

**NOAA NESDIS
CENTER for SATELLITE APPLICATIONS
and RESEARCH**

DOCUMENT GUIDELINE

**DG-8.3
CRITICAL DESIGN REVIEW REPORT
GUIDELINE
Version 3.0**

NOAA NESDIS STAR

DOCUMENT GUIDELINE

DG-8.3

Version: 3.0

Date: October 1, 2009

TITLE: Critical Design Review Report Guideline

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TITLE: DG-8.3: CRITICAL DESIGN REVIEW REPORT GUIDELINE VERSION 3.0

AUTHORS:

Ken Jensen (Raytheon Information Solutions)

CRITICAL DESIGN REVIEW REPORT DOCUMENT GUIDELINE VERSION HISTORY SUMMARY

Version	Description	Revised Sections	Date
1.0	New Document Guideline (DG-11.3) adapted from CMMI guidelines by Ken Jensen (Raytheon Information Solutions)	New Document	12/29/2006
2.0	Revised by Ken Jensen (Raytheon Information Solutions) for version 2. Minor revisions to References.	2	10/31/2007
3.0	Renamed DG-8.3 and revised by Ken Jensen (Raytheon Information Solutions) for version 3.	All	10/1/2009

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LIST OF ACRONYMS

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	Check List
CLI	Check List Item
CMMI	Capability Maturity Model Integration
CREST	Cooperative Remote Sensing and Technology Center
DG	Document Guideline
DPP	Development Project Plan
EPL	Enterprise Product Lifecycle
N/A	Not Applicable
NESDIS	National Environmental Satellite, Data, and Information Service
NOAA	National Oceanic and Atmospheric Administration
PAR	Process Asset Repository
PDR	Preliminary Design Review
PDRR	Preliminary Design Review Report
PG	Process Guideline
PRG	Peer Review Guideline
SG	Stakeholder Guideline
STAR	Center for Satellite Applications and Research
TD	Training Document
TG	Task Guideline
TRR	Test Readiness Review

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. The Critical Design Review Report (CDRR) is one component of this process.

1.1. Objective

The objective of this Document Guideline (DG) is to provide STAR standards for the CDRR. The intended users of this DG are the Critical Design Review (CDR)¹ reviewers who are responsible for writing the CDRR.

1.2. The Critical Design Review Report

A CDRR is produced following a project's CDR. It is a required project artifact of the STAR Enterprise Product Lifecycle (EPL)².

A separate CDRR is produced for each distinct product in the STAR Enterprise during the Design phase of the STAR EPL.

The intended target audiences are program management, the product development team, the Gate 4 reviewers and the Test Readiness Review (TRR) reviewers.

The CDRR should be developed as a Microsoft Word document. Upon approval, the approved version of the CDRR may be converted to an Adobe pdf file for storage in the project artifact repository.

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 For a description of the STAR EPL, refer to the STAR EPL Process Guidelines (PG-1 and PG-1.A).

The CDRR Appendix should be a Microsoft Excel document. Upon approval, the approved version of the CDRR Appendix may be converted to an Adobe pdf file for storage in the project artifact repository.

1.3. Background

This DG defines guidelines for producing a CDRR. This DG has been adapted from Capability Maturity Model Integration (CMMI) guidelines. It has been tailored to fit the STAR EPL process.

1.4. Benefits

A CDRR developed in accordance with the standards in this DG assists the development team to create a technical solution that meets customer needs and user expectations. It is therefore a requirement that a CDRR be written in accordance with the guidelines in this document.

1.5. Overview

This DG contains the following sections:

Section 1.0 -	Introduction
Section 2.0 -	References
Section 3.0 -	Standard Table of Contents
Section 4.0 -	Section Guidelines
Section 5.0 -	CDRR Updates
Appendix A -	CDR Check List
Appendix B -	Templates

2. REFERENCE DOCUMENTS

All of the following references are STAR EPL process assets that are accessible in a STAR EPL Process Asset Repository (PAR) on the STAR web site:

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

PG-1: STAR EPL Process Guideline provides the definitive description of the standard set of processes of the STAR EPL.

PG-1.A: STAR EPL Process Guideline Appendix, an appendix to PG-1, is a Microsoft Excel file that contains the STAR EPL process matrix (Stakeholder/Process Step matrix), listings of the process assets and standard artifacts, descriptions of process gates and reviews, and descriptions of stakeholder roles and functions.

