



NOAA NESDIS CENTER for SATELLITE APPLICATIONS and RESEARCH

PEER REVIEW GUIDELINE

PRG-8.1 CRITICAL DESIGN REVIEW PEER REVIEW GUIDELINE

Version 3.0

NOAA NESDIS STAR

PEER REVIEW GUIDELINE PRG-8.1

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TITLE: Critical Design Review Peer Review Guideline

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AUTHORS:

Ken Jensen (Raytheon Information Solutions)

CRITICAL DESIGN REVIEW PEER REVIEW GUIDELINE VERSION HISTORY SUMMARY

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LIST OF ACRONYMS

ATBD	Algorithm Theoretical Basis Document
CDD	Critical Design Document
CDR	Critical Design Review
CDRR	Critical Design Review Report
CICS	Cooperative Institute for Climate Studies
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CIOSS	Cooperative Institute for Oceanographic Satellite Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CL	Checklist
CLI	Checklist Item
CM/DM	Configuration Management/Data Management
COTS	Commercial Off The Shelf
CREST	Cooperative Remote Sensing and Technology Center
DDD	Detailed Design Document
DG	Document Guideline
DPP	Development Project Plan
EPG	Enterprise Process Group
EPL	Enterprise Project Lifecycle
ICD	Interface Control Document
IPT	Integrated Product Team
MDD	Metadata Document
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
OCD	Operations Concept Document
OSDPD	Office of Satellite Data Processing and Distribution
PAL	Process Asset Library
PBR	Project Baseline Report
PDD	Preliminary Design Document
PDR	Preliminary Design Review

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PDRR	Preliminary Design Review Report
PRG	Peer Review Guideline
PRR	Project Requirements Review
QA	Quality Assurance
RAD	Requirements Allocation Document
SDD	System Description Document
SPSRB	Satellite Products and Services Review Board
STAR	Center for Satellite Applications and Research
SWA	Software Architecture Document
TBD	To Be Determined
TBR	To Be Reviewed
TBS	To Be Specified
TD	Training Document
TG	Task Guideline
VVP	Verification and Validation Plan

1. INTRODUCTION

The NOAA/NESDIS Center for Satellite Applications and Research (STAR) develops a diverse spectrum of complex, often interrelated, environmental algorithms and software systems. These systems are developed through extensive research programs, and transitioned from research to operations when a sufficient level of maturity and end-user acceptance is achieved. Progress is often iterative, with subsequent deliveries providing additional robustness and functionality. Development and deployment is distributed, involving STAR, the Cooperative Institutes (CICS, CIMSS, CIOSS, CIRA, CREST) distributed throughout the US, multiple support contractors, and NESDIS Operations.

NESDIS/STAR is implementing an increased level of process maturity to support the exchange of these software systems from one location or platform to another. Critical Design Review (CDR) standards and guidelines are a part of this process improvement.

1.1. Objective

The objective of this Peer Review Guideline (PRG) is to provide STAR standards and guidelines for reviewing a project's compliance with requirements at a project CDR¹. This PRG defines standards and guidelines for participation on a CDR review team. It contains all information needed to prepare for, conduct, and close the CDR.

The intended users of this PRG are the CDR reviewers.

1.2. Overview

This PRG contains the following sections:

- Section 1.0 - Introduction
- Section 2.0 - References
- Section 3.0 - Preparing For The Review
- Section 4.0 - Conducting The Review
- Section 5.0 - Closing The Review

¹ Refer to the STAR EPL Process Guidelines (PG-1 and PG-1.A) for a description of the STAR EPL gates and reviews.

2. REFERENCE DOCUMENTS

The reference documents for the CDR include the recommended and optional process assets (c.f. Section 3.4) and the CDR artifacts (c.f. Section 3.5).

3. PREPARING FOR THE REVIEW

This section is concerned with how the CDR review team is selected and how the review team members should prepare for the CDR.

3.1. Background – The STAR EPL Process

The CDR is a standard review that occurs at a well-defined stage in the STAR EPL process. It is important that the CDR reviewers understand this process well enough to be able to evaluate the project's status with respect to the CDR entry criteria, objectives and exit criteria.

The STAR EPL consists of 11 process steps that take a product from initial conception through development, operations, maintenance, and retirement. In this lifecycle, project stakeholders work together to enable a product to predictably mature as it progresses through the lifecycle steps.

The process steps are organized into nine project phases:

- Basic (step 1)
- Exploratory (steps 2 – 3)
- Plan (steps 4 – 5)
- Design (steps 6 – 8)
- Build (steps 9 – 11)

The implementation of the process steps can be tailored to be appropriate for the characteristics of a given project, but all steps must be followed to ensure that the products are developed from research to operations by a standard, repeatable process. Tailoring details for a given project should be documented in the project artifacts (c.f. Section 3.5).

The CDR reviewer is referred to the STAR EPL Process Guidelines (PG-1) and Appendix (PG-1.A) for a thorough treatment of the entire process.

The STAR EPL standards and process assets are managed by a STAR Enterprise Process Group (EPG). The EPG is responsible for maintaining the STAR EPL process standards, managing changes, and providing training and guidance to help stakeholders implement the standards. The CDR reviewers for a project are encouraged to contact the EPG with any questions or concerns as they prepare for and close the CDR. Use the following contact:

Ken Jensen
Ken.Jensen@noaa.gov

3.2. The Critical Design Review

The CDR is a Design phase Technical Review that occurs during step 8 (Detailed Design) of the STAR EPL process.

The objectives of this phase are to establish the requirements to be satisfied by the project and the means to validate them, develop an algorithm and code design, and determine whether the project is ready to begin development and testing of pre-operational code.

The Design phase of the STAR EPL consists of process steps 6 – 8. Step 6 (Requirements) culminates with a Project Requirements Review (PRR). The project requirements are established in step 6 and approved at the PRR. Step 7 (Preliminary Design) culminates with a PDR. The preliminary design is established in step 7 and approved at the PDR. Step 8 includes the Critical Design Review (CDR) and culminates with a Gate 4 Review. The detailed design is established in step 8 and approved at the CDR.

The primary purpose of the CDR is to evaluate the algorithm detailed design to ensure that it meets the project requirements as a prelude to coding and testing of pre-operational code. The algorithm detailed design includes software architecture and code design described down to the sub-init layer. To achieve this purpose, the development team will produce project artifacts (c.f. Section 3.5) that should demonstrate readiness for pre-operational coding to the satisfaction of the CDR reviewers.

In addition, the CDR should:

- Review the project requirements
- Review the algorithm theoretical basis
- Review the software architecture and interfaces
- Review the verification and validation plans
- Review the allocation of project requirements to design components
- Evaluate risks and proposed actions to mitigate risks
- Review the status of previous actions and new actions

The CDR review activities should focus on closing actions coming out of the PDR and evaluating changes to requirements, solutions, design, and requirements allocation since the PDR.

3.3. Review Team

Responsibility for oversight of the project will have previously been assigned to a STAR Division and a specific STAR Branch within the Division.

The CDR Review Lead is nominally the STAR Branch Chief, but the Branch Chief may designate an alternative Lead, especially for relatively small projects). In deciding whether to lead or delegate, the Branch Chief should consider that the CDR is a technical review. Management issues (e.g., recommended modifications to the plan, resources, budget, and schedule) may be raised at the CDR, driven by risks that have developed since the PDR, but management decisions on these issues are typically deferred to the Gate 4 Review that follows the CDR.

The Review Lead selects the CDR review team. It is recommended that the following guidelines be followed for selecting the team:

Personnel who are on the project development team are excluded from the review team. There are no exceptions to this rule. The review is intended to be a dialogue between the developers and the reviewers, with the reviewers providing an objective evaluation of the project's detailed design. The membership of the project development team should be clearly documented in the project's Development Project Plan (DPP). Any additions to the development team since PDR should be noted in Section 1 of the Critical Design Document (CDD, c.f. Section 4.2.1 of this PRG).

It is highly desirable to include the PDR reviewers on the CDR review team. They will already be familiar with the project, the actions that came out of the PDR, the CDR entry and exit criteria, and many of the CDR artifacts that will be updates of PDR artifacts. The addition of new review team members is also recommended to provide "fresh eyes".

Include a systems engineer who is familiar with the STAR EPL process, especially with regard to the iterative development of requirements, requirements allocation, solutions and design. It is highly desirable that the same systems engineer who was a PDR reviewer be maintained on the CDR review team.

Include one or more scientists who are familiar with the project's algorithm theoretical basis, or can familiarize themselves quickly. It is highly desirable that the same scientists who were PDR reviewers be maintained on the CDR review team. If there has been some contention or controversy about the theoretical basis coming out of PDR, or if substantial new actions have been placed upon the theoretical basis as a result of the PDR, it is recommended that at least one new scientist be added to the review team.

