NEON CONFIGURATION MANAGEMENT PLAN (CMP)

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See configuration management system for approval history.

The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by Battelle. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	05/15/2009	NEON.MGMT.NPR.000047.CRE	Initial Release of the NEON CMP
A.1	07/23/2009		Changes per PDR
B	09/22/2009	NEON.MGMT.NPR.000084.CRE	Approval of submitted changes
C_DRAFT	3/01/2011	EC0-00280	Page 1 – 21 Revised to be in line with the new Configuration Management System (CMS) and added Hardware CM. Tracked changes version of this document is available in the CMS. NSF Pre Con version.
C1_DRAFT	10/11/2011	ECO-00288	Update document to new document numbers/template throughout the document.
D	07/16/2012	ECO-00327	Major update / rewrite of CMP to be in line with ANSI-EIA-STD-649-B_Configuration Management Standard. Tracked changes version of this document is available in Oracle Agile PLM.
E	10/15/2015	ECO-03371	Major update/rewrite to make the CM Plan comprehensive and consistent with ANSI/EIA-649-B and feedback from NSF.
F	10/16/2015	ECO-3379	Correction to NSF CR Criteria
G	11/14/2016	ECO-04315	Overhaul of entire CMP, update the PCCB process
H	04/06/2017	ECO-04610	Updates to Figure 5: NEON Assembly Numbering Schema, includes mention of CVAL documentation

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1 DESCRIPTION

This is the Configuration Management Plan (CMP) for the National Ecological Observatory Network (NEON), a program solely sponsored by the National Science Foundation (NSF) and managed under cooperative agreement by Battelle. NEON is a continental-scale ecological observatory consisting of physical ecological measurement sites located across the continental United States including Puerto Rico, Alaska and Hawaii. In addition, NEON has observers on the ground and assets that can be requested by the research community including airborne remote sensing and mobile measurement platforms. Ecological data is sent from the sites to a central data processing and publishing location. The anticipated operational life of the system is 30 years. More information on the observatory design can be found in The NEON Observatory Design.

1.1 Purpose

The purpose of NEON's CMP is to define how configuration management (CM) is implemented to support all stages of the NEON program life cycle. When effectively applied, CM facilitates orderly management of product configuration information and product baseline changes to enable capability revisions, improve reliability and maintainability, extend life, reduce cost, reduce risk and liability, as well as to correct defects. The CMP is consistent with ANSI/EIA-649-B National Consensus Standard for Configuration Management [CM].

ANSI/EIA-649-B describes the following benefits of CM from an industry view as:

- Measurable performance parameters are provided.
- Decisions are based on correct, current information.
- Production repeatability is enhanced.
- The application data (such as for procurement, design or servicing the product) is accessible, avoiding guesswork and trial and error.
- Downstream surprises are avoided.
- Cost and schedule savings are realized.
- Costly errors of ad hoc, erratic change management are avoided.

1.2 Scope

This CMP applies to all NEON subsystems and organizations involved with the development and implementation of the scientific capabilities of NEON, including their associated documentation, hardware and software. This CMP describes the necessary elements of CM and references lower level CM documents, protocols and procedures where appropriate and defines a methodology for NEON to manage and control product configuration. As defined in the ANSI/EIA-649-B, "CM is a comprehensive process for maintaining consistency of any product's performance, functional and physical attributes

with its requirements, design, and operational information." This CMP describes the five elements of CM as they apply to NEON in sections 3-7:

- CM Planning and Administration – A description of CM in regards to the NEON program organization members and their roles and responsibilities within the configuration management process.
- Configuration Identification (CI) – The basis from which the configuration of products are defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's lifecycle.
- Configuration Change Management (CCM) – This function includes managing both changes to and variances from the approved product configuration information for a product, using a systematic, measurable process. The configuration change management function applies to all types of products and all Life Cycle stages.
- Configuration Status Accounting (CSA) – Provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle.
- Configuration Verification & Audit (CV&A) – Review of processes, product definition information, documented verification of compliance with requirements, and an inspection of products, to confirm that products have achieved their required attributes and conforms to released product configuration definition information.

As illustrated in ANSI/EIA-649-B, configuration management implementation requires a balanced and consistent application of the CM functions and their underlying principles throughout the product life cycle. Figure 1 pictorially shows how the five CM functions and principles inter-relate when all elements are consistently implemented and applied.

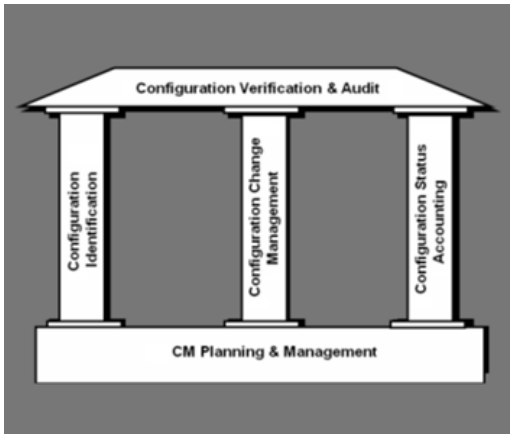

Figure 1: ANSI/EIA 649-B Functions

1.2.1 Order of Precedence

Nothing in this document supersedes applicable laws, regulations, and instructions referenced in Section 2 unless a specific waiver or exemption has been obtained.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

AD[01]	NEON.DOC.004200: NEON Systems Engineering Management Plan
AD[02]	NEON.DOC.001052: NEON Acceptance Plan
AD[03]	NEON.DOC.000239: NEON Requirements Management Plan
AD[04]	NEON.DOC.000001: NEON Observatory Design

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

RD[01]	NEON.DOC.000008	NEON Acronym List
RD[02]	NEON.DOC.000243	NEON Glossary of Terms
RD[03]	NEON.DOC.003005	NEON Software Configuration Management Plan
RD[04]	NEON.DOC.002767 NEON.DOC.002768	AIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline TIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
RD[05]	NEON.DOC.003051	NEON Change Request - Template
RD[06]	NEON.DOC.003326	NEON Scope Plan
RD[07]	NEON.DOC.003329	Engineering Product Team Software Release and Configuration Control Procedure
RD[08]	NEON.DOC.002651	NEON Data Product Numbering Convention
RD[09]	NEON.DOC.003311	NEON Data Products Development Plan

2.2.1 External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	ANSI/EIA-649-B Configuration Management Standard, April 2011
ER [02]	
ER [03]	

2.2.2 Acronyms

CCB	Change Control Board
CI	Configured Item
CM	Configuration Management or Configuration Managed
CMP	Configuration Management Plan
CMS	Configuration Management System
COTS	Commercial Off The Shelf
CR	Change Request against the Performance Measurement Baseline (PMB)
DCS	Document Control Specialist, aka “Change Analyst”
DFMEA	Design Failure Modes Effects and Analysis
ECO	Enterprise Change Order
ECR	Enterprise Change Request
HR	Human Resources
IPT	Integrated Product Team
NSF	National Science Foundation
PCCB	Program Change Control Board
PHA	Preliminary Hazards Analysis
PM	Program Manager
PMCS	Program Management Control System
RMB	Risk Management Board
RMS	Requirements Management System
SE	Systems Engineer

2.2.3 Definitions

Applicable Documents: Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations.

As-Built Configuration Management System: System used to document and maintain the current as built configuration

Baseline: Baseline as used in this plan is the identification of significant states within the revision history of a document, hardware or software Configuration Item (CM Item).

Change Control Board: A group comprised of technical and administrative representatives who review and approve or disapprove changes and variances to a configuration managed product and its supporting documentation.

Configuration Audit: Review of processes, product definition information, documented verification of compliance with requirements, and an inspection of products, to confirm that products have achieved their required attributes and conform to released product configuration definition information.

Configuration Change Management: The CM function that ensures changes to and variances from a configuration baseline are properly identified, recorded, evaluated, approved or disapproved, and incorporated and verified as appropriate.

Configuration Control: Configuration Control is the systematic evaluation, coordination, approval or disapproval, and implementation of all changes in the configuration of a CM Item after formal establishment of its configuration identification.

Configuration Identification: The CM function which (1) establishes a structure for products and product configuration information; (2) selects, defines, documents, and baselines product attributes; (3) assigns unique identifiers to each product and product configuration information.

Configuration Item: An aggregation of documentation, hardware, software, firmware or any discrete portion thereof that satisfies an end use function, and is designated for separate configuration management (Example, it has specified requirements, and is a CM item to which the affectivity of changes are addressed). aka "CM Item"

Configuration Management: A technical and management process for establishing and maintaining consistency of a product's functional and physical attributes with its requirements, design and operational information throughout its life.

Configuration Management System: The term "Configuration Management System" (CMS) refers to the software tool used to process, review, and control Configuration Items.

Change Request: A change request is a formal request of change relative to established baselines, i.e. cost, schedule, scope, requirements, design and product baselines. The change management process utilizes various types of change requests as identified in section 5: Configuration Change Management. The program level change request for managing cost, schedule and scope changes are referred to as Change Request (CR) throughout this document.

Configuration Status Accounting: The CM function that formalizes the recording and reporting of the established product configuration information, the status of requested changes, and the implementation of approved changes including changes occurring to products during operation and maintenance.

Configuration Verification and Audit: Verification of requirements and incorporation of approved configuration changes.

Deviation: A Deviation is required when a departure from approved product definition information is needed for a specific number of units of the product or for a specific period of time. A variance may be caused by design errors, manufacturing planning errors, supplier part slippages, production process issues, material recalls and by various other reasons. The Deviation differs from an Enterprise Change Order (ECO) as it does not require change to the configuration definition information it departs from because, upon approval, it is an authorized exception to the configuration information. Deviations

include a description of actions to be taken, a reason for deviating, affected CM items, specific time period and approval signatures.

