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1. MSFC Manual, MM 2410.13, subject: "MSFC General-Purpose Software Development and Management Requirements Manual"
2. The attached manual is published to implement policy and to provide procedural guidance governing the development of general-purpose software for MSFC.

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**MSFC General-Purpose Software Development and  
Management Requirements Manual**

**Information Systems Office**

## **PREFACE**

The MSFC General-Purpose Software Development and Management Requirements Manual implements policy and provides procedural guidance governing the development of all general-purpose software for MSFC. This manual is set within the framework of guidance provided by NASA Headquarters and serves to implement these requirements. It provides general guidelines for MSFC personnel, contractors, and subcontractors to follow when developing software for MSFC.

The Chief, Systems Development and Implementation Division, Information Systems Office, is responsible for the publication and maintenance of this manual. Any MSFC organization desiring changes will submit them to the Chief, Systems Development and Implementation Division, Information Systems Office.

Distribution of this manual is to basic organizational elements. Additional copies may be obtained from the Central Documentation Repository.

Orig s/by  
T. J. Lee  
Director

Distribution:  
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## Chapter 1

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#### 1.0 GENERAL

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## 1.0 GENERAL

### 1.1 Applicability

This document establishes an approach to develop general-purpose software for the Marshall Space Flight Center (MSFC). This document describes the structure of software development projects, including planning, tracking, formal reviews, quality controls, and functional verification; and references the applicable Automated Information Management (AIM) Software Development Life Cycle (SDLC) documentation. Procedures are described in sufficient detail to allow a clear understanding of the steps of a software development project from inception to completion, including the content of the end item delivered. It is applicable to all general-purpose software developed for MSFC.

### 1.2 References

This General-Purpose Software Development and Management Manual follows standard Government software development practices, and is based on and mapped to the NASA AIM SDLC Program Guidance. It emphasizes the importance of a controlled software development life cycle.

### 1.3 Approach

All software has an identifiable life span. This span begins when the need for software is first recognized, continues during the development and use of the software, and ends when the software is no longer needed. This span is known as the software life cycle. This manual presents a rigorous, repeatable, controlled approach to software development, including the life cycle phases, review requirements, baselines, standard documentation flow, and software development guidelines.

This manual recognizes all of the phases from initial concept through maintenance, operation, and eventual retirement of delivered software; is applicable to both pilot and prototype situations; and maps to the NASA AIM SDLC standards. The review requirements include those that provide for disciplined software development, allow the customer/user to follow and approve the progress of the development, and also allow establishment of baselines. Key baselines are established at critical points in the life cycle to ensure a controlled approach to development, to assure customer understanding and agreement, and to control change. Following the establishment of a baseline, formal change control will be required. The documentation set is designed to satisfy sound development procedures, satisfy contract requirements, and test, operate, maintain, and use the system. It also allows for differences in the size and complexity of systems.

Once the software is operational, modifications are often required to address new requirements, improve performance, or correct faults. These maintenance activities typically require subsets of the requirements identified in this manual, tailored to the type and scope of each modification.

#### 1.4 Mapping to NASA AIM Standards

Because the AIM SDLC was specifically developed to apply to NASA Agencywide software development (including primarily large-scale development activities), it requires administrative and technical control and review at various upper levels of the NASA organizational hierarchy. Because the majority of the development activities within MSFC are much more narrow in scope, the appropriate MSFC administrative and technical staff are mapped into the MSFC implementation of the AIM SDLC for review and program control purposes (Figure 1-1 depicts this mapping).

Although the terminology of functions and organizations differ between the AIM SDLC and the MSFC environment, the intent of this manual is to map clearly to the AIM SDLC standard. References are made throughout the manual text to the specific AIM Program Guidance Volume, document specification, phase, or review that directly supports the particular function. Where required by contractual obligations, as in Agencywide software development, the full AIM SDLC is followed.

#### 1.5 Tailoring the Standard

This manual presents the optimal life cycle, review requirements, and documentation requirements. Because of the broad and varied nature of software development, this manual may be tailored downward based upon agreement between the developer and customer. As the development activities vary between multiyear projects to support a large user base and single modules developed to support a single user, rigorous application of the manual must be balanced by a cost-effective, common sense approach to development. For smaller projects, the phases, reviews, and documents may be combined and the requirement for certain elements deleted, as long as the basic framework is followed. An example of this approach is shown in Appendix A. Any such tailoring is documented in the project management plan.

The AIM SDLC itself is flexible (tailorable). Cost and complexity of a project should be the factors determining the extent to which the AIM SDLC process should be implemented. This manual supports fully the AIM SDLC intention of tailoring the process to address specific project needs in coordination with the appropriate MSFC administrative and technical staff.

## 1.6 Explanation of AIM SDLC Methodology Documentation Approach

The documentation that directly supports the AIM SDLC methodology has been published in three volumes titled AIM Program Guidance.

Volume I of the AIM Program Guidance defines the AIM project life cycle methodology processes and procedures.

