



National Aeronautics and
Space Administration



AI1-SYS-SRQA

V3.10

RELEASE DATE: SEPTEMBER 11, 2008

ARES I-X

**SAFETY, RELIABILITY, AND QUALITY ASSURANCE
REQUIREMENTS**

Approved for Public Release; Distribution is Unlimited

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 1 of 54
Title: Ares I-X SR&QA Requirements	

REVISION AND HISTORY PAGE

Status	Revision No.	Change No.	Description	Release Date
Draft	b	-	Added clarification to PRACA section that CxPRACA is not required for ARF	XX/XX/XX
DRAFT	a		Title change addition of Ares I-X document number Draft pending final review	
Baseline	1.00		Addition of version number; removal draft from doc; removed "Flight Test" from Title in header changes performed by HLD 08/24/2007 in prep for baseline distribution	08/24/07
Revision	2.00		Updated TBDs/TBRs; Revised GMIP criteria; Revised FMEA scope; Updated MRB section	12/10/07
Draft a	2.00		CM modification to include draft	12/12/07
Draft b	2.00		Modifications made to incorporate comments received on CR	01/22/08
Baseline	2.00		Approved XCB 20080122	01/22/08
Revision	3.00		Updated editorial error; Revised FMEA scope; Updated MRB section	06/27/08
Baseline	3.00		CR AIX-0162 XCB 20080729	6/29/2008
Revision	3.10		CR AIX-0195 XCB 20080911 Update for special provisions for Avionics "Heritage Atlas" Hardware	9/11/2008

NOTE: Updates to this document, as released by numbered changes (Change XXX), are identified by a black bar on the right margin.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 2 of 54
Title: Ares I-X SR&QA Requirements	

TABLE OF CONTENTS

PARAGRAPH	PAGE
1.0 INTRODUCTION.....	5
1.1 PURPOSE.....	5
1.2 SCOPE.....	5
1.3 CHANGE AUTHORITY.....	5
2.0 DOCUMENTS	6
2.1 APPLICABLE DOCUMENTS.....	6
2.2 REFERENCE DOCUMENTS.....	8
3.0 SR&QA REQUIREMENTS	10
3.1 GENERAL	10
3.1.1 Waivers and Deviations to Ares I-X SR&QA Requirements	10
3.1.2 Existing Waivers and Deviations associated with “Heritage” Hardware or Software	10
3.1.3 Changes and Revisions	10
3.1.4 Safety, Reliability, and Quality Assurance Plans.....	10
3.1.5 Programmatic Audit and Reviews	11
4.0 RISK MANAGEMENT.....	11
5.0 SAFETY	11
5.1 SAFETY PLANNING	11
5.2 SYSTEM SAFETY MANAGEMENT FUNCTIONS.....	11
5.3 MISHAPS	12
5.4 TEST OR OPERATIONAL READINESS	12
5.5 CONTRACTOR SAFETY	12
5.6 INDUSTRIAL SAFETY	12
5.7 HAZARD ANALYSES.....	13
5.7.1 Special Provisions for Space Shuttle “Heritage Systems” Hazard Analysis	13
5.8 PHASED SAFETY REVIEW PROCESS.....	14
5.9 RANGE SAFETY.....	14
5.10 GROUND OPERATIONS SAFETY.....	14
6.0 RELIABILITY	14

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 3 of 54
Title: Ares I-X SR&QA Requirements	

6.1	RELIABILITY MANAGEMENT AND IMPLEMENTATION	15
6.2	FMEA'S AND CIL'S	15
6.2.1	Special Provisions for Space Shuttle "Heritage Systems" FMEA/CILs	15
6.3	ARES I-X GIDEP ALERTS	15
6.4	LIMITED LIFE ITEMS	16
6.5	EEE PARTS	16
6.6	COTS	16
7.0	QUALITY	16
7.1	QUALITY SYSTEMS REQUIREMENTS.....	17
7.1.1	Special Provisions for Shuttle "Heritage Systems" Quality Systems.	18
7.2	QUALITY PLANNING	18
7.3	SURVEILLANCE PLANS AND AUDITS	19
7.4	PARTS PROCUREMENT.....	19
7.5	WORKMANSHIP STANDARDS	19
7.6	VERIFICATION OF PURCHASED PRODUCTS.....	19
7.7	GOVERNMENT MANDATORY INSPECTION POINTS.....	21
7.7.1	Special Provisions for Avionics "Heritage Atlas" Hardware.....	21
7.8	DELEGATION OF QUALITY ASSURANCE FUNCTIONS.....	22
7.9	PROBLEM REPORTING.....	22
7.9.1	PRACA.....	22
7.9.2	NONCONFORMANCE MARKING IDENTIFICATION.....	22
7.10	MATERIAL REVIEW BOARDS.....	23
7.11	FINAL ACCEPTANCE	28
7.12	PROGRAM QUALITY PANEL	29
7.13	CONTROL OF QUALITY RECORDS	29
8.0	SOFTWARE ASSURANCE	29
8.1	PROGRAM.....	29
8.1.1	Special Provisions for Space Shuttle and Launch Vehicle "Heritage Systems" Software Assurance Requirements.....	29
8.2	PROVIDER SOFTWARE ASSURANCE.....	30
8.2.1	Provider Program.....	30
8.2.2	Management.....	30
8.3	REQUIREMENTS.....	30

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 4 of 54
Title: Ares I-X SR&QA Requirements	

8.3.1	Access	30
8.3.2	Software Quality	31
8.3.2.1	Product Assurance	31
8.3.2.2	Process Assurance.....	32
8.3.3	Discrepancy and Problem Reporting, and Corrective Action	32
8.3.4	Software V&V	32
8.3.5	Software IV&V	33
8.3.6	Software Safety	33
8.3.6.1	Software Safety Critical Evaluation and Analyses.....	33
8.3.6.2	Safety Activities	33
8.3.6.3	Certification Process.....	36
8.3.6.4	Operational use of Software	36
APPENDIX C.1 – LOCKHEED MARTIN IMPLEMENTATION OF ARES I-X SOFTWARE SR&QA REQUIREMENTS.....		43
APPENDIX C.2 – KSC IMPLEMENTATION OF ARES I-X SOFTWARE SR&QA REQUIREMENTS		47

APPENDIX

APPENDIX A ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS	37
APPENDIX B OPEN WORK	41
APPENDIX C SOFTWARE PROVISIONS	43
APPENDIX D FUNCTIONAL CRITICALITY DETERMINATION	53

TABLE

B1-1	TO BE DETERMINED ITEMS	41
B2-1	TO BE RESOLVED ISSUES	42

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 5 of 54
Title: Ares I-X SR&QA Requirements	

1.0 INTRODUCTION

1.1 PURPOSE

This document defines the safety and mission assurance requirements for the Ares I-X development flight test. These requirements have been established by the stakeholder organizations as essential to assure the flight readiness of the Ares I-X vehicle.

1.2 SCOPE

The requirements established herein are a tailored version of the CxP SR&QA requirements found in CxP 70059, CxP SR&QA Requirements. These requirements are based on a level of risk acceptance that is appropriate for this test and have taken the safety of the public and ground personnel into account in accordance with direction given in Section 1.3 of CxP 70059.

The requirements established herein are applicable to hardware and software designated as flight components, subsystems, systems, flight qualification hardware/software, Development Flight Instrumentation (DFI), and ground support equipment (as defined below) during all phases of the flight test. The phases include design and development, flight test preparation, operations, recovery of assets, and evaluation and assessment of the flight test data. These requirements apply to NASA, its contractors, support contractors, delegated agents (e.g., Defense Contract Management Agency (DCMA), and suppliers providing products and/or services to Ares I-X. These requirements apply to all procedures and activities performed at Kennedy Space Center (KSC) during pre-integration assembly and testing by non-KSC NASA and contractor personnel.

Ground Support Equipment (GSE) includes non-flight systems, equipment, or devices (with a physical or functional interface with flight hardware) necessary to routinely support the operations of transporting, receiving, handling, assembly, inspection, test, checkout, servicing, launch, and recovery of space vehicle at launch, landing, or retrieval sites.

1.3 CHANGE AUTHORITY

Proposed changes to this document shall be submitted by an Ares I-X Change Request (CR) to the Ares I-X Control Board for consideration and disposition.

All such requests will adhere to the Ares I-X Configuration Management Change Process.

Changes and requests for deviations or waivers to the SR&QA requirements of this document shall be presented to the XCB. The XCB shall include a supplemental member, selected by the Cx SR&QA Director, to serve as an ad hoc member of the XCB for changes, deviations and waivers to this document's requirements. Any XCB

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 6 of 54
Title: Ares I-X SR&QA Requirements	

non-concurrences to the requested changes, deviations, or waivers at the XCB shall be elevated to the CxP SR&QA Board.

The appropriate NASA Office of Primary Responsibility (OPR) identified for this document is SR&QA.

2.0 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents include specifications, models, standards, guidelines, handbooks, and other special publications. *Sources for this document are located in AIX-REF-SRQA v3.00.* The following documents apply in full:

ANSI/ASQ Z1.9- 2003	Sampling Procedures and Tables for Inspection by Variables for Percent Nonconforming
ANSI/ASQ Z1.4- 2003	Sampling Procedures and Tables for Inspection by Attributes
CxP 70056	Constellation Program Risk Management
KNPR 8715.3	KSC Safety Practices, Procedural Requirements
NPD 8710.5C	NASA Safety Policy for Pressure Vessels and Pressurized Systems
NPD 8730.2B	NASA Parts Policy
NPD 8730.5	NASA Quality Assurance Program Policy
NPR 6000.1G	Requirements for Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components
NPR 8621.1B	NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping
SAE AS 9100 B	Quality Management Systems – Aerospace- Requirements

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 7 of 54
Title: Ares I-X SR&QA Requirements	

The following requirements are applicable to the extent specified in the text:

11000-97-014	Atlas Program Parts, Materials, and Processes Requirement, Launch Vehicle
AFSPCMAN 91-710	Range User Range Safety Requirements
FSOP 6100	Florida Safety Operating Plan
NASA-STD-8719.13	Software Safety Standard
NPR 8705.6	Safety and Mission Assurance Audits, Reviews, and Assessments
NPR 8715.5	Range Safety Program
NPR 8735.2A	Management of Government Quality Assurance Functions for NASA Contracts
NSTS 5300.4 (1D-2)	Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program
NSTS 22254	Methodology for Conduct of Space Shuttle Program Hazard Analysis
NSTS 22206	Requirements for Preparation and Approval of Failure Modes and Effects Analysis and Critical Items List (FMEA/CIL)
CxP 70038	Constellation Program Hazard Analysis Methodology Document
CxP 70043	Constellation Program Hardware Failure Modes and Effects Analysis and Critical Items List (FMEA/CIL) Methodology
CxP 70059	Constellation Program SR&QA Requirements Document
CxP 70068	Constellation Program Problem Reporting, Analysis and Corrective Action (PRACA) Requirements, Volume 3
CxPMD-013	Charter for the Constellation Safety and Engineering Review Panel (CSERP)

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 8 of 54
Title: Ares I-X SR&QA Requirements	

2.2 REFERENCE DOCUMENTS

The following documents contain supplemental information to guide the user in the application of this document.

