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TECHNICAL OPERATING REPORT

(U) DETAILED TEST PLAN — SILO LAUNCH TEST FACILITY PROPELLANT LOADING AND PRESSURIZATION SYSTEM

APRIL 1960

prepared by **THE MARTIN COMPANY**
DENVER 1, COLORADO

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prepared for AIR FORCE BALLISTIC MISSILE DIVISION
AIR RESEARCH AND DEVELOPMENT COMMAND
UNITED STATES AIR FORCE
AIR FORCE UNIT POST OFFICE
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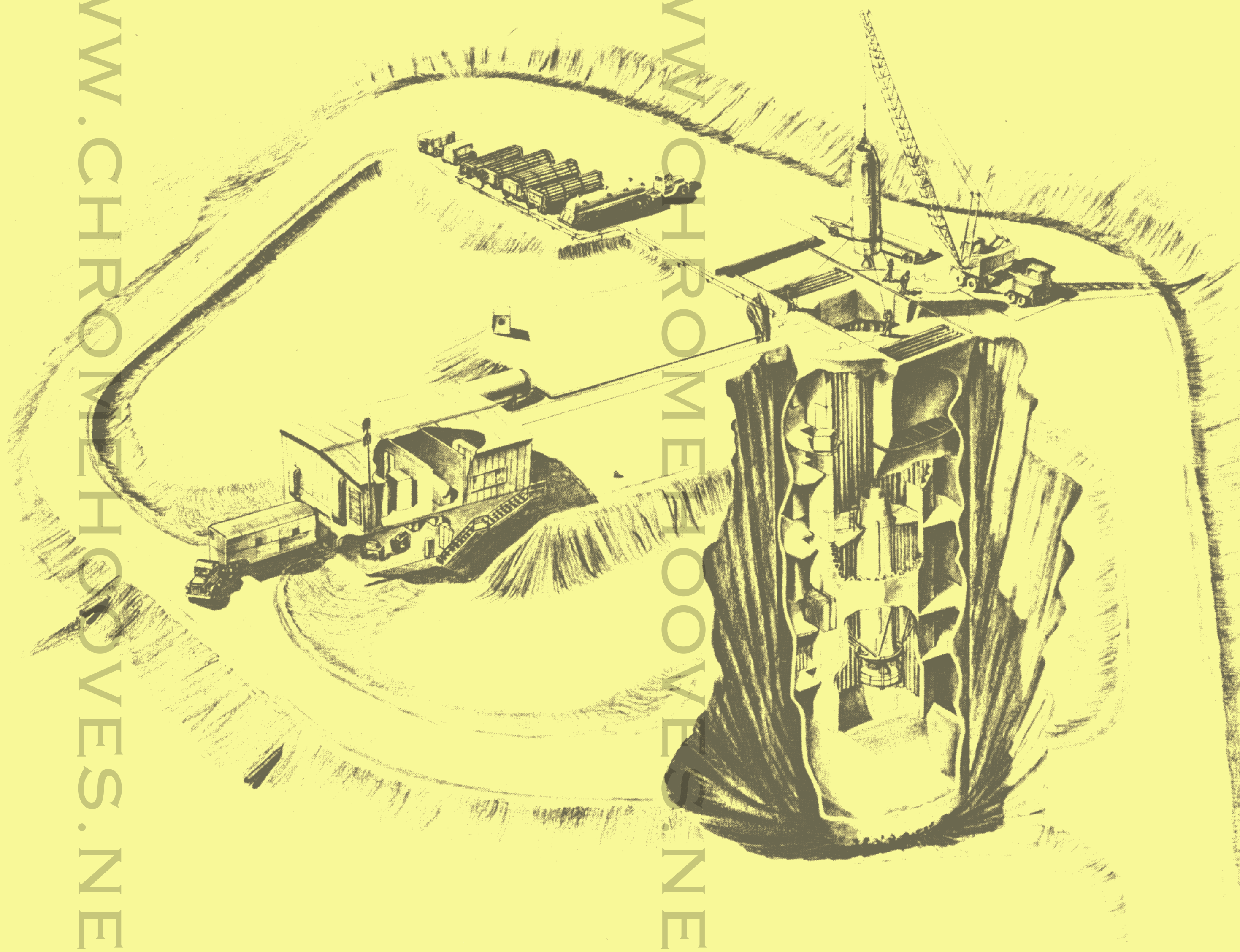

Silo Launch Test Facility

TP-51 Copy No. 44

Contract AF04(645)-56

DETAILED TEST PLAN
SILO LAUNCH TEST FACILITY
PROPELLANT LOADING AND PRESSURIZATION SYSTEM

April 1960

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FOREWORD

This test plan is submitted under Contract AF04(645)-56 in accordance with paragraph 3.5.7.7 of WDD-M-S-13 (Rev 3), dated 1 December 1957, and Specification Change Notices 1 through 84, as incorporated in paragraph 3.18, Section III of AFBM Exhibit 58-1.

CONTENTS

1.0 INTRODUCTION

The test program to be conducted at the Silo Launch Test Facility (SLTF) located at Vandenberg Air Force Base (VAFB), consists of five major tests as outlined in the program requirements (Ref 1). These tests, listed in the sequence in which they will be conducted, are: facility/utilities performance tests; missile installation and removal tests; propellant loading and pressurization system tests; captive tests; and flight tests. This program is designed to determine the feasibility of launching a Titan missile from within an underground (silo) launcher facility.

This report describes the propellant loading and pressurization system tests that will be conducted as an integral part of the test program. The purpose of the propellant loading and pressurization system tests is to demonstrate the ability of the propellant loading and pressurization system (PLPS) to supply and control the loading of gases, propellants, and water into the VS missile.

During these tests, Stage II lox and fuel tanks will be loaded with water ballast. The tanks will then be pressurized, vented, and unloaded. The Stage I fuel tanks will be loaded with RP-1. The lox tanks will then be loaded with liquid nitrogen (LN_2) to provide a safe handling medium for the initial checkout of the PLPS. The lox tank will be unloaded using both normal and emergency methods; emergency procedures will be practiced.

2.0 TEST OBJECTIVES

The SLTF propellant loading system tests will:

1) Demonstrate that missile tanks can be loaded and unloaded with fuel, LN_2, and gases from mobile carriers connected to the SLTF propellant loading system, within a reasonable period of time;

2) Demonstrate the ability of the ground operational equipment (GOE, in this case PLPS subsystem) to control the operation of the propellant loading and pressurization system;

3) Check out the main propellant lines disconnect and drain capability;

4) Demonstrate the operation to design specification (Ref 11) of the water loading system;

5) Demonstrate the operation to design specification (Ref 12) of the fuel loading system;

6) Demonstrate the operation to design specification (Ref 14) of the N_2 loading system;

7) Demonstrate the operation to design specification (Ref 13) of the lox loading system utilizing LN_2;

8) Demonstrate the operation to design specification (Ref 15) of the He loading system;

9) Verify the SLTF propellant loading and pressurization system procedures are adequate for loading and unloading a VS missile without damage to the missile on the facility;

10) Verify emergency procedures;

11) Determine silo air temperatures in the vicinity of the Stage I engine compartment during lox tank loading.

3.0 PREREQUISITES

Prior to commencement of the SLTF propellant loading system tests, the following prerequisites will have been accomplished:

1) Tests at the Propulsion Laboratory at The Martin Company, Denver Division, using a simulated SLTF lox loading system (Appendix A) will have verified the design assumptions on which the SLTF lox loading system is based. During these tests, hardware units (valves, pumps, etc) identical to the SLTF units will have been tested under simulated operating conditions.

