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Organization Procedure GRC-P7600.003

Revision G

7610/7620/7660 ORGANIZATION PROCEDURE

Aero Test Engineering

Approved by:

Chief, Research Testing Division/7600

This document identified the correct steps to accomplish this process. I acknowledge that by my signature I am the document owner for purposes of its maintenance and update.

**NASA – Glenn Research Center
Cleveland, OH 44135**

Glenn Research Center Organization Procedure	Title: AERO Test Engineering	
	Document No.: GRC-P7600.003	Rev.: G

**Document Owner: 7610/Aviation Environments Test Engineering Branch
7620/Aeropower & Propulsion Test Engineering Branch
7660/Electronic & Special Systems Branch
Point of Contact: Robert Freedman, 216-433-2038**

Change Record

Rev.	Effective Date	Description
Basic	04/09/1999	Initial Issue
A	06/15/1999	Response to audit see Change Request form for details, FCR1999-1040
B	04/24/2000	Correct records list, FCR2000-1189
C	08/24/2000	See FCR2000-1223 for details of changes
D	03/23/2001	General Revisions, FCR2001-1312
E	05/18/2001	Annual review, FCR2001-1329
F	11/04/2003	Document Number Changed from 7500.024 to 7600.003 General numbering and reference changes related to directorate re-organization and document re-numbering. FCR2003-1654
G	01/14/2004	Annual Review. References made to RTD Technicians, Paragraphs 3.6 to 3.9 Re-arranged and re-named. FCR2003-1680

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1.0 INTRODUCTION

1.1 Purpose

This document outlines the steps necessary to plan and execute testing activities in NASA Glenn Aero Test Facilities by developing and implementing a work plan. This procedure clearly defines the testing process in order to effectively meet the overall program\project\subproject objectives, fully satisfy the customer needs, effectively execute an efficient test effort, and to maximize the quality of the data.

1.2 Scope

This procedure pertains to all the aero test facilities and is accomplished by the Aero Test Engineering Team from 7610, 7620 and 7660. This document encompasses the pre approval consultation, the planning as detailed in the work plan, the implementation of the work plan, conduction of the test, and test close out.

2.0 REFERENCES

2.1 Applicable Documents

Document Number	Document Title
GRC-P2.6.1	Implementation - Experimental Testing
GRC-P2.6.3	Implementation - Hardware Development
GRC-P2.10.1	Hardware Product Assurance
GRC-P3.4	Facilities Management
GRC-P3.11.1	Control of Inspection, Measuring, and Test Equipment
GRC-P3.9	Acquisition Process
GRC-P4.7	Preventive and Corrective Action
GRC-P7100.001	Experimental Testing Applications
GRC-P7400.001	Manufacturing Engineering Division Business Model
GRC-P7600.001	Research Facility Management
GRC-P7300.005	Engineering and Design
GRC-P7300.016	Central Process System Operations
GRC-W7600.005	IMTE for 7610, 7620, 7630, 7640, 7660
GRC-W7600.006	Test Article Failure
GRC-W7600.007	Test Engineering Non-Conformance Identification and Reporting System
GRC-P7700.006	Engineering Development Division (EED) Hardware Development Procedure
	NASA Glenn Safety Manual on the Web at http://osat.grc.nasa.gov/

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NASA TM-105771	NASA Lewis 8-by-6-Foot Supersonic Wind Tunnel User Manual, 1993
NASA TM-106247	NASA Lewis 9-by-15-Foot Low Speed Wind Tunnel User Manual, 1993
NASA TM-105626	User Manual for NASA Lewis 10-by-10-Foot Supersonic Wind Tunnel, 1995
NASA TM-107159	NASA Lewis Icing Research Tunnel User Manual, 1996
NASA TM-208478	User Manual for NASA Glenn 1-by-1-Foot Supersonic Wind Tunnel, 1999
NASA TM-106565	NASA Lewis Wind Tunnel Model Systems Criteria, 1994
NASA TM 106569	NASA Lewis Propulsion System Laboratory Customer Guide Manual 1994
NASA TM 106589	NASA Lewis Propulsion System Laboratory Test Article systems Criteria 1994
	Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996

