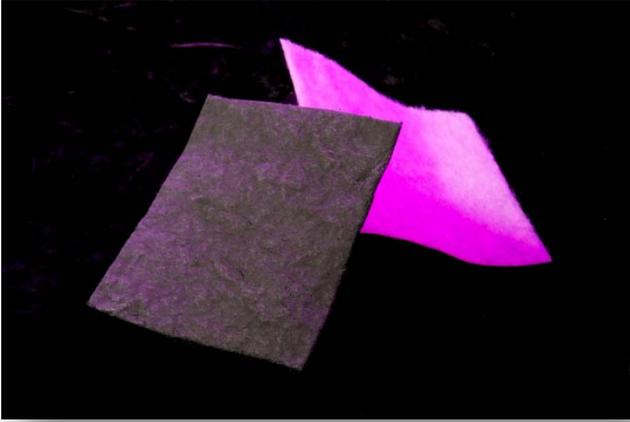


Advanced Materials Laboratory (AML)

User Test Planning Guide



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

Abstract – Advanced Materials Laboratory Test Planning Guide

Test process, milestones and inputs are unknowns to first-time users of the Advanced Materials Laboratory. 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.

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1.0 Introduction

The Johnson Space Center (JSC) has created and refined innovative analysis, design, development, and testing techniques that have been demonstrated in all phases of spaceflight. JSC is uniquely positioned to apply this expertise to components, systems, and vehicles that operate in remote or harsh environments. We offer a highly skilled workforce, unique facilities, flexible project management, and a proven management system.

1.1 Purpose

The purpose of this guide is to acquaint Requesters with the requirements for test, analysis, or simulation services at JSC. The guide includes facility services and capabilities, inputs required by the facility, major milestones, a roadmap of the facility's process, and roles and responsibilities of the facility and the Requester. Samples of deliverables, facility interfaces, and inputs necessary to define the cost and schedule are included as appendices to the guide.

1.2 Facility Availability

JSC test facilities are available for the National Aeronautics and Space Administration (NASA), other government agencies, and commercial requesters. We have developed user-friendly agreements to streamline business relationships and are eager to share our unique facilities and expertise. We invite your inquiries regarding application or adaptation of our capabilities to satisfy your special requirements. Briefings on general or specific subjects of mutual interest can be arranged at JSC or at your business site.

1.3 Inquiries

General inquiries regarding the use of JSC facilities should be directed to:

JSC Engineering Directorate
Johnson Space Center
2101 NASA Parkway, Houston, TX 77058
Phone: 281-483-8991
E-mail: beth.a.fischer@nasa.gov

Inquiries regarding the Advanced Materials Laboratory (AML) should be directed to:

Henry Tang
Advanced Materials Laboratory Manager
Johnson Space Center
2101 NASA Parkway, Houston, TX 77058
Phone: 281-483-2595
E-mail: henry.h.tang@nasa.gov

Please refer to the Engineering Services Web site, <https://jsceng.nasa.gov>, for additional information and general inquiries about test, analysis, and simulation capabilities at JSC.

1.4 Advanced Materials Laboratory

The JSC Advanced Materials Laboratory (AML) provides testing services for developing and evaluating materials and hardware for aerospace and industrial applications. The laboratory is equipped to evaluate various materials and structures, including fibrous structures (textiles), coated fibrous structures, polymer films, composites, foams, elastomers, papers, metals, and adhesives. We also provide test services that comply with industry and government standards, including American Society for Testing and Materials (ASTM), International Organization for Standardization (ISO), American Association of Textile Chemists and Colorists (AATCC), and Federal test standards. The laboratory can provide a wide range of services from quick response standard testing to custom designed test programs. Selected laboratory test equipment and capabilities are described in Appendix A.

Services Provided

- Weathering testing
- Optical digital microscopy
- Mechanical testing
 - Tensile/compression strength
 - Hardness
 - Impact
 - Abrasion/pilling
 - Tear strength
 - Burst strength
 - Puncture
 - Stiffness
 - Flexing and folding (mechanical cycling)
- Physical properties measurement
 - Air permeability (fabrics)
 - Oxygen index (flammability)
 - Viscosity
 - Dimension/weight
- Thermal and electrical property measurement
 - Thermal conductivity
 - Coefficient of thermal expansion
 - Thermal diffusivity/specific heat
 - Surface resistivity
 - Static testing

