PRINT DATE: 08/03/97

FAILURE MODES EFFECTS ANALYSIS (FMEA) – CIL HARDWARE
NUMBER: 02-1E-070 -X

SUBSYSTEM NAME: LANDING DECELERATION - WHEEL, BRAKE & TIRE
REVISION: 0 09/19/88

PART DATA

	PART NAME VENDOR NAME	PART NUMBER VENDOR NUMBER
LRU	: NOSE LANDING GEAR (NLG)	MC621-0050
SRU	: NLG WHEEL TIE BOLTS B. F. GOODRICH	75463-8-28

EXTENDED DESCRIPTION OF PART UNDER ANALYSIS:
NOSE LANDING GEAR WHEEL TIE BOLTS

REFERENCE DESIGNATORS:

QUANTITY OF LIKE ITEMS: 28
FOURTEEN PER WHEEL

FUNCTION:
SECURES TWO HALVES OF WHEEL TOGETHER.

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LRU: NOSE LANDING GEAR (NLG)
ITEM NAME: NLG WHEEL TIE BOLTS

CRITICALITY OF THIS FAILURE MODE: 1/1

FAILURE MODE:
STRUCTURAL FAILURE.

MISSION PHASE: DO DE-ORBIT

VEHICLE/PAYLOAD/KIT EFFECTIVITY:

102	COLUMBIA
103	DISCOVERY
104	ATLANTIS
105	ENDEAVOUR

CAUSE:
IMPROPER BOLT PRELOAD, OVERLOAD, DEFECTIVE MATERIAL

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:
TIE BOLT FAILURE MAY CAUSE WHEEL/TIRE ASSEMBLY FAILURE. IF FAILURE OCCURS AT OR SHORTLY AFTER NOSE WHEEL TOUCHDOWN, REMAINING WHEEL/TIRE ASSEMBLY WILL FAIL. PROBABLE FAILURE OF NLG STRUT OR ITS ATTACHMENTS.

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

(C) MISSION:
PROBABLE LOSS OF MISSION/CREW/VEHICLE DUE TO NOSE LANDING GEAR COLLAPSE (IF BOTH WHEEL/TIRE ASSEMBLIES FAIL).

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

(E) FUNCTIONAL CRITICALITY EFFECTS:

-DISPOSITION RATIONALE-

(A) DESIGN:
TIE BOLTS ARE DESIGNED TO A MINIMUM FACTOR OF SAFETY OF 1.5 WITH STANDARD MATERIAL ALLOWABLES. TIE BOLTS WERE STRENGTHENED AFTER ORBITER APPROACH AND LANDING TEST (ALT) - INCREASED DIAMETER, STRENGTH AND IMPROVED FATIGUE PROPERTIES. THE TIE BOLT NUTS ARE DISCARDED AFTER THEY HAVE BEEN USED ONCE.

(B) TEST:
QUALIFICATION TESTS: CERTIFICATION IS ACCOMPLISHED AS PART OF THE WHEEL ASSEMBLY, WHEEL/TIE BOLTS ARE SUBJECTED TO 1000 MILE ROLL TEST, YIELD COMBINED LOAD TESTS, STATIC LOAD TESTS AND PERFORMANCE TESTS.

YIELD COMBINED LOAD TEST: THE WHEEL WAS SUBJECTED TO TWO COMBINATIONS OF VERTICAL AND SIDE LOADS AS FOLLOWS;
ACTING INBD - 21,300 LBS VERTICAL LOAD AND 10,650 LBS SIDE LOAD.
ACTING OUTBD - 17,700 LBS VERTICAL LOAD AND 8,840 LBS SIDE LOAD.
THESE LOADS WERE APPLIED THROUGH THE TIRE CONSECUTIVELY AT THE ZERO DEGREE, 90 DEGREE, 180 DEGREE AND 270 DEGREE POSITIONS, WITH TWO MORE APPLICATIONS AT THE ZERO DEGREE POSITION. THERE WAS NO DAMAGE TO THE WHEEL OR TIE BOLTS.

ULTIMATE COMBINED LOAD TEST:
THE WHEEL WAS ALSO SUBJECTED TO TWO COMBINATIONS OF ULTIMATE VERTICAL AND SIDE LOADS AS FOLLOWS;
ACTING INBD - 27,750 LBS VERTICAL LOAD AND 13,900 LBS SIDE LOAD.
ACTING OUTBD - 23,100 LBS VERTICAL LOAD AND 11,550 LBS SIDE LOAD.

