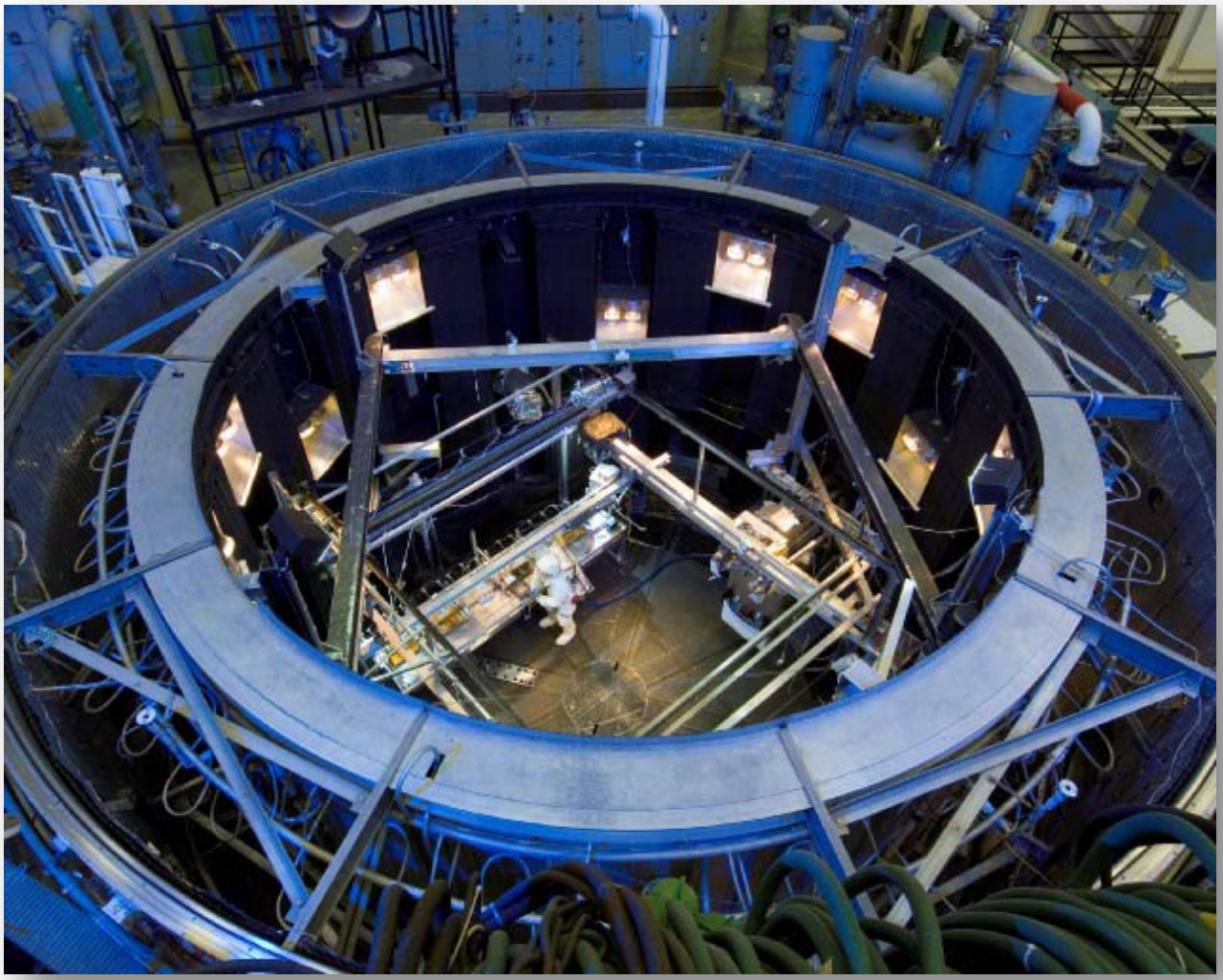
Abstract – Chamber B User Test Planning Guide

Test process, milestones and inputs are unknowns to first-time users of Chamber B. The User Test Planning Guide aids in establishing expectations for both NASA and non-NASA facility customers. The potential audience for this guide includes both internal and commercial spaceflight hardware/software developers. It is intended to assist their test engineering personnel in test planning and execution. Material covered includes a roadmap of the test process, roles and responsibilities of facility and user, major milestones, facility capabilities, and inputs required by the facility. Samples of deliverables, test article interfaces, and inputs necessary to define test scope, cost, and schedule are included as an appendix to the guide.

Chamber B Thermal/Vacuum Chamber

User Test Planning Guide



National Aeronautics and Space Administration
Lyndon B. Johnson Space Center
Houston, Texas 77058

Table of Contents

1.0 Chamber B Thermal/Vacuum Chamber

Chamber B is a 7.6 m (25 ft) diameter x 7.9 m (26 ft) high thermal-vacuum test facility. Its usable test volume and high fidelity space simulation capabilities are adaptable for thermal-vacuum testing of a wide variety of test articles. The chamber is human-rated and equipped with a traversing monorail that provides weight relief to a suited test subject. Major structural elements of the chamber include a removable top head, fixed chamber floor, dual airlocks at floor level, and a load bearing floor area 20 feet in diameter that will support a concentric load of 34,000 kg (75,000 lb). Additional test support equipment includes an internal jib crane; mass spectrometers; infrared cameras; television cameras; and two rolling bridge cranes with a capacity of 45,000 kg (100,000 lb), which are used to remove the chamber top and insert large test articles.

Services Provided
• Simulation of thermal/vacuum characteristics of space • Materials and hardware testing in extreme environments – Components, major spacecraft subassemblies, and complete spacecraft or payloads • Determination of design factors – Operating temperatures – Combined thermal and pressure-load distortions of dimensionally critical structural elements – Fluid/gas leak rates – Changes in absorptive or emissive properties of thermal coating – Evolution of harmful or undesirable off-gassing products – Presence of conditions conducive to electrical-arc or corona discharge • Human-rated testing in a thermal-vacuum environment*

* See Appendix G for additional information and requirements for human rated testing

Point of Contact

Lab Manager, Mike Montz
Johnson Space Center
2101 NASA Parkway, Houston, TX 77058
(281) 483-9148
michael.e.montz@nasa.gov

Specifications

General Characteristics

Type	Description
Outside Dimensions	10.7 m (35 ft) diameter x 13.1 m (43 ft) high
Working Dimensions	7.6 m (25 ft) diameter x 7.9 m (26 ft) high
Test Article Weight	34,000 kg (75,000 lb) concentric load maximum
Instrumentation	Real-time data acquisition and remote control
Access	10.7 m (35 ft) diameter removable top head; dual crew-locks at floor level

Vacuum System

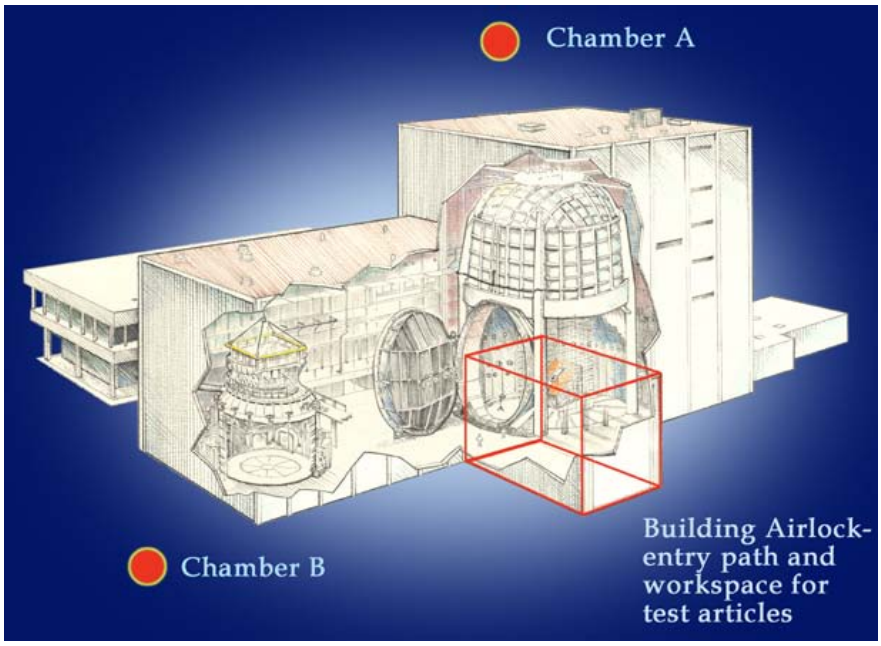
Type	Description
Types of Pumps	Staged roughing pumps, valved and trapped oil diffusion pumps, and 20 K (–424 °F) cryopumps
Pumpdown Time	8 hours to test conditions
Pumping Capacity	1 x 10^7 liters/sec condensables and 2 x 10^5 liters/sec noncondensables at 1 x 10^-6 torr pressure ***Note:*** *Usual chamber inleakage less than 3 x 10^5 liters/sec of air at 1 x 10^-6 torr pressure.*
Repressurization	Controllable from 90 sec minimum using dry gas