2.2 Records and Forms

Receiving Document
 NASA C-727 Shipping Request Document
 Work Plan
 NASA C-370 Test Readiness Verification Form
 F7600.006 Quality and Safety List – Form (or equal)
 F7600.007 Calibration Data Sheet – Form (or equal)
 NASA C-393 Squawk Sheet Form
 Requirements Document
 NASA C-919 Safety Permit and Supporting Documentation
 NASA C-923 Safety Permit Request
 NASA C-580 Qualified Operators List
 Results of Reviews
 Run Reports
 Test Article documentation
 Daily Test Plan
 Test Summary Report
 Completed Check Sheets

2.3 Definitions

7610	Aviation Environments Test Engineering Branch
7620	Aeropower & Propulsion Test Engineering Branch
7660	Electronic & Special Systems Branch
Aero Test Facilities	10X10 Foot Supersonic Wind Tunnel, 1X1 Foot Supersonic Wind Tunnel, 8X6 Foot Supersonic Wind Tunnel, 9X15 Foot Low Speed Wind Tunnel, Aero Acoustic Propulsion Lab (AAPL), Combustion Research Lab (CRL), Engine Components Research Lab (ECRL), Engine Research Building (ERB) Complex, Icing Research Tunnel (IRT), Propulsion System Lab (PSL)

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Buildup	Identify and complete those activities and tasks required to assemble the test article, to prepare the facility for testing and to accept the test article.
Calibration	The set of operations that establishes, under specified conditions, the relationship between values indicated by a measuring or generating instrument or system and the corresponding standard or known values derived from the standard.
CCB	Central Control Building – The Central Process Systems Operations Branch follows GRC-P7300.016 to schedule utilities for facilities.
Checksheet	A controlled document, which describes a logical sequence of activities to accomplish a task and must be initialed by the performing individual when completed. The RTD Aero Test Engineering Team along with the RTD Technicians develop the test article checksheets. The facility specific checksheets are developed by the RTD Aero Test Engineering Team or facility engineer (if one is designated) and RTD personnel. The checksheets are controlled by the Aero Test Engineering team in each facility. For additional guidance on what a checksheet might contain see Section 6.9 and Appendix F of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996.
Computing Requirements	A document that contains all information on data inputs, calculations, on-line data displays and post processing instructions. The Customer and the RTD Aero Test Engineering Team develop the research computing requirements. This document is given to ISD who uses it to produce data acquisition and reduction applications. These computer applications are kept by ISD and described in their GRC-P7100.001 (Experimental Testing Applications). For additional guidance on what might be contained in the computing requirements refer to Section 6.7 and Appendix D of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996.
Customer -aka Test Requestor	The person or organization that requested the test, either internal or external to GRC. See section 3.13.
Data Acquisition and Reduction	Data Acquisition is the collection of information from electronic sensors into a recording device. The Aero Test Engineering Team determines if only standard instrumentation systems are required to fulfill the data acquisition needs. They determine the schedule and resources needed for installation and checkout and if any other system(s) will be needed to fulfill requirements. Reduction is a set of computational instructions that takes the recorded data and converts it to engineering results.
Dynamic Data System (DDS)	A recording system for frequency dependent data. This can be digital or analog.
End-to-end checks	A checkout method for mechanical and electrical components and systems where the sensor or device is stimulated or an input, which simulates the device, is applied and the result is observed/verified at expected output device, channel or system.
ESCORT	A Glenn developed Steady State Data Acquisition System using commercial hardware supported and programmed by the Information

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Services Division (ISD).

Facility

See Aero Test Facilities.

Facility Systems

Facility Systems are support systems, which are not an inherent part of the test article like stings, struts and heaters, etc. Facility Systems are assessed by the Aero Test Engineering Team or the Facility Engineer and they determine what Facility Systems will be needed and if any changes are required on these systems. They determine the schedule and the resources that will be needed to assure the Facility Systems will be ready for the test project.

Field Engineering

The assemblage and fulfilling of technical requirements, specifications, analysis and engineering drawings which define hardware or part of a hardware system, which can include electronic systems. The process is less formal than the Implementation - Hardware Development process (CLP GRC-P2.6.3) or Engineering and Design (GRC-P7300.005) process but is used when there are time constraints, available test engineering resources and/or simplicity of design. It can encompass electrical and mechanical engineering.

