National Aeronautics and
Space Administration

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

FACILITY OPERATING PROCEDURE
FOR
THERMAL HUMIDITY CHAMBER
TH-3

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-3

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Release Date: 5 / 2 / 2005	**Marshall Space Flight Center Specification/Document Change Instruction**	Page 1 of 1
	Spec. / Doc. No. ET24-TH3-FOP-001	Copy No.:

Change No./Date	SCN/DCN No./Date	Replacement Page Instructions
Baseline 5-2-2005	-----	Initial issue for the ET24 organization. Supersedes MFOP-FA-ETF-434.

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1.0 GENERAL INFORMATION

1.1 PURPOSE

This document describes the procedures for the operation of Thermal Humidity Chamber TH-3 located in Marshall Space Flight Center (MSFC) Building 4619.

1.2 SCOPE

The procedures and practices outlined in this document are to be followed in the operation of chamber TH-3. This document provides a record copy of chamber TH-3 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MSOP-FA-ETF-413	Control of Hazardous Energy (Lockout/Tagout) Procedure for the Environmental Test Facility (soon to be superseded by ET24-LOTO-SOP-001)
MFOP-FA-ETF-426	Unattended Operation of the Environmental Test Facility (soon to be superseded by ET24-UnattnOps-SOP-001)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 the event of serious injury, do not move the injured person unless necessary to prevent further serious injury. The emergency telephone number is 911 as listed in section 1.5.

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.

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 ± 10 degrees C (± 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). 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
Fire	911
Ambulance	911
Security	911
Chemical Spills	911

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

A recommended method to ensure the chamber performs as expected is to use a "dummy" test article in a checkout test prior to testing. The checkout test is particularly critical for high value program critical hardware (PCH). The checkout test is effective for determining 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.

1.7 HAZARDS LIST

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

********** **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 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.

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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 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 in the locked position.

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 ambient temperature $\pm$ 10 degrees C ($\pm$ 18 degrees F) before removing the test article in order to minimize the extreme temperature hazard.

1.8 RESPONSIBILITY

ETF personnel shall be responsible for the operation of the TH3 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 low temperature/high temperature/humidity chamber is designated as Chamber TH-3. The chamber was manufactured by Despatch Industries, Minneapolis, Minnesota. Chamber TH-3 is identified as Model No. 16000. Unobstructed, usable internal space of the chamber is approximately a cube measuring 48 inches deep, 44 inches high, and 46 inches wide. The chamber has a front opening door with a 24 inch by 24 inch square view window located in the center of the door. The chamber is also equipped with a wiper to clear moisture from the window.

The chamber workspace dry bulb temperature is recorded with a 0.6 C resolution on a Honeywell Trueline DR4500. The chamber's humidity is recorded on a Honeywell DR4200. Both recorders are for indication only and no data shall be taken from these instruments unless they have been calibrated.

Four feed-through portholes are located in the side walls of the chamber (two on the each side). These four-inch diameter portholes are used for electrical and mechanical connections to the test article.

Cooling capability is provided by a mechanical cascade refrigeration system using R503, and a blend of CFC13/ HFC23 refrigerants. Heating is provided by air heaters equipped with nichrome wire heater elements. Humidity within the chamber is provided by energizing an immersion heater vapor generator, which is actuated by the relative humidity controller. Dehumidification of the chamber is accomplished by a separate refrigerated dehumidification coil connected to the refrigeration system. The chamber is also equipped with a vertical airflow package to regulate the amount of air circulation.

2.2 WATLOW CONTROLLER

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

2.3 PERFORMANCE

The chambers have adjustable temperature ranges of -70°C to +180°C. Temperatures within this range can be maintained to $\pm$ 2 degrees C (dry bulb or wet bulb) of nominal value. Relative humidity can be controlled to between 20% and 95% $\pm$ 5% if the temperature is in the range of 4 °C to 85°C. Temperatures outside this range can damage the humidity control components by freezing or boiling.

