



National Aeronautics and
Space Administration

George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama 35812

**FACILITY OPERATING PROCEDURE FOR
THE ETF LIQUID NITROGEN SYSTEM**

**ENVIRONMENTAL TEST FACILITY BRANCH
STRUCTURAL AND ENVIRONMENTAL TEST DIVISION
TEST LABORATORY
ENGINEERING DIRECTORATE**

**This Procedure Describes
Safety Critical Operations**

**CHECK THE MASTER LIST—
VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE**

**Facility Operating Procedure for
the ETF Liquid Nitrogen System**

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1.0 GENERAL INFORMATION

This document describes the process for operating the liquid nitrogen (LN₂) system.

1.1 PURPOSE

This document describes the procedures for the operation of the LN₂ system located at the Marshall Space Flight Center (MSFC) Environmental Test Facility (ETF).

1.2 SCOPE

The procedures and practices outlined in this document are to be followed in the operation of the LN₂ System. The LN₂ System provides liquid nitrogen for test chamber coolant in the ETF test areas of Building 4619.

1.3 APPLICABLE DOCUMENTS

| | |
|------------------|--|
| NPG 8715.3 | NASA Safety Manual |
| MPR 8715.1 | Marshall Safety, Health, and Environmental (SHE) Program |
| MWI 8715.1 | Electrical Safety Program |
| ET24-ETF-OWI-001 | Environmental Test Facility Test Program Control |
| ED26 (02-01) | Memorandum for Record, Safety Assessment for the ETF (soon to be issued as an ET24 memo, number unknown) |

1.4 SAFETY

All Test Personnel working in this facility shall be familiar with the safety documents listed above and shall report any safety hazards, unsafe practices, safety incidents or near misses to the ETF Branch Chief or the 4619 Building Manager Assistant. In the event of serious personnel injury, do not move the injured person except when necessary to prevent further serious injury. The emergency telephone number is 911 and other telephone numbers are listed in section 1.5.

All personnel involved in facilities using cryogenics shall be aware of possible freeze burns caused by contact with cold surfaces or liquids. Protective clothing including eye protection and gloves shall be worn by all personnel involved in handling of cryogenics or when making repairs/modifications to cryogenic facilities. Repairs/modifications to cryogenic systems shall be performed by certified cryogenic handlers. In the event of a cryogenics spill, line ruptures, or similar emergencies, personnel shall first ensure that there is no

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possibility of asphyxiation due to oxygen displacement. Use a portable oxygen monitor to verify oxygen is adequate before entering the spill area.

The pit areas underneath the chambers shall be chained-off during chamber operation to limit access to the enclosed areas.

ET24 Safety Assessment, Memorandum of Record ED26 (02-01) (soon to be issued as an ET24 memo, number unknown) delineates the procedures, personal protective equipment (PPE) requirements and job hazard analysis (JHAs) for hazards associated with operation of this chamber. Operators shall follow this and other applicable procedures, implement the risk mitigation methods listed in the JHAs and use the required PPE to minimize risk from potential hazards during LN₂ system operations.

1.5 EMERGENCY TELEPHONE NUMBERS

Dial **911** for all emergencies.

| | |
|-----------------|-----|
| Medical | 911 |
| Ambulance | 911 |
| Fire | 911 |
| Security | 911 |
| Chemical Spills | 911 |

Other numbers that can be used for emergency information, security, safety, and system maintenance are:

| | |
|---|-----------------|
| Medical Center | 544-2390 |
| Security | 544-4357 |
| Safety | 544-0046 |
| Utilities | 544-3919 |
| Communications Repair | 544-1771 |
| LN ₂ System Repair | 544-7937 |
| LN ₂ Refill/Central Air Station | 544-6339 |
| Emergency LN ₂ Refill/ Contractor Facilities | 247-5197 |
| Operation Chief/Jerry Howard | |
| Other Assistance | 544-HELP (4357) |

1.6 RESPONSIBILITY

ETF Personnel shall be responsible for the operation of the ETF's LN₂ System. The designated operator of the LN₂ System shall be responsible for the safe operation and conduct of the facility. This includes both personnel and hardware. Other task assignments and responsibilities at the ETF shall be in accordance with the organizational work instruction (OWI) ET24-ETF-OWI-001.

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1.7 HAZARDS LIST

- 480 and 120 volts AC electrical power
- Extreme cold temperatures
- Liquid nitrogen (LN₂)

***** WARNING *****

Failure to follow maintenance or operating procedures, techniques, restrictions, etc. exactly may result in severe personnel injury, loss of life or major equipment damage.

***** WARNING *****

Prior to performing maintenance on any equipment, lockout and tag the equipment in accordance with Lockout/Tagout Procedure MSOP-FA-ETF-413 (soon to be superseded by ET24-LOTO-SOP-001). Maintenance shall be performed by qualified technicians only.