PRG-8.1: Critical Design Review Peer Review Guideline is the PRG for preparing, conducting and closing a CDR. The PRG describes the standard CDR artifacts and the relevant STAR EPL process assets. It also states the standard CDR objectives, entry criteria, and exit criteria.

PRG-9: Test Readiness Review Peer Review Guideline is the PRG for preparing, conducting and closing a TRR. The PRG describes the standard TRR artifacts and the relevant STAR EPL process assets. It also states the standard TRR objectives, entry criteria, and exit criteria.

SG-17: STAR EPL Technical Review Lead Guidelines provides a description of standard tasks for Technical Review Leads.

SG-18: STAR EPL Technical Reviewer Guidelines provides a description of standard tasks for Technical Reviewers.

TG-8: STAR EPL Detailed Design Task Guidelines provides a description of standard tasks for process step 8, during which the CDRR is written.

DG-0.1: STAR Document Style Guideline is a STAR EPL Document Guideline (DG) that provides STAR standards for the style and appearance of STAR documents developed as Microsoft Word files.

3. STANDARD TABLE OF CONTENTS

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LIST OF ACRONYMS

1.0 CDR ENTRY CRITERIA

2.0 CDR RISKS

3.0 CDR ACTIONS

3.1 Completed Actions

3.2 Open Actions

3.3 New Actions

4.0 CDR EXIT CRITERIA

5.0 TRR ENTRY CRITERIA

6.0 TRR EXIT CRITERIA

7.0 SUMMARY

8.0 LIST OF REFERENCES

APPENDIX A – CDR CHECK LIST DISPOSITION

4. SECTION GUIDELINES

This section contains the STAR guidelines for each section of the CDRR.

The CDRR should follow the STAR standard for style and appearance, as stated in DG-0.1.

4.1. Table of Contents

The Table of Contents can be inserted by using Word's Insert → Reference → Index and Tables → Table of Contents function or by pasting the Table of Contents from this DG into your document and updating it for the section headers you make for your document. Use a page break if necessary to ensure that the Table of Contents appears at the top of a page.

4.2. List of Figures

A List of Figures should be provided after the Table of Contents. A page break should be used if necessary to ensure that the List of Figures appears at the top of a page. To create a List of Figures, use Word's Insert → Reference → Index and Tables → Table of Figures function, selecting the "Table of Figures" Style. Alternatively, the List of Figures can be created by pasting the List of Figures for this DG into your document.

Figures should be created by using Word's Insert → Picture → From File function or Word's Insert → Object function. Figures should be numbered X.Y, where X is the main section number where the figure resides and Y = 1,N is the ordered number of the figure in the section. Figure captions should have Arial bold 12 point font, should be center justified, and should have a "Table of Figures" Style. A Figure Caption template is provided in Appendix B of this DG.

4.3. List of Tables

A List of Tables should be provided after the List of Figures. The List of Tables can appear on the same page as the List of Figures, with three blank lines separating them, provided both lists can fit on the same page. If both lists cannot fit on the same page, a page break should be used to ensure that the List of Tables appears at the top of a page.

To create a List of Tables, use Word's Insert → Reference → Index and Tables → Table of Figures function, selecting the "Table - Header" Style. Alternatively, the List of Tables can be created by pasting the List of Tables for this DG into your document.

Tables should be created with the Table → Insert → Table function. Tables should be numbered X.Y, where X is the main section number where the table resides and Y = 1,N is the ordered number of the table in the section. Table titles should have Arial bold 12 point font, should be center justified, and should have a "Table - Header" Style. A Table Title template is provided in Appendix B of this DG. Table text should have Arial regular 10 point font.

4.4. List of Acronyms

The use of acronyms is encouraged. A two word or longer name for an item (e.g., Critical Design Review Report) should be given an acronym (e.g., CDRR) if the name is used more than once in the document. A List of Acronyms should be provided after the List of Tables. The List of Acronyms should be in alphanumeric order. Use the List of Acronyms in this DG as a template. A page break should be used if necessary to ensure that the List of Acronyms appears at the top of a page.