Component and signal input failures will have been simulated, and potential hazards and problem areas will have been identified. Propellant loading and unloading procedures and emergency procedures will have been verified;

2) The operation of the accessory supply system, launch sequencer, propellant loading and pressurization system, television system, disconnects, umbilical controls, and the CO_2 fire protection system GOE will have been verified, using Ground System Test Procedures (Appendix B2, numbers [327R92030: 13, 16, 20, 21, 24, 27, 28, and 29]) and using Calibration Procedures (Appendix B3 [327R92031: 13, 21, and 24]);

3) The operation of all facility-alarm subsystems will have been verified during functional checks, in accordance with Test Procedure 327R9030502-2 (Appendix B1);

4) The VS missile will have been installed in the silo in accordance with Procedures 327R9030500-2 and 327R9030501-2 (Appendix B1);

5) The missile emplacement tests outlined in Reference 2 will have been completed;

6) The inspection tests, proof pressure tests, leak tests, and cleanliness tests in accordance with test specifications for propellant systems (Ref 3 through 7) will have been accomplished. Performance tests under these specifications will then be run as a part of the test runs in this plan.

4.0 TEST CONFIGURATION

The test configuration consists of:

1) A VS missile;

2) The SLTF;

3) The propellant loading and pressurization system (GOE);

4) The accessory supply system (GOE);

5) The launch sequencer (GOE);

6) The commodity carriers;

7) The launch control and checkout system test set (CP 3500).

4.1 MISSILE CONFIGURATION

A Lot VS missile will be utilized in the SLTF for propellant loading system tests. The Lot VS missile configuration is defined in Reference 8, which specifies differences between the Lot VS and Lot J missile configurations. The major Lot VS missile characteristics that affect the SLTF propellant loading system tests follow.

4.1.1 Stage II Tanks

Provision is made for water ballasting the Stage II fuel and lox tanks. Because both the lox and fuel tank fill and drain connectors are the fuel tank connector type, they can both be manually connected and disconnected.

4.1.2 Pressurization

The Stage II tanks will be pressurized through the airborne pressurization system, using the 1500 psig ground-supplied N_2.

4.1.3 Stage I Tanks

The Stage I fuel tank is loaded through a manual connect, manual disconnect umbilical. The quantity of fuel loaded is controlled by a flowmeter in the PLS fuel loading system that stops loading after a preset quantity of fuel has been loaded.

The Stage I lox tank is loaded through a manually connected pneumatically disconnected probe type umbilical. The quantity of lox loaded is controlled by monitoring Bogue liquid level sensors of the missile tank.

4.1.4 Missile Umbilicals

The Lot VS missile is equipped with all Lot V (OSTF) umbilical receptacles. However, the SLTF provides only for umbilical connections required for Lot VS. These umbilicals and their positions are listed in Table 1.

4.2 FACILITY CONFIGURATION

The facility consists of an underground silo (with top cover) and a control structure, interconnected by a lined and covered trench. Access roads are provided, and also a parking area to accommodate propellant tank and gas storage trailers required for propellant loading. Fuel and lox loading system hydrants are provided near the mouth of the silo.

The facility layout is shown in the Frontispiece.

4.3 PROPELLANT LOADING AND PRESSURIZATION SYSTEM CONFIGURATION

The SLTF propellant loading and pressurization system permits loading of propellants and gases directly from mobile commodity carriers (located above ground) into a Lot VS missile (located in the silo).

Control of the propellant loading system is partly manual (using verbal commands to operators at manual valves or manually initiated remote valves) and partly automatic.

The water subsystem transfers domestic water from a facility water header to the Stage II fuel and lox tanks for ballast (Fig. 1). A flowmeter in the system is equipped with an automatic shutoff valve to stop the flow of water into the missile when a preset quantity is reached. The system is also capable of unloading water from Stage II and returning it to a facility sump.

The fuel subsystem is designed to transfer fuel from tank trailers located at ground level to the Stage I fuel tank (Fig. 2). After connection of the tank trailers to aboveground hydrants in the parking lot, the fuel fill operation is initiated manually. A flowmeter in the system is equipped with an automatic shutoff valve to stop the flow of fuel when a preset quantity is reached. Unloading is accomplished by a transfer pump, which pumps fuel from the missile back through the transfer system to the fuel tank trailers.

The lox loading subsystem is designed to transfer lox from tank trailers located at ground level to the Stage I lox tank. Initially, the PLPS-GOE will put valves in the facility and missile in proper positions for missile loading. Aboveground, two lox tanks will be manifolded together and connected to the lox hydrant. On verbal command from the PLPS operator, a lox truck operator at the lox hydrant will open a cooldown valve permitting an initial flow of from 80 to 100 gal per minute to enter the fill line and missile. Gaseous oxygen from lox boiloff will pass through the missile tanks and out of the tank vent. After a timed cooldown period, which is to be determined during SLTF lox loading system simulation tests at Denver (Appendix A), the normal flow loading valve at the hydrant will be opened and loading will continue at a rate of from 300 to 350 gal per minute.

The two lox trucks will be expended before the tanks are full. When the trucks are empty, they will be disconnected; two full trucks will be attached, and the loading will be resumed. The Bogue liquid level system will be monitored during fill. When the level reaches 100.5% of nominal, loading is to be stopped by the PLPS operator. (The SLTF lox loading system does not provide for topping or overfill bleed.)

Normal lox unloading will be achieved through the lox probe umbilical, a facility catch pot, and a facility pump that returns the lox to groundlevel. Emergency unloading after the probe has been retracted will be achieved through the engine OSBV's via the same catch pot and pump.

Helium will be supplied for anti-geysering and Stage I tank pressurization.

Helium injection for geysering suppression will be initiated automatically as soon as normal lox loading is verified.

The missile He storage system will be prepressurized with 500 psig He to set the primary and secondary regulators, and to prevent blowing of the He accumulator burst disc. This prepressurization will be initiated manually on verification that one truckload of lox (sufficient to cool down the He sphere) has been loaded aboard the missile. When the Stage I He accumulator lower limit pressure switch actuates, the PLPS will automatically open the He fill valve to pressurize the sphere to 3000 psig.

The N_2 subsystem will deliver N_2 from two aboveground tube-bank trailers to the silo for Stage II missile pressurization, GOE, and GSE. Nitrogen gas is to be provided at the following pressures (Fig. 5):

1) 1500 psig - for electrical disconnect actuation, degreaser operation, half-pressure check of the He sphere, and the 750-psig system;

2) 750 psig - for purging the Stage I gas generator, Stage I pneumatic operation, oxidizer suction bleed valve (OSBV) actuation, and gas generator oxidizer purge valve (GGOPV);

3) 150 psig - for cylinder-operated valves, purge gas for Stage I fuel and lox tanks, and blanket pressure for the fuel and lox system.

A separate N_2 system with storage cylinders in the equipment area at level No. 6 in the silo, will provide 3000 psig N_2 for engine start.

4.4 ACCESSORY SUPPLY SYSTEM

The accessory supply system (ASS) will provide power to all other GOE subsystems during launch control and checkout system operation, and will be required for PLPS testing.

4.5 LAUNCH SEQUENCER

The launch sequencer will provide timing functions and input signals required to permit sequential operation of the PLPS-GOE during propellant loading and unloading and during pressurization operations.

