This Operational Hazard Analysis is presented in accordance with Paragraph 4.2.3 of the ALSEP-LS-10, "System Safety Program Plan for ALSEP Flight Array E Lunar Seismic Profiling Experiment Sub ystem".

This document has been revised to incorporate those changes in hardware and operations that have occurred since the original release. All revisions and additions are highlighted by the use of revision bars on the right hand side of each page.

A change to Revision A of this document has been incorporated prior to release of Revision B (1-12-72). The change was the deletion of Paragraph 4.3.1.

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1.0 INTRODUCTION AND SCOPE

The Operation Hazard Analysis evaluates all known hazards identified throughout the operational life cycle of the LSP Experiments; (1) Manufacturing and Assembly, (2) Handling and Transportation, (3) Storage, (4) Maintenance, (5) Test, and (6) Operational Phases, Figures 1 thru 5 are provided to clarify the hardware flow.

1.1 Philosophy - This analysis has been performed by evaluating the effects of environmental extremes, human errors, interaction with other equipments, and possible inherent failures throughout the life cycle phases of the equipment in order to determine operational hazards to which personnel, equipment, facilities, and flight hardware may be exposed. The results of this analysis may be utilized as a design tool to; (1) eliminate the hazards through design changes, (2) minimize hazards through procedural means, or (3) provide awareness of the existence of the hazards by identifying them in applicable procedures. This analysis supplements the Detailed Hazard Analysis (ATM 1049).

1.1.1 Definitions

AIRME:	Apollo Initiator Resistance Measurement Equipment
BxA	Bendix Aerospace Systems Division
Detonator Assembly:	An EDC with a 2 conductor shielded cable attached and encapsulated at the attachment point
EDC:	End Detonating Cartridge (Contains 100 milligrams Lead Azaid and 100 milligrams HNS-1)
E&SA:	Electronic and Safe/Arm Assembly - The assembly consisting of the timers, the Thermal Battery, the EP Electronics, the Safe/Arm Slide Assembly, and the EDC. In addition to the operating E&SA there is a "structural" E&SA, which is merely a representative mass, to which live H&C s are attached for shipment as an EPTM.

EP:	Explosive Package - The assembly that results from the mating of an Electronic and Safe/Arm Assembly and a Housing and Charge Assembly.
EPTM:	Explosive Package Transport Module - One complete flight array of EP's consisting of eight EP's, mounted four each on two transport frames.
Explosive Safety Distance:	The distance from an explosive charge at which the safety of unprotected personnel is assured without special protective measures.
H&C:	Housing and Charge Assembly - A fiberglass housing containing a block of high explosives which is mated to the E&SA to make an EP. In addition to the live H&C's, there are inert H&C's to which the operational E&SA's are attached for shipment as an EPTM. (Contains HNS-II in following amounts; 1/8, 1/4, 1/2, 1, 3, and 6 pounds).
HNS:	Hexanitrostilbene
HNS I:	Superfine HNS
HNS II:	Relatively large grain HNS
KSC:	Kennedy Space Center
LEAD:	Booster Charge - contains HNS-II (approximately 150 milligrams)
LSP:	Lunar Seismic Profiling Experiment
NOL:	Naval Ordnance Laboratory
WSTF:	White Sands Test Facility

