Bendix
Aerospace Systems Division

Preliminary Design Considerations for On-Pad Testing of ALSEP

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SUMMARY

Within prescribed constraints, meaningful functional and performance testing of ALSEP can be effected after installation on the launch vehicle. Such testing could provide increased confidence of mission success in the event of extended launch delays or environmental stress during launch preparations.

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1.0 TESTING CONSTRAINTS

1.1 Access to ALSEP

1.1.1 Electrical connections. - Requirements for electrical connections to ALSEP necessitate the partial withdrawal of both subpackages from their installed positions in the LM SEQ bay compartments. Specific access needs are the following:

a. Central Station: Electrical connection to RTG simulator, J22, and to the RF link cable, J21. (The latter will be obviated if an "open" RF link can be implemented.)

b. SIDE: Insertion (and subsequent removal) of high voltage lock-out plug, and electrical connection, on both subpackages, of jumper cable to SIDE cable connectors.

c. PSE: Insertion (and subsequent removal) of shorting plug to inhibit uncaging, P31. Alternatively, connection of the sensor exciter cable at the same jack may be considered.

d. SWS: Removal (and subsequent insertion) of enable plug, J1.

It appears that the electrical connections defined above can be accomplished with a 50% withdrawal of each of the subpackages from its installed position.

1.1.2 Other access considerations.

a. The SEQ Bay door thermal coatings can be ruined by repeated operation.

b. Restrictions on ALSEP Subpackage withdrawal under 1g conditions are as follows:

1. The ALSEP handles may be used, with care, to slide the Subpackages on their rails in and out of the LM SEQ Bay; however, no lifting or twisting can be applied.

2. Below the handle is a slotted tab for attachment of a tool, or clip and lanyard, for heavy pulling.

3. Pushing against the interface tabs is permissible.

c. The surface of the SEQ Bay Door can be damaged by contact with equipment being maneuvered into position. Damage to this surface will require replacement of the door.

d. The inside surface of the SLA cannot be touched with bare hands. Contact with nylon gloves is acceptable.

e. All hand tools and items of equipment under 50 lbs. in weight must be tethered to the operator if not fastened to securely bolted down G.S.E.

1.1.3 Electrical power. - Provision of an RTG simulator is required. To preclude excessive cable loss with practical conductor sizing, the simulator should be no more than 40 feet from the LM SEQ Bay.

Ease of access with an electrical power cable depends on the period in the countdown. Access exists as follows: A 10-inch diameter access port is situated at the Xa 551" level (ALSEP/SEQ Bay access platform is at Xa 525" level) just above the top of the ladder to the Xa 525" platform. With the Mobile Service Structure in position around the vehicle on the pad, a platform (Platform 3A) is positioned adjacent to the 10" diameter access port at level Xa 512-3/4". (In the VAB, the closest platforms to the access port are at Xa 589 3/16" (Platform B - VAB, 2nd Floor) and Xa 380 3/16" (Platform B - VAB, Main Floor).

1.1.4 RF link. - An RF link must be established between the ALSEP and the system test set. Two alternative configurations may be considered: a "closed" link, featuring coaxial cable coupling of the test set to the ALSEP Central Station, and an "open" link, based upon radiated coupling with the ALSEP.

Electromagnetic interference must be reduced to a tolerable level by good engineering practice and by appropriate scheduling of ALSEP tests and shut-down, if necessary, of major sources of interference.

All RF connections to ALSEP (open or hard line) must be cleared by KSC Safety Department because of the proximity of installed ordnance items. Additional clearance and coordination will be required to preclude EMI with other Space vehicle systems.

1.1.5 Thermal. - Because On-pad testing of ALSEP must be accomplished with all equipment in the stowed position, thermal radiation will be relatively inefficient. No problem is anticipated on subpackage No. 2. However, the Central Station will be subjected to a rapid temperature rise (estimated at 20°F per hour) under operating conditions. This imposes a time limit on continuous testing of about 3 hours.