ULTIMATE RADIAL LOAD TEST:
THE WHEEL/TIRE ASSEMBLY SUPPORTED A LOAD OF 88,200 LBS APPLIED AT THE ZERO DEGREE POSITION, FOR 10 SECONDS, WITHOUT DAMAGE TO THE WHEEL OR TIE BOLTS.

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.

NLG WHEEL AND TIRE INSPECTION:
THE TIE BOLTS ARE INSPECTED (PER THE ML0308-0143 SPEC.) FOR EVIDENCE OF LOOSENESS, DEFORMATION OR CORROSION.
DURING WHEEL/TIRE INSPECTION AND INSTALLATION TIE BOLTS ARE CHECKED FOR DAMAGE AND TORQUED PER THE FOLLOWING PROCEDURE;
AFTER TIE BOLTS ARE DRAWN SNUG TIGHT, THEY ARE TORQUED IN A CRISS-CROSS PATTERN TO 95 PLUS OR MINUS 20 FT-LBS., THEN TORQUING IS CONTINUED IN A CRISS-CROSS PATTERN TO THE FINAL TORQUE OF 120 TO 130 FT-LBS.

NLG WHEEL/TIRE CERT:
VERIFIES NLG WHEEL/TIRE ASSEMBLY HAS BEEN BUILT UP AND TESTED PER THE VO70-510502 DRAWING, ML0308-0028 NOSE LANDING GEAR RIGGING SPECIFICATION AND ML0308-0143 NLG WHEEL/TIRE INSTALLATION AND INSPECTION SPECIFICATION.

FREQUENCY - ALL VEHICLES AT GROUND TURNAROUND.

(C) INSPECTION:
RECEIVING INSPECTION
SPS RECEIVING INSPECTION VERIFIES MP35N MATERIAL MEETS REQUIREMENTS OF SPS M646. B. F. GOODRICH RECEIVING INSPECTION SAMPLE CHECKS FOR TENSILE STRENGTH, HARDNESS, SURFACE FINISH AND ROUGHNESS AND ALL DIMENSIONS, INCLUDING GRIP LENGTH, SHANK LENGTH, HEAD RADIUS AND DIAMETERS.

CONTAMINATION CONTROL
CLEANLINESS AND CORROSION CONTROL REQUIREMENTS VERIFIED BY INSPECTION.

ASSEMBLY/INSTALLATION
THREADS ROLLED TO B. F. GOODRICH SPECIFICATION SS 31.2 VERIFIED BY INSPECTION. THREADS PER MIL-S-8879 METHOD B CERTIFIED. FABRICATION PROCEDURES VERIFIED BY INSPECTION. FABRICATION OF BOLTS VERIFIED BY GOVERNMENT SOURCE INSPECTION. TORQUING OF BOLTS TO SPECIFICATION REQUIREMENTS VERIFIED BY INSPECTION.

CRITICAL PROCESSES
HEAT TREATING OF MP35N BOLTS VERIFIED BY INSPECTION.

NONDESTRUCTIVE EVALUATION
SPS CERTIFIES 100% FLUORESCENT PENETRANT EXAMINATION PER MIL-I-6866. NO INDICATIONS PERMISSABLE. B. F. GOODRICH CONDUCTS FLUORESCENT PENETRANT INSPECTION OF SAMPLE PARTS.

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TESTING
SPS CONDUCTS TENSILE TESTING, FATIGUE TESTING, BOLT PRELOAD TESTING, STRESS DURABILITY TESTING AND METALLURGICAL MICROSTRUCTURE EVALUATION OF SAMPLE PARTS FROM EACH LOT AND LISTS ACTUAL VALUES ON CERTIFICATIONS.

PACKAGING/HANDLING
HANDLING AND PACKAGING REQUIREMENTS VERIFIED BY INSPECTION.

(D) FAILURE HISTORY:
NONE.

(E) OPERATIONAL USE:
WHEEL/TIRE FAILURE AT (OR SHORTLY AFTER) NLG TOUCHDOWN - CREW WILL USE AERO RUDDER AND DIFFERENTIAL BRAKING IN AN ATTEMPT TO MAINTAIN DIRECTIONAL CONTROL.

- APPROVALS -

EDITORIALLY APPROVED	: BNA	: J. Kyonura 8/3/97
EDITORIALLY APPROVED	: JSC	: A Searcy 9-12-97
TECHNICAL APPROVAL	: VIA APPROVAL FORM	: 96-CIL-011 02-1E