Include one or more software engineers who are familiar with the project's software architecture and the STAR EPL standards for code detailed design, or can familiarize themselves quickly. It is highly desirable that the same software engineers who were PDR reviewers be maintained on the CDR review team. If there has been some contention or controversy about the software architecture coming out of PDR, or if substantial new actions have been placed upon the software architecture as a result of the PDR, it is recommended that at least one new software engineer be added to the review team.

Include one or more representatives from STAR QA who are familiar with the project's QA history and the STAR EPL standards for QA, or can familiarize themselves quickly. It is highly desirable that the same QA personnel who were PDR reviewers be maintained on the CDR review team. If there has been some contention or controversy about QA coming out of PDR, or if substantial new actions have been placed upon QA as a result of the PDR, it is recommended that at least one new QA person be added to the review team.

Include one or more representatives from STAR CM/DM who are familiar with the project's CM/DM baseline and the STAR EPL standards for CM/DM, or can familiarize themselves quickly. It is highly desirable that the same CM/DM personnel who were PDR reviewers be maintained on the CDR review team. If there has been some contention or controversy about CM/DM coming out of PDR, or if substantial new actions have been placed upon CM/DM as a result of the PDR, it is recommended that at least one new CM/DM person be added to the review team.

Invite a technical representative from the intended operational organization (e.g. Office of Satellite Data Processing and Distribution - OSDPD). Consult with that organization's management for the selection of its representative. Ideally, this person will become the project's Operations Lead.

Invite one or more representatives from the Satellite Products and Services Review Board (SPSRB). The STAR Division Chief should consult with SPSRB management for the selection of SPSRB representatives.

The review team members will provide a diversity of skills and experience that can be usefully applied to the various aspects of the review. This will be detailed in Section 4.

The Review Lead should meet with the review team as soon as possible to plan the review preparation, including the assignment and scheduling of review preparation tasks (e.g. selection and study of process assets, review of specific PDR artifacts, delivery dates of CDR artifacts, and review of specific CDR artifacts) and should subsequently monitor progress against the review preparation plan.

3.4. Process Assets

STAR EPL process assets are a set of process guidelines, stakeholder guidelines, peer review guidelines, review check lists, task guidelines, document guidelines and training documents that define the enterprise standards and best practices. They are established and maintained under Configuration Management (CM) by an EPG under the direction of a Steering Committee. They are contained in a STAR Process Asset Repository (PAR) on the STAR website:

http://www.star.nesdis.noaa.gov/star/EPL_index.php

Process assets that are relevant for CDR preparation are briefly described in this section. There are separate subsections for recommended process assets and optional process assets.

The process assets described in this section should be available to the CDR reviewers in the STAR EPL PAR.

The CDR reviewer is encouraged to refer to each process asset for a more detailed description as soon as possible. Any problems (e.g., lack of access, missing process assets, questions about content, inconsistencies between process assets) should be brought to the attention of the STAR EPG (c.f. Section 3.1) as soon as possible.

3.4.1 Recommended Process Assets

It is very important that the CDR reviewers be familiar with these process assets before conducting the CDR.

CL-8.1: Critical Design Review Checklist contains the standard CDR Check List Items (CLIs) that the CDR reviewers are required to complete, unless the list has been tailored for the specific project. Refer to the DPP to determine whether the CDR Check List has been tailored. In that case, use the tailored Check List in the DPP Appendix.

SG-18: Technical Reviewer Guidelines contains the stakeholder guidelines for Technical Review reviewers. The CDR reviewer will find general guidelines for conducting technical reviews. These complement the specific CDR guidelines contained in this PRG.

TG-8: Detailed Design Task Guideline contains the task guidelines for the detailed design step (8) of the STAR EPL process. The CDR reviewer will find guidelines for interaction between the CDR review team and other project stakeholders.

DG-8.3: Critical Design Review Report Guidelines contains the standards and guidelines for writing the Critical Design Review Report (CDRR). The CDR reviewers, who are responsible for writing this report, will find it highly useful to know the required report content in advance of the review, so they can ensure that the review content will provide them with the information they need for the report.

3.4.2 Optional Process Assets

The process assets designated as optional will be helpful to the CDR reviewers, but are not required. Typically, a CDR reviewer will refer to some of these, depending on the division of responsibilities within the review team.

DG-1.1: Algorithm Theoretical Basis Document Guideline contains standards and guidelines for the Algorithm Theoretical Basis Document (ATBD). The ATBD is a standard project artifact for the CDR (c.f. Section 3.5.6 of this PRG). The CDR reviewers who are responsible for ensuring that the project's ATBD v2r1 complies with STAR standards should use DG-1.1 as a resource.

DG-1.2: Software Architecture Document Guideline contains standards and guidelines for the Software Architecture Document (SWA). The SWA is a standard project artifact for the CDR (c.f. Section 3.5.7 of this PRG). The CDR reviewers who are responsible for ensuring that the project's SWA v2r1 complies with STAR standards should use DG-1.2 as a resource.

DG-5.1: Development Project Plan Guideline contains standards and guidelines for the DPP. The DPP is a standard project artifact for the CDR (c.f. Section 3.5.2 of this PRG).

The CDR reviewers who are responsible for ensuring that the project's DPP complies with STAR standards should use DG-5.1 as a resource.

DG-5.4: Project Baseline Report Guideline contains standards and guidelines for the Project Baseline Report (PBR). The PBR is a standard project artifact for the CDR (c.f. Section 3.5.10 of this PRG). The CDR reviewers who are responsible for ensuring that the project's PBR complies with STAR standards should use DG-5.4 as a resource.

DG-6.1: Operations Concept Document Guideline contains standards and guidelines for the Operations Concept Document (OCD). The OCD is a standard project artifact for the CDR (c.f. Section 3.5.4 of this PRG). The CDR reviewers who are responsible for ensuring that the project's OCD complies with STAR standards should use DG-6.1 as a resource.

DG-6.2: Requirements Allocation Document Guideline contains standards and guidelines for the Requirements Allocation Document (RAD). The RAD is a standard project artifact for the CDR (c.f. Section 3.5.5 of this PRG). The CDR reviewers who are responsible for ensuring that the project's RAD complies with STAR standards should use DG-6.2 as a resource.

DG-6.3: Verification and Validation Plan Guideline contains standards and guidelines for the Verification and Validation Plan (VVP). The VVP is a standard project artifact for the CDR (c.f. Section 3.5.9 of this PRG). The CDR reviewers who are responsible for ensuring that the project's VVP complies with STAR standards should use DG-6.3 as a resource.

DG-8.1: Detailed Design Document Guideline contains standards and guidelines for the Detailed Design Document (DDD). The DDD is standard a project artifact for the CDR (c.f. Section 3.5.8 of this PRG). The CDR reviewers who are responsible for ensuring that the project's DDD complies with STAR standards should use DG-8.1 as a resource.

DG-8.2.A: Critical Design Document Appendix Guideline contains Microsoft PowerPoint slide templates for the standard CDR presentation slides. The CDR reviewers can use this document to become familiar with the expected content and format of the review.

3.5. Project Artifacts

Project artifacts are a set of items that are produced by the appropriate stakeholders during the product life cycle to support the reviews. They are maintained under CM in a project artifact repository.

The following CDR artifacts should be established in the project artifact repository via Baseline Build 2.4:

- Critical Design Document
- Development Project Plan v1.x
- Preliminary Design Review Report
- Operations Concept Document v1.2
- Requirements Allocation Document v1.2
- Algorithm Theoretical Basis Document v2.1
- Software Architecture Document v2.1
- Detailed Design Document v1.0
- Verification and Validation Plan v1.2
- Project Baseline Report v2.4

The CDR artifacts should be available to the CDR reviewers at least one week in advance of the date scheduled for the CDR. The project plan for some projects may call for some or all of these artifacts to be available to the reviewers earlier than one week in advance of the CDR. Consult the DPP for this information. If an artifact is not available on schedule, contact the Development Lead to resolve any problems that may be caused by late access to the artifacts.

3.5.1 Critical Design Document

The Critical Design Document (CDD) consists of the CDR presentation slides. The CDD is described in detail in Section 4.2.

3.5.2 Development Project Plan

The Development Project Plan (DPP) documents the plan for the development, testing, review, and transition to operations for the project, including stakeholders, tasks, work breakdown structure (WBS), schedule and resources. It contains the project objectives, tasks, milestones, stakeholders, and schedule. This information will be useful for the CDR reviewer in reviewing Section 1 of the CDD, and will be needed by the review team for determining a review preparation schedule (c.f. Section 3.7 of this PRG).

The DPP includes the CDR review objectives, which may or may not be tailored from the standard STAR EPL objectives for a CDR (c.f. Section 4.1 of this PRG). This information will be useful for the CDR reviewer in reviewing Section 1 of the CDD.

