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Deliverable Aerospace Software Supplement for AS9100A

Quality Management Systems - Aerospace - Requirements for Software (based on AS9100A)

FOREWORD

This document standardizes, to the greatest extent possible, the software quality management system requirements for the aerospace industry. The establishment of common requirements for use at all levels of the supply-chain by organizations around the world should result in improved quality and safety, and decreased costs, due to the elimination or reduction of organization-unique requirements and the resultant variation inherent in these multiple expectations.

STRUCTURE

HOW TO USE THIS SUPPLEMENT

This supplement to AS9100A is intended to clarify unique requirements for the supplier of deliverable software. The software may be embedded or loadable into a target computer by the same organization. Software may also be delivered as an end item from a software-only organization. In either case, the organization must meet the requirements of AS9100 and this supplement.

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INTRODUCTION

General

Where necessary, the quality management system requirements in AS9100A have been clarified for software. Where a paragraph within AS9100A does not need to be clarified for software, the requirements as stated in AS9100A apply.

Process Approach

The basic requirements of AS9100A apply. No additions or clarifications required for software.

1. SCOPE:

1.1 General:

The basic requirements of AS9100A apply with the following clarifications.

This document supplements the requirements of AS9100A for deliverable software.

This supplement contains Quality System requirements for suppliers of products that contain deliverable embedded or loadable airborne, spaceborne or ground support software components that are part of an aircraft Type Design, weapon system, missile or spacecraft operational software and/or support software that is used in the development and maintenance of deliverable software. This includes the host operating system software including assemblers, compilers, linkers, loaders, editors, code generators, analyzers, ground simulators and trainers, flight test data reduction, etc., that directly support creation, test and maintenance of the deliverable software. Where Commercial-Off-The-Shelf (COTS) or non-developmental components are integrated into a deliverable product, the organization and the customer shall agree on the extent of applicability of this supplement. The organization shall demonstrate that the software development infrastructure is in compliance with AS9100.

This document also applies to firmware as defined herein. It does not apply to programmable logic devices, including fuse-link or reconfigurable parts such as Application Specific Integrated Circuits, (ASIC) or Field Programmable Gate Arrays (FPGA). ASICS AND FPGA'S are addressed by RTCA/DO-254.

1.2 Application:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

2. NORMATIVE REFERENCE:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

3. TERMS AND DEFINITIONS:

The following terms are important to the understanding of this supplement and are included here for ease of use of the supplement.

baseline: The approved, recorded configuration of one or more configuration items, that thereafter serves as the basis for further development, and that is changed only through change control procedures. [RTCA/DO-178B]

configuration item: (1) One or more hardware or software components treated as a unit for configuration management purposes. (2) Software lifecycle data treated as a unit for configuration management purposes. [RTCA/DO-178B]

COTS - Commercial-Off-The-Shelf: Commercially available applications sold by vendors through public catalog listings. Contract-negotiated software developed for a specific application is not COTS software. [RTCA/DO-178B]

development: a software life cycle process that contains the activities and support for requirements analysis, design, coding, integration, testing, installation and acceptance of software products. The term “support” within the development lifecycle may include the activities and processes of:

- project management,
- configuration management,
- verification,
- regulatory authority liaison,
- safety,
- reliability and maintainability, and
- assurance.

escalation: Process for raising to a higher authority the responsibility to disposition nonconformances, process changes or deviations from contractual requirements and established standards.

firmware: An ordered set of instructions and associated data stored in a way that is not dynamically changeable; for example, microprograms stored in Read-Only Memory (ROM). [ANSI X3.172-1995]

functional requirements: A requirement that specifies a function that a system or system component must be able to perform. [IEEE-STD-610]

monitoring: The act of witnessing or inspecting selected instances of test, inspections, or other activity, or records of those activities, to assure that the activity is under control and that the reported results are representative of the expected results. Monitoring is usually associated with activities done over an extended period of time where 100% witnessing is considered impractical or unnecessary. Monitoring permits authentication that the claimed activity was performed as planned. [RTCA/DO-178B]

3. (Continued):

non-developmental software: Deliverable software that is not developed under the contract but is provided by the contractor, the Government, or a third party. Non-developmental software may be referred to as reusable software, Government furnished software, or commercially available software, depending on its source. [DOD-STD-2167A]

release: A particular version of a configuration item that is made available for a specific purpose (for example, test release). [ISO/IEC 12207]

replication: Copying a software product from one medium to another.

software: Computer programs and, possibly, associated documentation and data pertaining to the operation of a computer system. [RTCA/DO-178B] The executable programming logic and data that are embedded in hardware devices are considered to be included in this definition.

software development infrastructure: Includes the management and assurance of the activities and processes required to develop software.

software item: Any identifiable part of a software product.

software life cycle: (1) an ordered collection of processes determined by an organization to be sufficient and adequate to produce a software product. (2) The period of time that begins with the decisions to produce or modify a software product and ends when the product is retired from service. [RTCA/DO-178B]

software product: The set of computer programs, procedures and possibly associated documentation and data. [ISO/IEC 12207]

NOTE: A software product may be designated for delivery, an integral part of another product, or used in the development process.

