

104-EMD-001

## **ECS Maintenance and Development Project**

# **Software Quality Assurance Plan for the EMD Project**

Revision -

October 2003

Raytheon Company  
Upper Marlboro, Maryland

# Software Quality Assurance Plan for the EMD Project

Revision -

October 2003

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# Preface

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This document is a formal contract deliverable. It requires Government review and approval within 20 business days. Changes to this document will be made by document change notice (DCN) or by complete revision.

Any questions should be addressed to:

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# Abstract

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The Software Quality Assurance Plan (SQAP) establishes the Quality Assurance program for the EMD contract. This plan describes the Quality Assurance (QA) organization and audit, evaluation and monitoring activities applicable for the EMD Program. It describes EMD Quality Assurance activities performed by QA staff, directed by documented procedures. This plan also references activities performed by other organizations or functions that are monitored or audited by QA.

**Keywords:** SQAP, quality, ISO, AS9100, QMS, audit, evaluation, nonconformance, noncompliance, deficiency, process, procedure

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# 1. Purpose

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## 1.1 Purpose and Scope

This Software Quality Assurance Plan (SQAP) establishes the Quality Assurance program for the ECS Maintenance and Development (EMD) contract (NAS5-03098). This document is CDRL Item # 004 and is developed in accordance with the requirements of Data Item Description (DID) EMD-SQAP-4.

The SQAP addresses the organization, responsibilities, procedures, methods and tools employed by the Raytheon Team in maintaining, sustaining, and enhancing the EOSDIS Core System (ECS) under the EMD contract. This plan describes the Quality Assurance (QA) organization and the specific activities applicable for the EMD Program. In accordance with IEEE Std-730-2002, this plan will cover EMD Quality Assurance activities performed by members of the Quality Assurance organization and directed by applicable QA documented procedures. In addition, it will reference activities monitored by QA that are performed by other organizations or functions.

## 1.2 Software Items Covered

This SQAP covers the maintenance of all existing components of the ECS Science Data Processing System (SDPS). The SDPS supports science data management activities for 19 Earth Science instruments on 10 spacecraft. It interfaces with 34 external systems and supports a wide range of stakeholders. The existing ECS consists of more than a million lines of C++ custom code and 155 thousand lines of Java custom code, contained in more than 15 thousand modules. During the EMD Program, the SDPS will require further development to address significant changes in system throughputs and capacities, in addition to supporting new missions and satisfying stakeholder requirements.

## 1.3 Software Lifecycle

Since this is both a maintenance and development contract, the entire software lifecycle will be covered by the SQAP.

Requirements for new development may be received by the contractor or proposed by the EMD contractor as system enhancement proposals (SEP). New capability development is documented in Tickets, which provide operations concept, Level 4 requirements and verification criteria. Tickets are subject to internal peer review, which may include participation from Earth Science Data and Information System (ESDIS) and Distributed Active Archive Center (DAAC) representatives. Once requirements are adequately defined, software design and development may begin and will proceed through preliminary design and detailed design, with peer review at each design stage. When the design phase has concluded, software code will be developed and inspected, and unit tests will also be developed, reviewed, and executed. Integration and

subsequent system level verification and validation will take place prior to deployment. Early defect detection is emphasized in all phases through mature peer review and inspection activities.

Custom code is enhanced via Modification Requests and maintained based on trouble tickets and non-conformance reports (NCRs) from system users. The development process for such 'fixes' depends on established thresholds for changes to software lines of code and may include design and/or code peer reviews at specified stages.

## 2. Reference Documents

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### 2.1 Documents Referenced Herein

AS9100, Quality Systems - Aerospace - Model for Quality Assurance in Design, Development, Production, Installation and Servicing, Revision A, August 2001

IEEE Std-730-2002, IEEE Standard for Software Quality Assurance Plans, 23 September 2002

ISO 9001:2000, Quality Management Systems — Requirements, 15 December 2000

Landover Facility Procedures — Quality Assurance series

ECS/EMD Project and Work Instructions

ECS DID 305 Segment Design Specification

ECS DID 311 Database Design and Database

ECS DID 313 Internal Interface Control Document (ICD)

DID EMD-PP-5 Property Management Plan

DID EMD-RMP-6 Risk Management Plan

DID EMD-TP-1 Transition Plan

DID EMD-MCMR-12 Monthly Contractor Manpower Reporting

DID EMD-533-11 Monthly Contractor Cost Reporting — 533 Requirements

108-EMD-001 Program Management Plan for the EMD Project

110-EMD-001 Configuration Management Plan

117-EMD-001 Procurement Management Plan

207-EMD-001 EMD Security Management Plan

302-EMD-001 Software Maintenance and Development Plan

303-EMD-001 Hardware Maintenance and Development Plan

### 2.2 Documents Used to Develop this SQAP

IEEE Std-730-2002, IEEE Standard for Software Quality Assurance Plans, 23 September 2002

