



National Aeronautics and  
Space Administration

---

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

**FACILITY OPERATING PROCEDURE  
FOR  
THERMAL VACUUM CHAMBER V9**

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

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

**FACILITY OPERATING PROCEDURE  
FOR  
THERMAL VACUUM CHAMBER V9**

Originator: \_\_\_\_\_ Date: \_\_\_\_\_  
Robert C. Keener/SvT, Environmental Test Facility, ET24

Approval: \_\_\_\_\_ Date \_\_\_\_\_  
Jimmy Sisco, Mechanical Systems Manager, Environmental Test Facility, ET24

Approval: \_\_\_\_\_ Date: \_\_\_\_\_  
James R. Powers, Electrical Systems Manager, Environmental Test Facility, ET24

Approval: \_\_\_\_\_ Date \_\_\_\_\_  
James R. Stephens, Acting Branch Chief, Environmental Test Facility, ET24

Approval: \_\_\_\_\_ Date \_\_\_\_\_  
Alvin J. Eidson, Industrial Safety Department, QD50

Marshall Space Flight Center ET24		
Facility Operating Procedure	ET24-V9-FOP-001	Revision: Baseline
For Thermal Vacuum Chamber V9	Date: September 26, 2005	Page iii of iv

Release Date: <u>9 / 26 / 2005</u>		<b>Marshall Space Flight Center Specification/Document Change Instruction</b>	Page 1 of 1
			Copy No.:
Change No./Date	SCN/DCN No./Date	Spec. / Doc. No. <u>ET24-V9-FOP-001</u>	Replacement Page Instructions
Baseline/ 9-26-2005	-----	Initial issue for the ET24 organization. Supersedes MFOP-FA-ETF-415.	

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

Marshall Space Flight Center ET24		
Facility Operating Procedure	ET24-V9-FOP-001	Revision: Baseline
For Thermal Vacuum Chamber V9	Date: September 26, 2005	Page iv of iv

## TABLE OF CONTENTS

SECTION	TITLE	PAGE
<b>1.0</b>	<b>GENERAL INFORMATION</b>	<b>1</b>
1.1	PURPOSE	1
1.2	SCOPE	1
1.3	APPLICABLE DOCUMENTS	1
1.4	SAFETY	1
1.5	EMERGENCY TELEPHONE NUMBERS	2
1.6	CHECKOUT TEST	2
1.7	HAZARDS LIST	2
1.8	RESPONSIBILITIES	5
<b>2.0</b>	<b>FACILITY DESCRIPTION</b>	<b>5</b>
2.1	CHAMBER DESCRIPTION AND DIMENSIONS	5
2.2	VACUUM SYSTEM	5
2.3	CONTROL SYSTEM	5
2.4	THERMAL SYSTEM	6
2.5	PERFORMANCE	6
<b>3.0</b>	<b>FACILITY OPERATION</b>	<b>6</b>
3.1	FACILITY PREPARATION	6
3.2	VACUUM SYSTEM OPERATION	8
3.3	THERMAL CONDITIONING	9
3.4	UNATTENDED OPERATION	10
3.5	VACUUM SYSTEM SHUTDOWN	10
<b>4.0</b>	<b>EMERGENCY SHUTDOWN</b>	<b>11</b>

**ATTACHMENT A**

**ATTACHMENT B**

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 1 of 11

## 1.0 GENERAL INFORMATION

### 1.1 PURPOSE

This document describes the procedures for the operation of Thermal Vacuum Chamber V9 located in MSFC Building 4619.

### 1.2 SCOPE

The procedures and practices outlined in this document are to be followed in the operation of chamber V9. This document provides a record copy of chamber V9 operations.

### 1.3 APPLICABLE DOCUMENTS

MPR 8715.1	Marshall Safety, Health, and Environmental (SHE) Program
MSOP-FA-ETF-413	Control of Hazardous Energy (Lockout/Tagout) Procedure for the Environmental Test Facility (soon to be superseded by ET24-LOTO-SOP-001)
ET24-UnattnOps-SOP-001	Unattended Operation of the Environmental Test Facility
ET24-ETF-OWI-001	Environmental Test Facility Test Operations
ED26 (02-01)	Memorandum for Record, Safety Assessment for the ETF (soon to be re-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 incident or near misses to the ETF Branch Chief or the 4619 Building Manager Assistant.