NOTE: This is different than a product in ISO 9000.

stage: A defined segment of work.

NOTE: A stage does not imply the use of any specific life cycle model. The term stage is synonymous here with the term phase used in ISO/IEC 12207.

support software: Software that aids in the development or maintenance of other software. For purposes of this standard, support software includes system software used to facilitate the operation and maintenance of a computer system and it's associated programs. [IEEE-STD-610]

4. QUALITY MANAGEMENT SYSTEM:

4.1 General Requirements:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

4.2 Documentation Requirements:

4.2.1 General: The basic requirements of AS9100A apply. No additions or clarifications required for software.

4.2.2 Quality Manual: No additions or clarifications required for software, however the quality manual must address quality system requirements for software.

4.2.3 Control of Documents: The basic requirements of AS9100A apply. No additions or clarifications required for software.

4.2.4 Control of Records: The basic requirements of AS9100A apply with the following clarifications.

Where records are held on electronic media, consideration of the retention times and accessibility of the records should take into account the rate of degradation of the electronic images and the availability of the devices and software needed to access the records.

4.3 Configuration Management:

The basic requirements of AS9100A apply with the following clarifications.

The software configuration management process shall document the following (at a minimum):

a. Organizations involved in configuration management and responsibilities assigned to each organization.
b. Configuration management activities to be carried out.
c. Configuration management tools, techniques, and methodologies to be used.
d. The point at which software items should be brought under configuration control.

Additional requirements on configuration management are found in clause 7.

5. MANAGEMENT RESPONSIBILITY:

5.1 Management Commitment:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.2 Customer Focus:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.3 Quality Policy:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.4 Planning:

5.4.1 Quality Objectives: The basic requirements of AS9100A apply with the following clarifications.

In the absence of any overriding contractual requirements, the organization's quality system shall show evidence that the safety and reliability attributes of the software product have been considered and addressed.

5.4.2 Quality Management System Planning: The basic requirements of AS9100A apply with the following clarifications.

Quality planning for software shall occur at two levels:

- the organizational level; and
- the project/product level.

At the organizational level, software quality system planning shall identify:

a. software life cycle models to be used for the types of projects that the organization undertakes;
b. how the organization normally implements software life cycle processes;
c. how software engineering methods are tailored for the organization's projects within the life cycle;
d. any common templates for assisting the development of software products, such as software requirements documents, architectural design documents, detailed design documents, source code headers, and software user manuals;
e. software management planning such as technical, cost, and schedule planning, configuration management planning, verification and validation planning, safety, security and quality assurance planning;
f. tools and software/systems development, operations or maintenance environment;
g. conventions for the use of programming languages and software libraries.

At the project/product level, quality planning is discussed in clause 7.1.

5.5 Responsibility, Authority and Communication:

5.5.1 Responsibility and Authority: The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.5.2 Management Representative: The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.5.3 Internal Communication: The basic requirements of AS9100A apply with the following clarifications.

Processes and plans for software shall be coordinated with and communicated with impacted functional organizations.

5.6 Management Review:

5.6.1 General: The basic requirements of AS9100A apply with the following clarifications.

Top management shall review the software process(es) based on objective, quantitative data that will be used as a baseline for improvement.

5.6.2 Review Input: The basic requirements of AS9100A apply. No additions or clarifications required for software.

5.6.3 Review Output: The basic requirements of AS9100A apply. No additions or clarifications required for software.

6. RESOURCE MANAGEMENT:

6.1 Provision of Resources:

The basic requirements of AS9100A apply. No additions or clarifications required for software.

6.2 Human Resources :

6.2.1 General: The basic requirements of AS9100A apply. No additions or clarifications required for software.

6.2.2 Competence, Awareness and Training: The basic requirements of AS9100A apply with the following clarifications.

Skills of personnel performing software tasks, at a minimum, shall be maintained at a level required to meet customer and regulatory requirements.