1.7.1 Minimizing Electrical Shock Hazards

- 1.7.1.1 All electrical repairs and modifications shall be performed by electrical technicians to minimize the electrical shock hazard.
- 1.7.1.2 All bare electrical parts with a potential to ground of 50 volts or greater should remain de-energized. If this is infeasible, then safety related work practices shall be employed to prevent electrical shock. The safety related work practices shall be documented in accordance with MWI 8715.1 and approved by a senior ETF electrical engineer. All work near energized bare electrical parts shall be performed by qualified persons.
- 1.7.1.3 Personnel shall not enter into or reach into a space with energized bare electrical parts where there is a lack of illumination or an obstruction of view. Personnel shall never blindly reach into an area that may contain energized bare electrical parts.
- 1.7.1.4 Personnel shall remove all conductive apparel before working near energized bare electrical parts, including jewelry, watches, key chains, metalized aprons, and metal head gear.
- 1.7.1.5 Personnel may not perform housekeeping duties at close distances to energized bare electrical parts unless adequate safeguards are provided. Only non-conductive cleaning materials shall be used.
- 1.7.1.6 Any ladder used to reach an area containing bare electrical parts energized at 50 volts or greater shall have nonconductive side-rails.
- 1.7.1.7 Personnel working near bare electrical parts energized at 50 volts or greater shall be provided protective equipment adequate to insulate

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the potential shock hazard. Personnel shall use insulating tools near energized bare electrical parts.

- 1.7.1.8 Safety signs or tags shall be used to warn personnel that an electrical shock hazard is present when there are bare electrical parts energized at 50 volts or greater.
 - 1.7.1.9 Barricades shall be used in conjunction with signs or tags to limit personnel access.
 - 1.7.1.10 Any de-energized electrical parts that are not locked-out, tagged-out, or unplugged will be considered energized. If tag-out is the method used, two or more safeguard measures shall be used. Any bare electrical part that is energized at less than 50 volts to ground need not be locked-out or tagged-out provided there is no risk of burns or arcing.
 - 1.7.1.11 All live electrical parts energized at 50 volts or greater shall be guarded against accidental contact. Guarding methods include approved enclosures or permanent partitions or screens that restrict access by non-qualified personnel.
 - 1.7.1.12 Personnel shall not handle, energize or de-energize, plug-in or unplug any electrical device when the device is wet, the employee is wet, or the floor is wet.
 - 1.7.1.13 Locking type connectors shall be properly secured after connection.
 - 1.7.1.14 After a circuit has been de-energized by the opening of a protective device, the circuit shall be inspected by an ETF electrical technician before the circuit is re-energized.
 - 1.7.1.15 Over-current protective devices shall not be modified.
- 1.7.2 Minimizing LN₂ Hazards

Personnel shall be aware of the possibility of freeze burns by contact with cold surfaces or liquids. Protective clothing including eye protection and gloves shall be worn by all personnel involved in handling of cryogenics or when making repairs/modifications to cryogenic facilities. Repairs/modifications to cryogenic systems shall be performed by certified cryogenic handlers. In the event of a cryogenics spill, line ruptures, or similar emergencies, personnel shall first ensure that there is no possibility of asphyxiation due to oxygen displacement. Use a portable oxygen monitor to verify the area is safe before entering.

1.8 ACRONYMS

| | |
|-----------------------|-------------------------------------|
| ETF | Environmental Test Facility |
| GN₂ | Gaseous Nitrogen |
| GNR | Gaseous Nitrogen Pressure Regulator |
| GNV | Gaseous Nitrogen Valve |
| HOV | Hand Operated Valve |

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|-----------------------|---------------------------------|
| LN₂ | Liquid Nitrogen |
| LNV | Liquid Nitrogen Valve |
| OWI | Organizational Work Instruction |
| PLC | Programmable Logic Controller |
| PSIG | Pounds per Square Inch Gauge |
| ROV | Remote Operated Valve |
| SOV | Solenoid Operated Valve |

1.9 CONTAMINATION CONTROL

If any modification is performed on the LN₂ system, this work shall be performed in a manner so no contamination enters the system. If contamination is suspected, the system shall be cleaned adequately to remove any contamination that modification work may have introduced into the system.

2.0 FACILITY DESCRIPTION

The LN₂ System includes two 13,500 gallon supply vessels, with three supply lines and two return lines connecting to Building 4619. One supply line supplies Chambers Sunspot and V11. A second line supplies the V20 and Rome chambers. The Small Chambers Line supplies all other chambers including V1 through V8 vacuum chambers and TH1 and TH2 thermal humidity chambers. The two return lines are from V20/Rome and Sunspot. Both of these return lines can be configured to recycle excess LN₂ back to a vessel. The return lines from all other chambers are connected to a vent box, which cannot be configured to recycle to a vessel. Other variations in the operation and equipment of the LN₂ system are described below.

2.1 MODES OF OPERATION

This procedure describes various modes of LN₂ system operation used at the ETF. The LN₂ is provided to Building 4619 by pressurizing one of the vessels. The two returns from Building 4619 passes through a separator that vents the GN₂ to atmosphere and recycles the LN₂ back to either of the vessels for reuse. The preferred method of operation is to supply LN₂ from one pressurized vessel and recycle return LN₂ to the other vessel at atmospheric pressure. A less preferred method of operation is to supply LN₂ from one of the vessels by pressure and vent the return mixture of LN₂ and GN₂ to the atmosphere. LN₂ could be pumped by either of two pumps located near Vessel 1 but this method of delivery has never been used since pumping of LN₂ is expected to be problematic.