It will also be necessary to direct a high volume of low velocity cooling air over the sunshield, to ensure that maximum convection cooling is obtained.

Cooling facilities are available in the SLA at the LM SEQ Bay. A duct, terminating in a nozzle, will be run from the S IV B Stage Instrument Unit Cooling air duct to a position beneath the ALSEP graphite fuel cask. (Final design has not been established.) At the time of the projected testing of ALSEP, the Fuel Cask will not be installed; thus, a flexible duct may be attached to the Cask cooling nozzle and the available air can be directed over ALSEP. This solution requires no further modification of the I.U. cooling system nor the bringing in of extra cooling lines.

1.1.6 Operational constraints. - There are several operational constraints, some of which have been implemented by electrical interlocks described above. Others will require procedural precautions. Some of these constraints are listed below:

a. Central Station

1. Commandable heaters should not be energized for thermal control reasons.

b. Timer output should be inhibited to preclude inadvertent initiation of operational commands.

b. PSE

1. Uncage command cannot be exercised.

2. Leveling motors should not be run.

c. SWS

1. Dust cover removal cannot be effected (command can be sent but not executed).

2. Gain change command cannot be initiated.

d. LSM

1. Flip/Calibrate and Site Survey cannot be initiated.

2. Science data will read at saturation level.

e. SIDE

1. Dust cover cannot be removed.

2. CCIG seal cannot be broken.

NOTE: (1) and (2) limit the command access to SIDE.

3. High voltages are locked out.

Within the limitations of the above constraints, ALSEP data returned by on-pad testing can be expected to compare favorably with that obtained in laboratory Integrated System Tests (TP 2333034). Appendix A summarizes this comparison.

2.0 TEST FACILITIES

Two gross configurations of on-pad test facilities can be considered:

a. System Test Set installed in a building on the site at Cape Kennedy, up to several miles from the launch vehicle, with an "open" RF link to ALSEP.

b. System Test Set installed in a van, located near the base of the launch support structure, with either a "closed" or "open" RF link to ALSEP.

2.1 Building installation. - The System Test Set (STS) for this configuration requires no major redesign. An appropriate antenna (e.g. an S-band horn) is mounted on the roof of the building or in a window within line-of-sight to ALSEP in its pad location. The antenna is connected by coaxial cable to the STS diplexer.

At the ALSEP end, the RF link is completed through a possible antenna relay consisting of two identical antennas, one outside the Spacecraft LM adapter (SLA) and the other inside. The two antennas are connected by means of a coaxial cable. The external antenna is pointed at the test facility antenna while the inside antenna is radiatively coupled to the ALSEP antenna. As an alternative, the external antenna can be connected by coaxial cable directly to J21 on the Central Station, bypassing the ALSEP antenna.

The STS utilizes commercial 60-cycle power provided to building mains.

ALSEP is powered for these tests by an RTG simulator. To simplify the installation of the RTG simulator, this unit should be redesigned to reduce its weight and volume. Flexibility can be sacrificed without compromising performance specifications. The simulator is connected by a multiconductor cable to the ALSEP Central Station.

During the tests, the RTG simulator area will be manned by a test engineer who is in communication with the test facility via the standard KSC Intercommunication system.

Recommended location for the RTG simulator is on the Mobile Service Structure, Platform 3A.

Test facilities for ALSEP have been planned around an installation in the Parachute Building, M7-657, in the KSC Industrial area. This is situated some 7 miles from Pad B and 6 miles from Pad A by line-of-sight. The planned installation includes a 4-foot diameter dish antenna for S-Band transmission to and from the MILA MSFN Station. This antenna could be made adjustable to line up with Complex 39 Pad A or B.

2.2 Van installation. - The STS for van installation requires considerable mechanical modification to accommodate shock and vibration mounting on the bases and backs of the racks.