Heat Sink and Thermal Characteristics

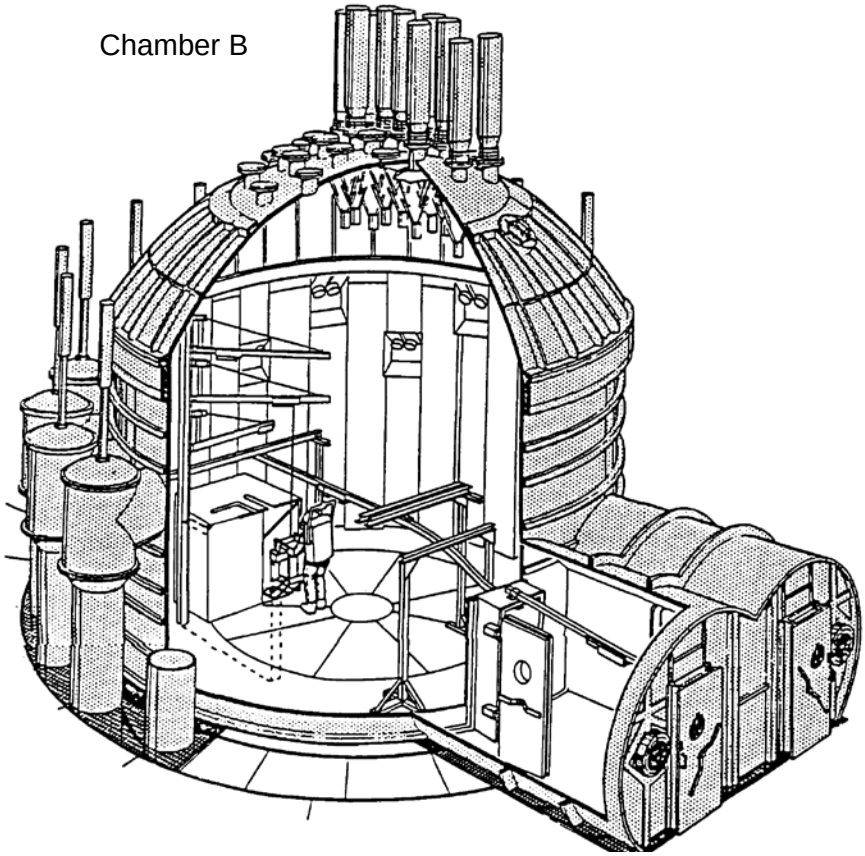
Type	Description
Full Chamber Shroud	Subcooled 90 K (–298 °F) LN2 shroud 130,000 W total heat absorption capacity, 1615 W/m^2 (150 W/ft^2) maximum heat flux
Temperature Range	–298 K Thermal Environment
Wall Emissivity	0.95
Measurement	Real-time traversing radiometer system

2.0 Facility Layout

Johnson Space Center (JSC) Building 32



Chamber B



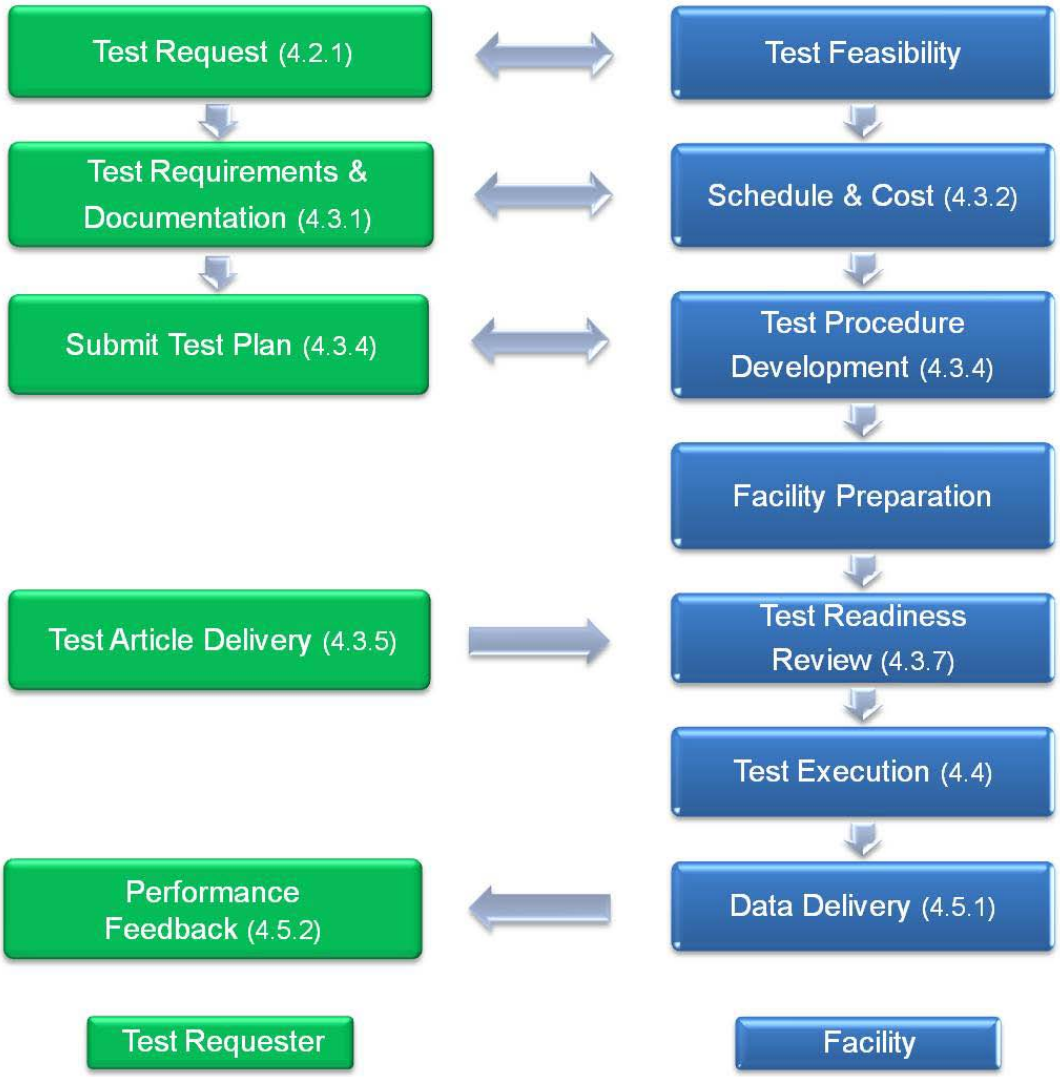
*See Appendix A for additional facility layouts

3.0 Safety and Health

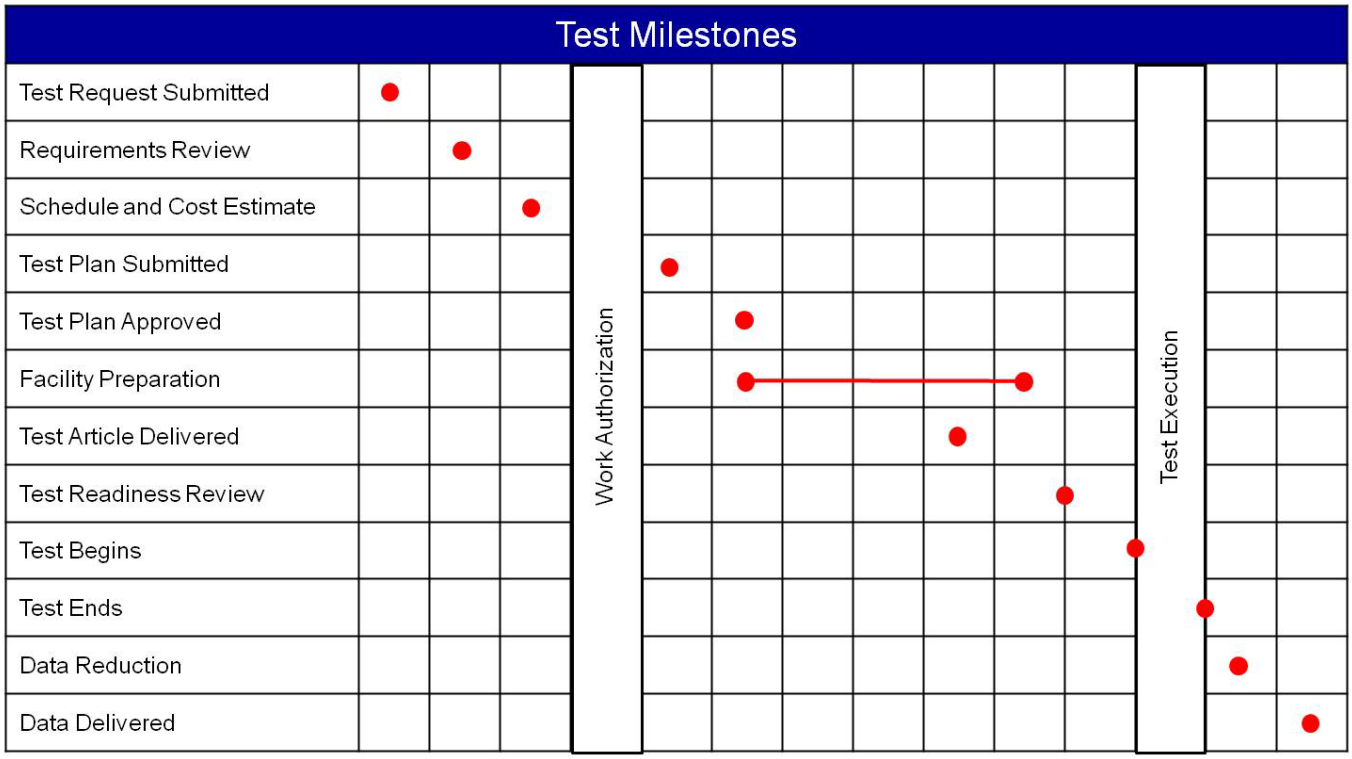
Safety is an integral part of the culture at the National Aeronautics and Space Administration (NASA). Management, leadership, and employee involvement from all organizations are critical to the success of NASA's safety program. In order to ensure personal safety and a safe test environment throughout the process, the requester shall furnish the facility with the information necessary to perform a hazard assessment of the test article. Additionally, while visiting JSC, the requester shall follow all facility-specific safety and health requirements. A facility safety briefing shall be provided to all personnel prior to the start of the test.

4.0 Test Process Flow

The flowchart presented below outlines the basic roadmap and significant milestones between the initial test request and delivery of test data. The flow is separated between Test Requester actions and Facility actions, highlighting interactions and inputs between the Test Requester and the facility Test Director.



The test schedule is highly dependent on the complexity of the test, facility availability, and sequence of runs. For time-critical testing, this schedule may be accelerated. A detailed schedule shall be developed following review of test objectives and requirements. Major milestones are presented below:



4.1. Export Controlled and Proprietary Information

JSC provides for protection of export controlled and proprietary information and hardware throughout the test process. The Test Requester shall clearly mark all export controlled or proprietary hardware items and data provided with a notice of restriction on disclosure or usage. The Test Director shall safeguard export controlled or proprietary items from unauthorized use and disclosure and ensure that test articles remain secure within the facility and are properly sequestered. Access to the facility is restricted to facility personnel and escorted visitors. Hardware items shall be returned to the Test Requester or disposed of in accordance with the Test Requester's instructions at the completion of the test activity.