EMD Task 101 Statement of Work for ECS SDPS Maintenance, August 2003

61-0010, Raytheon Quality Management System Manual

Raytheon Company Policy 000000079-RP, Product Assurance Requirements

Landover Facility Procedure 19-0-4, Software Quality Assurance Program Planning

## **3. Management**

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### **3.1 EMD Project Organization**

#### **3.1.1 Program Organizational Structure**

The EMD is organized and managed using integrated product teams (IPTs) and cross product teams (CPTs). The IPT is an integrated multidisciplinary team designed to meet common objectives and organized around a specific task, product, or service. CPTs are made up of the functions that will apply to multiple tasks on the EMD Contract and will typically provide similar services across many IPTs.

Program Management provides management oversight during all task life cycle phases and ensures that adequate support services are available for all tasks to include cost and schedule tracking, configuration management, procurement, quality assurance, computer infrastructure, contracts, and safety. More detailed information is provided in the Program Management Plan for the EMD Project (108-EMD-001).

#### **3.1.2 Quality Assurance Organization**

The Raytheon Information Technology Systems (ITS) Quality Assurance (QA) organization has the responsibility for implementing the QA program for the EMD Project. The ITS QA organization has dual reporting roles: to the Intelligence and Information Systems (IIS) division Product Assurance/Quality Director, and to the ITS General Manager, thereby ensuring program organizational independence.

The ITS Quality Manager has overall responsibility for quality assurance programs and will identify and direct the EMD Quality Assurance team members. The EMD QA team will provide independent and objective evaluation of process execution and work product quality. This separation of QA responsibilities from EMD product team organizations ensures the independence and organizational freedom to objectively evaluate product and process, monitor EMD development and maintenance activities, and to determine corrective action and verify compliance.

The QA Manager will be the primary interface with the ESDIS System Assurance Manager and System Assurance representatives. The EMD QA organization advocates open communication and interaction with ESDIS to ensure understanding and the achievement of our common objectives.

#### **3.1.3 AS9100/ISO 9000 Quality Management System**

Raytheon's fundamental standards for quality management are AS9100, ISO 9000 and best industry practices included in the Raytheon Integrated Product Development System (IPDS). Quality requirements are further flowed-down through Raytheon IIS division-level directives

and tailored specifically for EMD processes. Our Quality Management System (QMS) has been registered ISO 9000 compliant by National Quality Assurance (NQA), a Registrar Accreditation Board (RAB) accredited third-party auditing and assessment company. In August 2003, the Landover facility successfully completed an audit to requirements of AS9100 and was deemed compliant.

## **3.2 Tasks**

### **3.2.1 Maintenance and Development Lifecycles**

The EMD comprises both maintenance and development activities. Modification requests lead to system enhancements and may involve the complete software development lifecycle: requirements, design, development, code, unit test, integration, system-level test, and deployment and includes system, installation, and operational documentation. Maintenance of the system continues with evaluation of operational trouble tickets and NCRs, code changes, baseline control, and patch deployment.

### **3.2.2 Maintenance and Development Tasks**

Throughout the EMD Program, QA will conduct planned audits, evaluations, and monitoring activities aligned with those program activities identified in the software and hardware maintenance and development plans (SMDP/HMDP) and the EMD project schedule. In a maintenance environment, QA will establish ongoing programmatic tasks to ensure continuous monitoring, corrective action, improvement, and quality results. In the case of planned custom code development task orders, QA will define tasks directly tied to scheduled design, development, test, and deployment events within the task order scope of work. QA will identify these tasks and activities and track them in an EMD QA project schedule.

#### **3.2.2.1 Program Management Tasks**

Program Management (PM) tasks are defined as those that are ongoing activities, performed primarily by members of the PM Team and not tied to a scheduled event or milestone. As such, these tasks may have general or implied entry/exit criteria, which may be defined in EMD Project and Work Instructions. QA functions in both a monitoring capacity and conducts periodic process audits and product evaluations, as appropriate. PM tasks include, but are not limited to: Program Planning, Program Controls, Risk Management, Customer Interface, Program Review, Documentation, SEP and Task Order Planning.

#### **3.2.2.2 Maintenance and Engineering Support Tasks**

Maintenance and engineering support tasks are those associated with both development and maintenance activities. They may be ongoing, as for code and hardware maintenance, or tied to events identified by Task leads in the Primavera (P3) scheduling tool. Since these are not discreet tasks, entry criteria may be general, time-phased, or implied for ongoing activities, such as those based on the completion of a related activity. Engineering support tasks include, but are not limited to: COTS Maintenance, Failure Review, Problem Management (trouble ticket/NCR),

Help Desk Operations, Configuration Management (baseline management, configuration change request and control). Maintenance and support tasks will be performed by EMD IPTs and CPTs, as described in the Program Management Plan. QA will function in a monitoring capacity and also conduct periodic process audits, configuration audits and product evaluations, as appropriate.