3.5.3 Preliminary Design Review Report

The Preliminary Design Review Report (PDRR) is the approved report of the PDR reviewers. This artifact will be useful for the CDR reviewer in reviewing Section 2 of the CDD.

The PDRR should include the approval status for each preliminary design requirement, in the form of a PDR checklist where each CLI has a disposition status (Pass, Conditional Pass, Defer, Waive, or Not Applicable (N/A)). The CDR checklist is quite similar in form to the PDR check list (c.f. Section 5) that the CDR reviewers will be required to dispose of. The content of the CDR check list will also have a lot in common with the PDR check list, since the detailed design development is a maturation of many of the preliminary design items. The PDR checklist is therefore a valuable guide toward understanding the specific progress that should be demonstrated at the CDR.

CLIs with “Conditional Pass” status must have associated actions that should be closed prior to CDR. CLIs with “Defer” status also must have associated actions. Most items with “Defer” status at PDR will have been deferred to the CDR, though some items may be deferred to later in the product lifecycle. The actions associated with items deferred to the CDR must be addressed at the CDR.

The PDRR should also include an assessment of risk items, with recommendations for risk mitigation. In most cases, these recommendations will result in actions.

The PDRR should summarize the check list items and risks with a list of actions. Each action item should include a description, an association with a CLI and/or a risk, an assignment, and an intended closure date. The CDR reviewers are responsible for ensuring that the status of all PDR actions is reviewed and disposed of at the CDR.

The PDRR should include the CDR entry criteria and CDR exit criteria that were established at the PDR. The CDR reviewers are responsible for ensuring that CDR entry and exit criteria are met.

3.5.4 Operations Concept Document

The Operations Concept Document (OCD) contains the development team's concept for how the product should be produced and used. This information will be useful for the CDR reviewer in reviewing Section 3 of the CDD.

The OCD should document operational concepts and scenarios that include functionality, performance, maintenance, support, and disposal as appropriate. A scenario is a sequence of events that might occur in the use of the product, which is used to make explicit some of the needs of the stakeholders. It should identify and develop scenarios, consistent with the level of detail in the stakeholder needs, expectations, and constraints, in which the proposed product is expected to operate.

The OCD is distinct from a ConOps. A ConOps may be generated by the user to provide an overview of how the user envisions a potential product system to operate. It is a high level requirements document that provides a mechanism for users to describe their expectations of the target system in terms that need not be quantifiable and testable. The ConOps is typically used as input to the development of formal testable system and software requirements specifications. The OCD is a technical document created by the development team to describe how the users' vision can be realized in an operational environment.

The OCD should define the environment the product will operate in, including boundaries and constraints, consistent with the current level of detail in the requirements and detailed design. OCD v1.2, produced for the CDR, adds to v1.1 by providing a refinement of the operations concept that may occur as a result of detailed design development.

3.5.5 Requirements Allocation Document

The Requirements Allocation Document (RAD) contains the basic and derived requirements for the work products and the allocation of the requirements to system components and product components. This information will be useful for the CDR reviewer in reviewing Sections 4 and 9 of the CDD.

RAD v1.2, produced for the CDR, adds to v1.1 by updating the allocation of requirements to system and product components, based on the maturing of solutions and design since PDR.

3.5.6 Algorithm Theoretical Basis Document

The Algorithm Theoretical Basis Document (ATBD) contains the requirements and theoretical basis for the project algorithm. The purpose of the ATBD is to provide product developers, reviewers and users with a theoretical description (scientific and mathematical) of the algorithm that is used to create a product that meets user requirements. The purpose of the ATBD is to help demonstrate to the CDR reviewers that the algorithm detailed design provides for an implementation that is consistent with the theoretical basis and meets requirements. The intended target audience includes STAR programmers, scientists and managers and reviewers from the intended operational agency. This information will be useful for the CDR reviewer in reviewing Section 5 of the CDD.

3.5.7 Software Architecture Document

The Software Architecture Document (SWA) contains the software architecture and data flows for the project algorithm. This information will be useful for the CDR reviewer in reviewing Section 6 of the CDD.

Specific intended users of SWA version 2 are the pre-operational code programmers and the pre-operational requirements and design reviewers. The programmers should use SWA version 2 as a guide for writing the pre-operational code. Requirements reviewers should use SWA version 2 as a reference to help them verify that requirements have been satisfactorily allocated to product components. Design reviewers should use SWA version 2 as a reference to help them verify that the design properly implements the algorithm in a way that ensures the requirements allocation will be satisfied.

The software system is an integrated collection of software elements, or code, which produce well-defined output products from a well-defined set of input data. The software architecture describes the structure of the system software elements and the external and internal data flows between software elements.

At the detailed design level of maturity, the software architecture should describe four layers of data flows:

- Layer 0 (Context-Layer) consists of the external interfaces to the software system.
- Layer 1 (System-Layer) consists of the flows between the software units that comprise the software system
- Layer 2 (Unit-Layer) consists of the flows within each software unit
- Layer 3 (Sub-Unit-Layer) consists of the flows within sub-units of a software unit

The SWA should document all of these data flows with figures (data flow diagrams) and tables that provide a complete description of all software components and their input, internal, and output data flows.

3.5.8 Detailed Design Document

The Detailed Design Document (DDD) describes the product design and the design components at a level of detail that is sufficient for the development programmers to be able to use as a reference for writing fully functional pre-operational code. This information will be useful for the CDR reviewer in reviewing Section 7 of the CDD. A separate DDD is produced for each software unit that is part of the product processing system. The software units are the System-Layer elements that are defined in the software architecture, as described in the SWA.

The standard purpose and function of the DDD is to provide a method of detailing the unit-level structural procedure within the unit, place these in the context of the product system data processing chain, and specify the data, its formats, and the relationships that exist between the data to form the basis for the detailed design of the unit code.

3.5.9 Verification and Validation Plan

The VVP describes the work products to be verified and validated, the requirements for each selected work product and the verification and validation methods for each selected work product. This information will be useful for the CDR reviewer in reviewing Section 8 of the CDD.

VVP v1.2, produced for the CDR, adds to v1.1 by updating the listing and description of verification and validation items and plans, based on the maturing of the requirements allocation, solutions and design since PDR, as documented in the RAD and SWA.

3.5.10 Project Baseline Report

The Project Baseline Report (PBR) v2.4 includes the change history, approval status, and location of every Configuration Item in the project's baseline for Baseline Build 2.4. This information will be useful for the CDR reviewer in reviewing Section 8 of the CDD.

3.6. Entry Criteria

The CDR reviewers should ensure that all CDR entry criteria have been met before commencing the review. The CDR entry criteria should have been established at the PDR and documented in the PDRR. Note that entry criteria may be tailored from the standard STAR EPL set of CDR entry criteria. In that case, the PDRR should provide a rationale for deviations from the standard set.

The standard STAR EPL set of CDR entry criteria, listed in the standard CDR check list (CL-8.1), includes:

- Entry # 1 - A Preliminary Design Review Report (PDRR) has been written. The CDR reviewers have access to the current baseline version of the PDRR.
- Entry # 2 - A Development Project Plan (DPP) has been written. The CDR reviewers have access to the current baseline version of the DPP.
- Entry # 3 - An Operations Concept Document (OCD) has been written. The CDR reviewers have access to the current baseline version of the OCD.
- Entry # 4 - A Requirements Allocation Document (RAD) has been written. The CDR reviewers have access to the current baseline version of the RAD.
- Entry # 5 - An Algorithm Theoretical Basis Document (ATBD) has been written. The CDR reviewers have access to the current baseline version of the ATBD.
- Entry # 6 - A Software Architecture Document (SWA) has been written. The CDR reviewers have access to the current baseline version of the SWA.
- Entry # 7 - A Detailed Design Document (DDD) has been written for each software unit in the software architecture. The CDR reviewers have access to the current baseline version of each DDD.
- Entry # 8 - A Verification and Validation Plan (VVP) has been written. The CDR reviewers have access to the current baseline version of the VVP.
- Entry # 9 - A Critical Design Document (CDD) has been written. CDR review objectives are clearly stated in the CDD.
- Entry # 10 - A Project Baseline Report (PBR) has been written. The CDR reviewers have access to the current baseline version of the PBR.

The standard set of entry criteria calls for the availability of the standard set of project artifacts, without reference to the quality of these artifacts. Assessment of the quality of the artifacts is the main business of the CDR itself.

It is the responsibility of both the development team and the review team to ensure that CDR entry criteria have been met prior to the CDR. The CDR Review Lead and the Development Lead should be in communication during the entire step 8 process to identify and resolve issues affecting the CDR entry criteria well in advance of the scheduled CDR date.