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

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 2 of 11

The chamber can reach extreme temperatures both hot and cold. The test chamber and test article shall be given sufficient time to return to ambient temperature  $\pm 10$  degrees C ( $\pm 18$  degrees F) before removing the test article so that there is minimal extreme temperature hazard.

The personal protective equipment (PPE) requirements and job hazard analysis (JHAs) for operation of the chamber are listed in the ET24 Safety Assessment, Memorandum ED26 (02-01) (soon to be issued as an ET24 memo, number unknown). Chamber operators must be familiar with these documents to understand associated hazards and methods to mitigate the risk from these hazards.

\*\*\*\*\* **WARNING: FLAMMABLE GAS**\*\*\*\*\*

The Aquatrap refrigerant gas is flammable. Use caution when making repairs to Aquatrap. Maintain an operable Class B or CO<sub>2</sub> fire extinguisher within 40 feet of the chamber.

\*\*\*\*\*

## 1.5 EMERGENCY TELEPHONE NUMBERS

Dial **911** for all emergencies, including:

Medical	<b>911</b>
Fire	<b>911</b>
Ambulance	<b>911</b>
Security	<b>911</b>
Chemical Spills	<b>911</b>

Other numbers that can be used to obtain information about emergency, security, safety, and utilities are:

Medical Center	544-2390
Security	544-4357
Safety	544-0046
Utilities	544-3919
Other Assistance	544-4357 (4-HELP)

## 1.6 CHECKOUT TEST

Prior to testing an item in the facility, particularly for critical qualification tests, a "dummy" test article should be used for determining program set-points for the thermal controllers and safety devices. The "dummy" test article should provide an accurate thermal simulation of the actual test article.

## 1.7 HAZARDS LIST

- 208 AND 120 volts AC electrical power.
- Extreme temperatures (hot and cold)
- Liquid nitrogen (LN<sub>2</sub>)
- High kinetic energy in turbo pumps
- Flammable Gas in Aquatrap system
- Vacuum pump oil

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 3 of 11

\*\*\*\*\* **WARNING** \*\*\*\*\*

**Maintenance or operating procedures, techniques, restrictions, etc., may result in severe personnel injury, loss of life or major equipment damage if not followed exactly.**

\*\*\*\*\*

\*\*\*\*\* **WARNING** \*\*\*\*\*

**Prior to performing maintenance on any equipment, lockout and tagout 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 inside the chamber with a potential to ground of 50 volts or greater should remain de-energized when the chamber is open. If this is infeasible, then safety related work practices shall be employed to prevent electrical shock. The safety related work practices shall be documented 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 must not enter into or reach into a chamber with energized bare electrical parts where there is a lack of illumination or an obstruction of view. Personnel must 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 shall 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 enter chambers 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 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 electrical shock hazards are 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.
- 1.7.1.11 If tag-out is the method used, two or more isolation safeguard measures must 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.
- 1.7.1.12 All live electrical parts located outside the chamber and energized at 50 volts or greater must be guarded against accidental contact. Guarding methods include approved

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

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 4 of 11

enclosures or permanent partitions or screens that restrict access by non-qualified personnel.

- 1.7.1.13 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.
- 1.7.1.14 Locking type connectors shall be properly secured when connecting.
- 1.7.1.15 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.
- 1.7.1.16 Over-current protective devices shall not be modified.

#### 1.7.2 Minimizing Extreme Temperature Hazards

The test chamber and test article shall be given sufficient time to return to ambient temperature  $\pm 10$  degrees C ( $\pm 18$  degrees F) before removing the test article in order to minimize the extreme temperature hazard.

#### 1.7.3 Minimizing LN<sub>2</sub> Hazards

Personnel should be aware of the possibility of freeze burns by contact with cold surfaces or liquids. Protective clothing including eye protection and gloves must be worn by all personnel involved in handling of cryogenics or when making repairs/modifications to cryogenic facilities. Only certified cryogenic handlers shall perform repairs/modifications to cryogenic systems. In the event of a cryogenics spill, line ruptures, or similar emergencies, personnel must 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.

#### 1.7.4 Minimizing Turbo Pump Hazards

The turbo pumps have several rotors with many thin blades that rotate approximately 37,000 rpm. Mechanical shock and particles in the flow stream can cause rapid unpredictable failure of the pump. Allow adequate time for the rotors to come to a complete stop before any work is performed on the turbo pumps. Never expose the pumps to mechanical shock or move them when they are operating.

