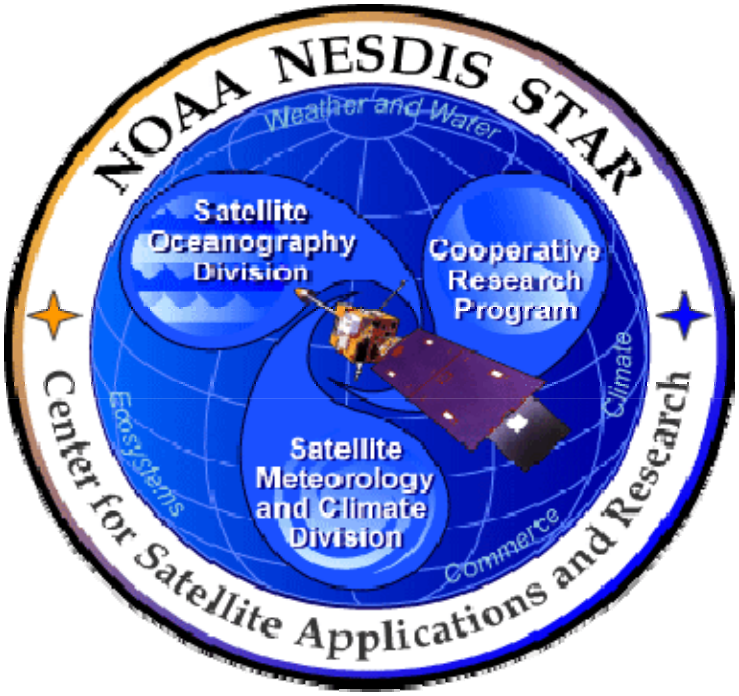


# NOAA NESDIS
# CENTER for SATELLITE APPLICATIONS and RESEARCH

# DOCUMENT GUIDELINE

## DG-6.3
## VERIFICATION AND VALIDATION PLAN GUIDELINE

## Version 3.0

TITLE: DG-6.3: VERIFICATION AND VALIDATION PLAN GUIDELINE VERSION 3.0


AUTHORS:

Ken Jensen (Raytheon Information Solutions)


VERIFICATION AND VALIDATION PLAN DOCUMENT GUIDELINE
VERSION HISTORY SUMMARY

| Version | Description | Revised Sections | Date |
|---|---|---|---|
| 1.0 | No version 1.0. | | |
| 2.0 | New Document Guideline (DG-9.4) adapted from CMMI guidelines by Ken Jensen (Raytheon Information Solutions) | New Document | 10/12/2007 |
| 3.0 | Renamed DG-6.3 and revised by Ken Jensen (RIS) for version 3 | | 10/1/2009 |
| | | | |

# TABLE OF CONTENTS

## LIST OF ACRONYMS

| | |
|---|---|
| CDR | Critical Design Review |
| 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 |
| CTR | Code Test Review |
| DG | Document Guideline |
| DPP | Development Project Plan |
| EPL | Enterprise Product Lifecycle |
| NESDIS | National Environmental Satellite, Data, and Information Service |
| NOAA | National Oceanic and Atmospheric Administration |
| OCD | Operations Concept Document |
| PAR | Process Asset Repository |
| PDR | Preliminary Design Review |
| PG | Process Guideline |
| PRG | Peer Review Guideline |
| PRR | Project Requirements Review |
| QA | Quality Assurance |
| RAD | Requirements Allocation Document |
| SG | Stakeholder Guideline |
| SPSRB | Satellite Products and Services Review Board |
| STAR | Center for Satellite Applications and Research |
| SWA | Software Architecture Document |
| TD | Training Document |
| TG | Task Guideline |
| TRR | Test Readiness Review |
| VCRM | Verification Cross Reference Matrix |
| VVP | Verification and Validation Plan |
| VVR | Verification and Validation Report |

## 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 Verification and Validation Plan (VVP) is one component of this process.