Document Warehouse: Electronic file location where the latest released configuration controlled documents is stored.

Enterprise Change Request: An Enterprise Change Request (ECR) is used to document proposed changes to the deliverables for review and approval.

Enterprise Change Order: An Enterprise Change Order (ECO) is used to release configuration controlled documents and parts, change the revision or obsolete CM Items in the CMS. The ECO is the means used to document changes. Each ECO has a description and reason for change, affected CM items list, and approval signatures. No CM Item in the CMS can change revision without an ECO.

Fit: The ability of a product to interface or interconnect with, or become an integral part of, another product.

Form: The shape, size, dimensions, and other physically measurable parameters that characterize a product.

Function: The action or actions that a product is designed to perform.

Integrated Product Team (IPT): a standard term used by the NEON Program for the integrated teams, but on implementation may also be called IDTs (deliverables focused), working IPTs (WIPTs), or other name that reflects the focus of the integrated team.

Item: Any object residing in storage considered inventory, examples: nuts & bolts.

Product: A product is defined as the result of a process. The following are generic product categories: Hardware, Software, and Documentation.

Program Change Control Board: The program-level CCB with representatives who review and approve or disapprove changes to the program budget, schedule, and scope baseline (the Performance Measurement Baseline).

Reference Documents: Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document.

Validation: The quality assurance (QA) process of establishing evidence that provides a high degree of assurance that the system meets the end user's needs, requirements, and expectations. – Have we designed the right system?

Verification: The quality control (QC) process that is used to establish whether a system complies with requirements (i.e. regulations, specifications, or conditions) imposed at the beginning of a development phase. – Have we built the system right?

Waiver: A Waiver provides approval of a product or CM Item not built according to the required configuration and specifications. Nominally, Waivers are requested during system integration,

verification and validation, or commissioning activities, where requirements can't be met due to performance or technical issues and provide justification as to why the system specification cannot be met. In most cases there is no relative cost or impact to the overall system and the Waiver is a document trace. However, in some cases impacts may exist and the overall program and CCB must grant approval to move forward with the delivery of the system.

3 CONFIGURATION MANAGEMENT PLANNING AND ADMINISTRATION

Configuration management within NEON is managed by the Configuration Management department, consisting of a Configuration Manager and Configuration Analysts. These individuals have been charged with overseeing all aspects of CM throughout the program life cycle. However, every individual contributor within NEON has CM responsibilities as identified below.

As defined in the ANSI/EIA-649-B, CM planning and administration over the life cycle of a product are essential to achieve an effective, predictable, and repeatable CM process. CM planning focuses on the product and on the customer(s), and it shapes the application of solid, practical procedures that result in cost avoidance and enhanced product quality and stability.

Comprehensive CM planning and administration for the NEON program includes:

- Applying the appropriate level of CM functions throughout the product's life cycle to prevent unauthorized changes to NEON CM Items while expediting the approval of those changes that are necessary or promise significant benefits to end users.
- Implementing policies and procedures, resulting in effective product configuration management
- Assigning CM functional responsibilities to various organizational elements
- Training of CM personnel and any others who have CM responsibilities
- Determining and applying adequate resources (i.e. Configuration Management system (CMS))
- Establishing CM performance indicators to serve as a basis for continuous improvement
- Integrating the organization's product configuration information processes

The CMP describes how configuration management is performed by NEON. The subordinate documents, as shown in Figure 2, explains in detail how the integral processes of configuration management are accomplished.

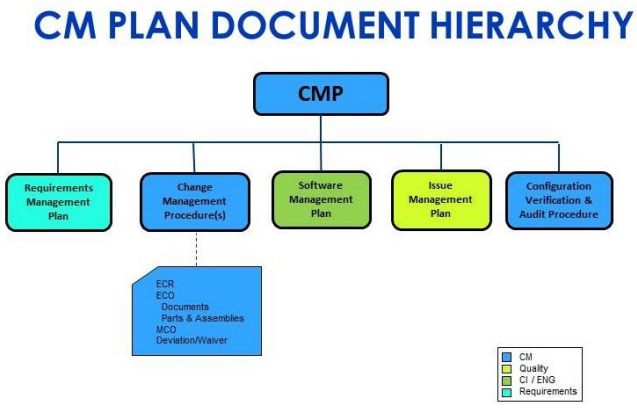

Figure 2: Configuration Management Plan Document Hierarchy

3.1 Responsibility and Authority

All product teams have CM responsibilities related to maintaining accurate configuration control and adhering to configuration management processes and procedures throughout the NEON program life cycle.

3.1.1 National Science Foundation (NSF)

The NSF Cognizant Program Officer is responsible for approving all change requests (CRs) that meet the criteria specified (NSF CR criteria) in accordance with the Cooperative Support Agreement (CSA). Any CR that falls within these criteria must be NSF approved prior to program implementation of the change. The definition of the criteria is provided in section 5, Configuration Change Management: however, in case of conflict, the terms of the CSA take precedence.

The CRs document changes to the program scope baseline, schedule baseline and cost baseline. CRs also document impacts to contingency funds. In accordance with the NSF Large Facility Manual:

- Contingency is established for the MREFC NEON Construction Program.
    - The NSF must approve any change to contingency funds in accordance with the CSA.
    - The NSF receives a summary of changes to the contingency as part of the contingency log, which is included in the monthly MREFC report for the Construction Program.
- No Contingency is established or managed for the R&RA NEON Initial Operations Program.

The NSF may request and review copies of any CR approved by the program, including CRs that do not impact contingency.

3.1.2 Program Manager (PM)

CM responsibilities for the NEON Program Manager (PM) are as follows:

- Full responsibility and accountability for implementation of the configuration management processes and principles defined in the CMP as well as supporting the Configuration Manager in the execution of the configuration management processes and principles.
- Full responsibility for making the final configuration decisions based on recommendations from the PCCB and approval by the NSF as required.
- Chairman of the Program Change Control Board (PCCB). The PM is the final NEON approver of a CR and has override authority over the PCCB recommendations. The PM is ultimately responsible for all CRs and for articulating their importance to the NSF.

3.1.3 Deputy Program/Program Manager (DPM)

CM responsibilities for the NEON Deputy Program Manager (DPM) are as follows:

- Provides support and input to the Systems Engineer and the Configuration Manager in execution of the configuration management processes and principles.
- Facilitates the CR process and the PCCB in a timely manner.
- Convenes the PCCB as necessary to get the CRs reviewed and approved or to review and make decisions on escalated issues, risks and opportunities.
- Submits the CRs requiring NSF approval and follow-up with the NSF on a regular basis to ensure timely feedback from the NSF.
- At the PM's discretion the DPM can chair the PCCB as the DPM is a full member of the PCCB.

3.1.4 Systems Engineering (SE) Lead

The Systems Engineer (SE) provides support and direction to the Configuration Manager in the execution of the configuration management processes and principles. The SE provides specific direction concerning the NEON program configuration items, baselines and change management. Systems Engineering is responsible for the scientific and technical integrity of the program and as such the scientific scope and technical change related CRs. The SE will work with the CR owners on capturing accurate justifications and descriptions in preparation of the CR for the CR process. SE will address requests from the NSF for additional scientific or technical clarifications or justification. The SE will execute controlled science and technical requirements changes for approved scientific and technical scope CRs. The SE is a full member of the PCCB.

3.1.5 Science Lead

The Program Science lead is responsible for the scientific performance of the NEON Program and adherence to scientific requirements derived from the NEON grand challenge questions. The Scientist will work with SE on scientific scope and technical change related CRs and is responsible to consult with external scientific working groups and the STEAC as necessary. The Scientist is responsible for the science organization's adherence to the configuration management processes and principles as defined in the CMP and for addressing science issues with the PCCB.

3.1.6 Engineering Lead

The NEON Engineer Lead is responsible for the technical development, performance and adherence to technical requirements of the NEON program. The Engineer Lead is responsible for the engineering and production organization's adherence to the configuration management processes and principles as defined in the CMP. The Engineering Lead is a full member of the PCCB.

3.1.7 Program Finance and Controls Lead

The Program Finance and Controls Lead is responsible for the PMCS team, and will support the PM, DPM and the Leads in assessing and capturing change impact to the schedule and budget baseline, and help to prepare the CR for the CR process. PMCS is responsible for ensuring budget, cost, and schedule data

included in CRs is accurate and complete. PMCS will execute controlled schedule and budget baseline updates and contingency log updates for approved CRs. The Program Finance and Controls Lead is responsible for the PMCS organization's adherence to the configuration management processes and principles as defined in the CMP. The Lead is a full member of the PCCB.

3.1.8 Data Products Lead

The Data Products Lead is responsible for the technical development, performance and adherence to technical requirements of the NEON Program related to the Data Products and Cyber Infrastructure for the Data Products. The Data Products Lead is responsible for the data product organization's adherence to the configuration management processes and principles as defined in the CMP. The Data Products Lead is a full member of the PCCB.

3.1.9 Quality Lead

The Quality Lead is responsible for development and implementation of Quality Processes, Quality Assurance, Quality Control processes for services, products, and data in construction and for operations. The Quality Lead is accountable for the quality of Configuration Management by ensuring the program is adhering to documented standards and processes, and meeting quality standards for the program and program deliverables. The Quality Lead is a full member of the PCCB.

3.1.10 Initial Operations Lead

The Initial Operations Lead is responsible for oversight of all operations issues and changes proposed for operations. The Lead is responsible for implementing and managing changes to established procedures and protocols, as well as service transition, maturity, and improvements during initial operations. The Lead is responsible for operational configuration changes and elevating changes to the Program Change Control Board (PCCB) for disposition. The Initial Operations Lead is a full member of the PCCB.