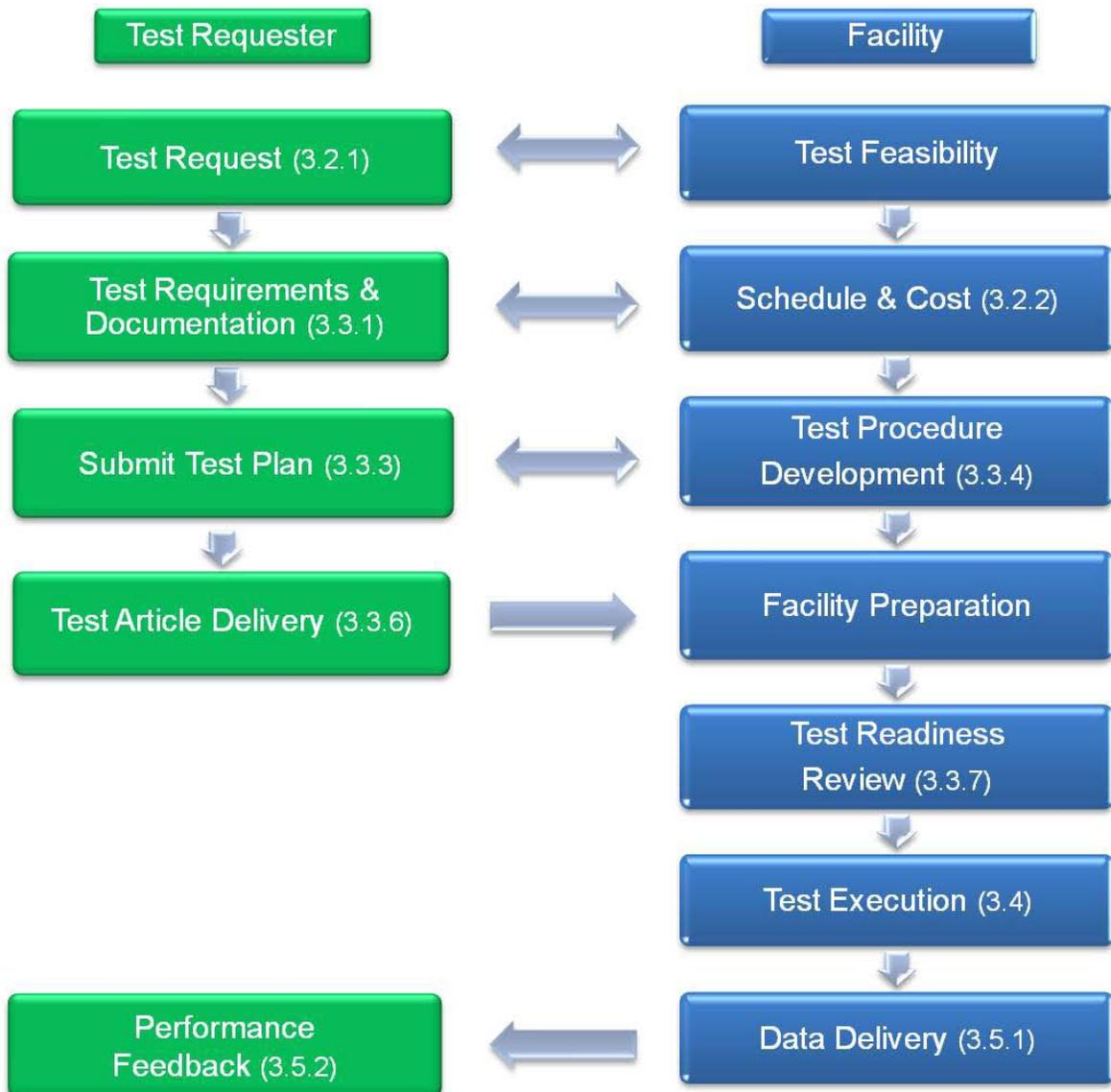


2.0 Safety and Health

Safety is an integral part of the culture at 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.

3.0 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 Requester actions and Laboratory actions, highlighting interactions and inputs between the Requester and the Laboratory.



3.1 Export Controlled and Proprietary Information

JSC provides for protection of export controlled and proprietary information and hardware throughout the analysis process. The Requester shall clearly mark all export controlled or proprietary samples and data provided with a notice of restriction on disclosure or usage. The Laboratory staff shall safeguard export controlled or proprietary items from unauthorized use and disclosure and ensure that samples remain secure within the facility and are properly sequestered. Access to the facility may be limited to facility personnel and escorted visitors only. Samples shall be returned to the Requester or disposed of in accordance with the Requester's instructions upon product acceptance.

