



National Aeronautics and
Space Administration

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

**FACILITY OPERATING PROCEDURE
FOR
THERMAL HUMIDITY CHAMBER
TH8**

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

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**FACILITY OPERATING PROCEDURE
FOR
THERMAL HUMIDITY CHAMBER
TH8**

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ATTACHMENT A

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1.0 GENERAL INFORMATION

1.1 PURPOSE

This document describes the procedures for the operation of Thermal Humidity Chamber TH8 located in the Marshall Space Flight Center (MSFC) Environmental Test Facility (ETF) Building 4612.

1.2 SCOPE

The procedures and practices outlined in this document are to be followed in the operation of chamber TH8. This document provides a record copy of chamber TH8 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MSOP-FA-ETF-413	Control of Hazardous Energy (Lockout/Tagout) Procedure for the Environmental Test Facility (soon to be superseded by ET24-LOTO-SOP-001)
MFOP-FA-ETF-426	Unattended Operation of the Environmental Test Facility (soon to be superseded by ET24-UnattnOps-SOP-001)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

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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 a temperature above the dew point and less than 104 °F (40 °C) before removing the test article in order to minimize the extreme temperature hazard.

In addition to the above safety precautions, all personnel involved in facilities using cryogenics shall be aware of the hazards. Always maintain an oxygen monitor when using cryogenic. To mitigate freeze burns, never contact cold surfaces or liquids and wear protective clothing including eye protection and gloves 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 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.

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

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 tests of program critical hardware, 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.

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*******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

- 480 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.

1.7.1 Minimizing Electrical Shock Hazards

- 1.7.1.1 All electrical repairs and modifications shall be performed by an electrical technician 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 possible. 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

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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 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 above the ambient dew point and less than 104°F (40°C) 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 TH8 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 TH8. The chamber was manufactured by Russells Technical Products, Holland, Michigan. Chamber TH8 is identified as Model No. RD-64-5-5-LN2-WC, Serial Number 05013199. Unobstructed, usable internal space of the chamber is approximately 48 inches deep, 48 inches high and 48 inches wide. One side of the chamber is a front opening door with a 22 inch square viewing window located near the center of the

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door.

Four feed-through portholes are located in the sidewalls of the chamber. Two portholes are on the west and east sides of the chamber. All portholes are 5 7/8" diameter. 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. Additional cooling capability is provide by liquid nitrogen (LN₂) overhead spray nozzles. These nozzles are designed to immerse the test article in a spray of liquid nitrogen.

*******WARNING*******

Never use LN₂ in the chamber unless the chamber is vented to the outside. Always use a portable oxygen monitor outside the chamber when using LN₂. Only certified cryogen handlers shall install, modify and connect LN₂ systems and components.

Air heaters equipped with 18 kilowatts electrical resistive heater elements provide heating. The chamber is also equipped with a vertical airflow package to regulate the amount of air circulation.

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

The chamber temperature and humidity are recorded on a Honeywell Trueline DR4500. This recorder is for indication only and no data shall be taken from these instruments unless they have been calibrated. Stamp on the chart paper that the plot is "not for record, for indication only."

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. The controller can store in up to 40 profiles. Operating personnel shall be thoroughly familiar with the "Watlow User Manual" operating instructions prior to programming the Watlow controller.

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2.3 PERFORMANCE

The following performance is approximate and will vary dependent on the heat capacity of the test article.

The chamber has an adjustable temperature range of -328°F to +365°F (-200°C to +185°C). Temperatures within this range can be maintained to ± 3.6 deg F (± 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°C	10 minutes
160°C to 20°C	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 east (right) side of the chamber. Switches and controls necessary for operation are listed as follows:

Switch	Switch State in UP Position	Switch State in CENTER Position	Switch State in DOWN Position
Pilot	ON	—	OFF
Circulation	ON	—	OFF
Heat	ON	—	OFF
Cooling	ON	—	OFF
Light	ON	—	OFF
Humidity System	ON	OFF	AUTOMATIC
LN2	ON	OFF	AUTOMATIC
GN2	ON	OFF	AUTOMATIC
Refrigeration Reset	Push Button- push to reset		

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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 refrigeration. The limiting relays shuts off the refrigeration system when triggered by conditions of high or low refrigerant pressure. The LN₂ switch shall be left in the OFF position unless LN₂ is connected to the chamber.