4.2 Test Initiation Phase

The test initiation phase establishes the relationship between the Test Requester and the Test Director. The Test Requester shall provide a test request to the Test Director, which will be used to determine test feasibility and to develop an estimated cost and a preliminary test schedule. An initial requirements review meeting may be necessary in order to discuss the characteristics of the test article, the test objectives, or any special considerations for the test. An on-site tour of the facility is highly recommended for familiarization and to provide an opportunity for an exchange of technical information.

Inputs: Test Requester provides test request, identifies Test Article Expert

Activities: Test Director reviews test request to determine test feasibility

Outputs: Facility delivers preliminary test plan and estimated cost and schedule to Test Requester

4.2.1 Test Request

The test request outlines the test objectives, test article description, and schedule. A Test Request Worksheet is provided in Appendix B. This worksheet addresses the basic requirements for testing in Chamber B. It is suggested that the Test Requester complete this worksheet to facilitate the development of a preliminary cost and schedule estimate. Contact the Test Director if you have questions about completing the Test Request Worksheet. Internal Test Requesters should also submit a JSC Form 90, Test Request Form, to the Test Director. This form is used by JSC as a formal means of requesting a test within JSC. It is the work authorizing document for the test team to provide support. JSC personnel will complete the Test Request Form (Form 90) for external Test Requesters.

At a minimum, the test request should include the following information:

Test Objective

A brief description of the test requirements including, but not limited to, the following:

- Desired test conditions (pressure, temperature, exposure time)
- Proposed test approach
- Test data requirements

Test Article Description

A brief description of the test article including, but not limited to, the following:

- Size (provide drawings, sketches, photos)
- Weight
- Test article interface (load points, method of suspension or test article support)
- Test article fluid interface requirements (type, pressure, flow)
- Orientation (fixed or moveable)

- Special considerations (e.g., hazards, cleanliness, compatibility)
- Handling and storage requirements

Schedule

Identify the required start date and proposed date for test completion.

4.3 Test Preparation Phase

The detailed test plan and test schedule are finalized during the test preparation phase. The Test Requester shall provide detailed test requirements and test article documentation to the Test Director. A Test Readiness Review (TRR) will be held following approval of the test plan.

Inputs:	Test Requester provides test requirements, test plan, and test article documentation
Activities:	Facility develops test procedure, begins assembly of facility interface/support structure(s)
	Test Requester ships/transports test article to JSC
Outputs:	Test Requester approves test plan/procedure and final test schedule
	Facility holds TRR

4.3.1 Test Requirements

A complete understanding of test requirements is mandatory for a successful test. Test requirements must be defined and reviewed so that the test team understands the effect of the requirements on test facility preparation. The Test Requester shall provide a detailed list of test requirements including, but not limited to, the following:

- Specific test conditions
- Interface requirements (e.g., fluid, structural, electrical, mechanical)
- Data/instrumentation requirements (provided by Test Requester and facility)
- Cleanliness
- Chamber penetrations (number, size, type)

4.3.2 Schedule and Cost Estimate

Following review of the test requirements, the Test Director will provide a cost and schedule estimate, including major milestones, to the Test Requester. The cost estimate is highly dependent on the level of detail provided for the test requirements.

4.3.3 Test Article Documentation

Test Article Drawings

The Test Requester shall provide detailed test article drawings as requested by the facility. Test article drawings are used to prepare the facility interfaces, test article support structures, and instrumentation connection points.

Material Safety Data Sheets

NASA must ensure that all materials exposed to test environments do not present a hazard to personnel or the test facility. The Test Requester shall deliver Material Safety Data Sheets (MSDS) for materials used in the construction of the test article with an assessment of expected byproducts produced during the thermal test. The MSDS shall be delivered prior to delivery of the test article. The Test Director will review the materials list for compatibility with the test environment and to determine protective measures for personnel, if required.

Materials Usage Control Board

Test article materials for which an MSDS does not exist will be reviewed by the Materials Usage Control Board (MUCB). The MUCB is responsible for reviewing the proposed usage and for accepting or rejecting the material, based on information available on material characteristics and applications and information supplied by the Test Requester.

Test Article Hazard Identification

The safety of facility personnel, facility equipment, and the test article is imperative to NASA. Potential hazards, material compatibility, and facility interfaces will be reviewed with the facility prior to testing. In certain instances, special precautions must be taken due to the severity level of these potential hazards. The Test Requester may be asked to provide further information to clarify or mitigate a potential hazard. A test article hazards checklist is provided in Appendix B.

4.3.4 Test Plan

A test plan shall be submitted by the Test Requester. A test plan is necessary to ensure that all requirements of the Test Requester and the facility are achieved in an efficient and reproducible manner. The test plan is instrumental in developing the detailed test procedure. The final test plan shall be approved by the Test Requester with concurrence from the Test Director. The test plan will be the controlling document, with respect to scope and approach for the test program. The test plan will include, at a minimum, the test objectives, scope, test article description, safety considerations, and data requirements. Changes to the test plan that occur after the TRR that result in a major change to the scope of the test or that present new hazards may require a delta TRR.

4.3.5 Test Schedule

A detailed schedule shall be developed by the Test Director and approved by the Test Requester. The schedule shall allow adequate time for review and approval of test requirements, assembly of facility interfaces/structures, and delivery of the test article. The

schedule of other tests and maintenance activities will be reviewed and potential conflicts shall be addressed by the Test Director.

4.3.6 Test Article Delivery

The test article delivery date will be determined on a case-by-case basis. An agreed-upon delivery date shall be captured as a milestone in the test schedule. The Test Requester shall provide detailed handling instructions prior to delivery of the test article, including handling hazards, cleanliness, and storage requirements. The test article shall be secured within the test facility, unless directed to provide other means of storage. An inspection of the test article shall be performed by the Test Director and Test Article Expert prior to the start of testing. NASA encourages Test Article Expert participation in the test article integration phase to provide immediate feedback on test article handling and any integration issues that arise.

4.3.7 Test Readiness Review

A TRR will be held to ensure the completion of all necessary facility and test article activities prior to test execution. The Test Requester shall submit documentation to the Test Readiness Review Board (TRRB), declaring that the test article is ready and there is no constraint to test. This is required to verify that there are no issues that would invalidate the test. The TRR Summary Sheet (Form 1850) is one version of such documentation for internal Test Requesters. The Test Director will provide instructions for submitting test hardware readiness documentation.

The TRR will include the following:

- Review of the test plan, test procedures, and other required test documentation
- Facility and test article readiness
- Review of configuration records, including facility interface control documents, pressure system certification, instrumentation calibration, and materials compatibility
- Confirmation that controls are in place to mitigate risks or hazards identified in the Test Hazard Analysis
- Assurance that data acquisition and processing functions are in place to adequately capture all critical data
- Verification that multimedia coverage is adequate to provide recognition and assessment of potential test anomalies

Approval to proceed with test operations is granted by the TRRB. The Test Director shall ensure that all TRR actions have been accomplished prior to the start of the test. The TRRB shall convene between 1 to 5 business days prior to the start of the test. TRRB participants shall include the following:

NASA TRRB Chairman
Test Director
Medical Doctor (Human-Rated Test)
NASA Test Safety Officer
Test Article Expert (Appointed by Test Requester)
Systems Safety Engineer
Quality Engineer – if required by facility

4.4 Test Execution Phase

NASA encourages Test Requester participation in the testing activity. The Test Requester shall provide a Test Article Expert to verify that test setup and execution meet the stated objectives. The Test Article Expert shall also verify test article performance and approve requested test deviations during test operations.

Inputs:	Approval to begin testing received from TRRB
Activities:	Facility completes facility preparations and test article integration, Detailed Test Procedure
	Facility conducts testing activity
Outputs:	Test completed

4.4.1 Test Authority

The Test Director has the authority and responsibility to direct the test in accordance with the approved test plan and to terminate test activities per test rules when danger is imminent or test control cannot be maintained. The Test Director will ensure that positive actions are taken to halt any steps in the test procedure whenever unsafe or hazardous test conditions arise. The Test Director, with the concurrence of the Test Requester, has the authority to terminate the test when sufficient data has been obtained to meet objectives or when objectives cannot be met. Test team personnel will accept directions only from the Test Director.

4.4.2 Test Deviations

Changes to the test procedure shall be approved by the Test Article Expert with concurrence from the Test Director. Deviations that result in a major change to the scope of the test or that present new hazards may require a delta TRR.

4.4.3 Facility Equipment

The facility equipment is meant for use by JSC personnel. Prior arrangements shall be made with the Test Director for potential use of this equipment by the Test Requester. The duration and type of use will be identified prior to authorization for use. JSC workstations are not available for use by Test Requester personnel. This is necessary to protect the integrity of the facility. The Test Requester shall make prior arrangements with the Test Director if a dedicated workstation is required during testing. The Test Requester is encouraged to bring a laptop for use during the test. Wireless Internet access is available in the facility.

4.5 Test Closeout Phase

Data shall be delivered to the Test Requester within 10 business days following completion of testing. The Test Requester shall notify NASA upon receipt of the data. Acceptance of the test data concludes the test activity.

Inputs:	Test completed
Activities:	NASA ships/transports test article to Test Requester
	NASA delivers data to Test Requester
Outputs:	Test Requester accepts data

4.5.1 Data Package

A data package is an assembly of test results. The format of the data package is normally specified by the Test Requester. The standard data package format includes a description of the test and objectives, test observations, test results, and data plots.

