National Aeronautics and
Space Administration

Marshall Space Flight Center

Environmental Test Facility

Engineering Solutions for Space Science and Exploration


V20 Vacuum Chamber


Thermal Vacuum Bakeout


Shroud Installation in V20


External Tank Foam Testing in V11


V2 Vacuum Chamber

Environmental Test Facilities (ETF) care used to simulate the extreme environments that hardware is expected to withstand during operations. The ETF provides these environments using 27 chambers capable of high vacuums, extreme temperatures and humidity, and high altitude conditions. Additionally, the ETF can perform vacuum bakeout and launch and re-entry testing. Feed throughs in chamber walls provide electrical, mechanical, and fluid connections to the test article.

Thermal Vacuum Testing

The ETF is equipped to perform thermal vacuum tests in any of 12 different chambers. !ese chambers range in size from 20 × 28 ftto 2 × 2.5 ft. !e largest of the ETF chambers, 20 ft dia.

Thermal-Humidity-Altitude Testing

Environmental simulations of extreme temperatures, humidity, and high-altitude pressures can be achieved in one of the thermal humidity-altitude test chambers. !ermal conditions alone or thermal conditions and controlled humidity can be simulated in these test chambers. Atmospheric flight conditions with extreme temperature, low pressures, and controlled humidity are simulated in the thermal altitude chambers. !e thermal humidity and thermal altitude chambers are cost efficient tools for research of the thermal stability of materials. Instrumentation includes thermocouples, humidity sensors, and pressure gauges.

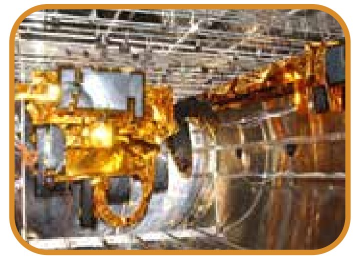

Sunspot Vacuum Chamber

Life-Cycle Testing

!e performance of hardware in space over decades can be simulated in a long-term thermal vacuum test. Two of the thermal vacuum chambers are used for life-cycle testing of space hardware. One chamber is equipped with vacuum rated motors that can position a test article in a liquid nitrogen shroud for rapid cooling. The chamber then has the capability to reposition the article near an array of infrared lamps for rapid heating. When equipped with a spacesuit arm, glove and viewport, the chamber can be used for pilot-in-the-loop simulation. !e chamber has been used to research on-orbit crack repair of reinforced carbon-carbon, the material on the leading edge of the shuttle's wing. Pilot-inthe-loop simulations can be used to test the effects of the space environment on many extravehicular activities that astronauts perform. The other chamber last performed a continuous 18-yr life-cycle test of an electrical contact slip ring, continuously maintaining the required high-vacuum environment.

Optical Cleanliness Thermal Vacuum Bakeout

The ETF is recognized as a leader in optical cleanliness vacuum bakeout, meeting MSFC Specification 1238, one of the most stringent certifications of optical cleanliness. !e ETF has been used to certify the cleanliness of components used on the Chandra X-Ray Telescope and the Hubble Space Telescope with future optical cleanliness vacuum bakeouts to include the Solar-B Telescope and James Webb Space Telescope. The entry doors of two out of three chambers are inside an ISO Class 7 clean room and the entry of the third chamber is in an ISO Class 8 clean room.



MLI Blanket Bakeout in Vacuum Chamber V7

Launch Simulation Testing

During launch, any flight hardware exposed to the external environment will undergo a rapid pressure change from one atmosphere to a high vacuum within minutes. Likewise, there is a rapid pressure increase upon reentry into the Earth's atmosphere. !is facility has the capability to accurately simulate the rapid dynamic depressurization and repressurization experienced during launch and reentry. In addition, two chambers are equipped with cryogenic systems and banks of high-energy infrared lamps that can provide temperature extremes of –240 °C to +343 °C.

