SYSTEMS MANAGEMENT STANDARD

EIA-649™ REV. C

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Revised 2019-02

Superseding EIA-649B

(R) Configuration Management Standard

RATIONALE

This standard was revised to clarify principles, content and to remove opinions in order to improve the quality and adoptability by all enterprises, whether commercial or government, regardless of industry.

FOREWORD

This standard is intended to be used when establishing, performing, evaluating or improving Configuration Management (CM) processes.

When appropriately and effectively applied, CM provides a positive impact on every aspect of the product life cycle. CM is a comprehensive process for establishing and maintaining consistency of any product's performance, functional and physical attributes with its requirements, design, and operational information.

The essence of CM, as portrayed in this standard, is the common-sense application of CM functions and their underlying fundamental principles, which have universal applicability across the broad spectrum of commercial and governmental enterprises. Collectively, the functions and principles in this document are meant to be used like a compass; they provide the reliable direction required to stay on course and aid in sound decision making moving forward.

This standard provides the rational basis upon which to apply good judgment in both planning for and executing CM. An understanding of not just what to do, but why it is necessary to tailor the application of CM functions.

This standard treats CM principles as statements of fact which relate to implementing actions. The implementing actions for each CM function are defined in CM planning guided by the type of product involved and the environments in which it is to be developed, produced, marketed, distributed, used, and maintained. Because of the broad scope of its applicability, this standard is not written as a requirements document, per se, but as the foundation document upon which requirements may be structured.

Since terminology varies considerably in different application environments, this standard provides neutral terminology for each defined term so that a user can determine appropriate substitutes for specific context, clarity, and understanding. Regardless of the term used, the same principles apply.

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The functions and principles found in Section 5 of this standard are "normative[1]" the remainder of this standard is informative.[2]

This revision replaces all previous revisions of this standard in whole.

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[1] Normative elements contain provisions with which it is necessary to conform (as described in the text above) in order to be able to claim conformance with the standard.
[2] Informative elements provide useful supportive information.

1. INTRODUCTION

Configuration Management (CM) is a technical and management process applying appropriate processes, resources, and controls, to establish and maintain consistency between product configuration information, and the product (see Figures 1 and 4).

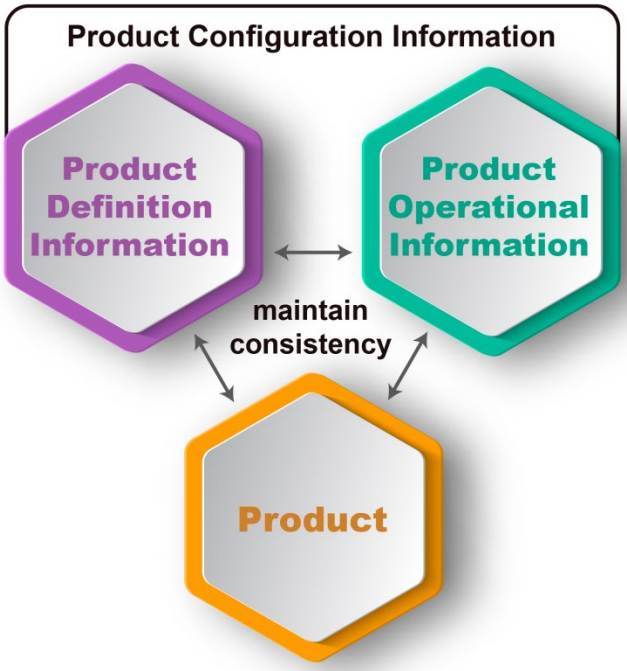

Figure 1 - The product configuration being managed

CM facilitates orderly identification of product attributes and:

- Provides control (i.e., traceability and management) of the product and its configuration information.
- Manages product changes that sustain and/or improve: capabilities, performance, resiliency, reliability, and maintainability; correct deficiencies; facilitate interface control; and extend product life.
- Manages departures from product requirements.

The term “product” in this standard should be interpreted as applicable to all product categories; e.g., documents, facilities, firmware, hardware, software, tools, materials, processes, services, systems. A disciplined CM process ensures that the product configuration information and changes to that information are identified, approved, verified, and recorded in sufficient detail to produce and support the product throughout its life cycle; and that the product conforms to the specified requirements. The CM processes result in accurate configuration information to facilitate product interchangeability and consistent reproducibility, and thus contributes to continuous safe and effective product development, production, operations, sustainment, and retirement.