NOTE

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

3.0 FACILITY OPERATION

The operations of chamber TH8 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 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. If this chamber is not listed in the safety assessment, use the PPE and JHA requirements for TH4.
- 3.1.2 First time operation requirements. Skip to Section 3.1.4 if the chamber has been operated previously. Perform the instructions in chapter 2: Preparation For Use, in the Russells User's Manual for Model RD-64-5-5-LN2-WC Serial Number 05013199.
- 3.1.3 Verify that all systems shutdown permanently when the electrical power is interrupted. If the compressor, fan or heating is re-energized when power is returned, then the chamber control shall be reconfigured to keep these systems off until manually switched on by an operator.

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3.1.4 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.

3.1.5 Calibration

3.1.5.1 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.

3.1.5.2 Verify that the calibrations do not expire before the expected test conclusion date.

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

3.1.7 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 **CLOSE** the chamber door.

3.3 THERMAL HUMIDITY TESTING

*******WARNING*******

Never use LN₂ in the chamber unless the chamber is vented to the outside. Always use a portable oxygen monitor outside the chamber when using LN₂. Only certified cryogen handlers shall install, modify and connect LN₂ systems and components.

3.3.1 Switch **ON** the Pilot Switch.

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- 3.3.2 Verify the Watlow controller is set to ambient temperature (20°C to 25°C). If a program has been terminated the control turns set points off.
- 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 left 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 left 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 0.0%. This step and step 3.3.2.6 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 3.3.2.3 and 3.3.2.4.
- 3.3.3 Ensure that data acquisition thermocouples are operating correctly. The thermocouples shall indicate the ambient temperature and be stable within ± 1 degrees C. 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 Press the up and down arrows for 6 seconds or more.
 - 3.3.4.3 Gradually lower the set-point until it passes the chamber temperature and the chamber switches off.
 - 3.3.4.4 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.
 - 3.3.4.5 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 Press the up and down arrows for 6 seconds or more.
 - 3.3.5.3 Gradually raise the set-point until it is above the chamber temperature and the chamber switches off.
 - 3.3.5.4 Lower the set-point to a temperature **20°C** below the chamber temperature and reset the alarm. Press the reset button twice to return power to the chamber.
 - 3.3.5.5 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.

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- 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.
 - 3.3.6.2 Use the up/down arrows to select the required temperature then press the left 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 0.0% 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 left 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.

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3.3.7.12 Select the starting step with the up/down arrow then press the right arrow. The profile then starts.

3.3.8 Switch **ON** the data acquisition computer and start the data acquisition.

3.3.9 Switch **ON** the LIGHT whenever viewing inside the chamber. Normally the LIGHT is 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 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 left arrow.

3.5.2 Verify the test article has returned to a temperature above the ambient dew point and less than 104°F (40°C).

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

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electrical parts energized at 50 volts or greater.

3.5.6 The test article may be removed now.

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. If this switch is not accessible, **OPEN** Breaker 9 in Panel PPQG near the rear of Chamber TA1.
- 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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TH8 As-run Buy-off Sheet

Test Number _____ Customer Contact _____

Calling TPS or Work Instructions _____ Start Time & Date _____

Test Description _____ End Time & Date _____

Data Process Rate _____

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

	3.3.2.1 _____	3.3.6.1 _____
3.1 FACILITY PREPARATION	3.3.2.2 _____	3.3.6.2 _____
3.1.1 _____	3.3.2.3 _____	3.3.6.3 _____
3.1.2 _____	3.3.2.4 _____	3.3.6.4 _____
3.1.3 _____	3.3.2.5 _____	3.3.6.5 _____
3.1.4 _____	3.3.2.6 _____	3.3.6.6 _____
3.1.5.1 _____	3.3.3 _____	3.3.7.1 _____
3.1.5.2 _____	3.3.4.1 _____	3.3.7.2 _____
3.1.6 _____	3.3.4.2 _____	3.3.7.3 _____
3.1.7 _____	3.3.4.3 _____	3.3.7.4 _____
3.2 TEST ARTICLE INSTALLATION	3.3.4.4 _____	3.3.7.5 _____
3.2.1 _____	3.3.4.5 _____	3.3.7.6 _____
3.2.2 _____	3.3.5.1 _____	3.3.7.7 _____
3.2.3 _____	3.3.5.2 _____	3.3.7.8 _____
	3.3.5.3 _____	3.3.7.9 _____
3.3 THERMAL HUMIDITY TESTING	3.3.5.4 _____	3.3.7.10 _____
3.3.1 _____	3.3.5.5 _____	3.3.7.11 _____

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

Marshall Space Flight Center ET24		
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TH8 As-run Buy-off Sheet

3.3.7.12 _____

3.3.8 _____

3.3.9 _____

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.**