3.1.11 NEON Staff and IPT Leads

All NEON staff, including the Program Office Leads and IPT Leads, may propose a CR or initiate an Engineering Change Request (ECR) for subsystems, parts and documentation within their purview. NEON staff and IPT leads are stakeholders for change and advise the PCCB on technical issues based on their individual area of expertise. The IPT Leads are responsible for any CR for their areas and act as the conduit for change recommendations to the PCCB; therefore, CRs generally note an IPT lead as an originator.

The NEON IPT Leads are responsible for identifying issues, threats and opportunities, and escalating them to the PCCB for review and decision as necessary, as well as identifying and justifying a need for change and bringing those change requests to the PCCB.

The CR originator is responsible for generating the content for the CR in collaboration with PMCS and other stakeholders as necessary. The originator is also responsible for working with all stakeholders to make sure the change impact is accurate and understood. The originator is responsible for introducing and representing the CR, ensuring that any issues raised are resolved, and for reworking the CR if requested by the DPM or PCCB. The originator may be requested to present and justify the CR to the PCCB.

3.1.12 Configuration Manager

The NEON Configuration Manager is responsible for the execution of the configuration management processes and principles in accordance with the CMP. The Configuration Manager supports the Program Manager (PM).

Specific responsibilities include:

- Manage the daily activities of the CM Analysts
- Develop and maintain the CMP along with supporting documents and processes
- Train NEON personnel in the CM processes, principles and tools
- Establish and manage the CM Systems
- Manage controlled documents and items
- Facilitate and track the change process by supporting IPTs
    - Verify quality of inputs
    - Escalate issues when/if needed
- Ensure appropriate use of CM Tools and processes
- Manage the Configured Items List
- Perform periodic audits of hardware, software and documentation of configured items to ensure compliance with established process and procedures
- Develop/produce appropriate status accounting reports

3.1.13 Configuration Analysts

The NEON Configuration Analysts (CA) reports to the Configuration Manager. The CA supports NEON staff in the development and progression of changes through closure or implementation.

Specific responsibilities include:

- Support the ECR and ECO processes
- Manage controlled documents and items
- Ensure that the program team is using the CM System as documented
- Ensure adherence to approved templates

- Escalate issues with configured items and CM processes to the Configuration Manager and the SE for timely resolution

3.2 Configuration Tools

Various tools will be used to manage configuration. Table 6-1 identifies the CM tools and their functions.

Table 1: CM Tools and Products

Function	Configuration Tools
Requirements Management	Requirements Management System (RMS): IBM Rationale DOORS
Problem Tracking and Reporting	Issue Management System (IMS): JIRA
Change Management (ECR, ECO, CR)	Configuration Management System (CMS): Oracle Agile PLM
Software Change Management	CI Software CNS: Jazz-RTC Location Controller Software: Subversion (SVN) Grape Software: Subversion (SVN)

3.3 Establish, Implement, and Maintain Procedures

CM procedures contain the detailed steps needed to implement the major CM functions, can be found in the Help section of the CMS.

3.4 CM Training

The goal of CM training is to convey an understanding of CM fundamentals, processes, principles, procedures and tools to the organization. Both formal CM training and on-the-job training, or as-needed training have been tailored to address the needs of the responsible departments, teams and individuals based on their level of involvement in CM activities. CM training on changes to processes, procedures and principles are generally delivered at the program level; IPT, department, team and individual level training is provided as needed. Training materials and events are planned to roll-out as changes are introduced, for example: Introduction of new processes or new tools.

All users of the Configuration Management System (CMS) will be trained prior to being issued an Active license for the CMS. Re-occurring training will occur as-needed based on user change of status or responsibilities. Annual refresher training will be provided.

3.5 Assess Compliance and Effectiveness

The effectiveness of the CM plan, processes, procedures and tools is assessed on an on-going basis to ensure compliance. By monitoring CM functions, improvement opportunities are identified before problems occur. More information on metrics used for evaluating the effectiveness of program CM processes, procedures and tools can be seen in Section 6, Configuration Status Accounting, and Section 7, Configuration Verification and Audit.

3.6 Product Configuration Information Processes

3.6.1 Plan for Data Collection and Information Processing

The various tools outlined in Table 1: CM Tools and Products are used to capture and manage CM-related information throughout the program lifecycle. Due to licensing constraints, not all NEON personnel will have access to the CM tools; instead the latest version of all released configured items will be available to all NEON personnel through the SharePoint Document Warehouse and the Drawing Warehouse. The SharePoint Document Warehouse and the Drawing Warehouse will be synchronized with the CMS on a daily basis. They both have extended search capabilities, making it easy for NEON personnel to locate a configured item.

3.6.2 Plan for Information Status Control

The Configuration Management System (CMS) shall provide information status control. At a minimum, the following status levels shall be used within the CMS for the various change requests discussed in section 5, Configuration Change Management:

- Pending
- Review – of which there may be multiple levels, including stakeholder review and Change Control Board review
- Released

3.6.3 Plan for Information Interoperability and Exchange

To ensure ease of access of CM-related items, a SharePoint Document Warehouse and Drawing Warehouse containing .pdf versions of all released configured items is maintained. Where required, the native file format may be used.

3.6.4 Plan for Preservation of CM-Related Information

CM-related information shall be retained for the life of the program from construction through 30 years of operations. Standard file formats shall be used for the configured items such that readability and accessibility is maintained (examples but not limited to: .doc, .xls, .ppt, .pdf, .vsd). The CMS system shall be backed up according to the documented NEON IT procedures on a daily basis.

4 CONFIGURATION IDENTIFICATION

Configuration Identification is the CM principle that identifies what items are required to be controlled for the organization to be successful. It is the basis from which the configuration of products are defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's lifecycle. As stated in ANSI/EIA-649-B, configuration identification results in:

- Organized composition of the product and associated information
- Defined, documented and baselined product configurations
- Unique identification of products and product configuration information
- Consistency between a product and the information about the product

ANSI/EIA-649-B specifically states "Product definition information is the product of system and design engineering, providing the technical basis for design, development, build, integration, verification, and change actions taken during all product life cycle phases. It describes a product's performance, functional, and physical attributes in such documents as specifications, requirements documents, and design information (drawings, part models, software design documents)."

4.1 Identifying the Enterprise, Products, and Product Configuration Information

To uniquely identify a product of a product configuration item, some or all of the following information is used:

- An Enterprise Identifier providing the source of the Item Identifier (NEON)
- An Item Identifier (Part Number, Software File Name, Document Number)
- A Version Identifier (Revision)
- For certain items, a Unit Identifier (Serial Number)

Additional Configuration identifiers will be applied to support the procurement, production, operations and maintenance processes. Some examples include identifying all parts to be ordered as spare, replacement or accessories (i.e., Field Replaceable Units, or FRUs, and Line Replaceable Units, or LRUs), any parts that have a service life component such as shelf life or a usage limit (i.e., Consumables), or whether the product involves custom fabrication ("MAKE") or is readily available, such as a COTS part ("BUY").

4.1.1 Product Structure

Product Structure is the method for showing the organization of a product and its components. It consists of relationships for the components in a product hierarchy and allows traceability from the lowest level component to the highest end-product. A common means of representing a Product Structure is by a Bill of Materials (BOM) or BOM hierarchy. NEON uses BOM and BOM hierarchies to implement product structure and these are both controlled in the CMS.

The product structure (BOM) supports the understanding the full parts list for ordering activities, and at NEON the BOMs are controlled and released to procurement and production through the CMS. They also serve as a manufacturing guide for developing lower level to higher level assemblies, and they are used as input to develop manufacturing work (assembly) instruction.

4.1.2 Configured Items (CI) versus Non-Configured Item (Non-CI or NCI)

Any item that requires a configuration to be identified and controlled due to its requirements, functionality or product relationship is called a Configured Item (CI). A CI is often serialized and the focus of design reviews. Any item that does not require the full configuration as previously defined is referred to as a Non-Configured Item (Non-CI or NCI). These typically are common items that are considered standard and interchangeable from any supplier, such as screws, nuts, washers, etc. Because Non-CI parts are used in the definition of CI assemblies, Non-CI parts will be identified in the CMS.

A NEON Configured Item meets one or more of the following criteria:

- Scientific: Subsystem, assembly, component or document that produces scientific data
- Engineering: Subsystem, assembly, component or document with requirements driving the design
- Calibration: Subsystem, assembly, or component that requires calibration
- Maintenance: Field Replaceable Unit (FRU) or Line Replaceable Units (LRU)
- Field Operations: Subsystem, assembly, component or document that is used to operate the observatory

Any CI may contain one or more CIs as depicted in the figure below. A CI may also contain one or more Non-CIs. A CI cannot be hierarchically organized within a Non-CI; by definition when a CI is organized within another item that item too becomes a configured item (CI).

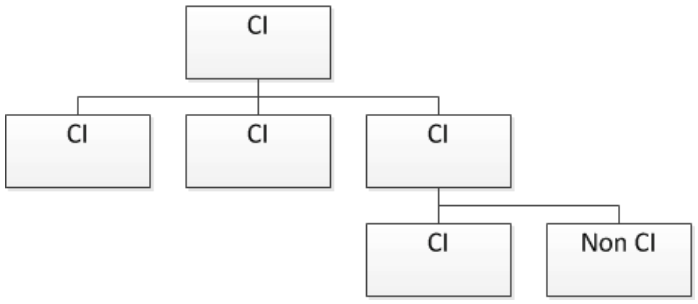

Figure 3: Example of CI at different levels in product tree

4.1.3 Revisions versus New Numbers

A revision represents a change to a document's contents or a modification to a part/assembly such that the part/assembly remains interchangeable with its previous variation. The following decision matrix applies to configuration controlled parts and assemblies in regards to upgrading to a new revision versus assigning a new part number (configuration identifier).