3.2 Test Initiation Phase

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

Inputs: Requester provides test request, identifies Technical Expert

Activities: Laboratory Manager or Test Engineer reviews test request to determine test feasibility

Outputs: Laboratory Manager or Test Engineer delivers preliminary test plan, cost estimate, and schedule to Requester

3.2.1 Test Request

The test request outlines the test objectives, test sample description, and schedule. A Test Request Worksheet is provided in Appendix B. This worksheet addresses the basic requirements for utilizing the Advanced Materials Laboratory. The Requester should complete this worksheet to facilitate the development of a preliminary cost and schedule estimate. Contact the Laboratory Manager or Test Engineer for assistance in completing the Test Request Worksheet.

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 (e.g., pressure, temperature, exposure time)
- Proposed test approach or test standard (e.g., tensile, thermal properties, hardness, impact)
- Data requirements

Test Sample Description

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

- Size, weight, and shape (provide drawings, sketches, photographs if available)
- Material type and specification (e.g., material name, manufacturer, composition, lot number)
- Test sample interface (e.g., load points, method of suspension or test article support)
- Orientation (e.g., fixed or moveable)
- Special considerations [e.g., hazards, cleanliness, compatibility, Material Safety Data Sheets (MSDS)]
- Handling and storage requirements

Schedule

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

3.3 Test Preparation Phase

The detailed test plan and test schedule are finalized during the test preparation phase. The Requester shall provide detailed test requirements and test sample documentation to the Test Engineer. A Test Readiness Review (TRR) may be required following approval of the test plan.

Inputs: Requester provides test requirements, test plan (if required), and test sample documentation

Activities: Test Engineer develops test procedure
Requester ships/ transports test sample to JSC

Outputs: Requester approves test plan/procedure and final test schedule
Facility holds TRR (if required)

3.3.1 Test Requirements

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

- Test approach or test standard
- Interface requirements (e.g., structural, electrical, mechanical)
- Process requirements
- Data/instrumentation requirements (e.g., data type, data format, number of channels, sample rate)
- Identified hazards

3.3.2 Schedule and Cost Estimate

Following review of the test requirements, the Laboratory Manager will provide a cost and schedule estimate to the Test Requester.

3.3.3 Test Sample Documentation

Test Sample Drawings

The Requester shall provide test sample drawings as requested by the facility. Test sample drawings are used to provide dimensional information required for preparation of test specimens, test fixtures, and instrumentation interfaces.

Material Safety Data Sheets

NASA must ensure that all chemicals, chemical compounds, and chemical mixtures do not present a hazard to personnel or the laboratory. The MSDS is required for the laboratory to identify and control potential hazards. The Requester shall deliver MSDS for chemical products to be analyzed. The MSDS shall be delivered along with the Materials Analysis Request Worksheet. The Test Engineer will review the MSDS for compatibility with the laboratory environment and determine protective measures for personnel, if required.

Material Technical Datasheet or Specifications

A material technical datasheet or specifications may be required for test samples supplied by the Requester. The materials specifications contain standard reference data that is useful for test planning and design. Reference material data includes the physical and mechanical properties of the materials and material-specific processing parameters.

3.3.4 Test Plan (If Required)

A test plan may be required, and can be prepared by the Test Engineer if requested by the Requester. The final test plan shall be approved by the Requester with concurrence from the Laboratory Manager. The test plan will include, at a minimum, the objectives, scope of work, safety considerations, and data requirements.

3.3.5 Test Schedule

A detailed schedule shall be developed by the Test Engineer and approved by the Requester and Laboratory Manager. The schedule shall allow adequate time for review and approval of requirements, preparation for the test, and delivery of the test sample. The schedule of other works and maintenance activities will be reviewed, and potential conflicts shall be addressed by the Laboratory Manager.

3.3.6 Test Sample Delivery

The test sample 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 Requester shall provide

detailed handling instructions prior to delivery of the test article, including handling hazards, cleanliness, and storage requirements. The test sample shall be secured within the test facility, unless directed to provide another means of storage.

3.3.7 Test Readiness Review

Depending on the complexity of the test and the classification of the test article, a TRR may be required prior to test execution. NASA has the ultimate authority to determine the need for a TRR. If required, the Requester shall submit documentation to the Test Readiness Review Board (TRRB), declaring that the test sample is ready and that there is no constraint to test. This is required to verify that there is no issue that would invalidate the test. The Laboratory Manager will provide instructions for submitting test sample readiness documentation.

