3. Associated Contractor Support

The following support is assumed to be available from associate contractors at Vandenberg Air Force Base.

a. Test Instrumentation: calibration, pretest checkout, test operation, post-test processing, and basic data reduction; The Martin Company.

b. PLS Maintenance: facility cleaning, labor, shop repair, field repair, and replacement of defective equipment plus other labor and craft support, such as electrical and pneumatic; The Martin Company.

c. Handling of Umbilical Disconnects and Other Missile Silo Equipment, Such as Silo Closure Doors; The American Machine & Foundry Company and The Martin Company.

d. Quality Control, Liquid and Gas Analysis; VAFB on request.

I. SAFETY REQUIREMENTS

1. Hazard Area

The hazard area for tests 2.1.1, 2.1.2, and 2.1.3 (indicated on Figure IX-b) includes the missile silo, propellant terminal, certain tunnels, the vent-and-fill shafts, and the surface area within 150 feet of the oxygen vent-and-fill shaft opening. Use of these areas is restricted to test and associated contractor personnel. During test 2.1.4, when the system will contain gaseous and liquid oxygen, the entire complex shall be restricted to all personnel for a period of four hours. The hazard area for test 2.1.4 is shown in Figure IX-c.

2. Warnings

Nontest personnel shall be warned to leave the hazard area before a test. Safety barriers shall be established at the entrance to the tunnel junctions or the control center and around the shaft opening. Audio warnings are to signal the start and completion of tests and significant conditions during the tests.

3. Safety Practices

Test and associate contractor support personnel are to:

a. Wear hard hats, clean cotton clothing, nonsparking shoes, neoprene gloves, and safety glasses or eye shields.

b. Wear face shields and asbestos gloves if work involves contact with gas or liquid.

c. Inspect the hazard area to insure that it is clean and clear of personnel, tools, materials, and debris.

d. Unless otherwise directed, remain out of the propellant terminal and missile silo during all tests and remain out of the complex during test 2.1.4.

e. Use only nonsparking tools and grounded portable equipment, and introduce only clean tools and materials into the complex.

f. Test the atmosphere with oxygen and nitrogen "sniffers" prior to entering a space after a test.

g. Observe the NO SMOKING precaution.

J. CRITERIA

The successful completion of the liquid oxygen line cooldown within the established countdown time will be considered the criterion of success.

2.2: LIQUID OXYGEN TRANSFER TESTS

A. PURPOSE

The purpose of this test series is to establish that: (1) the liquid oxygen piping system can be pressurized, (2) the main transfer and topping lines can be cooled down, (3) the missile tanks can be filled within the allotted countdown time*, (4) liquid oxygen levels can be maintained, and (5) the system can be safely returned to an unloaded condition.

B. TEST OBJECTIVES

These specific test objectives are based on basic system test objectives contained in STL document GM-TR-0165-00323B, revised 30 October 1958, and applicable to Test Plan I - 5.

1. Primary Objectives

a. Demonstrate that the liquid oxygen system can be pressurized, the lines cooled down, and the required amounts of liquid oxygen delivered to both missile tanks within the allotted countdown time.

b. Demonstrate the ability of the missile vent system to handle effluent gaseous oxygen at missile ullage pressures acceptable to an operational missile.

c. Demonstrate that the liquid oxygen topping system lines can be cooled down within the allotted countdown time.

d. Demonstrate the ability of the liquid oxygen topping system and the antigeysering system to maintain liquid levels in missile tanks during hold periods.

e. Demonstrate that the liquid oxygen unloading system can be filled and vented, lines cooled down, liquid oxygen unloaded from the missile tanks and umbilical piping, and the PLS returned to "ready" status. Determine further the time required to perform this operation.

*See System Specification for specific countdown time information.

2 Secondary Objectives

a. Determine the minimum time required for liquid oxygen cooldown and transfer.

b. Determine the consumption of liquid oxygen, liquid nitrogen, gaseous oxygen, and gaseous nitrogen to load, hold, unload, return to "ready" status, and reload.

c. Evaluate the effectiveness of liquid oxygen subcooling and investigate the possibility of eliminating the liquid oxygen subcooler from the system.

d. Evaluate the effectiveness of the antigeysering helium injection system.

e. Demonstrate that the liquid oxygen piping design does not permit pressure surges or liquid "slugging" effects in missile tanks during cooldown and fine loading.

f. Demonstrate the capability of liquid oxygen and high-pressure gas missile service lines to be disconnected without spillage or excess leakage of liquid.

C. SYSTEM SUMMARY

The liquid oxygen system can be broken down into the following subsystem areas:

(1) LO_2 storage,
(2) GO_2 storage and LO_2 pressurization,
(3) LO_2 transfer piping and equipment,
(4) LO_2 missile tanks,
(5) LO_2 missile unloading piping, pump, and other equipment,
(6) LO_2 missile topping system with LN_2 subcooler,
(7) GN_2 storage and LO_2 system blanketing, and
(8) LO_2 system and missile tanks venting.

The operation of the system is carried out automatically by means of the following control buttons:

(1) Load,
(2) Stop Topping,
(3) Shutdown, and
(4) Unload LO_2.

The control buttons, when depressed, will energize sequencer circuitry. The details of the sequence of operations that follow such action are discussed in the "ADL System Specification" (ADL Special Report 86). A summary of these operations as they apply to the transfer tests is given below.

With the liquid oxygen system in a ready condition and the helium and other nonpertinent nitrogen services removed from the sequencer logic, the depression of the "load" button will start the following sequence:

(1) The gaseous oxygen pressurization system will bring the liquid oxygen storage tank pressure up to the predetermined "line cooldown" pressure level.

(2) Liquid oxygen will be forced into the main and topping transfer piping by way of rapid and topping flow control valves. Line cooldown will take place. Oxygen will boil off and be vented through the missile vent system.

(3) When all line liquid sensors indicate the completion of cooldown, by signalling the presence of liquid, their signal will actuate the liquid oxygen storage tank pressurization control, which will automatically raise the pressure level and put the system into rapid transfer.

(4) Rapid transfer will continue until the missile tanks are filled to a predetermined level; then the LO_2 flow will be automatically reduced to the fine fill transfer rate. When the missile tank is filled, the LO_2 flow will be automatically reduced to the LO_2 topping rate, and antigeysering helium flow will be simultaneously and automatically started. The topping flow is automatically controlled to maintain a constant level in the liquid oxygen missile tanks.

(5) By actuating the "stop topping" control button, the LO_2 topping flow will stop, umbilicals will be drained, and missile tanks will be ready for pressurization. The PLS will be automatically vented at the completion of the umbilical drain. Normally, the LO_2 umbilical disconnect will be simulated from the Test Selector Panel.

(6) The depression of the "shutdown" button will close line-end valves (if these are open), depressurize the storage tank, and vent the tank and piping.

(7) The "unload LO_2" button will be depressed in order to unload the missile tanks. In the case of an actual (rather than simulated) umbilical disconnect, the umbilicals will be manually reconnected, and the unload sequence subsequently initiated from the equipment terminal. The missile tanks will be unloaded under pressure, and the LO_2 will be pumped to the storage tank. Residual liquid in the piping will boil off. The missile tanks will be purged and blanketed automatically.