Artifacts such as contracts, purchase orders, schedules, plans, costing and technical data are subject to CM where appropriate CM functions are applied to manage the information.

CM execution requires a balanced and consistent implementation of CM functions guided by CM principles throughout the product’s life cycle. Experience has demonstrated that the investment in resources necessary to perform effective CM is returned in long-term cost avoidance and risk mitigation. Significant expenses (e.g., to re-establish the accuracy of product configuration information) are avoided when CM is applied continuously throughout the product’s life cycle.

Benefits of appropriate CM include:

- Establishment and sustainment of an authoritative source of information

- Collaboration across capability roles, functions, and systems
- Improving efficiencies
- Improving information flow
- Improving process effectiveness
- Eliminating waste
- Improving product control
- A leaner, more reliable and resilient enterprise

Continuous CM application provides authentic approved source information for items such as:

- Administering warranties
- Determining liabilities
- Managing proposed changes
- Performing maintenance and overhaul
- Identifying and resolving safety, security and environmental issues

Revision	Description of Change	Release Date
Interim	Interim EIA standard EIA/IS-649 initiated to replace MIL-STD-973 by a task to develop an industry configuration management standard by ANSI project PN-3414.	Aug 1995
—	ANSI/EIA-649 initiated by ANSI project PN-3721 to submit the industry configuration management standard for approval by ANSI ballot.	May 1998
A	ANSI/EIA-649 initiated by a task to separate the normative principles from the informative material and expand the use of neutral terminology in the industry configuration management standard by ANSI project PN-4766 and approved by ANSI Ballot.	Oct 2004
B	Revision B was initiated to enhance the standard and to harmonize with other TechAmerica standards. Revision B is considered an entire rewrite of the standard so change bar indicators in the margins are not utilized.	Jun 2011
C	Revision C was initiated as part of a Five-Year review. It includes clarification to principles and content, as well as the removal of opinions, in order to improve the quality and adoptability, by all enterprises, of the standard as an actionable product.	

2. SCOPE

This standard defines five CM functions and their underlying principles. The functions are detailed in Section 5. The principles, highlighted in text boxes, are designed to individually identify the essence of the related CM function and can be used to collectively create a checklist of “best practice” criteria to evaluate a CM program.

The CM principles defined in this standard apply equally to internally focused enterprise information, processes, and supporting systems (i.e., Enterprise CM - policy driven, supporting the internal goals needed to achieve an efficient, effective and lean enterprise), as well as to the working relationships supported by the enterprise (i.e., Acquirer/Supplier CM - contracted relationship to support external trusted interaction with suppliers).

In an Enterprise CM context there are several methodologies for principle use by the enterprise:

- The principles of this standard provide direction for developing enterprise or functional CM plans focused on identifying, defining, authorizing, and managing CM activities.
- These plans identify the participants involved in activities, their responsibilities, their authority, and how accountability is administered to serve enterprise/activity objectives.
- The Enterprise uses CM’s integrity-based traceability and management capabilities as a foundation to support the “best practice” initiatives of data/information management, quality assurance, program/project management, systems engineering and life cycle logistics, by providing principle-guided functions to achieve a more efficient, effective and lean enterprise.

In the Acquirer/Supplier CM context there are several methodologies for conformance by a supplier:

- Acquirer requires a CM plan consistent with the principles of this standard from the supplier.
- Acquirer uses this standard to develop a checklist with which to evaluate supplier CM plans.
- Acquirer reviews and approves the supplier CM plan and makes it a requirement of the contract. This method requires both parties to the acquisition to understand both the concepts and the tailoring.
- Acquirer uses the principles of this standard as the basis for developing either or both an enterprise CM requirements document or a specific project CM requirements document to impose on suppliers. The requirements documents may state this standard’s principles as requirements and reference this standard’s paragraphs. Compliance with the contractual requirements constitutes conformance with this standard.

In describing each CM function and its principles, this standard utilizes neutral Configuration Management terminology, while also providing equivalent terms, that have historically been used in various product environments (see Table 2). There is no intent to express a preference for any particular set of terminology.

Similarly, this standard uses a neutral set of names for the phases of a product’s life cycle, which are generic enough to be easily mapped to the myriad of different life cycle models in use. Table 1 illustrates some of the aliases for each phase name and identifies characteristics that apply to each one.

Regardless of the titles chosen for these phases, or what the product is (i.e., a facility, software, an airplane or a machine screw), at some point in its history a product will go through all or most of these phases. The phases can have considerable overlap, or the sequence of the phases might change or be repeated, e.g., for product improvements and enhancements. Approved configurations of a product can be in the build, distribution, operation, and disposal phases simultaneously, and changes to those configurations may occur during all life cycle phases.