All Field Engineering is the responsibility of the Aero Test Engineering Team which follows formal guidelines where they exist and good design practices if no guidelines can be found. They do an informal (non documented) evaluation of any hazards and/or risks associated with the field change, if deemed necessary, by the engineer, the work is reviewed by a third party or obtains the necessary safety and management approval

FM&PO

Facility Management and Planning Office

In-House Fabrication

In House Fabrications are activities performed by Glenn organizations as a result of Field Engineering. Typically these consists of minor test article and/or facility repairs, including model fabrications, machining operations, or instrumentation fabrications or other tasks described from a field engineering activity as described above. All in house fabrications are reviewed to ensure they meet functionality requirements (electrically, mechanically, and structurally)

Installation

All the activities and tasks required to get the test article into the facility.

Instrumentation and Controls

Instrumentation is the sensors and systems, which measure current values of aerodynamic data. Controls are systems, which vary or maintain a parameter to a desired value. The Aero Test Engineering Team determines if all necessary instruments, instrumentation systems, and control systems are available and assess if any need modification. The Team determines a schedule and the resources needed for the modifications, installation and checkout of all instruments, instrumentation systems and control systems.

Instrumentation Manual

Describes and documents the connections of all test instrumentation to the facility data systems. For additional guidance on what an Instrument Manual might contain refer to Section 6.6 and Appendix C of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996

Operational Readiness

An independent review requested by the Facility Manager through the

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Review (ORR)	aero test engineering branches to assure the research test objectives <u>can be</u> accomplished. This is done by reviewing the readiness of the test article, facility, data acquisition systems, data reduction program, and assures the safety permit has been obtained.
Pre Run Meeting	A Pre Run meeting is held before each day of testing. The Test Conductor is in charge of these meetings which cover facility and test article safety concerns, test matrix for that run, assuring all priority "A" squawks are or will be completed before the run, and any concerns the run crew might have.
Product Assurance	Activities which demonstrate quality, safety, and reliability of the Data, Test Article, and/or Facility.
Procurement	Procurement is the act of obtaining all goods and services needed for the project. This is accomplished by using the Automated Purchase Request System (APRS) as defined in GRC-P3.9 (Procurement).
Project Reviews	<p>Project reviews are planned events that occur during the life cycle of a project. They can include</p> <ol style="list-style-type: none"> 1) Monthly management reviews, 2) Design Reviews, 3) Safety Reviews, and 4) Operational Readiness Reviews. <p>The need for these reviews is detailed in the Work Plan. For additional guidance on what project reviews contain as well as the person responsible for organizing these reviews refer to the Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996. The contents of the design reviews are presented in Section 7.1, the contents of the Safety Reviews are presented in Section 7.2 and the contents of the Operational Readiness Review (ORR) are presented in Section 7.3</p>
Quality and Safety List	This is a list of instruments, which can affect the quality of the Data or the safety of the test article or facility. It may contain all instruments in a facility with those effecting quality and safety for the current test designated.
Notification System	A master list of IMTE that affects quality and safety . This list is controlled by Logistics and Technical Information Division (LTID) and requires notification of when calibration is due . This instrumentation is calibrated on a periodic basis according to GRC-P 3.11.1 (Control of Inspection, Measuring, and Test Equipment).
Resources	Items required to perform the test activity including dollars, labor, facility time, materials, utilities, etc.
Requirements Document	The Requirement Document describes the purpose for the test, the approach, what is needed to conduct the test in general terms, and the desired results, and level of product assurance needed, that is data accuracy and uncertainty required. The Center Level Procedure (CLP) GRC-P2.6.1 uses the term test request, however the aero test engineering branches refer to it as a requirements document. The customer (test

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requestor) in conjunction with the Aero Test Engineering Team develops this document.

Run Report

A standard electronic report that provides information of each test run in a test program and is usually completed and distributed immediately following the test run. The report will contain basic and detailed information about the test run including: facility, personnel, dates and times, costs, narrative summary, test objectives, test results, problems, preventive and corrective actions, comments, plan/next scheduled run, etc.

