The attached document is the engineering model test plan written by the Active Seismic Experiment Engineering Group. This outlines and describes the scope and objective of the test that will be made by the ASE Engineering Group with the engineering model.

A master test schedule is included as part of the test plan. The tests are scheduled to be completed by 1 January so that the engineering model may be delivered to Systems Engineering for inclusion in System Tests.

Prepared by J. Zimmer

Approved by R. A. Schmidt

Approved by J. E. Dye

EXPERIMENTS ENGINEERING

TEST PLAN

FOR THE

ACTIVE SEISMIC EXPERIMENT

ENGINEERING MODEL TESTS

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1.0 SCOPE

This plan defines tests that will be made by the Active Seismic Experiment (ASE) Engineering Group with the ASE engineering model prior to delivery to the systems engineering.

2.0 TEST OBJECTIVES

The objectives of the engineering tests are to verify and demonstrate that the design meets the experiment operational and performance requirements as defined in CP 315000. In addition interface characteristics will be tested to verify compliance with interface requirements as defined in IC 314100.

3.0 COMPONENT TESTS

Component tests are tests of each of the major components of the ASE subsystem, including tests of two or more assemblies of a component. The major components are the Central Electronics, the Mortar Package, the Thumper, and the Geophones and Cabling.

3.1 Central electronics - The central electronics is comprised of gating, control, and data formating logic; a multiplexer and A/D converter; the grenade arming circuitry; engineering data analog circuitry; power protection circuitry; the receiver; and the geophone amplifier module.

3.1.1 Detailed tests -

3.1.1.1 Functional test of logic - Tests to verify that the logic functions properly in the 12 layer multiboard configuration. Logic tests will include tests of the subcontractor furnished multiplexer and A/D convertor.

3.1.1.2 Logic and miscellaneous circuitry - Tests of logic operation with miscellaneous circuitry such as real time event generation (RTE), engineering analog circuitry and arming circuitry. These tests a re to verify that the logic properly controls multiplexer gating, that analog voltages are accurately converted, and that logic commands to calibration arming and firing circuits are executed.

3.1.1.3 Power protection circuitry - Complete design verification tests of power protection circuitry. These are tests to demonstrate and measure transient power protection and overload switching characteristics.

3.1.1.4 Input power interface - Test of operation with min/max voltages. Test to verify that noise and transients generated on power lines are within requirements and that operation is satisfactory with ripple and

noise in power line. The transient power supply turn on characteristics will be determined to verify compliance with requirements.

3.1.1.5 Tests of geophone amplifier - Limited tests to verify performance of geophone pre-amplifier, filter, and log compressor. These tests will be made using a simulated geophone. Tests will also be made to determine saturation recovery characteristics, circuit delay times, and transient response of geophone electronics. (Complete tests of geophone amplifiers (pre-amplifier, filter and log compressor) are performed at subcontractors plant and are part of acceptance tests.)

3.1.1.5.1 Data processing tests - Tests to verify operation of the geophone amplifiers with the multiplexer and A/D convertor. Signals fed into the geophone amplifier through a geophone simulator will be recorded on tape then compared with input signal to demonstrate operation and accuracy.

3.1.1.6 Thermal vacuum tests - Tests will be conducted to determine operating temperature range margins in vacuum and to localize thermally sensitive circuitry and components.

3.1.2 Place of tests - All component tests of the central electronics will be made at Bendix Systems Division.

3.1.3 Facilities and special equipment requirements - For all tests except data processing, standard laboratory equipment will be used. For the data processing tests, a tape recorder and computor facilities will be required. A thermal controlled vacuum chamber is required for thermal tests (paragraph 3.1.1.6).

3.2 Mortar package component tests - Component tests of the mortar package will actually be mortar box tests which does not include the subcontractor furnished grenade launcher assembly (GLA). A grenade launcher assembly simulator will be used to test the mortar box electronics. The mortar box consists of the legs and structure, the thermal bag, and mortar box electronics. The mortar box electronics consists of range gating circuitry, temperature sensing and control circuits, and the grenade firing circuitry.