D. TEST OPERATION

The liquid oxygen transfer test will be carried out by permitting the system to perform within its operational sequence. The sequence has been briefly described in paragraph C above.

The seven test runs planned for this test series have been listed in Table 2.2a, together with pertinent test variables. The initial two tests (2.2.1 and 2.2.2) will use liquid and gaseous nitrogen in place of liquid and gaseous oxygen. Primarily, this provides a safer operation and permits personnel access to the propellant terminal and missile silo, where the integrity of the equipment can be visually verified.

The two nitrogen tests should verify all primary and secondary test objectives except those connected with subcooled liquid oxygen, antigeysering helium, simulated emergency shutdown, and reloading. The final test, operated at a condition optimized during the previous tests, should confirm all test objectives using the appropriate operational fluids. Personnel will not have access to the launcher complex during this test and during all tests involving liquid oxygen.

A topping flow rate will be used in all tests, but the LO_2 topping stream will not be directed through the subcooler for all tests. The operation of the subcooling system will be verified during tests 2.2.4, 2.2.5, and 2.2.7, while the antigeysering system will be checked during tests 2.2.3, 2.2.4, and 2.2.7. Response to emergency shutdown conditions will be tested during test 2.2.6 while the reload response will be determined in tests 2.2.5, 2.2.6, and 2.2.7.

TABLE 2.2a

LIQUID OXYGEN TRANSFER TESTS

Test Number	Primary Fluids	TEST SEQUENCE												Liquid Oxygen Topping Status	Anti-geysering Helium Injection During Hold	Concurrent Test Number	Applicable Notes
		Load	Hold 1 Hour	Stop Topping	Disconnect	Shut Down	Unload LO_2	Reload	Hold 1 Hour	Stop Topping	Disconnect	Shut Down	Unload LO_2				
2.2.1	LN_2 - GN_2	X	-	-	-	X	X	-	-	-	-	-	-	Not Subcooled	No	-	(3)
2.2.2	LN_2 - GN_2	X	X	X	A	X	X	-	-	-	-	-	-	Not Subcooled	No	6.2.1	(1) (4)
2.2.3	LO_2 - GO_2	X	X	-	-	X	X	-	-	-	-	-	-	Not Subcooled	Yes	-	(3)
2.2.4	LO_2 - GO_2	X	X	X	S	X	X	-	-	-	-	-	-	Subcooled	Yes	6.2.2	(4)
2.2.5	LO_2 - GO_2	X	X	-	-	X	X	X	-	X	S	X	X	Subcooled	No	6.2.3 6.2.4	(3)
2.2.6	LO_2 - GO_2	X	-	-	-	X	X	X	-	-	-	X	X	Not Subcooled	No	-	(2) (3)
2.2.7	LO_2 - GO_2	X	X	X	S	X	X	X	X	X	S	X	X	Subcooled	Yes	PLS:- 1.2.2 6.2.6	(3)

1. The disconnect operation actuated by the "Stop Topping" button will vent and drain the umbilicals but leave the missile loaded. The umbilical disconnect may be actual or simulated as indicated by the following code: (A) Actual; (S) Simulated.
2. First load cycle interrupted by "SHUTDOWN" signal during rapid load.
   Reload cycle interrupted by simultaneous loss of power and instrument air during rapid load.
3. Storage level high - LO_2 and GO_2
4. Storage level low - LO_2 and GO_2.

Test control will be exercised from the Command Control Center. During tests 2.2.1 and 2.2.2, the PL and PS Checkout Panel will be under observation.

Prior to each test, the liquid oxygen storage tank ullage transfer pressure will be adjusted to give the desired pressurization.

The countdown sequence will follow the actual accepted countdown sequence. Except for test 2.2.6, no test in the series will be interrupted during the entire sequence.

The liquid oxygen transfer system can be reactivated approximately six hours after the last test, when its liquid oxygen content will have boiled off.

Enumerated, detailed, and specific test steps for each test run will be covered in "Detailed Test Procedures," to be issued separately as a supplement to this test specification. The supplement will also include test prerequisites, pretest procedures, and the required status of valves and equipment after a test. The procedural documents will be enumerated as follows:

Test Number	Procedural Document Number
2.2.1	101-2.2.1
2.2.2	101-2.2.2
2.2.3	101-2.2.3
2.2.4	101-2.2.4
2.2.5	101-2.2.5
2.2.6	101-2.2.6
2.2.7	101-2.2.7

E. TEST CONTROL

The liquid oxygen transfer tests will be carried out automatically by means of the PLS Test Control Panel. The panel will be located in the Control Center and will contain "real time" indicating instruments required for test control. Additional pen-recorded, trend-indicating data will be available from the Strip Charts (5630), also located in the Control Center.

All controls and instruments required for test control are listed in Table 2.2b. A more detailed description of the PLS Test Control Panel, the Test Selector Panel, the PL and PS (Checkout) Panel, and a complete listing of all "Real Time" instrumentation can be found in Section V of this report.

TABLE 2.2b

TEST CONTROL AND INSTRUMENTATION REQUIREMENTS

Test No.	Control Units	PLS Control Panel Instrumentation	
All Tests	PLS Control Panel	PI-305	LSI-252
	Strip Charts (5630)	PI-225	LSI-253
	Test Selector Panel	PI-226	LSI-254
	PL and PS Panel	LSI-201	LSI-255
	Equipment and	LSI-202	LSI-256
	Facilities Console	LSI-203	LSI-257
		LSI-204	LSI-258
		LSI-205	LLI-251
		LSI-206	LLI-252
		LSI-212	MI-212
		LSI-251	MI-314

F. TEST DATA AND TEST INSTRUMENTATION REQUIREMENTS

In order to meet the test objectives defined above, specific test data must be collected, analyzed, and interpreted.

Table 2.2c lists the data requirements for test series 2.2, together with test instrumentation used to obtain the data. The material has been tabulated in order of specific test objectives justifying listed data and instrument requirements.

Essentially, only "Quick Look" instrumentation has been specified for data analysis. Specific instrumentation details, such as type of transducer, range, location, and desired accuracy have been listed in Table IV-d of Section IV.

G. EQUIPMENT REQUIREMENTS

The operation of the transfer tests will essentially require the use of the complete liquid oxygen system. The subsystem areas involved have been tabulated in paragraph C above.

The liquid oxygen flow system is shown in Figure B-3 of Appendix B. In addition, the test equipment requirements have been listed in Table 2.2d.