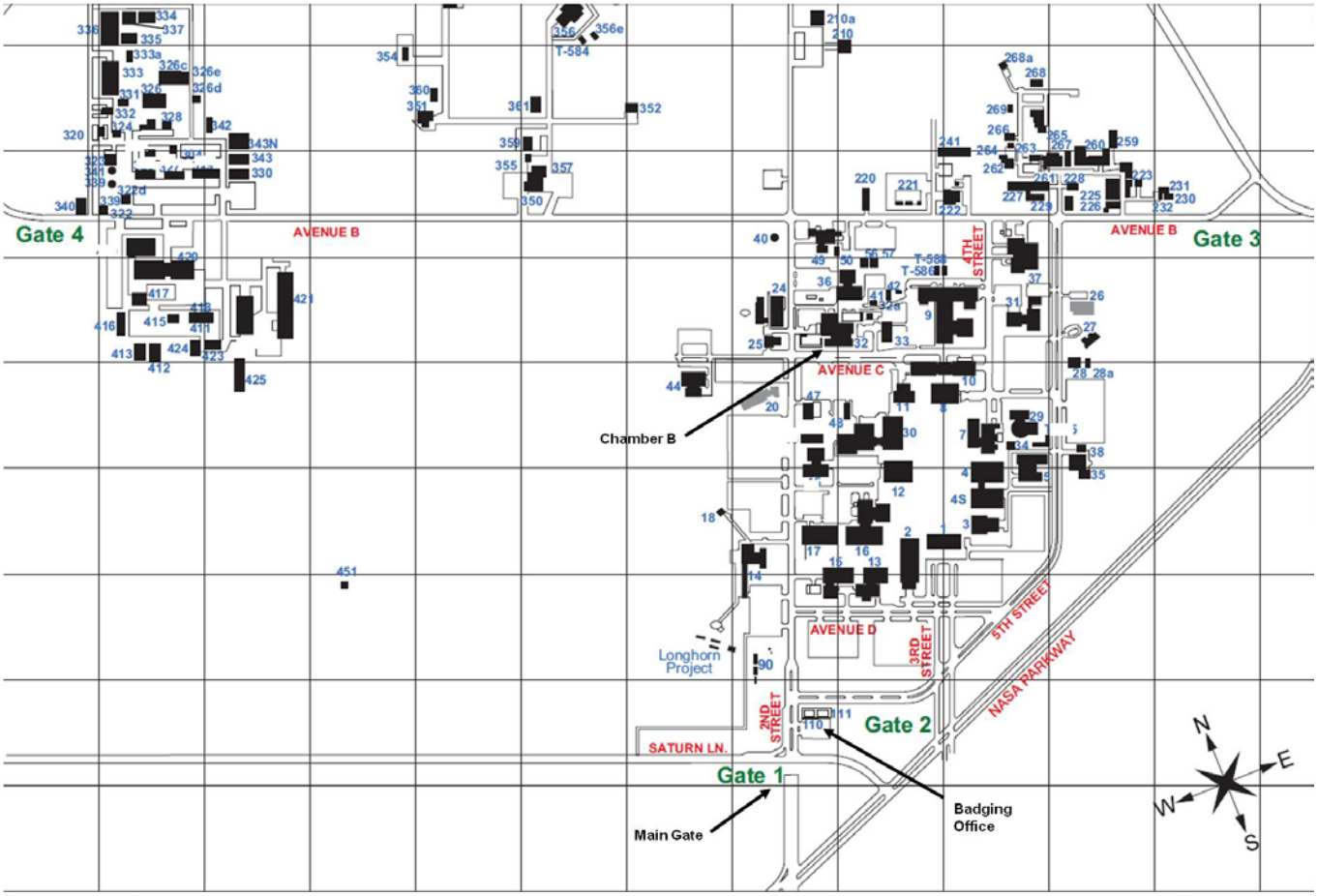
4.5.2 Customer Feedback

NASA requests feedback from our customers. Evaluation of the services we provide enables continued improvement to our process. A Customer Feedback form is included in Appendix F. You are encouraged to complete the Customer Feedback form and return it to the Test Director, following receipt of the test data. Your participation is greatly appreciated.

5.0 Facility Access

Identification badges are required for all persons requiring access to JSC. The Test Director or designee will initiate a badge request for all Test Requester personnel who will be participating in the test activity. Badge requests must be submitted at least 4 days prior to the visit to prevent badge processing delays. Badge requests for non-U.S. citizens may require a minimum of 30 business days to process. Test Requester personnel shall arrive at JSC Building 110 to pick up temporary identification badges. Visitors to JSC must show a current picture identification (valid driver's license, U.S. passport, government ID card).

Chamber B is located in JSC Building 32. A facility access briefing shall be provided to all personnel requiring access to the facility prior to the start of the test. All other personnel requiring entry must be escorted by a person approved for access.



6.0 Roles and Responsibilities

Test Director – Has overall responsibility for all phases of the test process.

Test Requester - The client requesting performance of a test activity. The Test Requester is responsible for the test article and for providing a Test Article Expert.

Test Article Expert – A representative of the Test Requester with thorough knowledge of the test article and how it is to be operated in the test environment. The Test Article Expert also is responsible for approving the test plan and verifying that test objectives are met.

Systems Safety Engineer – Reviews the test article hazard assessment and prepares an integrated hazard analysis for the test facility to identify any additional hazards that could result from mating the test article to the test facility.

Quality Engineer – Responsible for verifying that the test facility is ready for the test by ensuring that all constraints to the test have been closed.

Responsibilities Matrix

Item	Test Requester	Facility
Test Request Worksheet	Create	Review and provide assistance as needed
Cost and schedule	Approve	Create and sign off
Hazards	Identify test article hazards	Create test article/facility integrated hazard analysis
Test plan	Submit and approve	Review and approve
Detailed test procedure	Review and approve	Create and approve
Test hardware readiness	Submit and approve	Review and approve
Test Readiness Review Board	Submit and approve	Conduct and approve
Test execution	Verify test article performance Verify that test setup and execution meets objectives Approve requested deviations	Execute test
Provide test data/results	Notify Test Director of data receipt	Deliver to Test Requester
Review test data/results	Approve	
Shipping	Provide instruction	Execute per request

Acronyms

CPHS	Committee for the Protection of Human Subjects
FS	Full Scale
IR	Infrared
JSC	Johnson Space Center
MSDS	Materials Safety Data Sheets
MUCB	Materials Usage Control Board
NASA	National Aeronautics and Space Administration
RF	Radio Frequency
TRR	Test Readiness Review
TRRB	Test Readiness Review Board
UV	Ultraviolet

