03-1-0437 -X

SUBSYSTEM NAME: MAIN PROPULSION

REVISION: 2 07/17/00

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	:LH2 MANIFOLD RELIEF SHUTOFF VALVE UNITED SPACE ALLIANCE - NSLD	MC284-0406-0002 74329000-103

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
VALVE, ONE INCH LH2 FEEDLINE RELIEF SHUTOFF, PNEUMATICALLY ACTUATED CLOSED, NORMALLY OPEN.

VALVE WAS ORIGINALLY DESIGNED AND MANUFACTURED BY FAIRCHILD CONTROLS BUT IS NOW MANUFACTURED BY UNITED SPACE ALLIANCE-NSLD AS AN ALTERNATE PRODUCTION AGENCY.

REFERENCE DESIGNATORS: PV8

QUANTITY OF LIKE ITEMS: 1

FUNCTION:
ISOLATES THE LH2 PROPELLANT FEED SYSTEM FROM THE FEEDLINE RELIEF SYSTEM. MAINTAINED CLOSED FROM START OF PROPELLANT LOADING UNTIL MECO. VALVE IS MOUNTED ON THE INBOARD FILL & DRAIN VALVE BODY.

FAILURE MODES EFFECTS ANALYSIS FMEA -- CIL FAILURE MODE

NUMBER: 03-1-0437-05

REVISION#: 1 07/17/00

SUBSYSTEM NAME: MAIN PROPULSION
LRU: LH2 MANIFOLD RELIEF SHUTOFF VALVE **CRITICALITY OF THIS**
ITEM NAME: LH2 MANIFOLD RELIEF SHUTOFF VALVE **FAILURE MODE:** 1R2

FAILURE MODE:
ERRONEOUS INDICATION, VALVE OPEN, CLOSE POSITION INDICATOR IS ON PRELAUNCH AND ASCENT.

MISSION PHASE:
PL PRE-LAUNCH
LO LIFT-OFF

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

CAUSE:
PIECE PART STRUCTURAL FAILURE, BINDING, CONTAMINATION

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
POSITION SWITCH INDICATION CANNOT BE USED TO PASS THE B SCREEN. PIECE PART STRUCTURAL FAILURE MAY BE UNDETECTABLE BECAUSE POSITION SWITCHES ARE LOCATED IN THE ACTUATOR AND NOT AT THE END OF THE VALVE DRIVE MECHANISM.

POSITION INDICATOR HAS SUFFICIENT DEADBAND TO ALLOW A CLOSED INDICATION WHEN THE VALVE IS NOT FULLY CLOSED.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 03-1-0437-05

LOSS OF REDUNDANCY TO PREVENT LH2 OVERBOARD LEAKAGE. FEEDLINE RELIEF VALVE (RV6) WILL PREVENT OVERBOARD LEAKAGE OF LH2 (RELIEF PRESSURE ABOVE NOMINAL OPERATING PRESSURE). LCC REQUIREMENT FOR THE SHUTOFF VALVE (CLOSE INDICATION ON AT T-31 SECONDS) WOULD BE SATISFIED.

(B) INTERFACING SUBSYSTEM(S):
SAME AS A.

(C) MISSION:
NO EFFECT.

(D) CREW, VEHICLE, AND ELEMENT(S):
SAME AS C.

(E) FUNCTIONAL CRITICALITY EFFECTS:
CASE 1:
1R/2 2 SUCCESS PATHS. TIME FRAME - PRELAUNCH.
1) SHUTOFF VALVE (PV8) ERRONEOUS INDICATION.
2) RELIEF VALVE (RV6) FAILS TO REMAIN CLOSED.

LH2 WILL DUMP OVERBOARD RESULTING IN PROPELLANT LEAKAGE ON TO THE PAD SURFACE. FIRE/EXPLOSION HAZARD EXTERIOR TO THE VEHICLE AND ON THE PAD. FIRE AND/OR LEAKAGE MAY BE DETECTABLE USING TV CAMERAS AND FIRE DETECTOR SENSORS. POSSIBLE LOSS OF CREW/VEHICLE.

CASE 2:
1R/2 2 SUCCESS PATHS. TIME FRAME - ASCENT (PRE MECO).
1) SHUTOFF VALVE (PV8) ERRONEOUS INDICATION.
2) RELIEF VALVE (RV6) FAILS TO REMAIN CLOSED.