### 3.2.2.3 Development Tasks

Development tasks include those activities associated with a typical software development lifecycle. Development tasks may have a specified delivery schedule and may therefore be identified in P3. During the ECS contract, effective processes were established and documented in Project Instructions (PI) that direct the activities as listed below. More specific entry/exit criteria may be detailed for each in its applicable PI. Further information will also be provided in the Software Maintenance and Development Plan (SMDP), DID EMD-SMDP-2. The Quality Assurance organization participates in development related planning and review activities and audits them for compliance to established processes and entry/exit criteria.

Activity	Entry Criteria	Exit Criteria
Development planning	Receipt of new requirements	Plan Review and Approval.
Ticket (requirements) development	Planning document (draft ticket)	Ticket Peer Review, Action Item Work-off, Authorization to proceed
Design	Ticket/Ops Concept Previous stage authorization to proceed	Design Peer Review, Action Item Work-off, Authorization to proceed
Code	Design Completion Previous stage authorization to proceed	Code Peer Review, Action Item Work-off, Authorization to proceed
Test plan/procedures development	Developed in conjunction with Design & Code phase	Test Plan/Procedures completed, reviewed, Authorization to proceed as artifact of Design and Code phase
Test execution (Unit and Integration)	Code merged, test environment established, test procedures complete.	Test completion, as defined for specified test (e.g., no severity 1 NCR)

### 3.2.2.4 Deployment Tasks

Deployment tasks include those associated with the release of custom code (test executables, patches and system release) and COTS (new and upgrade). Deployments are planned and coordinated, and activities may be identified in Primavera and the Patch Plan. Release management includes various phase-related entry/exit criteria leading to a Pre-Ship Review (PSR) and includes completion of testing, NCR status and release-related documentation readiness. The Operations Deployment CPT is primarily responsible for performing deployment tasks. QA is responsible for monitoring the activities and conducting audits for compliance to established process.

### **3.2.3 Quality Assurance Processes**

The QA organization has well established, documented processes, referred to as Landover Facility Procedures (LFP). The QA LFPs outline the processes for conducting objective audits and product evaluations, including developing appropriate audit/evaluation criteria and audit checklists, conducting the audit, documenting and reporting results, to include any nonconformances, which are documented based on defined criteria, as Deficiency Reports (DR) or Corrective and Preventive Action Report (C/PARs), conducting follow-up and verification audits to ensure closed-loop corrective action, collecting metrics, and maintaining audit records. See section 9.2 for a complete list of current Quality Assurance LFPs.

## **3.3 Roles and Responsibilities**

### **3.3.1 Quality Assurance Manager**

The Quality Assurance organization will be led by a Quality Assurance Manager with the responsibility to:

- Ensure the EMD QA team is staffed appropriately.
- Manage the EMD Quality Assurance budget and schedule.
- Evaluate QA staff performance; provide direction and guidance, as appropriate.
- Provide appropriate resources: office space, materials, tools, and training to ensure that Quality Assurance activities can be carried out effectively.
- Support AS9100/ISO 9000 related activities and ensure continued conformance to the requirements of the standards.

### **3.3.2 Quality Assurance Engineers**

Quality Assurance Engineers (QAE) are assigned by the QA Manager to support the EMD Program. Each QAE is responsible for quality assurance activities, such as:

- Monitor EMD activities and ensure the appropriate standards, processes, and procedures are identified and implemented by EMD Program staff.
- Conduct audits and perform objective evaluations of EMD processes and work products, based on defined criteria, to ensure they are in accordance with and conform to specified standards, processes, and procedures.
- Record and communicate results of audits and evaluations, which include identifying nonconformances and documenting them as DRs or C/PARs.
- Collect and analyze QA activity metrics and report results to QA Manager and Program management, as appropriate.
- Assign, track and verify corrective actions resulting from audits, evaluations, monitoring or Quality Action Requests (QAR).

- Ensure continuous process improvement by participating in process teams, lessons learned, management reviews, and Raytheon Six Sigma projects.
- Manage QA-related activities, as assigned, in accordance with EMD Program schedule.
- Support AS9100/ISO 9000 activities and ensure continued conformance to the requirements of the standards.

### **3.4 Quality Assurance Estimated Resources**

The QA Manager has the responsibility for ensuring the EMD Program is staffed appropriately to support the quality assurance requirements of the applicable task orders. EMD staffing status will be reported monthly in the Contractor Manpower Report, DID EMD-MCMR-12.