3.7. Review Team Preparation

The sequence of steps that should be taken by the CDR review team in preparing for the CDR is as follows:

- The STAR Branch Chief selects the Review Lead
- The Review Lead selects the Review Team, following the guidelines in Section 3.3 of this PRG.
- The Review team meets to plan review preparation. The initial meeting should accomplish the following:
 - Assemble the necessary review tasks and assign them to review team members. These tasks include:
 - Review PRG-8.1 (this document), focusing on the sections that pertain to the areas you have been assigned to review. All team members should do this.
 - Review the project's CDR check list. This will be available as a DPP Appendix or, if there has been no tailoring, as the process asset CL-8.1. Note CLIs, focusing on the sections that pertain to the areas you have been assigned to review. Refer to these CLIs when reviewing the project artifacts. All team members should do this.
 - Review the project's DPP. Guidelines for the DPP review are in Section 4.2.1 of this PRG.
 - Review the PDRR for the project. Guidelines for the PDRR review are in Section 4.2.2 of this PRG.
 - Review the project's operations concept, documented in the OCD. Guidelines for the operations concept review are in Section 4.2.3 of this PRG.
 - Review the project requirements, documented in the RAD. Guidelines for the requirements review are in Section 4.2.4 of this PRG.

- Review the project's algorithm theoretical basis, documented in the ATBD. Guidelines for the algorithm theoretical basis review are in Section 4.2.5 of this PRG.
- Review the software architecture, documented in the SWA. Guidelines for the software architecture review are in Section 4.2.6 of this PRG.
- Review the project's detailed design, documented in the DDD for each software unit. Guidelines for the detailed design review are in Section 4.2.7 of this PRG.
- Review the project's baseline of configuration items, documented in the PBR. Guidelines for the baseline review are in Section 4.2.8 of this PRG.
- Review the project's verification plan, documented in the VVP. Guidelines for the verification plan review are in Section 4.2.8 of this PRG.
- Review the project's validation plan, documented in the VVP. Guidelines for the validation plan review are in Section 4.2.8 of this PRG.
- Review the allocation of project requirements to system components or product components, documented in the RAD. Guidelines for the requirements allocation review are in Section 4.2.9 of this PRG.
- Review the status of project risks. Guidelines for the review of project risks are in Section 4.2.10 of this PRG.
- Review the status of project actions. Guidelines for the review of project actions are in Section 4.2.10 of this PRG.
- Identify contacts with the development team and with other stakeholders, using the DPP to identify the relevant stakeholders. Assign the relevant contacts to the review team members, based on their assigned tasks.
- Determine the time, place, frequency, required attendees and optional attendees of CDR review team meetings.
 - The time should be based on the convenience to the review team.
 - The place usually should be at the site of the Review Lead. For cases where a majority of the required attendees are located at a different site than the Review Lead, this site can be selected as an alternative place. The selected site should have the infrastructure for hosting video and/or teleconferencing for off-site attendees.

- The frequency should be determined by the project timeline, the size of the project, and the size of the review team. Short project timelines large-size projects and large review teams typically require more frequent review team meetings. Also, decide whether CDR review team meetings will be held on a regular basis or on an “as needed” basis. It is recommended that meetings initially be held on a regular basis until it is determined that “as needed” meetings will suffice.
 - The required attendees should be determined by the Review Lead on a meeting-by-meeting basis, depending on the meeting’s agenda and current issues. Usually, all review team members are required attendees, though some may be designated as optional attendees for a meeting whose agenda and issues are not relevant to their role and responsibilities. The Review Lead may invite members of the development team to a meeting whose agenda and issues will benefit from their involvement.
- Review preparation plan is iterated, finalized, communicated to stakeholders.
 - The review preparation schedule and risks are finalized, in consultation with the relevant stakeholders. The schedule should include a schedule of deliveries of project artifacts, drawn up in consultation with the Development Lead. It is recommended that informal deliveries of project artifacts in draft condition be included in the schedule. It should be understood that informally delivered “as is” draft artifacts are solely for the purpose of helping the reviewers prepare for the review and are not reviewable items. Reviewers are encouraged to provide feedback to the development team to assist them in improving the artifacts prior to their final pre-review delivery.
 - The schedule for closing the review is finalized. This involves the writing and delivery of a CDR Report (CDRR, c.f. Section 5.3 of this PRG).
 - Review Lead communicates the proposed review schedule and risks to project management and to the Development Lead.
 - Review Lead communicates requests for deliveries to the Development Lead, according to the review preparation schedule.
 - Review tasks and schedule are finalized, in consultation with project management, and are folded into the DPP.
 - Review team members, and relevant stakeholders identified on the review preparation schedule, work their assigned tasks according to the schedule.

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- Review Lead monitors the status of the review preparation schedule and risks, and communicates issues to program management and the Development Lead. Review Lead, Development Lead, and program management collaborate in resolving any issues that arise. If necessary, the project plan may be modified to accommodate the resolution of issues.

4. CONDUCTING THE REVIEW

4.1. Review Objectives

The CDR objectives should be established in the DPP. Nominally, these will be the STAR EPL standard objectives for CDR. The CDR objectives may be tailored for a specific project, in which case the DPP should document the tailored objectives. If there is no tailoring, it is sufficient for the DPP to state that the standard objectives apply, and note that these are specified in this PRG, as follows:

The STAR EPL standard objectives for a CDR are:

- Identify relevant stakeholders and document their involvement according to the project plan.
- Identify requirements changes since PDR
- Provide all applicable technical data for the selected solution, including:
 - Operations concept
 - Theoretical Basis
 - Architecture, specifications, interfaces, detailed design description
 - Performance requirements, QA procedures, test data requirements
 - Verification and validation plans
- Provide an updated allocation of requirements to product components and system components of the detailed design.
- Identify and update project risks. Make recommendations for risk mitigation plans and actions.
- Document the closing of all action items since PDR. Make recommendations for open actions and new actions.

4.2. The Critical Design Document

The Critical Design Document (CDD), a Microsoft PowerPoint file, is the presentation document for a project's CDR. This document should be made available to the CDR reviewers in the project artifact repository.

The CDD should build on the Preliminary Design Document (PDD), adding design detail, updating the status of the requirements and requirements allocation, updating the status of actions from the PDR and updating the status of risks. It should accomplish the CDR objectives stated in Section 4.1 of this PRG.

The intended target audience is the CDR reviewers. Typically, the CDD is prepared by the project's development team under the direction of the Development Lead.

The CDD presentation slides are organized into eleven sections. These sections, described in DG-8.2 and illustrated in DG-8.2.A., are:

- Introduction
- PDR Report
- Operations Concept
- Requirements
- Algorithm Theoretical Basis
- Software Architecture and Interfaces
- Detailed Design Description
- Quality Assurance
- Requirements Allocation
- Risks and Actions
- Summary and Conclusions

A description of these sections is provided in the following eleven subsections, taken from the CDD Document Guidelines (DG-8.2), for the benefit of CDR Reviewers who have been assigned the task of reviewing the corresponding CDD section.

4.2.1 Section 1 – Introduction

The CDD shall include an Introduction Section. This section should be organized as follows:

1.0 INTRODUCTION

- 1.1 Development Project Plan
- 1.2 Project Objectives
- 1.3 Project Stakeholders
- 1.4 Project Timeline
- 1.5 Project Plan Changes
- 1.6 Stakeholder Involvement
- 1.7 PDR Guidelines and Checklist
- 1.8 PDR Report
- 1.9 Review Objectives

- **Section 1.1: Development Project Plan**

- Confirm that the CDD provides a pointer to the DPP. CDR reviewers should be able to obtain the DPP by using this pointer. A pointer to the DPP Document Guidelines (DG-5.1) should also be provided.

- **Section 1.2: Project Objectives.**

- Confirm that the project objectives are consistently identified in the CDD and the DPP.

- **Section 1.3: Project Stakeholders.**

- Confirm that stakeholder roles have been identified. Stakeholder roles are identified in Section 4.2.1 of the STAR EPL Process Guidelines (PG-1). Stakeholders should be named when known. There may be more than one name for a stakeholder role. Unspecified stakeholders should be identified by role with a TBD. Unspecified stakeholders constitute a project risk that should be addressed in Section 10 of the CDD. The ensemble of roles and named personnel constitute the Integrated Product Team (IPT).
- Confirm that a description of the tasks expected for each stakeholder is documented at a level of detail sufficient to give you a good sense of the IPT. This can be done explicitly in the CDR presentation slides and/or by reference to other project artifacts (e.g. DPP).

- **Section 1.4: Project Timeline**
 - Confirm that project milestones have been identified. Milestones should include the STAR EPL standard reviews (with the CDR highlighted) and associated review dates.
 - Confirm that a timeline of project tasks and schedule of milestones has been included in the DPP. It is recommended that an illustration of the project tasks and schedule be shown (e.g. a Gantt chart taken from a Microsoft Project file of the project plan). In particular, the tasks and schedule for the Design phase should be clearly illustrated, with the CDR milestone indicated.