AS 9006	Deliverable Aerospace Software Supplement
ARP 9009	Aerospace Contract Clauses
CxP 70128	Constellation Program Software Assurance Plan
CxP 70087	Reliability, Availability, and Maintainability Plan
DRD-4501SW-SRS	Software Requirements Specification (Avionics)
DRD-4501SW-SDP	Software Development Plan (Avionics)
DRD-4501QE-SAP	Software Assurance Plan (Avionics)
DRD-4501SW-STP	Software Test Plan (Avionics)
DRD-4501SW-STPR	Software Test Procedures (Avionics)
DRD-4501SW-STR	Software Test Report (Avionics)
DRD-4501SA-SS-HA	System Safety Hazard Analysis (Avionics)
DRD-4501SA-SSP	System Safety Plan (Avionics)
MSFC-STD-2594	MSFC Fastener Management & Control Practices
NASA-STD-(I)-5005C	Standard for the Design and Fabrication of Ground Support Equipment
NASA-STD-8719.7	Facility System Safety Guidebook
NASA-STD-8719.8	Expendable Launch Vehicle Payload Safety Review Process Standard
NASA-STD-8719.9	Standard for Lifting Devices and Equipment
NASA-STD-8719.10	Standard for Underwater Facility and Non-Open Water Operations
NASA-STD-8719.11	Safety Standard for Fire Protection

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 9 of 54
Title: Ares I-X SR&QA Requirements	

NASA-STD-8719.17	NASA Requirements for Ground-based Pressure Vessels and Pressurized Systems
NPD 1800.2B	NASA Occupational Health Program
NPD 8700.1C	NASA Policy for Safety and Mission Success
NPD 8710.2D	NASA Safety and Health Program Policy
NPD 8710.5C	NASA Safety Policy for Pressure Vessels and Pressurized Systems
NPR 1800.1B	NASA Occupational Health Program Procedures
NPR 8715.1	NASA Occupational Safety and Health Programs
NPR 8715.2	NASA Emergency Preparedness Plan Procedural Requirement
NPR 8715.3B	NASA General Safety Program Requirements
NSS 1740.12	Safety Standard for Explosives, Propellants, and Pyrotechnics
USA012000	Ares I-X Florida Safety Operating Plan
USA004615	Ground System Configuration Accounting
USA004618	Integrated Process for Ground System Modification
USA004621	Ground Systems Configuration Control Board Operations
USA004642	Problem Reporting and Corrective Action System
USA004655	System Assurance Analysis
USA004773	Ground Operations Certification/Recertification Process and Documentation Requirements
USA004778	Engineering Design Reviews
SW-E-0002 Book 2	Space Shuttle Ground Support Equipment General Design Requirements – New GSE
AIX-SYS-SMA-MP	Software Assurance Plan

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 10 of 54
Title: Ares I-X SR&QA Requirements	

3.0 SR&QA REQUIREMENTS

3.1 GENERAL

3.1.1 Waivers and Deviations to Ares I-X SR&QA Requirements

Any system, element, component, operation, or any part of the Ares I-X flight test architecture that requires a deviation to or waiver/exception from any SR&QA requirements defined within this document shall obtain XCB approval as defined in Section 1.3.

3.1.2 Existing Waivers and Deviations associated with “Heritage” Hardware or Software

Any existing waivers and deviations previously dispositioned for the hardware or software that was designed and/or fabricated for another program (e.g., SSP, Atlas, Peacekeeper) shall be reassessed for the Ares I-X mission.

3.1.3 Changes and Revisions

Any changes to existing Ares I-X flight test SR&QA requirements shall be approved by the XCB, as defined in Section 1.3, prior to implementation.

3.1.4 Safety, Reliability, and Quality Assurance Plans

Each Ares I-X IPT and SE&I shall document and maintain an SR&QA plan describing the implementation of the Ares I-X SR&QA requirements. Each plan may be in either a single or multiple documents (i.e., a single comprehensive SR&QA Plan or individual plans for safety, reliability, maintainability, supportability, quality assurance, and software assurance).

The SR&QA Plan(s) shall:

- a. Be traceable to the Ares I-X SR&QA requirement(s) identified herein.
- b. Serve as the primary planning and control document for any applicable contractor SR&QA Programs.
- c. Contain charts of the applicable IPT or SE&I organizational structure that implement SR&QA requirements.
- d. Document the authority, roles, and responsibility with respect to identifying and implementing SR&QA requirements.
- e. Describe tasks, product, implementing procedures, techniques, and management criteria for SR&QA activities.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 11 of 54
Title: Ares I-X SR&QA Requirements	

- f. Describe SR&QA objectives, implementing policies and procedures, and control systems throughout all lifecycle phases.

3.1.5 Programmatic Audit and Reviews

The MMO Manager and IPT managers shall support Programmatic Audit and Reviews (PA&R) performed by or on behalf of the Office of Safety and Mission Assurance per NPR 8705.6, "Safety and Mission Assurance Audits, Reviews, and Assessments", paragraphs 3.2.7 and 3.2.8.

The Ares I-X NASA Engineering and S&MA personnel will support the Safety and Mission Success Review (SMSR) which is a pre-brief to OCE and OSMA and prior to the Flight Test Readiness Review (FTRR).

4.0 RISK MANAGEMENT

Risk Management shall be accomplished in accordance with CxP 70056, Constellation Program Risk Management Plan. Section 1.5.5 of CxP 70056 specifies how the scope and detail of individual risk management plans will be tailored.

5.0 SAFETY

5.1 SAFETY PLANNING

Each IPT and SE&I shall develop a safety plan to identify their system of ensuring the management of safety risk. The safety plan shall describe how the identification, elimination and/or control of potential hazards which lead to injury, loss of personnel and/or damage or loss of flight or ground hardware throughout the complete cycle of the Mission will be assured. The Safety Plan will integrate and describe the relationship of all safety activities. Safety plans encompass Industrial Safety/Occupational Health, System Safety as well as Site Safety plans for new construction, activation and/or operations of site activities at their home centers, while at KSC, and during transportation to/from KSC. This plan can be a separate plan or part of the SR&QA Plan.

The Centers, IPTs, and contractors shall ensure that employees have a means to report any designs, procedures, operations, processes, or software that are unsafe or do not meet safety requirements.

5.2 SYSTEM SAFETY MANAGEMENT FUNCTIONS

Each IPT and SE&I shall perform the following System Safety Management functions:

- a. Provide for periodic independent reviews of the system safety tasks keyed to Mission milestones (e.g., CSERP).

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 12 of 54
Title: Ares I-X SR&QA Requirements	

- b. Present to Ares I-X and/or IPT milestone review boards the results of safety reviews at each milestone (PDR, CDR, SAR, and FRR, etc)
- c. Assist and support independent review groups (including OSMA) chartered to provide independent assessment of the Mission.
- d. Develop, maintain and make available to each IPT and SE&I an up-to-date system of identified hazards throughout the life of Ares I-X. Note: One Ares I-X system may be used.
- e. Provide the appropriate safety oversight or insight of the Ares I-X tests, operations, or activities at a level consistent with mishap potential for the life of the Ares I-X.

5.3 MISHAPS

To ensure proper mishap investigation, Ares I-X MMO shall complete a Mishap Preparedness and Contingency Plan that covers mishaps and close calls that may occur from initial fabrication through decommissioning and that meet all the requirements of NPR 8621.1B, NASA Procedural Requirements for Mishap and Close Call Reporting, Investigating, and Recordkeeping.

5.4 TEST OR OPERATIONAL READINESS

IPTs shall perform an appropriate Test Readiness Review (TRR) or an Operational Readiness Inspection (ORI) prior to performing any operation or test which (a) is potentially hazardous to personnel or hardware, (b) has high risk in terms of Mission importance, or (c) involves test hardware, facilities or effort having high dollar value. The TRR or ORI shall include a safety assessment of facilities, equipment, test articles, operational procedures and personnel capability and determine the safety, technical, and operational readiness of the test.

5.5 CONTRACTOR SAFETY

Each IPT shall ensure that contracts are written to hold contractors accountable for the safety of their employees, their services, and their products and their facilities in accordance with NASA, Federal, State and Local requirements. Contracts and grants covering NASA programs and operations must include appropriate mishap and close call notification, reporting, recording, and investigation procedures and corrective requirements detailed in the NASA Federal Acquisition Regulation (FAR) Supplement (NFS) and in NPR 8621.1B.

5.6 INDUSTRIAL SAFETY

Each IPT is responsible to coordinate with the applicable centers to ensure the applicable safety, health, and environmental requirements of the NASA Procedural

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 13 of 54
Title: Ares I-X SR&QA Requirements	

Requirements (NPRs), NASA Standards, and NASA Policy Directives (NPDs) are included in all contracts.

Note: The following NPRs, NPDs, and NASA Standards provide applicable industrial safety requirements for contracts: NPR 1800.1, NPD 1800.2, NPD 8700.1 para. 5h/5i, NPD 8710.5, NPD 8710.2, NPR 8715.1, NPR 8715.2, NPR 8715.3 chapters 1, 2, 3, 5, 7, 8, and 9 and Appendix E, and NASA-STD-8719.7, NASA-STD-8719.8, NASA-STD 8719.9, NASA-STD-8719.10, NASA-STD-8719.11, NASA-STD-8719.17, and NSS 1740.12.

If an IPT owns and operates a facility which contains a pressurized system or pressure vessels, they shall be required to comply with NPD 8710.5C, NASA Safety Policy for Pressure Vessels and Pressurized Systems.

5.7 HAZARD ANALYSES

Ares I-X shall perform hazards analyses in accordance with CxP 70038, Hazard Analyses Methodology with the scope defined below. Request to work to an alternate format/content shall be presented to the Constellation Safety and Engineering Review Panel (CSERP) for approval. The request shall include supporting rationale.

Ares I-X hazard analyses, at a minimum, shall address catastrophic and critical hazards as defined below.

Catastrophic hazard: (1) A hazard that could result in a mishap causing fatal injury to personnel, and/or loss of one or more major elements of the flight vehicle or ground facilities. (2) A condition that may cause death or permanently disabling injury, major system or facility destruction on the ground, loss of major systems, or loss of vehicle during the mission. [Note: For the Ares I-X mission, the loss of the vehicle is catastrophic up to and including separation of the 1st stage to the Upper Stage Simulator (USS).]

Critical hazard: a state or condition that could cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.