As the Control Account Manager (CAM), the QA Manager is also responsible for maintaining and monitoring the allocated budget for the Quality Assurance Work Breakdown Structure (WBS). Financial management status will be reported monthly in the Contractor Cost Reporting — 533 Requirements report, DID EMD-533-11.

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## 4. Documentation

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### 4.1 Purpose

This section will identify the documentation governing the development, verification, validation, use and maintenance of the ECS Science Data Processing System.

Quality Assurance engineers will conduct evaluations of specified documents to determine conformance to applicable standards and Data Item Descriptions (DID), as well as to ensure format, editorial, and technical adequacy. In accordance with LFP 19-0-22, Quality Assurance Product Evaluation Procedure, QA engineers will use a prescribed checklist to conduct document product evaluations. Document evaluation results will be provided to the authoring or responsible engineer as redlines for editorial comments or corrective actions for nonconformance to requirements.

### 4.2 Minimum Documentation Requirements

#### 4.2.1 Software Requirements Description

Level 3 requirements are specified by ESDIS in the ECS Functional & Performance Specification. Level 4 requirements, derived from the Level 3s are documented in EMD Tickets, which are controlled documents that include interfaces, operational concept, design requirements, design directives, test criteria (functional, error and performance) and mappings to test procedures.

QAEs review Requirements Tickets concurrent with their participation in Ticket Peer Reviews. QAEs have a dual role in the Peer Review process: in addition to review of the requirements document (Ticket), the process itself is subject to audit (see Section 3.2.3. Quality Assurance Processes).

#### 4.2.2 Software Design Description

The software design description documents developed under the ECS SDPS contract include ECS DID 305, Segment Design Specification, DID 311, Database Design and Database, and DID 313, Internal Interface Control Document (ICD). These documents will be maintained throughout the EMD contract period and will be subject to the QA review/evaluation described in Section 4.1 above.

#### 4.2.3 Verification and Validation Plans

Verification and validation (V&V) activities occur throughout the design and development lifecycle and include peer review of requirements, design artifacts, and code, as well as unit, integration and formal (witnessed) tests. For each design element, test plans for unit-level and

integration tests are developed and peer reviewed. Development unit and integration tests are scheduled and test plans and procedures are documented in accordance with specified formats.

Verification and validation activities are identified during the planning process and will be documented in the Planning Input Document (PID) and associated Ticket. Depending on several factors, e.g., complexity of the design, operational needs, and system impact, formal witnessed verification & validation tests may be planned. Formal tests will be documented in specified formats and test plans and procedures will be peer reviewed. Formal test plans may be submitted to ESDIS for review and approval prior to test execution, or reviewed concurrent with the development design peer review.

#### **4.2.4 Formal Verification Results Report and Validation Results Report**

The Verification Database (VDB) is the repository for formal verification and validation results and provides various reports on demand. At the conclusion of a witnessed, formal integration or acceptance test, results are initially documented in Criteria Verification Logs. The EMD test team reviews the log results with ESDIS Independent Verification and Validation (IV&V) representatives. Verification status requires IV&V concurrence prior to being formally documented as 'verified' in the VDB.

EMD test artifacts (e.g., execution forms, output logs and GUI screen captures) are maintained in formal Integration or formal Acceptance Test Folders and are subject to post-test and periodic QA audit and evaluation.

#### **4.2.5 User Documentation**

User documentation developed for the DAACs under the ECS SDPS contract include ECS DID 609, Operation Tool Manual, DID 625 Training Material, and DID 611, Mission Operations Procedures. These documents will be maintained throughout the EMD contract period and will be subject to QA review and evaluation as described in Section 4.1 above. In addition, software release documents such as release notes and installation documents are reviewed by QA during the deployment internal review process and pre-ship evaluations.

#### **4.2.6 Configuration Management Plan**

The EMD contractor will develop and deliver a Configuration Management Plan (DID EMD-CMP-19), three months after task authorization, as specified by the CDRL for EMD Task 101. QA will review and evaluate the CMP in accordance with the QA process as described in Section 3.2.3.

### **4.3 Other Documentation**

#### **4.3.1 Transition Plan**

The Transition Plan (DID EMD-TP-1), EMD Contractor document number 101-EMD-001, was developed and delivered in August 2003 – two weeks after task authorization, as specified by the

CDRL for EMD Task 101. The document was reviewed by QA and results recorded in Product Evaluation #0388, in accordance with QA process as described in Section 3.2.3.

#### **4.3.2 Program Management Plan**

The Program Management Plan (DID EMD-PMP-8), EMD Contractor document number 108-EMD-001, was developed and delivered in September 2003 — one month after task authorization, as specified by the CDRL for EMD Task 101. The document was reviewed by QA and results were recorded in Product Evaluation #0389.

#### **4.3.3 Development and Program Plans**

The EMD contractor will develop and deliver the following documents according to the specified schedule of the CDRL for EMD Task 101. QA will review and evaluate these documents in accordance with QA process as described in Section 3.2.3.