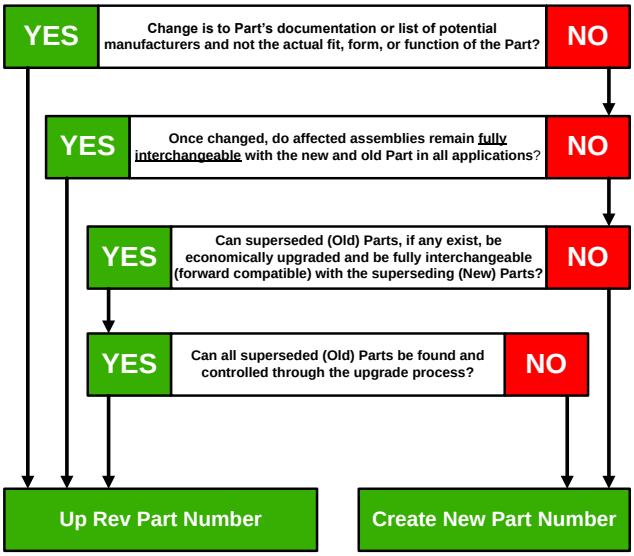

Figure 4: Rules of Interchangeability Decision Matrix

Revisions are communicated using an alpha revision identifier (i.e. A, B, C, etc.). Following standard CM protocol, the following letters shall not be used: I, O, Q, S, X and Z. A Non-CI part will always have a revision of "NCI".

4.1.4 Templates

NEON released templates shall be used to maintain consistency of configured items (documents, drawings, parts, assemblies, etc.) and non-configured items to provide a date. Approved NEON templates are stored in the CM management system as well as the SharePoint Document Warehouse.

4.1.5 Requirements

The NEON requirements form a hierarchical, linked series of objective statements that describe the system and science design. The requirements at the top of the hierarchy are the high-level science requirements that are the foundation of the NEON system and the design concept approved by the National Science Foundation during the Final Design Review process. Subsequent requirements decomposed, or further defined, from the top tier requirements are defined by NEON program subject matter experts sometimes with the aid of external working groups. These requirements form the

specification for the detailed design which is captured in the various forms of documents described in Section 4.2.4. Additional details on NEON requirements and their hierarchy can be found in the NEON Requirements Management Plan AD[03].

4.1.5.1 Requirements Numbering Convention

NEON requirements are uniquely identified with a number that is automatically generated by NEON's Requirements Management System (RMS). The alpha-numeric numbering convention for NEON requirements is as follows:

<Program ID>.<Subsystem>.<Tier>.<automatically generated 4 digit number>

The Program ID is NEON. Some example subsystems are: TIS, TOS, AIS, AOS, MDP, AOP, etc. The requirement tier is the level in the hierarchy to which the requirement is allocated. (Example requirement number: NEON.TIS.4.0001).

4.1.6 Documents

NEON configuration controlled documents are documents associated with the concept development, requirements definition, design, verification, fabrication, construction, deployment, acceptance, commissioning, operations, and maintenance of the NEON system. Some may be delivered to the National Science Foundation (NSF) and made available to the public, and some are internal documents for internal use by NEON personnel.

NEON configuration controlled documents are uniquely identified with an automatically generated document number (by the CMS). The numbering convention for the configuration controlled NEON documents are:

<Program ID>.<DOC>.<automatically generated 6 digit number>

The Program ID for NEON is NEON. (Example document number: NEON.DOC.000004). Each NEON document is further identified with a Revision, date of release and ECO number. Configuration Management maintains work instructions to assist in document creation and versioning within the CMS.

4.1.6.1 Document Naming Convention

A document name (title) should follow the conventions found within the appropriate released template.

4.1.6.2 Document Types

The following table captured the configuration controlled document types at NEON

Table 2: Configuration Managed Document Types

Document Type	Description

Document Type	Description
CAP	Corrective Action Preventive Action
DSN	Design Document
DWG	Drawings (including block diagrams)
FRM	Form / Template
GDL	Guideline / Work Instructions
GEN	General
HBK	Handbook
ICD	Interface Control Document
IDD	Interface Design Document
LIS	Lists
LOC	Locations (includes kmz files, maps, and may include excel spread sheet of lat/longs)
MAN	Manual
MEM	Memorandum (Technical)
NCR	Non Conformance Report
PKG	Package
PLA	Plan
POL	Policy
PRO	Procedure (Standard Operating Procedures and Protocols)
REP	Report
REQ	Requirements / Algorithm Theoretical Basis Documents (ATBD)
RFW	Request for Waiver
SCH	Schematic
SOW	Statement of Work
SPE	Specification (Note: Requirements are inputs to a design, specifications are outputs)
STD	Standards
TCS	Test Case
TSD	Trade Study Document
WID	Workflow Interface Document

4.1.7 Parts & Assemblies (P&A)

Parts and Assemblies are physical items for use in construction, manufacturing, test, operations, calibration, and maintenance. They can be manufactured in-house or procured from outside suppliers and can include COTS material, custom fabricated parts or a combination.

All NEON Parts and Assemblies have unique identifiers as described in the following sections. Some configuration-controlled parts and assemblies will additionally be identified with unique Unit Identifiers (or serial numbers) where there is a need to distinguish one unit of a product from another. Items that have are covered by warranty, are calibrated, or need any other kind of traceability will have these serial numbers associated with them.

4.1.7.1 Parts Numbering Convention

All NEON parts shall be identified by a unique 10 digit number (i.e. SSSSSSKIND) and a revision as documented in Section 4.2.1:

- SSSSSS = Sequential Number (Note: For historical purposes the sequential number begins with 03 for all components)
- KIND:
    - 0000 = Used if only one of a kind.
    - If two or more "KIND" identified, then:
        - 0001 = First of Kind
        - 0002 = Second of Kind
        - 0003+ and so forth

Part "KIND" numbers are used to uniquely identify parts that are similar in characteristics but differ by small variations. For parts with multiple variations, the part "KIND" number is defined in the part documentation which provides a detailed description of the part.

4.1.7.2 Assemblies Numbering Convention

The top-most system and subsystems within the CMS are numbered as follows:

- A011170000: System, NEON, All Designs
- B011170000: Subsystem, NEON, AOP Design
- C011170000: Subsystem, NEON, TIS Design
    - C0ddss0000 (dd = Domain#, ss = 01 (core), 03 (Relocatable #1), 04 (Relocatable #2)
- D011170000: Subsystem, NEON, MDP Design
- E011170000: Subsystem, NEON, TOS Design
- G011170000: Subsystem, NEON, AOS Design
- H011170000: Subsystem, NEON, AIS Design
    - H0ddss0000 (dd = Domain#, ss = 01 (core), 03 (Relocatable #1), 04 (Relocatable #2)

All NEON assemblies shall be identified by a unique 10 character number according to the following figure:

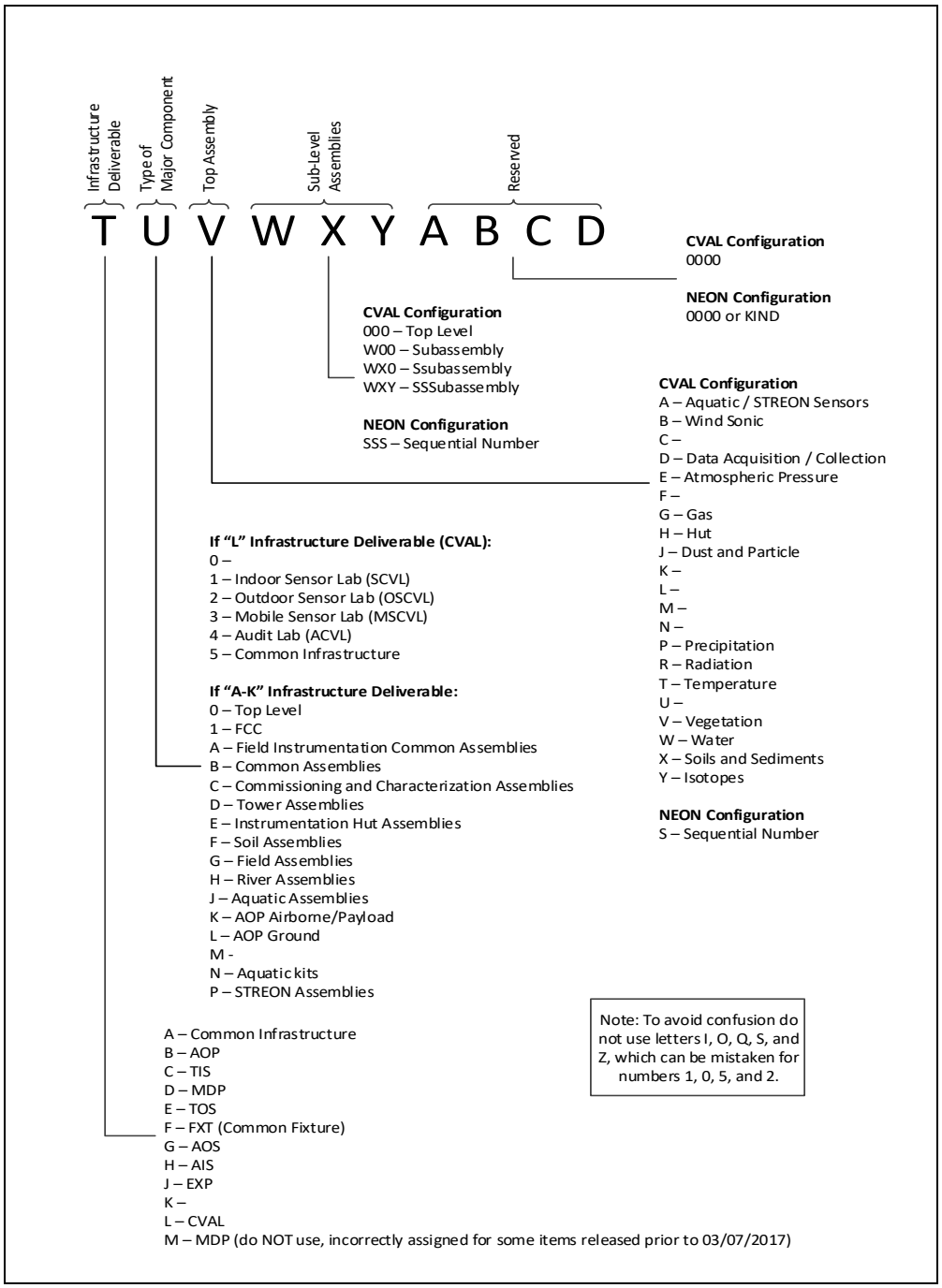

Figure 5: NEON Assembly Numbering Schema

NOTE: CVAL maintains quality control of internal documents for the metrology lab using the conventions outlined in Figure 5: NEON Assembly Numbering Schema

4.1.7.3 P&A Naming Convention

A part or assembly name, as defined in the CMS, shall follow the following convention, with items with asterisks being optional:

<Subclass>, <Physical or Functional Design Description>, <Design Detail #1>, *<Design Detail #2>*,*…*
Examples of this at NEON are "Assembly, Cable, Power Standard Shielded 25'", "Screw, Socket Head Button, 5/16-18, Stainless Steel, 0.625 Inches", and "Subsystem, 2D Wind, Heated, Level 1, Standard".

