



National Aeronautics and  
Space Administration

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

**FACILITY OPERATING PROCEDURE  
FOR  
THERMAL HUMIDITY CHAMBER  
TH-4**

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

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**FACILITY OPERATING PROCEDURE  
FOR  
THERMAL HUMIDITY CHAMBER  
TH-4**

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Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page iii of iv

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page iv of iv

## TABLE OF CONTENTS

SECTION		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	RESPONSIBILITES	4
<b>2.0</b>	<b>FACILITY DESCRIPTION</b>	<b>4</b>
2.1	CHAMBER DESCRIPTION AND DIMENSIONS	4
2.2	WATLOW CONTROLLER	5
2.3	PERFORMANCE	5
2.4	PANEL SWITCHES AND CONTROLS	5
<b>3.0</b>	<b>FACILITY OPERATION</b>	<b>6</b>
3.1	FACILITY PREPARATION	6
3.2	TEST ARTICLE INSTALLATION	7
3.3	THERMAL HUMIDITY TESTING	7
3.4	UNATTENDED OPERATION	10
3.5	SYSTEM SHUTDOWN	10
<b>4.0</b>	<b>EMERGENCY SHUTDOWN</b>	<b>11</b>

### ATTACHMENT A

**CHECK THE MASTER LIST-  
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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001	Revision: Baseline
	Date: May 2, 2005	Page 1 of 11

## 1.0 GENERAL INFORMATION

### 1.1 PURPOSE

This document describes the procedures for the operation of Thermal Humidity Chamber TH-4 located in the Marshall Space Flight Center (MSFC) Environmental Test Facility (ETF) Building 4619.

### 1.2 SCOPE

The procedures and practices outlined in this document are to be followed in the operation of chamber TH-4. This document provides a record copy of chamber TH-4 operations.

### 1.3 APPLICABLE DOCUMENTS

NPR 8715.3	NASA Safety Manual
MPR 8715.1	Marshall Safety, Health, and Environmental (SHE) Program
MWI 8715.1	Electrical Safety 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)
MFOP-FA-ETF-426	Unattended Operation of the Environmental Test Facility (soon to be superseded by ET24-UnattnOps-SOP-001)
ET24-OWI-ETF-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 shall be aware of the possibility of freeze burns by contact with cold surfaces or liquids. Protective clothing shall be worn by all personnel involved in handling of cryogenics or when making repairs/modifications to cryogenic facilities including eye protection, gloves and clothing that has no catch points. Only certified cryogenic handlers shall perform repairs/modifications to cryogenic systems. In the event of a cryogenics spill, line ruptures, or similar emergencies, personnel shall first be sure 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.

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 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 a temperature less than 104°F (40°C) and above the dew point before removing the test article in order to minimize the 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). Chamber operators shall be familiar with these documents to understand associated hazards and methods to mitigate the risk from these hazards.

### 1.5 EMERGENCY TELEPHONE NUMBERS

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

Medical	911
Ambulance	911
Fire	911
Security	911
Chemical Spills	911

Other numbers that can be used to obtain information about emergency, security, and safety 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 to determine program set-points for the thermal controllers and safety devices. The "dummy" test article shall provide an accurate thermal simulation of the actual test article.

\*\*\*\*\***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 HAZARDS LIST

- 208 and 120 volts AC electrical power
- Extreme temperatures (hot and cold)

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 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.**

\*\*\*\*\*

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 shall 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 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 chamber 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 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 shall 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 located outside the chamber and energized at 50 volts or greater shall be guarded against accidental contact. Guarding methods include approved enclosures, permanent partitions or screens that

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001	Revision: Baseline
	Date: May 2, 2005	Page 4 of 11

- 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 Extreme Temperature Hazards
- The test chamber and test article shall be given sufficient time to return to a temperature less than 104°F (40°C) and above the dew point before removing the test article in order to minimize the extreme temperature hazard.

## 1.8 RESPONSIBILITIES

ETF personnel shall be responsible for the operation of the TH4 Thermal Humidity Facility. The designated operator of the chamber shall be responsible for the safe operation and conduct of the facility. The operator shall record his name in the chamber logbook.

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

## 2.0 FACILITY DESCRIPTION

### 2.1 CHAMBER DESCRIPTION AND DIMENSIONS

The temperature humidity chamber is designated as ETF Test Chamber TH-4. The chamber was manufactured by Russells Technical Products, Holland, Michigan. Chamber TH-4 is identified as Model No. GD-64-5-5. ETF Technicians have built an extension to the front of the chamber that extends the depth 18 inches. Unobstructed, usable internal space of the chamber is approximately 66 inches deep, 47 inches high and 48 inches wide. One side of the chamber is a front opening door with a 22 inch by 22 inch square viewing window located near the center of the door.