The TRR will include the following:

- Review of the test plan, test procedures, and other required test documentation
- Confirmation of facility readiness
- Review of configuration records, including facility interface control documents, pressure system certification, instrumentation calibration, and materials compatibility
- Assurance that controls are in place to mitigate risks or hazards identified in the test hazard analysis
- Verification that data acquisition and processing functions are in place to adequately capture all critical data

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

NASA TRRB Chairman	Technical Expert (Appointed by Test Requester)
Laboratory Manager	Test Engineer
NASA Test Safety Officer	Quality Engineer – if required by facility

3.4 Test Execution Phase

NASA encourages Test Requester participation in the testing activity. It is suggested that the Test Requester provide a Technical Expert to verify that test setup and execution meet the stated objectives. In some cases, the Test Engineer may be designated as the Technical Expert.

Inputs: Approval to begin testing received from TRRB (if required)
Activities: Test Engineer completes facility buildup, Test Plan/Procedure
Test Engineer conducts testing activity
Outputs: Test completed

3.4.1 Test Authority

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

3.4.2 Test Deviations

Changes to the test plan/procedure shall be approved by the Technical Expert with concurrence from the Test Engineer. Deviations that result in a major change to the scope of the test or that present new hazards may require a delta TRR and/or changes to the cost and schedule.

3.4.3 Facility Equipment

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

3.5 Test Closeout Phase

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

Inputs: Test completed

Activities: Laboratory ships/ transports test sample to Requester
Laboratory Manager delivers data to Requester