Appropriate application of CM functions enables a user of this standard to plan and implement a CM program for a product, project, or enterprise. All functions apply during every phase of the product's life cycle but the degree to which each of the CM principles applies may vary. A scalable CM process should be defined, measured, continuously improved, and adhered to, that is commensurate with the product's complexity, its intended use, and its value over the product life cycle.

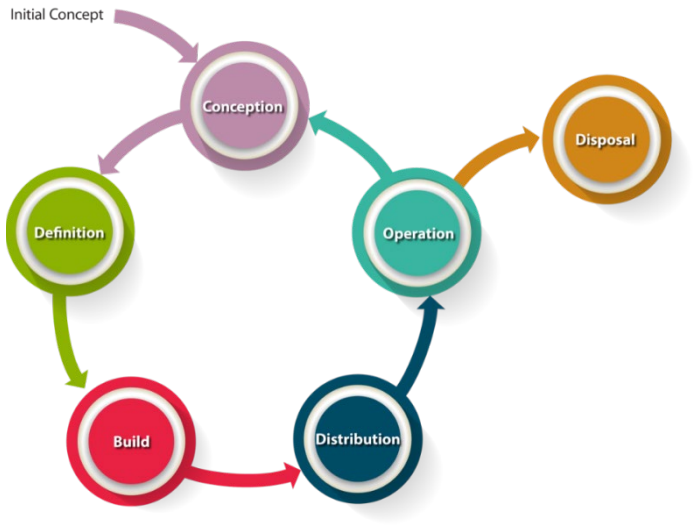

Figure 2 - The product life cycle being managed

Table 1 - Phases of a product's life cycle

Phases >	Conception	Definition	Build	Distribution	Operation	Disposal
Aliases	Concept Exploration Marketing Predevelopment Research Study Material Solution Analysis Technology Development	Design Development Engineering Engineering & Manufacturing Development Program Definition Source Coding Software Build	Construction Fabrication Manufacturing Production Software Build	Delivery Deployment Fielding Installation Sales	Maintenance On orbit Operation & Support Operational Performance Repair Service Life Warranties In-Service	Decommissioning Disposition Removal from Service
Characteristics Of the Phase	Analysis Functions Investigation Need Opportunity Mission Pre-Concept & Concept Definitions Survey Trade-Offs Requirements Definition	Architecture Detailed Design Evaluation Manufacturing Planning Preliminary Design Prototyping Software Code & Test Specification System Definition Testing Functional and Allocated Baselines	Assembly Facility Construction Installation Inspection Manufacture Production Product Baseline	Acceptance Commissioning Deployment Installation Order Setup Stock Supply Transport	Depreciate Maintain Modernize Modify Operate Recover Sustainment Upgrade Use Utilization	Archive Deactivate Destroy Disassemble Discard Disposition Environmental Impact Historical Significance Legacy Mothball Recycle Retrieval Scrap

An organization that has the responsibility for performing Configuration Management for a product during any period of its life cycle could be a commercial enterprise, e.g., contractor, subcontractor, supplier, or government agency. References in this standard to the acquirer (i.e., customer) should be interpreted as the entity that specifies requirements (functional and performance attributes) for the product or that acquires and uses the product. An acquirer may be external to the developing and producing organization or may be internal such as marketing, management, or the using department.

Configuration Management functions related to a product may be the responsibility of several organizations during its life cycle. For example, an organization with the responsibility to design and build a product will perform Configuration Management during the definition and build phases; other organizations or government activities with responsibility for upgrading the product and servicing units will perform Configuration Management during the operation phase.

GEIA-HB-649 “Configuration Management Standard Implementation Guide,” provides additional “how to” guidance for planning, managing, and implementing CM functions and principles.

3. REFERENCES

This standard does not cite any references, within its text, that constitute provisions of this standard. References cited within the text and listed in Annex B are for information purposes only.

4. TERMINOLOGY

Because this standard has global application across diverse industries and governmental activities in which terminology differs, a neutral set of terms is used. The neutral terms translate to that which is common to any particular user environment through the concepts inherent in their definitions.

This section promotes standardization by aiding in understanding equivalency of terms by defining the terms used within this standard and other closely related terms.

