MWI 8050.1
REVISION E
EFFECTIVE DATE: September 19, 2004
EXPIRATION DATE: September 19, 2009

MARSHALL WORK INSTRUCTION

QD01

VERIFICATION & VALIDATION OF HARDWARE, SOFTWARE, AND GROUND SUPPORT EQUIPMENT FOR MSFC PROJECTS

DOCUMENT HISTORY LOG

Status (Baseline/ Revision/ Canceled)	Document Revision	Effective Date	Description
Baseline		5/14/99	Document converted from MSFC-P04.1-C01 to a Directive. Previous history retained in system as part of canceled or superseded ISO Document files
Revision	A	8/3/99	Changes made to reflect new organizational codes. Para. 6.8, reference to "MPG 8730.10" changed to "MPG 8730.3" and "MPG 8730.11" changed to "MPG 1280.4."
Revision	B	3/6/00	References to canceled MPG 1441.1 changed to MPG 1440.2 in Paragraphs 3, 6.14, 6.15, and 9.
Revision	C	12/16/02	Updated Master List URL Paragraph 3, Applicable Documents: Updated Title of MPG 8060.1. Deleted Paragraph 6.6 per response to QSDN #139. Re-Numbered Paragraphs Due To Deletion of Paragraph 6.6
Revision	D	4/21/03	Document updated to be in compliance with AS9100 and with recent changes to MPG 8060.1. Title of directive changed to include "Validation." Para. 1: Updated contents to include validation as part of the process. Para. 2: Updated contents to include validation as part of the process. Para. 3: Revised QS Document Number. Added NPG 1441.1. Deleted MPD 1280.1. Para. 5: Updated definitions of verification and validation to agree with recent change to MPG 8060.1 and Agency definitions being established. Para. 6: Updated contents to include validation as part of the process. Para. 9: Updated records to include validation documentation and changed reference from MPG 1440.2 to NPG 1441.1
Revision	E	9/19/2004	Updated document in response to HQ Rules Review Action: • Removed ambiguity regarding requirements and guidelines within the document • Changed references from NPGs and MPGs to NPRs and MPRs respectively

1. PURPOSE

This instruction provides definitions and identifies responsibilities involved in the verification and validation of flight hardware, flight software, and associated ground support equipment (GSE) (i.e., hardware or software) interfacing with flight hardware and software for which MSFC has responsibility. It defines the detailed tasks and identifies the organizations responsible for conducting the tasks that serve as the basis for certifying that the product meets the requirements. These requirements include applicable Regulatory, Agency, Center, Program, and customer or user requirements. Implementation of this instruction will satisfy what is defined in MPR 8060.1 as verification and validation.

2. APPLICABILITY

Verification and validation in accordance with this Marshall Work Instruction (MWI) shall be required for each program and project within the scope of MPR 8060.1.

3. APPLICABLE DOCUMENTS

3.1 MPR 8060.1, “Flight Systems Design/Development Control”

3.2 MPR 8040.1, “Configuration Management, MSFC Programs/Projects”

3.3 MWI 7120.2, “Data Requirements Identification/Definition”

3.4 MPR 8730.1, “Inspection and Testing”

3.5 MPR 8730.3, “Control of Nonconforming Product”

3.6 MPR 1280.4, “MSFC Corrective Action System”

3.7 MPR 1440.2, “MSFC Records Management Program”

3.8 NPR 1441.1, “NASA Records Retention Schedule”

3.9 QD-R-001, “Failure Mode and Effects Analysis and Critical Items List”

3.10 MSFC-HDBK-2221, “Verification Handbook: Volume 1 & 2”

3.11 MPD 8720.1, “MSFC Reliability and Maintainability Program for Space Systems”

4. REFERENCES

None

5. DEFINITIONS

5.1 Verification. Proof, by examination of objective evidence, that the product complies with specifications. Verification is performed to ensure the product complies with requirements and may be determined by test, analysis, demonstration, inspection, or a combination of these.

5.2 Validation. Proof by examination of objective evidence, that the product accomplishes the intended purpose. Validation is performed to ensure that the product is ready for a particular use, function, or mission and may be determined by test, analysis, demonstration, or a combination of these.