Four feed-through portholes are located in the sidewalls of the chamber. Three portholes are on the east side of the chamber that measures 3 7/8" and one is on the west side that measures 2 7/8". These portholes are used for electrical and mechanical connections to the test article and for thermocouple feed-throughs.

Cooling capability is provided by a two-stage cascade refrigeration system using R-507 refrigerant in the high temperature system and R-23 refrigerant in the low temperature system. Air heaters equipped with electrical resistive heater elements provide heating. The chamber is also equipped with a vertical airflow package to regulate the amount of air circulation.

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 5 of 11

Humidity is provided by a low-pressure humidity vapor generator. The vapor generator is heated and pressurized to generate vapor that is injected into the chamber. Dehumidification is provided by a refrigerated dehumidify coil.

## 2.2 WATLOW SERIES F4 CONTROLLER

Temperature and humidity can be maintained at a constant value or continuously varied according to a predetermined program manually entered into the Watlow ramping Controller. The Watlow controller allows the operator to manually enter up to 256 temperature/humidity steps, with segment times up to 100 hours. Up to 40 profiles can be stored in the Watlow controller. Operating personnel shall be thoroughly familiar with the “Watlow User Manual” operating instructions prior to programming the Watlow controller.

## 2.3 PERFORMANCE

The chamber has an adjustable temperature range of -95°F to +320°F (-71°C to +160°C). Temperatures within this range can be maintained to  $\pm 3.6$  deg F ( $\pm 2$  deg C, and dry bulb or wet bulb) of nominal value.

Humidity can be controlled from 10% to 95%, but only within the temperature range of 40°F to 185°F (4°C to 85°C).

Heating and cooling rates vary depending on the thermal load presented by the test specimen. An empty chamber performs approximately as follows:

### Maximum Heating Rates

20°C to 96°C	15 minutes
20°C to 160°C	28 minutes

### Maximum Cooling Rates

160°C to 100°	10 minutes
160°C to 20°	35 minutes
20°C to -25°C	15 minutes
20°C to -68°C	40 minutes

## 2.4 PANEL SWITCHES AND CONTROLS

The chamber operational controls are located on the lower front side of the chamber. Switches and controls necessary for operation are listed as follows:

**CHECK THE MASTER LIST.  
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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 6 of 11

Switch	Switch State in UP Position	Switch State in CENTER Position	Switch State in DOWN Position
Unit On	ON	-	OFF
Humidity System	ON	OFF	AUTOMATIC
Aux. Cooling System	ON	OFF	AUTOMATIC

Near the switches are the Watlow controller and the Watlow product safeguard temperature-limiting controller.

There is a limiting relay reset button with fault indicator lights for chamber, humidity, and cooling. The limiting relays shuts off components of the chamber when triggered by conditions of over temperature, under temperature, high refrigerant pressure, low refrigerant pressure, humidity system over temp, or operator set temperature limit. The Aux Cooling System is not operational and shall be left in the OFF position.

**NOTE**

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

### 3.0 FACILITY OPERATION

The operations of chamber TH-4 varies according to the temperature range, humidity range, and whether steady state or varying environments is required. This procedure provides sufficient detail to operate the chamber in the steady state mode. This procedure provides general information about programming for varying environments but does not cover details for every feasible scenario. Operating personnel shall be thoroughly familiar with the Watlow User Manual operating instructions prior to programming a varying environment profile in the Watlow controller.

Complete the As-run Buy-off Sheet when operating the chamber. These sheets are typically provided with the TPS. If none is provided, use a copy of Attachment A.

#### 3.1 FACILITY PREPARATION

**Caution:** Use only deionized or distilled water in the humidification system. The use of untreated water causes a build up of scale in the vapor generator and wet bulb trough.

3.1.1 Review the Safety Assessment, Memorandum ED26 (02-01), to determine the

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 7 of 11

JHAs and PPE that applies 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.

- 3.1.2 If the chamber main power has been off for 12 hours or more, the crankcase heater shall be allowed to warm the crankcase for 24 hours prior to proceeding. Record any power outages of one hour or longer in the chamber logbook.

**Caution:** Failure to allow the crankcase heaters to warm the compressor crankcase before reactivating the chamber may result in serious damage to the compressor due to refrigerant slugging and lack of lubrication.

### 3.1.3 Calibration

- 3.1.3.1 Verify all instrumentation to be used to record data on the test has current calibration labels and is listed in the Chamber Calibrated Items list.
- 3.1.3.2 Verify that the calibrations do not expire before the expected test conclusion date.

- 3.1.4 Place all switches on the control panel to the **OFF** position.

- 3.1.5 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.