- o Section 1.0 provides descriptions of the concept behind the methodology, the principal participants in any project (see Figure 1-1 for an organizational chart that relates the AIM functions to the MSFC equivalent), the major activities involved, and a summary of the documentation.
- o Section 2.0 provides a description of the organization, roles, and responsibilities of the AIM program participants. Note that many of the organizations and functions described in Section 2.0 do not apply at the MSFC level.
- o Section 3.0 presents an overview of the Information Engineering methodology and discusses the most important AIM management activities in the early phases of the AIM project.
- o Section 4.0 discusses the comprehensive project management activities of the AIM project, including the use of a Work Breakdown Structure for AIM project planning and the use of formal Configuration Management for project management control.
- o Section 5.0 provides a description of the AIM life cycle and the major activities and documentation necessary to conduct an AIM project.
- o Section 6.0 provides a summary of the formal documentation used in an AIM project.

Volume II of the AIM Program Guidance details the document specifications providing guidelines for preparing the formal project documentation.

Volume III of the AIM Program Guidance contains detailed standards and guidelines related to the AIM Information Architecture. Note: This Volume is not referenced further within this manual.

At the time of this writing, the AIM standard is being revised. This manual follows the approved revision to avoid republishing in the near future. To aid in understanding this revision, Figure 1-2 shows the mapping of the 13 new AIM Document Specification (DS) documents to the 24 current AIM Data Item Description (DID) documents.

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Figure 1-1

MSFC-to-AIM Organization Function Structure Mapping

Note: This page can only be obtained in hard copy from the MSFC  
Documentation Repository.

Figure 1-2

Document Specification-to-Data Item Description Matrix

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## 2.0 METHODOLOGY - SOFTWARE DEVELOPMENT LIFE CYCLE

This section presents the MSFC view of the AIM SDLC methodology to be followed in developing MSFC software development projects. Figure 2-1 (extracted from AIM Program Guidance documentation) presents the phases and subphases of this SDLC with their associated documentation, review, and baseline milestone schedules. The following sections present descriptions of these phases and associated subphases.

### 2.1 Planning Phase

#### 2.1.1 Feasibility Subphase

The feasibility subphase begins when the need for a new system or major modification to an existing system is identified and a project request is initiated. A project Feasibility Study and Benefits Cost Analysis (DS-01) is performed, if requested by the NASA customer or project monitor. Specific tasks in this subphase include the development of candidate approaches, research into possible solutions to the need, analysis of commercial off-the-shelf (COTS) products, and risk analysis.

#### 2.1.2 Project Planning Subphase

The project planning subphase includes the statement and refinement of the user needs identification of resources and funding, and identification of any constraints. These items may be documented in the Project Initiation Agreement (DS-02), if requested by the NASA customer or project monitor, or may be documented by a work authorization document.

The major deliverable of this subphase is the Project Management Plan (DS-03), which provides the plan for the overall management of the project. At this point in the life cycle, the project plan includes the schedule and tasks required to complete the planning and definition phases and to proceed to the design phase. It is updated throughout the life cycle as further information becomes available. For example, resource estimates and schedules are updated as each life cycle phase is completed. Customer acceptance of the product of this phase is in the form of approval and funding to proceed to the next phase.

The Project Management Plan (DS-03) is the document by which the NASA Project Monitor and the Project Technical Lead can designate which DS's are expected deliverables and which formal reviews are conducted for the specific project. See Appendix A and B for guidelines in determining deliverables and reviews.

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Figure 2-1. AIM Project System Development Life Cycle

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## 2.2 Definition Phase

### 2.2.1 Preliminary Definition Subphase

The preliminary definition subphase defines and documents the preliminary high-level user requirements (major functions, data objects, and relationships) for the system in the preliminary Requirements Specification (DS-04).

Other deliverables of this subphase, if required, are the Configuration Management Plan (DS-05) and the draft versions of the Product Assurance Plan (DS-06) and the Procedures and Standards Manual (DS-07). Review and approval of these documents occur during the Preliminary Requirements Review (PRR).

### 2.2.2 Baselined Definition Subphase

The baselined definition subphase defines and documents detailed user requirements for the system. The developer and user work closely together to further define and document all system requirements, including functionality, users, performance, input, output (e.g., screens, reports, graphics), online and batch requirements, interfaces, operating environment, security and privacy act considerations, user interface requirements, etc.

The deliverable of this subphase is a user-approved Requirements Specification (DS-04). Review and approval of this document occurs during the System Requirements Review (SRR), which establishes the Functional Baseline. If required, the Product Assurance Plan (DS-06) and the Procedures and Standards Manual (DS-07) are delivered at the end of this phase.

## 2.3 Design Phase

### 2.3.1 Preliminary Design Subphase

The preliminary design subphase begins only after all requirements have been identified and detailed in the Requirements Specification (DS-04). An updated Project Management Plan (DS-03) is also delivered that addresses the schedule and resource estimates for the design phase. Working from the baselined requirements, the basic design approach to satisfy these requirements is developed. A Design Specification (DS-08) is formulated from system requirements, resulting in the allocation of requirements to system components, including either hardware or software. The overall design approach and trade-offs are documented.

This preliminary design (functionally oriented) is then mapped back to the Requirements Specifications (DS-04) document to ensure that the proposed computing functions map back to all requirements. During this phase, a decision may be made to implement a prototype project, a pilot project, or incremental development of the design. The preliminary design specification is defined in sufficient detail so that the final Design Specification (DS-08) can be completed during the next subphase (detailed design).

The major deliverable of this subphase is the preliminary version of the Design Specification (DS-08) document. It is reviewed and approved during the Preliminary Design Review (PDR). A draft Test Plan and Procedures (DS-09) is also prepared to identify the overall strategy for project testing.