Safety Permit

A document issued by a designated safety committee after they have reviewed and approved the documentation showing the test can be performed safely. Document is usually displayed at the test facility during the test.

Safety Permit Request and supporting documentation

The Safety Permit Request and supporting documentation are completed by the Aero Test Engineering Team and presented to the Safety Committee for approval. This assures a third party safety review of the requested test. For additional guidance on what a the Safety Permit and supporting documentation see Section 6.11 and Appendix G of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Glenn Research Center, 1996.

Squawks

Normally Squawks provide a record of anomalies, which occur during testing, but sometimes it is only a request for a facility or test article change. The squawk can affect the data, the test article or the facility. Each squawk is evaluated and assigned a priority by the individual who wrote it, from the following scale: "A" squawks must be completed before the next run, "B" squawks are desired for completion prior to the next run, and "C" squawks are to be completed in the future. Both "B" and "C" squawks must have completion dates given. The initiator will indicate by checking the appropriate box on the squawk sheet if the squawk effects data quality and if the customer has been notified.

Stress and Hazard Analysis

A Stress Analysis determines if the test article can withstand the environment to which it will be subjected during the test. The customer usually provides the stress analysis document and the Aero Test Engineering Team reviews it but if it is not provided then the Aero Test Engineering Team is responsible to generate a Stress Analysis. The Hazard Analysis is a risk assessment to determine if the risk level of running the test is acceptable. The Hazard Analysis is put together by the Aero Test Engineering Team.

Standard Instrumentation and control systems

This term refers to the instruments and systems used in many if not all the aero test facilities.

Standard Instruments are: Strain Gage signal conditioners, Amplifiers, Thermocouple Reference Ovens, Thermocouple Cold Junction references, Vibration meters, Frequency and Pulse Counters, Digital Multimeters, Oscilloscopes, Frequency to DC Converter and other electronic devices.

Standard Instrumentation systems are: Electronically Scanned Pressure (ESP), ESCORT, Mass Comp, Analog Tape Recorders, Hot Wire Systems, Laser Doppler Velocimetry, Infrared Thermal Imaging,

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Standard Handbook for Planning and Conduction Wind Tunnel Tests at NASA Lewis Research Center	Pressure Sensitive Paint (PSP), High Speed Video, Gas Analysis Standard Control Systems are: Westinghouse Distributed Process Family (WDPF), Programmable Logic Controllers (PLC), Probe Actuation and Control System (PACS), Test Matrix Sequencer (TMS)
Task Order (TO)	This is a reference document. Its intent is to provide guidance on a test-by-test basis. It offers definitive descriptions of what is expected if that section(s) is needed. The Work Plan, however, is the overriding document and clearly spells out what will or will not be included in any given testing program. Task Order is a request to RTD Technicians to accomplish work and will be Electronic
Test Article	The item or material, hardware or system being tested.
Test Article Checkout	Activities and tasks required to assure the test article is ready to test
Test Article Documentation	Test article documentation is the drawings (detail, assembly, and instrumentation), stress analysis, etc.
Test Conductor	See Section 3.5
Test Plan	A Test Plan is done near the start of the testing phase and concentrates on the test activities. It contains a brief description of the purpose of the test, test objectives, test article hardware (description including the different configurations) test matrix (showing all the phases and the extent each configuration to be tested), test schedule (the time required to test each phase and configuration), operational procedures, and required personnel. For additional guidance on what a Test Plan might contain -- refer to Section 6.12 and Appendix H of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Lewis Research Center, 1996 A daily Test Plan describes what the test objectives are for that particular run day's activity
Test Procedure	See Test Plan
Test Readiness Validation Form	C-370 is signed by management and assures all activities identified in the planning, and installation phases have been successfully completed. This form indicates that testing is now ready to commence.
Test Requirements	See Requirement Document
Test Requestor	See Customer
Test Summary Report	This report contains pertinent information to the test entry. It describes the test hardware, project goals, problems that arose during the test program, preventive and corrective actions, customer feedback, schedule and run time records including metrics, and summarizes the test result. It is prepared by the project engineer at the conclusion of a given test program. For additional guidance on what a project summary report contains refer to Section 6.14 and Appendix J of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Lewis Research Center, 1996
Work Request (WR)	Work Request (NASA-C-709) is a request to various organizations to accomplish work. Such as the Print Shop, Photo Lab, or the Work control office in Branch 7320.