3.2.1 Detailed tests-

3.2.1.1 Range line gating - Test of verify design of gating circuitry.

3.2.1.2 Test grenade and thermal match firing circuitry - These tests will be made to verify reliable operation of grenade and thermal match circuits in vacuum over temperature range with minimum charging voltages and pulse amplitudes.

3.2.1.3 Noise and crosstalk tests - Tests to verify that false triggering of firing circuits does not occur due to crosstalk or noise in the cables or in the circuit board.

3.2.3.1 RFI Tests - RFI tests will be made to demonstrate that Apollo standard initiators (ASI) are not fired due to stray RFI using fused one ohm resistors to simulate ASI's.

3.2.2 Place of tests - All mortar package (box) component tests will be made at Bendix Systems Division.

3.2.3 Facilities and special equipment - RFI special test equipment will be specified at a later date. A special exposive case will have to be designed and constructed for firing ASI's in vacuum chamber. A temperature controlled vacuum chamber will required.

3.3 Thumper component tests - The thumper consists of the electronic switching components, the 300 ft. cable, and the thumper housing.

3.3.1 Detailed tests -

3.3.1.1 ASI firing - Tests to verify ASI firing over operational temperature range with min/max voltages. (Note: Mortar box grenade firing test will verify thumper ASI firings in thermal vacuum.)

3.3.1.2 Sympathetic detonation - Test to verify that there are no sympathetic detonation of squibs under worst case conditions.

3.3.1.3 Pressure switch - Test operation of pressure switch and switching transient characteristics.

3.3.1.4 ASI engergy output - Test to verify that energy output of thumper is adequate. (Note: MSC will measure energy output in vacuum during brassboard testing phase.)

3.3.1.5 RFI tests - Test of the thumper will be made to demonstrate that ASI's are not fired due to stray RFI.

3.3.2 Place of tests - Component tests of thumper will be made at Bendix Systems Division.

3.3.3 Facilities and special equipment requirements - The special equipment and facilities requirements are the same as for the mortar box (Paragraph 3.2.3).

3.4 Cable and geophones - The cable and geophones consists of three geophone cables of specified lengths and three earth equivalent geophones. In addition one geophone housing contains a platimum resistor with a separate cable.

3.4.1 Detailed tests -

3.4.1.1 Geophones - The geophone characteristics will be verified at the subcontractor plant during acceptance tests. No special tests of the dynamic geophone characteristics will be made as part of these engineering tests. Limited tests will be made to demonstrate that the geophones are functioning. Where necessary comparison tests may be made with one geophone used as a control.

3.4.1.2 EMI and magnetic field tests - EMI and magnetic resistance tests of the geophone and geophone cable will be made to verify performance in a magnetic field.

3.4.1.3 Noise and crosscoupling tests - Crosscoupling tests will be performed in the deployed configuration to verify performance requirements.

3.4.2 Place of tests - Component tests of thumper will be made at Bendix Systems Division.

3.4.3 Facilities and special equipment requirement - Standard laboratory equipment will be used for these test and no unique facilities are required.

3.5 Ground support equipment component interface tests - The Ground Support Equipment (GSE) equipment consists of a subsystem test set and sensor simulators. The test set may be used to simulate the ALSEP Central Station at the central electronics interface. The sensor simulators w ith the test set has the capa bility of testing the mortar box and the central electronics components each as an enity.

3.5.1 Detailed tests -

3.5.1.1 Central electronics - The test set and geophone sensor simulators will be connected to the central electronics and tests conducted to verify physical mating and operation of the central electronics through the test set. In addition GSE test procedures will be evaluated.

3.5.1.2 Mortar box - The test set and GLA sensor simulator will be connected to the mortar box and tests conducted as outlined above (paragraph 3.4.1.1).