4.1.7.4 P&A Types – Subclasses and Part Categories

Each configured P&A is categorized with both a subclass and category as listed below:

Table 3: Parts & Assemblies Subclass and Category Options

Subclass:
Assembly
Assembly - Box Build
Assembly - Cable
Assembly - PCBA
Assembly - Site
Bolt
Cable
Camera
Capacitor
Circuit Breaker
Component
Connector / Jumper / Terminal Blocks
Controller
Diode
Enclosure
Fab
Ferrite
Filter
Firmware / Software
Fuse / Fuse Holder
Gasket
Hardware
IC Clock
Inductor / Coil
Integrated Circuit
Label

Subclass:
Nut
PCB
Pneumatic Controller
Power Supply
Regulator, IC
Relay
Resistor
Screw
Sensor
Sensor Accessory
Solenoid
Subsystem
Switch
Tool / Fixture / Equipment
Transducer
Transformer
Transistor
Tube Arrestor
Tubing
Washer / Spacer / Standoff
Wire

Category:
Civil
Electrical
Electro-Mechanical

Subclass:
Lamp
LED
Lens
Metal
Meter

Subclass:
Label
Mechanical
SW/FW
Science
Tool

4.1.8 Software

All NEON software and firmware files are uniquely identified (including category and type) and controlled in the respective CM systems (tools) as identified in Table 1: CM Tools and Products according to the NEON software configuration processes documented in the NEON Software Configuration Management Plan RD[03] and the Engineering PT Software Release and Configuration Control Procedure RD[07]. The software baselines are updated following integration and verification testing prior to the software being released for production. The Software Release naming convention for each build name and snapshot shall be identified in RD[03] and RD[07].

4.1.9 Data Products

All NEON data products are uniquely identified and controlled. They are identified by a data products numbering convention as defined in the NEON Data Product Numbering Convention document RD[08] and a data product name. The data product numbering convention maintains multiple consistent fields across subsystems and processing levels, but has been optimized by subsystem to improve efficiencies. Thus, there are four unique numbering conventions organized as follows:

- Instrument system data products: TIS and AIS
- Observation system data products: TOS and AOS
- Remote sensing data products: AOP
- Level 4 data products

The numbering conventions for the four data product categories are listed below for illustration purposes only; the convention is complex and therefore RD[08] must be referenced for the details:

TIS/AIS Level 0 – Level 3 Data Products: **NEON.DOM.SITE.DPL.PRNUM.REV.TERMS.HOR.VER.TMI**

TOS/AOS Level 0 – Level 3 Data Products: **NEON.DOM.SITE.DPL.PRNUM.REV.TERMS.TAB.SPI.TMI**

AOP Level 1 – Level 3 Data Products: **NEON.DOM.SITE.DPL.PRNUM.REV.TERMS.SPI.TMI.DATE**

Level 4 data products combine lower-level data products through mathematical, statistical, and/or algorithmic means. There are three scales of spatial representation within the Level 4 data products: site-level, AOP-region, and NEON Realm (continental scale). As a consequence, the point-based "site" substring (reflecting the combination of Domain and Site) in the above numbering conventions is modified as follows:

- DOM = D00
- SITE = CONT

Additionally, to organize the production and presentation of the Data Products, NEON has adopted a series of Data Product processing level descriptions that are consistent with national standards; these processing levels (Level 0 through 4) indicate the amount of processing that takes place on measurement/data streams, with "L0" representing raw data and "L4" representing the most derived data products as defined in the NEON Data Products Development Plan RD[09]. This document also defines Data Product maturity levels: Engineering-Grade, Provisional, and Science-Grade.

4.2 Baselines and Configurations

A baseline is an agreed-upon specific list of configured items (CIs) that captures the form, fit and function of the system at a point in time. Baselines temporarily "freeze" the system design to ensure that those developing/building the system are not attempting to build to a continuously changing design. In this way, the baseline forms the foundation of the change management process where the baseline serves as a basis for introducing changes in a controlled and coordinate way. Approved changes are then formally released as part of the next baseline update. Periodic baseline updates and releases are communicated to NEON staff and can be communicated externally to NEON if needed.

A configuration takes into account additional information to the baseline. Individual serial numbers, location information and calibration data are examples of additional information that combined with a baseline form a configuration.

4.2.1 Baselines

The NEON program baselines are as follows: requirements, instrument systems, observation systems, site and data products. The CM staff in conjunction with other NEON team members manages the definition, control, release-frequency and release of NEON's baselines.

Baselines are updated and released internally to NEON personnel via NEON's Intranet with the capability to publish and share externally if needed. Approved minor design changes occurring between baseline releases are added to the published baseline once they are implemented as incremental updates to the baseline. Major design changes, or those that drive significant updated to procurement and production planning, are included as part of the next baseline release.

4.2.1.1 Requirements Baseline

The requirements baseline consists of all system-level and science requirements. Requirements are baselined and released internally to NEON personnel via NEON's Intranet with the capability to publish and share externally if needed. Approved minor requirements changes occurring between baseline releases are added to the published baseline once they are implemented as incremental updates to the baseline. Major requirements changes, or those that drive significant design changes, are included as part of the next baseline release. Minor vs. major requirements changes are further defined in the NEON Requirements Management Plan AD[03].

4.2.1.2 Instrument Systems Baseline

The Instrument Systems (IS) baseline includes the TIS, AIS, MDP and AOP subsystems. At a minimum, each Instrument System Baseline consists of the following design elements:

- Subsystem Design Document
- Subsystem architecture
- Drawings: Mechanical, electrical, pneumatic
- Bill Of Materials (BOMs) within a subsystem product hierarchy
- Interface specifications, interconnection documents, and budgets (power, communications, mass, thermal, space)
- Command, Control and Configuration (C3) documents
- Sensor Type Configuration Definition Document (STCDD) if a sensor is designated as a Data Generating Device (DGD)
- Source code (software)
- Test cases, plans and results
- Reliability and safety analysis documents – DFMEA, PHA
- Preventive Maintenance Plans and Procedures
- Assembly instructions
- Installation procedures
- Production Plans and Manufacturing Quality Plans

4.2.1.3 Observation Systems Baseline

The Observation Systems (OS) baseline includes the TOS and AOS subsystems. At a minimum, each Observation System Baseline consists of all the following design elements:

- Science designs
- Sampling and observation protocols
- Configuration-controlled items/assemblies needed for sample collection
- Site-specific sampling designs

The OS design is baselined annually so the above design elements can be updated and released prior to the start of OS training material development and updates for the upcoming sampling season.

4.2.1.4 Site Baselines

Site Baselines apply to individual sites within NEON (TIS, AIS). At a minimum, a Site Baseline consists of the following elements:

- NEON System architecture
    - Site Configuration definition for each IS site: includes whether a site is Heated/Non-Heated/Extreme Heated, directions of tower booms, number of tower Measurement Levels (ML), etc. for a TIS site and Stream/River/Lake, Streambed Mount type, etc. for and AIS site. Site configuration information does not exist for MDP or AOP.
- Various site drawings
- Location Hierarchy Definition Documents (LHDDs)
    - Subsystem Demand by Site/by Unit. This is a mapping of the Configuration to the Architecture to show what types and versions of subsystems are present at each site and in what quantities.

RD[04] contains the information regarding the released AIS and TIS Site Configuration and Subsystem Demand.

4.2.1.5 Data Products Baseline

The NEON Data Products (DPS) baseline applies to all data products and the controlled documents that define the design for the implementation of the data products. It consists of the following elements:

- NEON Data Products Catalog (includes Data Product ID, Data Product Name and brief description)
- Algorithm Theoretical Basis Document (ATBD)
- Ingest and publication workbooks
- Definitional data
- Processing Description documents (unique to AOP data products)

4.2.2 As-Built Configuration

The As-Built Configuration consists of the delivered version of the Site baseline and the associated individual sensors installed at each site (TIS, AIS). The As-Built Configuration is unique for each site and may include approved waivers. The initial site configuration and details related to each site installation are documented and reviewed in the Initial Operational Capability Review (IOCR). The As-Built Configuration contains the following information and should be up-to-date at any given moment:

- AIS and TIS: Specific hardware listings of serial numbers, part numbers, specific versions of component software, any associated variances, sensor location information, diagrams, etc.
- OS: Specific protocols and procedures as well as any associated variances, etc.