The electrical input power circuit should be modified to accommodate either of two available sources:

a. A gasoline-driven generator on an adjacent trailer.

b. Base facility (commercial) power pigtailed out to the van. (An Interface Revision Notice (IRN) can be generated at KSC to provide a connector adjacent to the parking areas for the van at each pad. The connector would supply 60-cycle power at appropriate current and voltage.)

The RF link connecting the van installation to ALSEP can be the "open" type described above, with a small antenna mounted on the roof of the van, or the "closed" type, with a coaxial cable running from the van up through the Launch Support Structure to ALSEP. If the latter system is employed, two separate coaxial cables should be run, by different routings, to guard against simultaneous mechanical or thermal damage. Coaxial relays at both ends will then permit selection of either cable for test operations. The selected cable is electrically connected to the ALSEP antenna jack, J21, after manual removal of the antenna cable.

Estimated length of the cable run is 550 feet. Exact routing must be planned and the appropriate IRN is then generated.

The required RTG simulator is as described above.

3.0 RECOMMENDED PRIORITY OF ACTIONS

The following is the recommended sequence of action:

a. Obtain current EMI signature of the Cape Kennedy area with special emphasis on signal levels at S-band. Determine whether radiation at ALSEP frequencies is permissible. If levels are above ALSEP tolerance level or permission is not probable, proceed to Step 4.

b. Check availability of a suitable building for installation of the System Test Set. If none is available, proceed to Step 5.

c. Plan building installation of System Test Set with open RF link to ALSEP. End of sequence.

d. Plan van facility with closed RF link to ALSEP. End of sequence.

e. Plan van facility with open RF link to ALSEP. End of sequence.

APPENDIX A

Comparison of Laboratory and On-Pad System Tests

Parameter	Tested at BxA per 2333034	Capable of On-Pad Testing	Remarks
A. Central Station			
1. Input power	x	x	
2. Xmtr power output	x	x	New link loss figure.
3. Xmtr. frequency	x	x	
4. Xmtr AGC voltage	x	x	
5. Xmtr doubler current	x	x	
6. Xmtr select status	x	x	
7. PCU select status	x	x	
8. Shunt regulator current	x	x	
9. Experiment STBY status	x	x	
10. Data processor selection	x	x	Response to octal commands 34 and 35.
11. PDM load switching	x	x	Response to octal commands 21 and 23.
12. Dust detector status	x	x	
13. PCU switching control	x	x	Response to octal commands 62 and 60.
14. Xmtr select switching cont.	x	x	Response to oct. commands 12 and 15.
15. Xmtr ON-OFF control	x	x	Response to octal commands 14 and 13.
16. Command decoder selection	x	x	Response to alternate address
17. Data rate	x	x	
18. Command verification	x	x	
19. Dust detector control	x	x	Response to octal commands 27 and 31.
20. Dust detector temperatures	x	x	
21. Dust detector science data	x	x	Light source required.
22. Experiment power control	x	x	Response to octal commands 36, 37, 41-46, 50, and 52-54
23. Astronaut switch control	x	x	Requires manning of site.

APPENDIX A (cont.)

Parameter	Tested at BxA per 2333034	Capable of On-Pad Testing	Remarks
Central Station (cont.)			
24. Exp. ON status	x	x	
25. Commandable heater control	x	x	Momentary ON on pad to preclude excessive heating.
26. Auto. Cal. pulse	x		Complexity of procedure precludes.
27. Antenna radiation	x	x	Requires coupling to antenna.
28. Ripple off	x	x	
29. Temperatures of structure and components	x	x	
B. Solar Wind Spectrometer			
1. Power control	x	x	
2. Power consumption	x	x	
3. Power profile	x	x	
4. Data formatting	x	x	
5. Electrometer calibration	x	x	
6. Temperature calibration	x	x	
7. A/D converter calibration	x	x	
8. DC HV calibration	x	x	
9. AC HV calibration	x	x	
10. Cycle count	x	x	
11. Sequence count	x	x	
12. Dust cover removal	x	x	Response to octal command 122; no execution in ambient pressure.
C. SIDE			
1. Power control	x	x	
2. Power consumption	x	x	
3. Data formatting	x	x	
4. Command input register	x	x	Response to octal command 104.
5. One time command register	x	x	Response to octal command 105.
6. Mode register	x	x	

APPENDIX A (cont.)

