PRINT DATE: 08/03/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 02-1D-195 -X

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
REVISION: 2 02/21/92

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: INWS HYDRAULIC ACTUATOR ASSY	MC621-0058-0019
SRU	: SOLENOID VALVE	MC621-0058-0019E

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
SOLENOID VALVE (NORMALLY CLOSED)

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 2
TWO

FUNCTION:
SOLENOID VALVE NO. 1 CONTROLS HYDRAULIC PRESSURE TO THE NORMALLY CLOSED SHUTOFF VALVE. OPENING THE SOLENOID VALVE OPENS THE SHUTOFF VALVE. SOLENOID VALVE NO. 2 CONTROLS HYDRAULIC PRESSURE TO THE BYPASS VALVES AND ACTIVATES THE PRESSURE SWITCH WHICH TRANSMITS A READY SIGNAL TO THE STEERING CONTROL BOX.

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FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE
NUMBER: 02-1D-195- 01

REVISION#: 3 08/03/97
SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
LRU: INWS HYDRAULIC ACTUATOR ASSY
ITEM NAME: SOLENOID VALVE
CRITICALITY OF THIS FAILURE MODE: 1R3

FAILURE MODE:
FAILS CLOSED (SOLENOID VALVE NO. 1 AND/OR 2).

MISSION PHASE: DO DE-ORBIT

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

CAUSE:
BINDING CORE, PIN AND BALL, SHORTED COIL, OPEN COIL

CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO

REDUNDANCY SCREEN
A) PASS
B) FAIL
C) PASS

PASS/FAIL RATIONALE:
A)

B)
FAILS SCREEN "B" SINCE INWS IS NOT POWERED UNTIL LANDING GEAR DOWN COMMAND AND STEERING CANNOT BE ACTIVATED UNTIL WEIGHT ON NOSE GEAR.

C)

- FAILURE EFFECTS -

(A) SUBSYSTEM:
LOSS OF HYDRAULIC POWER TO OPERATE THE STEERING ACTUATOR RESULTING IN LOSS OF NOSEWHEEL STEERING FUNCTION. SYSTEM STAYS IN FREE CASTER MODE WITH DAMPING FUNCTION INTACT. IF SOLENOID VALVE NO. 2 FAILS CLOSED HYDRAULIC POWER TO OPERATE THE ACTUATOR WILL BE AVAILABLE BUT THE BYPASS VALVES WILL REMAIN IN THE BYPASS POSITION. THE SYSTEM WILL ALSO STAY IN THE

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FREE CASTOR MODE WITH DAMPING FUNCTION INTACT. SOLENOID VALVE NO. 2 OR NO. 1 FAILING CLOSED DURING ACTIVE STEERING WILL CAUSE THE BYPASS VALVES TO BYPASS PREMATURELY AND PUT THE SYSTEM IN THE FREE CASTER MODE WITH DAMPING FUNCTION INTACT. THE CRITICALITY FOR BOTH THESE CASES REMAINS THE SAME - 1R/3.

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

(C) MISSION:
NO EFFECT WITH FIRST FAILURE.

(D) CREW, VEHICLE, AND ELEMENT(S):
POSSIBLE LOSS OF CREW/VEHICLE WITH TWO ADDITIONAL FAILURES - LOSS OF DIFFERENTIAL BRAKING (WHICH IS CONSIDERED UNLIKE REDUNDANCY).

(E) FUNCTIONAL CRITICALITY EFFECTS:
CRIT 1R BECAUSE LOSS OF NWS MAY ALLOW VEHICLE TO DEPART RUNWAY RESULTING IN POSSIBLE LOSS OF CREW/VEHICLE.

-DISPOSITION RATIONALE-

(A) DESIGN:
ALL ELECTRICAL AND ELECTRONIC COMPONENTS IN THE VALVE ARE DESIGNED PER THE REQUIREMENTS OF MF0004-002. MATERIALS USED IN THE DESIGN OF THE VALVE ARE SELECTED IN ACCORDANCE WITH MC999-0096. ALSO, PARTS USED IN DESIGN AND FABRICATION ARE SELECTED FROM MF0004-400 (ELECTRICAL, ELECTRONIC AND ELECTRO-MECHANICAL PARTS).

(B) TEST:
QUALIFICATION TESTS - THE INWS QUAL TESTS INCLUDE: VIBRATION, ACCELERATION, SHOCK, THERMAL SHOCK, THERMAL VACUUM, THERMAL CYCLE AND ENDURANCE CYCLING. THE UNITS ARE SUBJECTED TO FUNCTIONAL TESTS BEFORE AND AFTER EACH ENVIRONMENT TEST. THE INWS WAS ALSO QUALIFIED BY SIMILARITY BY THE FOLLOWING TESTS: PROOF PRESSURE, SALT FOG, HUMIDITY, SAND AND DUST, EXPLOSIVE ATMOSPHERE, PRESSURE IMPULSE CYCLING, AND OPERATING LIFE CYCLING. DURING THE ORIGINAL QUALIFICATION TESTS THE SYSTEM SURVIVED 5400 ON/OFF (ENERGIZE/DE-ENERGIZE) CYCLES AT 30 CYCLES PER MINUTE WITHOUT FAILURE.