LSP - EXPLOSIVE TEST PACKAGE FLOW - WSTF

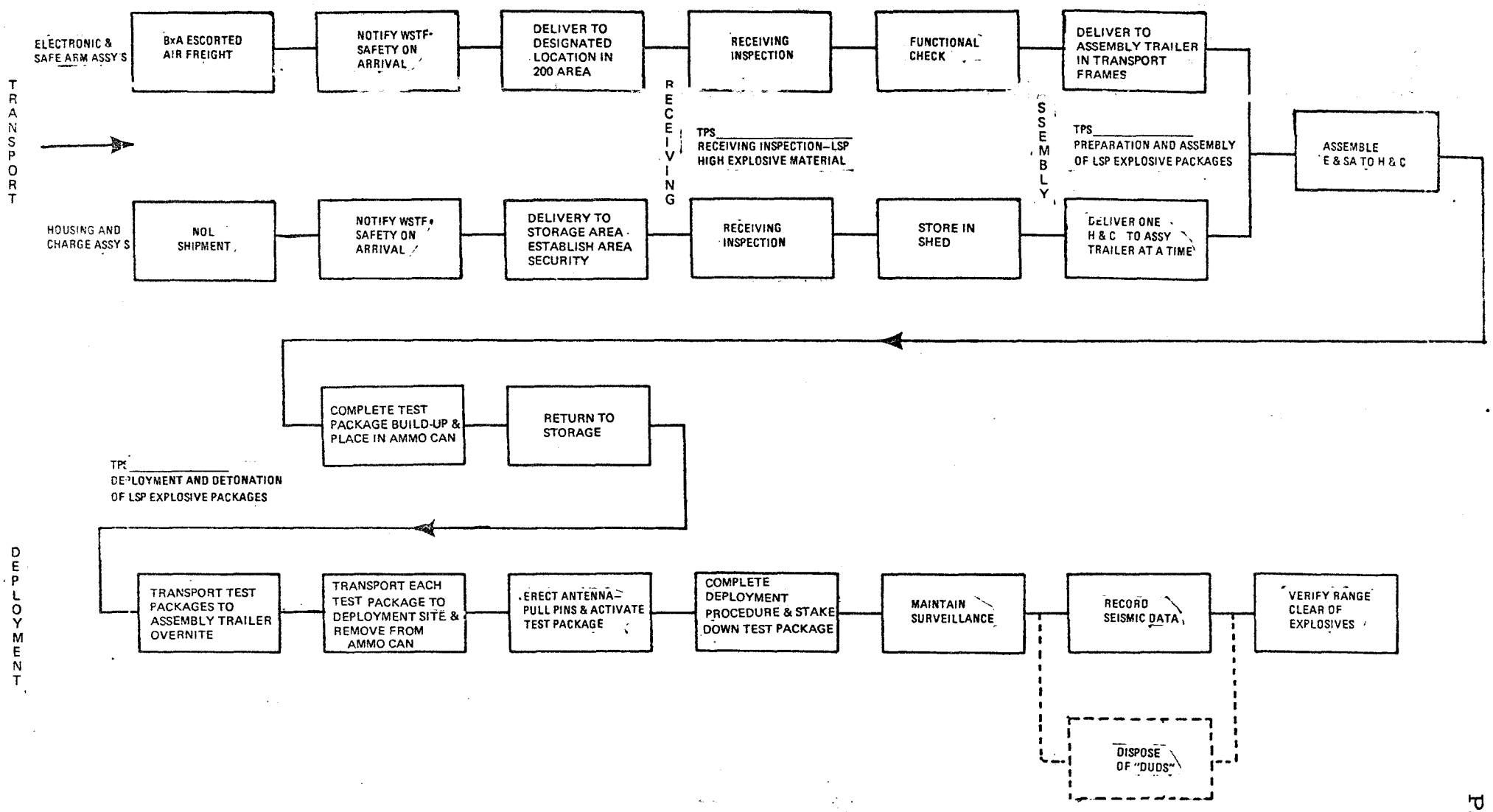


Figure 1

LSP EXPLOSIVE PACKAGE PROTOTYPE HARDWARE FLOW

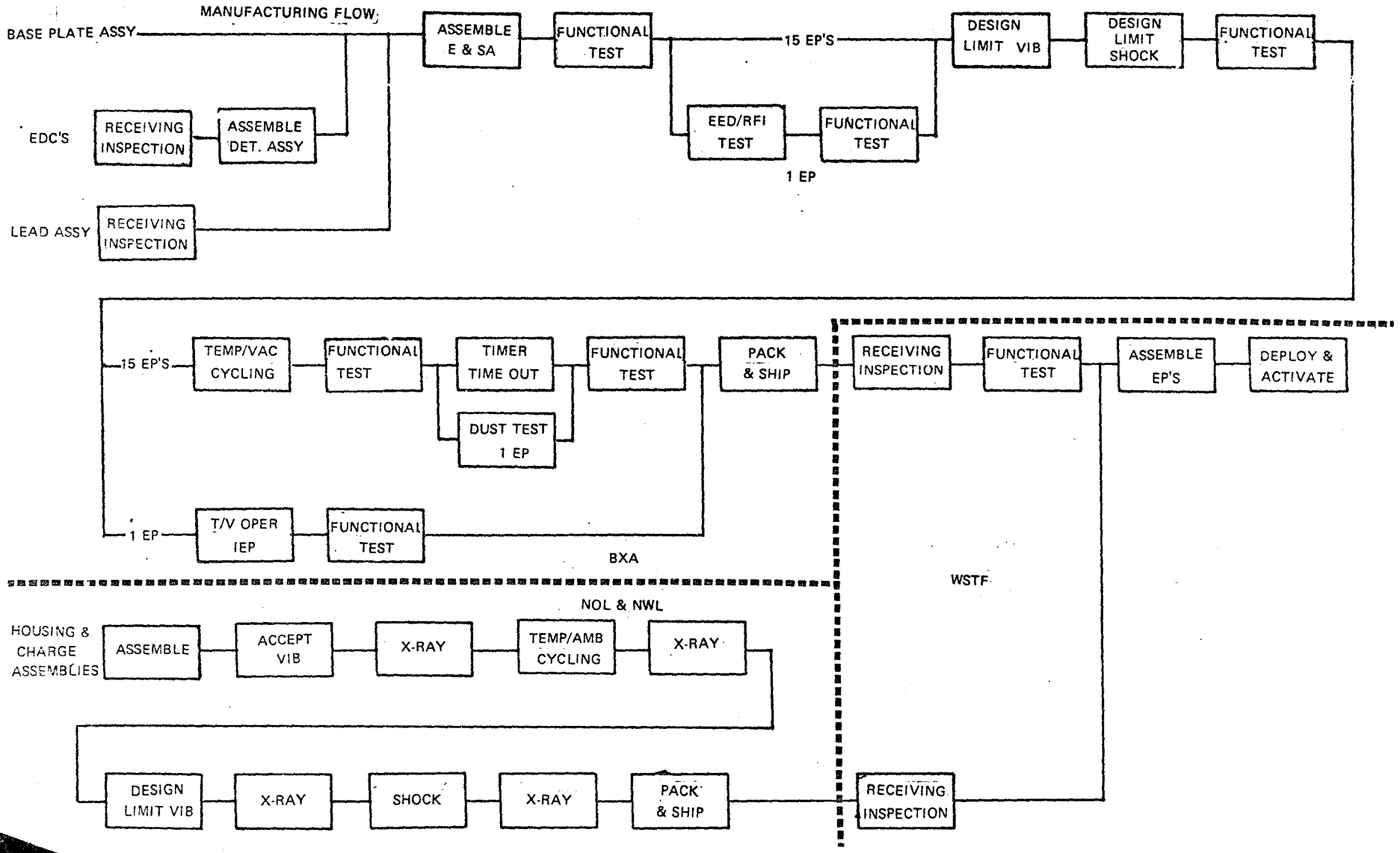


Figure 2

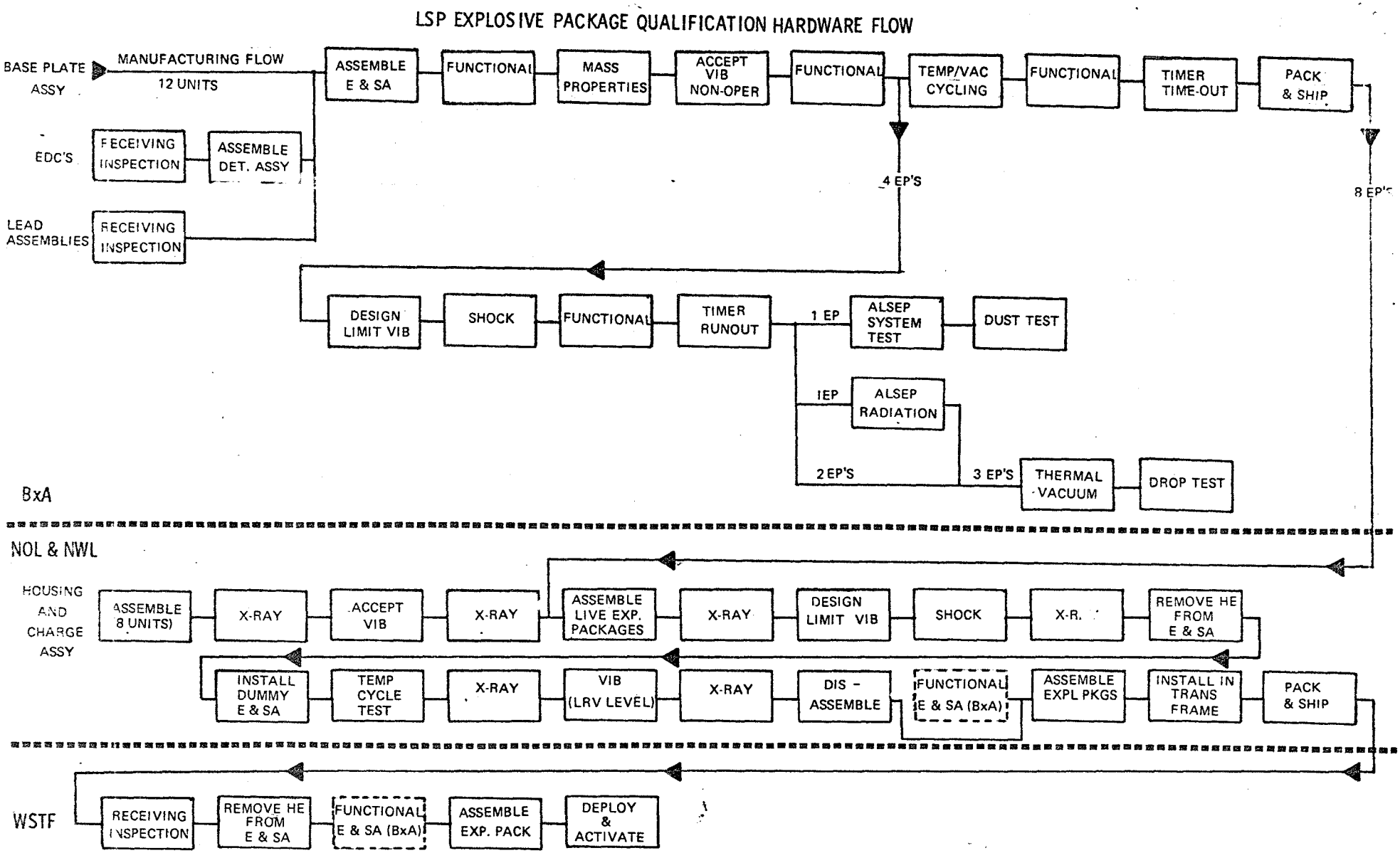

LSP EXPLOSIVE PACKAGE QUALIFICATION HARDWARE FLOW
BASE PLATE ASSY
MANUFACTURING FLOW
12 UNITS
ASSEMBLE E & SA
FUNCTIONAL
MASS PROPERTIES