4.5. Section 1 – CDR Entry Criteria

Explain the disposition of each CDR entry criteria item. The CDR entry criteria are established in the Preliminary Design Review Report (PDRR). Use a separate subsection for each item. Each subsection should include the following:

- A statement of the entry criteria item
- The disposition of the item. Possible dispositions include:
 - Pass – The item is approved.
 - Conditional Pass – The item is approved conditionally. Explain the condition or conditions. The condition or conditions typically involve one or more specific actions that must be closed to pass the item. Note that these actions will be discussed in Section 3 of the CDRR.
 - Defer – The item is deferred for consideration at a later review (e.g. TRR), often with recommended actions to be addressed prior to that review. Refer to the Section 3 subsection of the CDRR where these actions are stated.

Explain the reason for deferral and state the recommended review at which the item should be considered. There should be a clear and convincing rationale for deferring any entry criteria item to a review other than a delta CDR. The most common rationale will be schedule and resource constraints, combined with a demonstration that actions associated with the deferral can be taken in parallel with planned post-CDR tasks.

- Waive – The item has been excused for this project’s lifecycle. Explain the reason for waiving the item.
 - Not Applicable (N/A) – The item is not applicable to this project’s lifecycle. 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. This disposition will only occur if the item was mistakenly included in the project’s CDR Check List. Explain why this item should not be in the project’s CDR Check List.
- A list of open actions pertaining to the item, including new actions.
 - Any additional comments that are deemed relevant by the reviewer.

The following format for this section is recommended:

-
Entry # 1 - <Entry criteria # 1 Statement>

- STATUS: <Disposition (e.g. PASS), use upper case>
 - COMMENTS: <Any pertinent comments (e.g. rationale for the disposition, a list of associated actions) plus a reference to sections of the CDRR where the risk and associated actions are discussed>
- -

- Repeat for each entry criteria item

4.6. Section 2 – CDR Risks

The status of each project risk should be presented in the Critical Design Document (CDD). The CDD is described in PRG-8.1 and TG-8. The CDR reviewers should update this status, based on their judgment following the CDR. Refer to PG-1 for standard risk assessment techniques.

Provide an overview of the risk history and risk status. Itemize and report on the identified risks. Each risk should be reported as follows:

- Risk Statement – the risk number and statement. Risks should be numbered in chronological order of when they are identified.
- Risk History – For a risk that was identified prior to the CDR, note the date and/or the review when it was identified and its original evaluation status (e.g. High, Medium, Low). For a risk that originates with this report, note that it is a new risk.
- Assessment – the results from analysis of the risk. The assessment should include qualitative evaluation (e.g. High, Medium, Low) and quantitative evaluation (Severity and Probability). PG-1 provides guidelines for these assessments.
- Mitigation – recommended steps to mitigate the risk
- Pertinent Actions – List the action designation for each open action that pertains to the risk. The action designation convention is “XXX i,j,k,l”, where “XXX” is the acronym for the review where the action was generated (e.g. CDR), “i.j.k” is the number of the review Check List Item (CLI) that generated the action, and “l” is the unique action number. For example, the third action generated by the CDR CLI 1.7.23 would be designated “CDR 1.7.23.3”.

An example follows:

-

- **RISK # 2 - The project requirements do not take into account all customer needs and expectations**
 - Risk History: New risk
 - Risk Assessment: HIGH (Severity = 8, Probability = 7, Score = 56)

- Risk Mitigation:
 - Discuss the concept of operations with the customers and users.
 - Add requirements that take into account all customer needs and expectations
 - Modify requirements allocations to accommodate the new requirements
 - Document the requirements changes in the Requirements Allocation Document (RAD).
 - Review and approve the requirements changes and the RAD at the TRR.
 - Pertinent Actions:
 - CDR 1.7.23.1
 - CDR 1.7.23.2
 - CDR 1.7.23.3
-

4.7. Section 3 – CDR Actions

The status of risk mitigation actions for each project risk should be presented in the CDD. The CDD is described in PRG-8.1 and TG-8. The CDR reviewers should update this status, based on their judgment following the CDR.

Itemize and report on the recommended actions. There should be subsections for Completed Actions, Open Actions, and New Actions.

The subsection for Completed Actions should itemize and report on all previously identified actions that have been completed or withdrawn. Each action identified prior to CDR should be included in the CDD. Actions should be numbered. Adopt the action number used in the CDD. Each completed action should be reported in alphanumeric order, as follows:

- An action number, followed by an action statement.
- A statement of the criteria for closing the action.