THE QUAL TEST UNIT IS CYCLED A MINIMUM OF 8000 CYCLES (15 CYCLES PER MINUTE) AT NORMAL FULL STROKE WITH NO LOAD AND 3000 PSI. CHANNEL 1 AND 2 ALTERNATED EVERY 10 MINUTES AND TURNED OFF FOR 1 MINUTE DURING CYCLING. THE UNIT WAS ALSO CYCLED A MINIMUM OF 13,500 CYCLES (15 CYCLES PER MINUTE) AT HALF STROKE WITH NO LOAD AND 3,000 PSI. CHANNEL 1 AND 2 ALTERNATED EVERY 10 MINUTES AND TURNED OFF FOR 1 MINUTE DURING CYCLING WITHOUT FAILURE, DEGRADATION IN PERFORMANCE OR LEAKAGE. THE UNIT WAS ALSO COMMANDED TO MIDSTROKE TURNING CHANNEL 1 OFF AND ON FOR 2,500 CYCLES MINIMUM. REPEATED WITH CHANNEL 2. NO FAILURE OCCURRENCES FOR 5,000 MINIMUM OFF/ON CYCLES.

ACCEPTANCE TESTS: ACCEPTANCE TESTS ARE PERFORMED ON ALL UNITS DELIVERED BY THE SUPPLIER WHICH INCLUDE: COMPONENT FUNCTIONAL TEST, ACCEPTANCE VIBRATION TEST, FLUID CLEANLINESS, PROOF PRESSURE TEST, AND ACTUATOR RESTRAINED PROOF TEST.

GROUND TURNAROUND TEST
ANY TURNAROUND CHECKOUT TESTING IS ACCOMPLISHED IN ACCORDANCE WITH OMRSD. THE OMRSD DATA PROVIDED BELOW IS NO LONGER BEING KEPT UP-TO-DATE. IF THERE IS ANY DISCREPANCY BETWEEN THE GROUND TESTING DATA PROVIDED BELOW AND THE OMRSD, THE OMRSD IS THE MORE ACCURATE SOURCE OF THE DATA.

NWS1 AND NWS2 SWITCH - THE NWS SYSTEM IS EXERCISED THROUGHOUT IT'S NORMAL RANGE OF OPERATION IN BOTH NWS1 AND NWS2 MODE (THE NLG TORQUE LINKS ARE DISCONNECTED DURING THESE TESTS).

FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

(C) INSPECTION:
RECEIVING INSPECTION
RAW MATERIAL AND PROCESS CERTIFICATION ARE VERIFIED BY INSPECTION. TEST REPORTS AND RECORDS ARE MAINTAINED.

CONTAMINATION CONTROL
ALL HYDRAULIC FLUID INTERNAL SURFACES ARE MAINTAINED AT LEVEL 190 CLEANLINESS. SYSTEM CLEANLINESS IS VERIFIED ON A REGULAR BASIS BY FLUID SAMPLING ANALYSIS. SYSTEM HYDRAULIC FLUID IS ANALYZED FOR WATER AND FREON CONTENT (100 PPM MAX).

ASSEMBLY/INSTALLATION
ALL DETAIL PARTS ARE INSPECTED AND FLUSHED WITH SOLVENT PRIOR TO ASSEMBLY. CRITICAL DIMENSIONS AND SURFACE FINISHES ARE VERIFIED BY INSPECTION. SEALS ARE VISUALLY EXAMINED FOR CLEANLINESS AND DAMAGE. APPLICATION OF O-RING SEAL LUBRICANT IS VERIFIED BY INSPECTION. TORQUING AND LOCKWIRING OF FASTENERS IS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
MAGNETIC PARTICLE AND PENETRANT INSPECTION OF MACHINED PARTS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES

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SURFACE TREATMENTS SUCH AS PASSIVATION AND ANODIZING, PLATING, AND HEAT TREATMENT ARE VERIFIED BY INSPECTION. SOLDERING PER NHB5300.4(3A) AND CONFORMAL COATING OF PRINTED WIRING BOARDS ARE VERIFIED BY INSPECTION.

TESTING
THE ATP WHICH IS WITNESSED AND VERIFIED BY INSPECTION INCLUDES FLUID CLEANLINESS VERIFICATION, PROOF PRESSURE AND LEAK TESTING, PULL-IN AND DROP OUT VOLTAGES, DIELECTRIC STRENGTH, INSULATION RESISTANCE, AND WINDING RESISTANCE.

HANDLING/PACKAGING
PACKAGING AND HANDLING FOR SHIPMENT IS VERIFIED BY INSPECTION TO BE IN ACCORDANCE WITH REQUIREMENTS.

(D) FAILURE HISTORY:
NONE

(E) OPERATIONAL USE:
NONE

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: J. Kymura 8/4/97
EDITORIALLY APPROVED	: JSC	: A Heaney 8/5/97
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011_02-1D