ACCEPT VIB NON-OPER
FUNCTIONAL
TEMP/VAC CYCLING
FUNCTIONAL
TIMER TIME-OUT
PACK & SHIP
EDC'S
RECEIVING INSPECTION
ASSEMBLE DET. ASSY
LEAD ASSEMBLIES
RECEIVING INSPECTION
4 EP'S
8 EP'S
DESIGN LIMIT VIB
SHOCK
FUNCTIONAL
TIMER RUNOUT
1 EP
ALSEP SYSTEM TEST
DUST TEST
1EP
ALSEP RADIATION
2 EP'S
3 EP'S
THERMAL VACUUM
DROP TEST
BxA
NOL & NWL
HOUSING AND CHARGE ASSY
ASSEMBLE 8 UNITS)
X-RAY
ACCEPT VIB
X-RAY
ASSEMBLE LIVE EXP. PACKAGES
X-RAY
DESIGN LIMIT VIB
SHOCK
X-R.
REMOVE HE FROM E & SA
INSTALL DUMMY E & SA
TEMP CYCLE TEST
X-RAY
VIB (LRV LEVEL)
X-RAY
DIS - ASSEMBLE
FUNCTIONAL E & SA (BxA)
ASSEMBLE EXPL PKGS
INSTALL IN TRANS FRAME
PACK & SHIP
WSTF
RECEIVING INSPECTION
REMOVE HE FROM E & SA
FUNCTIONAL E & SA (BxA)
ASSEMBLE EXP. PACK
DEPLOY & ACTIVATE