### 2.3.2 Detailed Design Subphase

The preliminary design components from the previous subphase are now further defined and broken down as needed. The form of documentation varies depending on the automated software development tools available. Traceability to the Requirements Specification (DS-04) is maintained to ensure that all user requirements are met.

The major deliverables of this subphase are the completed Design Specification (DS-08) and an updated draft version of the Test Plan and Procedures (DS-09) documents. The Test Plan and Procedures (DS-09) must exercise each requirement identified in the Requirements Specifications (DS-04) document and be traceable directly to that requirements document. It consists of a series of test cases and expected results. Each set of test cases is documented as a test procedure, and the set of test procedures becomes the test plan. Invalid values and conditions should also be included in the test cases to ensure they are not accepted by the system. The Test Plan and Procedures (DS-09) may be appended to the Project Management Plan (DS-03) for smaller systems. The Design Specification (DS-08) provides a sufficient level of detail so that coding the modules becomes a task of translating the design into source code. Review and approval of these documents occur in the Critical Design Review (CDR), which establishes the Allocated Baseline. The User and Operations Guide (DS-10), Training Plan and Procedures (DS-11), and the System Implementation Plan (DS-12) documents are initiated, if required, and are updated throughout the Development Phase. DS-10 and DS-11 are also reviewed during the CDR.

## 2.4 Development Phase

### 2.4.1 Code Subphase

During this subphase, the detailed design is translated into the appropriate software code. The code conforms to project software standards. Peer walk-throughs are conducted to ensure compliance and are maintained with project documentation. The code is annotated to include author, change history, purpose of the module, and detailed program comments. Unit tests are executed by the developer to ensure that differences between expected and actual results are identified and corrected and that the software does not exhibit undesirable effects.

All of the documents initialized in the previous phases are updated to ensure that all requirements are included and adequately tested. The draft System Implementation Plan (DS-12) is delivered during this subphase and reviewed during the Test Readiness Review (TRR).

### 2.4.2 Developer Test Subphase

Following successful completion of unit tests, modules are grouped as logical functionally related sets, and integration testing is conducted. Results are documented, corrections made, and retesting occurs until all integration strings test cleanly. As testing is completed on several functionally related strings, formal system testing may begin.

System testing occurs to meet two objectives. The first objective is to ensure that the software meets the stated requirements. This testing is done by performing each test procedure in the test plan, thereby ensuring that all requirements are included and satisfied as planned, and by testing all possible branches. The second objective is to ensure that no adverse effects are exhibited by the software, interfaces to other systems function properly, and response times, if specified, are met. To accomplish this objective, the software must be tested in an environment as close to the production environment as possible. Results of each test procedure are documented. If problems are identified, they are documented on a problem report and forwarded to the developer for correction. Upon correction, re-testing occurs until all problem reports are closed, and all test procedures are completed satisfactorily. User participation in system testing is encouraged. User training may be initiated during this subphase.

The major deliverable of this subphase is the Test Plan and Procedures and Test Reports (DS-09). Following completion of development testing and the generation of the test plan, a TRR is conducted to verify that the system is ready for Government testing by the requesting NASA customer. A formal draft version of the User and Operations Guide (DS-10), the Training Plan and Procedures (DS-11), and the draft Version Description Document (DS-13) should be completed at this time and delivered to the NASA customer or project manager for review and approval.

### 2.4.3 Government Test Subphase

Following the successful completion of the full integration testing of the system by the development team, the system is turned over to the NASA customer for testing and eventual acceptance. User acceptance testing is executed by the user representatives or direct users. Its prime objective is to verify that the system meets the original user requirements and corresponds to the processing as depicted in the User and Operations Guide (DS-10). All components of the system are tested to confirm that the complete system solution works properly.

Government acceptance testing is typically executed under the control of end users and systems operations staff. The system development team acts primarily as technical consultants during this stage. The prime objective is to validate that the total system functions properly in a real-life or near real-life production environment.

The major deliverables during this subphase are the Test Reports and Automated Information Security (AIS) Certification (DS-09), User and Operations Guide (DS-10), the Training Plan and Procedures (DS-11), and System Implementation Plan (DS-12) (if they have all been specified as deliverable documents). This subphase is concluded with the Operations Readiness Review (ORR), which establishes the System Baseline. The Version Description Document (DS-13) is further updated during this subphase.

## 2.5 Implementation Phase

Following completion of the development phase, the software and any data are installed in the production environment, and any outstanding documentation is delivered in final version to the user. All discrepancies noted during the installation are resolved by corrective action. Following this resolution, the system is ready for production use. In some cases, systems may run in parallel to the systems they are replacing for a specified period.

On others, full production use may occur immediately. The System Baseline is maintained throughout this phase and the Sustaining Engineering Phase. The Project Management Plan (DS-03) is updated with the minutes of the Operations Readiness Review (ORR).

## 2.6 Sustaining Engineering Phase

Once the system has been placed in service, changes to the software may be required to optimize the system, add new requirements, or correct deficiencies. Rigid change control (see Section 6.0), quality assurance, and test procedures are followed to ensure the changes do not adversely affect the system. System documentation is updated and maintained to reflect any such changes. This sustaining engineering phase continues until the software is no longer in use.