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

* Cools from 20° C to -30° C in 20 minutes
* Cools from 20° C to -50° C in 40 minutes
* Cools from 20° C to -70° C in 120 minutes
* Heats from -70° C to 0° C in 15 minutes
* Heats from 0° C to 100° C in 30 minutes
* Heats from 0° C to 150° C in 50 minutes
* Heats from 0° C to 180° C in 110 minutes

2.4 PANEL SWITCHES AND CONTROLS

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

Master Breaker
Power Switch
Cooling Switch

Humidity Switch
Chamber Light
Low Temperature Alarm Control
High Temperature Alarm Control

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

3.0 FACILITY OPERATION

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

3.1 FACILITY PREPARATION

3.1.1 Review the Safety Assessment, Memorandum ED26 (02-01), to determine the 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 Determine that the test is ready to start.

3.1.3 Calibration

3.1.3.1 Verify all instrumentation to be used on the test has current calibration labels where applicable.

3.1.3.2 Verify that the calibration does 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 the TPS and/or test procedure. Test article configuration shall simulate service usage as closely as reasonable.

3.2.2 The test article shall be spaced in the chamber so as to provide free circulation between the test item(s) and the chamber walls.

3.2.3 Photograph the test article and test setup. Take as many photographs as necessary dependent on the complexity of the test setup. Copies of these photographs shall be

given to the ETF Test Data Administrator before or immediately following the end of testing.

3.3 ENVIRONMENTAL TESTING

3.3.1 Place the following switches in the **ON** position:

3.3.1.1 Master Breaker
3.3.1.2 Chamber Power Switch

3.3.2 Ensure that thermocouples are operating correctly. These include the temperature and humidity control sensors, and the thermocouples used for the data acquisition and recording systems.

3.3.3 Enter and verify the desired temperature/humidity profile in the Watlow controller.

3.3.4 Close and latch the chamber door.

NOTE: Complete the following steps before initiating the Start command.

3.3.5 High temperature alarm check and set:

3.3.5.1 Gradually lower the set-point until it passes the chamber temperature. The alarm indicator light should illuminate red.
3.3.5.2 Raise the set-point temperature 15°C above the chamber temperature and reset the alarm.
3.3.5.3 Adjust the set-point to 10°C above the maximum test profile temperature.

3.3.6 Low temperature alarm check:

3.3.6.1 Gradually raise the set-point until it is above the chamber temperature. The alarm indicator light should illuminate red.
3.3.6.2 Lower the set-point to a temperature 15°C below the chamber temperature and reset the alarm.
3.3.6.3 Adjust the set-point to 10°C below the minimum test profile temperature.

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

3.3.7 If a humidified environment is required, ensure the water supply is available.

NOTE: Use only deionized or distilled water in the humidification system. The use of untreated water causes failure of the vapor generator due to scale build up in the wet bulb trough.

3.3.8 The humidity sensor shall be removed if the maximum chamber temperature is to exceed 150°C.

3.3.9 Switch **ON** the Cooling.

3.3.10 Switch HUM **ON** if a temperature/humidity environment is required.

3.3.11 Start the Watlow controller program.

3.4 UNATTENDED OPERATION

The environmental 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 unattended period.

3.4.2 Verify that the deionized water supply is available at 20 $\pm$5 psig (for humidity generation only).

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 Position all control panel switches **OFF.**

3.5.2 Verify the test article has returned to ambient temperature.

3.5.3 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.

3.5.4 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.

3.5.5 Remove all test articles.

4.0 EMERGENCY SHUTDOWN

4.1 Position all control panel switches OFF.

4.2 Open the electrical disconnect located near the south west corner of the chamber.

4.2 Remove all test articles only when there is no significant risk of damage to the test article and no risk of injury to personnel.

TH3 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.

3.1 FACILITY PREPARATION

3.1.1 _____

3.1.2 _____

3.1.3.1 _____

3.1.3.2 _____

3.1.4 _____

3.1.5 _____

3.2 TEST ARTICLE INSTALLATION

3.2.1 _____

3.2.2 _____

3.2.3 _____

3.3 ENVIRONMENTAL TESTING

3.3.1.1_____

3.3.1.2 _____

3.3.2 _____

3.3.3 _____

3.3.4 _____

3.3.5.1 _____

3.3.5.2 _____

3.3.5.3 _____

3.3.6.1 _____

3.3.6.2 _____

3.3.6.3 _____

3.3.7 _____

3.3.8 _____

3.3.9 _____

3.3.10 _____

3.3.11 _____

3.4 UNATTENDED OPERATION

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 _____

QA _____

NA if not applicable

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