- **Section 1.5: Project Plan Changes**
 - Confirm that any modifications to the Project Plan since PDR are clearly explained, including the rationale and documentation of management concurrence.

- **Section 1.6: Stakeholder Involvement**
 - Confirm stakeholder involvement according to the project plan. Stakeholder involvement should be described in a way that shows the project plan is being followed.

- **Section 1.7: CDR Guidelines and Checklist**
 - This section should provide pointers to the CDR Peer Review Guidelines (PRG-8.1, this document) and CDR Checklist (CL-8.1).

- **Section 1.8: CDR Report**
 - This section should provide a pointer to the CDR Report Document Guidelines (DG-8.3).

- **Section 1.9: Review Objectives**
 - Ensure that the stated review objectives are satisfactory. Nominally, these objectives will be the STAR EPL standard objectives for a CDR. The standard objectives capture the standard sections of the review (c.f. Section 3).
 - Tailoring of review objectives is permissible. If the development team wishes to drop standard objectives or add other objectives, it is the responsibility of the Development Lead to consult with the CDR reviewers well enough in advance of the review to obtain reviewer buy-in for deviations. In that case, the CDD should note all deviations and note any impacts on exit criteria.

Impacts on exit criteria will be common, since the standard objectives are designed to meet the standard exit criteria.

4.2.2 Section 2 – PDR Report

The CDD shall include a PDR Report Section. This section should be organized as follows:

2.0 PDR REPORT

2.1 PDR Report

2.2 CDR Entry Criteria

2.3 CDR Exit Criteria

- **Section 2.1: PDR Report**

- The PDR report is an essential artifact for the CDR, because it documents the baseline from which to assess project progress since PDR. The CDD should provide a pointer to this document. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the PDRR by using this pointer, and cannot otherwise obtain access to the current baseline version of the PDRR, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.

- **Section 2.2: CDR Entry Criteria**

- Confirm that the entry criteria (c.f. Section 3.6 of this PRG) listed in this section are complete and correct.
- Look for examples where the entry criteria listed in this section differ from the set that was established at PDR, as documented in the PDRR. For these examples, the CDD should provide a convincing rationale for deviations, including tailored entry criteria and waived entry criteria. The CDR reviewers must approve any deviations. It is the responsibility of the Development Lead to consult with the CDR reviewers well enough in advance of the review to obtain reviewer buy-in for the deviation. If approved, the modified entry criteria should be documented in the CDRR with the modifications and rationale explicitly noted.
- For cases where advance reviewer buy-in for entry criteria deviations has not been obtained, the reviewers must decide whether the review should be delayed until the discrepancy is resolved or can continue with an action to resolve the discrepancy after the review.

- Confirm that each CDR entry criteria item is satisfied. Use the CDR artifacts as references for deciding on the status of each entry criteria item.
- **Section 2.3: CDR Exit Criteria**
 - Confirm that the exit criteria (c.f. Section 5.1 of this PRG) listed in this section are complete and correct. The CDR exit criteria should be documented in the PDRR. Note that exit criteria may be tailored from the standard STAR EPL set of CDR exit criteria. In that case, the PDRR should provide a rationale for deviations from the standard set.
 - Look for examples where the exit criteria listed in this section differ from the set that is documented in the PDRR. For these examples, the CDD should provide a convincing rationale for deviations, including tailored exit criteria and waived exit criteria. The CDR reviewers must approve any deviations. It is the responsibility of the Development Lead to consult with the CDR reviewers well enough in advance of the review to obtain reviewer buy-in for the deviation. If approved, the modified exit criteria should be documented in the CDRR with the modifications and rationale explicitly noted.
 - For cases where advance reviewer buy-in for exit criteria deviations has not been obtained, the reviewers must decide whether the review should be delayed until the discrepancy is resolved or can continue with an action to resolve the discrepancy after the review.
 - Confirm that each CDR exit criteria item is satisfied. Use the CDR artifacts as references for deciding on the status of each exit criteria item.

4.2.3 Section 3 – Operations Concept

The CDD shall include an Operations Concept Section. Most of the content for this section should either be adopted from the PDD, with updates to address any changes since PDR, or obtained directly from the OCD. This section should be organized as follows:

3.0 OPERATIONS CONCEPT

3.1 Operations Concept Overview

3.2 Customer/User Needs

3.3 Customer/User Expectations

3.4 Operational Scenario

- **Section 3.1: Operations Concept Overview**
 - This section provides an overview of the operations concept. The CDD should explain the link between the concept of operations and requirements development. The CDD should provide a pointer to the OCD. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the OCD by using this pointer, and cannot otherwise obtain access to the current baseline version of the OCD, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.
- **Section 3.2: Customer/User Needs**
 - Confirm that the PRD and OCD satisfactorily explain why the products are being produced.
- **Section 3.3: Customer/User Expectations**
 - Confirm that the PRD and OCD satisfactorily explain how the products will be used.
- **Section 3.4: Operational Scenario**
 - The operational scenario is the development team's description of how the customer/user concept of operations can be achieved in a real operational environment. Confirm that the PRD and OCD satisfactorily explain how the products should be produced, production and delivery scenarios have been described, consistent with the level of detail in the customer's concept of operations and the production environment constraints.

4.2.4 Section 4 – Requirements

The CDD shall include a Requirements Section. The purpose of this section is to demonstrate that the project requirements have been established at PRR, refined for PDR, and further refined after PDR. This section explains how the requirements are developed, refined and documented. There are two main aspects of the Requirements Allocation Document (RAD), (1) the basic and derived requirements and (2) their allocation to system components and work products. This section deals with the first aspect. The second aspect will be dealt with in Section 9 of the CDD.

This section should be organized as follows:

4.0 REQUIREMENTS

- 4.1 Requirements Development Process
- 4.2 Requirements Documentation
- 4.3 New Requirements Since PDR
- 4.4 Requirements Changes Since PDR

- **Section 4.1: Requirements Development Process**

- The purpose of this section is to illustrate the iterative development of requirements during the Design phase of the STAR EPL process. The presentation should show that the development of Solutions, Design, Requirements, and Requirements Allocation occurs iteratively in a closed loop with continual feedback between the four, with Requirements driving the Solutions and Design, and the Design then determining the Requirements Allocation. This provides the reviewers with the context for the remainder of the presentation, where the Solutions, Design and Requirements Allocation are described at the detailed design level of maturity.
- Confirm that the CDD illustrates the iterative development of requirements during the Design phase of the STAR EPL process.

- **Section 4.2: Requirements Documentation**

- The current baseline requirements will be documented in the RAD. RAD v1r2 is a CDR artifact. The CDD should provide a pointer to this document. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the RAD by using this pointer, and cannot otherwise obtain access to the current baseline version of the RAD, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.

- **Section 4.3: New Requirements Since PDR**

- This section should describe each new requirement since PDR in sufficient detail to allow the reviewers to determine the proper disposition of the new requirement. If the new requirement is a derived requirement, the higher-level driving requirements should be listed. If the new requirement is a basic requirement, its new derived requirements should be listed.
- It should be noted whether a new requirement has been previously approved (e.g. at a delta Requirements Review). If a new requirement has not yet been

approved, it becomes the responsibility of the CDR reviewers to dispose of the new requirement. To assist the CDR reviewers, the CDD should explain the rationale for the new requirement (e.g., revealed by a detailed design issue, new customer request), note the potential effects on the project plan, document the agreement of affected stakeholders, note new or modified risks that result from the new requirement and note any recommended actions that result from the new requirement.

- **Section 4.4: Requirements Changes Since PDR**

- This section should describe each changed requirement since PDR in sufficient detail to allow the reviewers to determine the proper disposition of the changed requirement. If the changed requirement is a derived requirement, the higher-level driving requirements should be listed. If the changed requirement is a basic requirement, any changed derived requirements should be listed.
- It should be noted whether a changed requirement has been previously approved (e.g. at a delta Requirements Review). If a changed requirement has not yet been approved, it becomes the responsibility of the CDR reviewers to dispose of the changed requirement. To assist the CDR reviewers, the CDD should explain the rationale for the change (e.g., revealed by a detailed design issue, operational constraint), note the potential effects on the project plan, document the agreement of affected stakeholders, note new or modified risks that result from the change and note any recommended actions that result from the change.

4.2.5 Section 5 – Algorithm Theoretical Basis

The CDD shall include an Algorithm Theoretical Basis Section. The purpose of this section is to provide a theoretical description (scientific and mathematical) of the algorithm that is used to create a product that meets user requirements. Most of the content for this section should be obtained directly from the ATBD. This section should be organized as follows:

5.0 ALGORITHM THEORETICAL BASIS

- 5.1 Algorithm Theoretical Basis Document
- 5.2 Algorithm Objectives
- 5.3 Sensor Inputs
- 5.4 Ancillary Inputs

- 5.5 Retrieval Strategy
- 5.6 Processing Outline
- 5.7 Physical Description
- 5.8 Mathematical Description
- 5.9 Algorithm Output
- 5.10 Performance Estimates
- 5.11 Practical Considerations

- **Section 5.1: Algorithm Theoretical Basis Document**

- This section introduces the Algorithm Theoretical Basis Document (ATBD). The CDD should provide a pointer to the ATBD.