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#### 3.0 DOCUMENTATION

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### 3.0 DOCUMENTATION

The documents referenced in the previous sections by the document specification numbers (DS-*nn*) correspond to the document summaries (AIM DS-*nn*) referenced in Section 6.0 of Volume I and the document details explained in Volume II of the AIM Program Guidance. The AIM Program Guidance Volume II provides a complete explanation of the expected contents of the formal documents, with a section-by-section boilerplate description of each document requirement. Examples of completed documents are also made available to the development team.

The AIM documentation "trail" and AIM DS's may be modified to meet the requirements, cost, and complexity factors of any particular project. The documentation generated tracks the development and configuration management of a project. By complying with the AIM documentation process, this manual provides a common approach and standardization for documenting systems. While this compliance presents a standard approach to system documentation, developers and users should jointly review the documentation requirements, agree upon the required documentation set, and document such as part of the Project Management Plan (DS-03). While no critical subset of documentation is defined in this manual, it is anticipated that the requirements, cost, and complexity will determine the critical documentation set in a particular project life cycle. See Appendix A (Software Documentation Requirements Guidelines) for suggested documentation tailoring.

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#### 4.0 FORMAL REVIEWS

Formal reviews are described in the following paragraphs. The purpose, participants, and major contents of each review are defined. The participants in each review shall consist of the system user, the system monitor, and members of the development team. Minutes are taken at each formal review. The minutes record the names and office of each participant, the results of all discussions and agreements, assignment of action items (including a description of the action, due date, and responsible individual), and are signed by a user, monitor, and developer representative to indicate concurrence. A record of the completion of each action item is appended to the minutes as completion occurs. A copy is maintained in a project historical file or kept as addendums to the Project Management Plan (DS-03), tracking project milestones and evolution. Formal reviews, like documentation, are determined by the nature and complexity of each project. All reviews do not apply to all projects. Any decision to conduct less than the full cycle of reviews should be documented in the Project Management Plan. See Appendix B (Formal Review Requirements Guidelines) for suggested reviews. In addition to formal reviews, informal reviews (e.g., peer reviews, peer walk-throughs, management reviews, informal customer/user status or technical reviews) are encouraged throughout the life cycle.

#### 4.1 Preliminary Requirements Review (PRR)

##### 4.1.1 Purpose

The PRR ensures that all major high-level system requirements have been identified and documented to allow both the user and developer to understand each key requirement, and that the preliminary version of the Requirements Specification (DS-04) is sufficient to begin further detail requirements analysis. The Baseline Definition subphase cannot begin until the PRR is completed and all key requirements are identified.

##### 4.1.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon the AIM SDLC documentation milestones. The PRR occurs at the end of the preliminary subphase in the definition phase. Documents should be delivered prior to the review, to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase.

- o Feasibility Study and Benefit Cost Analysis (DS-01). If requested by the NASA customer or project monitor, this analysis should be accomplished prior to the PRR and noted as such by all organizations represented in the participant list.
- o Project Initiation Agreement (DS-02). Based upon the above agreement, this document should be accomplished prior to the PRR and so noted.
- o Project Management Plan (PMP) (DS-03). The first version (1.0) should be accomplished at the end of the planning phase and be ready for review and signature at the PRR. Subsequent additions to the PMP are made following each review process.
- o Requirements Specification (DS-04). The draft version of this document, to include the functional requirements of the system, is prepared for preliminary review at the PRR. Preliminary approval is necessary prior to formalization of the baselined requirements to be presented at the System Requirements Review (SRR).
- o Configuration Management Plan (CMP) (DS-05). This plan, if not part of the PMP, is prepared for review and signature at the PRR.
- o Product Assurance Plan (DS-06). This plan, if not part of the PMP, is prepared in draft format, for preliminary review at the PRR. Preliminary review approval is necessary prior to formalization of the product assurance plans to be presented at the SRR.
- o Procedures and Standards Manual (DS-07). This manual, if not part of the PMP, is prepared in draft format for preliminary review at the PRR. Preliminary review approval is necessary prior to formalization of the procedures and standards to be presented at the SRR.

## 4.2 System Requirements Review (SRR)

### 4.2.1 Purpose

The SRR ensures that all system requirements are identified and documented in sufficient detail and clarity to allow both the user

and developer to understand exactly what is to be developed and what each specific requirement is to satisfy. The SRR ensures that the requirements specification is sufficient to begin design. The SRR is the most critical event in the software life cycle, as all further planning, resource estimating, scheduling, design, development, and testing are based on the requirements specification baselined in this review. This review and the baselining of system requirements are mandatory for all systems of any size. Any additional or changed requirements that follow this review are handled by the formal change process. The design phases cannot begin until the SRR is completed and all requirements are identified.

#### 4.2.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon the AIM SDLC documentation milestones. The SRR occurs at the end of the baselined subphase in the definition phase. Documents should be delivered prior to the review to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase. At this time, the following documents should be reviewed:

- o Requirements Specification (DS-04). The final version of this document, to include the baselined functional requirements of the system, is prepared for review and signature at the SRR. Review approval formalizes the baselined requirements, which are then subject to the PMP and CMP Change Control provisions.
- o Product Assurance Plan (DS-06). This plan, if not part of the PMP, is prepared in final format for review and signature at the SRR.
- o Procedures and Standards Manual (DS-07). This manual, if not part of the PMP, is prepared in final format for review and signature at the SRR.