Hazard Risk Acceptance: Ares I-X shall obtain Constellation Program Manager and/or CSERP approval or concurrence on all hazard reports as defined in CxPMD-013, Charter for the Constellation Safety and Engineering Review Panel (CSERP).

5.7.1 Special Provisions for Space Shuttle “Heritage Systems” Hazard Analysis

Ares I-X First Stage, GO and GS may perform and document hazards analyses for new, modified, or heritage hardware/software, in accordance with NSTS 22254, Methodology for Conduct of Space Shuttle Program Hazard Analyses.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 14 of 54
Title: Ares I-X SR&QA Requirements	

Existing Space Shuttle hazard analyses reports may be retained in original formats, but shall be re-assessed for the Ares I-X flight test application and updated accordingly. Request to work to an alternate format/content shall be presented to the Constellation Safety and Engineering Review Panel (CSERP) for approval. The request shall include supporting rationale.

5.8 PHASED SAFETY REVIEW PROCESS

Ares I-X shall utilize a phased safety review process. Safety packages are required for each Mission/IPT milestone review. The Phase II and III safety review process discussed in CxP 70038 shall be followed. The timeframe for the phased reviews should be coordinated with the CSERP.

5.9 RANGE SAFETY

Ares I-X shall coordinate with the Federal Aviation Administration (FAA) on each Range Operation that uses the National Airspace System and coordinate the required information with Range Safety personnel prior to submitting the request to the FAA center(s) with authority over the planned areas of operation.

Ares I-X shall comply with the requirements of NPR 8715.5, Range Safety Program, and the tailored Ares I-X Air Force Space Command Manual (AFSPCMAN) 91-710, Range User Range Safety Requirements.

The Launch Constellation Range Safety Panel (LCRSP), as directed by Constellation Program Management Directive CxP MD-103, shall serve as the technical forum to facilitate formulation and joint approval of NASA/USAF Range Safety policy agreements, to identify Range Safety requirements, and propose tailoring.

Ares I-X will support KSC, LCRSP, and the Range in the development of a quantitative assessment in order to verify compliance with the tailored AFSPCMAN 91-710 requirements.

5.10 GROUND OPERATIONS SAFETY

Ares I-X shall comply with the safety policies and requirements of the KSC Procedure Requirements documented in KNPR 8715.3. Operations performed in USA managed facilities are required to comply with applicable FSOP 6100 requirements. The specific requirements applicable to Ares I-X may be found in USA012000.

6.0 RELIABILITY

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 15 of 54
Title: Ares I-X SR&QA Requirements	

6.1 RELIABILITY MANAGEMENT AND IMPLEMENTATION

Each IPT and SE&I shall develop a Reliability Plan to describe their reliability approach for implementation of how to meet the requirements in this section. CxP 70087, Reliability, Availability, and Maintainability Plan may be used as a guide.

6.2 FMEA'S AND CIL'S

Ares I-X FMEAs and CILs shall be generated in accordance with CxP 70043, CxP Requirements for Preparation of Hardware Failure Mode and Effects Analysis and Critical Items List (FMEA/CIL). Request to work to an alternate format/content shall be presented to the Constellation Safety and Engineering Review Panel (CSERP) for approval. The request shall include supporting rationale.

Structure, pressure vessels, pressurized lines, and passive thermal protection (excluding MLI blanket) systems do not have to be addressed in the FMEA/CIL if they are addressed in hazard analysis reports.

FMEA/CILs will be approved and managed at the IPT level. IPTs shall assure that the failure modes captured in the FMEA/CILs that result in a catastrophic or critical hazard are documented in a hazard report to be reviewed at the CSERP.

6.2.1 Special Provisions for Space Shuttle "Heritage Systems" FMEA/CILs

Ares I-X First Stage, GO and GS FMEA/CILs for new, modified, or heritage hardware/software may be conducted in accordance with NSTS 22206, Requirements for Preparation and Approval of Failure Modes and Effects Analysis (FMEA) and Critical Items List (CIL).

Existing FMEA/CILS from heritage hardware may be retained in original formats but shall be re-assessed for the Ares I-X flight test application and updated accordingly. Request to work to an alternate format/content shall be presented to the Constellation Safety and Engineering Review Panel (CSERP) for approval. The request shall include supporting rationale.

6.3 ARES I-X GIDEP ALERTS

Problems with parts, materials, equipment, or software, which are of mutual concern to NASA and associated contractors, are reported by utilizing the NASA GIDEP ALERT system. The IPTs shall establish a systematic approach to evaluate and respond to all NASA ALERTS, safe-alerts, problem advisories, agency action notices, and NASA advisories and to investigate, resolve, and document parts and materials problems.

- a. Investigation. Upon receipt of a problem ALERT, the IPT will initiate an immediate investigation to determine the significance of the problem item identified by the ALERT.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 16 of 54
Title: Ares I-X SR&QA Requirements	

- b. Resolution. When investigation discloses known or suspected usage of the problem item identified in the problem ALERT, a problem report will be issued against flight equipment having such usage and against GSE in which the failure of the ALERT item could cause loss of vehicle systems or loss of personnel capability.
- c. Response. The IPT shall provide a documented response on each ALERT investigation and resolution to NASA in accordance with the applicable contract requirements.
- d. IPT – Initiated ALERTS. When the IPT encounters a significant problem with a part, material, or software which may adversely affect equipment, the IPT shall initiate an ALERT and submit it to their center's NASA ALERT coordinator.

6.4 LIMITED LIFE ITEMS

The IPTs shall identify limited life items (this does not include consumables), which require control from equipment date of manufacture throughout operational use, including storage. Provisions will be made for replacement or refurbishment of hardware after a specified age or operating time/cycle prior to launch. The IPTs shall report to MMO the status of limited life items and waivers on limited life items.

6.5 EEE PARTS

Each Ares I-X IPTs which have Electrical, Electronic, and Electromechanical (EEE) parts, with the exception of Avionics, shall develop and implement an EEE Parts Control Plan(s) that discusses the selection, acquisition, traceability, testing, handling, packaging, storage, and application of EEE parts in accordance with NPD 8730.2. The Avionics IPT shall comply with Atlas Program Parts, Materials, and Processes Requirement, Launch Vehicle (11000-97-014).

6.6 COTS

When selecting commercial off-the shelf (COTS) hardware or software used for Crit 1, Crit 1R, or Crit 1S applications, the flight test hardware and software developers shall identify the COTS used and examine historical data such as other contractor and program requirements and experiences as well as reliability history, including failure mode and effect analysis (FMEA), maintainability, problem reporting and corrective action, electrical, electronic, and electromechanical (EEE) parts control, materials specifications and applications, test data (certification and acceptance testing), and design data if existing. The results of this examination shall be documented and presented to the XCB for approval for use prior to procurement or within 90 days after these SR&QA requirements are levied on contracts.

7.0 QUALITY

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 17 of 54
Title: Ares I-X SR&QA Requirements	

7.1 QUALITY SYSTEMS REQUIREMENTS

Each IPT and SE&I shall flow AS9100 B to hardware developers with the exception that Jacobs is not required to be AS9100B compliant provided Jacobs contractually required its Ares I-X supplier to be AS9100B compliant. The applicable requirements shall be flowed to sub-tier suppliers.

In addition to the base AS9100 System requirements, AS 9006, Deliverable Aerospace Software Supplement, and ARP 9009, Aerospace Contract Clauses should be used as guidelines. The following supplemental requirements to AS 9100B shall also be met.

- a. In addition to the requirements set forth in AS9100, 7.5.2, the following requirements shall apply:
 1. Special processes, as defined in AS9100, section 7.5.2, performed by the contractor and NASA center shall be listed in the Quality Plan(s) and reviewed and approved by the IPT Quality Assurance.
 2. For ground operations, conduct Process Failure Modes and Effects Analysis (PFMEA) for critical processes or operations that are new and pose a high risk to personnel or equipment, or per direction of the XCB. PFMEA shall be reviewed and updated if necessary for critical processes or operations that have not been utilized in a 12 month period.
- b. In addition to the requirements set forth in AS9100, 7.5.3, the following requirements shall apply:
 1. Record the unique configuration of the product on manufacturing records and inspection documentation, including a delta or comparison of the as-built vs. as-designed records.)
 2. Establish and maintain documented stamp control policy and procedures.
- c. In addition to the requirements set forth in AS9100, 7.5.5, the requirements of NPR 6000.1, Packaging, Handling, and Transportation for Aeronautical and Space Systems, Equipment, and Associated Components shall be met.
- d. In addition to the requirements set forth in AS9100, 7.6, the Ares I-X IPTs shall maintain calibration on all test and measuring equipment and safety instruments used to perform measurements associated with the following functions:
 1. Acceptance testing (determining that a part, component, or system meets specifications).
 2. Inspection, maintenance, or calibration.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 18 of 54
Title: Ares I-X SR&QA Requirements	

3. Flight hardware qualification
4. Measurement of processes where test equipment accuracy is essential for the safety of personnel or the public.
5. Telecommunication, transmission, and test equipment where exact signal interfaces and circuit confirmations are essential to mission success.
6. Development, testing, and special applications where the specification, end products, or data are accuracy sensitive, including instruments used in hazardous and critical applications.

Ares I-X IPTs shall limit use of non-calibrated instruments to only applications where substantiated accuracy is not required, or for “indication only” purposes in non-hazardous, non-critical applications.

Ares I-X shall allow for a Metrology and Calibration Program that meets NSTS 5300.4 (1D-2).

7.1.1 Special Provisions for Shuttle “Heritage Systems” Quality Systems

Ares I-X shall allow for Quality Systems that meet NSTS 5300.4(1D-2) for the 1st Stage, GS, GO new, modified, or heritage hardware/software.

7.2 QUALITY PLANNING

Each IPT shall develop quality planning procedure(s) for use by the Production Engineering and Quality Planning departments or organizational equivalents. Quality planning procedure(s) shall be under change control and require NASA approval at release and subsequent revision.

The Quality planning procedure(s) shall delineate inspection requirements for all critical classes of hardware as defined by CxP 70043 (or NSTS 22206), and safety critical software as defined by NASA-STD-8719.13 section 4.1.1.2, and include where NASA or its delegated representatives shall perform Government Mandatory Inspection Points as specified in section 7.7 below. For integrated operations and in areas where Quality Planning Procedures are in conflict, the more stringent inspection requirement shall apply.

The inspection requirements for these critical classes of hardware and software shall provide for traceability to the applicable Hazard Analysis and CIL except for existing applicable SSP processes at KSC (note: new processes developed for Ares I-X at KSC will included HA and CIL traceability).

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 19 of 54
Title: Ares I-X SR&QA Requirements	

7.3 SURVEILLANCE PLANS AND AUDITS

Ares I-X hardware developers shall ensure that all systems, sub-systems and system modifications include surveillance plans as specified in NPR 8735.2.