- DID EMD-SMDP-2, Software Maintenance and Development Plan
- DID EMD-HMDP-3, Hardware Maintenance and Development Plan
- DID EMD-PP-5, Property Management Plan
- DID EMD-RMP-6, Risk Management Plan
- DID EMD-SMP-7, EMD Security Management Plan
- DID EMD-PM-17, Procurement Management Plan

#### **4.3.4 Review Documentation**

Quality Assurance will participate in program and milestone reviews, as appropriate. As above, QA will review and evaluate presentation and report materials in review packages, as indicated for CDRL items, to ensure compliance to review agenda, DID requirements, and the statement of work.

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# 5. Standards, Practices, Conventions, and Metrics

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## 5.1 Purpose

The purpose of this section of the SQAP is to identify the processes, product standards, and metrics used by the Sustaining Engineering IPT, and to explain how QA monitors and assures conformance to these requirements.

## 5.2 Content

### 5.2.1 Process Requirements

Documentation, design and coding standards, development and maintenance processes, and test standards and practices are all described in EMD Project Instructions (PI) and Work Instructions (WI) posted to an internal web page, accessible to EMD Program personnel. EMD product and process metrics are described in the Program Management Plan, also available via the web. Project PIs, WIs and plans are reviewed regularly and updated as appropriate.

QA will monitor conformance to these requirements through regularly scheduled, formally documented audits. Audit findings will be recorded in the Quality Assurance Tracking Database, and associated physical artifacts will be filed in the QA Repository. Findings that require corrective action will continue to be monitored and tracked to acceptable resolution.

### 5.2.2 Metrics

QA participates in the development, implementation, and data production for the metrics defined in the EMD PMP. These metrics, developed in coordination with the customer, are intended to enable management visibility into the health of the development/maintenance process and the operational ECS system. QA provides ESDIS management an independent analysis of these metrics on a monthly basis.

In addition to the metrics described in the EMD PMP, QA maintains internal metrics to assess the workload and effectiveness of the QA staff. These metrics are reviewed at staff meetings on a monthly basis, and are used to adjust workload assignments and to focus QA attention to potential problem areas.

The EMD QA Manager uses analysis of the EMD metrics, along with results from internal QA metrics to apprise Raytheon program and executive management at quarterly Quality System Management Reviews (QSMR). Analysis of the EMD metrics provides input into the Quality Program Indicator (QPI), an internal tool used for evaluating and reporting project health status to upper Raytheon management. QA internal metrics are used to report problems that require upper management's attention, as well as to report quality improvements.

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## **6. Software Reviews**

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### **6.1 Purpose**

#### **6.1.1 Technical and Peer Review**

Software reviews have a dual purpose on the EMD Program. First, software reviews present opportunities for defect containment. Secondly, they may serve as gates to assure appropriate progression to the next phase of the software lifecycle. EMD software reviews will be consistent with the applicable technical review descriptions in the EMD SOW and the criteria for peer reviews of software work products documented in the EMD Peer Review Process PI. Minimum requirements established by IEEE Std-730-2002 are described for EMD in Section 6.2. The schedule for software reviews will be determined for each project task order issued by ESDIS and for each individual sustaining engineering NCR that meets the thresholds for software peer reviews.

The reviews shall be accomplished according to governing EMD procedures and applicable technical review descriptions in the EMD SOW. Quality Assurance will attend significant reviews and audit the content, conduct, and follow-through on the review. As appropriate, QA will be a participant and may be included on the agenda to report on activities, findings, and software status.

### **6.2 Minimum Requirements**

#### **6.2.1 Software Specifications Review (SSR)**

The EMD implementation of the SSR is the Requirements Management process that includes Requirements Ticket peer reviews. The Ticket peer review is conducted to ensure adequacy of requirements prior to review and/or approval of the Ticket by ESDIS and baseline in the VDB. QA will participate in Ticket peer reviews and audit the process using criteria based on the applicable governing procedures.

#### **6.2.2 Architecture Design Review (ADR)**

The EMD implementation of the ADR is the Preliminary Design Review (PDR) stage of the Peer Review process. The PDR peer review is conducted to ensure adequacy of the preliminary design, to uncover errors and improve design quality, and to determine readiness to proceed to the next design phase. QA will participate in PDR peer reviews and will audit the process using criteria based on the applicable governing procedures.

### **6.2.3 Detailed Design Review (DDR)**

The EMD implementation of the DDR is the Detailed Design stage of the Peer Review process. The DDR peer review is conducted to determine sufficient design detail, to uncover errors and improve design quality, and to determine readiness to proceed to the next design phase. QA will participate in DDR peer reviews and audit the process using criteria based on the applicable governing procedures.