LH2 WILL DUMP OVERBOARD RESULTING IN LOSS OF PROPELLANT. FIRE/EXPLOSION HAZARD EXTERIOR TO THE VEHICLE. POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
THE VALVE IS A NORMALLY OPEN, FLAPPER-TYPE SHUTOFF VALVE, WITH A PNEUMATIC ACTUATOR. IT IS SPRING LOADED TO THE OPEN POSITION BY A BELLOWS WITHIN THE ACTUATOR. IN THE ACTUATOR-VENTED CONDITION THE BELLOWS SPRING FORCE IS TRANSMITTED TO THE VALVE FLAPPER VIA A BELLOWS GUIDE (SHAFT) AND MECHANICAL LINKAGE TO ROTATE THE FLAPPER AWAY FROM THE VALVE SEAT AND OUT OF THE FLOW STREAM. WHEN ACTUATION PRESSURE IS APPLIED TO THE ACTUATOR THE BELLOWS IS

COMPRESSED, CAUSING THE BELLOWS GUIDE AND MECHANICAL LINKAGE TO ROTATE THE FLAPPER TO THE VALVE CLOSED POSITION.

POSITION INDICATION IS PROVIDED BY MICRO SWITCHES LOCATED IN THE POSITION SWITCH COMPARTMENT AT THE OUTBOARD END OF THE ACTUATOR. THE SWITCHES ARE WIRED SO THAT THEY PROVIDE A SIGNAL ONLY WHEN THEY ARE OPEN. IN THE INSTALLED CONDITION THE SWITCHES ARE HELD IN THE CLOSED POSITION BY A LEAF SPRING. VALVE POSITION IS PROVIDED TO THE SWITCHES BY THE MOTION OF THE BELLOWS GUIDE; THE OUTBOARD END OF WHICH IS A SHAFT THAT PASSES INTO THE POSITION SWITCH COMPARTMENT. TO THE END OF THE SHAFT ARE BOLTED SHIMS (WASHERS). AS THE VALVE TRAVELS, SO DO THE WASHERS AT THE END OF THE BELLOWS GUIDE. THE LEAF SPRINGS FROM THE MICRO SWITCHES ARE DEFLECTED BY THE WASHERS. THUSLY, WHEN THE VALVE IS IN THE OPEN POSITION, THE OPEN POSITION MICRO SWITCH IS HELD OPEN BY THE DEFLECTED LEAF SPRING, THEREBY PROVIDING A OPEN POSITION SIGNAL. SIMILARLY, WHEN THE VALVE TRAVELS TO THE CLOSED POSITION, THE LEAF SPRING FROM THE CLOSED POSITION MICRO SWITCH OPENS THE SWITCH, SIGNALING THAT THE VALVE IS CLOSED.

FOR THE VALVE TO BE OPEN BUT INDICATE CLOSED (FOR REASONS OTHER THAN POSITION SWITCH FAILURE) REQUIRES STRUCTURAL FAILURE OF THE FLAPPER ACTUATION MECHANISM, WHICH IS A PINNED LINKAGE CONSISTING OF A FLAPPER ARM, A LINK, AND A BELLOWS GUIDE WELDED TO THE BELLOWS. SUCH A FAILURE COULD RELEASE LARGE PARTICLES BLOCKING THE POPPET SEAT, PREVENTING VALVE CLOSURE, WHILE PERMITTING FULL TRAVEL OF THE OUTBOARD END OF THE BELLOWS GUIDE, ACTUATING THE CLOSED MICROSWITCH. THE FLAPPER ARM IS MADE FROM COPPER-BERYLLIUM #172 AND HEAT TREATED TO CONDITION HT. THE FLAPPER LINK IS OF 2219-T87 AL AND IS 0.278 INCHES THICK. THE PINS ARE A286 CRES AND HAVE A 0.2475 INCH DIAMETER. THE BELLOWS GUIDE IS MACHINED FROM 304L CRES, WHICH IS SUBSEQUENTLY ANNEALED. STRESS ANALYSES OF THESE COMPONENTS INDICATE THE VALVE HAS A POSITIVE MARGIN OF SAFETY FOR ALL CONDITIONS OF VALVE OPERATIONS.