5 CONFIGURATION CHANGE MANAGEMENT

Configuration Change Management (CCM) is the CM principle that implements processes to control changes to configuration items (CIs). This function includes managing both changes to and variances from the approved product configuration information for a product, using a systematic, measurable process. The configuration change management function applies to all types of products and all Life Cycle stages

The configuration change management process includes:

- Identifying the need for a change or a variance
- Defining and documenting impacts of the proposed change or variance
- Evaluating the proposed change or variance and coordinating it through the approval or disapproval decision
- Incorporating the change in the product and its related product configuration information
- Verifying that the change has been incorporated and that the product is consistent with the product configuration information
- Capturing change and variance information for the product in the configuration status accounting system
- Completing any required follow-up study to identify and correct conditions that led to a need for a variance

5.1 Manage Requests for Changes

For NEON, Configuration Change Management is implemented through several processes and working groups ranging from Requestors, Originators, Reviewers/Stakeholders, the Integrated Product Teams, Change Management Boards, and the Program Change Control Board (PCCB). The goal is to delegate decision-making authority to the lowest level possible that can accomplish organizational objectives expeditiously, but without significant risks. NEON Configuration Change Management is implemented in all of the baselines previously identified in Section 4 throughout the life cycle of the configured item.

If a change is not approved, the board or IPT may decide to implement a Waiver to allow the use of material or software as-is for the remainder of deliveries, or may issue a Deviation to authorize the use of only a specific batch or release. The following sections provide an overview of the change management process, and describe the different types of change requests, their governing processes and their disposition. The change management process implements a decision tree that dispositions a change request according to three (3) criteria:

1. Change Impact Criteria: Is form, fit or function affected?
2. PCCB Review Criteria:
    - Cost Impact: +/- $35K in aggregate
    - Schedule Impact

- More than 30 calendar days (1 month) impact to an IOCR date.
- More than 5 days variance to the last Transition to Ops date package to the NSF (construction closeout may be impacted)
- Operational collections fall outside planned metrics by 10%

- Any Scope Change
- Site becomes inoperable
- Unplanned data outage exceeding 2 weeks

3. NSF CR Approval Criteria: - Pending NSF Battelle CA/CSAs
   - Requests for use of cost contingency exceeding $150,000
   - Any scientific or construction scope change
   - Construction closeout date is impacted

Depending on the decisions, the change request will be processed by one or more of the change management processes shown in the figure below. The purpose and application of each of these processes are further discussed in the subsections below.

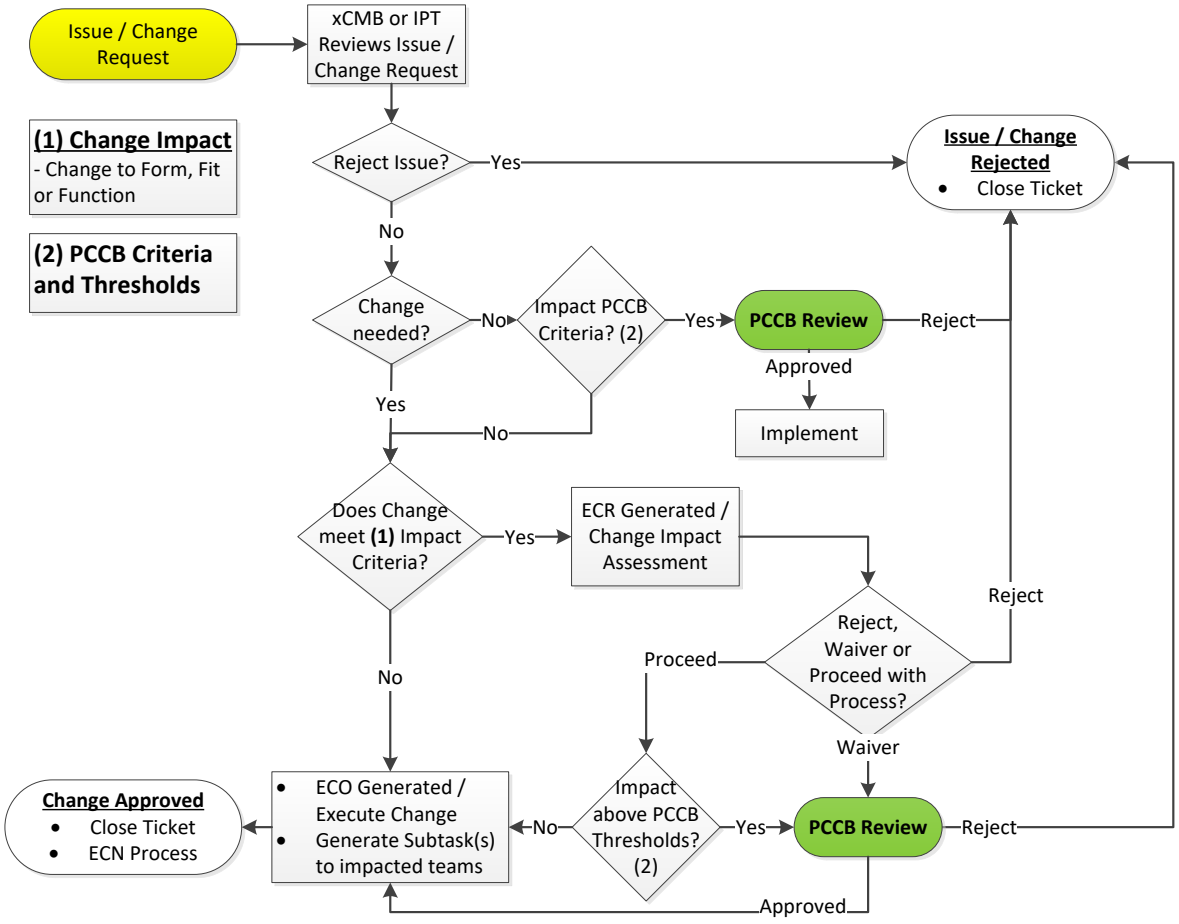

Figure 6: Change Management Process Flow

5.1.1 Program Change Control Board (PCCB)

The Program Change Request (CR) process is a key configuration change management process that is applied to manage cost and schedule changes to the program performance baseline (schedule and budget) as well as changes to the scientific and construction (technical) scope of the NEON Program. Changes to the performance baseline are managed by the PCCB.

5.1.1.1 PCCB Charter

The PCCB:

- Reviews and approves all changes requested related to the program baseline: technical scope, cost, and schedule.
- Manages and coordinates all change requests presented to the NSF in accordance with the CSA(s) established reporting thresholds for cost, schedule, and technical scope.
- Manages and approves all liens against contingency and contingency draws or returns.
- Addresses NEON Construction vs NEON Operations issues, and ensures work is completed against the appropriate scope, budget, and schedule.
- Designates the IPT level of authority for change approvals.

Anyone can propose a CR, including change boards, PMO, PMCS, NEON Team Leads, or other employees. However, IPT leads are responsible for any CR for their areas and, as such, ensure the originator and information is correct.

Changes to the program baseline include:

- Approved schedule impact CRs may impact contingency and will result in updates to the schedule baseline.
- Approved budget impact CRs will result in contingency updates and will be reflected in the NEON budget baseline and recorded in the Contingency Log.
- Approved scope changes will result in updates to the NEON baseline and may include the requirements baseline, baseline and product baseline.

Once it is determined that a CR is required, the CR process will be entered. The Program Change Control Board (PCCB) is responsible for reviewing CRs and their change impact against the program schedule and budget baseline and the program contingency as well as reviewing the merit and justification for scientific and construction scope changes.

The PCCB membership is responsible for providing the PM a recommendation for the dispositioning of a CR, but the PM retains full authority for final disposition.

5.1.1.2 PCCB Membership

PCCB membership includes:

- Program Manager – Chair
- Deputy PM – Facilitator, CR Manager
- Program Finance and Controls
- Engineering
- Data Products
- Quality
- Initial Operations
- Science
- Systems Engineering

Additional members or CR signatories may be added as needed/appropriate for specific changes.

5.1.1.3 PCCB Run Rules

The Run Rules for the PCCB are established by the Program Manager. These include:

- Delegates are allowed, when necessary, but must have full authority to act on behalf of the PCCB member.
- PCCB Chair has the authority to make decisions on behalf of any missing member.
- PCCB approval is generally based on majority recommendation; however, the PCCB chair provides final ruling and has full authority to override the recommendation made by the PCCB membership.
- Agenda will be set and distributed 2 working days in advance of the meeting.
- Agenda item requests must be sent at least 3 working days prior to the PCCB, and should be sent to the DPM and admin support. Agenda items should include:
    - Agenda Item title
    - Names of other individuals who need to attend to discuss the item
    - Materials to be presented or discussed, and/or reference to those items in established systems (i.e.,. ECRs, JIRA ticket)
- Additional attendees will be invited, as needed, to address items with the PCCB.
    - Delegates must have full authority to act on behalf of the attendee.
    - Attendees are excused once their item(s) has been addressed.

Decisions will be recorded in the minutes and available within 5 working days.

5.1.2 Enterprise Change Request (ECR)

The NEON Enterprise Change Request (ECR) process is intended to assess specific impacts of potential design changes on individual subsystems, the Observatory as a whole and to the cost and schedule baseline. An approved ECR may result in one or more Enterprise Change Orders (ECOs), which propose specific and well-defined changes to the individual controlled product components involved in an ECR. ECRs may be sent to the PCCB for approval before proceeding. A representative flow is shown in Figure 7: ECR and PCCB Process Flow shown below.