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2.2 SWITCHING OF SUPPLY VESSEL

This procedure describes switching of the supply vessel while in various modes of operation. The procedure allows continuous flow of LN₂ while switching the supply to the other vessel.

2.3 EQUIPMENT LOCATIONS

Most of the LN₂ controls are located on the LN₂ control screen in the control room, Room Number 168. Most of the LN₂ manual controls are located at the vessels near the southwest corner of Building 4619. The GN₂ (gaseous nitrogen) supply is at the Sunspot GN₂ control panel located near the entrance of the control room. Electrical power is provided to the LN₂ system from the control room power panels NP/LL213 and HNP/LL215, which are located on the control room west wall behind the control panel.

2.4 LN₂ PUMPS

There are two LN₂ pumps that are located at Vessel 1. These pumps could be used if there is not adequate flow by pressurization of a vessel. Since flow has proven to be adequate by pressurization so far, these pumps are not expected to operate. So until they are needed, the inlet, bypass valves and outlet valves for these pumps shall remain closed.

2.5 LN₂ SYSTEM VALVES AND REGULATORS

The following tables list valves and pressure regulators operated in this procedure. Each supply vessel has three main valves that control supply, vent, and return. Each of the two pumps has inlet, outlet, and bypass valves. Each of the three supply lines to Building 4619 has a valve. There are two valves for each vessel to control the automatic pressurization. There is one vent valve for cool down of the transfer line between Vessels 1 and Vessel 2.

These valves and regulators may be identified with three identification numbers,

- Control screen identifier in the table below in italics
- ETF drawing 4619-M071 identification numbers.
- Number installed by the system maintenance contractor, identified in the tables below in parenthesis.

The ETF numbers and the maintenance contractor numbers are typical on the ETF Drawing 4619-M071 with the contractor's number in parenthesis. All three identifications are listed in the following tables where applicable.

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LN₂ SYSTEM VALVES AND REGULATORS
VESSEL VALVES

| LOCATION | VESSEL 1 (SV3) | VESSEL 2 (SV19) | TRANSFER LINE |
|---|--|---|---|
| FUNCTION | | | |
| SUPPLY | <i>V1 Supply Valve</i> LNV52 (ROV200) | <i>V2 Supply Valve</i> LNV53 (ROV201) | NA |
| RETURN TO VESSEL | <i>V1 Return to Vessel</i> LNV36 (ROV4) | <i>V2 Return to Vessel</i> LNV57 (ROV202) | NA |
| VENT | <i>V1 Return to Vent Box</i> LNV38 (ROV5) | <i>V2 Return to Vent Box</i> LNV58 (ROV203) | NA |
| AUTOMATIC VENT | <i>V1 Vent Control</i> GNV109, R35 (SOV12, PC8) | <i>V2 Vent Control</i> V128, R42 (SOV205, PCV295) | NA |
| MANUAL VENT (chain actuated) | V94 (V9) | V125 (V202) | |
| AUTOMATIC PRESSURIZATION | <i>V1 Pressurization</i> GNV98 (ROV6) | <i>V2 Pressurization</i> GNV123 (ROV204) | NA |
| VACUUM JACKET COOL DOWN | NA | NA | <i>VJ Cool Down Valve</i> LNV55 (ROV206) |

CHAMBER SUPPLY VALVES

| SUPPLY FOR | V20/ROME | SUNSPOT/V11 | OTHER CHAMBERS |
|------------|---|---|---|
| | <i>V20/ Rome Supply</i> LNV60 (ROV112) | <i>Sunspot/V11 Supply</i> LNV62 (ROV113) | <i>Small Chamber Supply</i> LNV63 (ROV114) |

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CONTROL GN₂ VALVES AND REGULATORS

These devices seldom require adjustment during normal operation of the LN₂ system. They shall be checked for proper pressure settings following any maintenance on the system.

| LOCATION | SUNSPOT GN ₂ PANEL* | TANK PRESSURIZATION PANEL** |
|---|--|--------------------------------|
| FUNCTION | | |
| SUPPLY VALVE* | LN ₂ Tank Pressurization Supply Valve GNV85* | NA |
| SUPPLY REGULATOR * | LN ₂ Tank Pressurization Regulator GNR26* | NA |
| PANEL INLET VALVE** | NA | GNV100** |
| CONTROL REGULATOR ** | NA | GNR39** |
| SOV SUPPLY REGULATOR ** | NA | GNR41** |
| TANK PRESSURE REGULATOR ** | NA | GNR38** |

* These devices are located on the GN₂/Air panel near the door of the Sunspot control room but are not identified on Drawing 4619-M071.

** These devices are located outdoors below Vessel 1.

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PUMP VALVES

| LOCATION | PUMP P1 | PUMP P2 |
|---------------------|--------------------------|--------------------------|
| FUNCTION | | |
| INLET VALVE | LNV41 (V1) | LNV40 (V2) |
| OUTLET VALVE | LNV49 (V110) | LNV48 (V111) |
| BYPASS VALVE | LNV45 (SOV117) | LNV44 (SOV118) |

2.6 LN₂ CONTROL PANEL

The LN₂ system is controlled primarily from the control screen of the LN₂ control computer.