### 1.1. Objective

The objective of this Document Guideline (DG) is to provide STAR standards for the VVP. The intended users of this DG are the personnel assigned by the Project Lead to the task of creating a VVP for the project.

### 1.2. The 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.

Three versions of the VVP are produced during the Design phase of the STAR Enterprise Product Lifecycle (EPL)[1].

VVP v1r0, produced for the Project Requirements Review (PRR)[2], should include the plans for verification of work products, validation of requirements, and validation of products at the level of maturity of the requirements and requirements allocations that are documented in the project's Requirements Allocation Document (RAD) v1r0.

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

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

VVP v1r1 is a planned revision for the Preliminary Design Review (PDR). It adds to v1r0 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 PRR, as documented in RAD v1r1 and the project's Software Architecture Document (SWA) v2r0.

VVP v1r2 is a planned revision for the Critical Design Review (CDR). It adds to v1r1 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 RAD v1r2 and SWA v2r1.

Two additional versions of the VVP are produced during the Build phase of the STAR EPL.

VVP v1r3 is a planned revision for the Test Readiness Review (TRR). It adds to v1r2 by updating the listing and description of verification and validation items and plans, based on the development of the plan for unit testing.

VVP v1r4 is a planned revision for the Code Test Review (TRR). It adds to v1r3 by updating the listing and description of verification and validation items and plans, based on the development of the plan for system testing.

A separate VVP is produced for each distinct project in the STAR Enterprise.

The intended target audiences are customers, product users, requirements reviewers, design reviewers and project managers. Typically, the VVP is prepared by the project's development team, under the direction of the Project Lead and in consultation with quality assurance (QA) personnel and the primary customers and users.

The VVP should be developed as a Microsoft Word document. Upon approval, the approved version of the VVP 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 VVP. This DG has been adapted from Capability Maturity Model Integration (CMMI) guidelines (CMMI-DEV-v1.2, 2006). It has been tailored to fit the STAR EPL process.

### 1.4. Benefits

A VVP developed in accordance with the standards in this DG assists the development team to provide necessary quality assurance of the products and product components. It is therefore a requirement that a VVP be developed in accordance with the guidelines in this document. The VVP will be reviewed at the PRR, PDR and CDR to determine whether a project proceeds to the next step of the STAR EPL.

### 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 |
| Appendix A | - | Examples |
| 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-6: Project Requirements Review Guidelines** are the guidelines for the PRR. It is useful for the developer of VVP v1.0 to understand what the reviewers will expect when reviewing the VVP.

**CL-6: Project Requirements Review Check List** is the check list for the PRR. It is useful for the developer of VVP v1.0 to understand the specific Check List Items (CLI) that the reviewers of the VVP will be required to approve.

**PRG-7: Preliminary Design Review Guidelines** are the guidelines for the PDR. It is useful for the developer of VVP v1.1 to understand what the reviewers will expect when reviewing the VVP.

**CL-7: Preliminary Design Review Check List** is the check list for the PDR. It is useful for the developer of VVP v1.1 to understand the specific CLI that the reviewers of the VVP will be required to approve.

**PRG-8.1: Critical Design Review Guidelines** are the guidelines for the CDR. It is useful for the developer of VVP v1.2 to understand what the reviewers will expect when reviewing the VVP.

**CL-8.1: Critical Design Review Check List** is the check list for the CDR. It is useful for the developer of VVP v1.2 to understand the specific CLI that the reviewers of the VVP will be required to approve.

**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

**DG-11.4: Verification and Validation Report Guideline** is a STAR EPL Document Guideline (DG) that provides STAR standards for the Verification and Validation Report (VVR).

**SG-15: STAR EPL Development Tester Guidelines** provides a description of standard tasks for Development Testers, including development of the VVP.

**TG-6: STAR EPL Project Requirements Task Guidelines** provides a description of standard tasks for process step 6, during which VVP v1.0 is developed.