Figure 3

LSP EXPLOSIVE PACKAGE FLIGHT HARDWARE FLOW

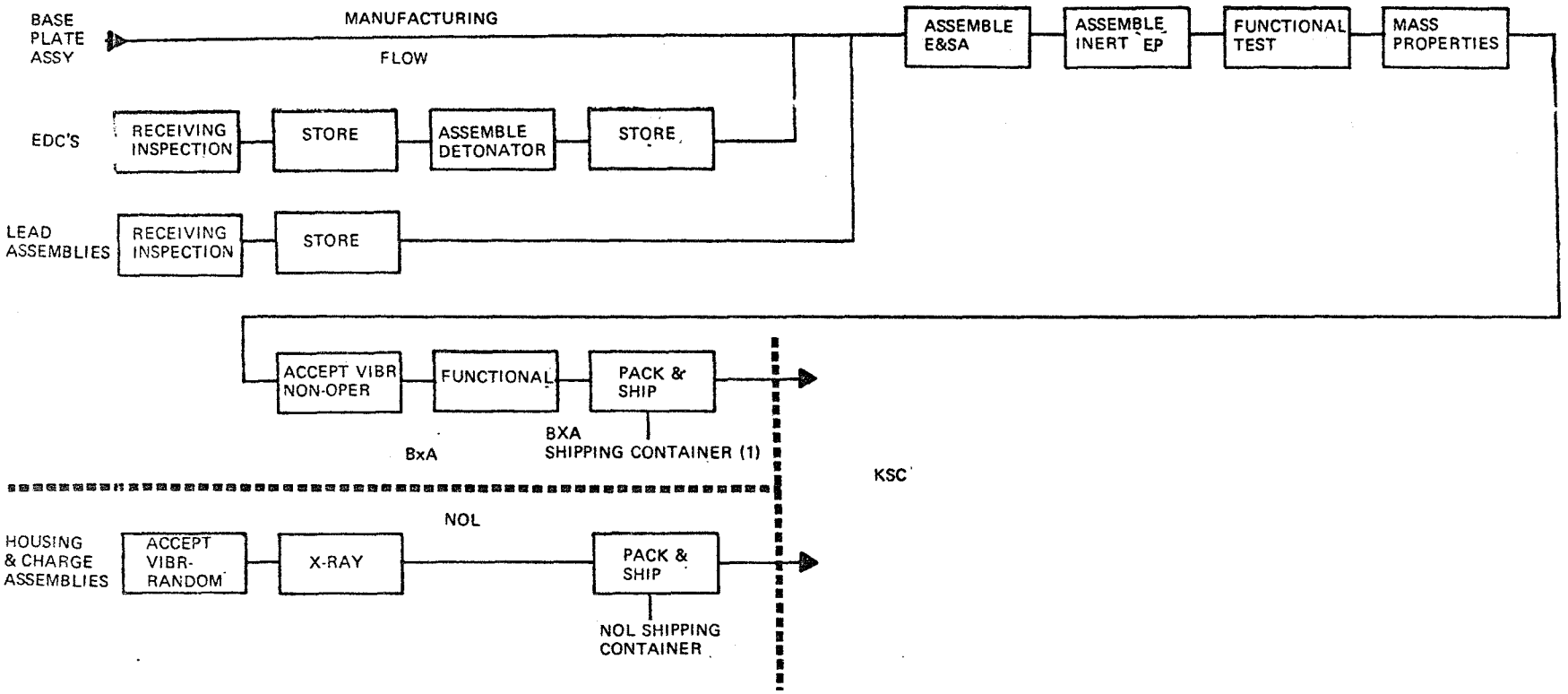


Figure 4

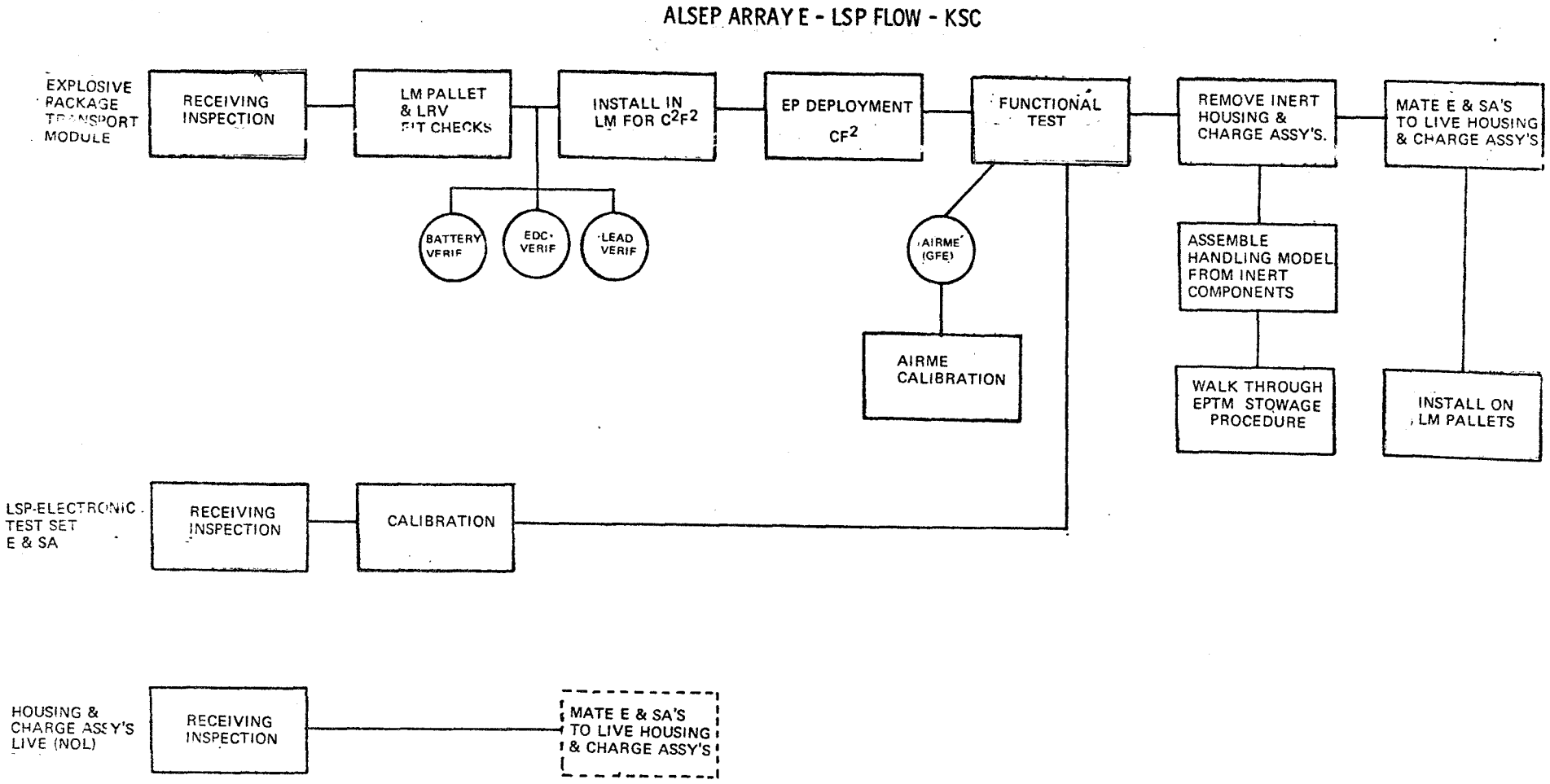

ALSEP ARRAY E - LSP FLOW - KSC
EXPLOSIVE PACKAGE TRANSPORT MODULE
RECEIVING INSPECTION
LM PALLET & LRV FIT CHECKS
INSTALL IN LM FOR C2F2
EP DEPLOYMENT CF2
FUNCTIONAL TEST
REMOVE INERT HOUSING & CHARGE ASSY'S.
MATE E & SA'S TO LIVE HOUSING & CHARGE ASSY'S
BATTERY VERIF
EDC VERIF
LEAD VERIF
AIRME (GFE)
AIRME CALIBRATION
ASSEMBLE HANDLING MODEL FROM INERT COMPONENTS
WALK THROUGH EPTM STOWAGE PROCEDURE
INSTALL ON LM PALLETS
LSP-ELECTRONIC TEST SET E & SA
RECEIVING INSPECTION
CALIBRATION
HOUSING & CHARGE ASSY'S LIVE (NOL)
RECEIVING INSPECTION
MATE E & SA'S TO LIVE HOUSING & CHARGE ASSY'S