6.3 Infrastructure:

The basic requirements of AS9100A apply with the following clarifications.

The organization shall determine, provide and maintain a software development and maintenance infrastructure needed to achieve conformity to product requirements. Infrastructure includes, as applicable:

a. software development and test tools and utilities including host development environments (host computer and related support software);
b. process equipment (including software loading, duplication/verification of media masters, virus checking, media transmittal and archiving facilities);
c. organizational policies, procedures, instructions and process documentation.

6.4 Work Environment:

The basic requirements of AS9100A apply with the following clarifications.

NOTE: Factors that may affect the conformity of software product include unauthorized access to online storage or master media, media degradation due to age, humidity, temperature, magnetic sources, handling and transportation damage, etc.

7. PRODUCT REALIZATION:

7.1 Planning of Product Realization:

The basic requirements of AS9100A apply with the following clarifications.

Planning for software shall be consistent with the organization's quality system and documented in a format suitable to the organization's method of operating.

Software planning shall address the following items, ensuring the compatibility of the requirements definition, design, coding, maintaining, testing, and delivery processes and the applicable documentation:

a. Quality requirements expressed in measurable terms, where appropriate.
b. The life cycle model for software development.
c. Defined criteria for starting and ending each project phase.
d. Identification of verification and validation activities to be carried out.
e. Identification of configuration management procedures to be carried out.
f. Detailed planning (including schedules, procedures, resources, and approval) and specific responsibilities and authorities for:

7.1 (Continued):

- Configuration management.
- Software quality engineering
- Verification and validation of developed products.
- Verification and validation of purchased products.
- Verification of customer-supplied products.
- Analysis of risks
- Cost and progress tracking (e.g., Earned Value Tracking)
- Control of nonconforming product and corrective action.
- Ensuring that activities described in the software plans are carried out.
- Installation

g. Identification and selection of software subcontractors (if applicable), including creating and coordinating the Statement of Work.
h. Identification and planning for COTS, and/or trade studies.
i. Identification of material, processes, or services to support operation and maintenance of the software product (e.g., compilers, translators, test equipment, and test software), if applicable.
j. Identification and planning of the verification of life cycle activities to be carried out.

7.2 Customer-Related Processes:

7.2.1 Determination of Requirements Related to the Product: The basic requirements of AS9100A apply. No additions or clarifications required for software.

7.2.2 Review of Requirements Related to the Product: The basic requirements of AS9100A apply. No additions or clarifications required for software.

7.2.3 Customer Communication: The basic requirements of AS9100A apply with the following clarifications.

Particular attention shall be given to communicating planned schedules, progress, costs, assumptions, and risks associated with the software product.

7.3 Design and Development:

7.3.1 Design and Development Planning: The basic requirements of AS9100A apply with the following clarifications.

The organization shall manage the interfaces between all groups involved with software development to ensure effective communication and clear assignment of responsibility.

Development planning shall address at a minimum the following items:

a. The definition of the project, including a statement of its objectives and reference to any related customer or organization projects and requirements.
b. The definition of input and output products of the project as a whole.
c. The organization of the project resources, including the team structure, responsibilities, use of subcontractors, and material resources to be used.
d. Identification of standards, rules, practices, conventions, tools, and techniques for development; configuration controls placed on tools; configuration management practices; method of controlling nonconforming products; methods of controlling software used to support development; procedures for archiving, backup, and recovery, including contingency planning; and methods of control for virus protection.
e. Planning such as quality, risk management, configuration management, integration, test, installation, migration, training, maintenance, and reuse.
f. Reliability, maintainability, and safety.
g. Schedules including the phases of the project; the work to be performed, the associated resources and timing; the associated dependencies; the milestones.
h. Software process improvement.

The organization shall have a documented process in place for evaluating and approving use of non-developmental software (e.g., COTS, re-engineered, reused/previously developed).

7.3.2 Design and Development Inputs: The basic requirements of AS9100A apply with the following clarifications.

These inputs shall be reviewed for adequacy. Requirements shall be complete, testable, unambiguous and not in conflict with each other.

The customer should provide the requirements. However, where mutually agreed upon, the organization may provide the requirements. In such a case, the organization shall:

a. Establish documented procedures for developing the requirements, including:
   - Methods for agreeing on requirements and authorizing changes.
   - Methods for the evaluation of prototypes or demonstrations, where used.
   - Recording and reviewing discussion results on both sides.
b. Develop the requirements in close cooperation with the customer and make efforts to prevent misunderstandings.
c. Obtain the customer's approval of the requirements prior to implementation when required by contract.