Selecting the device's icon on the computer screen sends a signal to the programmable logic controller (PLC) to energize or de-energize a control device such as a solenoid valve. The color of a device on the screen will change from gray to a bright color such as green or red when the device is Open or in the ON state. Typically the color change on the screen is triggered from a limit or reed switch at the device which may cause a short delay in the time from when the device is selected to the time when the device' icon changes color. This configuration provides feedback to the operator that the device has actually changed state. The operator shall be aware of this delay and allow time for the device to change state before selecting its icon again.

3.0 LN₂ SYSTEM SHUTDOWN CONFIGURATION

The following procedure prepares the LN₂ system for shutdown. Typical use would include when the LN₂ is not to be used for extended periods. If any modification is performed on the LN₂ system, this work shall be performed in a manner to minimize contamination that can enter the system.

3.1 Configure the ETF LN₂ System control screen as follows.

3.1.1 Set the toggle switch in back of the control room cabinet Bay 7 to the **Manual** (up) position.

3.1.2 **CLOSE** the V1 and V2 Supply valves.

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- 3.1.3 **CLOSE** the V1 and V2 Return to Vessel valves.
- 3.1.4 **OPEN** the V1 and V2 Return To Vent Box valves.
- 3.1.5 Verify the VJ Cool Down valve is **CLOSED**.
- 3.1.6 Verify the PUMP 1 and PUMP 2 Bypass valves are **CLOSED**.
- 3.1.7 **CLOSE** the three supply valves V20/Rome, Sunspot/V11 and Small Chambers.
- 3.2 Set the pressurization control located at both vessels as follows:
 - 3.2.1 Switch the Pressuring Control (left toggle switch) to **OFF** (down position).
 - 3.2.2 Switch the Vent Control (right toggle switch) to **VENT OPEN** (down position).
- 3.3 At the fill station **HANG** the **DO NOT FILL** sign on both vessels fill valves (V50/west valve for vessel V2 and V33/middle valve for vessel V1).
- 3.4 Configure the Sunspot control GN₂ panel as follows:
 - 3.4.1 **CLOSE** the LN₂ tank pressurization supply hand valve (GNV85).
 - 3.4.2 Set LN₂ tank pressurization regulator GNR26 to **ZERO** psig.
- 3.5 Configure the tank pressurization GN₂ panel under vessel 1 as follows:
 - 3.5.1 **CLOSE** LN₂ supply shutoff hand valve GNV100.
 - 3.5.2 **SET** tank pressurization regulator (GNR38) to **ZERO** psig.
 - 3.5.3 **SET** control supply pressure regulator (GNR39) to **ZERO** psig.
 - 3.5.4 **SET SOV** supply pressurization regulator (GNR41) to **ZERO** psig.
- 4.0 OPERATION WITH VESSEL 1 SUPPLY, VESSEL 2 CATCH**
Use this procedure to operate Vessel 1 (SV3) as the LN₂ supply. Perform this procedure sequentially, completing all steps.
 - 4.1 Configure the Sunspot control GN₂ panel as follows:
 - 4.1.1 **SET** the LN₂ tank pressurization regulator (GNR26) to **400** psig.
 - 4.1.2 **OPEN** the tank pressurization supply hand valve (GNV85).

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- 4.2 Configure the tank pressurization GN₂ panel as follows:
- 4.2.1 **OPEN** the supply shutoff hand valve (GNV100).
 - 4.2.2 **OPEN** all six GN₂ panel hand valves, 4 gauge shutoff valves SOV Supply Shutoff and Regulator Supply Hand Shutoff (GNV101 through GNV106).
 - 4.2.3 **SET** the Tank Pressurizing regulator (GNR38) to **85 psig** (this regulator is labeled 100 PSIG Maximum Setting but both vessels are only rated for 93 psig).
 - 4.2.4 **SET** the control supply pressure regulator (GNR39) to **25 psig** (maximum setting is 30 psig).
 - 4.2.5 **SET** the SOV supply pressure regulator (GNR41) to **70 PSIG** (maximum setting is 100 psig).
- 4.3 Set the toggle switch in back of the control room cabinet Bay 7 to the **Manual** (up) position.
- 4.4 **OPEN** the V2 Return to Vent Box Valve at the control screen.
- 4.5 **CLOSE** the V1 Return to Vessel Valve at the control screen.
- 4.6 Configure the Vessel V1 pressurizing panel as follows:
- 4.6.1 Switch the Pressuring Control (left toggle) set to **Automatic** and the Vent Control (right toggle) set to **Automatic**.
 - 4.6.2 Verify that the V1 pressure is 25 \pm 3 psig on the V1 pressurization gauge near the vessel.
- 4.7 Configure the LN₂ control screen as follows:
- 4.7.1 **OPEN** the V1 Supply Valve.
 - 4.7.2 **CLOSE** the V2 Supply Valve.
- 4.8 Configure the Vessel V2 pressurizing panel as follows:
- 4.8.1 Switch the Pressuring Control (left toggle) set to **OFF** and the Vent Control (right toggle) set to **Vent Open**.