- **Section 5.2: Algorithm Objectives**

- This section should describe the objectives of the algorithm, including the intended output data products and their intended use.
- Confirm that the algorithm objectives are derived from and consistent with the operations concept.

- **Section 5.5: Sensor Inputs**

- This section should describe the attributes of the sensing system(s) used to supply data for the algorithm. Confirm that these are accurately documented in the ATBD and the CDD.
- The sensor attributes are usually obtained from a Sensor Specification and/or other documentation from sensor reviews, which should be referred to. Often, there has been a formal presentation of sensor attributes made by the sensor development team. In that case, the CDR reviewers should confirm that the sensor attributes documented in the ATBD and CDD are consistent with the Sensor Specification and the sensor reviews.

- **Section 5.6: Ancillary Inputs**

- Confirm that the attributes of all input data used by the algorithm, including ancillary data, forward models and look-up tables, are documented in the ATBD and the CDD.

- **Section 5.7: Retrieval Strategy**

- Confirm that the fundamental approach for retrieval, as documented in the ATBD and CDD, is satisfactory.

- **Section 5.8: Processing Outline**

- This section should describe the processing outline of the retrieval algorithm. All key elements and sub-elements needed to convey a comprehensive sense of the algorithm should be included.
- Confirm that the description of the algorithm process flow is clear and consistent with the software architecture (c.f. Section 6 of the CDD). If a process flow diagram is not included in the CDD, the CDR reviewers should find it in the ATBD.

- **Section 5.9: Physical Description**

- This section should describe the physics and associated phenomenology key to the retrieval, referring to the relevant section of the ATBD. Often, the physics will be adopted from proven algorithm heritage. The CDD should note what parts of the physical description is based on proven algorithm heritage and what is new. If the approach is new, the CDD and the ATBD should explain why new algorithm physics is being used and evaluate the attendant risk.
- Confirm that the adopted approach is satisfactory, given the project requirements and the available algorithm technology.
- Confirm that the physical description of the algorithm is correct and consistent with the adopted approach.

- **Section 5.10: Mathematical Description**

- This section should describe the mathematics used by the retrieval, including all simplifications, approximations, and numerical methods, referring to the relevant section of the ATBD.
- Confirm that the mathematical description of the algorithm is correct and consistent with the physical description.

- **Section 5.11: Algorithm Output**

- This section should describe the algorithm output, mapping output characteristics to product requirements.
- Confirm that the algorithm output descriptions in the CDD and ATBD are consistent with the software architecture (Section 6 of the CDD) and with requirements.

Section 5.12: Performance Estimates

- This section describes, to the extent possible at the CDR stage of development, the predicted algorithm performance and quality of the products derived from analysis and tests with simulated and/or proxy test data. Confirm that the ATBD and CDD describe the predicted algorithm performance and quality of the products derived from analysis and tests with simulated and/or proxy test data, referring to the relevant sections of the ATBD.
- Confirm that verification methods and assumptions are noted in the ATBD and CDD, with references to the Verification and Validation Plan (VVP).
- Confirm that results from performance testing, as documented in the ATBD and the CDD, provide a convincing demonstration that the selected solution will meet requirements.
- Confirm that the documentation of performance testing in the ATBD and the CDD is sufficient to identify performance risks.

- **Section 5.13: Practical Considerations**

- This section should describe how the algorithm is numerically implemented, including any possible issues with computationally intensive operations (e.g., large matrix inversions), and describe any important programming and procedural aspects related to implementing the numerical model into operating code.
- Confirm that this section of the CDD and the relevant section of the ATBD adequately address the practical considerations specific to this algorithm.

4.2.6 Section 6 – Software Architecture and Interfaces

The CDD shall include a Software Architecture Section. The purpose of this section is to demonstrate that the algorithm process flow provides for an implementation that is consistent with the theoretical basis and meets requirements. Most of the content for this

section should be obtained directly from the SWA. This section should be organized as follows:

6.0 SOFTWARE ARCHITECTURE AND INTERFACES

6.1 Software Architecture Overview

6.2 Context-Layer

6.3 System-Layer

6.4 Unit-Layer

6.5 Sub-Unit-Layer

- **Section 6.1: Software Architecture Overview**

- This section should explain the concept and function of software architecture, introduce the Software Architecture Document (SWA), and provide a pointer to the SWA.
- Confirm that the CDD illustrates the four layers of software architecture, including the preliminary design layers (Context-Layer and System-Layer) and the detailed design layers (Unit-Layer and Sub-Unit-Layer).

- **Section 6.2: Context-Layer**

- This section should describe the flows between the system and its external interfaces, called the Context-Layer of the software architecture.
- Confirm that the CDD explains the concept of the Context-Layer, defining the interfaces between the software system and external sources and sinks. An external input is defined as a data source needed by the system that is produced or made available by a process external to the system. External output is defined as a data sink that is produced by the system for an external user.
- External interfaces must meet standard criteria. Confirm that the standard criteria for external interfaces are listed in the CDD and that the external interfaces in the software architecture meet the required criteria.
- Confirm that the CDD description of the Context-Layer software architecture is consistent with the SWA. The CDD presentation of the Context-Layer software architecture should show all external inputs and outputs to and from the software system, including a flow diagram, a discussion of each interface item at a level of detail that is warranted for that item, and a table.

- **Section 6.3: System-Layer**

- This section should describe the flows between the major software units that comprise the software system, called the System-Layer of the software architecture.
- Confirm that the CDD explains the concept of the System-Layer. The System-Layer data flow expands upon the Context-Layer data flow of Section 6.2, showing the next (first) layer of decomposition. In addition to the System-Layer inputs and outputs, the major processing units should be shown along with their inputs and outputs. Each unit should be designed as a stand-alone program for ease of testing and integration.
- Confirm that the System-Layer data flows are consistently and satisfactorily described in the SWA and CDD. The CDD and SWA should present the System-Layer data flows as a flow diagram and as a table.

- **Section 6.4: Unit-Layer**

- This section should describe the flows within the major software units that comprise the software system, called the Unit-Layer of the software architecture. The Unit-Layer data flow expands upon the System-Layer data flow of Section 6.3, showing the next layer of decomposition.
- Confirm that the Unit-Layer data flows are consistently and satisfactorily described in the SWA and CDD. The CDD and SWA should provide flow diagrams for each unit. The SWA should also include a table for each unit, listing the data flow items.

- **Section 6.5: Sub-Unit-Layer**

- This section should describe the flows within each Sub-Unit element of the Unit-Layer architecture, called the Sub-Unit-Layer of the software architecture.
- Confirm that the Sub-Unit Layer data flows are consistently and satisfactorily described in the SWA and CDD. The CDD and SWA should provide flow diagrams for each sub-unit.

4.2.7 Section 7 – Detailed Design Description

The CDD shall include a Detailed Design Description Section. The purpose of this section is to describe the product design at a level of detail that is sufficient for development

programmers to write fully functional pre-operational code and for operations to effectively perform system administrative and reactive maintenance functions.

The detailed design builds on the software architecture by providing a detailed description of each system element that is defined in the software architecture.

The detailed design describes the project system's functionality and design characteristics at a level of detail that covers, for each system element, its purpose, allocation to project requirements, external interfaces, decomposition into sub-elements, functional sequence, design language, and input/output file descriptions.

Most of the content for this section should be obtained directly from the DDDs. This section should be organized as follows:

7.0 DETAILED DESIGN DESCRIPTION

- 7.1 Detailed Design Description
- 7.2 Software Detailed Design
- 7.3 Unit and Sub-Unit Descriptions
- 7.4 Look Up Table Descriptions
- 7.5 File Descriptions

- **Section 7.1: Detailed Design Description**

- This section explains the concept of detailed design, serving as an overview for the sections to follow. The detailed design builds on the software architecture by providing a detailed description of each system element that is defined in the software architecture. Its purpose is to describe the product design at a level of detail that is sufficient for development programmers to write fully functional pre-operational code. Confirm that the CDD explains the concept of detailed design.

- **Section 7.2: Software Detailed Design**

- This section should provide an overview of the software detailed design, introduce the DDD, and provide pointers to a DDD for each unit in the software architecture.

