PRINT DATE: 08/03/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) -- CIL HARDWARE
NUMBER: 02-1D-184 -X

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
REVISION: 4 08/20/93

PART DATA

	PART NAME / **VENDOR NAME**	**PART NUMBER** / **VENDOR NUMBER**
LRU	: INWS HYDRAULIC ACTUATOR ASSY	MC621-0058-0019

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
HYDRAULIC ACTUATOR ASSEMBLY

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 1
ONE

FUNCTION:
PROVIDES HYDRAULIC POWER STEERING AND SHIMMY DAMPING TO THE NOSE WHEEL ASSEMBLY.

PRINT DATE: 09/07/93

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CRITICAL FAILURE MODE
NUMBER: 02-1D-184-02

REVISION# 4 08/20/93 R

SUBSYSTEM NAME: LANDING DECELERATION - NWS - MECHANISM
LRU: INWS HYDRAULIC ACTUATOR ASSY
ITEM NAME: INWS HYDRAULIC ACTUATOR ASSY

CRITICALITY OF THIS FAILURE MODE: 1/1

FAILURE MODE:
ACTUATOR PISTON JAMMED

MISSION PHASE:
DO DE-ORBIT

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

CAUSE:
FATIGUE, OVERSTRESS

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:
NOSE WHEEL LOCKUP IN DIRECTION OF FAILURE.

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

(C) MISSION:
POSSIBLE LOSS OF MISSION/CREW/VEHICLE DUE TO LOSS OF DIRECTIONAL CONTROL.

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

(E) FUNCTIONAL CRITICALITY EFFECTS:

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-DISPOSITION RATIONALE-

(A) DESIGN:
MATERIALS AND PROCESSES ARE IN ACCORDANCE WITH MC999-0096. ACTUATOR IS DESIGNED TO COMPLY WITH THE REQUIREMENTS OF MIL-C-5503. EQUIPMENT MOUNTING INTERFACES ARE DESIGNED TO WITHSTAND TERMINAL PEAK SAW TOOTH PULSES OF +/-40 G'S IN ALL AXES FOR 11 MILLISECONDS DURATION. PISTON/ROD ASSEMBLY IS DESIGNED TO ACCOMODATE PREDICTED FATIGUE/STRESS LEVELS WITH A MINIMUM FACTOR OF SAFETY OF 2.25.

(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:

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 IT'S 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 MINUMUM 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 THESE TESTS INCLUDE: COMPONENT FUNCTIONAL TEST, ACCEPTANCE VIBRATION TEST, PROOF PRESSURE TEST, AND ACTUATOR RESTRAINED PROOF TEST.

OMRSD: NWS1 AND NWS2 - VERIFIES THE ACTUATOR'S OPERATION THROUGHOUT ITS FULL RANGE OF MOTION; 9.00+/-0.56 DEGREES (NOSE WHEEL RIGHT AND LEFT MOVEMENT WITH THE TORQUE LINKS DISCONNECTED). THESE TESTS ARE ARE CONDUCTED USING BOTH NWS1 AND NWS2 MODES.

FREQUENCY - ALL VEHICLES AT EACH 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 REQULAR BASIS BY FLUID SAMPLING ANALYSIS. SYSTEM HYDRAULIC FLUID IS ANALYZED FOR WATER AND FREON CONTENT (100PPM 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. X-RAYS OF BRAZED TUBE AND FITTINGS ARE VERIFIED BY INSPECTION.

CRITICAL PROCESSES
SURFACE TREATMENTS SUCH AS PASSIVATION AND ANODIZING, PLATING, HEAT TREATMENT, SWAGING, BRAZING, ELECTRICAL BONDING 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

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(E) OPERATIONAL USE:
NONE

- APPROVALS -

EDITORIALLY APPROVED	: RI	: 9/7/93
EDITORIALLY APPROVED	: JSC	: 9/15/93
TECHNICAL APPROVAL	: VIA CR	: S50870L