3.5.1.3 Thumper - The test set will be used to verify that the test points provided properly check out the thumper.

3.5.2 Place of tests - GSE and ASE component interface tests will be performed at Bendix Systems Division.

3.5.3 Facilities and special test equipment requirements - There are no special test equipment test facilities required for these tests.

4.0 SUBSYSTEM TESTS

Subsystem tests are tests conducted to verify functional performance of the ASE and to test the subsystem in natural environments.

4.1 Component integration tests - Component Integration test will be conducted to verify component (cabling and convertors) mechanical and non-functional electrical interfaces with two or more components. Since all components interface with the central station, component integration tests consists basically of integration of each of the major components with the central electronics. Functional electrical interfaces will be tested after GSE interface tests except where noted.

4.1.1 Mortar box integration tests -

4.1.1.1 Mechanical interface - The cable connectors will be mated together and interwiring pin-to-pin connectors verified.

4.1.1.2 Electrical interface - All voltages delivered to mortar box from the central electronics will be measured to check interwiring and impedances at terminations.

4.1.2 Thumper integration tests -

4.1.2.1 Mechanical interface tests - The cable connectors will be mated together and interwiring pin-to-pin connections tested.

4.1.2.2 Electrical interface tests - All voltage delivered to the thumper will be measured to check interwiring and impedances at terminations.

4.1.2.3 Thumper activation test - The thumper will be manually operated to verify that the thumper switches the logic from engineering data mode to seismic data mode.

4.1.3 Geophone and cabling integration test

4.1.3.1 Mechanical interface - The cable connectors will be mated together and interwiring pin-to-pin connections tested.

4.1.3.1.1 Cable reel - The geophone and cable will be wound into the thumper reel to verify mechanical fit.

4.1.3.2 Electrical interface - The digital output at the central electronics will be checked to verify that each geophone output including the single temperature sensor output is appearing in the proper channel.

4.1.4 Place of tests - All component integration tests will be made at Bendix Systems Division.

4.1.5 Facilities and special equipment requirements - Standard laboratory test equipment will be used for these tests and no special facilities will be required.

4.2 GSE interface tests -

4.2.1 Detailed tests - The GSE test set will be connected to the ASE as a subsystem and complete operation tests performed to verify that the test set is capable of operating and testing the ASE subsystem.

4.2.2 Place of tests - All GSE inteface tests will be performed at Bendix System Division.

4.2.3 Facilities and special equipment requirements - No special test equipment is required and available laboratory facilities are adequate.

4.3 Functional tests - ASE subsystem functional tests will be performed utilizing the GSE test set except as noted. Mortar Box Thumper component tests may be conducted in parallel since only the central electronics and a single component are required for functional tests.

4.3.1 Complete subsystem tests - Tests made with all components connected to the central electronics operated through the GSE test set.

4.3.1.1 Power supply tests - The power transients will be observed as the thumper is activated, and the mortar box operated through GSE ordered commands. The power levels will be measured to verify compliance with requirements. In addition the power supply turn on transients will be measured also to verify compliance with requirements.

4.3.1.2 Noise interference - The subsystem will be monitored at several points to verify that false switching and triggering does not occur during functional operation of the thumper and mortar box.

4.3.1.3 Place of tests - Complete subsystem tests will be performed at the Bendix System Division.

4.3.1.4 Facilities and special equipment requirements - Standard laboratory test equipment will be used for these tests and no special facilities will be required.

4.3.2 Mortar box subsystem tests - These are functional tests that will be made utilizing the GSE test set with the central electronics and the mortar box.

4.3.2.1 Arming and firing tests - Execution of arming and firing commands ordered through the GSE test set will be verified with min/max voltages. In addition cable resistance changes due to the lunar environment will be simulated with resistors to verify operation through the high resistance cables.

4.3.2.2 Engineering data signals -

4.3.2.2.1 Noise interference - Tests will be made to determine if signal or power noises cause interference in the engineering data lines from the mortar box.

4.3.2.2.2 Accuracy - Tests will be made to verify analog conversion accuracy with cable impedance change with a temperature cable simulator.