NASA Ares I-X Government QA and CxP QA, or their delegated representatives, shall perform a review, as required by the CxP SR&QA Director, of the product or service provider's (e.g., contractor, government facility, NASA Center, etc., as applicable) quality system, including internally developed operating instructions, to validate compliance with contractually invoked quality program requirements.

Audits shall be thorough on-site reviews of an organization's quality activities and interfaces with other disciplines to determine that:

- a. SR&QA requirements are documented and implemented
- b. Ares I-X flight test requirements are being met
- c. Policies, procedures, and instructions are adequate
- d. Implementation is effective toward producing space flight quality products

7.4 PARTS PROCUREMENT

Parts procurement for the Ares I-X IPTs, with the exception of Avionics, shall meet the requirements of NPD 8730.2, NASA Parts Policy. The Avionics IPT shall comply with Atlas Program Parts, Materials, and Processes Requirement, Launch Vehicle (11000-97-014).

Consistent with the requirements of NPD 8730.2, IPT's shall implement a fastener integrity program. MSFC-STD-2594, MSFC Fastener Management & Control Practices should be used as a guide when developing this fastener integrity program.

7.5 WORKMANSHIP STANDARDS

Ares I-X IPTs, with the exception of Avionics, shall comply with the workmanship standards identified in paragraphs 4.i through 4.k of NPD 8730.5. The Avionics IPT shall comply with Atlas Program Parts, Materials, and Processes Requirement, Launch Vehicle (11000-97-014). Ares I-X First Stage, GO and GS may use SSP workmanship standards.

7.6 VERIFICATION OF PURCHASED PRODUCTS

When performing lot acceptance sampling for non-pyrotechnic items that require destructive testing, including circumstances for which visual inspection is not possible or adequate, statistical procedures described in ANSI/ASQC Z1.9-2003 for inspection by

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 20 of 54
Title: Ares I-X SR&QA Requirements	

variables and ANSI/ASQC Z1.4-2003 for inspection by attributes shall be used. [*For all Crit 1, 1R, and 2 classes of hardware, inspection level III shall be used with zero acceptable rejects. Upon rejection of a Crit 1, 1R, or 2 hardware item, sampling shall be discontinued until root cause has been determined and corrective actions have been implemented.*] Sampling plans, other than those described in the above documents may be utilized after approval of NASA or its designated Government quality representative.

For pyrotechnic device inspection, use of sampling inspection and sample plans shall be approved by the appropriate NASA design center QA organization. When used, sampling inspection shall be in accordance with ANSI/ASQC Z1.4, with the following exception: Whenever sampling inspection reveals one or more nonconforming items and the sampling plan does not require rejection of the lot, all items in the lot shall be inspected for the identified nonconforming characteristic.

For pyrotechnic device destructive lot acceptance testing (DLAT), the minimum number of parts to be destructively tested shall be as follows:

- a. Loaded pyrotechnic devices which contain an integral pyrotechnic charge: The minimum number of parts to be fired in DLAT shall be 10% of the lot or two units minimum, whichever is greater. Lot size equals the final number of units which are presented for formal lot acceptance. Fractional sample sizes 0.5 and above must be rounded upward and sizes below 0.5 must be rounded downward.
- b. Inert pyrotechnic devices which do not contain an explosive component but are functioned by a separable cartridge: The minimum number of parts to be fired from various lots of inert pyrotechnic devices will be established by the appropriate Project Office, based on the following criteria:
 1. Each unit of the lot shall be subjected to a proof load test, and a minimum of two units shall be subjected to an ultimate load test. Additional acceptance tests for inert pyrotechnic devices may be accomplished by one of the following methods:
 - a. Devices that can be functionally verified by the application of pneumatic pressure at an appropriate level of assembly or when completed may be accepted as a lot without a pyrotechnic DLAT firing. This approach requires that each unit in the lot function at an acceptable pressure and then be reassembled maintaining the components as a set. Components that are normally degraded during the functioning must be replaced. If other components are degraded, the pressure test must be repeated. These tests may be performed at an appropriate level of assembly.
 - b. Devices that cannot be functionally verified as specified in subparagraph (a) because the unit would be destroyed must be accepted by pyrotechnic DLAT firings. The DLAT sample size shall not be less than two units.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 21 of 54
Title: Ares I-X SR&QA Requirements	

- c. Frangible devices shall be accepted by a minimum of two pyrotechnic DLAT firings. These firings shall demonstrate the required performance margin in a manner dependent on the design of the device. Frangible nuts shall demonstrate the required performance margin with a single production cartridge/charge if dual cartridges/charges are used.

7.7 GOVERNMENT MANDATORY INSPECTION POINTS

Government Mandatory Inspection Points (GMIPs) should be established in order to assure conformance to hardware characteristics, manufacturing process requirements, operation conditions, and functional performance criteria that, if not met, can result in a catastrophic hazard (as defined in section 5.7). At a minimum, Safety-Critical Government Mandatory Inspection Points (GMIPs), as defined by NPR 8735.2, Section 8.2.1(a), shall be established and performed per Chapter 8 of NPR 8735.2, Management of Government QA Functions for NASA Contracts. Additional Government Mandatory Inspections Points shall be performed if requested by the MMO or applicable IPT per NPR 8735.2, paragraph 8.2.

GMIPs shall be performed by Government personnel, or personnel delegated authority to represent the Government by the applicable NASA QA organization.

The Government and Contractor shall jointly develop a Government Mandatory Inspection Point (GMIP) notification process that assures advance Government notification of work operations involving GMIPs, and that results in timely performance of GMIPs at subcontractors/suppliers.

Safety-Critical Government Mandatory Inspection Points (GMIPs) that are bypassed or omitted during processing shall request a missed MIP waiver from the XCB.

GMIPs cannot replace contractor inspections or relieve the contractor of the responsibilities for ensuring product quality.

7.7.1 Special Provisions for Avionics “Heritage Atlas” Hardware

Ares I-X shall allow for NIP’s (Notification of Inspection Points) that are imposed by previous delegations from the Atlas Program to be sufficient for the boxes considered Off-the-Shelf (OTS) Avionics “Heritage Atlas” hardware.

OTS Avionics “Heritage Atlas” hardware includes only the following components:

- FTINU (fault tolerant inertial navigation unit)
- RRGU (redundant rollrate gyro unit)
- PYC (pyrotechnic controller)
- URCU (upper stage remote control unit)
- MDU (master data unit)

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 22 of 54
Title: Ares I-X SR&QA Requirements	

- RDU (remote data unit)
- MVB (main vehicle battery)
- PYB (pyro battery)
- DFI S-Band Transmitters
- S-Band Antenna
- Video Cameras
- Ring Coupler
- VPDU (video power divider unit)
- Power Divider
- Bus Couplers.
- FTINU Mounting Plate
- Atlas Heritage OFI Transducers

7.8 DELEGATION OF QUALITY ASSURANCE FUNCTIONS

Delegation of Government QA functions on Ares I-X shall be in accordance with and meet the requirements of Chapter 5 and Appendix C of NPR 8735.2.

In addition, support contracts to non-government agencies used to assist NASA shall be developed and administered in accordance with and meet the requirements of NPR 8735.2, Chapter 6.

7.9 PROBLEM REPORTING

7.9.1 PRACA

At a minimum, Ares I-X hardware / software developers shall implement a closed-loop problem reporting and corrective action system for all problems concerning flight, test, simulator, and training hardware/software where that hardware/software is representative of flight hardware, and GSE. Problems include non-conformances, failures, and anomalies. The Ares I-X hardware developers may utilize the CxPRACA system for closed-loop reporting of these problems and the establishment of corrective action; with the exception that the Ares I-X shall utilize the CxPRACA system for activities at KSC. [Note: This does not include the Assembly and Refurbishment Facility (ARF).] The minimum set of required fields for PRACA shall be those listed in the taxonomy described in CxP 70068 Constellation Program Problem Reporting, Analysis and Corrective Action (PRACA) Requirements, Volume 3, for the interim PRACA.

7.9.2 NONCONFORMANCE MARKING IDENTIFICATION

Nonconforming hardware shall be marked or identified in a manner that will preclude redundant or duplicative nonconformance reports from being written.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 23 of 54
Title: Ares I-X SR&QA Requirements	

7.10 MATERIAL REVIEW BOARDS

The Material Review Board (MRB) system is the process through which technical review of nonconforming product that cannot or will not be returned to drawing/specification is conducted and the nonconformity is formally dispositioned.

The Ares I-X IPTs shall establish a Material Review Board (MRB) at their respective centers and/or with their contractors (in accordance with AS9100 unless governed by NSTS 5300.4(1D-2)). If the IPT contractor has a heritage MRB system which complies with NSTS 5300.4 (1D-2), they may utilize this system in lieu of complying with the new system specified below as long as the MRB membership includes NASA Engineering and NASA S&MA representatives, or their delegated representatives, from the applicable IPT.

The NASA Ares I-X IPTs shall approve the establishment of any Contractor Material Review Board (MRB) for dispositioning non-conformances associated only with that IPT and their Contractor's products. In either case, the MRB membership requirements specified below.

IPTs that are processing hardware whose design responsibility falls under the responsibility of a different Ares I-X IPT shall include the "Design" IPT Engineering and SR&QA representatives as part of the MRB. The processing IPT shall notify the SE&I Lead Engineer and Lead SE&I S&MA representative of any Joint IPT MRB that will be held.

The IPT Level MRB process shall be defined in the respective Quality Assurance Plan.

Each MRB has the authority to approve repair, use-as-is, downgrade, and scrap dispositions. Nonconformances that can be returned to print or repaired using a government approved, pre-existing repair procedure (e.g., standard repair) do not require MRB disposition. Return-to-Print is a generic term meaning that the problem has been fully resolved, and the hardware has been restored to full compliance with established design, certification, safety, and operating requirements. Returning a hardware item "to print" can involve, but is not limited to, removing the anomalous hardware and replacing it with fully conforming hardware, or performing maintenance on the hardware to restore full compliance with the governing engineering (e.g., drawing, spec).

- a. Membership: The IPT Level MRB shall, as a minimum, be composed of:
 1. For contractor produced hardware, one supplier representative whose primary responsibility is design engineering;
 2. For contractor produced hardware, one supplier representative whose primary responsibility is product quality;

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 24 of 54
Title: Ares I-X SR&QA Requirements	

3. NASA Engineering and NASA S&MA representatives, or their delegated representatives, from the applicable IPT.

Note: The requirement of MRB membership for the Avionics “Heritage Atlas” Hardware during initial disposition is not required. Off the Shelf Avionics “Heritage Atlas” hardware is defined in section 7.7.1. However, both NASA Engineering and NASA S&MA representatives, or their delegated representatives, from the applicable IPT will jointly review and concur or reject these dispositions prior to NASA acceptance of the associated hardware for use on Ares I-X. This process will be documented in the Avionics Review Plan, AIX-AVI-PLN-ARP.