#### 1.7.5 Minimizing Vacuum Pump Oil Hazards

The vacuum pump oil can cause skin and eye irritation. Avoid skin and eye contact with the oil. Remove this oil from the skin using soap and water. Wear safety glasses and gloves while adding or changing oil. Remove oil from the eyes by flushing with water for 15 minutes. Avoid breathing vacuum oil mist.

Any spilled oil is a slip hazard. Clean the area of any spilled oil immediately. Use barricades to limit access in the area until the spill is cleaned.

#### 1.7.6 Minimizing Aquatrap Hazards

The Aquatrap should be 50°F to 86°F when performing maintenance or repairs. The Aquatrap must be purged with a non-flammable gas such as GN<sub>2</sub> before making repairs. Always wear eye protection when performing repairs on the Aquatrap.

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 5 of 11

\*\*\*\*\***WARNING: FLAMMABLE GAS**\*\*\*\*\*

The Aquatrap refrigerant gas is flammable. An operable Class B or CO<sub>2</sub> fire extinguisher must be within 40 feet of the chamber. Never apply heat or an open flame to the Aquatrap.

\*\*\*\*\*

Use caution when connecting and disconnecting gas lines. Keep the area well ventilated and keep ignition sources at least 50 feet away. Wear eye protection when repairing the Aquatrap.

\*\*\*\*\***CAUTION:**\*\*\*\*\*

Do not tip the Aquatrap compressors more than 30° in any direction. Should the compressor be tipped more than 30°, set the compressor upright and wait four hours before operating.

Never allow gas lines to be crimped. Avoid making sharp bends in the gas lines. All gas lines must be connected/disconnected using two wrenches.

Only operate the Aquatrap when the ambient temperature is between 50° F and 95° F.

\*\*\*\*\*

## 1.8 RESPONSIBILITIES

ETF personnel will be responsible for the operation of the V9 Thermal Vacuum Facility. The designated operator of the chamber will be responsible for the safe operation and conduct of the facility. The operator will record his name in the chamber logbook.

Other task assignments and responsibilities at the ETF will be in accordance with ET24-ETF-OWI-001.

## 2.0 FACILITY DESCRIPTION

### 2.1 CHAMBER DESCRIPTION AND DIMENSIONS

Chamber V9 is located in Building 4619 Room 166. This thermal vacuum chamber is a stainless steel vessel. The inside working surface dimensions are 3' 6" diameter and 6' length. Installation of infrared lamps or cold plates reduces the interior space available for a test article.

### 2.2 VACUUM SYSTEM

The vacuum system consists of a mechanical roughing pump and a roughing valve, two Aquatrap, and two mechanical-pump-backed 8-inch turbomolecular pumps with pneumatic foreline valves.

### 2.3 CONTROL SYSTEM

The control system consists of switches for operating valves, Aquatrap, and pumps. The two turbo pumps and the two Aquatrap each have its own controller. The cryo trap has an LN<sub>2</sub> level controller. The LN<sub>2</sub> cold trap was not operational at release of this revision due to no LN<sub>2</sub>

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 6 of 11

available in Room 166. A Dimension Controller is used to control thermal conditioning. Pressure monitoring is by two convectron gauges and an ion gauge. These pressure gauges are controlled by a Granville Phillips GP307 controller. The GP307 controller has the control capability to close the high vacuum valves and switch off the infrared lamps in the event of a pressure rise. This capability must be selected and de-selected manually.

## 2.4 THERMAL SYSTEM

Infrared lamps mounted on a metal frame powered by a 3-phase power phaser provide controlled heating. A Dimension Controller controls the heating. The lamp array and cold plates can be added and removed when needed.

## 2.5 PERFORMANCE

Pumping speeds will vary with test specimen, gas load, and internal chamber conditions. A clean-dry system will perform approximately as follows:

- \* Atmosphere to 50 E -3 torr (1.0 E 5 to 6.7 Pascal) in approximately 30 minutes
- \* 50 E -3 torr to 1 E -5 torr (6.7 to 1.3 E-3 Pascal) in approximately 2 hours
- \* 50 E -3 torr to 5 E -6 torr (6.7 to 6.7 E-4 Pascal) in approximately 24 hours

### NOTE

Maintenance or operating procedures, techniques, restrictions, etc., requires emphasis for safe operation.

## 3.0 FACILITY OPERATION

The operations of chamber V9 will vary according to the temperature range, off-gassing rate of the test article, and whether steady state or varying environments are required. This procedure provides general instructions on how to operate the chamber but does not cover every possible scenario. Operating personnel should be thoroughly familiar with vacuum chamber operation and be familiar with the data acquisition software prior to operating this chamber.