FAILURE TO ACTUATE TO THE FULLY CLOSED POSITION COULD BE CAUSED BY BINDING AT ANY OF THE PINNED CONNECTIONS WITHIN THE FLAPPER LINKAGE (FLAPPER ARM TO FLAPPER LINK, FLAPPER LINK TO BELLOWS GUIDE, AND FLAPPER ARM TO CYLINDER CLEVIS). THE FLAPPER ARM, FLAPPER LINK, AND CLEVIS CYLINDER ARE ALL TREATED WITH A DRY LUBRICANT TO PREVENT BINDING. BINDING OF THE SLIDING CONTACT SURFACES BETWEEN THE CYLINDER CLEVIS AND BELLOWS GUIDE IS PRECLUDED BY TEFLON GUIDE RINGS.

FAILURE TO ACTUATE TO THE FULLY CLOSED POSITION DUE TO CONTAMINATION IS MINIMIZED DUE TO THE PRESENCE OF AN ET SCREEN, A GSE DEBRIS PLATE, AND A GSE FILTER.

(B) TEST:
ATP

AMBIENT AND CRYO (-300 DEG F) PROOF
VALVE BODY - 413 PSIG WITH VALVE BOTH OPEN AND CLOSED
ACTUATOR - 1275 PSIG

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0437-05

VALVE RESPONSE TIMES
AMBIENT - VALVE PRESSURIZED TO 5 PSIG; ACTUATOR PRESSURIZED TO 780 AND 400 PSIG (OPEN AND CLOSED).
CRYO (-300 DEG F) -
OPENING: VALVE PRESSURIZED TO 180 AND 20 PSIG; ACTUATOR 780 PSIG
CLOSING: VALVE PRESSURIZED TO 0 AND 220 PSIG; ACTUATOR 780 AND 400 PSIG

EXTERNAL LEAKAGE
AMBIENT AND CRYO (-300 DEG F) - VALVE BODY @ 50 AND 200 PSIG GHE, VALVE OPEN; ACTUATOR @ 780 PSIG GHE

INTERNAL LEAKAGE - AMBIENT AND CRYO (-300 DEG F)
INLET TO OUTLET @ 50 AND 200 PSIG GHE, VALVE CLOSED

POSITION INDICATION - VERIFICATION OF OPERATION (AMBIENT ONLY)

ELECTRICAL TESTS
ELECTRICAL BONDING; DIELECTRIC; INSULATION RESISTANCE

CERTIFICATION (TWO UNITS CERTIFIED)

VALVE RESPONSE TIMES
AMBIENT - VALVE PRESSURIZED TO 5 PSIG; ACTUATOR PRESSURIZED TO 780 AND 400 PSIG (OPEN AND CLOSED).
CRYO (-300 DEG F)
OPENING: VALVE PRESSURIZED TO 180 AND 20 PSIG; ACTUATOR 780 PSIG
CLOSING: VALVE PRESSURIZED TO 0 AND 220 PSIG; ACTUATOR 780 AND 400 PSIG
CRYO (-400 DEG F)
OPENING: VALVE PRESSURIZED TO 30 PSIG; ACTUATOR 780 PSIG
CLOSING: VALVE PRESSURIZED TO 0 AND 60 PSIG; ACTUATOR 780 AND 400 PSIG

EXTERNAL LEAKAGE
AMBIENT - VALVE BODY @ 50 AND 200 PSIG GHE, VALVE OPEN; ACTUATOR @ 780 PSIG GHE
CRYO (-300 DEG F) - VALVE BODY @ 50 AND 200 PSIG GHE, VALVE OPEN; ACTUATOR @ 780 PSIG GHE
CRYO (-400 DEG F) - VALVE BODY @ 50 PSIG GHE, VALVE OPEN; ACTUATOR @ 780 PSIG GHE

INTERNAL LEAKAGE
AMBIENT AND CRYO (-300 DEG F) - INLET TO OUTLET @ 50 AND 200 PSIG GHE, VALVE CLOSED
CRYO (-400 DEG F) - INLET TO OUTLET @ 50 PSIG GHE, VALVE CLOSED

LIFE TEST
CRYO (-400 DEG F) - 250 CYCLES AT 200 PSIG AND 250 CYCLES AT 50 PSIG FOLLOWED BY A CRYO (-400 DEG F) LEAKAGE TEST

AMBIENT - 1500 CYCLES @ 5 PSIG. AFTER EACH 500 CYCLES PERFORM AMBIENT LEAK TESTS.