**TG-7: STAR EPL Preliminary Design Task Guidelines** provides a description of standard tasks for process step 7, during which VVP v1.1 is developed.

**TG-8: STAR EPL Detailed Design Task Guidelines** provides a description of standard tasks for process step 8, during which VVP v1.2 is developed.

**TG-9: STAR EPL Code Development and Test Task Guidelines** provides a description of standard tasks for process step 9, during which VVP v1.3 is developed.

**TG-10: STAR EPL Code Test and Refinement Task Guidelines** provides a description of standard tasks for process step 10, during which VVP v1.4 is developed.

## 3. STANDARD TABLE OF CONTENTS

## 4. SECTION GUIDELINES

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

The VVP 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., Verification and Validation Plan) should be given an acronym (e.g., VVP) 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 – Introduction

The VVP shall include an Introduction Section. This section shall include

- A well-defined purpose and function for the document
- Specific intended user(s)
- How the intended user(s) should use the document
- A responsible entity for generating the document
- A responsible entity for review/approval of the document
- A responsible entity for storage, accessibility, and dissemination
- A brief overview of the contents of each main section

### 4.6. Section 2 – Verification

Verification is the formal process of confirming that the requirements specified for a specific product or system are satisfied by the completed product or system.

Describe the plan for the verification of work products. Subsections should include Verification Overview, Verification Items, Verification Methods, Verification Activities, and Verification Risks.

- The subsection for Verification Overview should define verification and explain the role of verification of work products in providing product quality assurance (QA).
- The subsection for Verification Items should identify all work products that have been selected for verification. These items should be part of the system architecture.
    - Work products are selected based on their potential contribution to meeting project objectives and requirements, and to addressing project risks. In addition to work products created during the implementation of the solutions and design, the work products to be verified may include those associated with maintenance, training and support services. Refer to the project's Operations Concept Document (OCD) for an identification of the latter.
    - All software work products should be selected. All software work products should be in the software architecture, as documented in the project's Software Architecture Document (SWA).
    - The list of identified work products should grow as solutions and design matures. The list may also change (work products added or deleted) as a result of peer review recommendations and actions (e.g., PRR, PDR, CDR, TRR, CTR).
    - Identify the requirements to be satisfied by each work product selected for verification, consistent with the requirements documented in the RAD. This is essential, as it is the requirements on the work products that are to be verified. Without requirements and requirements allocation, there is no basis for verification. The requirements to be satisfied for selected work products are derived requirements. They should be consistently documented in the VVP and the RAD. These requirements are typically developed after PRR and are documented in RAD revisions. The VVP developers must consult with the RAD developers throughout the Design and Build phases of the STAR EPL to ensure that requirements, requirements allocation and verification plan are consistent as the solution and design matures.
- The subsection for Verification Methods should describe the verification methods that will be used for each selected work product.

- The verification methods should be developed concurrently and iteratively with the product and product-component designs. The standard methods include analysis, demonstration, inspection, and test.
- The verification methods should be described in as much detail as possible and a rationale for their selection should be provided. Tailoring of verification methods for a project's individual needs is permitted. In that case, a tailoring rationale should be included.
- Note which verification items will be verified with each method or combination of methods. Create a Verification Cross Reference Matrix (VCRM) that relates each Verification Item to the method or methods planned for its verification. Demonstrate that the methods selected for verification of a given item will address the requirements to be verified for that item.