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- 4.8.2 Verify the V2 pressure is 0 psig on the V2 pressurization gauge near the vessel.
- 4.9 Configure the LN₂ System control screen as follows
 - 4.9.1 **OPEN** the V2 Return To Vessel Valve.
 - 4.9.2 **CLOSE** the V2 and V1 Return to Vent Box Valves.
- 4.10 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V1** (up) position.
- 4.11 If the catch vessel exceeds 90% fill, or if returning LN₂ to the V2 vessel must be stopped for other reasons, **OPEN** V2 Return to Vent Box Valve and **CLOSE** V2 Return to Vessel Valve.

5.0 OPERATION WITH VESSEL 2 SUPPLY, VESSEL 1 CATCH

- 5.1 Verify the Sections 4.1 and 4.2 have been completed.
- 5.2 Set the toggle switch in back of the control room cabinet Bay 7 to the **Manual** (up) position.
- 5.3 **OPEN** the V1 Return to Vent Box Valve.
- 5.4 **CLOSE** the V2 Return to Vessel Valve on the control screen.
- 5.5 Configure the Vessel V2 pressurizing panel as follows:
 - 5.5.1 Switch the Pressuring Control (left toggle) set to **Automatic** and the Vent Control (right toggle) set to **Automatic**.
 - 5.5.2 Verify that the V2 pressure is 25 ± 3 -psig on the V2 pressurization gauge near the vessel.
- 5.6 Configure the ETF LN₂ System control screen as follows:
 - 5.6.1 **OPEN** the VJ Cool Down Valve for 20 ± 10 seconds then **CLOSE** the VJ Cool Down Valve.
 - 5.6.2 **OPEN** the V2 Supply Valve.
 - 5.6.3 **CLOSE** the V1 Supply Valve.
- 5.7 Configure the Vessel V1 pressurizing panel as follows:

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- 5.7.1 Switch the Pressuring Control (left toggle) set to **OFF** and the Vent Control (right toggle) set to **Vent Open**.
- 5.7.2 Verify the V1 pressure is 0 psig on the V1 pressurization gauge near the vessel.
- 5.8 Configure the ETF LN₂ System control screen as follows:
 - 5.8.1 **OPEN** the V1 Return To Vessel Valve.
 - 5.8.2 **CLOSE** the V1 and V2 Return to Vent Box Valves.
- 5.9 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V2** (down) position.
- 5.10 If the catch vessel nears 90% fill or greater or returning LN₂ to the V1 vessel must be stopped for other reasons, **OPEN** V1 Return to Vent Box Valve and **CLOSE** V1 Return to Vessel Valve.

6.0 LN₂ SUPPLY VALVES

Use the following procedure to open the LN₂ supply to the test chambers. The Sunspot and V11 chambers share a supply line as does V20 and Rome chambers. All other chambers are on the Small Chambers Supply. These three supplies may be opened independently and in any order as needed.

- 6.1 **OPEN** the Small Chamber Supply for any LN₂ needs except for chambers V20, Rome, Sunspot, or V11.
- 6.2 **OPEN** the V20/ Rome Supply if either the Rome or V20 require LN₂.
- 6.3 **OPEN Sunspot/V11** Supply if either Sunspot or V11 require LN₂.
- 6.4 Once there is no need for LN₂ on a supply, **CLOSE** that supply valve.

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7.0 SWITCHING SUPPLY VESSEL FROM V1 TO V2

- 7.1 Verify that Sections 4.1 and 4.2 have been completed.
- 7.2 Set the toggle switch in back of the control room cabinet Bay 7 to the **Manual** (up) position.
- 7.3 **OPEN** the V1 Return to Vent Box Valve.
- 7.4 **CLOSE** the V2 Return to Vessel Valve at the LN₂ control screen.
- 7.5 Pressurize V2 Vessel at the V2 pressuring panel by switching the Pressuring Control to **AUTOMATIC** and the Vent Control to **AUTOMATIC**.
- 7.6 Verify the Vessel V2 is fully pressurized to 25 ±3 psig.
- 7.7 **OPEN** the VJ Cool Down Valve for 20 ±10 seconds on the control screen, and then **CLOSE** the VJ Cool Down Valve.
- 7.8 **OPEN** V2 Supply Valve on the control screen.
- 7.9 **CLOSE** the V1 Supply Valve on the control screen.
- 7.10 Vent the V1 Vessel at the V1 pressuring panel by switching the Pressuring Control to **OFF** and the Vent Control to **VENT OPEN**.
- 7.11 Verify the V1 vessel is at 0 psig.
- 7.12 At the LN₂ System control screen, **OPEN** V1 Return to Vessel Valve.
- 7.13 **CLOSE** the V1 Return to Vent Box Valve at the control screen.
- 7.14 At the Fill Station, **HANG** the **DO NOT FILL** sign on the V1 fill valve.
- 7.15 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V2** (down) position.