VIBRATION

TRANSIENT - (5 - 35 HZ) IN EACH OF THREE AXES, WITH VALVE CLOSED

RANDOM - (13.3 HOURS IN EACH OF THREE AXES WHILE PRESSURIZED TO 200 PSIG, AT -300 DEG F., AND WITH THE VALVE CLOSED. FOLLOWING EACH AXIS TEST, PERFORM CRYO (-300 DEG F) VALVE RESPONSE TIMES TEST, AND CRYO (- 300 DEG F) LEAKAGE TESTS (EXCEPT ACTUATOR).

DESIGN SHOCK (18 SHOCKS OF 15G EACH) - THREE IN EACH DIRECTION OF THREE AXES). UPON COMPLETION PERFORM AMBIENT VALVE RESPONSE TIMES TEST, AND AMBIENT LEAKAGE TESTS.

THERMAL CYCLE TEST - +70 DEG F TO -400 DEG F TO +70 DEG F TO +275 DEG F TO +150 DEG F TO +70 DEG F PERFORMED THREE TIMES FOLLOWED BY AMBIENT VALVE RESPONSE TIMES TEST, AMBIENT LEAKAGE TESTS, AND ELECTRICAL INSULATION TEST.

ELECTRICAL BONDING (ONE UNIT ONLY)

BURST TEST (ONE UNIT ONLY) - 550 PSIG VALVE BODY, 3400 PSIG ACTUATOR

OMRSD:
ANY TURNAROUND CHECKOUT IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD.

(C) INSPECTION:

RECEIVING INSPECTION
RAW MATERIALS ARE VERIFIED BY INSPECTION FOR MATERIAL AND PROCESS CERTIFICATION. BODY HOUSING FORGING IS ULTRASONICALLY INSPECTED.

CONTAMINATION
CONTROL CONTAMINATION CONTROL PROCESS AND CORROSION PROTECTION PROVISIONS ARE VERIFIED. CLEANLINESS TO LEVEL 400A IS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
ALL PARTS ARE PROTECTED FROM DAMAGE AND CONTAMINATION. LOG OF CLEAN ROOM AND TOOL CALIBRATION IS VERIFIED BY INSPECTION. DRAWING TORQUE AND SURFACE FINISH REQUIREMENTS ARE VERIFIED. COMPONENTS ARE VISUALLY AND DIMENSIONALLY INSPECTED DURING FABRICATION. SEALS ARE VISUALLY EXAMINED FOR DAMAGE AND CLEANLINESS PRIOR TO INSTALLATION. MANDATORY INSPECTION POINTS ARE INCLUDED IN THE ASSEMBLY PROCEDURE.

CRITICAL PROCESSES
HEAT TREATMENT, PARTS PASSIVATION, AND ANODIZING ARE VERIFIED. DRY FILM LUBRICANT APPLICATION IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
ULTRASONIC INSPECTION OF BODY HOUSING IS VERIFIED. WELDS ARE DYE PENETRANT INSPECTED.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE NUMBER: 03-1-0437-05

TESTING
ATP VERIFIED BY INSPECTION.

HANDLING/PACKAGING
HANDLING AND PACKAGING FOR SHIPMENT ARE VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
AT PALMDALE, VALVE INDICATED BOTH OPEN AND CLOSED WHEN THE VALVE WAS IN THE OPEN POSITION. THE CLOSED MICROSWITCH FAILED DUE TO MOVEMENT OF THE SWITCH HINGE POINT, WHICH CAUSED THE ACTUATION POINT TO SHIFT. THE SWITCH WAS REPLACED WITH AN IMPROVED DESIGN (DATE CODE LATER THAN 7624) AND THE VALVE SUCCESSFULLY PASSED ATP. (REF CAR AC2296)

AT PALMDALE AND DURING OV104 FRF BOTH POSITION INDICATIONS REMAINED ON WITH THE VALVE IN OPEN AND CLOSED POSITIONS. THE MICROSWITCHES (IMPROVED DESIGN, DATE CODE 7949) FAILED DUE TO MOVEMENT OF THE SWITCH HINGE POINT, WHICH CAUSED THE ACTUATION POINT TO SHIFT. THE SWITCHES AND SEALS WERE REPLACED AND THE VALVE SUCCESSFULLY PASSED ATP. THE SWITCH SCREENING PROCEDURE AT THE VALVE VENDOR WAS REVISED TO INCREASE THE MINIMUM DIFFERENTIAL TRAVEL BETWEEN SWITCH ON AND OFF POSITIONS. (REF CAR AD2339, AD0240)