- b. Responsibilities: As non-conformances are presented for MRB review, the supplier/user’s quality representative, in conjunction with the other MRB members, shall:
 1. Evaluate material submitted.
 2. Determine or recommend disposition, such as scrap, repair, etc
 3. Approve the method and procedure for repair, when repair is appropriate
 4. Provide supplier recommendations to the IPT MRB concerning nonconformance dispositions requiring approval and QA will verify implementation after approval is obtained
 5. Provide rationale and send forward to the XCB any disposition which requires a waiver, deviation, or exception
 6. Ensure that effective corrective and preventive actions, if required, are documented or linked on the nonconformance document
 7. Ensure that accurate records of MRB actions are maintained
- c. MRB Dispositions: Dispositions shall require the unanimous agreement and signature of the applicable board members. Nonconformances presented to the MRB for disposition shall include (as a minimum) the following:
 1. Part Name/Number
 2. Nonconformance Description – description of the nonconformity with sufficient detail to allow engineering evaluation and disposition. Digital photos should be included when available or beneficial to the MRB.
 3. Traceability to the nonconformance documentation (i.e., nonconformance report number, discrepancy report number, etc.)

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 25 of 54
Title: Ares I-X SR&QA Requirements	

4. Functional Criticality – The functional criticality (failure mode) of the item in the MRB state as determined by FMEA or Appendix D of this document
 5. Rationale – justification supporting the use of the item in the conditioned dispositioned in the MRB
- d. In determining dispositions, the MRB shall: consider the effect of the nonconformance upon the intended use; classify nonconformance for processing on a priority basis; review records of earlier review actions affecting the same or like article, software, or material; and consider the recommendations of personnel acting in an advisory capacity.
- e. The MRB shall disposition the nonconformance using one of the following disposition types
1. Waivers: This disposition shall be used if an Ares I-X Flight Test requirement cannot be met, and there is adequate rationale to justify the use of the product. This disposition requires approval by the XCB after being elevated to the Engineering Review Board (see section 7.10.f).
 2. Repair: When, in the opinion of the Board, an acceptable repair is possible, repair action may be authorized. Procedures shall be established and/or approved by the MRB to perform this repair. Procedures shall include appropriate inspections (including assignment of any appropriate GMIPs) and tests to verify the acceptability of the repair. The following applies to non-mission critical hardware only. Standard repair procedures, if developed, shall be under the control of the MRB. Standard repair procedures shall be approved by the MRB, including the NASA Ares I-X Engineering and S&MA representatives. The MRB may grant authority to apply these approved standard repair procedures for similar non-conformances. The standard repair procedure shall identify hardware applicability, extent of characteristic nonconformance, detailed instruction for accomplishing the repair, and inspection/ test criteria (including GMIPs) for the repaired article or material. The existence of standard repair procedures shall not relieve the supplier of the responsibility for initiating preventive action to the fullest extent practicable.
 3. Return to Vendor: Generally, if the product received is nonconforming it will be returned to vendor and does not require an MRB. If the nonconforming product is used, all MRB members must agree to accept the product.
 4. Use-as-is: The MRB is authorized to continue using a nonconforming product when it has concluded that the nonconformance does not impact the form, fit, or function of the product, and results in an acceptable level of risk. Analysis or other data supporting the determination that form, fit, and function are not

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 26 of 54
Title: Ares I-X SR&QA Requirements	

impacted and risk level shall be documented within the nonconformance report

5. Downgrade: Considerations should be given to alternate use of the downgraded article for supplier Ares I-X Flight Test training programs, engineering laboratory work, etc. in order to minimize the financial loss resulting from downgrade dispositions. The supplier shall assure that downgraded articles are accounted for as to their end use, and that they are not to be used for flight hardware. In addition, the supplier shall identify corrective actions taken to reduce costs resulting from nonconforming articles and materials scrap
6. Scrap: If the article or material is unfit for use, it shall be dispositioned in accordance with Ares I-X Flight Test approved Contractor procedures for identifying, controlling, and disposing of scrap or, in the case of software, further development or repair can be cancelled. The supplier shall assure that scrap is accounted for and that it is not to be used for flight hardware. In addition, the supplier shall identify corrective actions taken to reduce costs resulting from nonconforming articles and materials scrap

f. Elevation of Nonconformances:

Nonconformances shall be elevated from the IPT(s) Level MRB to the Ares I-X System Level MRB for approval, which is composed of the Ares I-X Engineering Review Board membership and the SE&I Lead System Engineer (LSE), when the nonconformance meets one or more of the following criteria. If a non-conformance meets any of the criteria below, the IPT shall not proceed with irreversible work until there is System-level MRB concurrence:

1. When an unanimous agreement cannot be achieved at the IPT(s) Level MRB level
2. Any substitution of parts/hardware deviating from drawing allowances. This does not include substitution of parts/hardware with the same part number(s).
3. Any MR that affects a characteristic controlled by an ICD, IRD, or affects the outer mold line (OML).
4. At the request of any IPT(s) Level MRB member (i.e., increased visibility even if the IPT Level MRB member agrees with the proposed disposition)
5. Requires a waiver to an Ares I-X requirement contained in an XCB controlled requirement document
6. Are a result of an unexplained anomaly

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 27 of 54
Title: Ares I-X SR&QA Requirements	

7. Required IPT(s) Level MRB actions are outside the cost/schedule capability of the affected IPT(s)

Nonconformances shall be elevated from the System Level MRB to the Ares I-X Control Board (XCB) for approval when the nonconformance meets one or more of the following criteria:

1. When an unanimous agreement cannot be achieved at the System Level MRB level
 2. At the request of any System Level MRB member (i.e., increased visibility even if the System Level MRB member agrees with the proposed disposition). Example could be due to anticipated risk increase.
 3. Requires a waiver to an Ares I-X requirement contained in an XCB controlled requirement document
 4. Required System Level MRB actions are outside the cost/schedule capability of the affected IPT(s)
- g. MRB Holding Area: The supplier shall establish holding areas for articles and materials submitted to the MRB. These holding areas shall provide for the following:
1. Access limited to MRB members, personnel escorted by an MRB member, and authorized personnel administering the area. The supplier shall make provisions to prevent unauthorized entrance when area is not attended and to preclude removal of hardware except in accordance with the approved MRB disposition.
 2. Storage facility.
 3. Posting of the current list of the names of authorized personnel, including MRB members.
 4. When the disposition affects Ares I-X contract requirements, the MMO, with respective contracting officer approval shall be required.
 5. Articles and materials shall be withheld from further processing until appropriate disposition is obtained
 6. Repair Controls: The supplier shall prepare manufacturing documents to accomplish repair operations, including standard repairs.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 28 of 54
Title: Ares I-X SR&QA Requirements	

7. Repair Controls: Prior to initiation of work, the supplier shall review these documents to assure that they provide detailed step-by-step instructions, material requirements, dimensional and process parameters, and any other considerations imposed by the MRB disposition.
8. Repair Controls: Appropriate inspection and test accomplishment shall be verified by the supplier to verify the acceptability of the repair.
9. Repair Controls: Repair records and data traceable to the affected article shall be maintained on file by the supplier.

7.11 FINAL ACCEPTANCE

Final Acceptance of Ares I-X hardware, software, and GSE shall be carried out in accordance with NPR 8735.2, 2.8 and performance of final product acceptance may not be delegated to a non-Government entity.

NASA Ares I-X Government QA, or their delegated representatives, shall plan and accept contractor delivered product based on the following:

- a. Verification activities for all critical equipment (i.e., equipment that could lead to catastrophic or critical hazards, which includes items that are classified as Crit 1, 1R, 1S, 2, 2R or 2S, shall include:
 1. Obtaining objective evidence of the quality of the product from suppliers (e.g., accompanying documentation, certificate of conformity, test reports, statistical records, process control),
 2. Review of the required documentation
 3. Inspection of products either upon receipt or at the supplier's premises
- b. Where tests are necessary for verification and validation, these tests shall be planned, controlled, reviewed, documented and witnessed by NASA Ares I-X Government QA or their delegated representatives for all critical equipment in accordance with the requirements for Government Mandatory Inspection Points (GMIPs).

The acceptance data package shall include an as-built parts list as well as build, assembly, and test records, or records as currently provided by a previously approved NASA Acceptance Data Package content for another NASA Program (e.g., SSP) (note that existing non-conformances, deviations and waivers dispositioned for the shuttle "heritage" hardware shall be reassessed for the I-X mission and included in the package). This is with the exception that the Avionics OTS hardware is not required to provide the as-built parts list or build and assembly records.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 29 of 54
Title: Ares I-X SR&QA Requirements	

The acceptance data package shall include component qualification and certification records. Component qualification and certification refers to qualification and certification for the configuration and mission profile being tested on Ares I-X. (e.g., certification of components for Shuttle loads and configuration shall not constitute certification for flight on Ares I-X unless the hardware configuration and loads are identical.)

7.12 PROGRAM QUALITY PANEL

Ares I-X IPT, SE&I, and Prime Contractors Quality personnel shall participate in the CxP Program-level Quality Panel as-required to help assure that the Quality system requirements are clearly defined and that those requirements are communicated and satisfactorily implemented.

7.13 CONTROL OF QUALITY RECORDS

IPT records, storage media and method of retrieval shall be defined and maintained for life of the Ares I-X flight test plus 5 years.

Methods of assuring records control by subcontractors shall also be defined, up to and including Contractor retaining records in the case of subcontractor business end.

Calibration records of equipment used as inspection, measuring, or test equipment shall be retained for 5 years after the equipment is excessed or no longer in NASA inventory.

The Contractor shall make provisions to meet and provide NASA or its delegated representative with access to all records of management reviews.

8.0 SOFTWARE ASSURANCE

8.1 PROGRAM

These requirements shall be applied to all new and modified software developed, acquired, modified, or maintained by or for Ares I-X. This includes all open source software, firmware, data, Programmable Logic Device/Controllers (PLD/PLC) computer programs, FPGAs, Government off-the-shelf (GOTS) software and modified off-the-shelf (MOTS) software when included in a NASA system.

Each flight test hardware and software developer should use CxP 70128, Constellation Software Assurance Plan, as a guide. See AIX-SYS-SMA-MP for all acquirer related software assurance activities.

8.1.1 Special Provisions for Space Shuttle and Launch Vehicle “Heritage Systems” Software Assurance Requirements

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 30 of 54
Title: Ares I-X SR&QA Requirements	

Ares I-X IPT Software Assurance Program for new, modified, or heritage hardware/software may be conducted in accordance with the existing processes developed by Lockheed Martin and Kennedy Space Center. These processes are depicted in Appendix C of this document and meet the intent of Section 8.0 Software Assurance.