Appendices

A. Facility Layout

B. Test Request Worksheet

C. Example Test Request Worksheet

D. Instrumentation Provided by Facility

E. Sample Test Plan and Test Requirements

F. Customer Feedback

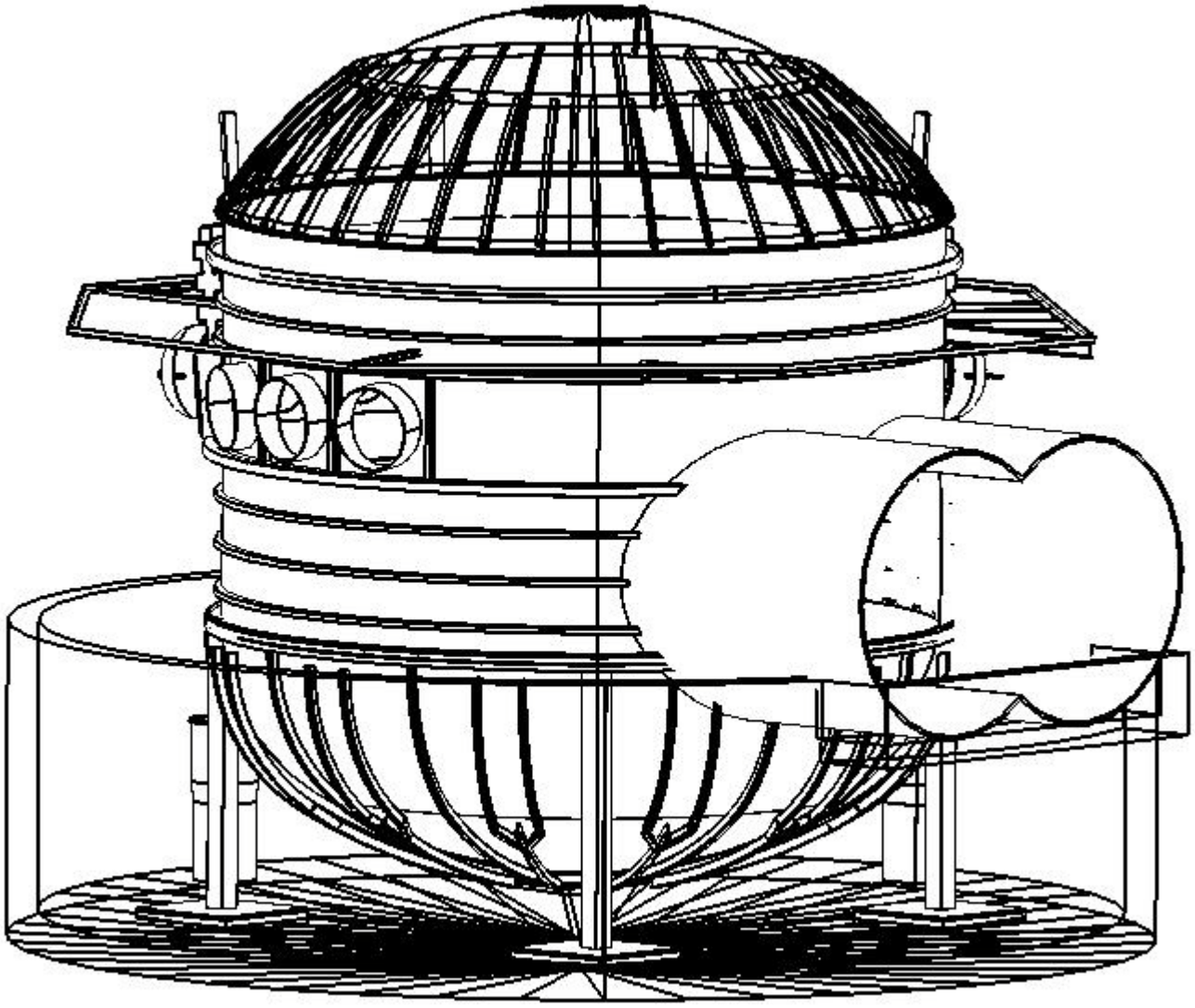
G. Human-Rated Testing

H. Human Research Informed Consent

Appendix A Facility Layout

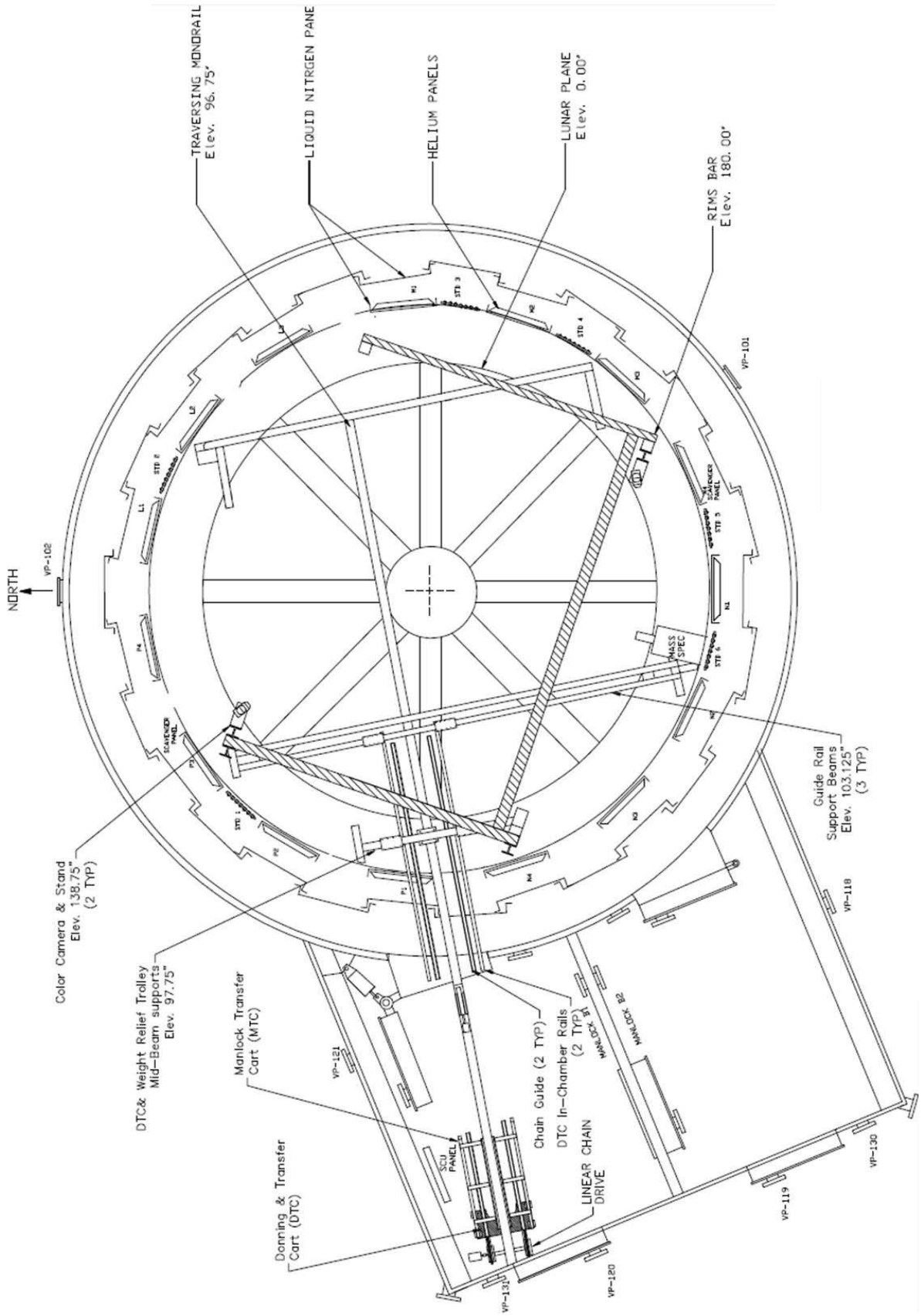
The test fixture drawings included in this guide are a sampling of the capabilities within the Thermal Vacuum Test Facilities. The facility maintains a variety of fixtures to support general and requester-specific testing. Additional test fixture drawings are available upon request. The facility can manufacture test fixtures to requester specifications. Contact the Test Director to discuss test article interface requirements*.

Chamber B Vessel



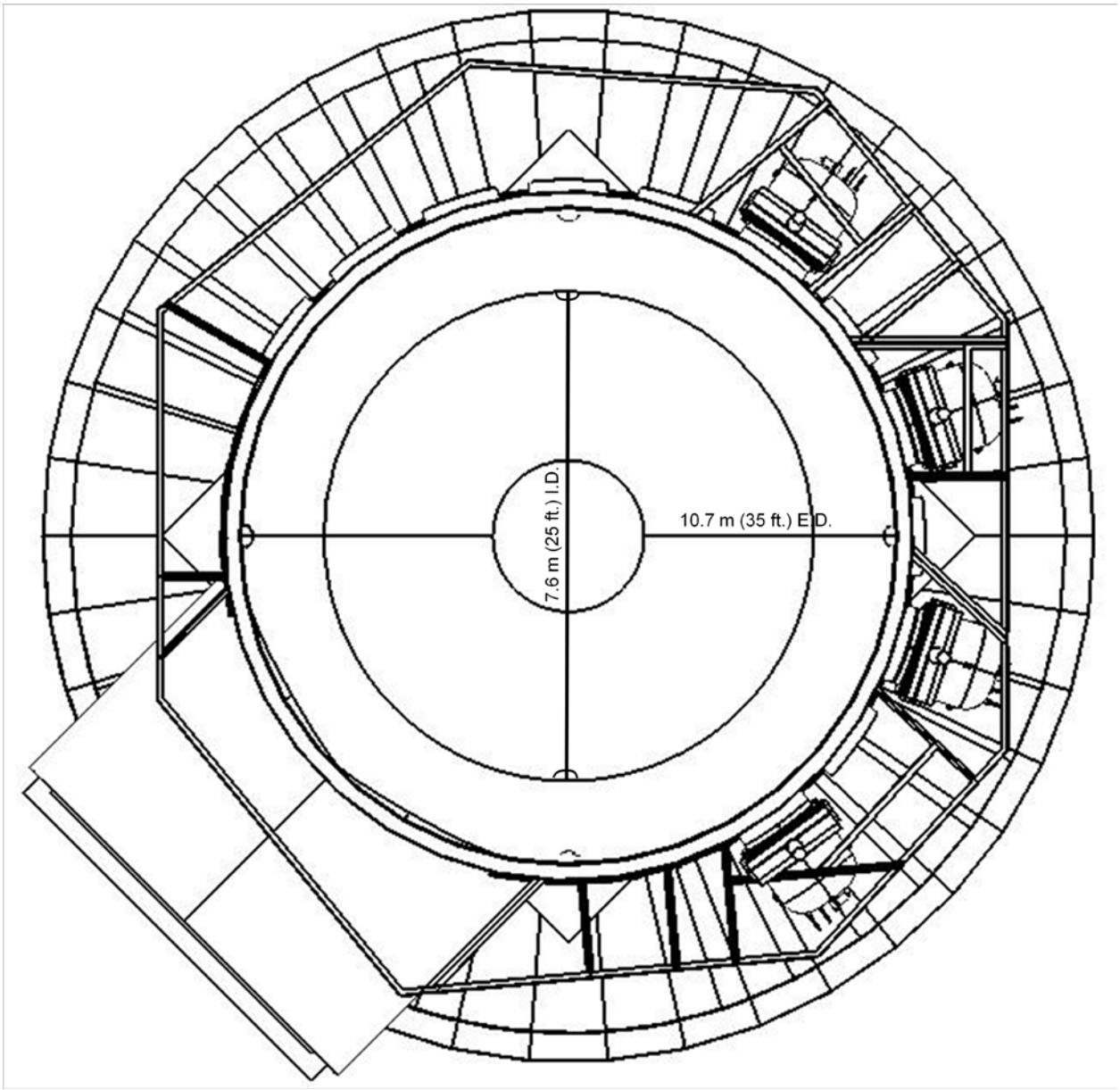
* Additional Chamber B drawings and models available upon request

Chamber B Basic Configuration

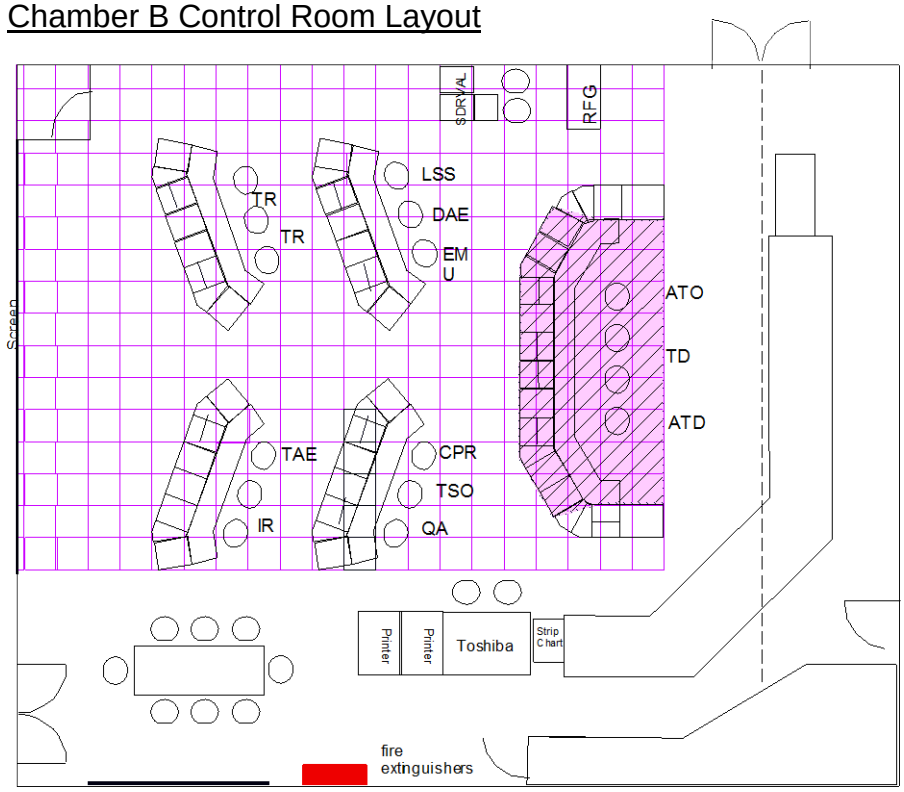


Chamber B Dimensions

Type	Description
Outside Dimensions	10.7 m (35 ft) diameter x 13.1 m (43 ft) high
Working Dimensions	7.6 m (25 ft) diameter x 7.9 m (26 ft) high
Test Article Weight	34,000 kg (75,000 lb) concentric load maximum