#### 4.3 Preliminary Design Review (PDR)

##### 4.3.1 Purpose

The PDR ensures that the high-level, system design implements all stated requirements. The PDR approves/baselines the preliminary design of the project.

#### 4.3.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon AIM SDLC documentation milestones. The PDR occurs at the end of the preliminary subphase in the design phase. Documents should be delivered prior to the review to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase. At this time, the following documents should be reviewed:

- o Project Management Plan (DS-03). The second version (1.1) would have been accomplished at the end of the definition phase and should be ready for review and signature at the PDR. It reflects any project plan updates deemed necessary in prior review cycles. The PMP is an evolutionary document, tracking project planning and progress. Subsequent additions to the Project Management Plan are made following each review process.
- o Design Specification (DS-08). A preliminary version of the design specification is presented for review at the PDR. It provides a high-level design overview of the project traced to the requirements as stated in the requirements specification. Informal concurrence should be reached, as this is the basis for the greater detail that is to be contained in the final version of this document to be presented at the Critical Design Review (CDR).
- o Test Plan and Procedures (DS-09). A preliminary draft version of the Test Plan and Procedures is presented for review at the PDR, giving an overview of the testing process that is to occur in the development of the project. Subsequent versions, providing the detailed test information, are presented at the CDR with results to be presented at the Test Readiness Review (TRR).

#### 4.4 Critical Design Review (CDR)

##### 4.4.1 Purpose

The CDR ensures that the detailed design satisfies the requirements specification and preliminary design documents and is in a form sufficient for coding to begin. This review is critical, as from this point forward, the design is frozen, and any changes that affect the design must be processed through the formal change process. Coding cannot begin until the design is baselined. Any request to begin coding prior to this must be accompanied with a risk analysis, and be approved by the appropriate manager.

#### 4.4.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon AIM SDLC documentation milestones. The CDR occurs at the end of the detailed subphase in the design phase. Documents should be delivered prior to the review to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase. At this time, the following documents should be reviewed:

- o Design Specifications (DS-08). The final version of the design specification is presented for review and signature at the CDR. It provides a detailed design overview of the project traced to the requirements as stated in the requirements specification. This overview represents the functional baseline for development of the software product. Formal concurrence is essential, as this approval results in the start of the system development (coding) efforts.
- o Test Plan and Procedures (DS-09). A second version of the Test Plan and Procedures is presented for review and signature at the CDR, giving a detailed overview of the testing process that is to occur in the development of the project. A subsequent version providing the detailed test results is presented at the TRR.
- o User and Operations Guide (DS-10). A draft version of the User and Operations Guide is presented at the CDR giving a broad functional overview of the operations procedures to be implemented in the system.
- o Training Plan and Procedures (DS-11). A draft version of the Training Plan and Procedures is presented for review at the CDR giving a broad overview of the training process for the system.

#### 4.5 Test Readiness Review (TRR)

##### 4.5.1 Purpose

The TRR verifies that the test plan, coding, unit testing, and integration are complete and that the system is ready for formal testing to begin.

#### 4.5.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon AIM SDLC documentation milestones. The TRR occurs at the end of the developer test subphase in the development phase. Documents should be delivered prior to the review to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase. At this time, the following documents should be reviewed:

- o Test Plan and Procedures (DS-09). A third and final version of the Test Plan and Procedures is presented for review at the TRR giving a detailed overview of the testing process that has occurred and the results (test reports) obtained in the developer testing of the system.
- o User and Operations Guide (DS-10). A second draft version of the User and Operations Guide is presented at the TRR giving a detailed functional overview of the user and operations procedures to be implemented in the system.
- o Training Plan and Procedures (DS-11). A second draft version of the Training Plan and Procedures is presented for review at the TRR giving a detailed functional overview of the training process for the system.
- o System Implementation Plan (DS-12). A formal draft version of the System Implementation Plan is presented for review and signature at the TRR giving an overview of the site implementation plans to be used. The subsequent System Implementation Plan with Site Acceptance Test Reports is presented at the Operational Readiness Review (ORR). Note that a system implementation plan does not have site plans and reports if a system is only being installed at MSFC.
- o Version Description Document (DS-13). A draft version of the Version Description Document is presented for review at the TRR giving a system overview.

## 4.6 Operations Readiness Review (ORR)

### 4.6.1 Purpose

The ORR ensures that design and testing have met all requirements, that the documentation reflects the way the software has been built, and that the system is ready for installation, use, and acceptance by the user.

### 4.6.2 Major Contents of the Review

Review contents are based upon the current project status. The project status can be measured by the documentation milestones; therefore, the contents of the reviews are based upon AIM SDLC documentation milestones. The ORR occurs at the end of the Government test subphase in the development phase. Documents should be delivered prior to the review to allow for a meaningful discussion, assignment of action items, and expedited transition to the next phase. At this time, the following documents should be reviewed:

- o Test Reports (DS-09). The test reports from the Government test subphase are reviewed to ensure there are no major remaining problems that would prevent the system from being implemented.
- o User and Operations Guide (DS-10). The final version of the User and Operations Guide is presented for review and signature at the ORR giving a detailed functional overview of the user and operations procedures to be implemented in the system.
- o Training Plan and Procedures (DS-11). The final version of the Training Plan and Procedures is presented for review and signature at the ORR giving a detailed overview of the training process for the system.
- o System Implementation Plan (DS-12). The final version of the System Implementation Plan is presented for review and signature at the ORR giving the detailed Site Implementation Plans to be used. This document is presented with accompanying Site Acceptance Test Reports. Note that a system implementation plan does not have site plans and reports if a system is only being installed at MSFC.
- o Version Description Document (DS-13). A first formal version of the Version Description Document is presented for review and signature at the ORR giving an overview of the implemented system.