4.6 LAUNCH CONTROL AND CHECKOUT SYSTEM TEST SET (CP 3500)

The CP 3500 test set is designed to provide missile and facility loads and simulated response signals to the launch control and checkout equipment (GOE) to verify correct GOE functioning.

During the SLTF-PLPS tests, it will be necessary to operate the PLPS, ASS, and launch sequencer GOE independent of the other GOE subsystems. Portions of the CP 3500 test set will be utilized to simulate the absent subsystems.

5.0 <u>TEST DESCRIPTION</u>

The PLPS test program, to be conducted at the VAFB-SLTF, is composed of two test parts.

Test Part I will be conducted after the VS missile has been installed and checked out according to procedures in Appendix B. Test Part I will verify the readiness of the SLTF-PLPS.

Test Part II will be a functional verification of the SLTF-PLPS and consists of three tests. The first Part II test will verify operation of the water ballast system. The second will demonstrate capability to fuel the missile. The third will verify operation of the lox system using LN_2.

Test procedures to be used in conducting these tests are listed in Appendix B. In addition to satisfying the test objectives of this plan, these tests will satisfy the performance tests of the test specifications (Ref 3 through 7).

5.1 TEST PART I -- PROPELLANT LOADING AND PRESSURIZATION SYSTEM READINESS

Readiness testing of the PLPS will be accomplished by manual and automatic checkout of the missile propellant and pressurization system, facility lox and He systems, the facility N_2 system, and the PLPS launch control equipment, in accordance with procedures listed in Appendix B.

5.1.1 Manual Checkout Operations

Manual checkout operations will be performed on each of the following systems.

5.1.1.1 Lox System

Manual checkout of the lox system will verify operation of the following missile-borne and facility components:

1) Missile lox and ballast vent valves;

2) Missile lox fill and drain valves;

3) Missile pressure regulators;

4) Facility lox valves;

5) Facility disconnects;

6) Lox unloading pump.

5.1.1.2 Gas System

Manual checkout of the gas system will verify operation of the facility He and N_2 valves.

5.1.1.3 Fuel System

Manual checkout of the fuel system will verify operation of the following:

1) Missile fuel and ballast vent valves;

2) Facility fuel valves;

3) Fuel unloading pump.

5.1.2 Automatic Checkout Operations

Automatic checkout operations controlled by the PLPS-GOE will perform a dry launch sequence checkout of the lox system and the gas system. During these dry run operations, emergency procedures that have been developed during SLTF lox-system simulation tests in Denver will be practiced.

5.2 TEST PART II -- PROPELLANT LOADING TEST

These tests will be conducted to verify operation of the water ballast system, the fuel transfer system, the lox loading and vent system, and the pressurization system (see Fig. 1 through 5). During these tests, the adequacy of the SLTF communication systems to support propellant loading operations will be assessed, and emergency procedures will be verified.

5.2.1 Water Ballast Transfer Test

This test will consist of sequentially loading the Stage II fuel and lox tanks with water, then pressurizing, venting, and sequentially unloading the tanks. The PLPS-GOE will have manually operated controls to position the missile valves and regulators in the configuration necessary to load ballast (water) into the missile; the PLPS operating mode switch will be in the checkout position.

Water will be supplied from the facility domestic water supply and will be loaded aboard the missile by a gravity feed system through a flowmeter and flexible hose. The flowmeter will automatically stop the flow when a preset quantity of water is loaded. The fuel and lox tanks will be loaded with 16,780 lb and 25,100 lb of water, respectively. Connectors will be provided to couple the water hose to the 3B4F and 3B1L airborne umbilical sockets. Each tank will be loaded separately. After both tanks are filled with the required quantity of water ballast they will be pressurized with N_2 to verify the operating of the Stage II pressurization system. After venting the tanks, each tank will be sequentially unloaded by disconnecting the hose from the flowmeter and draining the water into the silo sump.

Stage II ballasting details are contained in the procedures in Appendix B1.

5.2.2 Fuel Transfer Test

This test will consist of fueling the Stage I tank with 51,500 lb of fuel. Fuel will be supplied from mobile tank trailers located at ground level and loaded aboard the missile by gravity feed assisted by the pressure system on the tank trailers. The PLPS-GOE will orient the missile valves and regulators to the position necessary to load fuel into the missile with the PLPS operating mode switch in the checkout position. When the necessary prerequisities are met, the loading operation will be manually initiated. The amount of fuel loaded will be controlled by a flowmeter that will shut off when a predetermined amount of fuel has been loaded aboard the missile. On completion of fuel loading, checks will be conducted to ensure that the missile and facility are in a safe condition. The fuel will not be unloaded until the LN_2 tests (para 5.2.3) are complete.

5.2.3 Lox Transfer System Tests (Using N_2)

These tests will verify operation of the lox transfer system. Liquid nitrogen will be substituted for lox during these tests to reduce the hazards in case of malfunction.

Liquid nitrogen will be supplied from mobile tank trailers located at ground level and will be loaded aboard the missile by gravity feed assisted by the pressure system on the tank trailer. Approximately 83,000 lb LN_2 will be loaded for each test. The loading sequence will be manually initiated and will be controlled by the PLPS operator. The loading operation consists of precooling for a timed interval, followed by normal loading until the Bogue liquid level system indicates that the tank is full*. Helium loading will be initiated manually by the PLPS operator when at least one trailer full of LN_2 has been loaded into the missile.

The Stage I missile tanks will be pressurized and vented, and Stage I lox tank unloaded.

The LN_2 will be unloaded through the lox fill and drain line to the lox catch pot, and pumped by the lox unloading pump back to the tank trailer or the spill pond as directed. The unloading operation will also be controlled by the PLPS operator.

The PLPS-GOE will be operated with the operating mode switch in the launch position during the lox loading and pressurization sequences.

After completion of the above normal loading and unloading sequences, additional sequences will be conducted during which shutdowns will be initiated and emergency procedures will be evaluated. The emergency lox unloading operation will be verified by unloading the LN_2 through the missile OSBV to the lox catch pot, and pumping it back to the tank trailer or spill pond.

After the above sequences are completed, all propellants will be unloaded.

The missile and facility will then be recycled. The loading of lox will be accomplished during the captive test (Ref 8) which follows these PLPS tests.

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*Use of the Bogue sensor for loading LN_2 will require the addition of a correction factor to the indicated load.

6.0 DATA REQUIREMENTS

The only function requiring instrumentation during these tests is the silo air temperature measurement in the vicinity of the Stage I engine compartment. This temperature will be monitored during and after LN_2 loading to determine silo cooldown.

Flow rates during loading and unloading will be determined from time measurements and facility flow meters.

7.0 TEST EVALUATION

The general success of these tests will depend on the completion of the tests listed in Section 5.0 without injury to personnel or damage to the missile, facility, or support equipment.