- **Section 7.3: Unit and Sub-Unit Descriptions**

- Confirm that the detailed design, as documented in the CDD and the DDDs for each unit, fully defines the structure and capabilities of the software product components at the Unit-Layer. Documentation should explain the unit's purpose, list all requirements that the unit satisfies, list all interfaces, including external interfaces and system internal interfaces, list the major processing steps performed by the unit (these customarily correspond to sub-units), provide unit design language, and list assumptions and limitations that apply to the unit design.
- Confirm that the detailed design, as documented in the CDD and the DDDs for each unit, fully defines the structure and capabilities of the software product components at the Sub-Unit-Layer. Documentation should explain the sub-unit's purpose, list all requirements that the sub-unit satisfies, list all interfaces, provide sub-unit design language, and list assumptions and limitations that apply to the sub-unit design

- **Section 7.4: Look Up Table Descriptions**

- Confirm that the detailed design, as documented in the CDD and the DDDs for each unit, fully describes each Look Up Table (LUT) in the algorithm design. The LUT description should explain the purpose and function of each LUT, list and describe each LUT entry, and provide the LUT format. Note that a single LUT may be used by more than one software unit. Its description should then be included in each relevant DDD.

- **Section 7.5: File Descriptions**

- Confirm that the detailed design, as documented in the CDD and the DDDs for each unit, fully describes all other files in the algorithm design. Other files can be parameter files, system control files, input/intermediate/output data files, and ancillary data files. The file description should list and describe the contents of each file. The description should include the data format.

4.2.8 Section 8 – Quality Assurance

The CDD shall include a Quality Assurance Section. There are two types of quality assurance to review, Process QA and Product QA.

Process QA is concerned with assuring that the STAR EPL process standards are met during the planning, development, operations, and distribution phases of the project.

Process QA is achieved through the standard Gates and Technical Reviews of the STAR EPL process. Each review checklist and entry/exit criteria are designed to ensure that the relevant process standards are met by the implementation of standard practices during the steps leading up to the review. STAR QA personnel are responsible for Process QA.

Product QA is concerned with assuring that the work products created during the project's lifecycle meet their requirements. Product QA is achieved by verification of the project's work products and validation of the products, operator needs, and user needs. Configuration management (CM) and data management (DM) are essential Product QA functions. Development Testers and CM/DM personnel are responsible for Product QA.

This section should be organized as follows:

8.0 QUALITY ASSURANCE

8.1 Quality Assurance

8.2 Configuration Management

8.3 Verification and Validation Documentation

8.4 Verification Plan

8.5 Validation Plan

- **Section 8.1: Quality Assurance**

- This section introduces the concepts of process QA and product QA, noting the distinction between the two.

- **Section 8.2: Configuration Management**

- This section describes the Configuration Management and Data Management (CM/DM) status of the project..
- STAR should assign CM/DM personnel to the project during the Project Planning phase. Confirm that the CM/DM stakeholders for the project are identified. Verify the commitment of the CM/DM stakeholders to the Project Plan.
- Confirm that the CDD describes the CM/DM tools that are in use for the project.
- The project's baseline and change history are maintained in the PBR. The CDD should provide a pointer to the PBR. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the PBR

by using this pointer, and cannot otherwise obtain access to the current baseline version of the PBR, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.

- **Section 8.3: Verification and Validation Documentation**

- The CDD should explain the concepts of verification and validation.
- All material in this section should be taken from the VVP. The CDD should describe the VVP and provide a pointer to the VVP. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the VVP by using this pointer, and cannot otherwise obtain access to the current baseline version of the VVP, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.

- **Section 8.4: Verification Plan**

- Confirm that the CDD and VVP identify the work products to be verified and the requirements to be satisfied by each work product selected for verification. The requirements to be satisfied for selected work products are derived requirements. Confirm that they are consistently documented in the CDD, VVP and RAD.
- Confirm that the verification methods are satisfactory. The CDD and VVP should consistently describe the verification methods that will be used. The verification methods should be described in sufficient detail for reviewers to decide if they are satisfactory.
- Confirm that the CDD discusses the inclusion of verification activities in the DPP. The CDD should note any adjustments in the DPP (usually, schedule and resources) that are needed to accommodate the updated verification plan. Most important: the CDD should note any risk to milestone dates and impact on successor milestones.

Section 8.5: Validation Plan

- Confirm that the CDD and VVP identify user-driven requirements on the product or products to be validated. These are typically found in the project's basic requirements, should be documented in the RAD, and should have been discussed in Section 4 of this presentation.
- Confirm that the CDD and VVP satisfactorily describe the scope of the validation of products (e.g., product quality attributes, validation environments, validation campaigns), distinguishing between pre-launch and post-launch plans.
- Confirm that the CDD and VVP identify operator needs (operations and maintenance, or O&M) to be validated. Each product or product component must be maintainable and supportable in its intended operational environment. Operator needs are typically found in the project's derived requirements, should be documented in the RAD, and should have been discussed in Section 4 of this presentation. Most operator needs will be generic. Any needs that are specific to the project should be documented in the VDD and VVP.
- Confirm that the CDD and VVP identify the tools and training available for O&M.
- Confirm that the CDD and VVP describe the scope of the validation for each operator need. Usually, this will consist of simulations in the operational environment by the intended O&M personnel with the actual O&M tools and training in place.
- Confirm that the CDD and VVP identify user needs (training, support, use of products) to be validated. These are typically found in the project's derived requirements, should be documented in the RAD, and should have been discussed in Section 4 of this presentation. Many user needs will be generic. Any needs that are specific to the project should be documented in the VDD and VVP.
- Confirm that the CDD and VVP identify the tools, training, and support services available to the user (e.g. Users Manual) and the procedure for delivering these to the intended users.
- Confirm that the CDD and VVP describe the scope of the validation for each user need. Usually, this will consist of simulations in a user environment by the intended users and/or beta testers with the actual User tools and training in place.

4.2.9 Section 9 – Requirements Allocation

The CDD shall include a Requirements Allocation Section. There are two main aspects of the Requirements Allocation Document (RAD), (1) the basic and derived requirements and (2) their allocation to system components and work products. This section deals with the second aspect. The first aspect was dealt with in Section 4 of the CDD.

The primary purpose of this section is to demonstrate that the basic and derived requirements that were presented in Section 4 of the CDD have been properly allocated to the components of the designed product processing system. The sections for Requirements and Requirements Allocation are separated by sections on Algorithm Theoretical Basis, Software Architecture and Interfaces, Detailed Design and System Description, and Quality Assurance because it is expected that the requirements allocation will have been substantially updated since PDR by developments in these sections.

This section should be organized as follows:

9.0 REQUIREMENTS ALLOCATION

9.1 Requirements Allocation Development

9.2 Requirements Allocation Changes

- **Section 9.1: Requirements Allocation Development**

- Confirm that the CDD illustrates the iterative development of the requirements allocation during the Design phase of the STAR EPL process. The illustration should clearly show that the development of Solutions, Design, Requirements, and Requirements Allocation occurs iteratively in a closed loop with continual feedback between the four. The placement of the four components of Design Development is meant to show that Requirements (Section 4) drive the Solutions and Design (Sections 5 – 8), which in turn develop the Requirements Allocation (Section 9). The connection between Requirements Allocation and Requirements is caused by the need to maintain consistency between the two components.
- The current allocation of baseline requirements will be documented in the RAD. Access to this document is part of the CDR entry criteria. If the CDR reviewer cannot obtain access to the RAD by using the pointer provided in Section 4 of the CDD, and cannot otherwise obtain access to the current baseline version of the RAD, the reviewer should notify an appropriate person (e.g. Review Lead, Development Lead, Program Manager, STAR Web Developer) to obtain access.

- Confirm that the RAD contains the correct allocation of the requirements to system components and product components. The RAD should include a matrix that relates each system component or product component to relevant requirements.
- **Section 9.2: Requirements Allocation Changes**
 - Confirm that the RAD correctly documents each requirements allocation change since PDR. Each requirements allocation item that is documented in the RAD should include a note that it is either an old allocation, a new allocation, or a revised allocation. New allocations typically occur due to a new requirement, a revised requirement, a new design feature, or a revised design feature. Revised allocations typically occur due to new or revised design features. All of these should have been presented in the preceding sections of the CDD.
 - For each requirements allocation change, the CDD should:
 - Note whether the change is due to a new requirement, a changed requirement, or a design change,
 - List higher-level driving requirements, if the change is due to a new or revised derived requirement,
 - List derived requirements that are affected, if the change is due to a new or revised basic requirement,
 - Specify the design change and trace it to the design presentation in this CDD, if the change is due to a design change,
 - Note whether the change has been approved at a delta Requirements Review.
 - To assist the CDR reviewers in disposing of each unapproved requirements allocation change, the development team should provide the following information in this section of the CDD:
 - Explain the rationale for the change, referring to relevant sections of the CDD,
 - Note potential effects on the project plan,
 - Document the agreement of affected stakeholders,
 - Note new or modified risks that result (these will be discussed in Section 10 of the CDD),

- Note any recommended actions (these also will be discussed in Section 10 of the CDD).
- The CDR reviewers should dispose of each change that has not been approved at a delta Requirements Review, based on information provided by the development team in the CDD and RAD. The disposition of each change should be documented in the CDRR.