8.0 SWITCHING SUPPLY VESSEL FROM V2 TO V1

- 8.1 Verify the Sections 4.1 and 4.2 have been completed.
- 8.2 Set the toggle switch in back of the control room cabinet Bay 7 to the **Manual** (up) position.

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- 8.3 **OPEN** the V2 Return to Vent Box Valve.
- 8.4 **CLOSE** the V1 Return To Vessel Valve at the LN₂ control screen.
- 8.5 Pressurize V1 Vessel at the V1 pressuring panel by switching the Pressuring Control to **AUTOMATIC** and the Vent Control to **AUTOMATIC**.
- 8.6 Verify the Vessel V2 is fully pressurized to 25 ±3 psig.
- 8.7 Return to the LN₂ System control screen and **OPEN** V1 Supply Valve.
- 8.8 **CLOSE** the V2 Supply Valve at the control screen.
- 8.9 Vent the V2 Vessel at the V2 pressuring panel by switching the Pressuring Control to **OFF** and the Vent Control to **VENT OPEN**.
- 8.10 Verify the V2 vessel is at 0 psig.
- 8.11 At the LN₂ System control screen, **OPEN** V1 Return to Vessel Valve.
- 8.12 **CLOSE** the V2 Return to Vent Box Valve at the control screen.
- 8.13 At the Fill Station, **HANG** the **DO NOT FILL** sign on the V2 fill valve.
- 8.14 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V1** (up) position.

9.0 TRANSFERRING LN₂ FROM VESSEL V1 TO VESSEL V2

The system shall be configured as delineated in Section 4.0 prior to this transfer. Performing this section will disrupt the flow of LN₂ to the facility. Inform the operators of the chambers about the action prior to transferring LN₂. Coordinate the time of transfer with chamber operators to minimize the impact to testing. Operations are performed at the control computer unless another location is given.

- 9.1 Set the toggle switch in back of the control room cabinet Bay 7 to the **MANUAL** (up) position.
- 9.2 **OPEN** the V1 and V2 return to Vent Box valve.
- 9.3 **CLOSE** the V2 Return to Vessel valve.
- 9.4 **CLOSE** all three building supply valves.

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- 9.5 **MOVE** red lock located at the fill station from vessel loading valve on Vessel 2 to vessel loading valve of Vessel 1 and **HANG** the **DO NOT FILL** sign on the Vessel 1 fill valve.
- 9.6 **OPEN** the chain operated manual vent valve on Vessel 2 located at the vessel.
- 9.7 Verify the two toggle switches located at Vessel 2 pressurization control panel under the vessel are in the down position. This will put the Pressuring Control in the **OFF** position and the Vent Control in the **VENT OPEN** position.
- 9.8 **OPEN** the V2 vessel supply valve.
- 9.9 Monitor the vessel levels to verify when the LN₂ has been transferred.
- 9.10 **CLOSE** the supply valve to both vessels.
- 9.11 Vessel 1 requires two hand valves to be operated to allow the V1 supply valve to close. However this is a temporary operation that will not be required once the solenoid valve that control air to the actuator is replaced. If the V1 supply valve closes on its own, skip this step.
- 9.12 Place the Vessel 1 toggles switches located on the pressurization panel at the vessel in the down position. The pressuring toggle will be in the OFF position and the vent in the **VENT OPEN** position.
- 9.13 **CLOSE** the chain operated manual vent valve at Vessel 2.
- 9.14 At Vessel 2, position both toggle switches on the pressurization panel in the up position so that pressuring switch is in the **PRESSURIZATION ON** and the vent switch is in the **VENT AUTO** positions.
- 9.15 Wait until Vessel 2 has pressurized before proceeding.
- 9.16 **OPEN** V2 supply valve.
- 9.17 **OPEN** the V1 Return to Vessel valve.
- 9.18 **CLOSE** the V1 and V2 Return to Vent Box valves.
- 9.19 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V2** (down) position.

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10.0 TRANSFERRING LN₂ FROM VESSEL V2 TO VESSEL V1

The system shall be configured as delineated in Section 5.0 prior to this transfer. Performing this section may disrupt the flow of LN₂ to the facility. Inform the operators of the chambers about the action prior to transferring LN₂. Coordinate the time of transfer with chamber operators to minimize the impact to testing. Operations are performed at the control computer unless another location is given.

- 10.1 Set the toggle switch in back of the control room cabinet Bay 7 to the **MANUAL** (up) position.
- 10.2 **OPEN** the V1 and V2 Return to Vent Box valves.
- 10.3 **CLOSE** the V1 Return to Vessel valve.
- 10.4 **CLOSE** all building supply valves.
- 10.5 **MOVE** the red lock located at the fill station from vessel loading valve on Vessel 1 to vessel loading valve of Vessel 2 and **HANG** the **DO NOT FILL** sign on the Vessel 2 fill valve.
- 10.6 **OPEN** the chain operated manual vent valve on Vessel 1 located at the vessel.
- 10.7 Verify the two toggle switches located at Vessel 1 pressurization control panel under the vessel are in the down position. This will put the Pressuring Control in the **OFF** position and the Vent Control in the **VENT OPEN** position.
- 10.8 **OPEN** the V1 vessel supply valve.
- 10.9 Monitor the vessel levels to verify when the LN₂ has been transferred.
- 10.10 **CLOSE** the supply valve to both vessels.
- 10.11 Vessel 1 requires two hand valves to be operated to allow the V1 supply valve to close. However this is a temporary operation that will not be required once the solenoid valve that controls air to the actuator is replaced. If the V1 supply valve closes its own, skip this step.
- 10.12 Place the Vessel 2 toggles switches located on the pressurization panel at the vessel in the down position. The pressuring toggle will be in the OFF position and the vent in the **VENT OPEN** position.
- 10.13 **CLOSE** the chain operated manual vent valve at the V1 Vessel.