### **6.2.4 Verification and Validation Plan Review**

The EMD implementation of V&V plan reviews occurs during Design and Code and Unit Test Peer Reviews. At each successive peer review, the Integration Plan and Test Procedures will be evaluated to ensure the V&V methods are complete and appropriate based on the applicable requirements. As above, QA will participate in these V&V peer review activities and audit the process using criteria based on governing procedures.

### **6.2.5 Functional Audit**

EMD QA will conduct a Functional Configuration Audit (FCA) when a release Consent to Ship Review (CSR) is scheduled. This is also implemented on EMD through the continuous monitoring of verification activity for new functionality delivered as a patch rather than a full release.

### **6.2.6 Physical Audit**

EMD conducts a Physical Configuration Audit (PCA) when a release CSR or Release Status Review (RSR) is scheduled. The Configuration Management CPT will perform PCAs with appropriate support from QA. The PCA process will be periodically audited by QA to ensure its effectiveness and conformance to documented procedures.

### **6.2.7 In-Process Audits**

As discussed previously, in-process audits of the design will be accomplished for the EMD Program through design and development peer reviews monitored and audited by QA.

Interfaces are considered and addressed early in the requirements Ticket peer review and continue to be evaluated through design and development peer reviews (PDR/DDR/CUT).

Code is evaluated with design documentation and artifacts during the Code and Unit Test (CUT) inspection peer review.

Design implementation is evaluated to ensure functional requirements are appropriately met. This is achieved through peer review, verification testing and FCAs, monitored and audited by QA.

Test plans and procedures are reviewed for adequacy and suitability to demonstrate implementation of functional requirements. This is achieved through the design/development and

CUT peer reviews, with emphasis on Integration Plans and Test Procedures, Ticket requirements, and acceptance criteria.

### **6.2.8 Managerial Reviews**

EMD Program Management will conduct regular managerial reviews, such as program monthly reviews (PMR) to present general program and technical system status; and weekly status reviews that addresses an agreed-upon agenda and provides the opportunity to ensure common understanding of technical issues and priorities, discuss specific actions and mitigate overall program risks.

The Quality Management System (QMS) and Quality Assurance activities are reviewed and reported to program and executive management. QA will prepare a report for the EMD Program Manager that lists previous month QA-related activities, including monitoring, audits and product evaluations. The report will indicate the number of audit/evaluations performed, the number of deficiencies, if any, and issues, concerns or observations resulting from trends; including positive feedback. QA also presents Quality System Management Reviews (QSMR) to executive management quarterly. This review provides program and process insight to enable management to assess the suitability and effectiveness of the Landover facility QMS.

### **6.2.9 Software Configuration Management Plan Review**

The EMD implementation of this will occur during the document review cycles the EMD CM Plan will go through from draft to final contract deliverable. There are many functional reviewers and QA will focus on DID compliance and the adequacy and completeness of the CM methods defined for EMD.

### **6.2.10 Post-Implementation Review**

The EMD implementation of this will be the Lessons Learned Review scheduled according to the EMD SOW.

## **6.3 Other Reviews and Audits**

EMD process audits are scheduled by QA for key processes implementing EMD activities and tasks described in Section 3.2.2 at a frequency appropriate to their maturity and impact on EMD and the ECS system. EMD product evaluations are conducted on all contract deliverables during the document preparation review cycles, and key products from the tasks in Section 3.2.2. The QA schedule will reflect the status, accomplishment and frequency of these process audits and product evaluations.

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## 7. Test

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The EMD SOW requires testing in addition to the software verification and validation testing described in Section 4.2.3. End-to-end performance tests of extended duration will be monitored by QA when scheduled. Regression and Installation testing will be executed for each patch or major release and the resulting test reports audited by QA as part of the deployment audit process.

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## **8. Problem Reporting and Corrective Action**

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This section of the SQAP describes the process for reporting, tracking, and resolving problems/issues from software items and software development and maintenance processes and work products.

### **8.1 Hardware and Software Items**

Problems concerning SDPS custom code, COTS, and associated software/hardware items may be reported by the Sustaining Engineering IPT and/or the operational DAACs as nonconformance reports (NCRs) or Trouble Tickets. The responsible organizations and the processes and tools used for reporting, tracking and resolving these problem reports are described in EMD Project and Work Instructions.

### **8.2 EMD Process and Work Products**

Problems resulting from EMD software development and maintenance processes and work products may be reported by project personnel or identified by QA as a result of formal audits and evaluations or informal surveillance. Project personnel may also identify and report problems to QA via a Quality Action Request (QAR), which will initiate an investigation by QA. Results from formal audits/evaluations or informal surveillance that require corrective actions, as well as QARs, are documented and tracked in the QA Tracking Database. Associated physical artifacts are filed and maintained in the QA Repository. In accordance with established LFPs (see Section 9.2), all corrective actions will be monitored and tracked to acceptable resolution.