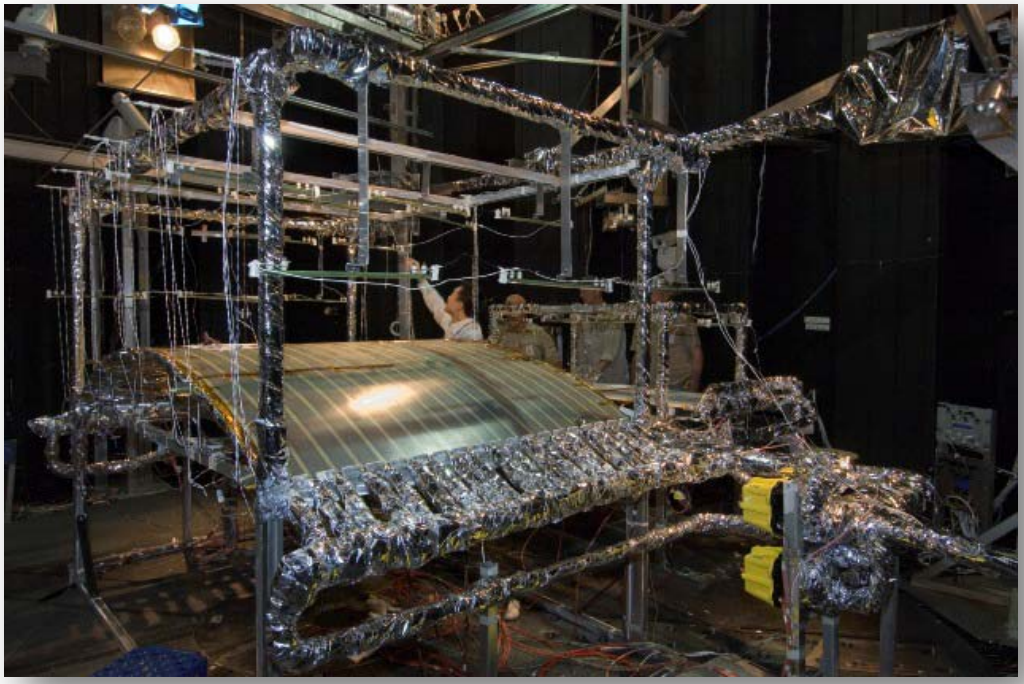


Chamber B Control Room Layout



ATD – Alternate Test Director
TD – Test Director
LSS – Life Support Systems Engineer (if required)
DAE – Data Analysis Engineer
EMU – Suit Engineer (if required)
TR – Test Requester
TAE – Test Article Expert
IR – Infrared Camera Operator (if required)
CPR – Medical Doctor (if required)
TSO – Test Safety Officer
QA – Quality Assurance

Chamber B Pumpdown Curve



Chamber B – Thermal Control System Test

Removal of Chamber B Top Head

Appendix B Test Request Worksheet

Test Requester Information

Test Article Expert:	Contact Information (Phone, E-mail, Address):

Test Objectives

Purpose of Test:	
Proposed Test Start Date:	Critical Test Start Date:

Test Article

Test Article Description:	
Physical Dimensions (L/W/H):	Weight:

Test Article Handling Requirements

Cleanliness Level:	Controlled Access:
Special Moving/Handling:	

Test Article Interface

Support Structure Required/Interface Points:	Orientation (fixed or moveable):
Mechanical Interfaces (fluids, operating pressure, flow, ventilation):	
Test Article Power Requirements (volts, amps, watts):	

Test Environment

Complete the Test Environment table below for steady-state conditions or provide a plot of the test environment to be simulated for a continuous environment.

Type	Minimum	Maximum	Ramp Rate	Tolerance	No. of Cycles
Pressure					
Temperature					
Termination Criteria:					
Hardware Functional (description of functional to be performed):					

Human-Rated Testing

Human-Rated (Yes/No):	No. Human Test Subjects:	NASA or Requester Subjects:
List Requester-Provided Subjects:		

* Human Test Subjects must have a current Air Force Class III Category I Flying Physical and Physiological Training to participate in suited test operations involving reduced pressure.

** Each Test Subject must complete the NASA/JSC Human Research Informed Consent form. The form should be sent to the Chairperson, Johnson Space Center Committee for the Protection of Human Subjects.

Instrumentation

Instrumentation Provided by Test Requester:
List the primary measurements to be made (temperature, pressure, time):

Data Acquisition and Recording

Number of Channels:	Audio/Video Recording (Yes/No):
Sampling Rates:	Photographic Film (Yes/No):
Real-Time Data Processing (Yes/No):	High Speed/Low Speed:
Data Handling Requirements (storage, delivery, format):	

Other Information

List any other information pertinent to the test:

Test Article Hazard Checklist

A hazard analysis statement is required for any of the following applicable attributes of any of your provided hardware (test article, support equipment).

Hazard	Y	N	Comments
Mechanical			
Handling (> 40 lb or > 4 ft, any dimension)			
Instability			
Sharp Edges			
Pinch Points			
Exposed Mechanisms (rotating, reciprocating)			
Pressure Systems			
Stored Energy (springs, weights, flywheels)			
Ejected Parts, Projectiles			
Electrical			
Voltage (> 50 volts)			
Batteries			
Generation/Storage (coils, magnets, capacitors)			
Electrostatic Sensitive Devices			

Hazard	Y	N	Comments
Thermal			
Hot Surfaces (> 113 °F, 45 °C)			
Heaters			
Cold Surfaces (< 39 °F, 4 °C)			
Cooling Devices			
Radiation			
Ionizing			
Non-Ionizing			
Laser			
Microwave			
Infrared (IR)			
Ultraviolet (UV)			
Radio Frequency (RF)			
Visible Light, High Intensity			
Material			
Uncontained Brittle Materials			
Test Environment Incompatibility			
Contained Fluids			
Toxic, Corrosive, Flammable Fluids			
Biohazards			
Miscellaneous			
Noise Level (> 85 dBA)			
Ultrasonic			

Appendix C Example Test Request Worksheet

Test Requester Information

Test Article Expert:	Contact Information (Phone, E-mail, Address):
[Identify Test Article Expert]	[Test Article Expert Contact Information]

Test Objectives

Purpose of Test:	
Provide stated primary and secondary objectives. Wherever possible, specific goals and/or limitations should be included. The primary objectives are to be interpreted as minimum achievements for test success, and the secondary objectives are considered highly desirable options. *The objective of this test is to evaluate the performance of TA-1 during exposure to vacuum and a thermal environment ranging from –140 ± 4 °F to 160 ± 4 °F, with hardware functionals at ambient temperature, –35 ± 4 °F, –75 ± 4 °F, –140 ± 4 °F and 160 ± 4 °F. A total of 3 thermal cycles are required. One hour soaks should occur at –140 °F, +160 °F. Critical temperatures for TA-1 are +190 °F, –160 °F.*	
Proposed Test Start Date: *Proposed Start Date*	Critical Test Start Date: *Need Date*

Test Article

Test Article Description:	
Technical description of the test article, defining method of operation and theoretical considerations, referring to drawings and/or schematics if necessary. Operational characteristics, including normal and off-limit performance parameters, such as temperature, voltage, current, and flow rate. Operational constraints of the test article that cannot be violated without harming the test article (for example, pressure limits, environmental temperature limits, system cleanliness, and fluid purity).	
Physical Dimensions (L/W/H): *X" in length and X" in diameter*	Weight: *X mg*

Test Article Handling Requirements

Cleanliness Level:	Controlled Access:
Generally clean	*Secured overnight*
Special Moving/Handling: *Test Requester will transport TA-1 directly to the test facility and remove from facility at completion of the test.*	

Test Article Interface

Support Structure/Interface Points:	Orientation (fixed or moveable):
Mount TA-1 vertically to provide a view outside of chamber.	*Fixed*
Mechanical Interface (fluids, operating pressure, flow, ventilation): *Drawings attached:* *TA-1 Assembly* *TA-1 TC locations*	
Test Article Power Requirements (volts, amps, watts): *120 Vdc for test article; 120 Vac for provided instrumentation (network analyzer, noise figure meter, noise source, digital multimeter, laptop computer, and docking station)*	

Test Environment

Complete the Test Environment table below or provide a plot of the test environment to be simulated.

Type	Minimum	Maximum	Ramp Rate	Tolerance	No. of Cycles
Pressure	1 x 10^{-4}		N/A	+/- 25%	3
Temperature	–135 F	160 °F	2 °F/minute	+/- 4 °F	3

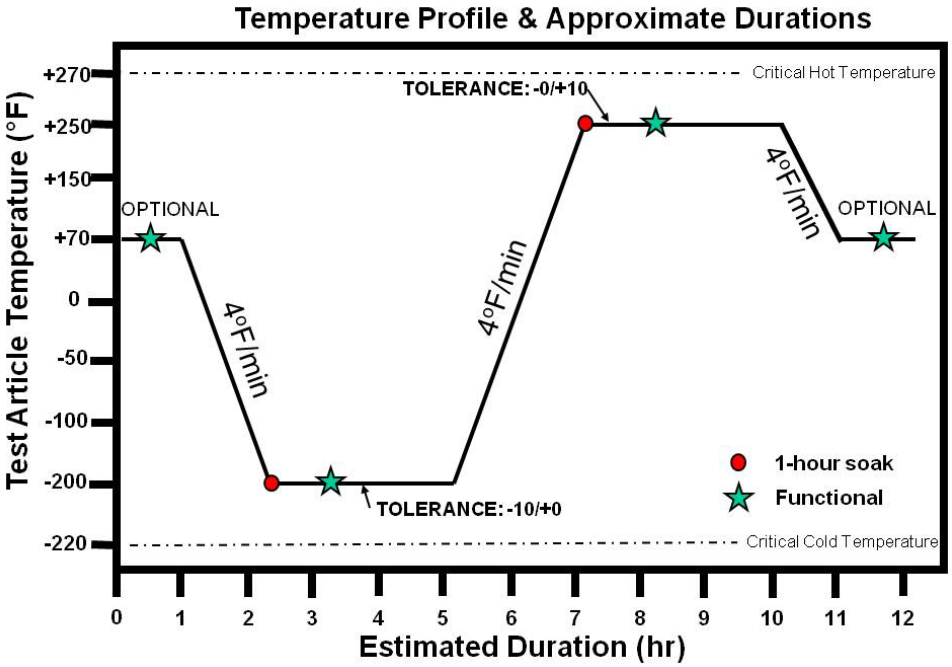
Termination Criteria:

Critical temperatures for TA-1 are +190 °F, -160 °F.