TABLE 2.2c

TEST DATA AND INSTRUMENTATION REQUIREMENTS

Test Objective	Test Data Requirements	Test Instrumentation	Test No.
1a	(1) GO_2 pressure	PR-302	2.2.1 thru 6
		PR-305	all
	(1a) Storage tank GO_2 temperature	TR-201, 305	2.2.1 thru 6
	(2) LO_2 fill line temperatures	TR-202, 209, 213, 214	all
		TR-203, 204, 217, 218 207, 208	2.2.1 thru 6
	(3) LO_2 fill line pressures	PR-219, 217	all
		PR-202, 203, 207, 205 222	2.2.1 thru 6
	(4) LO_2 fill line liquid sensing	LSR-201, 202, 203, 204 205, 206, 212	2.2.1 thru 6
	(5) Missile tank pressure	PR-225, 226	all
	(6) Missile tank inlet temperature	TR-210, 219, 220	all
	(7) Missile tank liquid	LSR-251, 252, 253, 254 255, 256, 257, 258, LLR-251, 252	2.2.1 thru 6
	(8) Elapsed time		all
	(9) Valve position	MR-202, 204, 205, 209 303, 314	all
		MR-201, 203, MR(T)-304, 305, 213, 214, 215	2.2.1 thru 6
1b	(10) Missile tank press	PR-225, 226	all
	(11) Missile vent gas temp.	TR-306, 307	2.2.1 thru 6
	(12) Missile tank level sensing	LLR-251, 252	all
	(13) Elapsed time		all
	(14) Valve position	MR-311, 312, 314, 310	all
	(15) Vent blower on-off	MR-313	all

TABLE 2.2c (Continued)

Test Objective	Test Data Requirements	Test Instrumentation	Test No.
1c	(16) Visual observation	none	2.2.1
1d	(17) LO_2 unload piping liquid sense	LSR-205, 206, 207, 212	2.2.1 thru 6
	(18) Missile tank pressure	PR-225, 226	all
	(19) Storage tank pressure	PR-305	all
	(20) LO_2 piping pressure	PR-221, 223	2.2.1 thru 6
	(21) LO_2 piping temperature	TR-214	all
	(22) GN_2 blanket pressure	PR-510, 511, 507	2.2.1 thru 6
	(23) Pump on-off information	MR-212	2.2.1 thru 6
	(24) Valve position	MR-207, 210, 211, 302 301, 308, 505, 516 518, 503, 519	2.2.1 thru 6
	(25) Vent gas temperatures	MR-309, 522	all
		TR-304, 305, 306	2.2.1 thru 6
2a	(26) See objective 1a items 1 through 9	-	-
2b	(27) LO_2 topping line temperature	TR-205, 206, 212, 216	2.2.1 thru 6
		TR-211, 215	all
	(28) LO_2 topping line pressure	PR-209, 211 213, 216	2.2.1 thru 6
	(29) LO_2 main line flow	PR-215, 214	all
	(30) LO_2 topping line flow	FR-201, 202	all
	(31) Valve position	MR-203, 206, 208	2.2.1 thru 6
		MR(T)-213, 214	all
		MR-202	
2c	(32) LO_2 storage tank level	PR-224 (LLI-201)	all
	(33) GO_2 bottle temperature	TR-301, 302	all
		TR-303	2.2.1 thru 6

TABLE 2.2c (Continued)

Test Objective	Test Data Requirements	Test Instrumentation	Test No.
2c (cont'd)	(34) GO_2 bottle pressure	PR-301	all
	(35) GN_2 bottle temperature	TR-503	all
	(36) GN_2 bottle pressure	PR-510	2.2.1 thru 6
	(37) LO_2 subcooler LN_2 level	PR-220 (LLI-401)	2.2.1 thru 6
	(38) Valve position	MR(T)-304, 305	all
		MR-303	all
		MR-505, 516, 518, 519	2.2.1 thru 6
2d	(39) Missile tank pressure	PR-225, 226	all
	(40) LO_2 main line pressure	PR-207, 221	2.2.1 thru 6
		PR-217	all
	(41) LO_2 topping line pressure	PR-209	2.2.1 thru 6
		PR-216	all
	(42) LO_2 main line liquid sense	LSR-203, 204	2.2.1 thru 6

TABLE 2.2d

EQUIPMENT REQUIREMENTS

Test No.	Tanks	Equipment Lines	Valves	Misc.
All	T-201	201	CV-201	C-201
	T-202	202	CV-205	F-201
	T-203	203	CV-206	F-202
	T-301A	204	CV-207	F-203
	T-301B	205	CV-301	F-204
	T-301C	206	CV-302	F-205
	T-401	208	CV-311	P-201
	T-505	209	CV-312	Stage I LO_2 Tank
		210	CV-313	Stage II LO_2 Tank
		211	CV-314	C-301
		212	CV-315	P-303
		213	CV-350	S-301
		214	CV-401	S-303
		215	CV-402	C-401
		216	CV-410	S-509
		217	CV-411	S-510
		301	CV-412	S-513
		302	CV-413	P-701
		303	CV-501	P-702
		306	CV-502	
		308	CV-511	
		309	CV-512	
		310	CV-528	
		311	CV-529	
		313	CV-530	
		316	CV-531	
		317	CV-532	
		318	CV-533	
		319	CV-534	
		320	CV-535	
		321	CV-536	
		326	CV-539	
		328	CV-701	
		333	CV-702	
		338	CV-704	
		340	CV-706	
		341	CV-750	
		344	CV-752	
		345	CHV-507	
		346	CHV-508	

TABLE 2. 2d (Continued)

Test No.	Tanks	Equipment Lines	Valves	Misc.
		347	CHV-512	
		348	CHV-513	
		349	CHV-518	
		350	CHV-520	
		351	CHV-521	
		352	CHV-522	
		353	CHV-523	
		354	FCV-201	
		355	FCV-202	
		401	FCV-203	
		402	FCV-204	
		501	FCV-205	
		528	FCV-206	
		540	FCV-207	
		541	FCV-208	
		550	FCV-209	
		551	FCV-211	
		553	FCV-212	
		556	FCV-215	
		557	FCV-217	
		558	FCV-218	
		563	FCV-301	
		564	FCV-302	
		566	FCV-303	
		567	FCV-304	
		568	FCV-305	
		569	FCV-306	
		570	FCV-307	
		571	FCV-510	
		572	FCV-511	
		573	FCV-516	
		574	FCV-517	
		575	FCV-701	
		576	FCV-702	
		701	PRV-502	
		702	SV-301	
		703	SV-303	
		705	SV-305	
			SV-306	
			SV-307	
			SV-308	

TABLE 2.2d (Continued)

Test No.	Tanks	Equipment Lines	Valves	Misc.
			SV-310	
			SV-311	
			SV-312	
			SV-313	
			SV-314	
			SV-315	
			SV-317	
			SV-318	
			SV-319	
			SV-320	
			SV-337	
			SV-338	
			SV-501	
			SV-502	
			SV-503	
			SV-504	
			SV-523	
			SV-530	
			SV-531	
			SV-532	

A complete listing of all OSTF-PLS equipment requirements, including manufacturers' names and model numbers, will be found in the ADL Propellant Loading System Specifications.

B. SUPPORT REQUIREMENTS

To carry out the cooldown tests, the following support will be required from sources other than Arthur D. Little, Inc., at the Vandenberg Air Force Base.

1. Facilities and Services

a. Power

Electrical power will be required to operate the following equipment:

(1) LO_2 pump, system controls and instrumentation, test instrumentation.

(2) Air conditioning and ventilation.

b. Air Conditioning and Ventilation

This service will be required for the following areas:

(1) Propellant Terminal (PT),

(2) Missile Silo (MS),

(3) Tunnel between PT and MS,

(4) Third level of the Equipment Terminal, and

(5) Command Control Center.

c. Lighting

The following areas will require lighting:

(1) Propellant Terminal (PT)

(2) Missile Silo (MS)

(3) Tunnel between PT and MS

(4) Third level of the Equipment Terminal

(5) Command Control Center.

d. PLS Cleanliness

Prior to each test run, inspect the system (covered under "EQUIPMENT REQUIREMENTS") to insure that it is under proper blanketing and that the areas are void of unsafe materials and in a clear condition.