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Chapter 5 - Change Control/Baselines

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Chapter 5

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5.0 CHANGE CONTROL/BASELINES

- 5.1 Functional Baseline
- 5.2 Allocated Baseline
- 5.3 System Baseline

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## 5.0 CHANGE CONTROL/BASELINES

Change control provides the lock and keys for the integrity of baselines as they occur throughout the system life cycle. Most systems encounter change from performance issues, technology upgrades, new requirements, or fixes to identified problem areas. The initial system is developed based upon the approved requirements and design. These documents must be changed in a controlled manner reflecting all approved changes, in accordance with the Configuration Management Plan (DS-05).

Changes and special requests must be reported and recorded. The development team is prohibited from implementing them without proper authority. The development team must make a separate estimate for each change or special request, establish a schedule for meeting the request, and present a statement of expected impacts other efforts caused by undertaking the requests.

Special emergency procedures must be established to recover from an unforeseen failure condition or to prevent system collapse. Such changes generally cannot wait for the normal request cycle. This requires the registration, tracking, and control of errors/problems in a Problem Report (sample problem report elements are included in Appendix C), and the subsequent evaluation and solution to the problems. As soon as possible, the emergency change effort must be augmented to meet the requirements of the standard change procedure. Formal configuration management control must be exercised to ensure that an emergency system change does not create another crisis.

Each system should be controlled through an established Configuration Control Board (CCB), whose responsibility is to monitor and control all changes requested for its designated systems. Specifications for the creation and function of this CCB are recorded in the Project Management Plan. Because of the variety of applications, and broad range of customer communities, a single change control form, process, or baseline has not been found to be practical. However, commonality of forms, procedures, and boards is highly encouraged within common customer bases.

### 5.1 Functional Baseline

The functional baseline is established following approval of the Requirements Specification document at the end of the SRR. This document is placed under formal configuration control and must be updated to include all approved changes that occur during the life cycle of the system.

5.2 Allocated Baseline

The allocated baseline is established following approval of the Design Specification document at the end of the CDR. This document is placed under formal configuration control and must be updated to include all approved changes that occur during the life cycle of the system.

5.3 System Baseline

The system baseline is established at the completion and approval of the development test phases at the end of the ORR. Changes that occur during the sustaining engineering phase must be documented, approved, and controlled.

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Chapter 6 - Quality Controls and Standards

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6.0 QUALITY CONTROLS AND STANDARDS

6.1 Developer Quality Control

6.2 Government Quality Control

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## 6.0 QUALITY CONTROLS AND STANDARDS

### 6.1 Developer Quality Control

Within the AIM SDLC process, many internal quality controls exist that have been installed to ensure that quality is built into the system. Specifically, the multiple tiers of testing are designed to identify and filter out problems prior to production, and the multiple reviews are designed to ensure common understanding and agreement throughout the process. There is also within the SDLC process a formal enforcement of requirements traceability.

Informally, there is room within the SDLC for use of automated design tools to assist with the above formal procedures that also assist with other quality factors that range from code generation for prototyping purposes (and eventually production software) to maintenance of software libraries to the use of quality metric tools giving code complexity ratings and other quality factors. Peer walk-throughs and other internal contractor testing methods reinforcing the formal testing procedures are encouraged.

### 6.2 Government Quality Control

Many formal quality control tools are contained within the AIM SDLC process. The Product Assurance Plan (DS-06) identifies the policies, standards, procedures, and practices for product quality assurance of the software, data, and documentation of the system. Design is constrained by the use of accepted Government, NASA, and industry standards and practices, as noted in the Procedures and Standards Manual (DS-07). Traceability is enforced throughout the requirements definition and design processes.

These quality assurance measures are reinforced through the use of a formal review process that presents a check-and-balance system for the project user and NASA monitor to verify the above process is working. Reviews at critical points in the life cycle ensure completion and correctness of critical components in the system development process.

These reviews lead to a Government test subphase in the development phase that occurs just prior to the ORR and just after the TRR. This testing subphase is designed to give the Government the opportunity to completely exercise a system prior to system implementation and to ensure the system is ready for customer use.

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Appendix A - Software Documentation Requirements Guidelines

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## APPENDIX A

### SOFTWARE DOCUMENTATION REQUIREMENTS GUIDELINES

#### Establishing the Project Category

The four categories (A, B, C, and D) have been established as guidelines for determining a proper documentation set. A category decision is based upon the best available judgement and agreement between the developer and the sponsoring organization, and must consider the following factors:

- o Estimated size of the activity measured in projected personnel assigned and allocated for the development period
- o Number of users who will be actively using the system upon implementation
- o Criticality of the software
- o Complexity of the hardware and software environment
- o Span of operations that consider activities ranging from Agencywide, large-scale systems to small systems developed for a specific laboratory, office, or individual

The decision to assign any of the four categories could also be dictated by the authorized sponsor, no matter what the guidelines recommend.