## 3.2 TEST ARTICLE INSTALLATION

- 3.2.1 Install the test article. Test article configuration shall be in accordance with its test procedure. Test article configuration shall simulate service usage as closely as reasonable. The test article shall be spaced in the chamber so as to provide free air circulation between the test item(s) and the chamber walls. If the test article is too heavy to lift by hand, use a powered forklift in accordance with MSOP-FA-ETF-414.
- 3.2.2 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.
- 3.2.3 Seal the chamber.

## 3.3 THERMAL HUMIDITY TESTING

- 3.3.1 Switch **ON** the UNIT ON switch.
- 3.3.2 Set the controller to ambient temperature (20°C to 25°C). If a program has been  
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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 8 of 11

terminated the control switches off set points.

- 3.3.2.1 Use the down arrow to select SP1 then press the right arrow.
- 3.3.2.2 Use the up/down arrow to select the required temperature then press the right arrow.
- 3.3.2.3 Use the down arrow to select SP2 for controlled humidity and then press the right arrow.
- 3.3.2.4 Use the up/down arrow to select the required humidity then press the right arrow. If controlled humidity is not required then use the down arrow to set the humidity to OFF. The humidity goes to off one step below 1%. This step and step 3.3.2.5 may be omitted if the humidity switch on the chamber front control panel is positioned OFF.
- 3.3.2.5 If the temperature must be reset then repeat steps 3.3.2.1 and 3.3.2.2.
- 3.3.2.6 If the humidity must be reset, repeat steps 3.6.2.3 and 3.6.2.4.

3.3.3 Ensure that data acquisition thermocouples are operating correctly. The thermocouples shall indicate the ambient temperature and be stable within  $\pm 2$  deg F. These include the temperature control sensors, and the thermocouples used for the data acquisition.

3.3.4 High temperature alarm check and set on the Watlow Temperature Limiter:

- 3.3.4.1 Press the MODE button until **AHI** appears on the LED readout.
- 3.3.4.2 Gradually lower the set-point until it passes the chamber temperature. The alarm buzzer becomes audible and the chamber switches off.
- 3.3.4.3 Raise the set-point temperature **20 degrees C** above the chamber temperature and reset the alarm. Press the reset button twice to return power to the chamber.
- 3.3.4.4 Adjust the set-point to **10 degrees C** above the maximum test profile temperature.

3.3.5 Low temperature alarm check:

- 3.3.5.1 Press the MODE button until **ALO** appears on the LED readout.
- 3.3.5.2 Gradually raise the set-point until it is above the chamber temperature. The alarm buzzer becomes audible and the chamber switches off.
- 3.3.5.3 Lower the set-point to a temperature **20 degrees C** below the chamber temperature and reset the alarm. Press the reset button twice to return power to the chamber.
- 3.3.5.4 Adjust the set-point to **10 degrees C** below the minimum test profile temperature.

**NOTE: Do not continue with test if the alarms do not operate properly.**

3.3.6 If the chamber is to be manually controlled, enter the settings for the required temperature and/or humidity into the Watlow controller.

- 3.3.6.1 Use the down arrow to select SP1 then press the right arrow.

**CHECK THE MASTER LIST.  
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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 9 of 11

- 3.3.6.2 Use the up/down arrows to select the required temperature then press the right arrow.
  - 3.3.6.3 Use the down arrow to select SP2 if controlled humidity is required and then press the right arrow. To switch off humidity press the down arrow once past 1% to OFF. This step and step 3.3.6.4 may be omitted if the humidity switch on the chamber front control panel is positioned OFF.
  - 3.3.6.4 Use the up/down arrow to select the required humidity then press the right arrow.
  - 3.3.6.5 If the temperature must be reset then repeat steps 3.3.6.1 and 3.3.6.2.
  - 3.3.6.6 If the humidity must be reset, repeat steps 3.3.6.3 and 3.3.6.4.
- 3.3.7 If the chamber is to be automatically controlled for variable temperature and/or humidity, enter the required profiles for temperature and/or humidity into the Watlow controller. The following steps direct the setup of one step in the profile. These steps provide a general guide but do not cover every scenario. The actual setup of the Watlow controller depends on the test requirements.
- 3.3.7.1 Press the down arrow to select Profiles from the Main Page then press the right arrow.
  - 3.3.7.2 Select Create Profile with the down arrow then press the right arrow.
  - 3.3.7.3 Select Name Profile with the down arrows then press the left right arrow. You may skip to 3.3.7.5 and allow the controller to name the profile.
  - 3.3.7.4 Select the position of the letter in the name using the left/right arrows then use the up/down arrows to change the letter. The name can be up to 10 characters. When finished go to the right of the name with the right arrow.
  - 3.3.7.5 Select Ramp or Soak time with the up/down arrows then press the right arrow.
  - 3.3.7.6 Select Don't Wait with the up/down arrow then press the right arrow.
  - 3.3.7.7 Select Humidity or No Humidity with the up/down arrow then press the right arrow.
  - 3.3.7.8 Change the position of the time characters with the right arrow and change the time character with the up/down arrows. Go to the right of the time characters when finished using the right arrow.
  - 3.3.7.9 Select SP1, the ramp/ soak temperature, and SP2, the ramp or soak humidity, using the up/down arrows then press the right arrow. Change the values of the temperature or humidity with the up/down arrows then press the right arrow.
  - 3.3.7.10 Select Save with the up arrow.
  - 3.3.7.11 To run the profile, press the green profile button then select the profile by name using the up/down arrows.
  - 3.3.7.12 Select the starting step with the up/down arrow then press the right arrow. The profile will then start.
- 3.3.8 Switch **ON** the data acquisition computer and start the data acquisition.