Specific cleaning requirements will be called for during or at the completion of a maintenance and repair operation rather than prior to a test. (See Section IX.)

e. First-Aid Services

A first-aid station at the test site should be set up and manned during pretest, test, and post-test warmup operations.

f. Communications

Communications will be required between: Areas 1, 3, 5, 7, 9, 11, 13, and 18. ADL communication requirements have been covered in more detail in Section VIII.

g. Visual and Audio Warning System

During test runs 2.2.1 and 2.2.2, the propellant terminal, missile silo, and adjacent surface areas will be restricted to all but authorized personnel participating in the test. The duration of this "Warning Level" will be approximately eight hours per test.

During tests, 2.2.3, 2.2.4, 2.2.5, 2.2.6, and 2.2.7, the propellant terminal, adjacent surface areas, and missile silo will be restricted for eight hours to all but authorized personnel participating in the test. The complete launcher area will be closed to all personnel for a period of four additional hours.

The warning will be expected to signal the above requirements.

h. Sole Facility Use

ADL and other personnel associated with each test run will require sole occupancy of the following areas for eight hours per test run:

Propellant terminal
Missile silo
Equipment terminal (limited area), and
Control Center (limited area).

2. Supply Requirements

The following quantities of liquids and gases should cover all transfer test run requirements.

Test No.	Fluid	Receptacle	Initial Fill Storage Tank	Usage
2.2.1	LN_2	T-201	25,200 gallons	3,000 gallons
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-301	205,000 SCF	20,000 SCF
	GN_2	T-504	33,600 SCF	100 SCR
2.2.2	LN_2	T-201	25,200 gallons	4,785 gallons
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-301	205,000 SCF	20,000 SCF
	GN_2	T-504	33,600 SCF	100 SCF
2.2.3	LO_2	T-201	25,200 gallons	3,200 gallons
	GO_2	T-301	205,000 SCF	15,000 SCF
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-504	33,600 SCF	6,000 SCF
	He	T-601	113,700 SCF	2,100 SCF

Test No.	Fluid	Receptacle	Initial Fill Storage Tank	Usage
2.2.4	LO_2	T-201	22,600 gallons	3,200 gallons
	GO_2	T-301	204,000 SCF	15,000 SCF
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-504	33,600 SCF	6,000 SCF
	He	T-601	113,700 SCF	2,100 SCF
	LN_2	T-401	1,470 gallons	230 gallons
2.2.5	LO_2	T-201	25,200 gallons	4,600 gallons
	GO_2	T-301	204,000 SCF	23,000 SCF
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-504	33,600 SCF	12,000 SCF
	LN_2	T-401	1,470 gallons	460 gallons
2.2.6	LO_2	T-201	25,200 gallons	3,000 gallons
	GO_2	T-301	204,000 SCF	23,000 SCF
	GN_2	T-504	33,600 SCF	12,000 SCF
	GN_2	T-502	33,600 SCF	200 SCF
2.2.7	LO_2	T-201	25,200 gallons	5,700 gallons
	LN_2	T-401	1,470 gallons	460 gallons
	GO_2	T-301	204,000 SCF	24,000 SCF
	GN_2	T-502	33,600 SCF	200 SCF
	GN_2	T-504	33,600 SCF	12,200 SCF
	He		113,700 SCF	4,200 SCF

3. Associated Contractor Support

The following support is assumed to be available from associate contractors at Vandenberg Air Force Base.

a. Test instrumentation: calibration, pretest checkout, test operation, post-test processing, and basic data reduction; The Martin Company.

b. PLS maintenance: facility cleaning, labor, shop repair, field repair, and replacement of defective equipment plus other labor and craft support, such as electrical and pneumatic; The Martin Company.

c. Handling of umbilical disconnects and other missile silo equipment, such as silo closure doors; The American Machine and Foundry Company and The Martin Company.

d. Quality control: liquid and gas analysis. Vandenberg Air Force Base on request.

I SAFETY REQUIREMENTS

1. Hazard Area

The hazard area for test 2.2.1 and 2.1.2 (indicated on Figure IX-b) includes the missile silo, propellant terminal, certain tunnels, vent-and-fill shafts, and the surface area within 150 feet of the oxygen vent-and-fill shaft opening. Use of these areas is restricted to test and associate contractor support personnel only. During tests 2.2.3, 2.2.4, 2.2.5, 2.2.6, and 2.2.7, when the system will contain gaseous and liquid oxygen, the complex will be restricted to all personnel for a period of four hours per test. (See Figure IX-c.)

2. Warnings

Nontest personnel shall be warned to leave the hazard area before a test. Safety barriers shall be established at the entrance from the tunnel junctions or control center and around the shaft opening. Audio warnings are to signal the start and completion of tests and significant conditions during test progress.

3. Safety Practices

Test and associated contractor support personnel are to:

a. Wear hard hats, clean cotton clothing, nonsparking shoes, neoprene gloves, and safety glasses or eye shields.

b. Wear face shields and asbestos gloves if work involves contact with gas or liquid gas.

c. Inspect the hazard area to insure that it is clean, and clear of personnel, tools, materials, and debris.

d. Unless otherwise directed, remain out of the propellant terminal and missile silo during all tests and out of the entire complex during tests 2.2.3 through 2.2.7.

e. Use only nonsparking tools and grounded portable equipment, and introduce only clean tools and materials into the complex.

f. Test the atmosphere with oxygen and nitrogen "sniffers" prior to entering a space after a test.

g. Observe the NO SMOKING precaution.

J. CRITERIA

The ability of the PLS to deliver liquid oxygen to the missile in sufficient quantity and at acceptable pressure and temperature within allowable countdown time will be considered the criterion of success.

6.1 AND 6.2: HELIUM TRANSFER TESTS

A. PURPOSE

The purpose of this test series is to demonstrate the ability of the PLS helium system to deliver the required cold and warm helium to the missile helium system as well as to supply warm helium to the missile antigeysering helium injection system.

B. TEST OBJECTIVES

These specific test objectives are based on basic system test objectives contained in STL document GM-TR-0165-00323B, revised 30 October 1958, and applicable to Test Plan I - 5.

1. Primary Objectives

a. Demonstrate that the PLS helium system can supply the required cold and warm helium to the missile helium system at the proper temperatures and pressures within the allotted countdown time, during hold periods, and during and after missile elevation.

b. Demonstrate that the PLS helium system can supply warm helium to the antigeysering connections in the liquid oxygen system during hold periods.

c. Demonstrate that the PLS helium recovery system can safely recover uncontaminated helium from the missile in-flight bottles during unloading operations.

2. Secondary Objectives

a. Determine the consumption of helium and liquid nitrogen during load and antigeysering operations.

b. Evaluate the effectiveness of the helium recovery system.

C. SYSTEM SUMMARY

The systems to be tested can be broken down into the following subsystems:

(1) Helium Storage,
(2) Warm Helium Transfer,
(3) Cold Helium Transfer,
(4) Helium Cooler,
(5) Antigeysering Helium Injection, and
(6) Helium Recovery.