### **8.3 Quality Management System**

Problems uncovered during ISO audits or project process audits that indicate a failure of the Quality Management System, are documented as C/PARs. QA is responsible for the tracking and status reporting of C/PARs. The QA manager, who is also the Landover Site ISO Coordinator, reports on ISO activities (ISO training, scheduled audits, C/PAR status) to EMD Program and Executive Management.

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## 9. Tools, Techniques, and Methodologies

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### 9.1 Tools and Equipment

QA will use standard tools and procedures already established and proven effective during the ECS contract, to continue support on the EMD Program. QAEs will use standard Microsoft Windows-based computers and software applications to ensure collaborative ease of use and consistency across the EMD Program:

- QA Tracking Database – is a Microsoft Access database, custom designed by and accessible only to QA. It was developed to document audit and evaluation results, deficiency reports, and status. Records in the database are updated, maintained and statused as corrective action and verification activities are carried out to closure. The database will be used to generate data and metrics necessary for program and executive management reports and reviews, as well as to demonstrate compliance to the requirements of ISO 9000 and AS9100.
- QA will use Microsoft Project to schedule and track QA activities planned as ongoing or aligned with the EMD Program schedule (in Primavera).
- Microsoft Office products, such as Word, Excel and PowerPoint are standard and will be used to develop documentation, QA metrics reports and graphs, and review or presentation material, as appropriate. Visio Professional may also be used to develop process flows and other diagrams.

### 9.2 Methodologies and Process

The EMD QA organization relies on a well-established hierarchy of documented processes to direct QA activities, stemming from the Raytheon Quality Management System Manual, IPDS, IIS Product Assurance/Quality policies and procedures. The latter of which have been tailored and documented at the local level as Landover Facility Procedures and listed below:

19-0-0	ISO Implementation Map
19-0-2	Quality System Management Review
19-0-4	Software Quality Assurance Program Planning
19-0-14	Quality Assurance Deficiency Reporting
19-0-16	Quality Management System Records
19-0-17	Internal Quality System Audits
19-0-19	Quality Assurance Audit Procedure
19-0-20	Quality Assurance Evaluation Criteria Procedure
19-0-22	Quality Assurance Product Evaluation Procedure
19-0-23	Quality Assurance Status and Metrics Reporting
19-0-24	Corrective and Preventive Action

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## 10. Media Control

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During the EMD Program ECS SDPS and COTS software and media will be controlled by the Configuration Management organization through established process and use of appropriate tools (e.g., Rational® ClearCase®). For more information and detail, refer to the EMD Configuration Management Plan (DID EMD-CMP-19).

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# 11. Supplier Control

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## 11.1 Supply Chain Management

Raytheon's Supply Chain Management (SCM) organization is responsible for subcontract and procurement management. SCM will ensure that all required products and services are competitively selected, to the fullest extent possible, in accordance with prime contract terms and conditions, company policies and procedures, and all applicable statutes and regulations.

Further details and information will be available in a separate Procurement Management Plan to be developed in accordance with DID EMD-PM-17 and evaluated by QA prior to delivery.

## 11.2 Quality Assurance Role

As part of the Raytheon Quality Management System, SCM procedures and procurement records are subject to audit and inspection. Quality Assurance performs annual audits to the requirements of AS9100 and ISO 9000, as well as internal Raytheon policies and procedures to ensure continued compliance.

All subcontractor team members working onsite are directed to adhere to EMD processes and procedures, and are subject to process audit and work product evaluations. In addition, QA participates in and contributes to regular subcontractor performance evaluation.

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## **12. Records Collection, Maintenance, and Retention**

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### **12.1 Quality Assurance Tracking Database**

Quality Assurance engineers document audit and product evaluation results in an MS Access-based database, i.e., the QA Tracking Database. The database is access-restricted to QAEs. Data entry correction and database modifications is further restricted to the Quality Assurance Manager or designee. The database resides on a network server that is included in the Information Technology (IT) routine back-up schedule.

### **12.2 Quality Assurance Repository**

The Quality Assurance organization maintains a physical records repository collocated within the QA office space. Complete audit records include the formal audit or product evaluation report (generated from the QA Tracking Database), and as appropriate, Deficiency Reports (DRs), checklists, and other artifacts and evidence. Quality Assurance audit and product evaluation records are retained three years minimum, in accordance with Raytheon Company Policy 00000024-RP, unless otherwise stipulated by EMD Contract. Upon request, audit records are available for EMD Program and ESDIS System Assurance review.

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# 13. Training

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In order to carry out the Quality Assurance activities described herein, each QAE is expected to have fundamental knowledge of the following areas through prior experience or training.