4.1 Definitions

For purposes of this standard, the definitions in Table 2 apply. The terms in the first column of this table are the ones primarily used in this standard. They are neutral terms and are not unique to any industry or governmental practice. Related terms are also provided in column 3 of the table. There is no intent to express a preference for any particular terminology. When planning and documenting a CM program, an enterprise may substitute any other terms familiar to their environment for the terminology used within this standard. There is also no intent to rigidly adhere to the neutral terminology within this standard if, in specific instances, use of a related term provides clarity.

For additional definitions of other configuration management terms and configuration attributes, see the latest versions of GEIA-HB-649, EIA-649-1, EIA-649-2, and ANSI/EIA-836. These artifacts logically extend the CM principles of this standard, establish a common data exchange language for interoperability between enterprises, and provide the relationships between defined terms and their properties.

Annex C provides an alphabetical list of the related terms cross-referenced to the terms defined in Table 2. Terms found in Webster’s dictionary which are commonly used in the English language are not defined in this standard.

Table 2 - Terms, definitions, and related terms

Neutral Term Used in This Standard	649 Definition	Related Terms
acquirer	An individual or enterprise that (1) commissions the engineering or design of a product; (2) is a prospective purchaser of the end products of a system or a portion thereof; (3) is a procurer of a product; (4) is a user or consumer of the product; or (5) an obtainer of output.	customer, acquisition activity, authority, buyer, engineering user, external end user, internal user, management, marketing department, procuring activity, specification activity, prime contractor
approval authority	The organization or person authorized to approve: (1) A configuration change to a product, (2) Changes to product definition information and other related documents, (3) Release (or cancellation) of documents for use anywhere or in a specific program and (4) Commitment of resources.	change approval authority, configuration change management authority, change control board chairperson, decision authority, project manager, material review board
approved configuration	The baseline plus any approved changes	
artifact	(1) A contained piece of information that is used or produced by a software or hardware development process, or by deployment and operation of a system. Examples of artifacts include: representational views, model files, source files, scripts, and binary executable files, a table in a database system, a development deliverable, a word-processing document, or a mail message. (2) Physical entities and their elements such as patterns, parts, components, and assemblies. New artifacts can be created by grouping existing artifacts.	document, software, physical items
baseline	See configuration baseline.	
change board	A group comprised of technical and administrative representatives who review and recommend approval or disapproval to the approval authority, of changes and variances to a configuration managed product and its supporting documentation.	change control board, change review board, configuration control board; program review board
configuration	(1) The product attributes of an existing or planned product, or a combination of products, i.e., product requirements, the product, and associated product configuration information; (2) one of a series of sequentially created variations of a product.	
configurability	The capability to temporarily adapt or rearrange the configuration of a system or system of systems to accommodate the needs of a particular application or deployment.	
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.	functional configuration audit, physical configuration audit, product configuration verification, conformity inspection, configuration conformance check, product consistency verification, system verification review
configuration baseline	Configuration of a product, at a specific point in time, which serves as a basis for defining change, for conducting verifications, and for other management activities. For a software product, the build baseline includes the actual product.	Allocated Baseline, build baseline, developmental baseline, Functional Baseline, product baseline
configuration change	A change to the product configuration information and the product.	engineering change
configuration change management	The CM function that ensures changes to and variances from a configuration baseline are properly identified, recorded, evaluated, dispositioned, and incorporated and verified as appropriate.	change control, change management, enterprise change management
configuration control	The systematic proposal, justification, evaluation, coordination, disposition of proposed changes or requested variances and the implementation of all approved changes or variances in the configuration after the establishment of a configuration baseline.	configuration governance, configuration change management
configuration identification	The CM function which (1) assigns unique identifiers to each product and product configuration information; (2) establishes a structure for products and product configuration information; (3) selects, defines, documents, and baselines product attributes.	
configuration item (CI)	A product, allocated components of a product, or both, that satisfies an end use function, has distinct requirements, functionality and/or product relationships, and is designated for distinct control.	Computer Software Configuration Item (CSCI), configuration object, configured product, designated item, product, functionally significant item