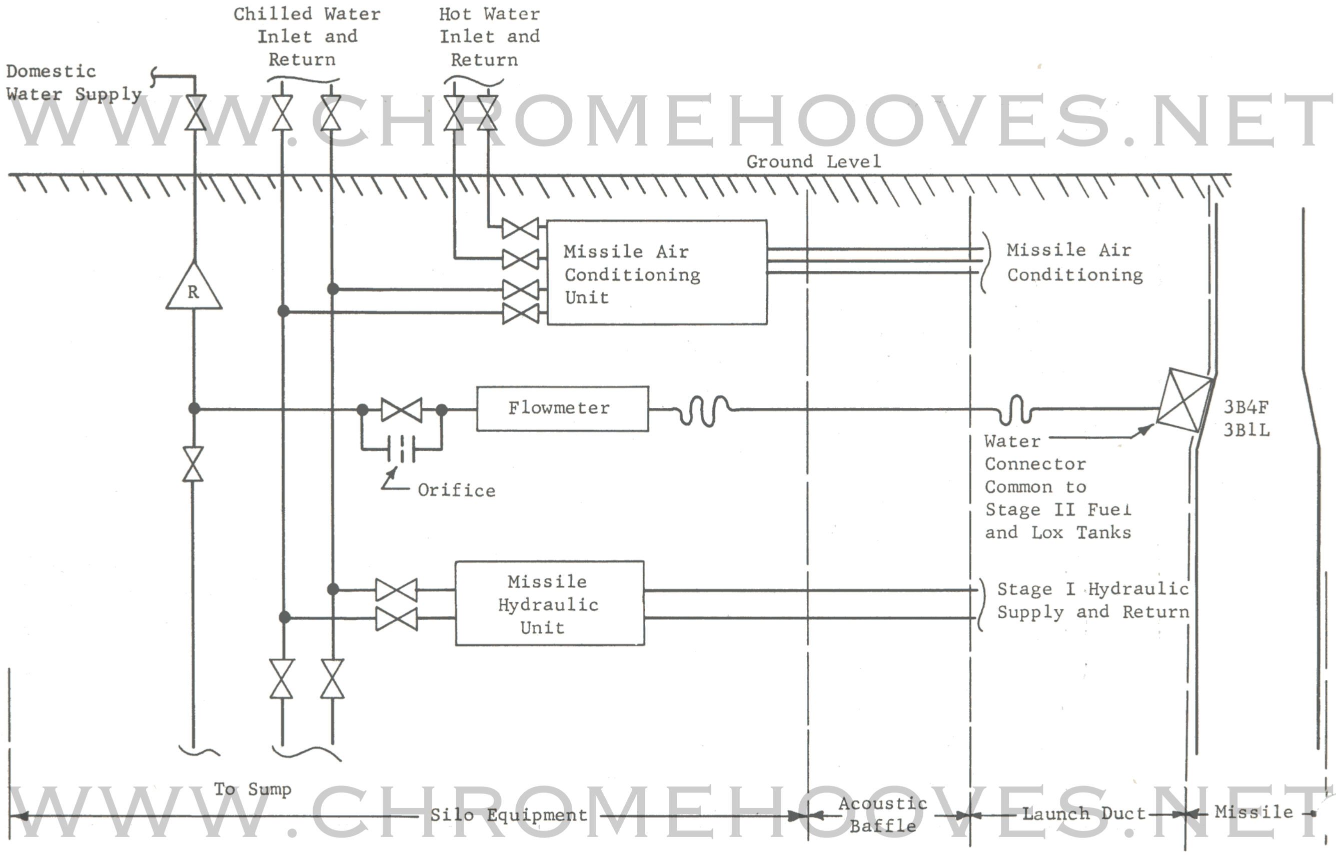
The specific criteria for success are listed in Table 2.

Table 1. SLTF Umbilical and Vent Locations

Compartment	Code	Size (in.)	Type	Station	Quadrant	Angle Off BLO	Remarks
Guidance	1B1A	5	Air conditioning	137.838	II	62° 35'	
	1B1E	-	Electrical	137.650	II	46° 47'	FCS. Stage II fuel vents.
	1B2E	-	Electrical	137.650	II	39° 37'	Power. gyro heaters.
	1B3E	-	Electrical	153.369	II	39° 37'	IRSS. battery temp. power
Missile Safety	2B1A	5	Air conditioning	219.129	II	45°	
Sustainer Engine	3B1E	-	Electrical	371.815	II	15°	APS
	3B2E	-	Electrical	371.815	II and III	ON BLO	APS. IRSS
	3B3E	-	Electrical	371.815	II	60°	IRSS arming
	3B4E	-	Electrical	371.815	II	75°	Vent control
	3B1A	8	Air conditioning	382.258	I and II	ON WL60	
	3B1HE	1/2	He fill	428.133	II	63° 28'	N_2 pressurization
	3B2N	3/8	N_2 pneumatic	428.133	II	56° 23'	Vent actuation
	3B4F	3	Water fill	392.758	I	60°	Manual
	3B1L	3	Water fill	392.633	III	15°	Manual
	3B1T	-	Instrument	377.883	I	45°	Flyaway umbilical
Transition	1C1LV	6	Lox vent	499.958	III and IV	ON WL60	
Booster Engine	3D1E	-	Electrical	972.914	II	81° 06'	Checkout and kill parameters
	3D2E	-	Electrical	972.914	II	86° 12'	Checkout and kill parameters
	3D1HE	1/2	He fill	971.854	I	84° 23'	
	3D5N	3/8	N_2 pneumatic	989.321	II	75° 14'	
	3D3HE	3/8	He	981.165	II	75° 14'	Anti-geysering
	3D1H	5/8	Hydraulic supply	980.946	II	66° 06'	
	3D2H	3/4	Hydraulic return	988.884	II	66° 24'	
	3D1N	3/8	N_2	989.758	II	79° 51'	Gas generator purge
	3D2N	3/8	N_2	989.758	II	61° 34'	Valve actuation
	1E1F	3	Fuel fill	1008.633	IV	9° 42'	
	1E1L	6	Lox fill	1013.133	II and III	ON BLO	
Under-Engine Skirt	1E1N	2	N_2 Start	1036.071	II	66° 33'	
	1E2L	1 1/2	Lox	1036.071	I	66° 33'	OSBV bleed and drain
	1E1T	-	Instrument	-	-	-	Pull away landline

Table 2. Criteria for Success

Test Objective	Test Function	Success Criteria
1	Fuel and LN_2 transfer tests	The PLPS is to be capable of loading and unloading the missile with fuel, lox, and gases in the required quantities without damage to missile or facility or injury to personnel.
2	All tests	The PLPS-GOE is to be capable of controlling the missile-borne and facility components as described in Reference 9.
3	Fuel, N_2, and lox transfer tests	The lox fill and drain line is to be capable of manual connection and automatic disconnection; the fuel fill and drain line is to be capable of manual connect and disconnect.
4	Water ballast transfer test	The water system is to be capable of flowing a maximum of 350 gpm into the missile and shutting off after a predetermined amount has been reached; the water system is to be capable of unloading the missile at a flow rate of 130 gpm.
5	Fuel-transfer test	The fuel system is to be capable of delivering a maximum of 350 gpm to the missile at a pressure of approximately 20 psig and shutting off after a predetermined amount has been reached.
	LN_2 transfer test	The fuel system is to be capable of unloading the missile at a flow rate of 250 gpm.
6	All tests	The N_2 system is to be capable of providing the N_2 required for the conduct of these tests.
7	LN_2 transfer test	The lox system is to be capable of delivering LN_2 at a maximum cooldown rate of 100 gpm and subsequently increasing to a maximum of 350 gpm during normal loading. Delivery temperature is not to exceed -314°F at a fluid pressure of 20 psig. This system is to be capable of unloading the missile at flow rates between 60 (OSBV unloading) and 250 gpm (normal unloading) to the surface-based trailer or holding pond.
8	Fuel, N_2, and LN_2 transfer tests	The He system is to be capable of supplying the He required for the conduct of these tests.
9	Verify loading and unloading procedures	Procedures are adequate to load and unload propellants and gases without damage to missile or facility.
10	Verify emergency procedures	Procedures are adequate to cope with all foreseeable emergencies.
11	Determine silo air temperatures	Temperature 0°F minimum.