6. INSTRUCTIONS

Historically, NASA has developed "one of a kind" products given a single set of requirements that both capture the design/manufacturing specifications and the customer requirements for a particular mission. This heritage has somewhat merged verification and validation into one process. Due to the increasing diversity of products (e.g., hardware, software) developed by NASA and the emphasis on NASA to use common terminology with industry standards, the two processes need to be differentiated as having two distinct objectives. As defined, the verification process ensures the product complies with specifications (e.g., a battery is designed and built to a particular set of specifications or a piece of software is coded to a particular set of specifications). The validation process ensures the product is ready for a particular use, function, or mission as stipulated by the customer (e.g., the battery can be used to power a satellite or power a telescope; the software can be used as an operating system for an experimental rack or a processing experiment). The explanation of the differences between the verification and validation processes is not intended to require additional documentation be produced to satisfy this instruction. It is an attempt to explain to the reader when evaluating the initial set of requirements that there is a different viewpoint on whether the requirement is being established for design/manufacturing purposes or to satisfy the customer's intended use.

The project manager has overall responsibility for developing and implementing a verification and validation program that will be the basis for endorsement that the hardware, software, or GSE (i.e., product) meets specification and is ready for a particular use, function, or mission. The verification and validation program centers around a set of requirements: (a) those requirements that the project manager obtains from the customer or user; (b) applicable Regulatory, Agency, Center, and Program requirements; and (c) those requirements practiced and used by the design and manufacturing discipline organizations. The paragraphs to follow identify activities needed to be performed, either sequentially or concurrently, that shall ensure readiness of the product.

Implementation of the verification and validation program at MSFC requires participation by three principal organizations: (a) the Project Office (i.e., the Project Manager and Systems Engineer); (b) the Engineering Directorate Departments; and (c) the Safety and Mission

Assurance Office or applicable contractor counterparts of these organizations. Specific responsibilities for these organizations are provided below.

For guidance and documentation templates on implementing paragraphs 6.1 – 6.18, refer to MSFC-HDBK-2221, "Verification Handbook: Volume 1 & 2"

Actionee	**Shall Perform All Actions**	
Systems Engineer and ED Group/Product Directorate Group	6.1	Review the project requirements to ensure they can be verified and validated.
Systems Engineer and ED Group/Product Directorate Group	6.2	Identify and document traceability of all project requirements down to the point of implementation.
Systems Engineer, S&MA, and ED Group/Product Directorate Group	6.3	Develop and document a verification and validation program for the project requirements that identifies the following: (a) method (e.g., test, analysis, inspection, demonstration, validation of records, similarity, or combination thereof) (Reference TABLE 1), (b) detailed activity and planning information for the stated methods, (c) success criteria, (d) traceability to project safety and reliability verification requirements (e.g., Hazard Reports, FMEA/CIL, Reliability prediction including Probabilistic Risk Assessment (PRA) {as applicable}), (e) needed compliance data, (f) responsible party, and (g) nonconformances, waivers, deviations. Data Requirements (DR) for the verification and validation information on both in-house and out-of-house projects shall be controlled and prepared in accordance with MWI 7120.2.

TABLE 1. VERIFICATION AND VALIDATION METHODS

Test	Test (e.g., functional, environmental) is the actual operation to ensure that the performance is in accordance with the requirement(s).
Analysis	Analysis involves the use of engineering analysis, qualitative assessment, computer modeling and/or simulations to ensure compliance to the requirement(s). Analysis is a method used in lieu of, or in addition to, testing.
Inspection	Inspection is the physical evaluation to ensure that the requirement(s) has been incorporated or met. Inspection shall be used as the method on the product to satisfy such requirements as construction features, workmanship, dimensions, and physical conditions identified on the engineering documentation (e.g., drawings, Engineering Parts List [EPL]).
Demonstration	Demonstration is the "acting out" to ensure the requirement(s) has been incorporated or met. Demonstration shall be used as the method on the product to satisfy such requirements as accessibility, replaceability, and human factors.
Validation of Records	Validation of records is the use of vendor-furnished/supplied manufacturing or processing records to ensure the requirement(s) has been incorporated or met. Validation of records shall be used as the method to satisfy incorporation of requirements for such items as Commercial Off-The-Shelf (COTS) products and products purchased to standards.
Similarity	Similarity is the process of assessing prior data, configuration, processes, or applications and concluding that the item under assessment is similar or identical to another item that has previously been verified to equivalent or more stringent specifications or validated to an equivalent use or function. Similarity shall only be used when each of the following criteria is met: 1. Engineering evaluation(s) reveals that design configurations between the item under assessment and the similar item would produce the same results if the verification/validation activity was performed on the item under assessment. 2. The similar item was designed for and verified/validated to equal or higher environmental (e.g., thermal, stress) levels than those required for the item under assessment. 3. The item under assessment was built by the same manufacturer using the same manufacturing processes and the same quality control procedures as the similar item.

	4. Similarity assessment shall undergo an independent evaluation by a technically qualified person or group other than the person(s) performing the assessment. Similarity shall not be used when either of the following conditions exists: 1. The similar item used in the assessment was itself verified/validated using similarity as the method. 2. Items whose criticality is 1 or 1R (i.e., items whose failure or malfunction could result in loss of vehicle, life, or serious injury). For additional information on criticality definition, see QD-R-001.