Complete the As-run Buy-off Sheets when operating the chamber. These sheets are typically provided with the TPS. If none are provided, then use a copy of Attachment A. Additional Buy-off sheets shall be added to the test record if the test is required to restart.

## 3.1 FACILITY PREPARATION

- 3.1.1 Review the Safety Assessment, Memorandum ED26 (02-01) (soon to be issued as an ET24 memo, number unknown), to determine the JHAs and PPE that apply to operation of this chamber. Implement the risk mitigation methods listed in the JHAs and use the required PPE to minimize risk from potential hazards while operating this chamber.

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 7 of 11

3.1.2 Verify an operable Class B or CO<sub>2</sub> fire extinguisher is available within 40 feet of the chamber. The nearest fire extinguisher should be in the high bay on the south wall near Column 7. The extinguisher in the back of the room is not suitable for flammable gas fires and must not be used on a fire at the Aquatraps. Only personnel trained in the use of fire extinguishers should use them. Untrained personnel shall evacuate and call 911 from a safe location.

**\*\*\*\*\*WARNING: FLAMMABLE GAS \*\*\*\*\***  
**The Aquatrap refrigerant gas is flammable. Never apply heat or allow an open flame near the Aquatrap components.**  
**\*\*\*\*\***

3.1.3 Ensure that all connections to the chamber are compatible with proper operation of the chamber. Determine that the test is ready to start.

**\*\*\*\*\*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.**  
**\*\*\*\*\***

3.1.4 Verify the ambient temperature is between 50°F and 95°F. The Aquatrap shall not be operated outside this ambient temperature range.

3.1.5 Visually inspect the level and condition of the oil in the three mechanical pumps (two backing pumps and the roughing pump). Add or change oil as needed. Oil should be changed whenever it is darkened, contaminated, milky, or if the pump performance has degraded. Wear safety glasses and gloves while adding or changing oil. Remove oil from the eyes by flushing with water for 15 minutes. Avoid breathing vacuum oil mist. Any spilled oil is a slip hazard. Clean the area of any spilled oil immediately. Use barricades to limit access in the area until the spill is cleaned.

3.1.6 Photograph the test article inside the test chamber before the chamber is sealed. Take as many photographs as considered necessary dependent on the complexity of the test. Submit the photograph(s) to the ETF Test Data Administrator.

**3.1.7 Calibration**

3.1.7.1 Verify that instrumentation to be used on the test has current calibration labels where applicable.

3.1.7.2 Verify that the calibration will not expire before the expected test conclusion date.

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 8 of 11

\*\*\*\*\***CAUTION**\*\*\*\*\*

Do not tip the Aquatrap compressors more than 30° in any direction. Should the compressor be tipped more than 30°, log the incident in the chamber log, set the compressor upright and wait four hours before operating.

\*\*\*\*\*

- 3.1.8 Place all switches on the control panel to the **OFF**, **SAFE**, or **NORMAL** operating position.
- 3.1.9 Visually inspect electrical equipment for external damage including flexible cords, connectors, and plugs. An ETF electrical technician shall repair damage before proceeding to the next step.
- 3.1.10 Position the door closed and secure it to the chamber with at least 2 clamps on opposite sides of the door.
- 3.1.11 Ensure that the data system is setup and operational as required for the test. Start recording data if using PACRATS data acquisition software.

### 3.2 VACUUM SYSTEM OPERATION

- 3.2.1 Switch the Granville-Phillips model 307 “OFF-SP-ON” switch to the **ON** position. Also verify the auto setpoint (SP) setting.
- 3.2.2 Turn mechanical roughing pump switch **ON**, and allow pump to warm.
- 3.2.3 **OPEN** the roughing valve.
- 3.2.4 Loosen the bolts that clamp the door.
- 3.2.5 Verify the cooling water is flowing to the turbo pumps and Aquatrap (if Aquatrap are in use).
- 3.2.6 Turn **ON** turbo-pump backing pump no. 1, no. 2, or both as needed.
- 3.2.7 Verify foreline vents are **CLOSED**.
- 3.2.8 **OPEN** foreline valves No. 1, No. 2, or both as needed.
- 3.2.9 Turn **ON** turbo pump controller turbo power no. 1, or no. 2, or both as needed
- 3.2.10 Allow the turbo pump time to reach operating speed.
- 3.2.11 Complete the following three steps to operate the Aquatrap.
  - 3.2.11.1 Switch **ON** power to Aquatrap to the operating turbo pumps. The Aquatrap power switch is the rocker switch located at the front of the Aquatrap compressor.