Outputs: Requester accepts data
Requester completes Customer Feedback form

3.5.1 Data Package

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

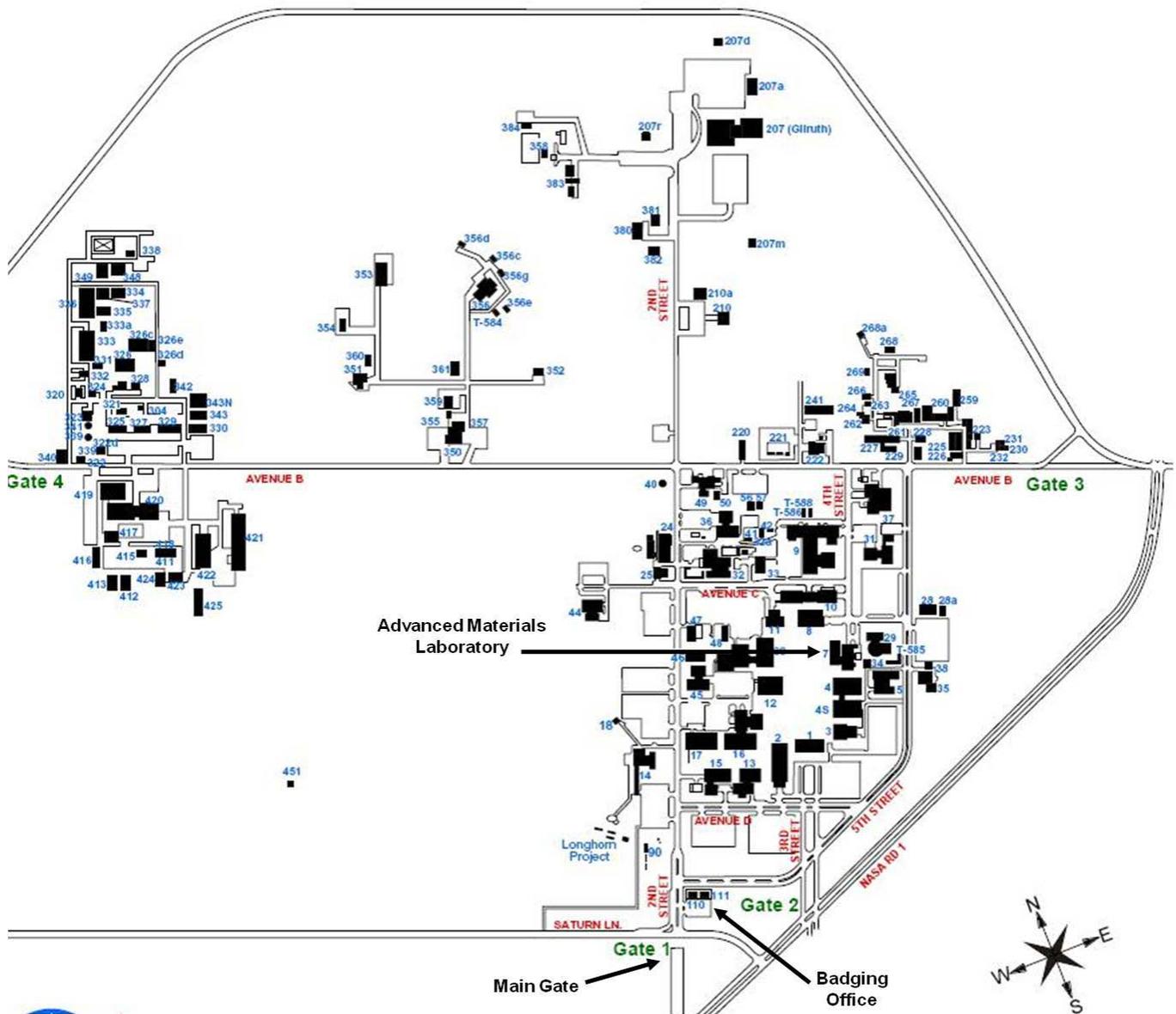
3.5.2 Customer Feedback

JSC 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 C. You are encouraged to complete this form and return it to the Laboratory Manager, following receipt of the test data. Your feedback is greatly appreciated.

4.0 Facility Access

Identification badges are required for all persons requiring access to JSC. The Laboratory Manager/Test Engineer 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 (e.g., valid driver's license, U.S. passport, government ID card).

The Advanced Materials Laboratory is located in JSC Building 7. A facility access briefing shall be provided to all personnel requiring access to the facility prior to the start of the test.



5.0 Roles and Responsibilities

Laboratory Manager – The initial interface between the Laboratory and the Requester. The Laboratory Manager has overall responsibility for all phases of the test process.

Test Engineer – One or more individuals responsible for coordinating and executing the test per the requirements defined by the Requester. The Test Engineer is the primary interface between the Laboratory and the Technical Expert.

Requester – The client requesting testing. The Requester is responsible for defining the requirements and providing authorization to proceed.

Technical Expert – A representative of the Requester with thorough knowledge of the requirements. The Technical Expert also is responsible for approving the test plan, verifying that objectives are met, and approving change requests.

Responsibilities Matrix

Item	Test Requester	Laboratory Manager
Test Request Worksheet	Submit	Review and provide assistance as needed
Cost and schedule	Approve	Create and sign off
Hazards	Identify test sample hazards	Review
Test plan/procedure	Approve	Create and approve
Test sample readiness (if required)	Submit and approve	Review and approve
Test Readiness Review Board (if required)	Submit and approve	Conduct and approve
Test execution	Verify that test setup and execution meet objectives Approve requested deviations	Execute test
Test data/results	Acknowledge data receipt and approval	Deliver to Requester and archive in database
Shipping	Provide instruction	Execute per request

Acronyms

°C	degrees Celsius
°F	degrees Fahrenheit
2-D	two-dimensional
3-D	three-dimensional
AATCC	American Association of Textile Chemists and Colorists
AML	Advanced Materials Laboratory
ASTM	American Society for Testing and Materials
cm ²	square centimeters
cps	centimeters per second
CTE	Coefficient of Thermal Expansion
dBA	decibel A-weighting
ft	feet
FTP	File Transfer Protocol
IR	Infrared
ISO	International Organization for Standardization
JSC	Johnson Space Center
lb	pound(s)
m ² /s	square meters per second
mm	millimeter(s)
MSDS	Material Safety Data Sheets
N/A	Not Applicable
N ₂	nitrogen
NASA	National Aeronautics and Space Administration
O ₂	oxygen
RF	Radio Frequency
TD	Test Director
TMA	Thermal Mechanical Analyzer
TRR	Test Readiness Review
TRRB	Test Readiness Review Board
UV	Ultraviolet

W Watt(s)

W/m.K Watt(s) per meter Kelvin

Appendices

- A. Selected Laboratory Equipment
- B. Test Request Worksheet
- C. Customer Feedback

Appendix A Selected Laboratory Equipment

Thermal and Electrical Properties Measurement Equipment

Guarded Hot Plate Instrument

The Netzsch Titan System is designed to measure the thermal conductivity of insulation materials at various temperatures and vacuum levels. It is a vacuum-tight guarded hot plate system with a new design integrating a state-of-the-art design, electronics, and software. It is one of the few units that completely fulfills the latest ISO 8302, ASTM C177, and DIN/EN12667 standards. The instrument has the following specifications:

- Symmetric test configurations (two samples)
- Test specimen dimensions: 3000 mm
- Thermal conductivity range: 0 – 2 W/m.K
- Inert atmospheres from ambient to vacuum pressure down to 1×10^{-5} Torr
- Test temperature range of -160 to 190 °C
- High accuracy: better than 2% for sample thicknesses up to 100 mm



Thermal Mechanical Analyzer (TMA)

The TA Instruments TMA2910 Thermal Mechanical Analyzer measures the Coefficient of Thermal Expansion (CTE) of various materials at temperatures of -140 to 425 °C. It also can measure other material thermal properties, such as the softening point and glass transition temperature. This instrument is compliant with ASTM E831, Standard Test Method for Linear Thermal Expansion of Solid Materials by Thermomechanical Analysis.