4.3.2.3 Range line operation - Tests will be made to verify that range line gating generates RTE signal in data format.

4.3.2.4 Place of tests - Complete subsystem tests will be performed at the Bendix Systems Division.

4.3.2.5 Facilities and special test equipment requirements - Standard laboratory test equipment will be used for these tests and no special facilities will be required.

4.3.3 Thumper subsystem tests - These are functional tests that will be made utilizing the GSE test set with the central electronics and the thumper.

4.3.3.1 Thumper activation - The thumper will be manually operated to verify that it causes switching in the central electronics. In addition capacitor charging time will be measured to verify that squibs may be fired within predicted times.

4.3.3.2 ASI detonation - ASI's will be fired at the thumper to verify operation using temperature simulator cable. In addition pressure switch operation will be verified.

4.3.3.3 Place of tests - Complete subsystem tests will be performed at the Bendix Systems Division.

4.3.3.4 Facilities and special equipment requirements - Standard laboratory test equipment will be used for these tests and no special facilities will be required.

4.3.4 Special cable test - Tests will be conducted to verify that operating the thumper with the thumper cable deployed next to the geophone cable will not generate noise or crosstalk in the geophone cable.

4.3.4.1 Test details - Thumper transients during activation will be recorded independently to verify noise in or out of the passband of the seismic detection system. Additional tests will be made to verify that geophone cable is adequate shielded and decoupled from thumper cable.

4.3.4.2 Place of test - These tests will be made at the Bendix System Division.

4.3.4.3 Facilities and special equipment requirement - No special test equipment is required. The test will be conducted in laboratory screen room.

5.0 SPECIAL FIELD TESTS

5.1 Grenade firing tests - This test will be made to verify that the mortar box and grenade design functions are required.

5.1.1 Details of tests - Partically loaded grenades will be fired from a deployed mortar box by simulated commands. The grenade trajectory will be filmed with high speed cameras. Films will be used to verify explosions detonation on impact. The projected range will be measured and compared with the range predicted with velocity launch tube angle and flight time to after correction for atmospheric effects. The mortar box stability during grenade launch will be recorded on film.

5.1.2 Place of test - This test will be performed at the Space Ordnance System test facilities in El Segundo, California.

5.1.3 Facilities and special equipment requirements - Multiple high speed cameras will be required to record trajectory and explosion on impact. Special test fixtures to be supplied by the subcontractor will be used to measure grenade launch angle and velocity independent of ASE devices. The subcontractors test facilities will be used for these tests.

5.2 Subsystem field tests - Tests to demonstrate performance of the ASE subsystem mortar package operation.

5.2.1 Details of test

5.2.1.1 Grenade firings - Full or partically loaded grenades will be fired from a deployed mortar box through the central electronics. The GSE test set will be required to operate the subsystem. Grenade trajectory will be recorded with high speed cameras and ranges measured, corrected for atmospheric effects and compared with ASE measured parameters. A spare receiving antenna at a different coordinate will be used in conjunction with explosion detectors to record transmitter shut off coincidence with explosion instant. (The self extending antenna design will be completely verified independently at Computer Devices of Canada, Ottawa, Ontario, Canada).

5.2.1.2 Seismic energy - The seismic energy induced by the launch grenades will be recorded by a commercial seismic detection system and compared with the energy induced by deployed equivalent charges. Either an earth equivalent model of the subcontracted geophone or a commerical geophone will be used to verify ASE data recording. Arrival time measurement will be measured and recorded simultaneously with the ASE subsystem and the comme rical seismic detection sy stem. It remains to be determined if the bandwidths and energy amplitude recording can be compared accurately except for timing. (The subcontractors design effort is contractly committed primarily to produce a lunar geophone. Performance will be verified during acceptance tests.)