The operation of the helium system is carried out automatically by means of the following control buttons:

(1) Load,
(2) Stop Topping,
(3) Shutdown,
(4) Unload Helium,
(5) Helium Recovered, and
(6) Unload LO_2.

The control buttons, when depressed, will energize sequencer circuitry. The details of the sequence of operations that follow such action are discussed in the "ADL System Specifications" (ADL Special Report 86). A summary of these operations as they apply to the helium tests is given below.

With the helium system in a "ready" condition, the depression of the "load" button will start the following sequence:

(1) Helium will flow out of the storage bottles, through the cold helium system, and into the missile in-flight bottles until the helium pressure in the bottles reaches an initial predetermined level.

(2) After LO_2 line cooldown, or its simulation, helium flow will automatically be reinitiated and the missile in-flight bottles pressurized to their in-flight pressure.

(3) The completion of LO_2 fine load will automatically initiate antigeysering helium flow, which will continue throughout the hold period.

(4) The depression of the "stop topping" button will simulate the helium umbilical disconnect and automatically start warm helium delivery to the helium in-flight bottles.

(5) The depression of the "shutdown" button at any time stops helium flow to the missile from the propellant loading system.

(6) Before LO_2 is unloaded, the helium recovery system will automatically become operative. Helium gas, supplied for missile ullage pressurization, will thus be recovered down to a predetermined pressure level. The remaining helium, together with nitrogen gas supplied automatically at this time, will be used to effect pressurized liquid oxygen missile tank unloading.

D. TEST OPERATION

Four categories of tests have been planned for the helium transfer tests. The first test--6.1.1--will load warm helium and prove out the operation of the system at reduced pressures. Test runs 6.2.1, 2, 3, and 4 will be performed in conjunction with liquid nitrogen or liquid oxygen transfer. Test run 6.2.6 will be in combination with a fuel and liquid oxygen transfer. The fourth category (test 6.2.5) will be a helium transfer, first interrupted by a "shutdown" command and later by the simulated loss of power and instrument air. Table 6.1a lists the helium transfer tests, together with test variables.

The helium transfer tests will be operated from the PLS Test Control Panel, located in the Command Control Center. The Test Selector Panel will be used to set up the PL and PS sequencer to perform tests not carried out in conjunction with a liquid oxygen transfer test. During the first helium test (6.1.1), the propellant terminal and missile silo will be manned by observers. During portions of all other tests, all areas except the Command Control Center will be evacuated.

Enumerated, detailed, step-by-step procedure for each test will be covered in "Detailed Test Procedures," to be issued separately as a supplement to this report. These will be enumerated as follows:

Test Number	Procedural Document Number
6.1.1	101-6.1.1
6.2.1	101-6.2.1
6.2.2	101-6.2.2
6.2.3	101-6.2.3
6.2.4	101-6.2.4
6.2.5	101-6.2.5
6.2.6	101-6.2.6

TABLE 6.1a

HELIUM TRANSFER TESTS

Test No.	Helium Flow Control Valve Setting (% Design)	Helium Storage Bottle Used	Liquid Nitrogen in Helium Cooler	Warm Helium Delivery to Helium In-Flight Spheres	Antigeysering Helium Injection Required	Helium Recovery Operation	Fluids in SM Tanks	In-Flight Bottle Pressure (psi)	1-Hour Hold	Nitrogen Pressure via Helium System	Concurrent Tests	Applicable Notes
6.1.1	100	#A	No	Yes	No	Yes	None	500/2000	No	No	-	1
6.2.1	100	#B	Yes	No	No	Yes	LN_2	3000	Yes	Yes	2.2.2	2
6.2.2	100	#A	Yes	Yes	Yes	Yes	LO_2	3000	Yes	Yes	2.2.4	3
6.2.3	120	#B	Yes	Yes	No	Yes	LO_2	3000	Yes	Yes	2.2.5	3
6.2.4	80	#A	Yes	Yes	No	Yes	LO_2	3000	No	Yes	2.2.5	3
6.2.5	100	#B	Yes	No	No	Yes	None	1000/2000	No	No	-	4
6.2.6	100	#A & #B	Yes	Yes	Yes	Yes	LO_2 & fuel	3000	Yes	Yes	1.2.2 2.2.7	5
2.2.1	Not	#B	Not	Only	Yes	No	LN_2	500	No	Yes	-	
2.2.3	Critical	#A	Required	Only	Yes	No	LO_2	500	No	Yes	-	6
2.2.6		#B		Only	No	No	LO_2	500	No	Yes	-	

1. Warm helium to be loaded to 500 psi; liquid oxygen in missile tanks simulated, and the warm helium then pressurized up to 2000 psi.

2. Complete helium cycle with LN_2 aboard missile tank; cold helium delivery only.

3. Complete helium cycle with LO_2 aboard missile tank, including antigeysering and warm helium deliveries, as indicated.

4. Cold helium only. Shutdown button to be depressed when in-flight bottle pressure is approximately 1000 psi. After return to "loading," simulated power and instrument air failure to be tested when pressure is approximately 2000 psi.

5. This test—part of the PLS test—includes a helium reload cycle.

6. These liquid oxygen tests require limited support from the helium system.

E. TEST CONTROL

The helium transfer tests will be controlled from the PLS Test Control Panel, located in the Command Control Center. The PLS Test Control Panel and the Strip Charts (5630) will contain the "real time" indicating instruments required.

Table 6.1b lists the control equipment and control instrumentation used in all helium transfer tests.

TABLE 6.1b

CONTROL EQUIPMENT AND INSTRUMENTATION REQUIREMENTS

Test No.	Control Unit	Control Instrumentation
All	PLS Test Control Panel Test Selector Panel PL and PS Panel	PI-609, PI-608, TI-607, TI-606.

F. TEST DATA AND TEST INSTRUMENTATION REQUIREMENTS

In order to meet the test objectives defined above, specific test data must be collected, analyzed, and interpreted.

Table 6.1c lists the data requirements for test series 6.1 and 6.2, together with test instrumentation used to obtain the data. The material has been tabulated in order to test objectives which justify the specific data and instrument requirements.

Essentially, only "Quick Look" instrumentation has been specified for data analysis. Specific instrumentation details, such as type of transducer, range, location, and desired accuracy have been listed in Table IV-d in Section IV. The location of a specific test instrument can also be found in Figure B-2 of Appendix B.

G. EQUIPMENT REQUIREMENTS

The helium transfer system has been broken down and the subsystem tabulated in paragraph C above.

Table 6.1d is a complete listing of equipment to be used in each test series.