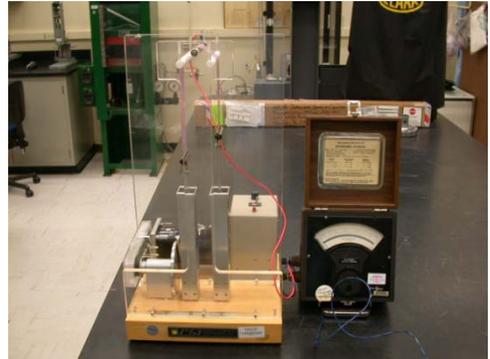
Thermal Diffusivity Tester

The Anter Flashline 3000 Thermal Diffusivity Tester is capable of measuring the thermal diffusivity, specific heat, and thermal conductivity (indirectly) of thermally conductive or insulation materials. The Thermal Diffusivity Tester employs the flash technique, and it is capable of measuring thermal diffusivity ranging from 10^{-7} to 10^{-3} m²/s within the operating

temperature range of -100 to 200 °C at an atmospheric pressure to 1×10^{-5} Torr pressure. This instrument is compliant with ASTM E2585.

Electrical Properties Measurement Instruments

The Atlas Static Testing Apparatus measures the tendency of materials and fibers to generate electrostatic charges. It also measures the effectiveness of antistatic agents and treatments on materials.



The Monroe Electronic Surface Resistivity Meter is a handheld device that measures the surface electrical property of various materials. This instrument is compliant with ASTM D257.



Environmental Chamber

The Atlas ES25 WeatherOmeter is an environmental chamber used to evaluate lightfastness and aging of materials under accelerated weathering conditions. It provides a variety of weathering environments by controlling temperature, humidity, moisture spray, and Ultraviolet (UV) lighting (sunlight simulation).



Mechanical Properties Measurement Equipment

Universal Tensile/Compression Testing Machines

The laboratory is equipped with two universal testing machines—An MTS ReNew 4505 floor standing model and an Instron SF1242 benchtop model. They are both capable of performing tension, compression, flexure, tear, peel, and shear testing for polymers, composites, textiles, metals, and ceramics.

The MTS ReNew 4505 has a maximum load capacity of 22,400 lb. It could be equipped with a thermal chamber, ATS Thermal Chamber, to conduct testing at extreme temperatures ranging from -180 to 425 °C. The Instron SF 1242 has a maximum load capacity of 2,240 lb.



Hardness Testing Instruments

The laboratory has two different types of hardness testers—A Rockwell hardness tester and a Shore hardness tester.

The Clark Hardness Tester is used to measure the hardness of rigid materials, such as metals and hard plastics. The applicable test standard includes ASTM E18.

The Shore Hardness Tester is used to measure the indentation hardness of elastomeric materials, such as rubber and soft plastics. The applicable test standard includes ASTM D2240.



Tensile Impact Tester

The Tinius Olsen Tensile Impact Tester is a low-capacity machine for impact testing of plastic specimens. The tester has energy capacities of 60 and 180 inch-pounds. This machine is designed to perform tests per ASTM D1822, Standard Test Method for Tensile-Impact Energy to Break Plastics and Electrical Insulating Materials.



Burst Testers

The laboratory has three Mullen Burst Testers—two hydraulic burst testers (with different pressure capacities) for measuring the resistance of fibrous structures, plastic laminates, films, and paper products to bursting; and a hydrostatic tester for measuring a material's resistance to water penetration. The applicable test standard includes ASTM D3786.



Impact Puncture Apparatus

The Dart Drop Apparatus, Model CS-126, is used to measure the impact and puncture resistance of plastic film. It measures the velocity of a free-falling dart and determines the kinetic energy required for the dart to pass through the test specimen. The applicable test standard includes ASTM D4272.

Abrasion and Wear Testers

There are seven different abrasion testers and one pilling tester in the laboratory. The abrasion testers include a single-headed Taber Abrasion Tester, Schiefer Abrasion Testing Machine, Wyco Precision Wear Tester, CSI Stoll Flex Abrasion Tester, CSI Stoll Quartermaster Universal Wear Tester, Altas Accelerator, and CS-231 Webbing Abrasion Tester. The pilling tester is a Multimotion Abrasion Pilling Tester made by United State Testing Company.