4.2.10 Section 10 – Risks and Actions

The CDD shall include a Risks and Actions Section. The purpose of this section is to provide an updated description of the status of identified project risks and associated actions for reviewer assessment and concurrence.

This section should be organized as follows:

10.0 RISKS AND ACTIONS

10.1 PDR Risks and Actions

10.2 New Risks and Actions

10.3 Risk Summary

- **Section 10.1: PDR Risks and Actions**

- The status of project risks at PDR should have been reported in a “Risk Assessment” section of the PDRR.
- Confirm that the PDRR and CDD correctly document the status of risks at PDR. Each risk should be reported as follows:
 - Risk Statement – the description of the risk
 - Assessment – the results from analysis of the risk. The assessment should include quantitative evaluation of Severity and Likelihood of Occurrence
 - Mitigation – the plan to mitigate the risk
 - Actions – list of actions to implement the mitigation plan
- Confirm that the CDD provides the status of the associated actions for each PDR risk. Each action should be reported as follows:
 - Action statement

- Closure Criteria
 - Closure Plan
 - Status – status of the action, with respect to the closure plan
- **Section 10.2: New Risks and Actions**
 - Confirm that the CDD reports the status of each risk that has been identified since PDR in sufficient detail for the reviewers to be able to assess the development team’s recommended actions to mitigate the risks. Each new risk should be described in the CDD as follows:
 - Risk Statement – the description of the risk
 - Assessment – the results from analysis of the risk. The assessment should include evaluation (e.g. High, Medium, Low)
 - Mitigation – the plan to mitigate the risk
 - Actions – list of actions to implement the mitigation plan
 - Confirm that the CDD provides the status of the associated actions for each new risk. Each action should be reported as follows:
 - Action statement
 - Closure Criteria
 - Closure Plan
 - Status – status of the action, with respect to the closure plan
 - **Section 10.3: Risk Summary**
 - Confirm that the CDD provides a list of risks that can be closed.
 - Confirm that the CDD provides a list of risks that remain open, in priority order (HIGH, then MEDIUM, then LOW). If the PDRR contained a table of risks, look for an updated table that has the same format. The updated table should add risks identified since PDR, modify the evaluation and prioritization of PDR risks based on current status, and update the mitigation plans, actions and status. For each risk, list the actions that must be closed to reduce the risk to an acceptable level, with closure plans and estimated closure dates.

4.2.11 Section 11 – Summary and Conclusions

The CDD shall include a Summary and Conclusions Section. This section is organized as follows:

11.0 SUMMARY AND CONCLUSIONS

11.1 Review Objectives Status

11.2 Issues, Actions and Risks

11.3 Next Steps

11.4 Open Discussion

- **Section 11.1: Review Objectives Status**
 - Confirm that all review objectives have been addressed by the CDD. Look for notable conclusions from each CDD section to be summarized here.
- **Section 11.2: Issues, Actions and Risks**
 - Confirm that the CDD lists all outstanding issues, actions and risks that require attention. Look for notable conclusions from each issue, action and risk to be summarized here.
- **Section 11.3: Next Steps**
 - Confirm that the CDD lists the recommendations of the development team for the next steps after the CDR, including preparation for Gate 4 Review and the Build phase, steps 9-11, of the STAR EPL.
- **Section 11.4: Open Discussion**
 - The CDD states here that the review is open for free discussion. Note: If the development team has prepared for and conducted the review in accordance with standards and if the reviewers have prepared for the review in accordance with standards, there should be no need for additional discussion.

5. CLOSING THE REVIEW

5.1. Exit Criteria

The CDR reviewers should ensure that all CDR exit criteria have been met before closing the review. The CDR exit criteria should have been established at the PDR and documented in the PDRR. Note that exit criteria may be tailored from the standard STAR EPL set of CDR exit criteria. In that case, the PDRR should provide a rationale for deviations from the standard set. The standard STAR EPL set of CDR exit criteria, listed in the standard CDR check list (CL-11.1), includes the following 13 items:

- Exit # 1 - PDR "Conditional Pass" items have been satisfactorily disposed of.
- Exit # 2 - PDR "Defer" items have been satisfactorily disposed of.
- Exit # 3 – Project plan and DPP are satisfactory
- Exit # 4 - Operations concept and OCD are satisfactory.
- Exit # 5 - Requirements changes since PDR are approved.
- Exit # 6 - Algorithm theoretical basis and ATBD are satisfactory.
- Exit # 7 - Software architecture and SWA are satisfactory.
- Exit # 8 – Software detailed design and DDDs are satisfactory.
- Exit # 9 - Verification and validation plan and VVP are satisfactory.
- Exit # 10 - Requirements allocation and RAD are satisfactory.
- Exit # 11 - Project baseline and PBR are satisfactory.
- Exit # 12 - The CDRR documents the current status of project risks, actions and CDR exit criteria.
- Exit # 13 - Project risks and actions are acceptable. Project is ready for the Build phase.

The interpretation of the terms “satisfactory” and “acceptable” in the exit criteria is subjective. That is, an item is “satisfactory” or “acceptable” if the reviewers find it satisfactory or acceptable to them. The reviewers are encouraged to refer to the set of relevant process assets (c.f. Section 3.4 of this PRG) to assist them in determining what their criteria for “satisfactory” and “acceptable” should be.

Note also that exit criteria item # 12 applies to the CDRR. This document (c.f. Section 5.3 of this PRG) is the responsibility of the CDR reviewers. The CDR is not properly closed until a CDRR has been written that satisfies exit criteria item # 12.

5.2. CDR Checklist

The CDR checklist is an essential item that must be completed to close the review. It contains the CLIs that must be checked off by the CDR reviewers. Checking off a CLI involves recording one of the following dispositions for each item:

- Pass – The item is approved.
- Conditional Pass – The item is approved conditionally. The condition or conditions typically involve one or more specific actions that must be closed to pass the item. Conditional Pass items are typically reconsidered at a delta CDR.
- Defer – The item is deferred for consideration at a later review (e.g. Test Readiness Review), often with recommended actions to be addressed prior to that review.
- Waive – The item has been excused for this project’s lifecycle. It is expected that a rationale for waiving an item be provided in the CDRR.
- Not Applicable (N/A) – The item is not applicable to this project’s lifecycle. This disposition will only occur if the item was mistakenly included in the project’s CDR checklist. The distinction between this disposition and the “Waive” disposition is that “Waive” items are applicable to the project’s lifecycle, though they have been excused for some reason.

In addition, the checklist includes the following Columns to be filled in for each CLI:

- Risk – A risk evaluation pertaining to the item (e.g. Red/Yellow/Green/Blue or High/Medium/Low/None). An item with a risk evaluation of Medium or worse should generate at least one action. Low risk items may also generate actions, at the discretion of the reviewers.
- Actions (Y/N) – Note (Yes or No) whether there are open actions pertaining to this item.
- Comments – Include any explanatory comments (e.g. rationales for the designation of the item, rationales for the risk evaluation, description of open actions, identification of the review that should address the actions).

The CDR reviewers can use the standard checklist provided in the CDR Checklist spreadsheet (STAR EPL process asset CL-8.1) to record their disposition of the CLIs, if the checklist for this project's CDR has not been modified. If there has been a modification, the CDR reviewers should use a modified spreadsheet that includes the CDR CLIs that have been agreed to. The CDR CLIs that have been approved for a specific project should be included in the project's DPP. Any modifications to the checklist during the Design phase must be approved by project management and should be documented in a DPP revision.

Typically, each member of the review team is assigned a subset of the checklist to check off, and some items may be assigned to more than one review team member. The Review Lead is responsible for collecting the finished checklists from each review team member, resolving conflicts between team members, and producing a unified checklist with all items checked off. The Critical Design Review Report (CDRR, c.f. Section 5.3 of this PRG) typically includes a copy of this unified CDR checklist.

5.3. CDR Report

The CDRR is the one project artifact that is the responsibility of the CDR review team. Responsibilities for writing parts of the CDRR should be assigned to review team members by the Review Lead. These should be agreed upon well in advance of the review, during review preparation meetings.

Standards and guidelines for the CDRR can be found in STAR EPL process asset DG-8.3 (Critical Design Review Report Guidelines). The CDR review team should follow the standards and guidelines in DG-8.3, unless there are tailored standards and guidelines specific to this project. In that case, the DPP should either note the tailored standards and guidelines or should provide a reference to a document where these are noted.

The CDRR should be updated to record the closing of "Conditional Pass" and "Defer" items after the CDR. CDRR updates should include a change history. Details can be found in DG-8.3.

END OF DOCUMENT