#### Category Overview

- A** - Critical, Agencywide applications, large-scale development effort, complex hardware and software environment, and users throughout NASA. This category of software requires the development and support of all 13 AIM documents and 6 life-cycle review phases.
- B** - Sensitive, large-scale MSFC-wide applications, large development effort, complex hardware and software environment, and users throughout MSFC. If there are multiple organizations involved in development and the work is to be performed on more than one site, the project may be designated as Category B.

- C** - Medium-scale support applications, average size development effort, noncomplex hardware and software environment, conducted within a self-contained organization, does not involve complicated interactions with other projects, and is not on the critical path for any other development effort (also appropriate for pilot systems).
  
- D** - Administrative and general support, single-use programs such as a prototype or a one-shot task of minimal effort. Although no significant documentation effort should be undertaken, the project must be authorized, an overview must be prepared, and users must know how to operate the system.

#### Determining the Documentation Requirements

The assignment of a software category for determining the AIM Documentation Specification (DS) requirements is a subjective decision in its application. Use the Project Complexity Chart (Figure A-1) as a checklist to assign a software category code to each of the 11 specific factors. In most cases, the category of the individual 11 factors defined within the Project Complexity Chart can be approximated upon agreement by the developer and the customer, but there are times when certain factor characteristics are not known until the project is in an advanced phase (e.g., design). The DS requirements may then need to be adjusted by mutual agreement.

Unless the software category evaluation dictates the same A-D code for each factor, which is very unlikely, a certain amount of judgement and common sense is needed to decide which overall factor code to use. Each factor must be evaluated on its own merit, then the 11 codes are evaluated together and a project software category code assigned. This code must be approved by the NASA customer or project monitor.

#### Applying the Software Category Code to the Guidelines

Once determined, the overall project software category code must be applied against the Software Documentation Requirements Guidelines Chart (Figure A-2) to decide which of the 13 different AIM DS's must be developed and delivered, and which of the 6 reviews must be conducted in support of the application project. The software category code is located in the left column on the chart and the applicable subcolumn (A-D) is used. A code is supplied (i.e., M, O, P, and S) within that specific column for each DS listed.

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**M - Mandatory.** The DS must be developed and delivered for the project.

**O - Optional.** The decision of whether or not this DS is required is left to the discretion of the authorized NASA customer or project monitor.

**P -Project Management Plan (PMP) Inclusion.** The project is small or simple enough that the information dictated by the DS explanation could be included within the PMP.

**S -Sign-Off Acceptance Only.** As an example, an approved (signed) document may be all that is needed to initiate a specific project.

The project development team and the NASA project monitor must now reach a mutual agreement on the deliverable DS's and include in the Project Management Plan.

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Figure A-1.

Complexity Chart Supporting Software Documentation  
Requirements Guidelines

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Documentation MSFC Repository.

Figure A-2.

Matrix for Software Documentation Requirements Guidelines

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Appendix B - Formal Review Requirements Guidelines

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APPENDIX B

FORMAL REVIEW REQUIREMENTS GUIDELINES

Determining the Formal Review Requirement

Formal reviews are held at key milestones during each project, at which time the formal documents are approved and the project status is reviewed. Section 4.0 of this document defines the six different formal review processes available to monitor and control the implementation of the phases/subphases of the development life cycle. Appendix A establishes four software categories as guidelines for determining a proper documentation set.

Formal Review Decision

Use the four software categories, the full formal review explanation, and the matrix for formal review requirements guidelines chart (Figure B-1) to determine which formal reviews are recommended to be conducted. The chart serves strictly as a guideline and the final decision on the review requirement would be based upon the best available judgement and agreement between the NASA project monitor and the project development team.

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Figure B-1.

Matrix for Formal Review Requirements Guidelines

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Appendix C - Sample Problem Report Elements

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APPENDIX C

SAMPLE PROBLEM REPORT ELEMENTS

Problem Description

Identifier  
Classification (e.g., hardware, software, data  
base, documentation problem, new requirement)  
Date found  
Originator information (e.g., who, where, phone)  
Software impacted  
Description of problem  
System on which identified  
Date corrective action required  
Testing or retesting requirements  
Priority (a, b, c, d, etc.; define each)

Problem Analysis

Date received  
Assigned to  
Error classification analysis  
Error analysis  
Resource estimate to fix  
Time frame to fix  
Documentation impacts to fix  
Signature of analyst and date  
Board or management approval to fix and establish priority

Corrective action

Description of correction  
Programs/jobs changed, date, and code commented with fix,  
date, and name of corrector  
Documentation pages corrected (pages attached, including change  
change record)  
Analyst signature and date

Closure

Management approval to implement  
Version in which incorporated  
Customer approval to implement  
Management closure approval and date

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Appendix D - Acronyms and Abbreviations

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APPENDIX D

ACRONYMS AND ABBREVIATIONS

AIM	Automated Information Management
AIS	Automated Information Security
CCB	Configuration Control Board
CDR	Critical Design Review
CMP	Configuration Management Plan
COTS	Commercial Off-The-Shelf
DID	Data Item Description
DS	Document Specification
MSFC	Marshall Space Flight Center
ORR	Operations Readiness Review
PDR	Preliminary Design Review
PMP	Project Management Plan
PRR	Preliminary Requirements Review
SDLC	Software Development Life Cycle
SRR	System Requirements Review
TRR	Test Readiness Review

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Appendix E - Glossary

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## APPENDIX E

### GLOSSARY

Agencywide System. Administrative information systems that are used at multiple NASA facilities.