-
-
- A statement of the status of the action. The status will be “Closed” or “Withdrawn”. There should be a demonstration that the closure criteria have been satisfied or a rationale for withdrawing the action.

For example:

-

ACTION: PDR 1.1.1.1 - Discuss project objectives with customers and users to ensure that they are derived from customer needs and expectations.

- Closure Criteria
 - Confirmation that the project objectives are in line with customer needs and expectations
- Closure Plan
 - Discuss the project objectives with customers
 - Document customer agreement with the project objectives in the Critical Design Document (CDD)
- Status:
 - **Closed.** The CDD documents customer agreements with the project objectives.

-

Completed actions may be listed in numerical order, but it is more useful to group them according to the risk that generates them, following the standard presentation of risks and actions in the CDD.

The subsection for Open Actions should report the status of each action from previous reviews that the CDR reviewers determine has not been completed. Typically, these actions have been presented at the CDR as still open, with a recommended closure plan. In that case, the CDR reviewers may accept the closure plan or recommend a modified plan. Each action identified prior to CDR should be included in the CDD. Adopt the action

number used in the CDD. Each open action should be reported in alphanumeric order, as follows:

- An action number, followed by an action statement.
- A statement of the criteria for closing the action.
- A statement of the closure plan for the action. A proper closure plan description should include a list of tasks, assignment of tasks, needed resources, task schedule, impact on the project plan, criteria for approval and risks. A closure plan for each action should be provided by the development team prior to the CDR if possible.
- A statement of the status of the action. The status will be "Open".

There may be cases where the CDR reviewers determine that an action presented as completed is still open because the closure criteria have not been completely met. In that case, the action status should be stated as "Open", with recommended steps for closure.

For example:

-

ACTION: PDR 1.1.1.1 - Discuss project objectives with customers and users to ensure that they are derived from customer needs and expectations.

- Closure Criteria
 - Confirmation that the project objectives are in line with customer needs and expectations
- Closure Plan
 - Discuss the project objectives with customers
 - Document customer agreement with the project objectives in the Critical Design Document (CDD)
- Status:
 - **Open.** The CDD documents customer agreements with the project objectives and treats this action as completed, but the CDR Reviewers have determined that the CDD does not document the agreement of customer X. Recommended steps for closure are listed in new action CDR n1.n2.n3.n4.

-

Open actions may be listed in numerical order, but it is more useful to group them according to the risk that generates them, following the standard presentation of risks and actions in the CDD.

The subsection for New Actions should itemize and report on all actions that have been identified at the CDR. New actions may originate from the development team and be presented in the CDD. Alternatively, they will be identified by the CDR reviewers and documented for the first time in the CDRR. Actions identified at the CDR should be numbered as “CDR n1.n2.n3.n4”. “n1.n2.n3” should correspond to the CDR check list item responsible for generating the action. “n4” is a unique number (1, 2, 3, etc.).

- A statement of the criteria for closing the action.
- A statement of the closure plan for the action. A proper closure plan description should include a list of tasks, assignment of tasks, needed resources, task schedule, impact on the project plan, criteria for approval and risks. For each action identified by the development team at the CDR, a closure plan should be included in the CDD. The CDR reviewers should adopt this closure plan or modify it if warranted. For each action identified by the CDR reviewers, the reviewers should provide a recommended closure plan.
- A statement of the status of the action. The status will be “Closed” or “Open”. For each action listed as “Closed”, there should be a demonstration that the closure criteria have been satisfied.

New actions may be listed in numerical order, but it is more useful to group them according to the risk that generates them, following the standard presentation of risks and actions in the TRD.

4.8. Section 4 – CDR Exit Criteria

Explain the disposition of each CDR exit criteria item. The CDR exit criteria are established in the PDRR. Use a separate subsection for each item. Each subsection should include the following:

- A statement of the exit criteria item
- The disposition of the item. Possible dispositions include:
 - Pass – The item is approved.
 - Conditional Pass – The item is approved conditionally. Explain the condition or conditions. The condition or conditions typically involve one or more specific actions that must be closed to pass the item. Refer to the Section 3 subsection of the CDRR where these actions are stated.
 - Defer – The item is deferred for consideration at a later review (e.g. TRR), often with recommended actions to be addressed prior to that review. Refer to the Section 3 subsection of the CDRR where these actions are stated. Explain the reason for deferral and state the recommended review at which the item should be considered. There should be a clear and convincing rationale for deferring any exit criteria item to a review other than a delta CDR. The most common rationale will be schedule and resource constraints, combined with a demonstration that actions associated with the deferral can be taken in parallel with planned post-CDR tasks.
 - Waive – The item has been excused for this project’s lifecycle. Explain the reason for waiving the item.
 - Not Applicable (N/A) – The item is not applicable to this project’s lifecycle. 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. This disposition will only occur if the item was mistakenly included in the project’s CDR Check List. Explain why this item should not be in the project’s CDR Check List.
- A list of open actions pertaining to the item, including new actions.
- Any additional comments that are deemed relevant by the reviewer.

The following format for this section is recommended:

-
Exit # 1 - <Exit criteria # 1 Statement>

- STATUS: <Disposition (e.g. PASS), use upper case>

-
- COMMENTS: <Any pertinent comments (e.g. rationale for the disposition, a list of associated actions) plus a reference to sections of the CDRR where the risk and associated actions are discussed>
-

- Repeat for each entry criteria item

4.9. Section 5 – TRR Entry Criteria

State the entry criteria for the next technical review, the TRR. The STAR EPL standard TRR entry criteria can be found in STAR EPL process asset PRG-9. Project-unique TRR entry criteria should be found in the project's Development Project Plan (DPP). Additional tailoring may be necessary to accommodate deferred items in the CDR Check List. The CDR Reviewers should determine this and revise the TRR entry criteria as needed.

4.10. Section 6 – TRR Exit Criteria

State the exit criteria for the next technical review, the TRR. The STAR EPL standard TRR exit criteria can be found in STAR EPL process asset PRG-9. Project-unique TRR exit criteria should be found in the project's DPP. Additional tailoring may be necessary to accommodate deferred items in the CDR Check List. The CDR Reviewers should determine this and revise the TRR exit criteria as needed.

4.11. Section 7 – Summary

A Summary section is provided for the CDR reviewers to include any concluding remarks that are deemed useful to the Gate 4 and TRR reviewers. The section can also include recommendations to the development team that are not already captured by the recommended actions.

4.12. Section 8 – List of References

This section should consist of a List of References that includes all references cited in the document. Include all references deemed useful by the CDR reviewers. References should

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be listed in alphabetical order. References that begin with an author list should begin with the last name of the lead author. A template is provided in Appendix B.

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5. CDRR UPDATES

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. This should be captured in the Version History section (c.f. Appendix B.6 of this DG) and also explicitly noted in the appropriate subsections of the main document. There should be at least one CDRR update prior to a delta CDR. If there are no “Conditional Pass” or “Defer” items, there is no need for a CDRR update and no need for a delta CDR. Even so, a CDRR update may be made at the discretion of the CDR Review Lead if it is deemed useful to update risk evaluations or other comments for the benefit of the Gate 4 and/or TRR reviewers.

APPENDIX A – CDR CHECK LIST

A completed CDR Check List should be included as an Appendix to the CDRR. The appendix should be in the form of a Microsoft Excel spreadsheet and an Object in the Microsoft Word document that should be created by pasting the spreadsheet into the document.

The CDR reviewers can use the standard Check List provided in the CDR Check List spreadsheet (STAR EPL process asset CL-8.1) to record their disposition of the CLIs, if the Check List 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 Check List items that have been agreed to. The CDR Check List items that have been approved for a specific project should be included in the DPP (Appendix C).

The Review Lead is responsible for the correctness of the Check List. The Review Lead can, and usually should, delegate responsibility for various items on the Check List to various review team members.

An example of a filled-in CDR Check List will be placed in the STAR EPL PAR.