- The subsection for Verification Activities should describe all functions (i.e. tasks, actions and activities) planned for the verification of each of the verification items. These should be described in as much detail as possible. It is expected that the description will become more detailed as the design matures.
  - Place the verification activities in the context of the project plan, as documented in the project's Development Project Plan (DPP). Identify roles and responsibilities. Identify the process steps during which items will be verified and the reviews at which the verification will be evaluated. Make allowances for the possible need for re-verification of an item due to rework on that item or on related items that have interfaces with the item.
  - The subsection can be organized item by item. Alternatively, items that will be verified in a group by a common set of activities can be organized activity by activity.
- The subsection for Verification Risks should identify and evaluate risks to successful verification of the selected work products. The risks documented in this subsection will be reviewed and possible actions generated at PRR, PDR, CDR, TRR and CTR. Each revision of the VVP should update the status of risks that were documented in the previous VVP version.

### 4.7. Section 3 – Validation

Validation is a process of evaluation, integration, and test activities conducted to ensure that the final developed system satisfies the user's mission requirements.

Describe the validation plan. Subsections should include Validation Overview, Validation Environments, Validation of Requirements, Validation of Operator Needs, Validation of User Needs, Validation of Products, and Validation Documentation.

- The subsection for Validation Overview should define validation, explain the basic principles of validation, and explain the role of validation of requirements, operator needs, user needs and products in providing process and product QA.
- The subsection for Validation Environments should describe the environments planned for product validation. There should be subsections for Pre-Launch and Post-Launch.
    - The subsection for Pre-Launch should describe the pre-launch validation environments. Pre-launch validation is typically focused on requirements, needs and beta testing of products in pre-operational environments, often with the use of simulated and/or proxy sources of truth data.
    - The subsection for Post-Launch should describe the post-launch validation environments. Post-launch validation is typically focused on testing of operational products, often with the use of external in situ sources of truth data obtained by field campaigns.
- The subsection for Validation of Requirements should describe the plan for validating the requirements. Requirements validation is concerned with ensuring that the requirements and requirements allocation provide a satisfactory balance between customer/user needs and expectations, NESDIS mission goals, technical feasibility, the available resources and external constraints.
    - Basic requirements are validated by a demonstration that a balance has been established between customer/user needs and expectations, and constraints on the production, distribution and performance of products.
    - Derived requirements are validated by a demonstration that they are the best set of requirements to satisfy the basic requirements.
    - Requirements allocations are validated by a demonstration that the solution and design provides a feasible, satisfactory implementation for meeting the requirements.
    - The plan can be a general plan that applies to all requirements and can also include specific activities that are pertinent to specific sets of requirements. These should be explicitly noted.

  - It is important for the VVP developers to consult with the RAD developers to ensure that the plan for validation of requirements is consistent with the current version of the requirements and requirements allocation.

- The subsection for Validation of Operator Needs should describe the plan for ensuring that the operations and maintenance requirements, as documented in the project's RAD, are properly derived from operator needs that are documented in the project's OCD. This is a subset of general requirements validation that is documented in its own subsection to assist operations and maintenance personnel in focusing on the requirements specific to their needs.
- The subsection for Validation of User Needs should describe the plan for ensuring that the product performance, delivery and support requirements, as documented in the project's RAD, are properly derived from customer/user needs that are documented in the project's OCD. This is a subset of general requirements validation that is documented in its own subsection to customers and users in focusing on the requirements specific to their needs.
- The subsection for Validation of Products should consist of separate and distinct subsections for the validation of each distinct product in the project's product processing system. Each "Validation of <Product N>" subsection should contain subsections for Product Description, Product Requirements, Validation Plan, Capabilities and Resources, and Risks.
  - The subsection for Product Description should describe the content and intended use of the product in as much detail as possible. If the product consists of a set of distinct product components, each of these should be described. The VVP developer should use the project's OCD as a source of information and should ensure that the description in this subsection is consistent with the OCD. It is permissible, even encouraged, to adopt material from the OCD
  - The subsection for Product Requirements should itemize the product requirements. These should be documented as basic or derived requirements in the RAD. The VVP developer should use the project's RAD as a source of information and should ensure that the description in this subsection is consistent with the RAD.
  - The subsection for Validation Plan should describe the plan for the validation of the product requirements.
    - For each product component, the scope of the validation (e.g., operational behavior, maintenance, training, and user interface) should be described. The product or product component must be maintainable

and supportable in its intended operational environment. Address the validation of the actual maintenance, training, and support services that may be delivered along with the product.