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

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 9 of 11

- 3.2.11.2 PRESS the COOL button on either or both Aquatrap controllers as needed. Verify the Aquatraps are cooling, indicated by a green flashing light below the COOL button and falling temperatures shown on the controller's LCD displays
- 3.2.11.3 Wait until the Aquatraps achieve steady state cold temperature. The green light below the COOL button will stay illuminated once the Aquatrap has achieved its steady state cold temperature. Cool-down typically takes one hour.
- 3.2.12 Verify the chamber pressure is in the range of  $1.0 \times 10^{-1}$  to  $7.0 \times 10^{-2}$  torr (100 to 70 millitorr).
- 3.2.13 Verify each turbo pump in use is operating normal as indicated by the green colored light by the Normal label on the pump controller. If one of the Load lights is illuminated on the controller, allow the pump to come up to speed before proceeding.
- 3.2.14 CLOSE the roughing valve.
- 3.2.15 OPEN hi-vac valves to the operating turbo pumps.
- 3.2.16 Switch OFF the mechanical roughing pump.
- 3.2.17 Switch ON the ion gauge controller. Pressure should be in the  $10^{-4}$  torr range or less.
- 3.2.18 After the system is in high vacuum state, and pressure is lower than the set point of the GP 307 pressure gauge controller (i.e.,  $5.0 \text{ E-}4$  torr), select the SP position. Adjust the vacuum gauge set point to approximately 10 times greater than the chamber pressure. As the pressure improves, the set point shall be re-adjusted.

\*\*\*\*\*CAUTION\*\*\*\*\*

**If at any time the chamber pressure climbs above the GP307 set point, the hi-vac valves will close and seal the chamber.**

\*\*\*\*\*

### 3.3 THERMAL CONDITIONING

- 3.3.1 Switch ON the Dimension controller.
- 3.3.2 Set the Dimension Loop 1, 2, or 3 (lamp-array zones 1, 2, and 3 respectively) set-point to the desired temperature. Ensure the respective phaser breaker is ON at the phaser rack.
- 3.3.3 Switch ON the toggle switch next to the R.I. limiter.
- 3.3.4 PRESS the R.I. limiter reset button.
- 3.3.5 ADJUST the R.I. limiter dial to that temperature at which cutoff is to occur. Attachment B lists the setting for the required temperatures.

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

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 10 of 11

3.3.6 Verify test article temperatures on the data system, and adjust the Dimension set-point accordingly.

### 3.4 UNATTENDED OPERATION

The thermal vacuum chamber is designed for continuous automatic operation. To preclude inadvertent automatic shutdown of the chamber or anomalies in the test environment and/or test data, complete the following steps before leaving the operating equipment unattended.

3.4.1 Verify that all facility expendable sources will be available for the unattended period.

3.4.2 Complete applicable sections of the procedure ET24-UnattnOps-SOP-001, Unattended Operation of the Environmental Test Facility.

### 3.5 VACUUM SYSTEM SHUTDOWN

3.5.1 Switch **OFF** and **DE-ENERGIZE** all circuits in the chamber including IR lamp circuits. Verify all of the customer's circuits are switched off and de-energized.

3.5.2 **CLOSE** the hi-vac valves.

3.5.3 Turn **OFF** the ion gauge controller.

3.5.4 Press the WARM buttons on the Aquatrap controllers and allow the Aquatraps to warm for about 30 minutes. Verify the Aquatrap is warming, indicated by a flashing red light below the WARM button and increasing temperatures shown on the controller's LCD display.

3.5.5 Switch **OFF** turbo pumps.

3.5.6 Verify the Aquatraps are warmed to the ambient temperature. At Ambient, the temperature indicated on the Aquatrap controller is approximately 310° K and the LED WARM and COOL lights are off.

3.5.7 Switch **OFF** the Aquatraps at the rocker switches on the front of the compressors.

\*\*\*\*\***CAUTION**\*\*\*\*\*

**The Aquatrap may start cooling at any time following a power outage if the switch on the compressor is not switched OFF.**

\*\*\*\*\*

3.5.8 **CLOSE** the foreline valves.

3.5.9 **STOP** turbo-backing pump.