8.2 PROVIDER SOFTWARE ASSURANCE

8.2.1 Provider Program

The SW provider shall plan, document, and implement a software assurance program covering the entire software lifecycle. This includes documentation of software assurance procedures, processes, deliverables, tools, techniques, and methods to be used. (Note: This plan can be a standalone Software Assurance Plan or part of another SR&QA Plan.)

The SW provider software assurance program shall describe what metrics will be collected and reported in regards to the software assurance program activities. The SW acquirer software assurance program shall describe what metrics will be reported from the project by both the acquirer and provider.

8.2.2 Management

The SW provider shall identify a person, within SR&QA, with responsibilities for directing and managing the software assurance program.

The SW provider shall conduct and document periodic reviews of the software assurance process.

The SW provider shall have approval authority on the establishment and composition of all software baselines and any changes to the baselines before submission to the acquirer. This includes changes to software plans, procedures, verification approaches, design, and code.

The SW provider shall provide software assurance status reports to the acquirer SR&QA SW Manager which will include, but are not limited to, the results of provider assurance activities, areas of concern, outstanding problem reports, and provider SW metrics and SW Assurance metrics.

8.3 REQUIREMENTS

8.3.1 Access

The SW provider shall allow access to software and associated artifacts to enable insight/oversight by software engineering and acquirer software assurance which includes Independent Verification and Validation (IV&V) and NASA's SR&QA

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 31 of 54
Title: Ares I-X SR&QA Requirements	

organizations. Software and associated artifacts include source code, problem/error reports, plans, requirements, analyses results, test results, review results, the as built configuration, SW Data Acceptance Package, and library files needed to produce executable code.

8.3.2 Software Quality

8.3.2.1 Product Assurance

In addition to the software requirements herein the Ares I-X Provider SR&QA SW Managers shall assure the following:

- a. Software code meets requirements (Engineering standards specified in the development plan).
- b. Error handling and fault detection, isolation and recovery requirements have been addressed.
- c. Verification and validation plans and procedures contain provisions to determine if fault tolerance and safety criteria are met.
- d. Plans are complete and mutually consistent.
- e. Flight test documentation, including changes, is reviewed for impact to the quality of the product.
- f. Formal and acceptance software test procedures are reviewed and approved.
- g. Formal and acceptance software testing are witnessed by software assurance personnel to verify satisfactory completion and outcome.
- h. Lower level testing results and software development folders (or equivalent) are updated, audited, and complete.
- i. Functional configuration and physical configuration maintained in accordance with certification requirements.
- j. Software quality metrics are in place and are used to ensure the quality and safety of the software products being delivered.
- k. Software development plans specify the standards and procedures for management, acquisition, engineering, and assurance activities.
- l. Problems with products are reported during participation in formal and informal reviews and during regular reporting to flight test management and engineering during team meetings.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 32 of 54
Title: Ares I-X SR&QA Requirements	

- m. Changes to the software and software induced operational workarounds have been reviewed and approved.

8.3.2.2 Process Assurance

The Ares I-X Provider SR&QA Managers shall assure the following:

- a. Software engineering practices, development environment, test environment, and libraries employed for the flight test adhere to applicable standards and procedures.
- b. Formal reviews and inspections address software quality issues.
- c. Software is developed according to an approved process
- d. Trends in software quality metrics are reported to assist in risk mitigation
- e. Status and quality of the software are presented at formal reviews

8.3.3 Discrepancy and Problem Reporting, and Corrective Action

The Ares I-X Provider SR&QA Managers shall approve safety-critical discrepancy report closures.

All discrepancy reports for safety-critical software shall be reviewed regularly for safety impacts by the Ares I-X Provider SR&QA Managers.

All changes to safety-critical software, including those that result from problem or discrepancy resolution shall be evaluated by the Ares I-X Provider SR&QA Managers for potential safety impacts, including the creation of new hazard contributions and impacts, modification of existing hazard controls or mitigations, or detrimental effect on safety-critical software or hardware. The SW acquirer shall also be informed of all changes to safety-critical software.

8.3.4 Software V&V

The Ares I-X Provider SR&QA managers shall assure that software verification and validation (V&V) activities are performed according to approved plans, policies, procedures, and standards.

The Ares I-X Provider SR&QA managers shall participate in the formal and informal reviews. Such activities include peer reviews, inspections, and milestone reviews (for example, software requirements review, design reviews, test readiness reviews, certification readiness reviews).

Each task/Element shall collect data on the types and causes of defects detected.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 33 of 54
Title: Ares I-X SR&QA Requirements	

8.3.5 Software IV&V

Ares I-X shall utilize software IV&V with the NASA IV&V Facility determining the level of IV&V services to be provided to the Ares I-X flight test.

The NASA IV&V Facility will prepare an Independent Verification and Validation Plan (IVVP) for Ares I-X.

The SW provider shall provide access to all data and information required for the IV&V effort to IV&V Facility personnel.

8.3.6 Software Safety

The Ares I-X Provider SR&QA managers shall perform a software safety-criticality evaluation on all software, regardless of source, during the concept or formulation phase (prior to acquisition and planning).

8.3.6.1 Software Safety Critical Evaluation and Analyses

When a system is determined to be safety-critical (e.g. through a preliminary hazard analysis), the provider SR&QA Manager shall perform a software assessment and apply a risk methodology to evaluate all software associated with the system to ensure safety and mission success.

The SW provider SR&QA Manager shall classify software as safety-critical per NASA-STD-8719.13B Section 4.1.1.2.

8.3.6.2 Safety Activities

The software safety-critical classification shall require the approval of the IPT Element Review Board.

8.3.6.2.1 General Requirements for Software Safety Analyses

The provider shall conduct Software Safety analyses in accordance with CxP 70038, Hazard Analysis Methodology, across the software life-cycle in conjunction with the overall system safety analyses.

The provider shall integrate all software assessments (i.e. safety analyses, evaluations and hazard reports) with the system safety assessment as a deliverable product.

The SW provider SR&QA Manager shall assure that software safety risks are captured, addressed, and managed as part of the risk management process.

The SR&QA SW Manager shall:

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 34 of 54
Title: Ares I-X SR&QA Requirements	

- a. Communicate software safety concerns directly to the Ares I-X flight test manager for resolution within the flight test.
- b. Elevate software safety concerns that cannot be resolved within the flight test.

The SW provider shall prepare, maintain, and implement a Software Safety Plan.

The SW provider Software Safety Plan shall require IPT ERB approval.

The SW provider and acquirer SR&QA managers shall manage all safety-critical software and associated documentation, simulators, test suites, and data in accordance with the SW provider software configuration management process.

Changes to baselined safety-critical software shall require IPT ERB approval.

The SW provider SR&QA managers shall perform the following software safety activities:

- a. Evaluate all hazards to determine whether the software is a contributing cause, control, mitigation or other factor.
- b. Evaluate identified hazards associated with a specific requirement, design concept and/or operation to determine if software is a contributor to hazard causes, controls, or mitigations.
- c. Identify the specific software module or function associated with the hazard cause, hazard control or loss of a safety critical function. This includes any related data, criticality references, the software component (CSC, CSCI and CSU), related dependencies and, if necessary, identification down to the lowest level of code.
- d. Identify the software error(s) or computer based control failure that can result in the hazard, loss of the hazard control or loss of a safety critical function.
- e. Identify the verification (requirements and methods) of the Computer Based Control System (CBCS) requirements and control(s).

8.3.6.2.2 Software Safety Requirements Development and Analysis

The SW provider shall ensure that the software safety-critical requirements are clearly identified as such in all software requirement specification (SRS) documents.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 35 of 54
Title: Ares I-X SR&QA Requirements	

8.3.6.2.3 Software Safety Design and Analysis

The SW provider shall analyze the implementation of the software safety requirements in the Software Design to verify that the design prevents, controls, or mitigates the identified hazards.

The SW provider shall verify that the software safety requirements are testable.

The SW provider shall ensure that the Software Safety Design Analyses includes the following:

- a. Determine that the design does not compromise any safety controls or processes, that any new hazard, hazard cause, or hazard contribution is identified and that the design maintains the system in a safe state during all constraints and modes of operation.
- b. Analysis of off-the-shelf or legacy/reused software and software tools used for the development of safety-critical software.
- c. Identify all associated relevant hazardous commands used.
- d. Identify the verification method used for the safety requirements.
- e. Clearly identify safety-critical design elements in the design documentation.

The SW provider shall present the Software Safety Design analysis results at milestone reviews and Constellation safety reviews.

8.3.6.2.4 Software Safety Implementation

The SW provider shall perform code analyses to verify the correct implementation of safety-critical requirements and software safety design features.

The SW provider shall utilize coding standards to limit the use of language features which can reduce software safety.

The SW provider shall present the software safety code analysis results at milestone reviews and Constellation safety reviews.

8.3.6.2.5 Software Safety Testing and Analysis

The SW provider shall verify the software safety requirements and safety-critical software functions by the verification method of test, unless otherwise approved by the Acquirer SR&QA Manager.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 36 of 54
Title: Ares I-X SR&QA Requirements	

The SW provider shall analyze verification and validation plans, procedures, and methods for correctness, coverage, and effectiveness.

The SW provider shall conduct final verification and validation (V&V) tests using only tested, validated models, simulations and analysis tools.

The SW provider shall record and report the results of all tests for review by the Acquirer SR&QA Manager and Constellation safety reviews.

8.3.6.2.6 Software Safety Traceability

The SW provider shall implement and maintain traceability which maps all system hazards, related hazard commands with their associated computer based controls requirements, down to the CSC, CSCI, CSU, implementation and test.

The SW provider shall report status on the traceability to the Acquirer SR&QA Manager and Constellation safety reviews.

8.3.6.3 Certification Process

The SW provider shall verify all safety-critical software prior to release and operational use, including tools, off the shelf, legacy, and reused software.

The SW provider SR&QA Manager shall approve the test and final results and reports prior to acceptance of the software and the system.

The SW provider SR&QA Manager shall present the software products (i.e. requirements, verifications, open issues, etc.) to milestone reviews.

8.3.6.4 Operational use of Software

The SW provider shall ensure the software safety change analysis includes an assessment of the amount of regression testing needed to verify that the implementation of new software requirements have not affected the implementation of existing safety-critical software.

The SW provider shall provide operational documentation, including software user manuals and/or procedures.

The SW provider shall ensure that the operational documentation describes all safety related commands, data, input sequences, options, and other items necessary for the safe operation of the system.