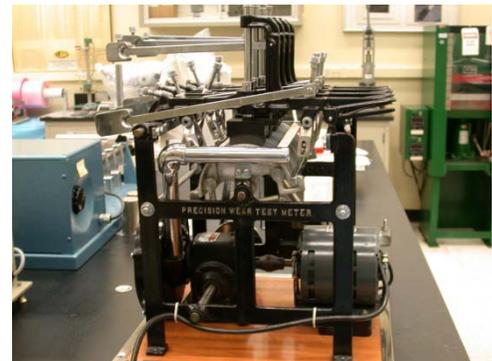
The Taber Abrasion Tester is a rotary machine that is equipped with various abrasion wheels to evaluate the wear resistance of plastics, textiles, and thin films. The applicable test standards include ASTM D1044, D3389, D3884, and D4060.



The Schiefer Abrasion Testing Machine applies a uniform abrasive action on the entire surface of a test specimen. It is ideal for evaluating fabric construction that has various fiber blends and finishing treatments. The applicable test standard includes ASTM D4158.



The Wyco Precision Wear Tester is an abrasion machine with an oscillating drum mechanism. It subjects the test specimens to known conditions of pressure, tension, and abrasion action. It can be used with various abrasive surfaces such as sandpaper, wire mesh, leather, and cloth. The abrasion resistance of the specimen is assessed by measuring the number of cycles to failure, reduction of strength, or visual changes. The applicable test standard includes ASTM D4157.



The CSI Stoll Flex Abrasion Tester is designed to assess the wear resistance of fibrous structures to combine flexing and abrasion actions. A test specimen is abraded with a specific abrasion bar under controlled tension and a unidirectional reciprocal folding motion. The applicable test standard includes ASTM D3885.



The CSI Stoll Quartermaster Universal Wear Tester is an inflated diaphragm abrasion tester designed to assess the wear resistance of textile or other fibrous structures. A test specimen is rubbed either unidirectionally or multidirectionally against a specified abrasive surface. The specimen is held in a fixed position and supported by an inflated rubber diaphragm that is held under constant pressure. The applicable test standard includes ASTM D3886.

The Altas Accelerator is designed to rapidly determine wet and dry abrasion resistance of flexible materials, including textiles, paper, leather, and plastics. Material specimens are rapidly tumbled within a cylindrical test chamber lined with an appropriate abrasion material. The tumbling action is provided by a propeller-shaped rotor for a predetermined time at a predetermined speed. The applicable test standard includes AATCC Test Method 93.



The CS-231 Webbing Abrasion Tester is an instrument for determining the abrasion resistance of textile webbing, yarn, or cordage. An oscillating drum drives and cycles a test specimen over an abrasion bar. It has a cycling rate of 67 cycles per minute. The level of abrasion resistance is measured based on the reduction in the breaking strength of the test material. A custom-built cooling box could be installed into the instrument to provide active liquid nitrogen cooling for testing at cold temperatures down to -250 °F.



The Multimotion Abrasion Pilling Tester measures the pilling tendency of woven and knitted fibrous structures by subjecting a specimen to multimotion abrasion cycles. Properties that can be studied include shedding tendencies, resistance to abrasion, and the tendency to acquire shine or gloss. The applicable test standard includes ASTM D3511.



Tear Tester – Textile

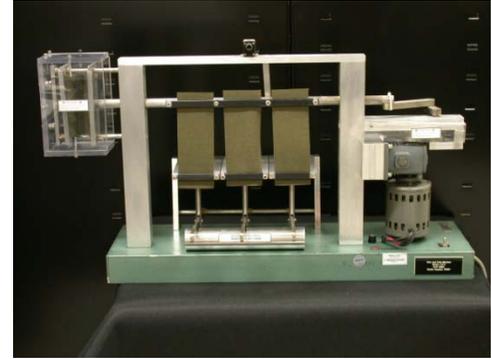
The Elmendorf Tear Tester measures the tear resistance of woven and coated fibrous structures, foils, plastic films, laminate, and paper. The tester can be configured to have testing capacities of 1,600, 3,200 and 6,400 grams. The applicable test standards include ASTM D1424 and D1922.



Flex and Fold Testers

The laboratory is equipped with four different types of flexing or folding test machines—CSI (Model SC-15) Flex and Fold Machine, B&R/TMI Testoflexer, M.I.T. Folding Endurance Tester, and Kohler-Molin Model Folding Endurance Tester.