3.5.10 Open foreline vent valves.

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001 Date: September 26, 2005	Revision: Baseline Page 11 of 11

- 3.5.11 Verify all circuits in the chamber are switched off and de-energized, including IR lamp circuits and all of the customer's circuits. If it is infeasible to de-energize all circuits, comply with all requirements of Section 1.7.1 Minimizing Electrical Shock Hazards. If it is infeasible to de-energize all circuits on the test article, provide the customer with a copy of Section 1.7.1 Minimizing Electrical Shock Hazards.
- 3.5.12 **OPEN** the chamber repress valve.
- 3.5.13 Allow the chamber about 30 minutes to reach atmospheric pressure.
- 3.5.14 **CLOSE** the chamber repress valve.
- 3.5.15 Verify the chamber and test article have returned to ambient temperature  $\pm 10$  degrees C (+18 degrees F) and are above the dew point temperature.
- 3.5.16 After the door is opened, and before other activities, an ETF electrical technician shall check for potential on all of the ETF's bare electrical parts energized at 50 volts or greater. The customer shall check for potential on the test article's bare electrical parts energized at 50 volts or greater.
- 3.5.17 Test article may now be removed from the chamber.

#### 4.0 EMERGENCY SHUTDOWN

- 4.1 Switch **OFF** the **LIMITER** power toggle switch, located near the center of the instrumentation/control rack, between the Dimension controller and the RI limiter.
- 4.2 On level C of the instrumentation/control rack, switch **OFF** the following toggle switches:  
**TURBO 1 HI-VAC VLV**  
**TURBO 2 HI-VAC VLV**  
**ROUGHING VALVE**
- 4.3 Return to section 3.5 VACUUM SYSTEM SHUTDOWN and shut down the rest of the system.
- 4.4 Vent the chamber and remove test article only when there is no significant risk of injury to personnel.

Marshall Space Flight Center ET24		
Attachment A to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 1 of 2

### V9 As-run Buy-off Sheets

Test Number \_\_\_\_\_ Customer Contact \_\_\_\_\_

Calling TPS or Work Instructions \_\_\_\_\_ Start Time & Date \_\_\_\_\_

Test Description \_\_\_\_\_ End Time & Date \_\_\_\_\_

Data Process Rate \_\_\_\_\_

- |                                    |                                 |                                                            |
|------------------------------------|---------------------------------|------------------------------------------------------------|
| <b>3.1 Facility Preparation</b>    | 3.2.5 _____                     | 3.3.2 _____                                                |
| 3.1.1 _____                        | 3.2.6 _____                     | 3.3.3 _____                                                |
| 3.1.2 _____                        | 3.2.7 _____                     | 3.3.4 _____                                                |
| 3.1.3 _____                        | 3.2.8 _____                     | 3.3.5 _____                                                |
| 3.1.4 _____                        | 3.2.9 _____                     | 3.3.6 _____                                                |
| 3.1.5 _____                        | 3.2.10 _____                    | <b>3.4 Unattended Operation</b><br>(N/A if Not Applicable) |
| 3.1.6 _____                        | 3.2.11.1 _____                  |                                                            |
| 3.1.7.1 _____                      | 3.2.11.2 _____                  | 3.4.1 _____                                                |
| 3.1.7.2 _____                      | 3.2.11.3 _____                  | 3.4.2 _____                                                |
| 3.1.8 _____                        | 3.2.12 _____                    | <b>3.5 Vacuum System Shutdown</b>                          |
| 3.1.9 _____                        | 3.2.13 _____                    |                                                            |
| 3.1.10 _____                       | 3.2.14 _____                    | 3.5.1 _____                                                |
| 3.1.11 _____                       | 3.2.15 _____                    | 3.5.2 _____                                                |
| <b>3.2 Vacuum System Operation</b> | 3.2.16 _____                    | 3.5.3 _____                                                |
|                                    | 3.2.1 _____                     | 3.2.17 _____                                               |
| 3.2.2 _____                        | 3.2.18 _____                    | 3.5.5 _____                                                |
| 3.2.3 _____                        | <b>3.3 Thermal Conditioning</b> | 3.5.6 _____                                                |
| 3.2.4 _____                        |                                 | 3.3.1 _____                                                |
|                                    |                                 | 3.5.8 _____                                                |

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

Marshall Space Flight Center ET24		
Attachment A to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 2 of 2

**V9 As-run Buy-off Sheets**

3.5.9 \_\_\_\_\_

3.5.10 \_\_\_\_\_

3.5.11 \_\_\_\_\_

3.4.12 \_\_\_\_\_

3.5.13 \_\_\_\_\_

3.5.14 \_\_\_\_\_

3.5.15 \_\_\_\_\_

3.5.16 \_\_\_\_\_

3.5.17 \_\_\_\_\_

QA \_\_\_\_\_  
(N/A if Not Applicable)

