

**FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE  
NUMBER: 02-1D-200 -X**

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

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**PART DATA**

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	<b>PART NAME VENDOR NAME</b>	<b>PART NUMBER VENDOR NUMBER</b>
LRU	: INWS HYDRAULIC ACTUATOR ASSY	MC621-0058-0019
SRU	: BYPASS VALVE	MC621-0058-0019G

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**EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:  
BYPASS VALVE**

**REFERENCE DESIGNATORS:**

**QUANTITY OF LIKE ITEMS: 2  
TWO**

**FUNCTION:  
THE BYPASS VALVES ARE LOCATED HYDRAULICALLY BETWEEN THE SERVO VALVE  
AND THE STEERING ACTUATOR PRESSURE PORTS. THEY CHANGE THE OPERATING  
MODE FROM DAMPING TO STEERING OR STEERING TO DAMPING.**

**FAILURE MODES EFFECTS ANALYSIS FMEA – CIL FAILURE MODE**

**NUMBER: 02-1D-200- 02**

**REVISION#: 3                    08/03/97**

**SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM**

**LRU: INWS HYDRAULIC ACTUATOR ASSY**

**CRITICALITY OF THIS**

**ITEM NAME: BYPASS VALVE**

**FAILURE MODE: 1R3**

**FAILURE MODE:**

**ONE BYPASS VALVE FAIL IN STEERING POSITION**

**MISSION PHASE:            DO   DE-ORBIT**

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

**CAUSE:**  
**BINDING OF ONE BYPASS SPOOL, FRACTURED SPRING.**

**CRITICALITY 1/1 DURING INTACT ABORT ONLY? NO**

<b>REDUNDANCY SCREEN</b>	<b>A) PASS</b>
	<b>B) FAIL</b>
	<b>C) PASS</b>

**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:**

**NO EFFECT IN STEERING MODE. SHIMMY DAMPING CAPABILITY STILL MAINTAINED  
PROVIDED BY THE DAMPING ORIFICE CREATED BY THE WORKING BYPASS VALVE.**

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**(B) INTERFACING SUBSYSTEM(S):**

NWS ACTUATOR FREE CASTER FUNCTION MAINTAINED. HOWEVER, SINCE THE EFFECTIVE ORIFICE HAS BEEN REDUCED THE TORQUE IS FOUR TIMES THE NORMAL DAMPING TORQUE.

**(C) MISSION:**

NO EFFECT WITH FIRST-FAILURE.

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

POSSIBLE LOSS OF CREW/VEHICLE WITH TWO OTHER FAILURES - LOSS OF SECOND BYPASS VALVE FAILING IN THE STEERING POSITION AND LOSS OF DIFFERENTIAL BRAKING. THESE FAILURES WOULD CAUSE LOSS OF DIRECTIONAL CONTROL.

**(E) FUNCTIONAL CRITICALITY EFFECTS:**

CRIT 1R BECAUSE LOSS OF NWS MAY ALLOW VEHICLE TO DEPART RUNWAY RESULTING IN POSSIBLE LOSS OF CREW/VEHICLE.

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**-DISPOSITION RATIONALE-**

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**(A) DESIGN:**

SYSTEM IS DESIGNED TO PREVENT LEAKAGE AND CONTAMINATED FLUID; CYCLIC AND LEAK PROOF TESTS PER MIL-C-5503 AND CLEANLINESS REQUIREMENTS PER LEVEL 190 OF MA0110-301. HYDRAULIC FLUID FILTER IS A 5 MICRON NOMINAL AND 15 MICRON ABSOLUTE UNIT. MATING SURFACES ARE DESIGNED TO BE SUFFICIENTLY SMOOTH SO AS TO MINIMIZE THE METAL WEAR PARTICLES THAT MAY CAUSE GALLING. SPRING MATERIAL CHOSEN FOR ITS ABILITY TO WITHSTAND DESIGN RANDOM VIBRATION, LANDING SHOCK, AND BENCH HANDLING SHOCK.

**(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. DURING PRESSURE IMPULSE CYCLING TESTS THE UNIT SURVIVED 120,482 IMPULSE CYCLES WITHOUT FAILURE OR INADVERTENT OPERATION. IMPULSE CYCLE SEQUENCES FOR NOSEWHEEL STEERING WERE QUALIFIED BY SIMILARITY. THE ORIGINAL NOSEWHEEL STEERING ACTUATOR IMPULSES WERE AS FOLLOWS:

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WITH HYDRAULIC PRESSURE HOOKED UP TO THE SUPPLY PORT -

SEQUENCE #1: 30,312 CYCLES FROM 300 PSI TO 4,500 PSI AND BACK TO 300 PSI AT 3 CYCLES PER SECOND.

SEQUENCE #2: 30,010 CYCLES FROM 3,000 PSI TO 1500 PSI AND BACK TO 3,000 PSI AT 3 CYCLES PER SECOND.

WITH HYDRAULIC PRESSURE HOOKED UP TO THE RETURN PORT -

30,120 CYCLES OF SEQUENCE #1 AND 30,240 OF SEQUENCE #2 WERE PERFORMED.

DURING SUPPLY PROOF PRESSURE TEST THE NWS ACTUATOR IS PRESSURIZED TO 4500 PSIG AT A TEMPERATURE OF +275 DEG. F. PRESSURE IS APPLIED FOR 5 MINUTES MINIMUM WHILE THE ACTUATOR IS IN ITS FULLY EXTENDED POSITION. DURING RETURN PROOF PRESSURE TEST THE ACTUATOR IS PRESSURIZED AT ITS RETURN PORT AS ABOVE. SYSTEM MODE SELECTOR IS OFF DURING THE RETURN PROOF PRESSURE TEST. NO DAMAGE OR LEAKAGE IS TOLERATED DURING THESE TESTS.

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.

THE BYPASS VALVES ARE TESTED TO VERIFY THAT THE DAMPING RATE OF THE ACTUATOR, WHILE IN BYPASS MODE ARE WITHIN ACCEPTABLE LIMITS. THE NLG TORQUE LINKS ARE DISCONNECTED DURING THESE TESTS)

**(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

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**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.**

**NONDESTRUCTIVE EVALUATION**

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

**CRITICAL PROCESSES**

**SURFACE TREATMENTS SUCH AS PASSIVATION AND ANODIZING, PLATING, AND HEAT TREATMENT ARE VERIFIED BY INSPECTION.**

**TESTING**

**THE ATP WHICH IS WITNESSED AND VERIFIED BY INSPECTION INCLUDES FLUID CLEANLINESS VERIFICATION, PROOF PRESSURE AND LEAK TESTING.**

**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**

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**- APPROVALS -**

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EDITORIALLY APPROVED	: BNA	: <u>J. Kamura 8/4/97</u>
EDITORIALLY APPROVED	: JSC	: <u>d. Deary 9/9/97</u>
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