DURING A SUBSYSTEM CHECKOUT ON OV102 (REF CAR AD1325) AT KSC THE PV7 LO2 RELIEF ISOLATION VALVE OPEN AND CLOSE POSITION INDICATORS WERE INTERMITTENT. REPEATED VALVE CYCLING CORRECTED THE PROBLEM. THE VALVE WAS REMOVED AND SUBJECTED TO TESTS. NO ANOMALY COULD BE FOUND. THE INTERMITTENT POSITION INDICATION WAS A ONE TIME OCCURRENCE WHICH COULD NOT BE REPEATED. THE CAUSE FOR THE ANOMALY COULD NOT BE DETERMINED. THE VALVE WAS CLEANED, REACCEPTANCE TESTED SATISFACTORILY, AND RETURNED TO ROCKWELL SPARES INVENTORY. FUTURE SWITCH FAILURES WILL BE MONITORED FOR A TREND.

A FAILURE OF THE VALVE TO CLOSE OCCURRED DURING QUALIFICATION TESTING (REFERENCE CAR AC1189). THE CAUSE WAS INTERFERENCE DUE TO THE OVERSIZED DIAMETER OF THE PISTON GUIDE RING GROOVE. THE DESIGN WAS CHANGED (THE GROOVE DIAMETER WAS REDUCED) TO ELIMINATE THE PROBLEM.

A FAILURE AT NSTL OF A VALVE TO ACTUATE WAS CAUSED BY BINDING OF THE ALUMINUM BRONZE BUSHING TO THE SHAFT. AN MCR AUTHORIZED DRAWING CHANGES TO TEFLON COAT AND POLISH THE SHAFT (REFERENCE CAR A7950).

GENERAL SYSTEM CONTAMINATION

THIS FAILURE MODE HAS NOT OCCURRED ON THIS COMPONENT DUE TO CONTAMINATION. HOWEVER, GENERAL MPS SYSTEM CONTAMINATION HAS OCCURRED WHICH MAY LODGE ANYWHERE IN THE SYSTEM CAUSING THIS FAILURE MODE (REFERENCE THE FOLLOWING PARAGRAPHS).

CONTAMINATION FAILURES HAVE OCCURRED AT ALL PHASES OF MANUFACTURING AND PARTS REPLACEMENT. IN ALL CASES, STRICT ADHERENCE TO CLEANLINESS CONTROL PROCEDURES IS THE PRIMARY METHOD OF CONTAMINATION PREVENTION.

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0437-05

NUMEROUS LARGE PARTICLES OF BLACK RUBBER MATERIAL WERE FOUND DURING A POST FLIGHT EXAMINATION OF THE LH2 17 INCH DISCONNECT OF OV099 (FLIGHT 7, REFERENCE CAR AC9800). THE LO2 AND LH2 SYSTEMS OF ALL VEHICLES WERE EXAMINED. NO RUBBER WAS FOUND IN ANY OTHER VEHICLES. AFTER EXTENSIVE INVESTIGATION THE ORIGIN WAS NOT DETERMINED.

METAL SHAVINGS HAVE BEEN DISCOVERED IN LINES AND COMPONENTS, WHICH WAS MOST LIKELY GENERATED WHEN THEY WERE CUT OUT AND/OR REPLACED (REFERENCE CARS AC9868, A9654, AC2210, AB1706; DR AD2226). METHODS ARE BEING REVISED TO MINIMIZE PARTICLE GENERATION WHEN INSTALLING/REPLACING COMPONENTS, LINES, AND FITTINGS REQUIRING WELDED OR BRAZED JOINTS (PRODUCT QUALITY IMPROVEMENT COUNCIL). PERSONNEL HAVE BEEN CAUTIONED. ROCKWELL PROBLEM ACTION CENTER WILL CONTINUE TO MONITOR BRAZING/WELDING REWORK CONTAMINATION. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

A PIECE OF A BRAZING PREFORM LODGED IN A 2-WAY SOLENOID VALVE ON OV- 099 AT PALMDALE CAUSING A LEAKAGE FAILURE (REFERENCE CARS AC2111, AB2538). STEEL AND ALUMINUM PARTICLES CAUSED EXCESSIVE LEAKAGE ON THE 850 PSIG HELIUM RELIEF VALVE (REF CAR AC2229). FOR BOTH FAILURES CORRECTIVE ACTION WAS TO ADD SPECIAL PURGE PORTS TO THE MPS HELIUM PANEL ASSEMBLIES TO IMPROVE THE QUALITY OF FINAL CLOSEOUT BRAZES.