TABLE 6.1c

DATA AND INSTRUMENTATION

Test Objective	Test Data Requirements	Test Instrumentation	Test No.
1a	(1) Helium pressure	PR-601, 603	6.1.1, 6.2.2, 4, 6
		PR-602, 604	6.2.1, 3, 5, 6
		PR-605	all
	(2) Helium flow	FR-601 (OF 601) (OF 602)	6.1.1, 6.2.1, 3, 5, 6
	(3) Valve position	MR (T) 603	6.1.1, 6.2.2, 4, 6
		MR (T) 604	6.2.1, 3, 5, 6
	(4) Helium loading pressure	PR-606	6.1.1, 6.2.2, 4, 6
	(5) Helium loading pressure	PR-607	all
	(6) Helium temperature to cooler	TR-603	6.2.1, 4, 6
	(7) Helium temperature from cooler	TR-604	6.2.1, 4, 6
	(8) Cold helium valve position	MR-602	all
	(9) Warm helium valve position	MR-601	all
	(10) Helium loading temperature	TR-605	6.2.1, 6
	(11) Helium temperature missile tanks	TR-606, 607, 608	all
	(12) Helium pressure missile tanks	PR-608, 609	all
	(13) Elapsed time		all
1b	(14) Helium pressure	PR-603	6.1.1, 6.2.2, 4, 6
	(15) Helium flow	FR-601 (OF 602) (OF 601)	6.2.1, 6.2.3, 5, 6 6.2.2, 4, 6
	(16) Valve position	MR(T) 603	6.1.1, 6.2.2, 4, 6
		MR-601	all
	(17) Helium delivery pressure	PR-606	6.1.1, 6.2.2, 4, 6
1c	(18) Valve position	MR-602, 605	all
	(19) Helium pressure	PR-607	all
2a	(20) Helium temperature	TR-601	6.1.1, 6.2.2, 4, 6
		TR-602	6.2.1, 3, 5, 6
	(21) Helium pressure	PR-601	6.1.1, 6.2.2, 4, 6
		PR-602	6.2.1, 3, 5, 6
		PR-401	6.2.1, 4, 6.2.6
	(22) Visual observation	none	6.2.1, 4, 6.2.6
2b	(23) Helium temperature	TR-601	6.1.1, 6.2.2, 4, 6
		TR-602	6.2.1, 3, 5, 6
	(24) Helium pressure	PR-601	6.1.1, 6.2.2, 4, 6
		PR-602	6.2.1, 3, 5, 6
		PR-607	all
		PR-606	6.1.1, 6.2.2, 4, 6
	(25) Valve position	MR-602, 605	all

TABLE 6.1d

EQUIPMENT REQUIREMENTS

Test No.	Tanks	Lines	Valves	Misc.
6.1.1	T-601A	524 601 606 533 602 608 539 603 609 548 604 610 582 605 611 612 613 614 615	CV-503 FCV-601 SV-517 CV-504 FCV-602 SV-601 CV-601 FCV-603 SV-603 CV-602 FCV-604 SV-605 CV-603 FCV-605 SV-606 CV-604 SV-607 CV-607 SV-608 CV-610	C-601 C-602 S-601 Missile Helium Storage System
6.2.1	T-601B T-402	402 604 524 605 533 606 535 608 536 609 539 611 548 612 582 613 601 614 603 615	CV-404 FCV-601 SV-517 CV-405 FCV-602 SV-518 CV-406 FCV-603 SV-519 CV-407 FCV-604 SV-522 CV-408 FCV-605 SV-601 CV-409 FCV-703 SV-603 CV-503 SV-605 CV-504 SV-606 CV-601 SV-607 CV-602 SV-608 CV-603 CV-604 CV-608 CV-611 CV-703 CV-705 CV-751	C-601 C-602 P-703 S-602 Missile Helium Storage System

TABLE 6.1d (Continued)

Test No.	Tanks	Lines		Valves			Misc.
6.2.2	T-601A T-402	402 524 533 535 536 539 548 582 601 602 603	604 605 606 608 609 610 611 612 613 614 615	CV-404 CV-406 CV-407 CV-408 CV-409 CV-503 CV-504 CV-601 CV-602 CV-603 CV-604 CV-607 CV-610 CV-703 CV-705 CV-751 CV-405	FCV-601 FCV-602 FCV-603 FCV-604 FCV-605 FCV-703	SV-517 SV-518 SV-519 SV-522 SV-601 SV-603 SV-605 SV-606 SV-607 SV-608	C-601 C-602 P-703 S-601 Missile Helium Storage System Injection System
6.2.3	T-601B T-402	402 524 533 535 536 539 548 582 601 602 603	604 605 606 608 609 610 611 612 613 614 615	CV-404 CV-405 CV-406 CV-407 CV-408 CV-409 CV-503 CV-504 CV-601 CV-602 CV-603 CV-604 CV-608 CV-611 CV-703 CV-705 CV-751	FCV-601 FCV-602 FCV-603 FCV-604 FCV-605 FCV-703	SV-517 SV-518 SV-519 SV-522 SV-601 SV-603 SV-605 SV-606 SV-607 SV-608	C-601 C-602 P-703 S-602 Missile Helium Storage System

TABLE 6.1d (Continued)

Test No.	Tanks	Lines		Valves			Misc.
6.2.4	T-601A T-402	402 524 533 535 536 539 548 582 601 602 603	604 605 606 608 609 610 611 612 613 614 615	CV-404 CV-405 CV-406 CV-407 CV-408 CV-409 CV-503 CV-504 CV-601 CV-602 CV-603 CV-604 CV-607 CV-610 CV-703 CV-705 CV-751	FCV-601 FCV-602 FCV-603 FCV-604 FCV-605 FCV-703	SV-517 SV-518 SV-519 SV-522 SV-601 SV-603 SV-605 SV-606 SV-607 SV-608	C-601 C-602 P-703 S-601 Missile Helium Storage System
6.2.5	T-601B T-402	402 524 533 535 536 539 548 582 601 603	604 605 606 608 609 611 612 613 614 615	CV-404 CV-405 CV-406 CV-407 CV-408 CV-409 CV-503 CV-504 CV-601 CV-602 CV-603 CV-604 CV-608 CV-611 CV-703 CV-705 CV-751	FCV-601 FCV-602 FCV-603 FCV-604 FCV-605 FCV-703	SV-517 SV-518 SV-519 SV-522 SV-601 SV-603 SV-605 SV-606 SV-607 SV-608	C-601 C-602 P-703 S-602 Missile Helium Storage System

TABLE 6.1d (Continued)

Test No.	Tanks	Lines		Valves			Misc.
6.2.6	T-601A	402	604	CV-404	FCV-601	SV-517	C-601
	T-601B	524	605	CV-405	FCV-602	SV-518	C-602
	T-402	533	606	CV-406	FCV-603	SV-519	P-703
		535	608	CV-407	FCV-604	SV-522	S-601
		536	609	CV-408	FCV-605	SV-601	S-602
		539	610	CV-409	FCV-703	SV-603	
		548	611	CV-503		SV-605	Missile Helium
		582	612	CV-504	CV-603	SV-606	Storage System
		601	613	CV-601		SV-607	
		602	614	CV-602		SV-608	Injection
		603	615	CV-604			System
				CV-607			
				CV-608			
				CV-610			
				CV-611			
				CV-703			
				CV-705			
				CV-751			

H. SUPPORT REQUIREMENTS

1. Facilities and Service

a. Power

Electrical power will be required to operate the following equipment:

(1) Pumps, system controls and instrumentation, test instrumentation,
(2) Charging equipment, and
(3) Air conditioning and ventilation.

b. Air Conditioning and Ventilation

This service will be required for the following areas:

(1) Propellant Terminal (PT),
(2) Missile Silo (MS),
(3) Tunnel between PT and MS,
(4) Third level of Equipment Terminal, and
(5) Command Control Center.

c. Lighting

Lighting will be required in the areas listed in (b) above.

d. PLS Cleanliness

Prior to each test run, inspect the system under "Equipment Requirements" to insure that it is under proper blanketing and that the areas are void of unsafe materials.