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Work Plan

The Work Plan, is done in response to the requirements document. It is the up front planning document. It lays out what needs to be done when it needs to be done and who or what it will take to get it done. Therefore as a minimum, the work plan shall include a list of tasks that need to be accomplished, a schedule when these tasks will be done, and the resources (cost and labor) it will take to accomplish these tasks. This document is signed early in the execution phase. For additional guidance on what a Work Plan might contain refer to section 6.4 and Appendix B of Standards Handbook for Planning and Conducting Wind Tunnel Tests at NASA Lewis Research Center, 1996

3.0 RESPONSIBILITIES

3.1 Research Testing Division (RTD) Project Engineer

In this procedure the RTD Project Engineer, as a member of the Aero Test Engineering Team, provides the team leadership required to assure the test project planning and execution is accomplished. The Project Engineer assures good communications with the Aero Test Engineering Team through scheduled meetings, which coordinate their activities, and ensures tasks are identified and an Aero Test Engineering Team member is identified to accomplish each task. The Project Engineer and the Aero Test Engineering Team reports progress to management and the customer, through project reviews as required in the work plan. The Project Engineer consults with management to solve resource problems, which cannot be adequately handled within the identified test planning project resources. The Project Engineer can be called upon to advise the facility manager in making test activity decisions. The Project Engineer assures any changes to the customer agreement (requirements) resulting from detailed negotiations are received as documented amendments per GRC-P2.2.1 or 2.2.2 and reflected appropriately in the work plan. Finally the Project Engineer is responsible for the execution of all test-related activities as defined in the work plan. The project engineer is the point of contact for all test-related activities. The Project Engineer is responsible for Customer Supplied Hardware. The Project Engineer will keep the Records and Forms defined in this document. The Project Engineer will have the Test Readiness Verification Form filled in and signed by management before the start of the testing phase. The Project Engineer will assure all personnel assigned to the project know how to properly fill out a squawk sheet.

3.2 RTD Aero Test Engineering Team

In this procedure the Aero Test Engineering Team consists of members or contractor staff supporting one of the Aero Test Engineering Branches (7610, 7620 and 7660). This team provides the mechanical and electrical/electronic engineering expertise to determine and to successfully execute all test-related activities, which will be defined in the work plan. The team also provides support for pre test consultations and provides the input specifics for the activities identified such as purchases required with cost and delivery estimates, tasks to be accomplished with an appropriate schedule consistent with the project milestones. The Aero Test Engineering Team assures check sheets, computing requirements and data reduction instructions, instruments, instrumentation, control, and facility systems are available. They provide any field engineering required. They assist in assembling the safety permit package doing stress and hazard analysis as required. The Aero Test Engineering Team and the Project Engineer report progress to

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management, the customer, as well as various other review committees. The team is responsible for all aspects of Product Assurance as defined in the Work Plan.

3.3 RTD Facility Engineer

The facility engineer ensures the safety and readiness of the facility for testing, and that maintenance and other facility activities are planned so they do not interfere with the test program. They also prepare time, labor, and cost estimates and provide the engineering and/or oversight needed for any facility related modifications required to successfully complete the test program. They assure facility check sheets are available. If no facility engineer is designated, these duties fall to the Aero Test Engineering Team.

3.4 RTD Facility Manager

Facility Manager for the Aero Test Facilities is the facility focal point as defined in GRC-P2.6.1. and GRC-P7600.001. During the planning portion of this procedure, the Facility Manager is responsible for: 1) deciding through consultation with the aero test engineering branches if, when and where a test would be run in the Glenn aero facilities; 2) setting the test window; 3) providing the customer with a cost estimate to conduct the test. 4) Ensuring an internal or external customer agreement is initiated and signed per GRC-P2.2.1 or 2.2.2. The Facility Manager notifies the Aero Test Engineering management and the Aero Test Engineering Team that the test is formally accepted and transfers the project point of contact function to the project engineer. The Facility Manager for the Aero Test Facilities appoints a chairperson for the ORR if required by the Work Plan.