Automated Information Management (AIM) Program. The framework for the development, implementation, operation, and maintenance of Agencywide administrative information systems.

Automated Information Management Council (AIMCO). AIMCO has the review and recommendation responsibility for all AIM projects.

Automated Information Security (AIS). AIS is the NASA security policies and requirements that ensure the installed system meets NASA's security requirements.

Baseline. A documented reference for changes to a computer system.

Commercial Off-the-Shelf (COTS). Software that can be obtained commercially from outside vendors for use within a software system.

Configuration Control Board (CCB). The CCB analyzes, gives priority, and approves proposed system changes.

Document Specification Numbers (DS-*nn*). AIM document specification numbers are formal documents with a section-by-section boilerplate description of each document requirement. These documents are used for defining and maintaining the software system.

DS-01 Feasibility Study and Benefit Cost Analysis (FSBCA). The results of the study and benefit cost analysis are documented in an FSBCA. The study results are used to determine if a candidate application should continue into the Project Planning Subphase.

DS-02 Project Initiation Agreement (PIA). DS-02 is the mechanism for obtaining an agreement to proceed with the project in terms of project scope, project management structure, resources, schedule, and reporting requirements.

DS-03 Project Management Plan (PMP). The PMP documents the plan for user participation, roles and responsibilities, staffing, schedules, milestones, life-cycle costs, funding, requirements for security, product assurance, documentation, and procedures and standards.

DS-04 Requirements Specifications (RS). The RS specifies in detail the complete requirements (functional and software) of a system. The RS is an evolving document that grows in specificity and detail as the requirements for the system are defined.

DS-05 Configuration Management Plan (CMP). The CMP identifies the policies, standards, procedures, and practices for formal configuration management of the hardware, software, data, and documentation of a project.

DS-06 Product Assurance Plan (PAP). The PAP documents the organization structure, roles and responsibilities, resources, methodology, activities, and tools to ensure that the system to be delivered complies with the application requirements and technical standards.

DS-07 Procedures and Standards Manual (PSM). The PSM contains the procedures, standards, guidelines, and restrictions related to the development of the system. These procedures and standards are used to ensure uniformity among the configuration items in the system as they progress through the project life cycle.

DS-08 Design Specification (DS). The DS describes the decomposition of the highest level software, data base, and hardware components into lower level units.

DS-09 Test Plan and Procedures (TPP). The TPP initially contains software test plans, descriptions, and procedures for formal testing and configuration audit of a system, and ultimately the individual test cases and the test reports that are generated during the execution of the test cases.

DS-10 User and Operations Guide (UOG). The UOG provides operating instructions for the end user, system administrator, data-base administrator, and operations personnel.

DS-11 Training Plan and Procedures (TRPP). The TRPP contains the resources, roles and responsibilities, and schedules for formal training of personnel affected by the system.

DS-12 System Implementation Plan (SIP). The SIP defines how the system is to be installed, how the system is to be supported through the Implementation Phase, and how the receiving sites are to be supported as they move to an operational status.

DS-13 Version Description Document (VDD). The VDD describes a specific version of a system and any interim changes that have occurred. The VDD documents the contents, status, and structure of the latest software release.

Embedded Software. Embedded software is designed to execute in a computational device that controls or performs a specific process in support of an end item. End-item examples include payloads, vehicles, experiments, flight avionics, ground-support equipment, and other mission support such as mission, payload, and science operations. It could also include laboratory experiments and simulations such as training, verification, or breadboard simulators. This software is not used for general-purpose computing applications.

For software development management methodology purposes, the above definition is not to be confused with the Federal Information Resources Management Regulation (FIRMR) definition of embedded.

General-Purpose Software. General-purpose software is software for a computer system whose primary purpose is for diverse computational applications. This software is required to carry out the day-to-day activities of MSFC, including various administrative and business, scientific and engineering, and mission-support systems.

MSFC Program Technical Manager. This position serves as the NASA Headquarters focal point for that project. The responsibilities include the review and approval of project documents. Other responsibilities include conducting and approving formal and informal project reviews.

MSFC Project Manager. The MSFC Project Manager is responsible for the day-to-day management of a project beginning at the Project Definition Phase. The responsibilities include the planning for and execution of project activities.

NASA Project Monitor. The position is required for Agencywide software development projects. Agencywide projects will be managed from the AIM Program Office, allowing management to view and to satisfy NASA needs for administrative information from an Agencywide perspective. At the same time, management can deal with the requirements for, and constraints imposed on the acquisition of information resources, taking into account appropriate legislative regulatory requirements.

Project Technical Lead. The Project Technical Lead ensures that projects are implemented successfully. The Project Technical Lead ensures that the project team carries out the project's activities systematically. The Project Technical Lead keeps management aware of project progress, both fiscal and technical.

Software Development Life Cycle (SDLC). The AIM SDLC methodology is defined into six phases in the life of a software project: planning, definition, design, development, implementation, and sustaining engineering.