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- 10.14 At the Vessel 1, position both toggle switches on the pressurization panel in the up position so that pressuring switch is in the **PRESSURIZATION ON** and the vent switch is in the **VENT AUTO** positions.
- 10.15 Wait until Vessel 1 has pressurized before proceeding.
- 10.16 **OPEN** V1 supply valve.
- 10.17 **OPEN** the V2 Return to Vessel valve.
- 10.18 **CLOSE** the V1 and V2 Return to Vent Box valves.
- 10.19 Set the two toggle switches in back of the control room cabinet Bay 7 to the **Automatic** (down) position and the source to **V1** (up) position.

11.0 EMERGENCY SHUTDOWN PROCEDURE

Use this procedure to shut down the LN₂ system temporarily during an emergency. This procedure will stop the flow of LN₂ from the supply vessel(s). Perform this procedure sequentially, completing all steps. Prior to re-establishing flow to any part of the LN₂ system following an emergency shutdown, the system shall be evaluated and determined safe by the ETF Branch Chief or representative. Once determined safe, reconfigure the LN₂ system per the applicable section of this procedure.

- 11.1 **CLOSE** the V20/Rome Supply, Sunspot/V11 Supply and Small Chambers Supply.
- 11.2 Set the toggle switch in back of the control room cabinet Bay 7 to the Manual (up) position.
- 11.3 **CLOSE** V1 and V2 Supply Valves on the control screen.
- 11.4 **OPEN** V1 and V2 Return to Vessel Valve.
- 11.5 If it is safe to get near the vessels, switch both pressuring panels to **OFF** on the pressuring control and to **VENT OPEN** on the vent control.
- 11.6 If there is an electrical fault, configure the control room power panel HNP as follows.
 - 11.6.1 CIRCUIT BREAKER 10 **OPEN**
 - 11.6.2 CIRCUIT BREAKER 9 **OPEN**