3.5 RTD Test Conductor

A test conductor is a person who is responsible for planning, execution, directing, and reporting of the test day activities. This is a designated responsibility of a member of the Aero Test Engineering Team.

3.6 RTD Technicians

RTD Technicians provides the time and labor estimates required to accomplish the tasks assigned to them during the work planning process. The mechanical, electrical, and electronic technicians respond to electronic task orders (TO) entered by the Aero Test Engineering Team, which lead to the successful implementation of the work plan. They provide personnel to operate the facility and/or test article. They perform in-house fabrication when requested on the TO.

3.7 Facilities Division 7310 and 7320 Branches

These FD engineering branches provide expertise for the mechanical, electrical, architectural, civil, and structural facility engineering, which might be, required to accommodate a test article or to enhance a facility capability to support a requested test.

3.8 Engineering Development Division (EDD) Engineering

EDD provides time, labor and cost estimates for any design tasks assigned to them by the Aero Test Engineering Team or the research customer.

They provide the expertise for the mechanical and/or electrical design tasks assigned which usually consist of complex and/or time consuming test article designs or facility to test article

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interface designs that can not be accomplished by the Aero Test Engineering Team using Field Engineering principles.

3.9 EDD Fabrication

EDD provides cost estimates and time to fabricate parts which may be required for the test article, facility or for the test article to facility interface and the expertise to manufacture test article parts and/or facility support systems from drawings, this includes providing instrumentation services. They can also repair or modify existing parts.

3.10 Information Services Division (ISD)

ISD provides an estimate of time and labor resources required to complete their assigned tasks, such as the data acquisition and reduction programs. They provide the programmers who write the ESCORT program, the service personnel who assure the ESCORT system is functioning normally and within calibration. They assist the Aero Test Engineering Team during the checkout of the data acquisition and/or reduction applications for both the ESCORT and Dynamic data systems.

3.11 Safety Committee

There are several safety committees. Each committee is appointed and charged to review the experiments within their area of the Glenn Research Center to ensure conformance with the Glenn Safety Manual. In this procedure the designated area safety committee reviews the submitted safety permit request and supporting documentation and issues a safety permit when all safety concerns are satisfied. All aero tests require a Safety Permit.

3.12 Logistics and Technical Information Division (LTID)

LTID provides the Metrology services. They maintain the Notification system. They provide calibration and/or recalibration services for quality and safety instrumentation.

3.13 Customer (Test Requestor)

The customer develops through negotiations with the Project Engineer and Aero Test Engineering Team members a detailed requirement document. The customer (test requestor) documents all changes resulting from this negotiation. A sign amendment is filed with the original signed customer agreement as required in GRC-P2.2.1 or 2.2.2. This document is the basis for developing the Work Plan. The Customer is consulted about installation and checkout problems and concurs on all changes these may have on the original requirements. The customer evaluates the data as it is received and interprets the trends assuring the data meets, the quality required. The Customer provides input to the daily test plan for each test run. The customer may at any time in the process initiate changes to the requirements.

4.0 Procedure

Responsible Person or Organization

Block No. Activity

FM&PO	4.1 and 4.1A	Evaluate Proposed test request Use FM&PO branch procedure <u>GRC-P7600.001</u> (Research Facility Management). If at the end of this activity, the test project is approved the FM&PO will notify 7610, 7620, 7660
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**Responsible Person or
Organization**

Block No.