Legend:

Note: This legend applies to Figures 1 through A-1.

- X000 lb - pounds of pressure in line shown
- relief valve
- check valve
- manual valve
- manual valve for drainage, sampling, etc
- filter
- pressure regulator
- connection to another system
- pressure gage
- vent line
- ½ in. R ½ in. reducer (reduction in pipe size)
- flow-control valve
- remotely-operated solenoid valve
- missile connector
- flexible hose
- quick disconnect
- burst disc

Fig. 1 Schematic of SLTF Propellant Loading System (Water)

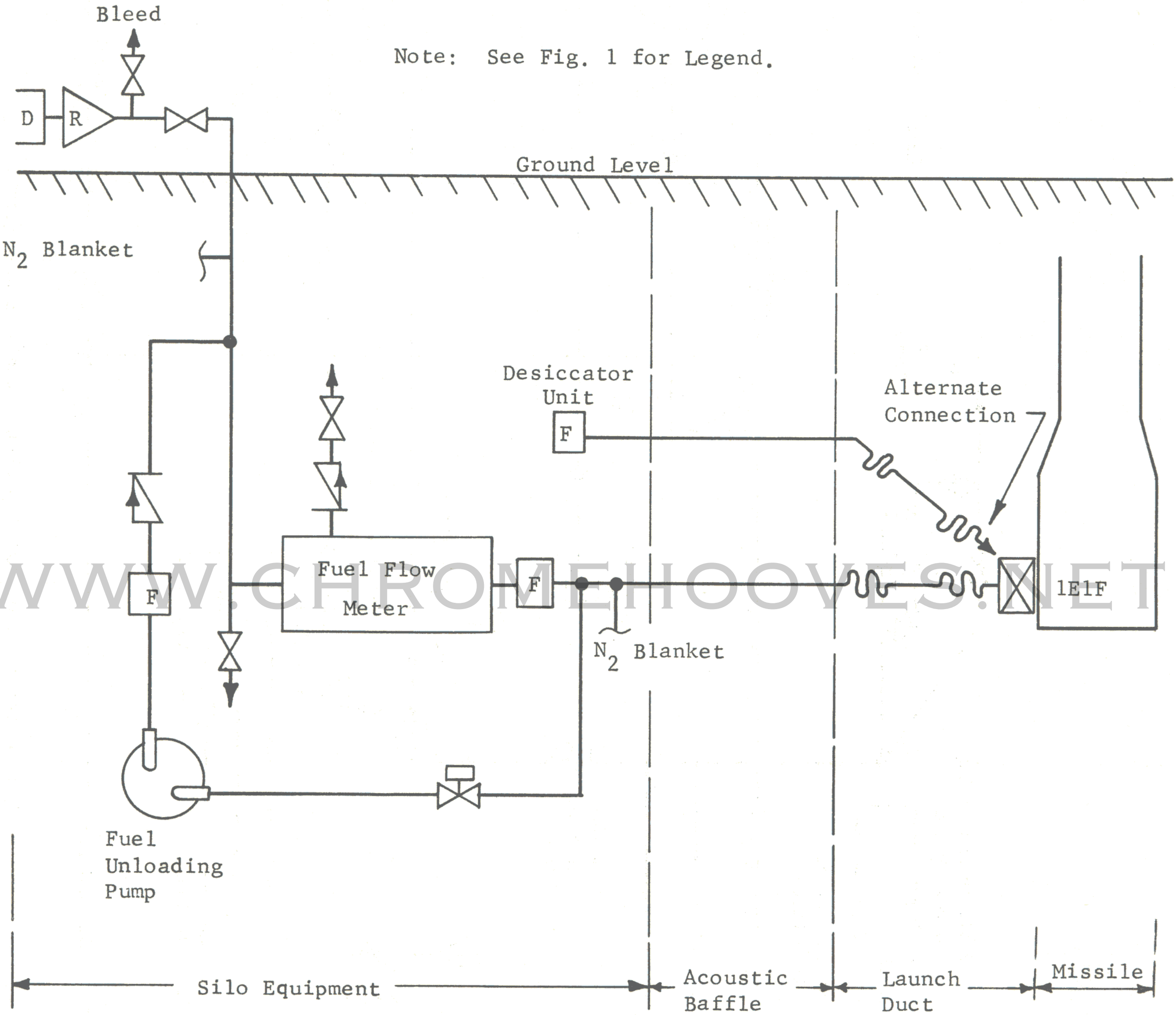


Fig. 2 Schematic of SLTF Propellant Loading System (Fuel)

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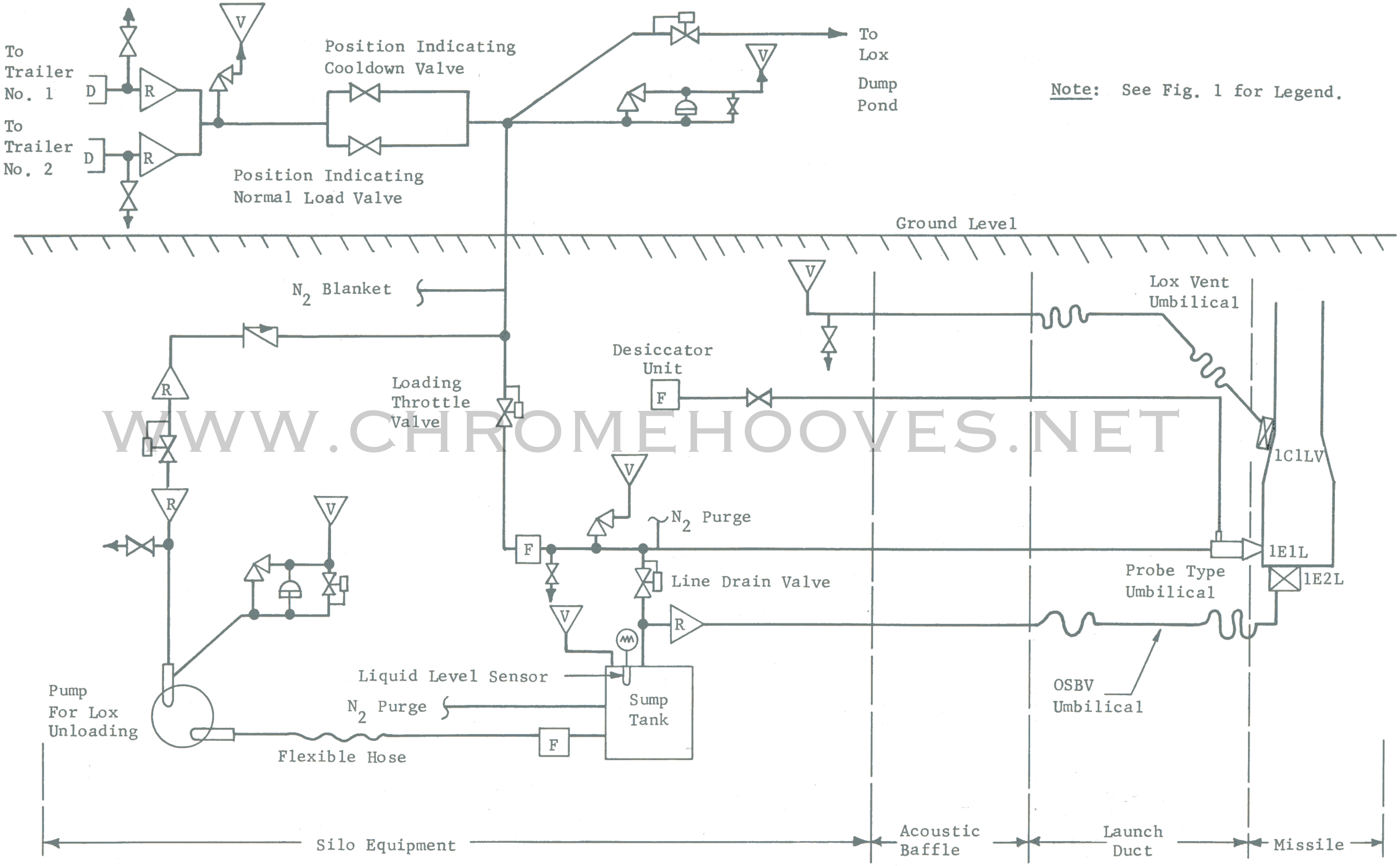