Input data to design shall be defined and documented in terms of functional requirements. Interfaces between the software product and other products shall be defined and documented. The software requirements shall be expressed in terms that allow validation during product acceptance.

7.3.3 Design and Development Outputs: The basic requirements of AS9100A apply with the following clarifications.

For software, design and development includes all activity from planning to product delivery.

For software, the required output from the design and development activities shall be defined and documented. The following are examples of documentation that should be reviewed for correctness, completeness, and consistency with the requirements:

a. Architectural design.
b. Detailed design.
c. Source code.
d. User guides.
e. Software version description.
f. Updated risk assessment.
g. Assurance and safety assessments.
h. Integration and test procedures.
i. Make-buy/trade studies.
j. Final test plans.
k. Coding standards and conventions.
l. External interface control documents.
m. Test tool configuration, test data, test scripts and test drivers/stubs.

7.3.3 (Continued):

There shall be evidence that design and development outputs have been coordinated with the customer as required by contract.

For software, key characteristics may include but not be limited to stability of requirements, stability of code size, defect levels, defect containment, cyclomatic complexity, memory and timing utilization or other product and process characteristics that have the potential to adversely impact development costs and schedules, specified performance, maintainability, safety, reliability or other customer expectations. The organization shall determine the software key characteristics that are appropriate for the software product and process. Appropriate measures of the key characteristic shall be established and used to manage or track the characteristic during the life cycle. Levels or thresholds shall be established and action taken to mitigate adverse trends of the selected key characteristics.

7.3.4 Design and Development Review: The basic requirements of AS9100A apply. No additions or clarifications required for software.

7.3.5 Design and Development Verification: The basic requirements of AS 9100 apply with the following clarifications.

In some cases, the results of processes cannot be fully verified. An example is where safety critical software cannot be tested under actual circumstances without risking serious consequences or perhaps the circumstances are rare and difficult to simulate. Due to the inability to test some software products exhaustively and conclusively, the organization shall demonstrate alternative methods of verification such as simulation testing or Failure Modes and Effects Analysis.

7.3.6 Design and Development Validation: The basic requirements of AS 9100 apply with the following clarifications.

In some cases the product cannot be fully validated. An example is where safety critical software cannot be validated under actual circumstances without risking serious consequences or perhaps the circumstances are rare and difficult to create. Due to the inability to validate some software products exhaustively and conclusively, the organization shall demonstrate alternative methods of validation such as operational simulation, or safety/hazard analysis.

The type and extent of methods used shall be commensurate with the risk and consequences of design and development failures.

7.3.6.1 Documentation of Design and/or Development Verification and Validation: The basic requirements of AS 9100 apply. No additions or clarifications required for software.

7.3.6.2 Documentation of Design and/or Development Verification and Validation Testing: The basic requirements of AS 9100 apply. No additions or clarifications required for software.

7.3.7 Control of Design and Development Changes: The basic requirements of AS 9100 apply with the following clarifications.

Software changes shall be evaluated for impact to applicable products and processes within the life-cycle.

Any software changes shall be assessed for impacts to system safety, reliability and maintainability.

7.4 Purchasing:

7.4.1 Purchasing Process: The basic requirements of AS 9100 apply with the following clarifications.

The organization shall ensure that software source selection and approval includes all impacted functional organizations, (e.g. purchasing, software engineering, software quality, configuration management, etc).

7.4.2 Purchasing Information: The basic requirements of AS 9100 apply with the following clarifications.

In addition, where appropriate, purchasing data shall include standards to be applied (e.g. communication protocol, architectural specification, engineering standard, or regulatory guidance).

7.4.3 Verification of Purchased Product: The basic requirements of AS 9100 apply with the following clarifications.

Where the organization utilizes certification / conformity reports to verify purchased product, the data in those reports shall be in accordance with approved specifications.

When COTS software is procured for integration into deliverable products, end item requirements allocated to the COTS software shall be verified as part of end item verification/validation. COTS software shall be identified and configuration controlled to support conformity, certification, and customer acceptance requirements.

7.5 Production and Service Provision:

7.5.1 Control of Production and Service Provision: The following requirements replace the contents of AS9100A in their entirety.