Figure 5

2.0 APPLICABLE DOCUMENTS

The following documents have been referred to in the preparation of this report.

BxA ALSEP-LS-10 6 April 1971	System Safety Plan for ALSEP Flight Array E Lunar Seismic Profiling Experiment Subsystem
BxA Dwg. #2365390 Rev. A 23 Aug 1971	Safety Requirements - Lunar Seismic Profile (LSP) Experiments Explosive Sub-Assemblies
The Franklin Institute Research Laboratory Tech. Report #FM-B2419 Dec. 1965	Instruction Manual Apollo Initiator Resistance Measuring Equipment (AIRME)
BxA TP2365388 Rev. #1 5 Mar 1971	Test Procedure EDC Bridgewire Resistance Measurement for LSP Inert Explosive Package
BxA Doc. LS 11 14 Sept. 1971	LSP Field Test Safety Plan
BxA Doc. ATM 1049 16 August 1971	LSP Detailed System Hazard Analysis
KSC SP-4-43-5 15 March 1965	Explosive Safety Handbook

3.0 MANUFACTURING AND ASSEMBLY

3.1 Assembly at BxA - During the Manufacturing and Assembly phase at BxA the EDCs and Lead Assemblies are placed in a segregated and isolated area within the Bonded Stores prior to removal to the assembly area.

Assembly of the LSP explosive subassemblies are performed in a specified access controlled area which have explosive warning placards posted at all entrances, and prominent signs which prohibit smoking within the area.

An EDC Holding fixture is provided to ensure protection of personnel and adjacent equipment in the event of an inadvertent detonation, while the EDC is being built up into a detonator assembly. During this assembly the personnel are grounded to avoid detonation by a static electric charge.

3.2 Assembly at WSTF - The H&C's and E&SA's are brought from the storage areas to an assembly area, where the E&SA is placed on top of the H&C and a vertically downward pressure is applied on the E&SA with an EP Assembly press. Eight screws are installed in the mounting holes and tightened to 5±1/2 inch pounds.

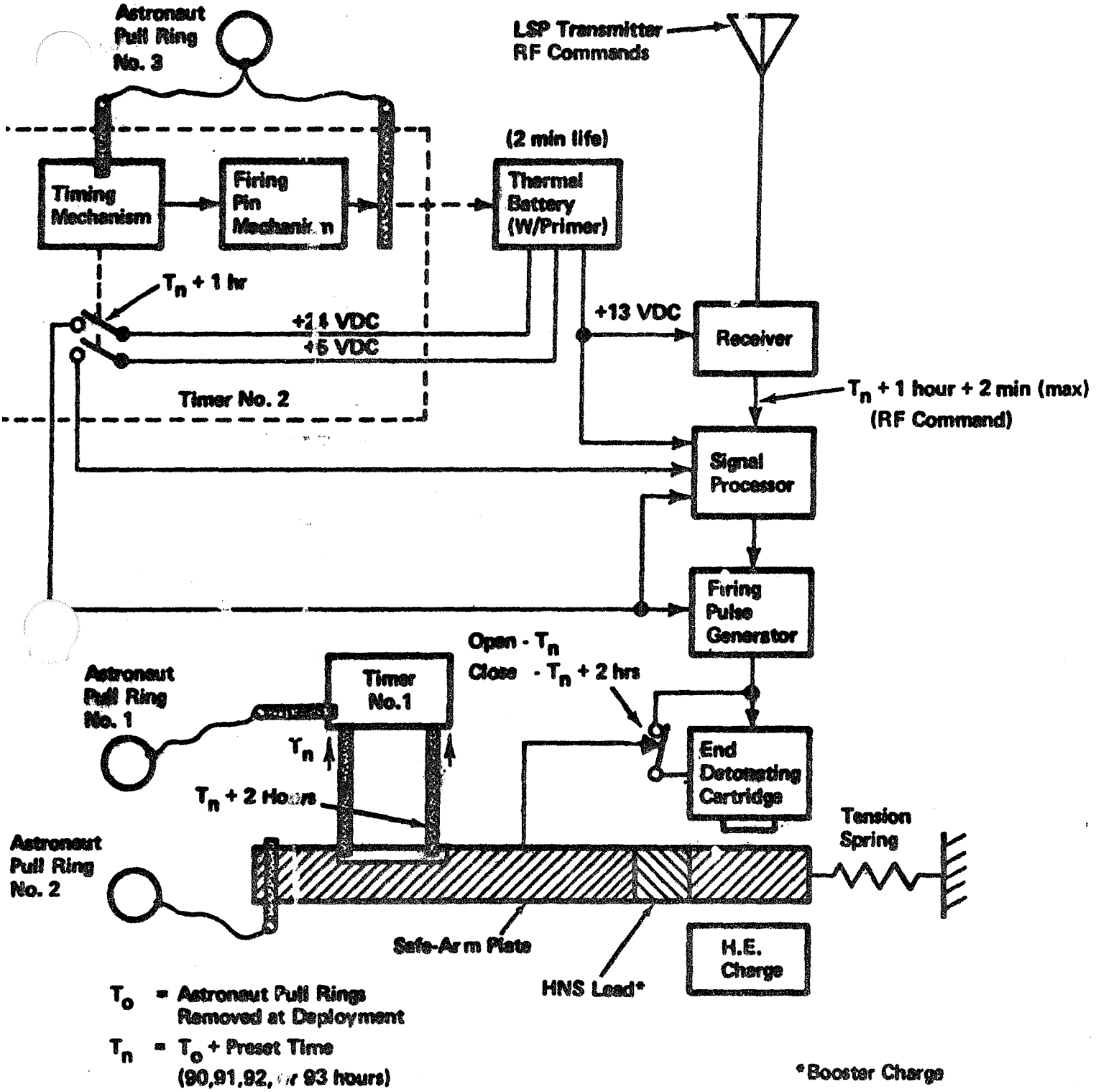
3.3 Assembly at KSC - Eight E&SA's and H&C's are assembled into eight EP's in a controlled assembly area by BxA-KSC personnel and installed on two Transport frames to complete the EPTM. The EPTM is then installed on the LM pallet.