Fig. 3 Schematic of SLTF Propellant Loading System (Lox)

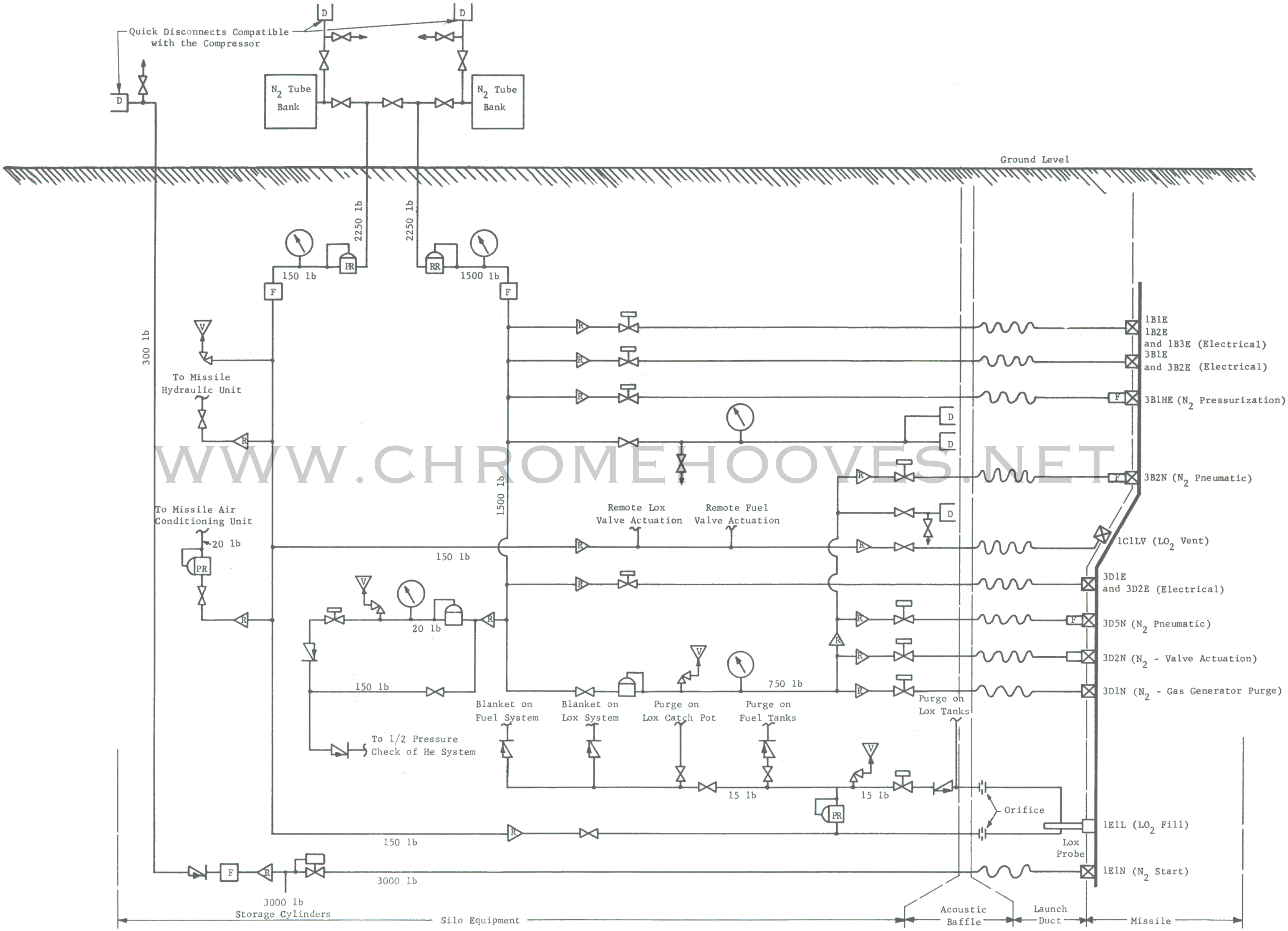

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Fig. 4 Schematic of SLTF Propellant Loading System N_2

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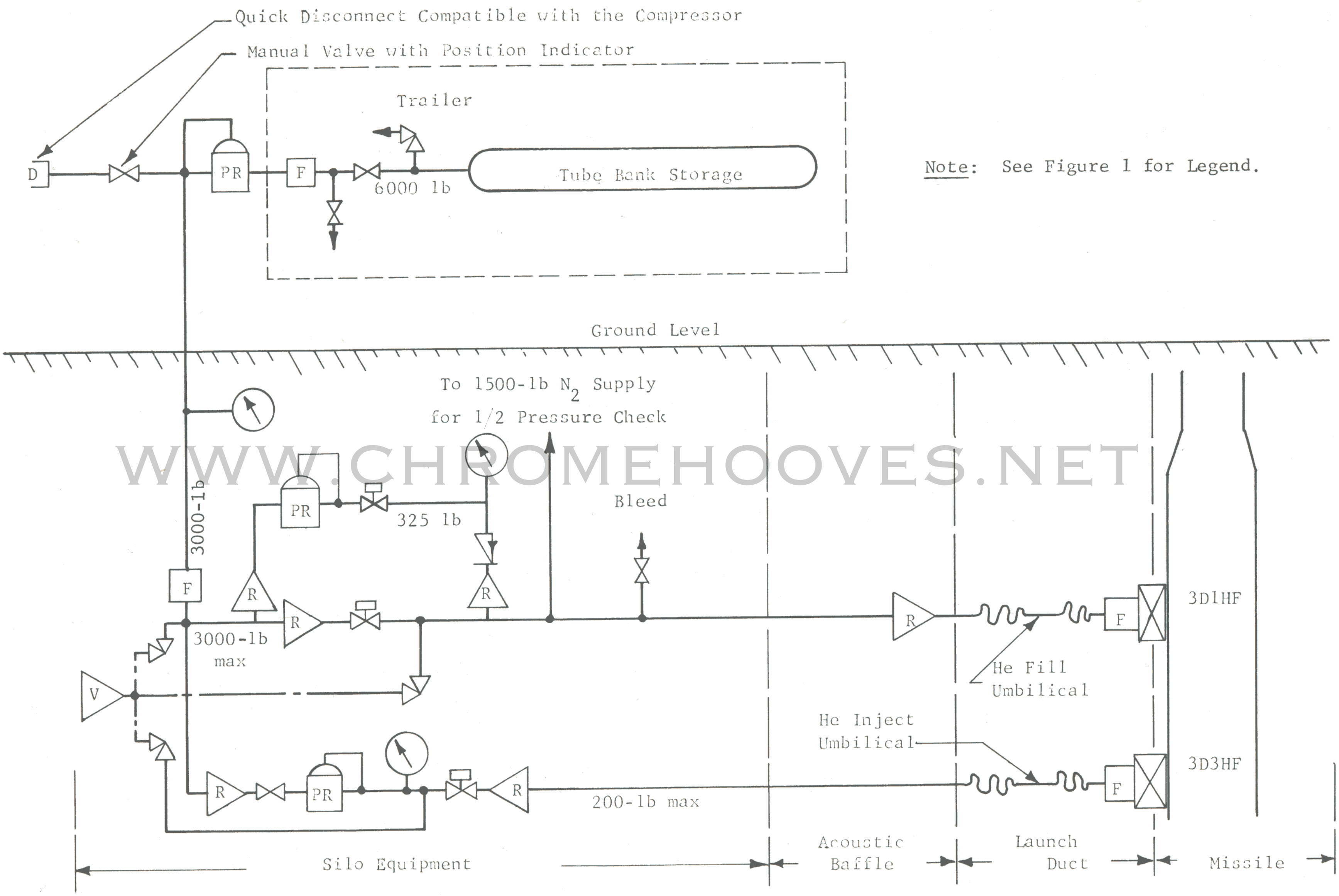