Specific cleaning requirements will be called for during or at completion of a maintenance and repair operation rather than prior to a test. (See Section IX.)

e. First-Aid Service

A first-aid station at the test site should be set up and manned during pretest, test, and post-test operations. See paragraph I for safety considerations.

f. Communications

Communications will be required between: Areas 1, 2, 3, 4, 5, 6, 7, 9, 11, 13, 15, and 18. ADL communication requirements have been covered in more detail in Section VIII.

g. Visual and Audio Warning System

A visual warning system should be in effect during the test to protect personnel in the hazard area defined in Figures IX-a and IX-b.

An audio warning system should be in effect to warn personnel from the hazard area, signal the start of tests, signal significant test conditions, and sound the "all clear."

h. Sole Facility Use

During test runs 6.1.1 and 6.2.5, ADL and other personnel associated with the test run will require sole occupancy of portions of the propellant terminal and missile silo.

As the other test runs are all done in conjunction with another test, the sole occupancy requirements will be the same as those called for by the concurrent test listed in Table 6.1a.

2. Supply Requirements

The following quantities of liquids and gases will be required for test series 6.1 and 6.2.

Test No.	Bottle or Tank	Helium Initial Fill	Requirements Usage	Concurrent Test Giving Other Supplies
6.1.1	601A, 601B	165,200 SCF	234 SCF	NONE
6.2.1	- -	-	11,000 SCF	2.2.2
6.2.2	- -	-	13,000 SCF	2.2.4
6.2.3	- -	-	11,000 SCF	2.2.5
6.2.4	- -	-	11,000 SCF	2.2.5
6.2.5	- -	-	11,000 SCF	NONE
6.2.6	- -	-	25,640 SCF	1.2.2, 2.2.7

3. Associated Contractor Support

The associated contractor support called for under the concurrent test will be required for test series 6.1 and 6.2.

I. SAFETY REQUIREMENTS

1. Hazard Area

The hazard area for tests 6.1.1 and 6.2.5 (indicated on Figure IX-b) include the propellant terminal, missile silo, certain tunnels, the vent-and-fill shafts, and the surface area within 10 feet of the shaft openings. The hazard areas for tests 6.2.1, 6.2.2, 6.2.3, 6.2.4, and 6.2.6 are the same as those for the 1.2 or 2.2 parent tests. These areas shall be restricted to test and associated contractor support personnel only.

2. Warnings

Nontest personnel shall be warned to leave the hazard area before a test. Safety barriers shall be established at tunnel junctions one and two and around the shaft openings (for tests 6.1.1 and 6.2.5) or at the entrance from the control center and around the shaft opening (test 6.2.1, etc.). Audio warnings are to signal the start and completion of tests and significant conditions during the tests' progress.

3. Safety Practices

Test and associated contractor support personnel are to:

a. Wear hard hats, clean cotton clothing, and neoprene gloves.

b. Wear safety glasses or eye shields if working near charged, high-pressure gas lines and equipment.

c. Inspect the hazard area to insure that it is clean, and clear of personnel, tools, materials, and debris.

d. Unless otherwise specified, stay out of the propellant terminal and missile silo during the tests.

e. Use only nonsparking tools and grounded portable equipment, and introduce only clean tools and materials into the complex.

f. Test the atmosphere with oxygen and nitrogen "sniffers" prior to entering a space after a test.

g. Observe the NO SMOKING precautions.

J. CRITERIA

The ability of the PLS to deliver helium to the missile interface at the required pressure and temperature and in a sufficient quantity will be considered the criterion of success.

PLS: COMBINED PROPELLANT LOADING SYSTEMS TESTS

A. PURPOSE

The purpose of this test is to demonstrate the ability of the propellant loading system to perform a complete load, hold, unload, reload, and unload cycle for liquid oxygen and helium in conjunction with a fuel loading and unloading operation. The complete operation is to be carried out in accordance with established countdown procedure.*

B. TEST OBJECTIVES

These specific test objectives are based on basic system test objectives contained in STL document GM-TR-0165-00323B, revised 30 October, 1958, and applicable to Test Plan I - 5.

1. Primary Objectives

PLS-1 Demonstrate that fuel can be delivered to the proper level in both missile tanks, and that the PLS can then simultaneously load liquid oxygen and helium in the required quantities within the countdown time sequence.

PLS-2 Demonstrate that: (a) the PLS can safely unload the missile of all commodities, (b) the missile can be purged and blanketed, and (c) the system can be returned to a "ready" status.

C. SYSTEM SUMMARY

The operational function of each major subsystem has been covered under the following individual captions:

Tests 2.2
Tests 6.1 and 6.2
Tests 1.2

---

* See ADL "System Specifications", ADL Special Report No. 86.

The combined test will be carried out as follows:

(1) All resupply requirements will be completed, and the liquid oxygen, helium, and fuel systems placed in a "ready" status.

(2) Fuel will be loaded aboard the missile, fuel umbilicals will be disconnected, and the PLS fuel system will be drained.

(3) Liquid oxygen and helium will now be loaded simultaneously within allotted countdown times. After a one-hour hold period, liquid oxygen will be unloaded and helium recovered. Liquid oxygen missile tanks will be purged and blanketed in accordance with normal unload procedure.

(4) At the earliest possible time, but no sooner than one hour* following the completion of the liquid oxygen unload operation, helium and liquid oxygen will be reloaded aboard the missile. At the completion of liquid oxygen fine loading, the liquid oxygen missile tanks will be maintained full by means of topping for the remainder of the appropriate countdown period. Liquid oxygen will then be unloaded and helium recovered.

(5) The fuel will finally be unloaded from the missile following the manual reconnect of fuel umbilicals.

(6) During these operations liquid oxygen and helium umbilical disconnect will be simulated by the Test Selector Panel.

D. TEST OPERATION

The combined propellant loading system test will be carried out in accordance with detailed test operation requirements, covered in the liquid oxygen, helium, and fuel test requirements of this section. Specific tests which make up the combined PLS test are covered in Table PLS. 1a.

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* The intent here is to reload when the liquid oxygen lines have returned to ambient temperature. If reload were to follow immediately after the load, the lines would still be full of liquid, and reloading problems would not be encountered.

TABLE PLS. 1a

COMBINED PROPELLANT LOADING SYSTEM
TEST CONDITIONS

Test No.	Corresponding Subsystem Test Run Numbers		
	Liquid Oxygen	Fuel	Helium
PLS. 1	2. 2. 7	1. 2. 2	6. 2. 6

Only one test run is planned. It will involve the use of appropriate operational fluids with no substitutions. No planned interruptions or delays will be imposed on the sequence. The minimum number of variables will be imposed on the test, since this is essentially the final proof test, of Group I, Test Plan 5.

Personnel will not be permitted access to the launcher complex while liquid oxygen is being transferred through th PLS or stored on board the missile.

Test control will be exercised from the Control Center, except for fuel loading and unloading, which will be controlled by means of the Fuel Control Panel, located in the equipment terminal.