- For each product component, the plan for validating product performance requirements should be described. Identify error sources to be tested (e.g. calibration, sensor noise). Identify and justify stratifications to be tested, including typical and stressing conditions. Identify test data sets that span the stratifications. Describe all assumptions that have been made concerning performance estimation. To the extent possible, the potential for degraded performance should be explored, along with mitigating strategies.

- The subsection for Capabilities and Resources should describe the hardware, software, personnel and budget resources that will be needed to implement the validation plan. Address internal and external resources. Identify agreements, contracts, memoranda of understanding, etc. that will be needed to acquire the external resources. Distinguish between pre-launch and post-launch plans. Place all of this in the context of the project plan and schedule to the extent possible.
- The subsection for Risks should identify and evaluate risks to successful validation of the product. Refer to the product requirements to ensure that issues affecting validation of the product and its components are identified and evaluated. The risks documented in this subsection will be reviewed and possible actions generated at PRR, PDR, CDR, TRR, and CTR. Each revision of the VVP should update the status of risks that were documented in the previous VVP version.

- The subsection for Validation Documentation should explain how the validation of requirements, operator needs, user needs and products will be documented in the project's VVR. STAR EPL process asset DG-11.4 provides guidelines for the VVR. Identify personnel who have been tasked with creating, presenting and reviewing the validation sections of the VVR. Place VVR activities in the context of the project plan, as documented in the project's DPP.

### 4.8. Section 4 – 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 Product Team. References should

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.

## APPENDIX A - EXAMPLES

An example of a VVP that follows the STAR standards and guidelines will be developed and placed in the STAR EPL PAR.

## APPENDIX B - TEMPLATES

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

### 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>
## VERIFICATION AND VALIDATION PLAN
## Version <X>

### 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

VERIFICATION AND VALIDATION PLAN
Version: <X>
Date: <Date of Latest Signature Approval>

<Project Name>
Verification and Validation Plan

Page <Y> of <Z>

### B.3 Document Cover Page Footer Template:

Hardcopy Uncontrolled

### B.4 Document Footer Template:




Hardcopy Uncontrolled

### 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> VERIFICATION AND VALIDATION PLAN VERSION <X>

AUTHORS:

<Lead Author>

<Co-Author 1>

<Co-Author 2>

<etc.>

APPROVAL SIGNATURES:

_____ <Actual Signature Date>
<Name of Project Development Lead> Date
Project Development Lead

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

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

### B.6 Version History Page Template:

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

<PROJECT NAME>
VERIFICATION AND VALIDATION PLAN
VERSION HISTORY SUMMARY

| Version | Description | Revised Sections | Date |
|---|---|---|---|
| 1.0 | Created by <Name of Developer(s)> of <Name of Developers' Agency/Company> for Project Requirements Review. | New Document | <Actual date of Latest approval signature> |
| 1.1 | Revised by <Name of Developer(s)> of <Name of Developers' Agency/Company> for Preliminary Design Review | <applicable sections> | <Actual date of Latest approval signature> |
| 1.2 | Revised by <Name of Developer(s)> of <Name of Developers' Agency/Company> for Critical Design Review | <applicable sections> | <Actual date of Latest approval signature> |
| 2.0 | Revised by <Name of Developer(s)> of <Name of Developers' Agency/Company> for System Readiness Review | <applicable sections> | <Actual date of Latest approval signature> |
| 2.1 | [As needed] Revised by <Name of Developer(s)> of <Name of Developers' Agency/Company> to describe changes during operations | <applicable sections> | <Actual date of Latest approval signature> |
| 2.2 | Ditto | Ditto | Ditto |
| etc. | | | |

### 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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END OF DOCUMENT