SEVERAL FOREIGN MATERIALS WERE INTRODUCED INTO THE MPS SYSTEM DURING MANUFACTURE AND PARTS REPLACEMENT. EXAMPLES ARE: GLASS CLOTH IN LINE TO PREVENT TRAVEL OF CHIPS DOWN LINE; POLYSTYRENE OBJECT TO HOLD VALVE POPPET OPEN WHILE PURGING; COTTON SWAB MATERIAL AND GLASS BEADS FROM CLEANING OPERATION; MISCELLANEOUS PLASTIC; FOAM; AND TAPE (REFERENCE CARS AB4751, AC2217, AC6768, AC9868, MPS3A0005, AC7912, AB0530). MATERIALS WERE REMOVED AND PERSONNEL WERE CAUTIONED. A HIGH FLOW DELTA P TEST AT PALMDALE WAS ADDED TO VERIFY THAT LINES WERE NOT PLUGGED. GRIT BLASTING (GLASS BEADS AND SAND USED TO CLEAN A LINE) IS NO LONGER PERFORMED. PROCEDURES ARE BEING REVISED TO IMPROVE CLEANLINESS MAINTENANCE DURING COMPONENT BUILD UP AND REWORK (REFERENCE MCR 12512). SUPPLIER DOCUMENTS/PROCEDURES HAVE BEEN REVIEWED AND CLEANLINESS MAINTENANCE PROCEDURES HAVE BEEN IMPROVED.

ONE PIECE OF WIRE WAS FOUND IN THE INTERNAL RELIEF VALVE OF THE LO2 PREVALVE ON OV103 (REFERENCE CAR AC9101). THE SOURCE OF THE CONTAMINATION WAS NEVER FOUND, BUT IT WAS BELIEVED TO BE FROM THE ET. OTHER CONTAMINATION HAS BEEN FOUND ON THE FEEDLINE SCREENS, SUCH AS AN UNIDENTIFIED ROUND OBJECT AND VARIOUS METALLIC PARTICLES (REFERENCE CARS AB0529 AND AB0530). SOURCE OF CONTAMINATION WAS UNDETERMINED. BORE SCOPE EXAMINATIONS ARE CONDUCTED ON ALL FEEDLINE SCREENS EVERY FIFTH FLIGHT TO VERIFY CLEANLINESS. CONTAMINATION WAS REMOVED WHEN POSSIBLE.

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

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL FAILURE MODE
NUMBER: 03-1-0437-05

(E) OPERATIONAL USE:
FLIGHT: WHEN THE ULLAGE PRESSURE DROPS BELOW 28 PSI, THE CREW WILL OPEN THE LH2 FLOW CONTROL VALVE WITH THE COCKPIT SWITCH. WHEN THIS IS INEFFECTIVE AND THE NPSP DROPS BELOW A PREFLIGHT ACCEPTED VALUE, THE CREW WILL ABORT TO TAL OR ACLS.

GROUND: GROUND OPERATIONS SAFING PROCEDURES CONTAIN SAFING SEQUENCE OF EVENTS FOR MAJOR LEAKS IN THE HYDROGEN SYSTEM.

- 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	: STUART KOBATA	: /S/ STUART KOBATA
MPS SUBSYSTEM MGR.	: TIM REITH	: /S/ TIM REITH
MOD	: JEFFREY L. MUSLER	: /S/ JEFFREY L. MUSLER
USA SAM	: MICHAEL SNYDER	: /S/ MICHAEL SNYDER
USA ORBITER ELEMENT	: SUZANNE LITTLE	: /S/ SUZANNE LITTLE
NASA SR&QA	: HUGO MARTINEZ	: /S/ HUGO MARTINEZ