Hardware Functional (description of functional to be performed):

Hardware functional to be performed per the attached thermal profile. Duration of hardware functionals is ~ 1 hour per functional

Sample Thermal Profile with Functionals



Human-Rated Testing*

Human-Rated (Yes/No):	No. Human Test Subjects:	NASA or Requester Subjects:
List Requester-Provided Subjects**:		

* Human Test Subjects must have a current Air Force Class III Category I Flying Physical and Physiological Training to participate in suited test operations involving reduced pressure.

** Each Test Subject must complete the NASA/JSC Human Research Informed Consent form. The form should be sent to the Chairperson, Johnson Space Center Committee for the Protection of Human Subjects.

Instrumentation

Instrumentation Provided by Test Requester:

Identify requirements for instrumentation, data recording, displays, and data processing.

Power Supply – 120 Vdc

Network Analyzer

Noise Figure Meter

Noise Source

Digital Multimeter

Laptop Computer and Docking Station

List the primary measurements to be made (temperature, pressure, time):

Temperature of TA-1 – 14 TCs (See attached drawing for TC locations)

Atmospheric Pressure

Data Acquisition and Recording

Number of Channels: *14*	Audio/Video Recording (Yes/No): *No*
Sampling Rates: *1 sample/minute*	Photographic Film (Yes/No): *Yes*
Real-Time Data Processing (Yes/No): *No*	High Speed/Low Speed: *N/A*
Data Handling Requirements (storage, delivery, format): DVD (Excel File)	

Other Information

List any other information pertinent to the test:

Test Article Hazard Checklist

A hazard analysis statement is required for any of the following applicable attributes of any of your provided hardware (test article, support equipment).

Hazard	Y	N	Comments
Mechanical			*Identify the hazards and present the approach for mitigating each*
Handling (> 40 lb or > 4 ft, any dimension)			
Instability			
Sharp Edges			
Pinch Points			
Exposed Mechanisms (rotating, reciprocating)			
Pressure Systems			
Stored Energy (springs, weights, flywheels)			
Ejected Parts, Projectiles			
Electrical			
Voltage (> 50 volts)			*TA-1 power supply 120 Vdc*
Batteries			
Generation/Storage (coils, magnets, capacitors)			
Electrostatic Sensitive Devices			
Thermal			*Identify the hazards and present the approach for mitigating each*
Hot Surfaces (> 113 °F, 45 °C)			
Heaters			
Cold Surfaces (< 39 °F, 4 °C)			
Cooling Devices			

Hazard	Y	N	Comments
Radiation			
Ionizing			
Non-Ionizing			
Laser			
Microwave			
Infrared (IR)			
Ultraviolet (UV)			
Radio Frequency (RF)			
Visible Light, High Intensity			
Material			
Uncontained Brittle Materials			
Test Environment Incompatibility			
Contained Fluids			
Toxic, Corrosive, Flammable Fluids			
Biohazards			
Miscellaneous			
Noise Level (> 85 dBA)			
Ultrasonic			

Appendix D Instrumentation Provided by Facility

Data is typically recorded at one sample-per-second, but higher rates can be achieved if desired. The following table lists instrumentation capabilities that are commonly available. We can accommodate different ranges or types of instrumentation as required by the Test Requester. Contact the Test Director to discuss data/instrumentation requirements.

Instrumentation	Range
Absolute Pressure	Ambient – 320 PSIA ± 0.5% Full Scale (FS)
Differential Pressure	0 – 300 PSID ± 0.5% FS
Flow	As low as 10 SCFM ± 1% FS
Thermocouples	Type T ± 350 °F* ± 3 °F
Infrared Camera	An infrared imaging radiometer may be located in the main chamber for monitoring static and dynamic thermal patterns. A model 600 IR imaging radiometer is used inside a pressurized aluminum can wrapped with a thermal blanket and heater tape and mounted on a pan and tilt mechanism. Support equipment is located outside the chamber for camera 15 vdc, 4-amp power, and control of focus, zoom, orientation, N2 purging, and camera temperature.
Mass Spectrometer	The Micromass PC is a self-contained industry standard personal computer and quadruple mass spectrometer combination. The analyzer is fitted directly into the chamber. It consists of an Electron Impact ION Source, which ionizes any atoms or molecules present in the chamber and a quadruple mass filter, which can be used to selectively focus the ions produced onto a detector. The analyzer is equipped with two detectors, a Faraday Bucket and a SEM.

* IR Lamps can be used to increase the temperature of the test article

Temperature is recorded in degrees Fahrenheit and the chamber is equipped with type T thermocouples. We can accommodate a wide range of pressure and flow parameters. We can also accommodate current and voltage measurements.

Appendix E Sample Test Plan and Test Requirements

1.0 Introduction

1.1 Scope

This document provides the test requirements for *[Test Article]*. Testing is planned for *[Timeframe].*

1.2 Background

Reason for test program

1.3 Objectives

The primary objective of this test is to evaluate *[primary objective]*

Additional/secondary objectives

2.0 Test Article Description and Layout

2.1 Test Article Description

Provide a summary of general specifications for the test article.

General Test Article Specifications

NAME	DIMENSIONS	MASS

2.2 Test Article Storage and Handling Instructions

- *Delivery information*
- *Inspection*
- *Test Article Assembly requirements and responsibilities (Test Requester and Facility)*

3.0 Test Article Interface Requirements

Provide general description of test article interface. Include schematics/drawings/specifications.

3.1 Environment Simulation Requirements

Provide detailed test environment requirements including tolerances. Include a table or plot of the desired test conditions.

3.2 Fluid Systems Interface Requirements

Include fluid requirements and operating parameters for test article(s)

Fluid Specifications

Test Article	Fluid	Max. Flow Rate(kg/s:lbm/hr)	Temperature(K)(°F)	Pressure
Test Article 1	*Fluid Name*	*i.e., 500 lb/hr*	*i.e., 50 to 130 °F*	*i.e., 50 psig*

3.3 Electrical Systems Interface Requirements

Power requirements for test article and/or support equipment

3.4 Structural Systems Interface Requirements

- *Support structure*
- *Mounting requirements*
- *Orientation*
- *Responsibilities (Test Requester and Facility)*

3.5 Data/Instrumentation Requirements

Define instrumentation and data acquisition requirements for the test

Example Data Acquisition Requirements Table

Parameter	Instrument	Quantity	Accuracy	Range
Flow Rate	*Flow Meter*	*1*	*± 1 lbm/hr*	*0 - 750 lbm/hr*
Temperature	*Thermocouple – Surface*	*80*	*± 3 °F*	*–243 °F – +150 °F*
Sink Temperature	*Thermocouple*	*20 ±*	*± 3 °F*	*–243 °F – +118 °F*
Pressure	*Pressure Transducer*	*1*	*± 1% Full Scale*	
Electrical Power	*Watt Transducer*			

3.6 Cleanliness

Example: The test articles shall be visibly clean.

3.7 Safety

The test articles and all support systems shall be subjected to a safety review to determine the existence of single point failures and other potentially hazardous conditions. The results will be prepared and published by NASA in a Hazards Analysis Report and presented to the TRRB.

3.8 Pressure Vessel Analysis

- *Operating pressures*
- *Maximum Allowable Operating Pressure for test article*

3.9 Consumables

Consumables required by test article

3.10 Support Personnel

Support Personnel

Role	Name	Contact Number	E-mail
Test Requestor			
Test Article Expert			

4.0 Test Plan

4.1 Test Matrix

Define test sequence by including a table or plot of the test matrix.

4.2 Test Procedure

Include test-article-specific procedure, including the following:

- *Test Article fit check*
- *Functionals*
- *Test Article operational instructions*

4.3 Reporting

Identify test-specific data to be provided at the completion of the test activity

Appendix F Customer Feedback

TEST CUSTOMER FEEDBACK							
Test Title:						**Facility:**	
Test Number:	**TD:**					**Test Date:**	
	SCORE (Check or Click on Box)						
	Poor					Excellent	
SCHEDULE:	**1**	**2**	**3**	**4**	**5**	**N/A**	
1. Was the test initiated and completed to meet your requirements?	☐	☐	☐	☐	☐	☐	
2. Were we able to accommodate your requested schedule changes?	☐	☐	☐	☐	☐	☐	
COST:							
3. Was the test performed within estimated budget?	☐	☐	☐	☐	☐	☐	
4. Was the test cost reasonable for the test performed?	☐	☐	☐	☐	☐	☐	
PRODUCT:							
5. Was the provided test data accurate?	☐	☐	☐	☐	☐	☐	
6. Was the test data provided to you in an acceptable format and a timely manner?	☐	☐	☐	☐	☐	☐	
FACILITY (Test Position and Support Hardware):							
7. Did the facility's capability meet the needs of the test requirements?	☐	☐	☐	☐	☐	☐	
8. Was the facility reliable during the test?	☐	☐	☐	☐	☐	☐	
TEST TEAM:							
9. Did you find the test team helpful and knowledgeable in meeting your objective?	☐	☐	☐	☐	☐	☐	
10. Would you consider using this test facility for future tests?	☐	☐	☐	☐	☐	☐	
Note: We are concerned and interested in your comments and would like an opportunity to improve our service							
Comments/Suggestions for Improvement:							
Customer Name & Organization:							
Return to: Michael Montz, michael.e.montz@nasa.gov							