Fig. 5 Schematic of SLTF Propellant Loading System (He)

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APPENDIX A

SIMULATION OF SLTF LOX TRANSFER SYSTEM

1.0 INTRODUCTION

This test will be conducted in the Denver Propulsion Laboratory to support the feasibility study of an in-silo launch configuration for the Titan missile to be conducted at the SLTF located at VAFB.

The purpose of the lox transfer test is to evaluate the design of the lox loading system for SLTF, and to determine the feasibility of unloading the Stage I lox tank through the OSBV. When completed, this test will provide propellant loading procedures and emergency procedures to be used during the SLTF test program.

The lox transfer system will be designed to duplicate, as nearly as possible within limits of the test cell capabilities, the actual configuration of the system that will be installed at the SLTF.

2.0 TEST OBJECTIVES

The objectives to be accomplished during the conduct of this test are as follows:

1) Evaluate the design of the lox loading system for SLTF;

2) Determine the feasibility of unloading the Stage I lox tank through the OSBV;

3) Establish suitable procedures for loading and unloading the missile;

4) Establish emergency procedures to be used during lox loading and unloading.

3.0 TEST CONFIGURATION

3.1 FACILITY - PROPULSION LABORATORY

Six cells comprise the main portion of the facility for flow testing of components and complete propulsion systems. All cells are serviced with lox, LN_2, RP-1, process water, high pressure N_2, and high pressure He.

Two of these cells will flow-test complete systems and are located in a high bay area served by a 20-ton overhead crane.

Lox, LN_2, and RP-1 are handled at pressures of 40 to 1000 psi and volume flows of 150 to 3000 gpm. Helium and N_2 are handled at pressures up to 5500 psi. The largest storage units available are tanks for lox and LN_2 (28,000 gal each), a 10,000-gal tank for RP-1, a 20,000-gal tank for process water, and storage for He and N_2 of 360,000 standard cu ft (scf) and 480,000 scf respectively.

A total of 309 instrumentation channels is currently assigned to the test cells and the recording is done on 35 recorders with a total capacity of 1020 channels. Remote control high speed cameras provide additional test records and all tests can be monitored by closed loop television.

3.2 LOX TRANSFER SYSTEM

The system will be designed in general accordance with Figure A-1 insofar as it pertains to component placement, arrangement, and order of occurrence in the system. The system will be capable of transferring lox from a point approximately 100 ft above the missile loading connection at a maximum rate of 300 gpm and a working pressure of 100 psig. A pump will be located below the missile loading connection to provide a capability of unloading the missile under the following simulated conditions:

1) Normal - unloading will be accomplished through the missile fill connector. The lox will flow through the piping used for filling and will discharge back to the initial filling point. The maximum unloading rate is 250 gpm.

2) Emergency - unloading will be accomplished through the OSBV connector. The lox will flow through the same piping used for filling and will discharge back to the initial filling point. Unloading rate is 60 to 70 gpm.

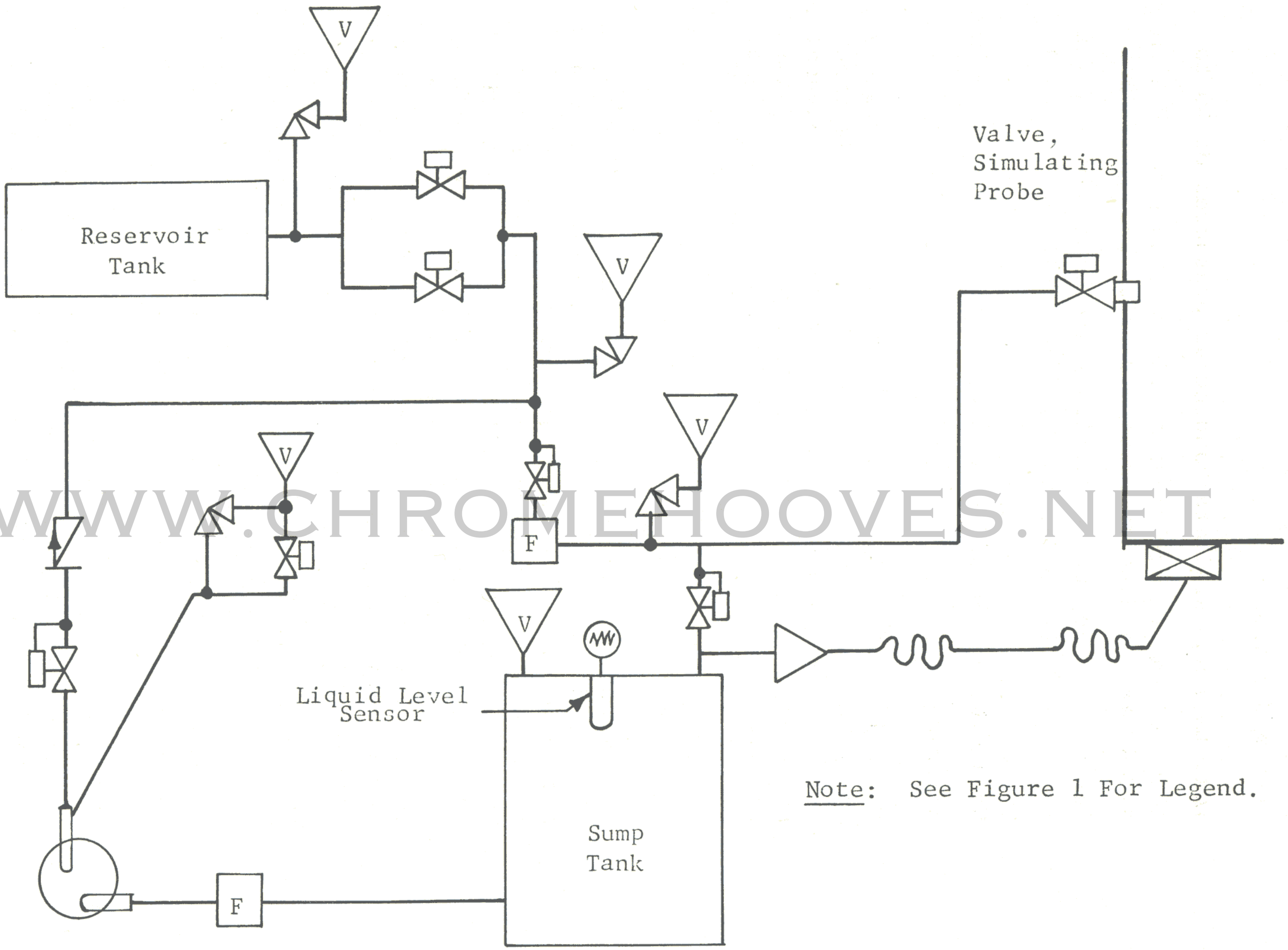

Fig. A-1 Schematic of Denver Test Simulation of SLTF Propellant Loading System (Lox)