3.4 Hazard Consideration #1 - Incorrect assembly of Timer No. 1 to the Safe-Arm Plate during assembly at BxA (para. 3.1) could result in the arming pin not engaging the Safe-Arm Plate, (Fig. 6), allowing immediate movement of the safe-arm plate to the armed position upon removal of Pull Ring Pin No. 2.

3.4.1 Recommendation - Verify that the arming pin retains the safe/arm slide in the safe position prior to final installation of the Safe/Arm Slide safety pin.

3.5 Hazard Consideration #2 - A cold solder joint at the EDC grounding switch could result in an open circuit, causing the EDC to be in an unsafe condition during handling and testing.

3.5.1 Recommendations - Perform continuity check after assembly of the EDC grounding switch connections.



BLOCK DIAGRAM OF EXPLOSIVE PACKAGE

Figure 6

3.6 Hazard Consideration #3 - Incorrect installation of Timer Starter Pins (Pull Ring Numbers 1 or 3) could result in inadvertent timer operation.

3.6.1 Recommendations - Visual inspection to verify that the timer pawl remains engaged with the start tooth. Temporarily lock wire pins in place and maintain security on timers to avoid tampering.

4.0 HANDLING & TRANSPORTATION (H&T)

4.1 H&T to WSTF & KSC - The LSP is transported as an EPTM consisting of two transport frames with four E&SA's assembled to four inert H&C's mounted on each of the two transport frames.

The EPTM is transported in one ALSEP shipping container by escorted air freight. The E&SA's are categorized as Class "C" Explosives (defined in KSC Explosive Safety Handbook) as each contains one EDC and one Lead.

The live H&C's are Class "A" explosive and are transported separately by the NOL, in NOL provided shipping containers. BCA is responsible for the coordination of the delivery of the H&C's with NOL to assure schedule compatibility, and for notification of cognizant site safety personnel upon arrival of the shipments.

4.2 H & T to LM - Prior to launch the E&SA's and H&C's are removed from their storage areas, assembled into EP's and transported as an EPTM on the LM pallet for installation in the LM.

4.3 Hazard Consideration #4 - There are no known unique hazards during this operational phase. Although allowable maximum packaged storage temperature, (80°F: 26.7°C) for the experiment may be exceeded during transportation or storage, HNS sensitivity is nearly constant to temperatures up to 400°F and does not constitute a hazard unique to this operation.

5.0 STORAGE

5.1 WSTF Storage - The E & SA's and the H & C's prior to assembly, and the EP's after assembly are placed in a non-environmentally controlled containers and stored in a non-environmentally controlled structure until ready for use at the test site.

5.2 KSC Storage - The above storage procedure differs at KSC where the E & SA's are stored within the environmentally controlled shipping container in a bonded environmentally controlled area, while the H & C's are stored in an explosive storage bunker. The two assemblies are not combined into EP's until shortly before installation into the LM.

5.3 Hazard Consideration - Same as paragraph 4.3 for WSTF storage.

5.3.1 Recommendations - Same as paragraph 4.3.1.

6.0 MAINTENANCE

6.1 WSTF Maintenance - After the EP's are assembled they are placed in individual containers and transported to the deployment sites. If a mishap should occur which requires a maintenance action, the EP's would be disassembled and the E & SA returned to a maintenance area and repaired prior to redeployment.