Marshall Space Flight Center ET24		
Attachment B to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 1 of 4

Research Incorporated Temperature Limiter  
SETPOINT DIAL SETTINGS VS TEMPERATURE

DEG F	0	1	2	3	4	5	6	7	8	9
-300	0.									
-290	6.9	6.2	5.5	4.8	4.1	3.4	2.7	2.0	1.3	0.7
-280	14.0	13.3	12.5	11.8	11.1	10.4	9.7	9.0	8.3	7.6
-270	21.4	20.6	19.9	19.1	18.4	17.7	16.9	16.2	15.5	14.7
-260	29.1	28.3	27.5	26.7	26.0	25.2	24.4	23.7	22.9	22.1
-250	37.0	36.2	35.4	34.6	33.8	33.0	32.2	31.4	30.6	29.8
-240	45.2	44.3	43.5	42.7	41.9	41.0	40.2	39.4	38.6	37.8
-230	53.6	52.7	51.9	51.0	50.2	49.3	48.5	47.7	46.8	46.0
-220	62.3	61.4	60.5	59.6	58.8	57.9	57.0	56.2	55.3	54.5
-210	71.2	70.3	69.4	68.5	67.6	66.7	65.8	64.9	64.0	63.2
-200	80.4	79.5	78.5	77.6	76.7	75.8	74.9	73.9	73.0	72.1
-190	89.8	88.9	87.9	87.0	86.0	85.1	84.1	83.2	82.3	81.3
-180	99.5	98.5	97.5	96.6	95.6	94.6	93.7	92.7	91.7	90.8
-170	109.4	108.4	107.4	106.4	105.4	104.4	103.4	102.4	101.5	100.5
-160	119.6	118.6	117.5	116.5	115.5	114.5	113.4	112.4	111.4	110.4
-150	130.0	128.9	127.9	126.8	125.8	124.8	123.7	122.7	121.6	120.6
-140	140.6	139.6	138.5	137.4	136.4	135.3	134.2	133.2	132.1	131.0
-130	151.6	150.4	149.4	148.3	147.2	146.1	145.0	143.9	142.8	141.7

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

Marshall Space Flight Center ET24		
Attachment B to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 2 of 4

Research Incorporated Temperature Limiter  
SETPOINT DIAL SETTINGS VS TEMPERATURE

DEG F	0	1	2	3	4	5	6	7	8	9
-120	162.7	161.6	160.4	159.3	158.2	157.1	156.0	154.9	153.8	152.7
-110	174.1	172.9	171.8	170.6	169.5	168.4	167.2	166.1	165.0	163.8
-100	185.7	184.5	183.4	182.2	181.0	179.9	178.7	177.5	176.4	175.2
-90	197.6	196.4	195.2	194.0	192.8	191.6	190.4	189.2	188.1	186.9
-80	209.7	208.5	207.2	206.0	204.8	203.6	202.4	201.2	200.0	198.8
-70	222.0	220.8	219.5	218.3	217.0	215.8	214.6	213.3	212.1	210.9
-60	234.5	233.3	232.0	230.8	229.5	228.2	227.0	225.7	224.5	223.2
-50	247.3	246.0	244.7	243.5	242.2	240.9	239.6	238.4	237.1	235.8
-40	260.3	259.0	257.7	256.4	255.1	253.8	252.5	251.2	249.9	248.6
-30	273.5	272.2	270.8	269.5	268.2	266.9	265.5	264.2	262.9	261.6
-20	286.9	285.5	284.2	282.8	281.5	280.1	278.8	277.5	276.1	274.8
-10	300.4	299.1	297.7	296.3	295.0	293.6	292.3	290.9	289.6	288.2
-0	314.1	312.8	311.4	310.0	308.6	307.3	305.9	304.5	303.1	301.8
0	314.1	315.5	316.9	318.3	319.7	321.1	322.5	323.8	325.2	326.6
10	328.0	329.4	330.8	332.2	333.6	335.0	336.4	337.8	339.2	340.6
20	342.0	343.4	344.9	346.3	347.7	349.1	350.5	351.9	353.3	354.8
30	356.2	357.6	359.4	360.6	362.1	363.5	365.0	366.4	367.9	369.4
40	370.8	372.3	373.8	375.2	376.7	378.2	379.6	381.1	382.6	384.1
50	385.5	387.0	388.5	390.0	391.5	393.0	394.4	395.9	397.4	398.9