For software, the term “Production” is intended to cover only the deployment of approved, released software for loading into the target computer system. Accordingly, the applicable controls for software are restricted to the following:

The organization shall have documented processes for configuration-controlled build & release, replication, and installation of software items or products.

a. Build and Release

The following provisions shall be addressed in the documented build and release processes:

1. Identification of the software items that constitute each release, including associated build instructions;
2. Identification of the types (or classes) of release, depending on the frequency and/or impact on the customer's operations and ability to implement changes at any point in time;
3. Decision criteria and guidance to determine where localized temporary fixes may be incorporated or release of a complete updated copy of the software product is necessary.
4. Verification of the build process to ensure adequacy of process instructions

The release of software shall establish a baseline that documents the tests completed and the resolution of identified deficiencies.

b. Replication

The following provisions shall be addressed in the documented replication processes:

1. Identification of the master and the copies, including format, variant, and version.
2. Disaster recovery plans.
3. The period of obligation of the organization to supply copies and the capability of reading master copies.
4. Type of media for each software item and its associated labeling.
5. How copyright and licensing concerns are addressed and agreed upon.
6. Controlling the environment under which the replication is effected to ensure repeatability.
7. Verification that each copy is a faithful replica of the master.

c. Installation

For software product installations, the organization and customer shall agree on their respective roles, responsibilities, and obligations, and such agreements shall be documented.

7.5.1.1 Production Documentation: The following requirements replace the contents of AS9100A in their entirety.

Approved production documentation for software, at a minimum, shall consist of a software definition drawing (sometimes called a version description document, software version description, software configuration index, etc.) It shall identify the specific source code components by version, the support software, build instructions, and a software loading procedure that assures a valid, repeatable load of the executable software into the target computer. It shall also include or reference a change or problem report summary.

7.5.1.2 Control of Production Process Changes: The following requirements replace the contents of AS9100A in their entirety.

Changes to procedures that affect the loading, verification of load, virus and data integrity checks (i.e., cyclic redundancy checks (CRC) or checksums), labeling, internal part marking (when required), etc., shall be made in accordance with formal configuration controlled procedures.

7.5.1.3 Control of Production Equipment, Tools, and Numerical Control (N.C.) Machine Programs: The following requirements replace the contents of AS9100A in their entirety.

Equipment and tools that transfer and verify executable software data from computer sensible media (such as disk, compact disc (CD) or server resident files) shall be validated to ensure the integrity of the load operation and the ability to initialize the target system after the load.

7.5.1.4 Control of Work Transferred, on a Temporary Basis, Outside the Organization's Facilities: The following requirements replace the contents of AS9100A in their entirety.

When factory load and verify operations are transferred from the facility in which the software is developed, processes and procedures shall ensure the integrity of the transfer, archiving and retrieval of the master media.

7.5.1.5 Control of Service Operations: The basic requirements of AS9100A apply. No additions or clarifications required for software.

7.5.2 Validation of Processes for Production and Service Provision: The following requirement replaces the contents of AS9100A in its entirety.

For production and service provision, any software development process, (e.g., assembly, compilation, linkage) that cannot be directly inspected, shall be validated by operational verification of the final product.

7.5.3 Identification and Traceability: The following requirements replace the contents of AS9100A in their entirety.

The organization shall establish and maintain procedures for identifying software items during all phases, starting from specification, through development, test, replication, and delivery. These procedures shall continue to apply after delivery of a product if required by contract.

Throughout the product life cycle, there shall be procedures to trace the components of the software item or product (for example, that each software requirement is traced from systems requirements to software requirements, design, code, and test).

The organization shall establish and maintain a configuration management system for software products, which provides the capability to:

a. Identify uniquely the versions of each software item.
b. Identify the versions of each software item that together constitute a specific version of a complete product.
c. Identify the build status of software products under development, delivered, or installed.
d. Manage access and changes to controlled items.
e. Provide coordination for the updating of multiple products in one or more locations as required.
f. Identify and track all actions and changes resulting from a change request, or problem, from initiation through release.

Procedures shall be applied to ensure that the following can be identified for each software item:

g. The approved production documentation for all software configuration items.
h. Associated development tools and test suites.
i. Interfaces to other software items and to target computer hardware.
j. The development and target computer hardware and software environment.
k. Source code and executable code.

The organization shall establish and maintain configuration status accounting procedures to record, manage, and report on the status of software, the support environment, and related hardware items, change requests, and the implementation of approved changes.

Configuration management shall maintain identification and traceability of unique software releases to their targeted environment.

NOTE: In some industry sectors, configuration management is a means by which identification and traceability are maintained (see 4.3).

7.5.4 Customer Property: The basic requirements of AS9100A apply. No additions or clarifications required for software