The SW provider shall ensure that all error message descriptions and corrective actions are included in operational documentation.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 37 of 54
Title: Ares I-X SR&QA Requirements	

APPENDIX A ACRONYMS AND ABBREVIATIONS AND GLOSSARY OF TERMS

A1.0 ACRONYMS AND ABBREVIATIONS

AFSPCMAN	Air Force Space Command Manual
ALERT	Acute Launch Emergency Reliability Tip
ANSI/ASQC	American National Standards Institute / American Society of Quality Control
ARP	Aerospace Recommended Practice
AS	Aerospace Standard
CBCS	Computer Based Control System
CDR	Critical Design Review
COTS	Commercial Off-the-Shelf
CR	Change Request
CSC	Computer Software Component/Configuration
CSCI	Computer Software Configuration Item
CSERP	Constellation Safety and Engineering Review Panel
CSU	Computer Software Unit
CxP	Constellation Program
CxPMD	Constellation Program Management Directive
DCMA	Defense Contract Management Agency
DFI	Development Flight Instrumentation
DFMR	Design for Minimum Risk
EEE	Electrical, Electronic, and Electromechanical
ERB	Engineering Review Board
ESD	Electrostatic Discharge
FAA	Federal Aviation Administration
FAR	Federal Acquisition Regulation
FMEA/CIL	Failure Modes and Effects Analysis / Critical Items List
FPGA	Field Programmable Gate Array
FRR	Flight Readiness Review
FSOP	Florida Safety Operating Plan
FTINU	Fault Tolerant Inertial Navigation Unit
FTS	Flight Termination System
GIDEP	Government-Industry Data Exchange Program

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 38 of 54
Title: Ares I-X SR&QA Requirements	

GMIP	Government Mandatory Inspection Point
GO	Ground Operations
GOTS	Government Off-the-Shelf
GS	Ground Systems
GSE	Ground Support Equipment
HB	High Bay
ICD	Interface Control Document
IPT	Integrated Project Team
IRD	Interface Requirement Document
IV&V	Independent Verification and Validation
IVVP	Independent Verification and Validation Plan
KNPR	KSC NASA Procedural Requirements
KSC	Kennedy Space Center
LCRSP	Launch Constellation Range Safety Panel
MDU	Master Data Unit
MMO	Mission Management Office
MOTS	Modified Off-the-shelf
MR	Material Review
MRB	Material Review Board
MVB	Main Vehicle Battery
NASA	National Aeronautics and Space Administration
NFS	NASA FAR Supplement
NPD	NASA Policy Directive
NPR	NASA Procedural Requirements
NSTS	National Space Transportation System
OCE	Office of Chief Engineer
OFI	Operational Flight Instrumentation
OML	Outer Mold Line
OPR	Office of Primary Responsibility
ORI	Operational Readiness Inspection
OSMA	Office of Safety and Mission Assurance
OTS	Off the Shelf
PA&R	Programmatic Audit and Reviews
PDR	Preliminary Design Review
PFMEA	Process Failure Modes and Effects Analysis

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 39 of 54
Title: Ares I-X SR&QA Requirements	

PLD/PLC	Programmable Logic Device/ Programmable Logic Controllers
PRACA	Problem Reporting, Analysis and Corrective Action
PYB	Pyrotechnic Battery
PYC	Pyrotechnic Controller
QA	Quality Assurance
RDU	Remote Data Unit
RRGU	Redundant Rollrate Gyro Unit
S&MA	Safety and Mission Assurance
SAE AS	Society of Automotive Engineers Aerospace Standard
SAP	Software Assurance Plan
SAR	System Acceptance Review
SDP	Software Development Plan
SE&I	System Engineering and Integration
SMP	Software Metrics Plan
SMR	Software Metrics Report
SR&QA	Safety, Reliability and Quality Assurance
SRS	Software Requirement Specification
SSP	System Safety Plan
SW	Software
TBD	To Be Determined
TBR	To Be Resolved
TPS	Thermal Protection System
TRR	Test Readiness Review
USA	United Space Alliance
USAF	United States Air Force
USS	Upper Stage Simulator
VPDU	Video Power Divider Unit
V&V	Verification and Validation
XCB	Ares I-X Control Board

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 40 of 54
Title: Ares I-X SR&QA Requirements	

A2.0 GLOSSARY OF TERMS

Term	Description

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 41 of 54
Title: Ares I-X SR&QA Requirements	

APPENDIX B OPEN WORK

B1.0 TO BE DETERMINED

Table B1-1 lists the specific To Be Determined (TBD) items in the document that are not yet known. The TBD is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. The TBD item is numbered based on the section where the first occurrence of the item is located as the first digit and a consecutive number as the second digit (i.e., **<TBD 4-1>** is the first undetermined item assigned in Section 4 of the document). As each TBD is solved, the updated text is inserted in each place that the TBD appears in the document and the item is removed from this table. As new TBD items are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBDs will not be renumbered.

TABLE B1-1 TO BE DETERMINED ITEMS

TBD	Section	Description	Closure Rationale
7-1	7.1	<TBR 7-1> Special processes, as defined in AS9100, section 7.5.2 shall be identified and <TBD 7-1> special processes will be reviewed with the CxP Quality Panel. -CLOSED-	Special processes, as defined in AS9100, section 7.5.2, performed by the contractor and NASA center shall be listed in the Quality Plan(s) and reviewed and approved by the IPT Quality Assurance.
7-2	7.11	[<TBD 7-2> certification shall be provided that as-built vs. as-design has been accomplished, and any discrepancies have been reviewed and approved by NASA.] -CLOSED-	Addressed in section 7.1.a

B2.0 TO BE RESOLVED

Table B2-1 lists the specific To Be Resolved (TBR) issues in the document that are not yet known. The TBR is inserted as a placeholder wherever the required data is needed and is formatted in bold type within brackets. The TBR issue is numbered based on the section where the first occurrence of the issue is located as the first digit and a consecutive number as the second digit (i.e., **<TBR 4-1>** is the first unresolved issue assigned in Section 4 of the document). As each TBR is resolved, the updated text is

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 42 of 54
Title: Ares I-X SR&QA Requirements	

inserted in each place that the TBR appears in the document and the issue is removed from this table. As new TBR issues are assigned, they will be added to this list in accordance with the above described numbering scheme. Original TBRs will not be renumbered.

TABLE B2-1 TO BE RESOLVED ISSUES

TBR	Section	Description	Closure Rationale
7-1	7.1	< TBR 7-1 > Special processes, as defined in AS9100, section 7.5.2 shall be identified and < TBD 7-1 > special processes will be reviewed with the CxP Quality Panel. -CLOSED-	Special processes, as defined in AS9100, section 7.5.2, performed by the contractor and NASA center shall be listed in the Quality Plan(s) and reviewed and approved by the IPT Quality Assurance.
7-2	7.1	In addition to the requirements set forth in AS9100, 7.6, the requirements of NPD 8730.1B, Metrology and Calibration < TBR 7-2 > shall be met. -CLOSED-	e. In addition to the requirements set forth in AS9100, 7.6, the Ares I-X IPTs shall maintain calibration on all test and measuring equipment and safety instruments used to perform measurements associated with the following functions:
7-3	7.6	< TBR 7-3 > [For all Crit 1, 1R, and 2 classes of hardware, inspection level III shall be used with zero acceptable rejects. Upon rejection of a Crit 1, 1R, or 2 hardware item, sampling shall be discontinued until root cause has been determined and corrective actions have been implemented. -CLOSED-	For pyrotechnic device inspection, use of sampling inspection and sample plans shall be approved by the appropriate NASA design center QA organization. When used, sampling inspection shall be in accordance with ANSI/ASQC Z1.4, with the following exception: Whenever sampling inspection reveals one or more nonconforming items and the sampling plan does not require rejection of the lot, all items in the lot shall be inspected for the identified nonconforming characteristic.
8-1	8.0	Software Management Plan < TBR 8-1 > -CLOSED-	Appendix C Added

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 43 of 54
Title: Ares I-X SR&QA Requirements	

APPENDIX C SOFTWARE PROVISIONS

APPENDIX C.1 – LOCKHEED MARTIN IMPLEMENTATION OF ARES I-X SOFTWARE SR&QA REQUIREMENTS

Sub-section Number (from software section 8)	Lockheed Martin Implementation
8.1	Lockheed Martin is using the Atlas Software Development Plan (SDP) and Atlas Software Assurance Plan (SAP) and Atlas Software Metrics Plan (SMP) to accomplish all Software Assurance requirements. The metrics parameters in the SMP have been modified per NASA request to suit Ares I-X.
8.2.1	The SAP and SMR meet these requirements
8.2.2	The Lockheed Martin Ares I-X SQA has been assigned this task and the LM SAP and SDP cover these requirements
8.3.1	The SAP and the Statement of Work (SOW) meet this requirement.
8.3.2.1	LM will review the test signoff matrix to assure that all of the required personnel have approved their test data. We do verify the software products for formal testing. The SDP, SAP and SMR meet these requirements.
8.3.2.2	The SAP meets this requirement.
8.3.3	The SDP meets these requirements. The SDP describes the process for identifying discrepancies and making changes to safety-critical software
8.3.4	The SDP and SAP meet these requirements.
8.3.5	The SOW defines LM support of IV&V and is consistent with NASA policy.
8.3.6	The System Safety Plan (SSP) and the SDP meet this requirement.
8.3.6.1	Lockheed Martin shall use the current Atlas V requirements for determining safety-critical evaluations and analyses (SSP and SDP). The “Mission Success” portion of this evaluation and analysis process is performed by Engineering and is outlined below: <ul style="list-style-type: none"> 1. Requirements analysis: <ul style="list-style-type: none"> a. Software Development Plan (DRD-4501SW-SDP), describes the process of gathering and approving

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 44 of 54
Title: Ares I-X SR&QA Requirements	

	<p>requirements, NASA approval is required.</p> <p>b. Fishbone diagrams available on-site at Lockheed Martin</p> <p>2. Verification Scope Sheets (VSS) used to link requirements to particular tests.</p> <p>3. Anomaly reporting and corrective action during software development is accomplished via Software Action Requests (SARs) and tracked via Systems Engineering Database (SEDB). This process is detailed in the LM software development plan.</p> <p>4. Off-nominal tests performed as part of normal FASTER and SIL testing including dispersions and abort scenarios.</p> <p>5. Systems Engineering Management Plan (DRD-4501-SEMP)</p> <p>a. Addresses Mission Success processes</p> <p>b. LM may be audited to verify that this process is being followed.</p> <p>6. Lockheed Martin Software Assurance Plan (DRD-4501-SAP) calls for LM Mission Success group to perform several audits of internal LM processes during development</p> <p>a. NASA Software Assurance will verify that these audits are performed.</p> <p>7. Hi-fidelity test beds including the System Integration Lab (SIL) and the Flight Analogous System Test Enhanced Resource (FASTER)</p> <p>a. FASTER</p> <p>i. Flight computer FTINU and dynamic simulations used for</p>
--	---

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 45 of 54
Title: Ares I-X SR&QA Requirements	