Heater Mat Assembly Test in Vacuum Chamber V7

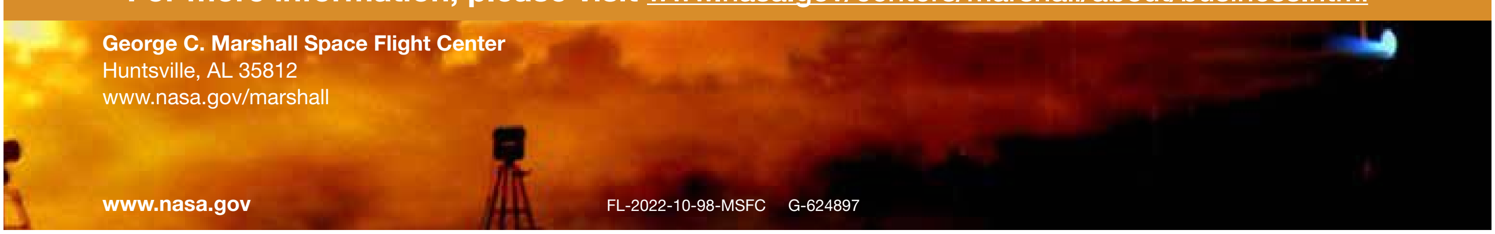
Vacuum Bakeout

The thermal vacuum bakeouts are performed in six chambers with test article sizes up to 15-ft diameter. Instrumentation includes thermocouples and convection and ionization pressure gauges.

Chamber Specifications

Chamber	Primary Use	Vacuum Pressures	Temperatures	Thermal Conditioning	Dimensions
V1	Optical cleanliness	5 × 10–7 torr	Ambient to 180 °C	IR Lamps	4 ft dia × 7 ft
V2	Optical cleanliness	5 × 10–7 torr	Ambient to 180 °C	IR Lamps	4 ft dia × 10 ft
V3	Pilot-in-the-Loop On-orbit simulation	5 × 10–8 torr	–100 to 100 °C	IR Lamps, LN2	4 ft dia × 10 ft
V4 & V8	Vacuum bakeout	1 × 10–6 torr	Ambient to 175 °C	IR Lamps	2 ft dia × 2.5 ft
V5	Thermal vacuum	1 × 10–6 torr	–170 to 150 °C	IR Lamps, LN_2	3 ft dia × 4 ft
V6	Thermal vacuum	1 × 10–7 torr	–170 to 150 °C	IR Lamps, LN_2	3 ft dia × 4 ft
V7	Vacuum bakeout	5 × 10–7 torr	–170 to 150 °C	IR Lamps, LN_2	8 ft dia × 10 ft
V9	Vacuum bakeout	1 × 10–6 torr	Ambient to 170 °C I	R Lamps, LN_2	4 ft dia × 7 ft
V10	Life cycle	5 × 10–8 torr	Ambient	N/A	1.5 ft dia × 1.5 ft
V11/RAC	Launch simulation	1 × 10–6 torr	–240 to 340 °C	IR Lamps, LH_e	4 ft dia × 10 ft
V12	Vacuum effected demo	1 × 10–6 torr	–100 to 100 °C	IR Lamps, LN_2	1.5 ft dia × 2 ft
V15 (in operation 12/06)	Thermal vacuum	1 × 10–7 torr	–170 to 180 °C	IR Lamps, LN_2	12 ft dia × 20 ft
Sunspot	Thermal vacuum	1 × 10–6 torr	–170 to 200 °C	IR Lamps, LN_2	10 ft dia × 12 ft
V20	Thermal vacuum	1 × 10–6 torr	–170 to 200 °C	IR Lamps, LN_2	20 ft dia × 28 ft
TH1–TH3 and TH5–TH8	Thermal humidity	Ambient	–70 to 190 °C	Electrical resistive and refrigeration	4 × 4 × 4 ft
TH4	Thermal humidity	Ambient	–70 to 160 °C	Electrical resistive and refrigeration	4 × 5 × 4 ft
V14/MEG	Vacuum bakeout	1 × 10–6 torr	Ambient to 150 °C	IR Lamps	12 × 8 ft
TA1	Thermal altitude	Ambient to 100,000 ft	–70 to 190 °C	Electrical resistive and refrigeration	4 × 4 × 4 ft
TA2	Thermal altitude	Ambient to 150,000 ft	Ambient to 200 °C	Electrical resistive	1.5 × 2 × 1.5 ft
TA3	Thermal altitude	Ambient to 200,000 ft	Ambient to 200 °C	Electrical resistive	1 × 1.5 × 1 ft

For more information, please visit www.nasa.gov/centers/marshall/about/business.html



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