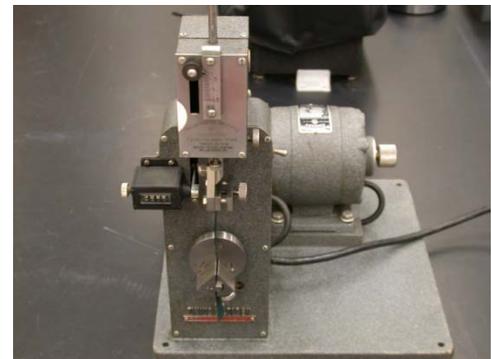
The CSI Flex and Fold Machine subjects fabrics, thin films, or paper products to flexing or folding actions to assess their durability and break down resistance to mechanical cycling. It has a cycling rate of 39 cycles per minute.



The B&R/TMI Testoflexer is an instrument for testing the flex life of shoe upper leather, coated textiles, and similar materials. It determines the number of flexing cycles that a material can withstand before it cracks in the creases, powders, or peels off in the folds.



The M.I.T. Folding Endurance Tester is used to estimate the ability of paper or textile to withstand repeated bending, folding, and creasing. It could also be used to measure the deterioration of paper upon aging. The applicable test standards include ASTM D2176 and ISO 5626.



The Thwing-Albert Kohler-Molin Model Folding Endurance Tester is developed for endurance testing of papers and fatigue testing of textiles, polymers, and thin sheet materials. The applicable test standard includes ISO 5626.



Stiffness Testers

The laboratory is equipped with three different types of stiffness testers—Tinius Olsen Stiffness Tester, Clark Softness Tester, and Gurley Stiffness Tester.

The Tinius Olsen Stiffness Tester employs the cantilever bending principle to measure the flexural stiffness of woven and coated fibrous structures.

The Clark Softness Tester measures the softness or stiffness of substrate samples and determines the rigidity or flabbiness of the sample.

The Gurley Stiffness Tester measures the bending stiffness of textile and flexible materials. The applicable test standard includes ASTM D1388.



Physical Properties Measurement Equipment

Digital Microscope

The Keyence VHX-600E Digital Microscope is equipped with three different zoom lenses and a borescope. The three zoom lenses cover a magnification range of 5x to 1000x. The microscope includes the software to capture 2-D and 3-D images. It measures dimensions in all three axes and performs profile analysis.



Air Permeation Testers

A TexTest Instruments FX3300 Air Permeability Tester III is developed to measure air permeability of flat materials, such as paper, fabric, open non-woven, and foam products. It also measures the pressure drop at a given air velocity for air filtration materials. The applicable test standard includes ASTM D737.



Viscosity Measurement Instruments

Two types of Brookfield Digital Viscometers, Model LVTDV-II and RVTDV-II, are available in the laboratory. Both models are capable of measuring and calculating viscosity (in cps) and shear stress (in dynes/cm²) for different types of fluids. The Model LVTDV-II evaluates fluids with viscosity ranging from 1 to 2,000,000 cps. The Model RVTDV-II evaluates fluids with viscosity ranging from 100 to 13,000,000 cps. The applicable test standards include ASTM D1084 and D2196.



Oxygen Index Flammability Tester

MKM Model JD-14 Oxygen Index Flammability Tester is designed to measure the oxygen index for various materials. The oxygen index is the minimum concentration of oxygen in percent of volume that will support flaming combustion in a flowing mixture of oxygen (O₂) and nitrogen (N₂). This instrument employs the top surface ignition method to determine the oxygen index. The applicable test standard includes ASTM D2863.



Appendix B Test Request Worksheet

Requester Information

Technical POC:	Contact Information (Phone, E-mail, Address):
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Objectives

Purpose of Test/Analysis:	
Proposed Test Start Date:	Critical Test Start Date:
Describe Material(s):	

Handling Requirements

Cleanliness Level:	Controlled Access:
Special Moving/Handling:	

Additional Information

List any other information pertinent to this request:

Drawings

We can accept files through a File Transfer Protocol (FTP) site, by e-mail, or via standard mail.

1. E-mail drawings to henry.h.tang@nasa.gov.
2. The Laboratory Manager will send an invitation to the NASA FTP site to upload and send files.
3. Mail drawings to National Aeronautics and Space Administration, Attention Henry Tang, Mail Code EC2, Lyndon B. Johnson Space Center, Houston, TX 77058.

Hazard Checklist

A hazard analysis statement is required for any of the following applicable attributes of any of your provided material.

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			
Thermal			
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			
Pyrotechnics/Explosives			

Appendix C Customer Feedback

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