	<p style="text-align: right;">flight software testing</p> <ul style="list-style-type: none"> b. SIL <ul style="list-style-type: none"> i. Includes all avionics components including: FTINU(1), RRGU(2), ATVC(1), MDU(1), Battery Simulations, pyro controllers, KSC test box, FS boxes including Rec(1), ISC(1) and the APUC(1) <p>8. Complete set of tests</p> <ul style="list-style-type: none"> a. Desktop or branch testing at CSU level b. FASTER – flight software testing c. SIL – Ground and avionics software testing d. Test Like You Fly (TLYF) <p>9. Lockheed Martin Test Like You Fly philosophy</p> <ul style="list-style-type: none"> a. The LM TLYF process is outlined in LM document 2.3.8.1-T2-Test-1.2-P <p>NASA to verify that Mission success concept of Ops documentation delivered by LM is followed.</p>
8.3.6.2	The Hazard analysis reports are DRD type 1 documents which require NASA IPT approval
8.3.6.2.1	<p>Lockheed Martin shall use the current Atlas V requirements for determining safety-critical evaluations and analyses (SSP and SDP).</p> <p>see DRD-4501SA-SS-HA (System Safety Hazard Analysis) and the Software Requirement Specification (SRS), both documents are type 1 and require NASA IPT approval</p> <p>The “Mission Success” portion of this evaluation and analysis is performed by Engineering and is outlined above: See 8.3.6.1 above</p>
8.3.6.2.2	The SRS will specify what software is safety-critical.
8.3.6.2.3	The SSP and SDP meet these requirements
8.3.6.2.4	The SSP and SDP meet these requirements.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 46 of 54
Title: Ares I-X SR&QA Requirements	

	Lockheed Martin system safety personnel support safety reviews.
8.3.6.2.5	The SSP and SDP meet these requirements. Lockheed Martin system safety personnel support safety reviews.
8.3.6.2.6	The SDP meets these requirements
8.3.6.3	The SAP meets these requirements
8.3.6.4	See The flight and ground software test plans DRD-4501SW-STP And DRD-4501SW-SDP Software Development Plan

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 47 of 54
Title: Ares I-X SR&QA Requirements	

APPENDIX C.2 – KSC IMPLEMENTATION OF ARES I-X SOFTWARE SR&QA REQUIREMENTS

PURPOSE

This appendix provides a summary of the integrated development process used for Kennedy Space Center (KSC) Space Shuttle Ground System modifications. All hardware and software developed and modified by the KSC Ground Operations (GO) and Ground System (GS) Integrated Product Teams (IPTs) in support of the Ares I-X test flight use this process.

The KSC GO/GS IPT is comprised of NASA project management, engineering, and SR&QA representatives. The IPT also includes contractor personnel who are supporting approved IPT projects.

SCOPE

This process applies to new and modified hardware/software developed by the KSC GO/GS IPTs in support of the Ares I-X test flight. For existing KSC hardware and software that do not require modification for use with the test flight, only the Operations section will apply. While this appendix is based on the process used by the SSP SPOC for shuttle ground system modifications, this process may be applied to any contractor supporting the KSC GO/GS IPTs.

MODIFICATION PROCESS

INITIATION AND REQUIREMENTS

The GO/GS IPT identifies a modification need, establishes high level requirements and initiates a modification request to a contractor to support the Ares I-X test flight.

The GO/GS IPT establishes a partnership agreement with a contractor to perform the modification. Once a partnership agreement is signed, the initial project requirements are approved for further implementation.

The contractor develops a project plan (PP), or similar artifact, to define all modification activities, schedules and deliverables. The PP establishes the initial project and system technical requirements, including initial safety requirements. Standards to be applied and system assurance activities are established and documented in the PP.

The GO/GS IPT approves the PP for execution.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 48 of 54
Title: Ares I-X SR&QA Requirements	

ENGINEERING DEVELOPMENT

Once the PP is approved, engineering development begins. System assurance and safety analysis is performed in parallel with the engineering development phase.

For major modifications, a separate Requirements Document (RD) may be developed to finalize all technical, safety and product requirements. For minor modifications, the requirements listed in the PP may be sufficient for design and implementation.

Once requirements are baselined, the GO/GS IPT controls and approves all changes to the baselined requirements.

Hardware and software design products are developed and released for informal and formal design reviews. Software design products may include software code.

At formal design reviews, stakeholder comments are submitted in writing and dispositioned in review meeting minutes. Hazard and safety analysis results are presented at formal design reviews.

Final hardware and software design products are approved and released for configuration management.

Process assurance of the PP is performed during the engineering development phase.

SYSTEM ASSURANCE AND SAFETY ANALYSIS

System assurance and safety analysis is performed in parallel with the engineering development phase. Analysis products are reviewed in conjunction with the informal and formal design reviews.

If a system performs a critical function, a System Assurance Analysis (SAA) is developed to document the hazard and safety analyses performed on the system. All design products are reviewed for the SAA analyses.

The SAA may include the following hazard and safety analyses products:

- A Criticality Assessment (CA) that assigns a criticality (either C or NC) to all functions of the system without regard for redundancy. Software is not independently assigned a criticality in the CA; however, if the system it controls is critical than the software is also considered critical.
- A Failure Modes and Effects Analysis (FMEA), which analyzes all credible failure modes of the Line Replacement Units (LRUs) used in a critical function.
- Critical single failure points identified in the FMEA are documented in a Critical Items List (CIL) and submitted to the appropriate risk boards for approval.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 49 of 54
Title: Ares I-X SR&QA Requirements	

- A Fault Tree (FT), which provides a top down graphical representation of all hazards and hazard causes associated with the system. Software failures are included in the FT.
- A Hazard Analysis (HA), which lists the hazard controls (such as warnings, caution notes, or operational steps) for the hazards listed on the FT.
- For modifications to command and control systems, a critical data path and signal analysis is performed. CILs are written on the command and control hardware (not software) that can cause failure of critical data/signals. If a software function can cause a critical failure, then the CIL is written against the hardware processor in which the software resides.

Process assurance of the PP is performed during the system assurance and safety analysis phase.

IMPLEMENTATION

Work packages are developed, approved and executed to implement the approved design.

Design changes required during implementation are approved by the GO/GS IPTs. All design changes are reviewed for impacts to the approved hazard and safety analysis products.

During implementation, informal tests for functional verification may be performed. Informal tests may include unit, subsystem and system testing and are performed by the appropriate engineering, design and stakeholder personnel.

Process assurance of the PP is performed during the implementation phase.

TESTING AND VERIFICATION

After implementation is complete, one or more formal functional verification tests are performed. Formal verification of the system including software is performed by the appropriate engineering, design and stakeholder personnel using approved test procedures. For major modifications, verification testing results are reported at an Operational Readiness Review (ORR).

Quality buys required during formal verification testing are performed per the SSP and Ares I-X Quality Planning Requirements Documents (QPRDs).

Design changes required during testing and verification are approved by the GO/GS IPTs. All design changes are reviewed for impacts to the approved hazard and safety analysis products.

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 50 of 54
Title: Ares I-X SR&QA Requirements	

Process assurance of the PP is performed during the testing and verification phase.

VALIDATION AND CERTIFICATION

After verification is complete, stakeholder system engineers, both NASA and contractor, validate modifications to their individual ground systems prior to initial operational use. Formal validation of the system including software is performed by the appropriate personnel using approved test procedures. For major modifications, system validation results are reported at an ORR.

After validation is complete with individual ground systems, integrated validation testing across systems and across IPTs is performed as required. Integrated validation is performed using approved procedures and results are reported at an ORR.

Quality buys required during system and integrated validation testing are performed per the SSP and Ares I-X QPRDs.

Design changes required during validation and certification are reviewed by the GO/GS IPTs and approved by the appropriate Ares 1-X control boards. All design changes are reviewed for impacts to the approved hazard and safety analysis products.

Hardware and software modifications identified as performing a critical function are certified prior to initial operational use. A certification report is developed listing all test procedures performed, test results and all requirements satisfied by the testing. For major modifications, the certification report is presented at an ORR.

For major modifications, the following items are reviewed at an ORR:

- Formal verification testing results
- Formal validation testing results
- Integrated validation testing results
- Interface and Operational Test Requirements (OTR) testing results
- Open problems/non-conformances
- Requirements traceability status
- System Assurance Analysis status
- Hazard reports, Critical Item List (CIL) and mitigation status
- Training status
- Documentation status
- Operational procedure status
- Constraints to operations
- Lessons learned
- Other open issues

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 51 of 54
Title: Ares I-X SR&QA Requirements	

Prior to approval for initial operational use, all open problems or non-conformances discovered during implementation and testing that have not been closed are reviewed for constraints to operations and approval for use as-is. For major modifications, this open problem review is presented at an ORR. Open problems are entered into the Problem Reporting, Analysis and Corrective Action (PRACA) to be worked to closure during the operations phase. Open problems are entered in PRACA after ORR and prior to initial operational use.

Operational Readiness is signed by NASA and contractor management prior to initial operational use of any modification. For new systems, the configuration approved at operational readiness is the initial baseline placed under configuration management control.

Process assurance of the PP is performed during the validation and certification phase. The PP is closed at the completion of the validation and certification phase.

OPERATIONS

GO and GS IPT controlled hardware/software are operated in accordance with approved procedures.

Operational procedures include safety information and safing operation steps where appropriate.

Problems and non-conformances that occur during operations are documented and worked to closure in the PRACA system.

Problems and non-conformances involving critical hardware/software are reviewed for safety impacts and are properly identified and communicated with the operation and management teams.

During operations, any change to the baselined hardware/software configurations are performed according to the Engineering Support Request (ESR) or the PRACA process and approved by the GO/GS IPTs.

REFERENCE DOCUMENTS

NASA-STD-(I)-5005C, Standard for the Design and Fabrication of Ground Support Equipment

SW-E-0002 Book 2, Space Shuttle Ground Support Equipment General Design Requirements – New GSE

USA004615, Ground System Configuration Accounting

Revision: v3.10	Document No: AI1-SYS-SRQA
Release Date: September 11, 2008	Page: 52 of 54
Title: Ares I-X SR&QA Requirements	

USA004618, Integrated Process for Ground System Modification
USA004621, Ground Systems Configuration Control Board Operations
USA004642, Problem Reporting and Corrective Action System
USA004655, System Assurance Analysis
USA004773, Ground Operations Certification/Recertification Process and
Documentation Requirements
USA004778, Engineering Design Reviews

APPENDIX D FUNCTIONAL CRITICALITY DETERMINATION

The following is an analysis flowchart for the determination of the functional criticality of an identified nonconformance. This flowchart is only applicable to items (Parts, Modules, LRUs, Software programs, etc.) where a FMEA has not been performed addressing the identified nonconformance.