Activity

		line management and ensure a customer agreement is initiated and signed per GRC-P2.21 or 2.2.2. If rejected it is returned to the customer.
Aero Test Engineering Team	4.2	Provide expert assistance in evaluation proposed test Provide mechanical and electrical engineering expertise into the evaluation process.
Customer (Test Requestor)	4.3	Revise Test Request If the Facility manager rejects the test request the customer decides if the test request can be altered to allow testing and resubmits request for approval or ends the process.
Aero Test Engineering Team	4.4	Develops Work Plan The Project Engineer with the assistance of the Aero Test Engineering Team and Facility Engineer gathers technical information from the customer (test requestor), aero test engineering management and other services organizations (as described in section 3.6, 3.7, 3.8, 3.9, and 3.13 of this procedure) to assure the team fully understands the signed customer agreement (test requirements) and to develop a work plan. Any amendments to the original customer agreement are to be documented, signed and dated. The Aero Test Engineering Team uses the Standards Handbook for Planning and Conducting Wind Tunnel Test at NASA Glenn Research Center, 1996 as guidance to accomplish this task.
Aero Test Engineering Team-	4.5	Review and Approves Work Plan The Aero Test Engineering team submits the work plan for review and approval. Attached to the Work Plan is a copy of the Test Readiness Verification Form with the boxes deemed appropriate by the team marked. The team revises the work plan according the review comments. Aero Test Engineering Management and the Aero Test Engineering Team will approve and signs the work plan, the Customer (Test Requestor) will concur. The Work Plan shall be retained as a Record. This approval should occur early in the implementation phase.
Aero Test Engineering Team-	4.6	Implement Work Plan The Project Engineer or designated team member: <ul style="list-style-type: none"> • Provides mechanical/electrical expertise for buildup and installation of the test article through tasks identified in the work plan. • Initiates Procurements using <u>CLP GRC-P3.9</u> (Purchase Request Process) and monitors progress. • Initiates design activities through EDD using <u>CLP GRC-P2.6.3</u> (Implementation -Hardware Development) or

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**Responsible Person or
Organization**

Block No. Activity

- GRC-P7700.006 (EDD Hardware Development Procedure), or using Engineering and Design (GRC-P7300.005) procedure or within using Field Engineering.
- Supports all Project Reviews described in the Work Plan
 - Initiates fabrication tasks and monitors progress through EDD using CLP GRC-P7400.001 (Business Model) or through RTD using in-house fabrication and documented through the electronic TO system.
 - When a test article is supplied by an external customer, the Project Engineer is to assure the hardware is received and verified through receiving or at the facility. Any hardware found damaged will be recorded and reported to the customer. The Project Engineer will store and track any hardware sent by the customer and identified on the receiving document. The Project Engineer will assure all hardware received is returned to the customer. The Project Engineer will keep the Receiving and Shipping documents as Records.
 - Initiates work plan tasks for RTD using RTD's Electronic Task Order system.
 - Prepares the safety permit request and supporting documentation for the safety committee and obtains the safety permit.
 - Completes and/or updates the facility and test article check sheets.
 - Develops an instrumentation manual.
 - Applies standard instrumentation and control systems to required measurements.
 - Develops and verifies instrumentation and control systems.
 - Identifies and documents all instrumentation affecting quality and safety are calibrated per GRC-P3.11.1 using Work Instruction GRC-W7600.005 and Form F7600.006 (Quality and Safety List) or equal
 - Provides necessary alarm/shutdown control systems.
 - Provides facility data acquisition and reduction computing requirements to ISD.
 - Evaluates test article data accuracy and reduction requirements.
 - Determines required data acquisition systems.
 - Configures instrumentation, controls and data systems.
 - Provides uncertainty analysis if required by work plan.