Parameter	Tested at BxA per 2333034	Capable of On-Pad Testing	Remarks
SIDE (cont.)			
7. Dust cover & seal status	x	x	
8. Frame reset	x	x	Response to octal commands 104, 105, 110.
9. Ground plane stepper status	x	x	
10. Ground plane voltage	x	x	
11. Ground plane control	x	x	Response to octal commands 104 and 110.
12. Velocity filter reset	x	x	Response to octal commands 106 and 110.
13. Velocity filter voltage	x	x	
14. LE CPA voltage	x	x	
15. Velocity filter ON/OFF control	x	x	Response to octal commands 104, 107 and 110.
16. LE CPA ON/OFF control	x	x	Response to octal commands 105, 107, and 110.
17. HE CPA ON/OFF control	x	x	Response to octal commands 104, 105, 107 and 110.
18. Forced cal. ON/OFF control	x	x	Response to octal commands 106, 107 and 110.
19. X10 accumulation control	x	x	Response to octal commands 104, 105, 106 and 110.
20. Frame counter	x	x	
21. Calibration	x	x	
22. Analog LE detector count	x	x	
23. Analog HE detector count	x	x	
24. Temperatures	x	x	
25. Supply & reference voltages	x	x	
26. Electrometer range	x	x	
27. CCGE range	x	x	

APPENDIX A (cont.)

Parameter	Tested at BxA per 2333034	Capable of On-Pad Testing	Remarks
D. PSE			
1. Power control	x	x	
2. Power consumption	x	x	
3. Amplifier gain status	x	x	HK data
4. Level direction & speed	x	x	HK data
5. Level mode & coarse sensor mode	x	x	HK data
6. Thermal control status	x	x	HK data
7. Calibration status	x	x	HK data
8. Uncage status	x	x	HK data
9. Sensor temperature	x	x	
10. Level direction control	x	x	Response to octal command 74
11. Level speed control	x	x	Response to octal command 75
12. Level mode control	x	x	Response to octal command 103.
13. Coarse sensor control	x	x	Response to oct. command 102.
14. Thermal mode control	x	x	Response to oct. command 76
15. Leveling motor control	x	-	Not recommended for on-pad
16. Gain change control	x	x	Response to octal commands 63, 64, and 67.
17. Calibration control	x	x	Response to octal commands 65 and 66.
18. Feedback filter control	x	x	Response to octal command 101.
19. Uncage control	x	x	Response to octal command 73 (Uncaging inhibited)
20. Pressure control	x	-	Req. sensor exciter.

APPENDIX A (cont.)

Parameter	Tested at BxA per 2333034	Capable of On-Pad Testing	Remarks
E. ME (LSM)			
1. Power control	x	x	
2. Power consumption	x	x	
3. Flip positions status	x	x	
4. Gimbal positions status	x	x	
5. Thermal control mode	x	x	
6. Heater status	x	x	
7. Measurement range	x	x	
8. Field offsets	x	x	
9. Cal. mode status	x	x	
10. Offset ratchet address	x	x	
11. Filter status	x	x	
12. Cal. inhibit status	x	x	
13. Science data	x	-	Complexity of measurement precludes on-pad.
14. Range select control	x	x	Response to octal command 123.
15. Sensor temperatures	x	x	
16. Level status	x	x	
17. Reference voltage	x	x	
18. Offset ratchet control	x	x	Response to octal command 125.
19. Steady field offset control	x	x	Response to octal command 124.
20. Flip calibrate	x	-	Not feasible on pad
21. Filter bypass control	x	x	
22. Site survey	x	-	Not feasible on pad
23. Thermal control select	x	x	Response to octal command 134.