The system piping, fittings, valves, flexible hoses, and expansion joints are of the same type as used at the SLTF.

3.3 SYSTEM CONTROL EQUIPMENT

The loading and unloading throttling valves are pneumatically actuated and remotely operated. The loading valve will regulate a constant downstream flow rate of 300 gpm into the missile tanks. The unloading valve is capable of regulating the downstream flow of the unloading pump to prevent cavitation of the pump.

The line drain valve will be remotely operated and the line drain and check valves will be as indicated.

The filters will be installed in the system at the point indicated in Figure A. These filters will be in-line and will be capable of retaining 98% of all foreign particles larger than 10 μ contained in the lox with a maximum pressure drop of 10 psi at rated flow.

The remotely disconnected fill connector will not be used for these tests. In its place a valve of like mass and material for simulating cooldown requirements will be provided.

A stainless steel sump tank, of not less than 100 gal capacity, will be located at the lowest point in the system to provide a liquid head to the unloading pump.

4.0 TEST DESCRIPTION

Five major test runs that will be programmed to test the lox loading system design for SLTF and develop procedures are:

1) Normal loading;

2) Normal unloading, pressurized;

3) Normal unloading, unpressurized (closed system);

4) Emergency unloading, pressurized;

5) Emergency unloading, unpressurized.

Due to safety requirements, all valves will be remotely controlled; however, all will be manually initiated.

The "SLTF Liquid Oxygen Loading and Unloading Test Procedures" for the above tests will be released soon under Propulsion Laboratory Number 01-AFF.

5.0 DATA REQUIRED

Instrumentation will be included in the system to enable direct or subsequent determination of the following:

1) Venting capacities of the lox loading system and the missile tanks. Also the venting characteristics required of the AF dewar trucks when unloading the missile;

2) Liquid hammer effect on the fill line and the missile tanks during cooldown;

3) Dependable parameters to indicate when transfer line and propellant tanks are cooled down;

4) Time required for cooldown of fill lines and missile tanks, for complete loading of the Stage I lox tank, and for unloading through the OSBV and fill connector;

5) Delivery pressures of the lox to the missile tanks, and through the system;

6) Geysering encountered during the filling operation and during hold periods.

APPENDIX B

TEST AND OTHER PROCEDURES

1. SLTF TEST PROCEDURES

327R9030500-1	Administrative Procedures - GMAB
501-1	Loading and Unloading Missile Trailers
503-1	Propulsion Receiving Inspection
507-1	Electrical Receiving Inspection
510-1	Flight Controls Receiving Inspection
513-1	Instrumentation Receiving Inspection
517-1	Missile Safety System Receiving Inspection
505-1	Ordnance Installation - GMAB
500-2	Administrative - Installation in Silo and Checkout
501-2	VS Missile, Installation and Assembly
502-2	Damage Control System Functional Check
506-2	PLPS Preflight Checkout
509-2	Facility Power Checkout
512-2	Missile Air Conditioning Checkout
515-2	TV System Functional Verification
516-2	Communications System Verification
519-2	Facility Functional Verification
520-2	Propellant Loading - Truck Fill
521-2	Ballasting Stage II
500-4	Administrative Procedure - Post Fire Operations
506-4	PLPS Post Fire Procedure

327R9030509-4	Facility Power Post Fire Procedure
520-4	Propellant Unloading Procedure
506-5	PLPS Maintenance

2. GROUND SYSTEM OPERATING PROCEDURES

327R9203020	Secondary Power
024	TV Systems
026	Missile Release System
016	GOE for Missile Electrical
012	Console Control Circuits (CCC)
025	Camera Control System
018	Engine Control System
022	Missile Hydraulics
021	Missile Auxiliary Air Conditioning
013	Launch Sequencer
014	Propellant Loading and Pressurization System
015	Flight Control System
023	Missile Safety System
027	Propellant Disconnects
028	Umbilical Controls
029	CO_2 Fire Protection System
011	Launch Mode Compatibility

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3. CALIBRATION PROCEDURES

327R9203124	TV System Calibration
125	Photo Optic System Calibration
121	Missile Auxiliary Air Condition Calibration
113	Launch Sequencer Calibration
115	Flight Control System Calibration
123	Missile Safety System Calibration

APPENDIX C

REFERENCES

REFERENCES

Ref No.

1 Space Technology Laboratories; Program Requirements and General Test Plan for Titan Silo Launch Test Facility (SLTF) Vandenberg Air Force Base; STL-TR-59-RD00-09889; CONFIDENTIAL

2 The Martin Company; BH Missile Installation and Removal; TP-50; UNCLASSIFIED

3 The Martin Company; Test Specification - Propellant Loading System, SLTF, Water; 327R9213008; UNCLASSIFIED

4 The Martin Company; Test Specification - Propellant Loading System, SLTF, Fuel; 327R9211008; UNCLASSIFIED

5 The Martin Company; Test Specification - Propellant Loading System, SLTF, Liquid Oxygen; 327R9212008; UNCLASSIFIED

6 The Martin Company; Test Specification - Propellant Loading System, SLTF, Nitrogen; 327R9214008; UNCLASSIFIED

7 The Martin Company; Test Specification - Propellant Loading System, SLTF, Helium; 327R9215008; UNCLASSIFIED

8 The Martin Company; Detailed Test Plan Silo Launch Test Facility - Captive Test; TP-52; CONFIDENTIAL

9 The Martin Company; Design Specification for the Propellant Loading and Pressurization System, Ground Operating Equipment; 327R2500005; UNCLASSIFIED

10 The Martin Company; Detailed Specification for Model XSM-68 (Series 3) Ballistic Missile; WDD-M-S-4 (Rev 2); SECRET

11 The Martin Company; Design Specification - Propellant Loading System SLTF - Water; 327R9213005; UNCLASSIFIED

12 The Martin Company; <u>Design Specification - Propellant Loading System SLTF - Fuel</u>; 327R9211005; UNCLASSIFIED

13 The Martin Company; <u>Design Specification - Propellant Loading System SLTF - Liquid Oxygen</u>; 327R9212005; UNCLASSIFIED

14 The Martin Company; <u>Design Specification - Propellant Loading System SLTF - Nitrogen</u>; 327R9214005; UNCLASSIFIED

15 The Martin Company; <u>Design Specification - Propellant Loading System SLTF - Helium</u>; 327R9215005; UNCLASSIFIED

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