Appendix G Human-Rated Testing

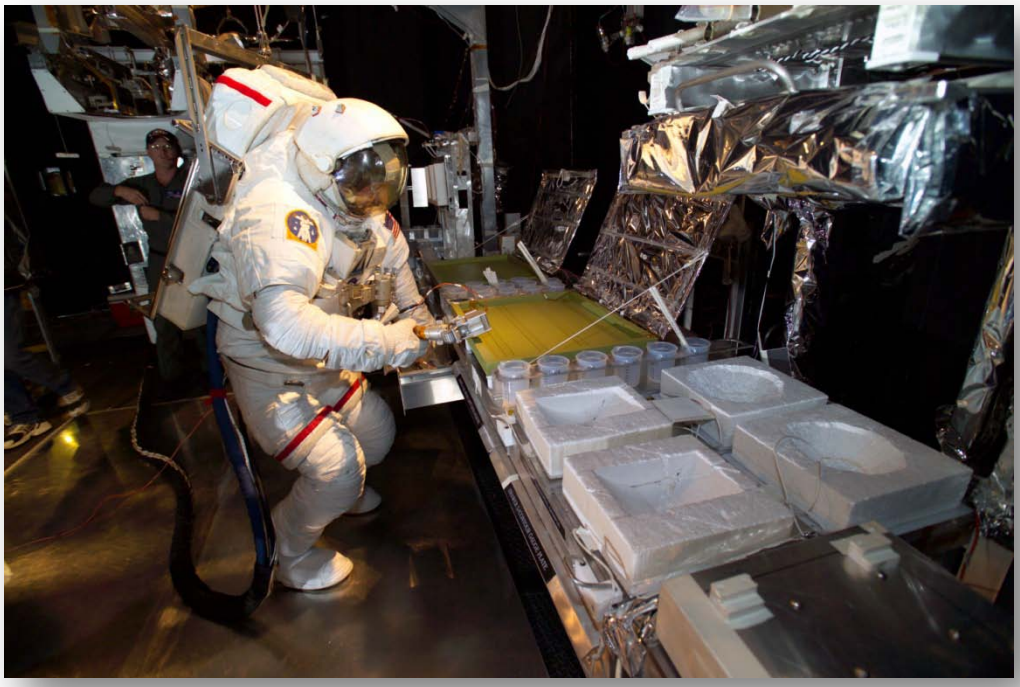
Chamber B is a human-rated chamber equipped with a traversing monorail that provides weight relief to one suited crewmember at a time. The traversing monorail allows two degrees of freedom inside the chamber and 18.6 square meters (200 square feet) of working space. During the test the suit is attached by cables to large constant-force negator springs. These springs carry the weight of the suit for the test subject. The springs and cables are housed in a carriage which travels along a monorail. The monorail traverses along rollers. This gives the test subject the freedom of movement in the chamber.

Chamber B – Traversing Monorail with Weight Relief System

The chamber also has dual airlocks to provide easy access to the test articles and a means of transporting test subjects to the test environment and back during tests. The airlocks can also be used as an altitude chamber for independent tests. One airlock is equipped with a water deluge system and other features that permit its use for testing with oxygen-rich atmospheres.

To protect the test subject, Chamber B has a number of safety features including, but not limited to the following:

- Emergency Repress System: allows air into the chamber and brings the pressure back from vacuum to sea-level in 90 seconds.
- Fire Suppression System: sprays water into the chamber in the event of a fire.
- Dual Airlocks: one side is reserved for the test subject; the other side is reserved for rescue personnel.



Chamber B – Return-to-Flight Human-Rated Thermal Vacuum Testing

Chamber B – Traversing Monorail with Weight Relief System

Test Subject Requirements for Human-Rated Testing

Test Subjects may be provided by the Requester or NASA. The Requester shall provide a list of Test Subjects to the Test Director at least 4 weeks prior to the start of testing. Testing involving human subjects is governed by the JSC Committee for the Protection of Human Subjects (CPHS). Test Subjects for hazardous testing must meet the following requirements:

Air Force Class III Category I Flying Physical

All Test Subjects must have the equivalent of a Class III physical examination or better (as judged by a NASA medical officer cognizant of human testing hazards) before participating as a Test Subject for hazardous testing. The physical examination must have been completed within one year of the scheduled test date.

Physiological Training

Test Subjects exposed to altitudes greater than 10,000 feet must complete Category I physiological training. Physiological training is designed to familiarize personnel exposed to decreased barometric pressure with the physiological stresses encountered and how to successfully overcome these stresses.

NASA/JSC Human Research Informed Consent

Test Subjects must complete the NASA/JSC Human Research Informed Consent form. The signed form will be sent to the chairperson of the JSC CPHS. A detailed description of the test will be attached to the consent form. The Test Director is responsible for the detailed description of the test. A copy of the NASA/JSC Human Research Informed Consent form is included in Appendix H.

Appendix H Human Research Informed Consent

NASA/JSC HUMAN RESEARCH INFORMED CONSENT

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject in the following research study, test, investigation, or other evaluation procedure:

NAME OF INVESTIGATION _____

_____

_____

FLIGHT TO WHICH ASSIGNED _____

PRINCIPAL INVESTIGATOR _____

_____

RESPONSIBLE NASA PROJECT SCIENTIST _____

_____

I understand or acknowledge that:

(a) This procedure is part of an investigation approved by NASA.

(b) I am performing these duties as part of my employment with _____ .

(c) This research study has been reviewed and approved by the JSC Committee for the Protection of Human Subjects (CPHS) which has also determined that the investigation _____ risk to the subject.
(minimal or reasonable)

(d) Definitions:

"Minimal risk" means that the probability and magnitude of harm or discomfort anticipated in the research are not greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests.

"Reasonable risk" means that the probability and magnitude of harm or discomfort anticipated in the research are greater in and of themselves than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests, but that the risks of harm or discomfort are considered to be acceptable when weighed against the anticipated benefits and the importance of the knowledge to be gained from the research.

"Protected Research Data" means that the individually identifiable research data maintained or shared will be protected.

(e) The research procedures were explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered to my satisfaction. A layman's description was provided to me. **

(f) I am medically qualified to participate in the investigation.

(g) I know that I can refuse to participate in the tests at any stage of their performance, and my refusal will be honored, except in those cases when, in the opinion of the responsible physician, termination of the tests could have detrimental consequences for my health and/or the health of the other subjects. I further understand that my withdrawal or refusal to participate in this investigation will not result in any penalty or loss of benefits to which I am otherwise entitled.

(h) In the event of physical injury resulting from this study and calling for immediate action or attention, NASA will provide or cause to be provided, the necessary treatment. I also understand that NASA will pay for any claims of injury, loss of life or property damage to the extent required by the Federal Employees Compensation Act or the Federal Tort Claims Act. My agreement to participate shall not be construed as a release of NASA or any third party from any future liability which may arise from, or in connection with, the above procedures.

(i) Except as provided for by Agency-approved routine uses under the Privacy Act, the confidentiality of any data obtained as a result of my participation as a research subject in this study shall be maintained so that no data may be linked with me as an individual. I understand, however, that if a "life-threatening" abnormality is detected, the investigator will notify me and the JSC Flight Medicine Clinic. Such information may be used to determine the need for care or medical follow-up, which, in certain circumstances, could affect my professional (flight) status.

Signature: Signature:

Test Subject Date Witness Date

2. I, the test subject designated above, do further understand that the responsible Principal Investigator designated above for the research investigation for which I am participating, must meet the following elements as a condition for valid authorization for disclosure of my protected research data

(a) Provide specific and meaningful description of the types of information to be used or disclosed.

(b) Identify the person(s) or class of persons who will be allowed the use of my protected research data.

(c) Identify the person(s) or class of persons to whom the research institution may release my protected research data.

(d) A description of the purpose of the requested use or disclosure of my protected research data.

(e) Provide an explanation indicating that the use or disclosure of my protected research data will be used till the end of the research study.

Signature: Signature:

Test Subject Date Principal Investigator Date

2. I, the Principal Investigator of the investigation certify that:

(a) I have thoroughly and accurately described the research investigation and procedures to the test subject and have provided him/her with a layman's description of the same.

(b) The test setup involves _____ risk to the test subject. All equipment

_____
(minimal or reasonable)
to be used has been inspected and certified for safe and proper operation.

(c) The test subject is medically qualified to participate.

(d) Except as provided for by Agency-approved routine uses under the Privacy Act, the confidentiality of any data obtained as a result of the test subject's participation in this study shall be maintained so that no data may be linked to him/her as an individual.

(e) The test protocol has not been changed from that originally approved by the JSC CPHS.

Signature:	Signature:
Principal Investigator Date	NASA Project Scientist Date

Notes:

* This form is valid for the period including preflight, in-flight, and postflight data collection sessions for the mission. Before the first baseline data collection, the Principal Investigator will repeat the briefing concerning risks involved in the investigation. A signed, dated copy of this form with attachments must be forwarded to Chairperson,

Johnson Space Center Committee for the Protection of Human Subjects, Mail Code SA, Lyndon B. Johnson Space Center, Houston, Texas 77058.

** A detailed description of the investigation will be attached to this consent form. The Principal Investigator is responsible for formulating this document, which should be in layman's terms such that the subject clearly understands what procedures will be required of him/her and the risks associated therewith.

The detailed description of the research must, at a minimum, include the following:

(1) An explanation of the purposes of the research and the expected duration of the subject's participation, a description of the procedures to be followed, and identification of any procedures which are experimental;

(2) A description of any reasonably foreseeable risks or discomforts to the subject, including, but not limited to, possible adverse reactions of all medications to be administered and any risks/hazards resulting from exposure to ionizing radiation;

(3) A description of any benefits to the subject or to others which may reasonably be expected from the research;

(4) A disclosure of appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject;

(5) A statement describing the extent, if any, to which confidentiality of records identifying the subject will be maintained;

(6) Clarification of all forms of behavior, if any, interdicted by the research protocol (e.g., exercise, diet, medications, etc.); and

(7) An explanation of whom to contact for answers to pertinent questions about the research and research subjects' rights, and whom to contact in the event of a research-related injury to the subject.

When appropriate, the following information shall also be provided in the detailed description:

(8) A statement that the particular treatment or procedure may involve risks to the subject (or to the embryo or fetus, if the subject is or may become pregnant) which are currently unforeseeable;

(9) Anticipated circumstances under which the subject's participation may be terminated by the investigator without regard to the subject's consent;

(10) Any additional costs to the subject that may result from participation in the research;

(11) The consequences of a subject's decision to withdraw from the research and procedures for orderly termination of participation by the subject;

(12) A statement that significant new findings developed during the course of the research which may relate to the subject's willingness to continue participation will be provided to the subject; and

(13) The approximate number of subjects involved in the study.