## 13.1 Training Requirements

It is the responsibility of the Quality Assurance Manager to establish basic QAE skills, training and experience requirements. The QA Manager will assess QAE capability, identify training needs, and facilitate training delivery via applicable Raytheon and Landover procedures.

EMD QAEs either already possess the following knowledge through work experience or receive targeted training prior to engaging in quality assurance tasks.

- Software Engineering Principles – General understanding of software lifecycle and software work products.
- ECS SDPS – General understanding of the EOSDIS Core System Science Data Processing System.

## 13.2 Raytheon Provided Training

The training listed below was developed by Raytheon for the specified purpose and is available to all EMD Quality Engineers.

- Internal Auditor Training – Describes the fundamental principles in preparing, conducting and documenting an internal audit.
- ISO 9000/AS9100 – Overview describing the requirements of the ISO 9000 Quality Management Systems standard and additional Aerospace requirements.
- Raytheon Integrated Product Development System (IPDS) – Overview and understanding of the structure within which Raytheon common processes are integrated and deployed.
- Raytheon Six Sigma (R6 $\sigma$ ) – Overview of the fundamentals of R6 $\sigma$ , which is broader in scope than traditional six sigma. Specialist training provides specific guidance for applying the principles and tools to achieve improvement objectives.

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# 14. Risk Management

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## 14.1 Risk Management Approach

Raytheon has a well-structured continuous risk management system (CRMS) in place that meets the guidelines of NPG 7120.5A. Risk factors such as technical complexity, staff experience/availability, external dependencies, and COTS integration are considered in costing and scheduling and form an integral part of the EMD planning process for system enhancements. As a result, potential risks are identified and addressed early in the process and tracked throughout the development process until they can be closed. Further detail will be provided in a separate Risk Management Plan to be developed and delivered in accordance with the CDRL schedule and DID EMD-RMP-6.

## 14.2 Quality Assurance Role

The Quality Assurance program monitors the risk process via scheduled program audits and annual AS9100/ISO 9000 audits. QA participates in risk mitigation strategies, such as monitoring PVC testing, auditing design and development reviews, and participation in management/customer reviews. QA identifies and reports program risk through its analysis of noncompliance and corrective action trends resulting from program audits and evaluations.

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## 15. Glossary

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Terms and abbreviations used in this SQAP are listed below. Most are well understood within the EMD Program and similar industry and programs. Abbreviations and acronyms referenced herein have been defined within this plan.

ADR	Architecture Design Review
CAM	Control Account Manager
CCB	Configuration Control Board
C/PAR	Corrective and Preventive Action Report
CPT	Cross Product Team
CRMS	Continuous Risk Management System
CSR	Consent to Ship Review
CUT	Code and Unit Test
DAAC	Distributed Active Archive Center
DDR	Detailed Design Review
DID	Data Item Description
DR	Deficiency Reports
ECS	EOSDIS Core System
EMD	ECS Maintenance and Development
ESDIS	Earth Science Data and Information System
FCA	Functional Configuration Audit
HMDP	Hardware Maintenance and Development Plan
ICD	Interface Control Document
IIS	Intelligence and Information Systems
IPDS	Integrated Product Development System
IPT	Integrated Product Team
IT	Information Technology
ITS	Information Technology Systems
IV&V	Independent Verification and Validation
LFP	Landover Facility Procedures
NCR	Non-Conformance Report
NQA	National Quality Assurance
PCA	Physical Configuration Audit
PDR	Preliminary Design Review
PI	Project Instruction
PID	Planning Input Document
PM	Program Management
PSR	Pre-Ship Review
QA	Quality Assurance
QAE	Quality Assurance Engineer
QAR	Quality Action Request
QMS	Quality Management System

QPI	Quality Program Indicator
QSMR	Quality System Management Review
R6 $\sigma$	Raytheon Six Sigma
RAB	Registrar Accreditation Board
RSR	Release Status Review
SCM	Supply Chain Management
SDPS	Science Data Processing System
SEP	System Enhancement Proposal
SMDP	Software Maintenance and Development Plan
SQAP	Software Quality Assurance Plan
SSR	Software Specifications Review
VDB	Verification Database
WBS	Work Breakdown Structure
WI	Work Instruction

## **16. SQAP Change Procedure and History**

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### **16.1 Change Control**

This document, produced by the Quality Assurance organization, will undergo a review by members of Program Management and the Configuration Control Board (CCB), and will be released upon their approval. Thereafter, the document will be under Configuration Management control. Subsequent changes or modifications to this document will be the responsibility of QA. Proposed changes will be coordinated by QA and reviewed and approved by the CCB.

### **16.2 Modification History**

This is the initial release of the Software Quality Assurance Plan for the EMD Project. Future versions will be identified by a revision indicator (letter or number) and the revision history will be documented in the front matter of this SQAP.

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