E. TEST CONTROL

The liquid oxygen and helium system control will be carried out from the PLS Test Control Panel. Fuel system control will be exercised from the Fuel Control Panel, in the equipment terminal. The "Real Time" instrumentation used in test series 2. 2, 6. 2, and 1. 2 will again be required. All controls and instruments required for test operation and control have been referenced in Table PLS. 1b.

TABLE PLS. 1b

SUMMARY OF TEST CONTROL AND INSTRUMENTATION REQUIREMENTS

Test No.	Concurrent Test No.	Test Control (Table reference)
PLS. 1	2. 2. 7	2.2b
	1. 2. 2	1.2b
	6. 2. 6	6. 1b

F. TEST DATA AND INSTRUMENTATION REQUIREMENTS

In order to meet the test objectives defined above, specific test data must be collected, analyzed and interpreted.

Table PLS. 1c lists a summary of the data required for test PLS. 1 together with references to test instrumentation required to obtain the data.

Essentially, only "Quick Look" instrumentation has been specified for data analysis. Specific instrumentation details, such as type of transducer, range, location and desired accuracy have been listed in Table IV-d of Section IV. Location of a specific test instrument can also be found in Figures B-1, B-2, and B-3 of Appendix B.

TABLE PLS.1c

SUMMARY OF DATA AND INSTRUMENTATION REQUIREMENTS

Test Objective	Test Data Requirements and Test Instrumentation
PLS-1	See Data and Instrumentation requirementation in:
PLS-2	Tables: 2. 2c for test 2. 2. 7 1. 2c for test 1. 2. 2 6. 1c for test 6. 2. 6

G. EQUIPMENT REQUIREMENTS

The operation of the combined PLS test will require the use of:

(1) The complete liquid oxygen system
(2) The complete helium system
(3) The complete fuel system and gaseous nitrogen services.

Flow diagrams of the involved areas are shown in Figures B-1, B-2, and B-3 of Appendix B. In addition, the test equipment requirements have been listed in Tables 2.2d, 6.1d., and 1.2d.

H. SUPPORT REQUIREMENTS

To carry out the cooldown tests, the following support will be required from sources other than Arthur D. Little, Inc., at the Vandenberg Air Force Base.

1. Facilities and Services

a. Power

See requirements under tests 2.2.7, 6.2.6, and 1.2.2.

b. Air Conditioning and Ventilation.

This service will be required for the following areas:

(1) Propellant Terminal (PT)
(2) Missile Silo (MS)
(3) Tunnel between PT and MS,
(4) Third level of the Equipment Terminal, and
(5) Command Control Center.

c. Lighting

The following areas will require lighting:

(1) Propellant Terminal (PT)
(2) Missile Silo (MS)
(3) Tunnel between PT and MS,
(4) Third level of the Equipment Terminal, and
(5) Command Control Center.

d. PLS Cleanliness

Prior to each test run, inspect the complete system to insure that it is under proper blanketing and that the areas are void of unsafe materials and in a clear condition. Specific cleaning requirements will be called for during or at the completion of a maintenance and repair operation rather than prior to a test. (See Section IX.)

e. First-Aid Services

A first-aid station at the test site should be set up and manned during pretest, test, and post-test operations.

f. Communications

Communications will be required between all areas for these tests. ADL communication requirements have been covered in more detail in Section VIII.

g. Visual and Audio Warning System

The following warning periods are expected:

(1) Fuel Loading (4 hours): launcher complex "restricted" to all but authorized personnel.

(2) LO_2 and helium pretest checkout (4 hours): area "restricted."

(3) LO_2 and helium loading, hold, unloading (4 hours): launcher complex "closed" to all personnel.

(4) LO_2 and helium reloading, hold and unloading (4 hours): launcher complex "closed."

(5) Post LO_2 checkout (2 hours): launcher complex "restricted."

(6) Fuel unloading (4 hours): launcher complex "restricted."

Maximum warning system activity: approximately 22 hours.

h. Sole Facility Use

ADL and other personnel directly involved in the combined PLS test will require sole occupancy of the following areas for a period of 24 hours.

Propellant Terminal,
Missile Silo,
Equipment Terminal (limited area) and,
Control Center (limited area).

2. Supply Requirements

The following quantities of liquids and gases will be required for the combined PLS test operation. These requirements have already been included under the individual test requirements (2.2.7, 6.2.6, and 1.2.2).

Propellant or gas	Amount	Unit	Ref. test number specifying this requirement	Receptacle	Delivery pressure (psi)
LO_2	19,610	Gal	2.2.7	T-201	atm
LN_2	540	Gal	2.2.7 & 6.2.6	T-401 & 402	atm
Fuel	12,000	Gal	1.2.2	T-101	atm
GO_2	23,000	SCF	2.2.7	T-301 A, B, C	2400
GN_2	9,600	SCF	2.2.7, 6.2.6 & 1.2.2	T-502, 3, 4 & 5	2400
He	11,000	SCF	6.2.6	T-601 A, B	6000

3. Associated Contractor Support

The following support is assumed to be available from associate contractors at Vandenberg Air Force Base.

a. Test Instrumentation: calibration, pretest checkout, test operations, post-test processing, and basic data reduction: The Martin Company.

b. PLS maintenance, facility cleaning, labor, shop repair, field repair, and replacement of defective equipment plus other labor and craft support, such as electrical and pneumatic: The Martin Company.

c. Handling of umbilical disconnects and other missile silo equipment, such as silo closure doors: The American Machine and Foundry Company and The Martin Company.

d. Quality Control, liquid and gas analysis: VAFB on request.

I. SAFETY REQUIREMENTS

1. Hazard Area

The hazard area for these tests includes the launch complex beyond the Control Center and the surface area within 150 feet of the missile silo opening. Use of these areas will be restricted to test and associated contractor personnel only.

2. Warnings

Nontest personnel shall be warned to leave the hazard area before a test. Safety barriers shall be established at the entrance from the control center and around the missile silo opening. Audio warnings are to signal the start and completion of tests and significant conditions during tests' progress.

3. Safety Practices

Test and associated contractor support personnel are to:

a. Wear hard hats, clean cotton clothing, nonsparking shoes, neoprene gloves, and safety glasses or eye shields.

b. Wear face shields and asbestos gloves if working involves contact with gas or liquid gas.

c. Inspect the hazard area to insure that it is clean and clear of personnel, tools, materials and debris.

d. Unless otherwise directed, remain out of the propellant terminal and missile silo during all tests and out of the complex during liquid oxygen transfer.

e. Use only nonsparking tools and grounded portable equipment, and introduce only clean tools and materials into the complex.

f. Test the atmosphere with oxygen and nitrogen "sniffers" prior to entering a space after a test.

g. Observe the NO SMOKING precaution.

J. CRITERIA

The following will be considered the criteria of success of the combined PLS test:

(1) To load fuel aboard missile prior to test in the quantity required and to unload the fuel from the missile after tests have been completed.

(2) To load liquid oxygen aboard the fueled missile within established countdown conditions in the quantity and at the temperatures required.

(3) To load the missile with helium and liquid oxygen simultaneously, and to supply the missile with sufficient helium at the required temperature and pressure.