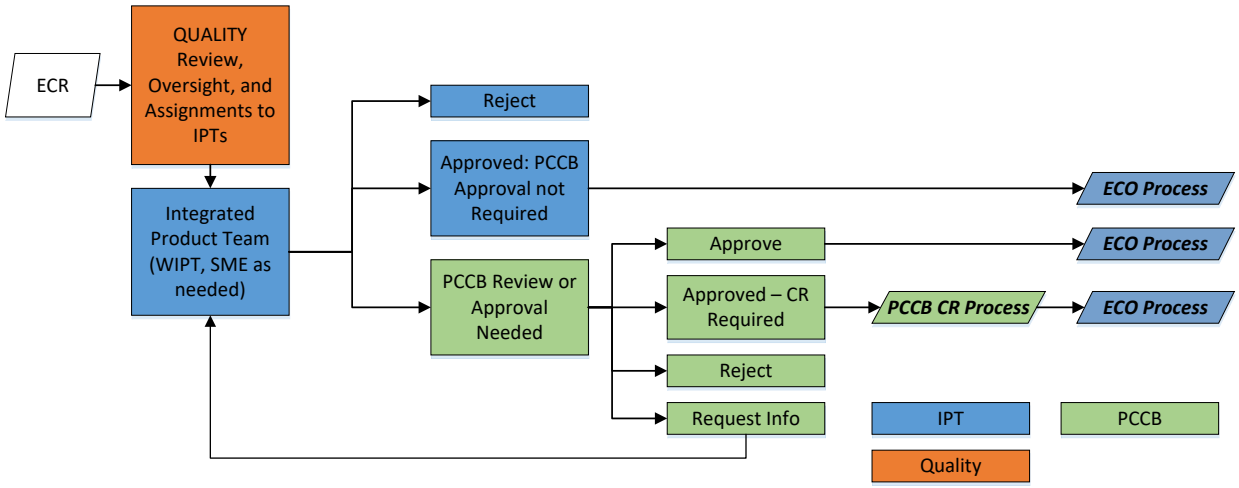

Figure 7: ECR and PCCB Process Flow

5.1.3 Enterprise Change Order (ECO)

The Enterprise Change Order (ECO) is the process used for configuration control of NEON Documents, Parts and Assemblies. Once the ECO is initiated, the process consists of a Stakeholder and CCB review. Once a document is released using the NEON ECO Process, it is officially available for use for procurement, production and field implementation.

5.1.4 Variances (Deviations and Waivers)

If it is necessary to depart from a released product configuration, a Variance is created. A Variance my either be a Deviation or Waiver. The use cases for and differences between a Deviation and Waiver are discussed in the subsections below. Deviations and Waivers may be sent to the PCCB for review and approval based on impact and established thresholds.

5.1.4.1 Deviation

A Deviation is required when a departure from approved product configuration definition information is needed for a specific number of units of the product or for a specific period of time. Information gathered is defined below:

- Deviation Number: 10 Digit Unique ID <DEV>-<automatically generated 6 digit number>
- Variance Basis: Location, Lot, Quantity, and Time
- Cause of Variance
- Corrective Action
- Variance Reason Code: Design Errors, manufacturing planning errors, material recall, production process issues, supplier faults, supplier part shortages
- Effective from and to Dates
- Scope: Lots, Qty, serial numbers (Example: Serial Number range x to y)

5.1.4.2 Waiver

A Waiver provides permanent approval of a controlled product or Configured Item not built according to the required configuration and specifications. Information gathered is defined below:

- Waiver Number: 10 Digit Unique ID <WVR>-<automatically generated 6 digit number>
- Variance Basis: Location
- Cause of Variance
- Corrective Action
- Variance Reason Code: requirements not met
- Scope: locations affected (Example: Healy, Domain: 19 Taiga)

Waivers are reviewed and discussed by the Change Management Boards or at formal program reviews, such as Initial Operational Capability Reviews (IOCRs) as defined in the NEON Acceptance Plan [AD04], before submittal to the CMS for the formal approval process.

5.1.5 PCCB and CR Process

When a CR is needed, the CR originator is responsible for creating the CR and representing the CR through the review and approval process. Program Finance and Controls and the Systems Engineer will work with the originator to capture the change impacts to schedule, budget and scientific/construction scope. Once the CR is complete, the Deputy Program Manager (DPM), who is the facilitator of the CR process, will schedule the CR for the PCCB to review and disposition. If needed, the CR will be sent to the NSF for concurrence prior to implementing the CR.

The PCCB may also send a CR back for additional information and updates. When updates are complete, the originator will resubmit the CR for PCCB review.

The representative CR Process flow is captured in the figure below using a change submitted though an IPT as an example.

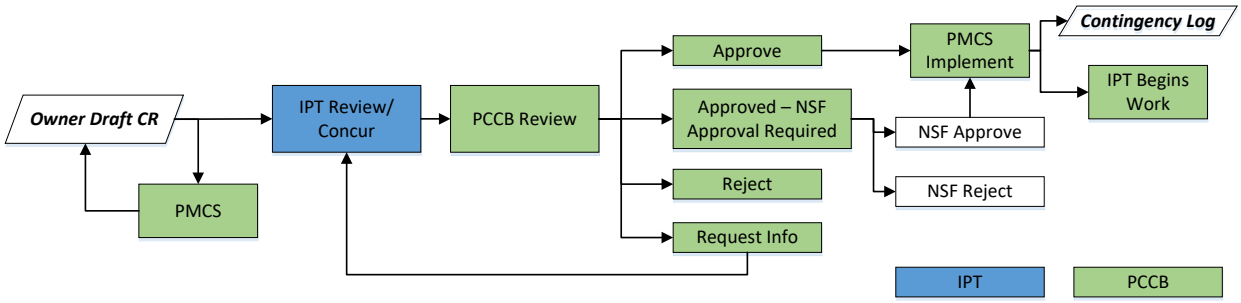

Figure 8: CR and PCCB Process Flow

If the PCCB approved CR meets or exceeds any one of the thresholds for NSF CR Approval Criteria as documented in the Cooperative Support Agreement (noted in section 5.1), the DPM will submit it to the NSF for review and approval:

If the NSF approves the CR, the DPM will record the approval and initiate the execution of the change:

- Update of contingency log (PMCS)
- Update of schedule baseline (PMCS)
- Update scientific and technical requirements (SE)
- Inform originator, IPT and/or Change Management Board and any impacted stakeholders (DPM).

If the NSF rejects the CR or requests changes to the CR, the PCCB will evaluate the feedback from the NSF and determine the next steps.

The DPM provides status of the CRs to the IPTs following the PCCB, and as needed based on NSF approvals.

Once a CR has been approved and executed, an electronic copy of the CR, will be provided to CM to retain as a record in the CMS. A courtesy copy may be retained by the PCCB for quick reference.

The NEON Change Request Template RD[05] is used in the CR process.

5.1.6 Warranty, Repair, and other PCCB Items

Construction warranty relates to the failure of a deliverable(s) within one year of IOCR due to a defect in design, materials, or workmanship of the deliverable(s). Warranty does not cover normal wear and tear, unexpected environmental conditions, or force majeure. Such items are referred to as repair, and may

need to be paid from construction if the deliverable has not yet completed IOCR. Construction warranty does not, however, extend past the date construction begins contract closeout. At that time, all deliverables will have transitioned to Initial Operations, and all systems and deliverables, including any warranty or repair are managed as part of Initial Operations.

The PCCB addresses warranty and repair issues for the program, including feasibility as well as impact to Construction and Initial Operations. The PCCB is responsible for authorizing and ensuring any associated work is charged to the appropriate contract responsible for the work.

For the Construction contract, warranty and repair are unbudgeted items managed as a Risk against Construction contingency. For this reason, any items that are approved for work in Construction must also be routed to the Risk Management Board (RMB) to address the related Risk.

The representative routing of a warranty or repair is shown in Figure 9.

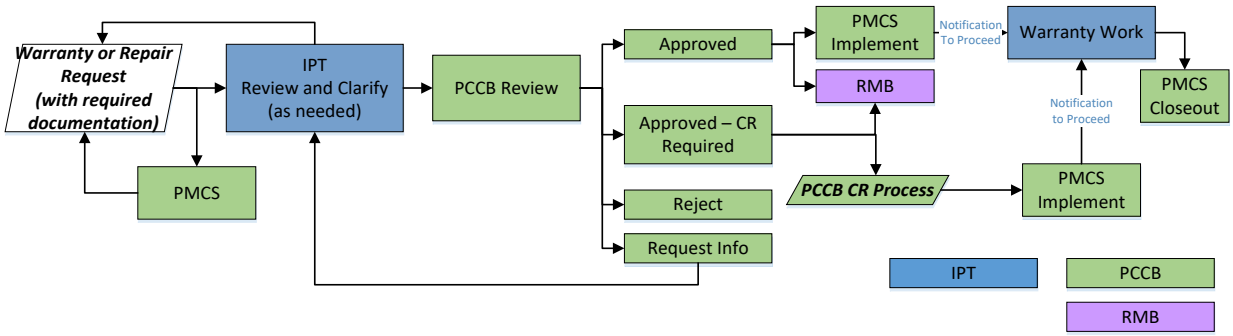

Figure 9: Warranty and Repair Process Flow

As part of the warranty and repair process:

- IPTs or responsible groups review the item to ensure they agree with the request and that it is properly classified as warranty or repair.
    - The IPT will also determine if a supplier warranty applies, and if so, coordinate resolution with the supplier and contracts.
- The PCCB authorizes the work to resolve a warranty or repair item.
    - For construction, the RMB is notified so that a call on the related warranty or repair risks can be implemented.
    - For Initial Operations, repair is a budgeted item
- The PCCB facilitator is responsible for communicating decisions to the item owner, including rationale if an item is rejected.
- PMCS supports cost and schedule data associated with the warranty or repair request, including opening/closure of any job numbers to capture costs related to the work.

For unexpected environmental conditions or force majeure, the costs to repair may exceed or strain the planned budget. In these cases, the IPT will provide the Program Manager with a recommendation so that the issue can be addressed with the NSF.