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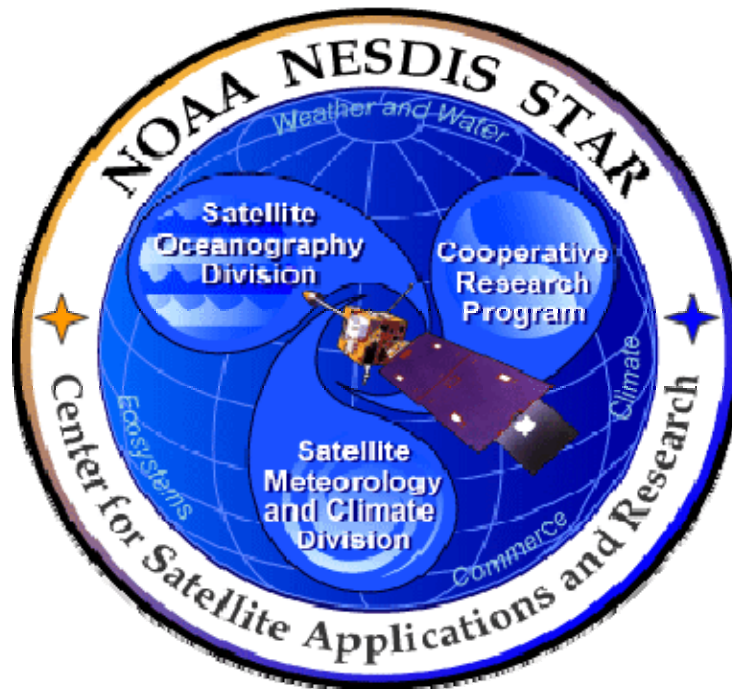
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APPENDIX B - TEMPLATES

This appendix contains templates for specific pages and sections of the CDRR.

B.1 Cover Page Template:

In this template, <X> = 1.0 for version 1, <X> = 1.1 for version 1 revision 1, <X> = 2.0 for version 2 etc. <Project Name> should be the actual approved name of the Project.



NOAA NESDIS CENTER for SATELLITE APPLICATIONS and RESEARCH

**<PROJECT NAME>
CRITICAL DESIGN REVIEW REPORT
Version <X>**

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B.2 Document Header Template:

In this template, <X> = 1.0 for version 1, <X> = 1.1 for version 1 revision 1, <X> = 2.0 for version 2 etc.

In this template, <Project Name> should be the actual approved name of the Project.

In this template, <Y> = the actual page number.

In this template, <Z> = the actual total number of pages

NOAA/NESDIS/STAR

CRITICAL DESIGN REVIEW REPORT
Version: <X>
Date: <Date of Latest Signature Approval>

<Project Name>
Critical Design Review Report

Page <Y> of <Z>

B.3 Document Cover Page Footer Template:

Hardcopy Uncontrolled

B.4 Document Footer Template:

Hardcopy Uncontrolled

Hardcopy Uncontrolled

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B.5 Approval Page Template:

In this template, <X> = 1.0 for version 1, <X> = 1.1 for version 1 revision 1, <X> = 2.0 for version 2 etc. <Project Name> should be the actual approved name of the Project.

TITLE: <PROJECT NAME> CRITICAL DESIGN REVIEW REPORT VERSION <X>

AUTHORS:

<Lead Author>

<Co-Author 1>

<Co-Author 2>

<etc.>

APPROVAL SIGNATURES:

<Name of CDR Review Lead> Date <Actual Signature Date>
CDR Review Lead

<Name of Project Manager> Date <Actual Signature Date>
Project Manager

<Name of Agency Approver> Date <Actual Signature Date>
Agency

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B.6 Version History Page Template:

In this template, <Project Name> should be the actual approved name of the Project.

<PROJECT NAME>
CRITICAL DESIGN REVIEW REPORT
VERSION HISTORY SUMMARY

Version	Description	Revised Sections	Date
1.0	Created by <Name of Developer(s)> of <Name of Developers' Agency/Company>.	New Document	<Actual date of Latest approval signature>
1.1	[As needed] Revised by <Name of Developer(s)> of <Name of Developers' Agency/Company> to include updated status of CDR actions	<applicable sections>	<Actual date of Latest approval signature>
etc.	Ditto		

B.7 Figure Caption Template:

Figure 2.3 - <Figure caption in Arial regular 12 point font>

B.8 Table Title Template:

Table 4.5 - <Table title in Arial regular 12 point font>

B.9 List of References Template:

- Ackerman, S. *et al.* (1997). Discriminating clear-sky from cloud with MODIS: Algorithm Theoretical Basis Document, Version 3.2.
- Asrar, G., M. Fuchs, E. T. Kanemasu, and J. L. Hatfield (1984). Estimating absorbed photosynthetically active radiation and leaf area index from spectral reflectance in wheat. *Agron. J.*, 76:300-306.
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