S&MA	6.4	Transmit safety and reliability assessment derived safety verifications (e.g., Hazard Reports, FMEA/CIL, Reliability prediction including Probabilistic Risk Assessment (PRA) {as applicable} verification) to the project for incorporation into the verification and validation program.
Project Manager/ Systems Engineer	6.5	Baseline the project requirements and the verification/validation program in accordance with MPR 8040.1.
ED Group/Product Directorate Group	6.6	Develop procedures that (a) include traceability to the verification and validation requirements and success criteria that the activity is intended to satisfy, (b) require the “as-run” procedure data be recorded and compared to the success criteria, and (c) document the configuration of the unit under test and ensure it is representative of the actual flight configuration or ground configuration if it is GSE.
S&MA and ED Group/Product Directorate Group	6.7	Perform the activities (e.g., stress analysis, thermal vacuum test, and inspections) as identified in the verification and validation program to support the objective of providing evidence that the product meets the requirement(s). Document and resolve nonconformances, failures, and

		anomalies that occur during the verification and validation process in accordance with MPR 8730.3 and MPR 1280.4.
S&MA	6.8	Assure Quality Assurance (QA) personnel or Quality Designee(s) are appointed in accordance with MPR 8730.1 to perform inspections or monitor tests in support of the verification and validation process.
Systems Engineer, ED Group/Product Directorate Group, and S&MA	6.9	Evaluate any rework, repair, and redesign that occurs to the existing configuration during the verification and validation program to determine if existing compliance data is invalidated and reverification/ revalidation is required. Documents objective evidence that these items have been reviewed for verification/validation impact. Performs reverification/revalidation if required.
ED Group/Product Directorate and S&MA	6.10	Document the results of the verification/validation activity in a manner (e.g. Compliance Document, Certification Reports, etc.) that clearly identifies compliance or noncompliance and traceability to the verification/ validation requirement(s) and project requirement(s). The individual submitting compliance data shall sign the data certifying the technical adequacy and accuracy of the data.
Systems Engineer, ED Group/Product Directorate Group and S&MA	6.11	Review compliance data and provide comments with respect to the: (a) technical adequacy, (b) need for an independent assessment, and (c) data satisfying the verification/validation requirements and project requirement(s). Any compliance data related to a safety requirement shall be reviewed for concurrence by the project's S&MA lead or designee.
Project Manager/ Systems Engineer	6.12	Request additional independent assessment (i.e., "second set of eyes") of the compliance data on a case-by-case basis, taking into account the criticality and fidelity of the hardware or software and the verification/validation method used to satisfy the requirement(s).

Project Manager/ Systems Engineer	6.13	Provide final approval and maintain the project's compliance data as a record during the life of the project in accordance with MPR 1440.2.
Project Manager/ Systems Engineer	6.14	Provide the compliance data as part of the data package for project identified acceptance reviews (e.g., Design Certification Review, Acceptance Review, Flight Readiness Review) and acceptance audits (e.g., Functional Configuration Audit, Physical Configuration Audit).
Project Manager	6.15	After completion of the project, archives compliance data in accordance with NPR 1441.1.

For hardware, software, and/or GSE that is reused, refurbished, or reflown for a new particular use, function, or mission, the following tasks shall be performed inclusive of the tasks mentioned above:

Actionee		**Shall Perform All Actions**
Systems Engineer, ED Group/Product Directorate Group and S&MA	6.16	Evaluate any requirement changes, configuration changes, nonconformances, and anomalies to determine if existing compliance data is invalidated and reverification/ revalidation is required. Document objective evidence that these items have been reviewed for verification/ validation impact against the new use, function, or mission.
Project Manager/ Systems Engineer	6.17	Approve the reverification/revalidation program.
ED Group/Product Directorate Group and S&MA	6.18	Perform the verification/validation activity identified in the reverification/revalidation program.

7. NOTES

None

8. SAFETY PRECAUTIONS AND WARNING NOTES

None

9. RECORDS

The Project Manager shall be responsible for maintaining and archiving the following verification and validation related documentation as records in accordance with MPR 1440.2 and NPR 1441.1:

9.1 Verification and validation program documentation

9.2 Compliance Data, including nonconformances, waivers, and deviations.

10. PERSONNEL TRAINING AND CERTIFICATION

None

11. FLOW DIAGRAM

None

12. CANCELLATION

MWI 8050.1D dated April 21, 2003

Original signed by
Robin N. Henderson for

David A. King
Director