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Responsible Person or

<u>Organization</u>	<u>Block No.</u>	<u>Activity</u>
Customer	4.6A	The customer may at any point in the process of implementation change or alter requirements, which will demand some re-planning. All changes to requirements will be documented as required by GRC-P 2.2.1 or 2.2.2.
Aero Test Engineering Team	4.6B	The Aero Test Engineering Team reviews the request for change given either orally (the team documents the oral request) or in writing. If accepted aero management is notified as required in 4.6C (below) and the persons designated per the customer agreement signs the amendment. The team revises the work plan (for small changes this may only be updating the schedule) to reflect this change in requirements. If rejected the team may renegotiate with the customer.
Aero Test Engineering Team	4.6C	<p>Aero Management will be apprised of the significant changes that occur because of</p> <ul style="list-style-type: none"> • Requirements, • Delays • Any other reason. <p>Significant here is defined as those one time changes which will cause a 10% increase or decrease or if the accumulation of changes exceeds 20% of the original signed customer agreement and work plan in any of the following areas:</p> <ul style="list-style-type: none"> • Scheduled entry or removal dates, • Total labor hours for the project • Total estimated dollars for the project
Customer	4.6D	The customer decides if the change can or should be revised per recommendations from the Aero Test Engineering Team. If yes the customer resubmits the request if no it ends.
Aero Test Engineering Team	4.7	<p>Checkout: Product Assurance Activity</p> <p>The Aero Test Engineering Team preforms test article and support system checks such as mechanical and electrical end-to-end checks. Correcting and reverifying all problem items identified and reverifying the component or system. Verifying the integrity and operation of each component and system prior to testing. Checkout problems meeting the criteria listen in GRC-W7600.007 (Test Engineering Non-conformance identification and reporting system) will be logged and reported.</p>
Aero Test Engineering Team	4.8	<p>Receive Permission to Test</p> <ul style="list-style-type: none"> • The Facility Manager selects a chairperson for the ORR if required by the Work Plan. After all the action items from the ORR have been closed out or if an ORR is not

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required and the Safety Permit has been issued the Project engineer reviews with management the Test Readiness Verification form C-370 and obtains the appropriate signatures then testing can commence. C-370 will be retained as a Record.

Aero Test Engineering
Team

4.9

Conduct test /verify data activity:

The project engineer:

- Assures facility and services (air, exhaust, and power) are scheduled with CCB. Using GRC-P7300.016 (Central Process System Operations.)
- Ensures Aero Test Engineering Team members are available to provide the necessary test run coverage.
- Monitors the resources provided for conducting the test

The test conductor:

- Has complete authority over the testing activity.
- Is the focal point for all test day activities and functions
- Prepares and conducts a daily test planning meeting in coordination with customer and all team members.
- Reviews the completed pre and post run check sheets for any noted anomalies or problems.
- Reviews all the “A” squawks verifies they are complete.
- Executes and documents via a run report the test according to the Daily Test Plan.
- Provides for safe and satisfactory operation of facility and test article.
- Has all anomalies to the data, test article, and facility recorded as squawks.
- Assures if there is a test article failure that GRC-W7600.006 (Test Article Failure) is followed.
- Prepares the daily run reports.

The Aero Test Engineering Team:

- Analyzes incoming test data and assures customer identified quality data is valid and accurate
- The customer will be notified of all problems, which can effect the product, Quality Data. These will be reported on a Squawk Sheet (C-393), problems meeting the criteria of GRC-W7600.007 will be logged, reported and will be kept as a Record by the Project Engineer in the facility.

At the completion or between repetitions of the test plan, testing may be repeated, continued, modified, interrupted or

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stopped, as appropriate, based upon:

- The test objectives satisfied.
- Unexpected test results.
- Failure of the test article {see GRC –W7600.006 (Test Article Failure)}, or (see Glenn Safety Manual)
- Performance, , instrumentation, or test facility abnormalities
- Consumption of resources.

The technical judgment of the customer or test conductor.

Aero Test Engineering
Team

4.10

Provide Final Data /Results

- At the conclusion of the test the Test Engineering Team provides the customer with final data/results. If any non-conformities are found follow GRC-W7600.007 (Test Engineering Non-conformance identification and reporting system). The Team reviews with the customer all data results assuring all data meets the stated testing objectives for validity and accuracy. This can consist of reprocessing already provided Steady State Escort data and Dynamic Data. The Team assures processing of High Speed Imaging, Schlieren Photographs, Pressure/Temperature Sensitive Paint Imaging, and Model Photographs meet the customer's requirements. All Data becomes the property of the customer and will be retained by them.

Aero Test Engineering
Team

4.11

Implement Project Closeout:

The Aero Test Engineering Team issue electronic TOs to implement the removal activities defined in the work plan which include:

- Removal of the test article.
- Box test article and all customer supplied equipment and return to customer or store if supplied by Glenn.

The Project Engineer then:

- Writes project summary report if required by work plan.
- Store all documentation called out in this procedure, GRC-W7600.005, and GRC-W7600.006 and GRC-W7600.007. File located in the Project File at the facility.

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