The evaluation of recurring repair and warranty issues may reveal a design problem that result in a recommended design change. In these cases, the design change will be managed separately from the repair or warranty as part of the design change management (ECR) process and approval.

Any issue or item can be referred to the PCCB for review and disposition. Such items may include trade study results, design options, and recommended improvements.

5.2 Coordination, Evaluation and Disposition of Requested Changes

The need for a change is typically the result of a resolution strategy identified by a team of subject matter experts and stakeholders chartered to address an issue. Issues may be identified during design, manufacturing, construction, deployment, integration, verification and operation activities.

The IPTs are a collaborative team for Field Operations, Engineering and Science activities, with responsibilities are documented in the IPT Charter. IPTs are typically the first to be aware of, or exposed to, potential issues. Many issues are handled directly in the IPTs, but some may require the ability to authorize change beyond their allocated threshold. These issues are escalated to the board or PCCB having the appropriate approval threshold and cross-functional support of interdepartmental personnel.

Change Management Boards (xCMB) are groups of personnel authorized by NEON Management to address change control affecting the program scope, schedule or budget within specified authority thresholds (for example, production materials). xCMB personnel are formally charged by program management with the responsibility of maintaining the timely flow and remediation (or escalation) of issues. Similar to IPT's, CMBs can be instantiated as needed to address program needs.

If an issue is not accepted or waived, a formal change is required to correct the problem. The change must be evaluated to determine the impact and variance to plan. These evaluations and rejections or approvals are processed, depending on the level of impact, by either an IPT, or if escalated, by the PCCB. The change management process is discussed in section 5.1, Manage Requests for Change, and depicted in Figure 7 above.

The Change Management Board charters, membership and decision making thresholds are defined in their charters. The following is an overview of the general criteria for change approval reviewed by the change boards:

- Identifying the need for a change or a variance
- Defining and documenting impacts of the proposed change or variance
- Evaluating the proposed change or variance and coordinating it through the approval or disapproval decision

- Incorporating the change in the product and its related product configuration information
- Verifying that the change has been incorporated and that the product is consistent with the product configuration information
- Capturing change and variance information for the product in the configuration status accounting system
- Completing any required follow-up study to identify and correct conditions that led to a need for a variance

5.3 Implementation of Approved Changes

Change implementation is accomplished through the structure and workflow provided in the Engineering Change Order (ECO) process as discussed in Enterprise Change Order (ECO). Subject matter experts, depending on the item changed, are identified as reviewers and added to the workflow process within the Configuration Management System (CMS). The default status for all ECOs is to remain open until implementation is verified by the reviewers.

The Configuration Management System (CMS) allows for linkages within the system architecture to higher and lower assemblies in the hierarchy. This linking ensures that all affected items are identified to have changes implemented in accordance with directions in the ECR. A report may be generated upon request to show the status of open ECOs. The updates will be reflected in the applicable baselines as discussed in 4.2.1.

6 CONFIGURATION STATUS ACCOUNTING (CSA)

As defined in ANSI/EIA-649-B, "CSA is the CM principle which provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle" ensuring that:

- Information about the product and product configuration information is captured, correlated, stored, and maintained as the product evolves through all phases of its life cycle
- Current, accurate information concerning change decisions, design changes, variances, investigations of design problems, warranties, and shelf and operating life calculations is retrievable
- The complete collection of product configuration information is organized, indexed and readily available
- Current and historical configurations of the product, including part identifiers and product configuration information identifiers for specifications, engineering drawings, and part models, are accurately determinable and traceable
- Users have the capability to access configuration-related information and to analyze, assess, compare, determine status, and create reports
- CSA information is accurately related to the exact applicable version/revision of the product and to configuration baselines
- The CSA system enables capture of meaningful metrics to be used to improve the CM process.

6.1 CSA Capture and Reporting

CSA information is a cumulative collection that expands as the product life cycle evolves from a need for a product through the concept and requirements definition, design, production, deployment, and operations and maintenance. NEON uses various CM tools in which CSA is an integral function (presented previously Table 1). Configuration status is mined using the Configuration Management System (CMS) to support requested reports for review.

6.2 CSA Performance Measurements

Measurements shall be collected to provide insight into the CM process performance and to guide the implementation of improvements over time. The collection of measurements and the creation of metrics will require well established processes and proper setup and implementation of enterprise configuration management and issue management tools.

As the tools and processes mature, the collection of data to support the following measures will be initially collected. The measures and metrics will adjust over time to support specific management directives, goals and measurement plans.

Monitor and distinguish change associated with:

- Customer change to requests to requirements, component or subsystem design, permitting and protocol implementation.
- Internal design changes to accommodate missing components, scope change and supplier driven changes.
- Changes requested to accommodate manufacturing process improvement.
- Changes due to the software errors.
- Changes due to obsolescence and reliability issues.
- Average amount of time to process a typical change.
- Number of ECOs pending approval longer than defined timeframe.
- Number of change requests rejected.

The metrics that may be derived from the measurements collected as described above include Requirements Stability, Design Stability, Customer Influence, Supplier Influence and Component Reliability.

7 CONFIGURATION VERIFICATION AND AUDIT

Due to the complexity of NEON, configured items are inspected or audited in phases, by stakeholders identified as subject matter experts. The timing of each phase is determined by the delivery schedule. After the initial verification and baselining, the NEON configurations are managed through oversight of the Change Management Boards and the Project Change Control Board. Following are the primary functions and responsibilities of the participants in the construction or operations of NEON:

- The approved product definition information is complete, accurate and current to produce the product, and applicable operations and maintenance instructions, training, and spare and repair parts
- The physical, functional, and interface requirements, defined in the approved product definition information, are achieved by the product
- An adequate process is in place to maintain consistency between the product and its product configuration information throughout the product life cycle
- Verification of the initial product configuration to assure that it meets its documented configuration requirements
- Verification of the incorporation of approved changes (to include Variances: Deviations, Waivers)

7.1 Verifying Product Configuration

Product configuration verification is implemented through various systems engineering processes as discussed below.

7.1.1 Baseline Verification and Establishment

The baselines are established and verified during the different phases of the system development life cycle through the formal review processes as discussed in the Systems Engineering Management Plan AD[01]. Following are the processes by which the configured items are verified and baselines established:

- Requirements Baseline: Verified and baselined during a Formal Requirements Review
- Instrumentation Baselines:
    - Sensor and Infrastructure Subsystem Designs: Verified and baselined during a Final Production Design Review (FPDR)
    - Cyber Infrastructure Software Applications: Verified and baselined prior to scheduled deliveries
    - Grape and Location Controller Software: Verified and baselined prior to scheduled deliveries
    - AOP Software, Sensor and Infrastructure Subsystem Designs: Verified and baselined during a Final Production Design Review (FPDR)
- Observation System Baselines:

- Sampling Protocols and Science Designs: Verified and baselined during a Formal Design Review

- Site Baselines:
  - Civil Infrastructure Designs: 100% Design verified and baselined during the Site Design Review Process
- Data Products Baseline: Verified and baselined during a Formal Design Review

7.1.2 As-Built Configuration Verification

As-Built Configurations are initially verified and established at the following events:

- TIS/AIS Civil Infrastructure: Established and verified during the Civil Infrastructure Acceptance.
- TIS/AIS Sensor and Infrastructure Subsystem: Established and verified during the IOCR for each specific site.

During these events, the presented configurations are reviewed to verify that changes relative to the baseline have been included in the initial as-built configuration.

As-Built configurations must be maintained for the life of the NEON program.

7.1.3 Baseline Change Verification

Change implementation to the baselines is verified through oversight provided in the Engineering Change Order (ECO) process. Subject matter experts, depending on the item changed, are identified as reviewers and added to the workflow process. The default status for all ECOs is to remain open until implementation is verified by the reviewers.

The Configuration Management System (CMS) allows for linkages between items in the system architecture to higher and lower assemblies in the hierarchy. This linking ensures that all affected items identified in the Engineering Change Request (ECR) have changes implemented in accordance with directions.

7.2 Configuration Audits

Configuration Audit is essentially a review of configuration verification records, configuration information, and inspection of physical product typically performed at the conclusion of product development or at the start of fabrication and deployment. Audits are a summation of the configuration verification activity to assure that:

- The product to be produced will achieve its required performance and its interfaces are valid
- The product instance being audited is consistent with the product configuration definition information
- All products and their components are properly and uniquely identified
- CM processes and procedures are in place to maintain consistency between the product and its product configuration information.

7.3 Functional Configuration Audit (FCA)

The Functional Configuration Audit (FCA) is used to verify and certify that the actual performance of a product (system, configuration item) meets specified requirements.

Conduct of the audit essentially encompasses a review of the results of the tests, analyses, inspections, demonstrations and simulations performed to prove specified performance requirements were achieved.

7.4 Physical Configuration Audit (PCA)

The objective of PCA is to provide confidence that the product exactly matches the detail design in the applicable product definition information so the product can be produced, maintained, and upgraded when needed. The PCA establishes a product baseline defining the starting point for controlling the production configuration and the basis for future acquisitions of the product. The PCA examines the actual configuration of a unit that is representative of the deliverable product configuration to validate that:

- Product definition information matches the configuration of the deliverable unit
- Each CM item is correctly and uniquely identified
- The product requirements verified and validated at FCA were achieved by a product whose configuration is equal to or represented in the product definition information of the deliverable unit
- All required FCA actions have been completed and applicable changes occurring post FCA have been verified

7.5 Audit Plans

Auditing will be performed by site personnel and various IPT's.

7.5.1 Site Audits

Site audits are conducted periodically by site personnel and supplemented by other NEON personnel who perform on-site audits on a planned basis.

7.5.2 Baseline Audits

The defined baselines will be audited and verified periodically by CM.