5.2.2 Place of test - This test is tentively scheduled to be performed at the White Sands Proving Grounds in New Mexico.

5.2.3 Facilities and special equipment requirement - The facilities required are an approved remote range for explosive testing and temporary equipment storage facilities. Tentatively the special test equipment requirements are as follows:

(1) Two high speed cameras
(2) Portable 60 cps power units
(3) Commercial seismic detection system
(4) Two multiple channel recorders
(5) A photo electric explosion detector
(6) 30 mc receivers and antennas

(A complete list of test facilities and special equipment will be determined when the test procedures are completed.)

5.3 Thumper field test - This test is to demonstrate operation and performance of the thumper.

5.3.1 Details of test - The thumper will be activated manually with operational power supplied through the cable from a battery. The explosion instant will be made available through the pressure switch closure. Induced energy will be recorded by the PI's seismic data system.

5.3.2 Place of test - This test will be performed at the USGS facilities in Flagstaff, Arizona.

5.3.3 Facilites and special equipment requirements - Special equipment facilities will be provided by the PI at time of test.

5.4 RF antenna field tests - The performance of the receiver and transmitter antenna design will be verified during this test. The extension of the transmitter antenna to the deployed configuration will be tested in the subcontractor vacuum chamber.

5.4.1 Subsystem RF radiation test details - Testing of the transmitter antenna will be performed with the four radiating elements extended.

5.4.1.1 Flight tests - The transmitter antenna radiator pattern will be measured. The results will be correlated with observed grenade tumble characteristics to verify that energy will be received at all time in flight.

5.4.1.2 Tests at and near ground - The RF radiated by the TX antenna will be measured and recorded at the near ground by simulation of the flight termination. Flight termination will be simulated by sliding the grenade with extended antenna elements from a tower or pole. The tests will include measurements of RF radiated at ground level with one or more antenna elements removed to simulated fracture prior to detonation. These tests will utilize the subcontractor furnished transmitter driven by a standard battery.

5.4.1.3 Subsystem tests - Tests will be performed using the ASE central electronics with the subcontractor furnished receiver and the receiver antenna to detect transmitted energy, and RTE generation. These test will be performed with the receiver remotely located in hilly terrain with the grenade flight termination again simulated from the pole or tower.

5.4.2 Place of tests - The place of tests will be determined at a later date. Tenatively it is planned to conduct these tests at a remote area near Ann Arbor, Michigan.

5.4.3 Facilities and special equipment requirements - A tower or suitable pole for flight termination simulation test is required. The special test equipment requirements include a field strength meter and a mobile power supply or set of dry cell batteries. A complete list of test equipment will be determined when the test procedures are completed.

6.0 PROTOTYPE MODEL SUPPORT

Two weeks are scheduled to incorporate and design refinements that may be suggested during these tests. The brassboard model will be available for preliminary design evaluation of and design change.

7.0 TEST RECORDING AND PROCEDURES -

Test procedures for each of the general tests outlined will be written. Each test procedure will include a test record format. The results of the tests will be recorded and maintained on file at Bendix Systems Division.

Systems Division
Ann Arbor, Michigan

MANAGEMENT CONTROL PLAN SCHEDULE

Engineering Test Plan Schedule

No:	Revision	Group
Issued On: 9/14/66	Revised On	P/C Check

Line	Item	CY 1966 Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	CY 1968 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	CY 19 Jan	Feb	Mar	Apr	May
1																												
2	ENGINEERING MODEL TESTS																											
3																												
4	COMPONENT TESTS								10/6	11/28																		
5	CENTRAL ELECTRONICS							9/19																				
6	MORTAR PACKAGE							9/19																				
7	THUMPER							9/19																				
8	GEOPHONES AND CABLING									11/21																		
9	GSE INTERFACE								11/14	11/16																		
10																												
11	SUBSYSTEM TESTS																											
12	COMPONENT INTEGRATION									11/30																		
13	GSE INTERFACE									11/14																		
14	FUNCTIONAL TESTS									11/15	12/9																	
15																												
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17																												
18	SPECIAL FIELD TESTS																											
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20	GRENADE FIRING							9/22 △																				
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24	THUMPER OPERATIONAL FIELD TEST								10/14 △																			
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