6.2 KSC Maintenance - During the Crew Fit and Function (CF^2) exercise the EPTM with live EDC's and "Leads, and an inert H & C block are deployed, simulating Lunar deployment. The results of the exercise will determine necessary modifications and decal implacements. The items used for CF^2 will be refurbished as necessary for use as flight hardware. The explosive package pull pins will not be exercised at this time.

6.3 Conclusion - There are no known unique hazards during these operational phases.

7.0 TEST

7.1 Functional Test - Functional testing is conducted on the E & SA's (without an H& C) at BxA, WSTF, and KSC during various points of the hardware flow. The functional tests are conducted to determine the electronics equipment integrity after environmental testing. Three types of testing equipment are used for the functional tests; (1) The LSP-ETS Electronics and S/A Assembly which provides for suppling 5.5, 13.75, 24.75 VDC to the E & SA and provides a load for the E & SA assembly checkout. A ground is provided across the EDC connections to maintain the E & SA assembly in a safe condition when it is functioned and allowing the grounding switch to be opened. (2) The AIRME which allows the testing of the EDC Bridgewire. This test is done by allowing a maximum of 20.0 milliamperes to flow across the EDC bridgewire for a maximum of 15 seconds (automatic timer to keep exposure time of all initiators approximately equal). During this test the EDC grounding switch connection cannot be grounded in order to provide the measurement. (3) A modified ALINCO test set to perform the same function as the AIRME. The major difference between the two is that the ALINCO does not have the 110 Volt hazard, does not have the timer capability, and allows a maximum current of 5 milliaperes across the bridgewire. The modification of the ALINCO test set consists of an added resistance range to the instrument from a maximum of 30 ohms to a maximum of 3000 ohms.

7.2 Destructive Test - Destructive testing is conducted at WSTF only. The E & SA and H & C assemblies are combined into an Explosive Package and transported to the test site for "time-out" and activation. During the "time-out" period subsequent Explosive Packages are being assembled and awaiting deployment. The sequence of Explosive Packages are as follows; (a) 1 package deployed and 3 being assembled during "time-out", (b) 3 packages deployed while 4 being assembled during "time-out", (c) 4 packages being deployed while 4 being assembled during "time-out", (d) 4 being deployed while 4 being assembled and, (e 4 being deployed while none are being assembled.

7.3 Hazard Consideration - An open circuit at the test set EDC grounding connection during a functional (Paragraph 7.1) would allow the EDC to remain in an unsafe condition when the Safe-Arm Slide moves to the armed position.

7.3.1 Recommendation - The hazardous condition can be minimized by by providing for a continuity check of the ground connection prior to testing, however this would not allow for awareness of the circuit opening after the continuity check. The hazardous condition can be eliminated with the use of an indicator which will allow the test conductor to be aware of an open circuit throughout the testing phase.

7.4 Hazard Consideration - The LSPE Field Test Plan (WSTF) operational sequence (paragraph 6.8) allows subsequent sets of explosive packages to be assembled during the "time-out" period of a previously deployed package. This could allow assembled packages to be stored approximately 3 days without test result knowledge, and could lead to possible additional handling in the event of test failure or premature detonation which would require field modifications.

7.4.1 Recommendation - Subsequent packages should not be assembled until after the test results have been examined (In the case of a premature detonation of an unknown cause, the HE packages can be detonated without loss of the E & S/A's), or a minimum consideration would be to not assemble subsequent packages at least 8 hours prior to detonation.

7.5 Hazard Condition - During functional testing of the EDC bridgewire with AIRME, the initiator is shorted in a safe condition with switch S1D and S1E until the test is conducted (15 sec). The Modified ALINCO Tester used at WSTF does not incorporate this safety feature, resulting in an unsafe condition of EDC through the testing operation.

7.5.1 Recommendation - Incorporate the shorting feature of the AIRME into the ALINCO Tester.

8. LUNAR

8.1 Lunar Deployment - The LSP is transported to the Moon in the descent stage of the LM and deployed on the lunar surface during the second and third periods of extra-vehicular activity. During flight the explosive materials in the LSI are completely contained within 8 Explosive Packages stored in Quadrant III of the LM descent stage. During lunar deployment the Explosive Packages are removed from the LM and placed in Lunar Roving Vehicle for deployment at a distance from a few meters to a maximum of 3.5 km from the ALSEP Central Station, at which time the safety pull pins (3) are removed to start the timers, and the antenna is deployed. The timers are set to allow the Explosive Packages to be Armed at a minimum time of 90 hours after the pins are removed, at which time, the Crew Members have left the lunar surface, and the Explosive Packages may be detonated. If the Explosive Packages are not detonated within 2 hours after the armed position is attained the Safe-Arm Plate moves to a resafe position and cannot be detonated by a command signal.

8.2 Conclusion - There are no known unique hazards during this operational phase.