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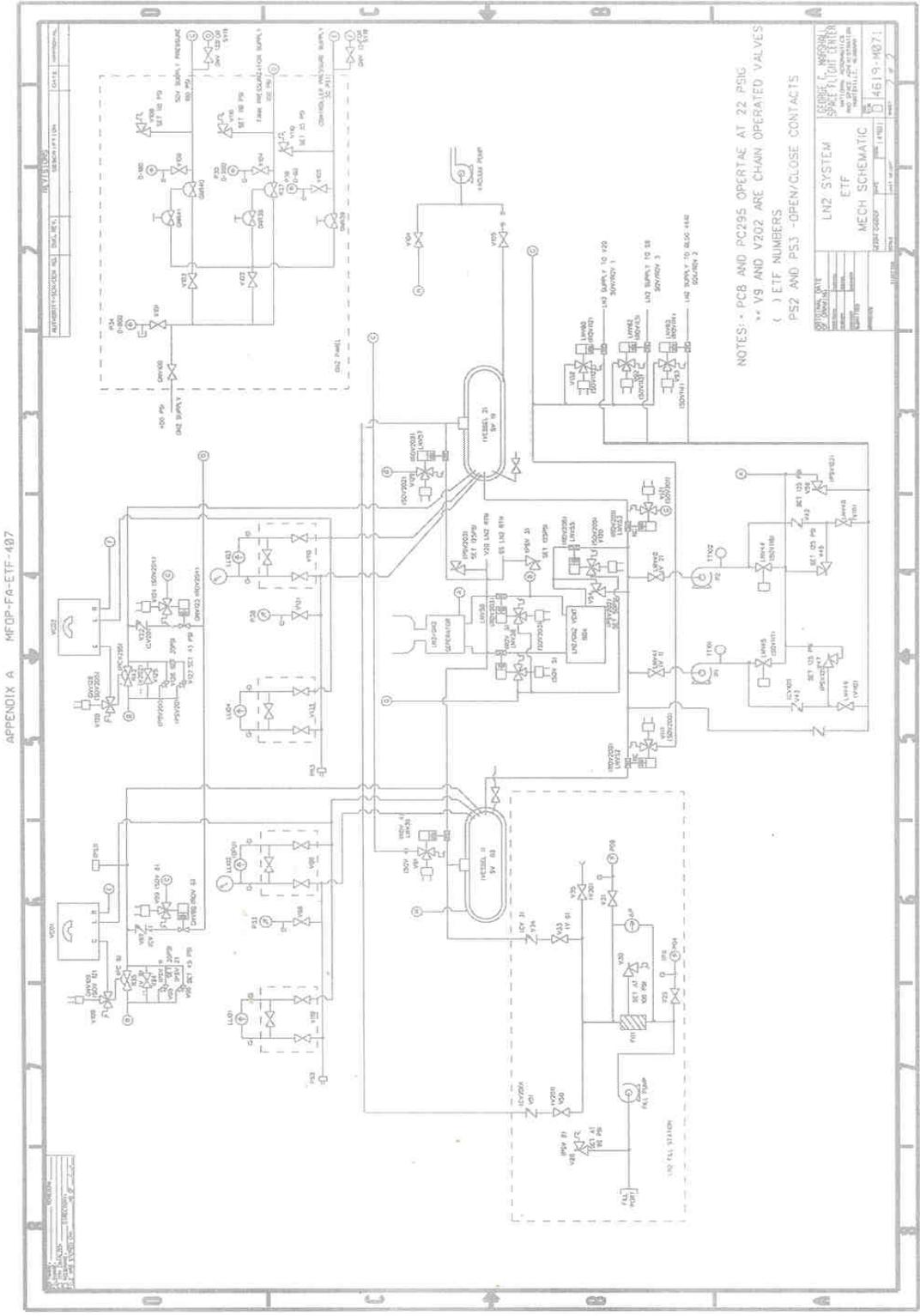
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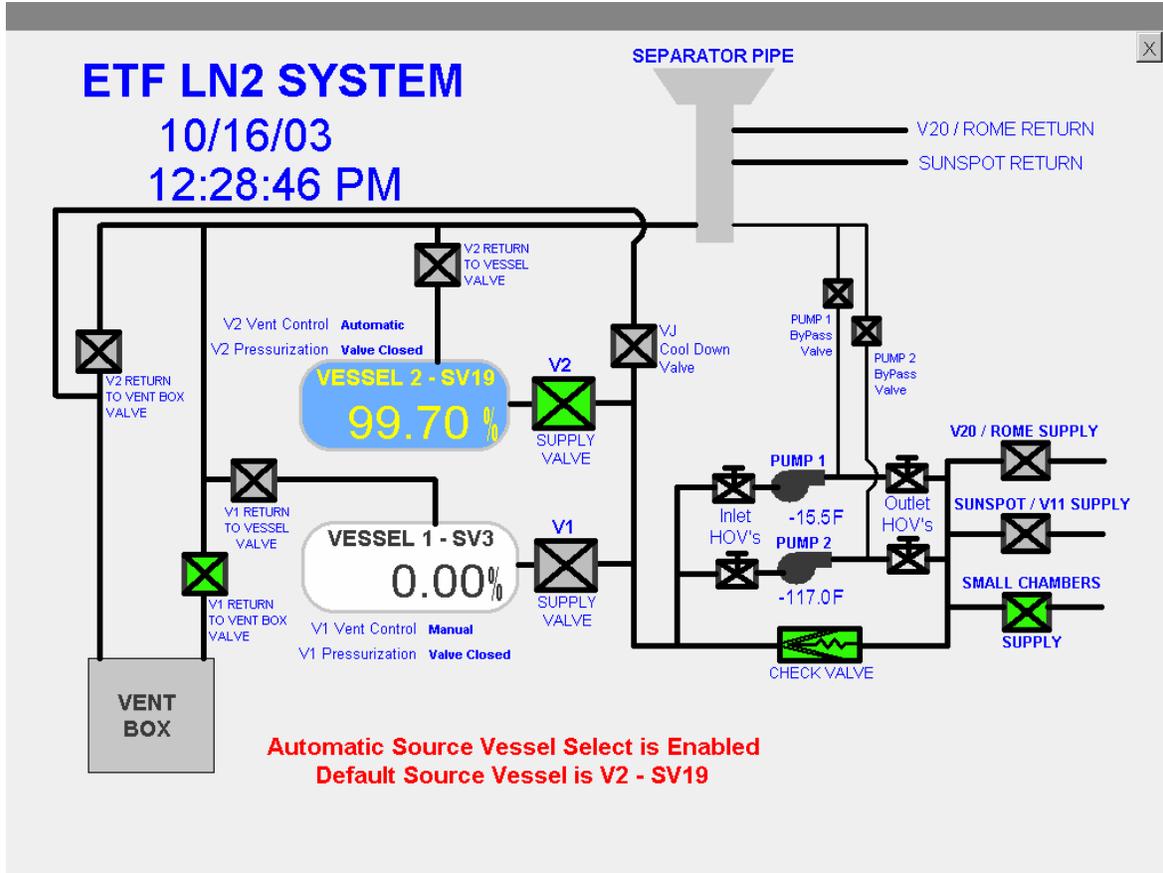
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APPENDIX A, LN2 SYSTEM MECHANICAL SCHEMATIC



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APPENDIX B
ETF LN2 SYSTEM CONTROL SCREEN



CHECK THE MASTER LIST—VERIFY THAT THIS IS THE CORRECT VERSION BEFORE USE