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

Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 10 of 11

3.3.9 Switch **ON** the LIGHT whenever viewing inside the chamber. Normally the LIGHT shall be switched **OFF**

### 3.4 UNATTENDED OPERATION

The thermal humidity 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 are be available for the unattended period.
- 3.4.2 Verify that the deionized water supply is available if humidity is required.
- 3.4.3 Complete applicable sections of the procedure MFOP-FA-ETF-426 (soon to re-numbered ET24-UnattnOps-SOP-001), Unattended Operation of the Environmental Test Laboratory.

### 3.5 SYSTEM SHUTDOWN

- 3.5.1 From the Main Page select SP1 using the up/down arrows then press the right arrow. Using the up/down arrow, set the temperature to ambient then press the right arrow.
- 3.5.2 Verify the test article has returned to a temperature less than 104°F (40°C) and above the dew point.
- 3.5.3 Position all control panel switches **OFF**.
- 3.5.4 Verify all circuits in the chamber are switched off and de-energized including 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.
- 3.5.5 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.
- 3.5.6 The test article may be removed now.

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Marshall Space Flight Center ET24		
Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001 Date: May 2, 2005	Revision: Baseline Page 11 of 11

#### **4.0 EMERGENCY SHUTDOWN**

- 4.1 Position all control panel switches **OFF**.
- 4.2 Open the power disconnect to the chamber located behind the chamber.
- 4.3 Remove all test articles only when there is no risk of injury to personnel or damage to the test specimen. Go to Section 3.5 to shutdown the chamber.

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Marshall Space Flight Center ET24		
Attachment A to the Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001	Revision: Baseline
	Date: May 2, 2005	Page 1 of 2

## TH-4 As-run Buy-off Sheet

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

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

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

Initial each step once completed. If test exceeds one day, date the first step each new day.

	3.3.2.2 _____	3.3.6.4 _____
<b>3.1 FACILITY PREPARATION</b>	3.3.2.3 _____	3.3.6.5 _____
3.1.1 _____	3.3.2.4 _____	3.3.6.6 _____
3.1.2 _____	3.3.2.5 _____	3.3.7.1 _____
3.1.3.1 _____	3.3.2.6 _____	3.3.7.2 _____
3.1.3.2 _____	3.3.3 _____	3.3.7.3 _____
3.1.4 _____	3.3.4.1 _____	3.3.7.4 _____
3.1.5 _____	3.3.4.2 _____	3.3.7.5 _____
<b>3.2 TEST ARTICLE INSTALLATION</b>	3.3.4.3 _____	3.3.7.6 _____
	3.3.4.4 _____	3.3.7.7 _____
3.2.1 _____	3.3.5.1 _____	3.3.7.8 _____
3.2.2 _____	3.3.5.2 _____	3.3.7.9 _____
3.2.3 _____	3.3.5.3 _____	3.3.7.10 _____
<b>3.3 THERMAL HUMIDITY TESTING</b>	3.3.5.4 _____	3.3.7.11 _____
3.3.1 _____	3.3.6.1 _____	3.3.7.12 _____
	3.3.6.2 _____	3.3.8 _____
3.3.2.1 _____	3.3.6.3 _____	3.3.9 _____

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

Marshall Space Flight Center ET24		
Attachment A to the Facility Operating Procedure For Thermal Humidity Chamber TH4	ET24-TH4-FOP-001	Revision: Baseline
	Date: May 2, 2005	Page 2 of 2

## TH-4 As-run Buy-off Sheet

### 3.4 UNATTENDED OPERATION

NA if not applicable

3.4.1 \_\_\_\_\_

3.4.2 \_\_\_\_\_

3.4.3 \_\_\_\_\_

### 3.5 SYSTEM SHUTDOWN

3.5.1 \_\_\_\_\_

3.5.2 \_\_\_\_\_

3.5.3 \_\_\_\_\_

3.5.4 \_\_\_\_\_

3.5.5 \_\_\_\_\_

3.5.6 \_\_\_\_\_

QA \_\_\_\_\_

NA if not applicable

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