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

Marshall Space Flight Center ET24		
Attachment B to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 3 of 4

Research Incorporated Temperature Limiter  
SETPOINT DIAL SETTINGS VS TEMPERATURE

DEG F	0	1	2	3	4	5	6	7	8	9
60	400.4	401.9	403.4	404.9	406.4	407.9	409.4	410.9	412.5	414.0
70	415.5	417.0	418.5	420.0	421.6	423.1	424.6	426.1	427.7	429.2
80	430.7	432.3	433.8	435.3	436.9	438.4	439.9	441.5	443.0	444.6
90	446.1	447.7	449.2	450.8	452.3	453.9	455.5	457.0	458.6	460.1
100	461.7	463.3	464.8	466.4	468.0	469.6	471.1	472.7	474.3	475.9
110	477.5	479.0	480.6	482.2	483.8	485.4	487.0	488.6	490.2	491.8
120	493.4	495.0	496.6	498.2	499.8	501.4	503.0	504.6	506.2	507.8
130	509.5	511.1	512.7	514.3	515.9	517.6	519.2	520.8	522.4	524.1
140	525.7	527.3	529.0	530.6	532.2	533.9	535.5	537.2	538.8	540.5
150	542.1	543.8	545.4	547.1	548.7	550.4	552.0	553.7	555.4	557.0
160	558.7	560.3	562.0	563.7	565.4	567.0	568.7	570.4	572.0	573.7
170	575.4	577.1	578.8	580.5	582.1	583.8	585.5	587.2	588.9	590.6
180	592.3	594.0	595.7	597.4	599.1	600.8	602.5	604.2	605.9	607.6
190	609.3	611.0	612.8	614.5	616.2	617.9	619.6	621.3	623.1	624.8
200	626.5	628.3	630.0	631.7	633.4	635.2	636.9	638.6	640.4	642.1
210	643.9	645.6	647.4	649.1	650.8	652.6	654.3	656.1	657.9	659.6
220	661.4	663.1	664.9	666.6	668.4	670.2	671.9	673.7	675.5	677.2
230	679.0	680.8	682.6	684.3	686.1	687.9	689.7	691.4	693.2	695.0
240	696.8	698.6	700.4	702.2	704.0	705.7	707.5	709.3	711.1	712.9

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

Marshall Space Flight Center ET24		
Attachment B to Facility Operating Procedure For Thermal Vacuum Chamber V9	ET24-V9-FOP-001	Revision: Baseline
	Date: September 26, 2005	Page 4 of 4

Research Incorporated Temperature Limiter  
SETPOINT DIAL SETTINGS VS TEMPERATURE

DEG F	0	1	2	3	4	5	6	7	8	9
250	714.7	716.5	718.3	720.1	721.9	723.8	725.6	727.4	729.2	731.0
260	732.8	734.6	736.4	738.3	740.1	741.9	743.7	745.5	747.4	749.2
270	751.0	752.9	754.7	756.5	758.4	760.2	762.0	763.9	765.7	767.5
280	769.4	771.2	773.1	774.9	776.8	778.6	780.5	782.3	784.2	786.0
290	787.9	789.7	791.6	793.5	795.3	797.2	799.1	800.9	802.8	804.7
300	806.5	808.4	810.3	812.1	814.0	815.9	817.8	819.6	821.5	823.4
310	825.3	827.2	829.1	830.9	832.8	834.7	836.6	838.5	840.4	842.3
320	844.2	846.1	848.0	849.9	851.8	853.7	855.6	857.5	859.0	861.3
330	863.2	865.1	867.1	869.0	870.9	872.8	874.7	876.6	878.5	880.5
340	882.4	884.3	886.2	888.2	890.1	892.0	894.0	895.9	897.8	899.7
350	901.7	903.6	905.6	907.5	909.4	911.4	913.3	915.3	917.2	919.2
360	921.1	923.0	925.0	927.0	928.9	930.9	932.8	934.8	936.7	938.7
370	940.6	942.6	944.6	946.5	948.5	950.5	952.4	954.4	956.4	958.3
380	960.3	962.3	964.3	966.2	968.2	970.2	972.2	974.1	976.1	978.1
390	980.1	982.1	984.1	986.1	988.0	990.0	992.0	994.0	996.0	998.0
400	1000.0									

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