Neutral Term Used in This Standard	649 Definition	Related Terms
configuration management (CM)	A technical and management process applying appropriate processes, resources, and controls, to establish and maintain consistency between product configuration information, and the product.	
configuration status accounting (CSA)	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 product units during operation and maintenance.	configuration database, configuration records, status accounting
configuration verification	Verification of requirements and incorporation of approved configuration changes (see verification).	
customization	The action to permanently establish a configuration of a system or system of systems with a unique set of items to satisfy a particular application or deployment with no intention of changing or rearranging the custom configuration over the life of the product.	
design activity	An organization that has, or has had, responsibility for the design of an item. (Adapted from ASME Y14.100)	design authority
design release configuration	The set of design information, incrementally released to date, by the development activity for a product during a product's definition (development) phase.	Design Release Baseline, developmental baseline, development configuration, developmental configuration baseline, release record
disposition (noun)	Refer to Merriam-Webster dictionary.	
disposition (verb)	To make a decision on a change to either approve, disapprove, defer or cancel.	
document	Refer to Merriam-Webster dictionary.	records, specifications, engineering drawings, drawing lists, reports, standards, models, metadata, attributes, database, source code
effectivity	A designation, defining the product range; e.g., serial numbers, block numbers, batch numbers, lot numbers, model, dates or event, at which a specific product configuration applies, a change is to be or has been affected, or to which a variance applies.	batch number, break-in point, block number, change applicability, incorporation date(s), lot number, serial number, series
enterprise	A business or government organization or a discrete portion thereof.	company, contractor, design authority (legacy), design activity, manufacturer, organization, supplier
enterprise identifier	A string of characters that uniquely identifies the enterprise. This identifier is assigned by an issuing organization within a scheme and is unique to that scheme.	CAGE Code, D-U-N-S number, ISO/SAE WMI code, Organization Identifier
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.	
functional attributes	Measurable performance characteristics. These are expressed in terms of quantitative parameters; e.g., range, speed, lethality, reliability, maintainability, resiliency, safety, processing speed, random access memory, and operational and logistical parameters, including their respective tolerances where applicable.	attributes, characteristics, requirements
group identifier	An alphanumeric identifier that (1) uniquely identifies a group of like units (lot) of the same product which are manufactured or assembled under uniform conditions and are expected to function in a consistent manner. (2) uniquely designates a specific volumetric quantity (batch) of a material, usually a chemical mixture, created at the same time and expected to have properties similar to, but not necessarily identical to other batches created at other times.	batch number, block number, date, date code, lot number
information	A combination of data and the application of rules, that is recorded, classified, organized, related, or interpreted within a certain context.	organized data, facts, knowledge
interface control	The process of identifying, recording, and managing product attributes' interface information at the common boundary of two or more products provided by one or more organizations.	interface management

Neutral Term Used in This Standard	649 Definition	Related Terms
interface information	The documented and agreed-to functional and physical attributes (characteristics) required to exist at a common boundary between two or more products. The attributes can consist of software languages, software codes, wires, plugs, sockets, or computer system menus and services. They can also be expressed in terms of quantitative parameters; e.g., physical size, shape, material composition, and operating and logistical parameters, including their respective tolerances where applicable.	interface attributes, interface control document, interface control drawing, interface specification
major change	A change with significant impacts, such as impacts to functional and physical interchangeability and supportability of the product (see Table 4).	class I change
metadata	Data about data, properties (title, document number, creation date, etc.) used to identify or define a data item.	data attributes
minor change	A change that has little or no significant impact (see Table 4).	class II change
performance	A quantitative measure characterizing a physical or functional attribute relating to the execution of an operation or function; e.g., quantity (how many or how much), quality (how well), coverage (how much area, how far), timeliness (how responsive, how frequent), and readiness (availability, mission/operational readiness).	
physical attributes	Quantitative and qualitative characteristics of material, including interfaces; e.g., composition, dimensions, finishes, tolerances, source and object code, compilation information, complexity level, data structure, platform, drivers.	attribute(s), characteristics, requirements
product	Anything used in or resulting from the execution of a process including the process itself.	assembly, component, Computer Software Configuration Item (CSCI), Configuration Item (CI), end item, facility, hardware, item, material, part, service, set, software, system, unit, asset, artifact, commodity
product configuration information	Information about a product consisting of product definition information and product operational information.	configuration documentation, product information
product definition information	Information that defines the product's requirements, documents the product attributes including the process information, and is the authoritative source for configuration management of the product.	associated lists, configuration documentation, design basis, design documentation, design information, design output, engineering drawing, interface control document, interface document, model-based definition/product model, requirements document, software requirements specification, software design document, software product specification, specification, technical data, technical data package, Product Definition Data, Product Definition Element, Product Definition Data Set
product identifier	An identifier, unique to the issuing organization, used to designate products of the same configuration, and to differentiate them from other products.	dash number, document identifier, item name, model, name, nomenclature, part name, part number, title, version
product operational information	Information developed from product definition information used to test, operate, maintain and dispose of a product.	operation instructions, operational information, maintenance instructions, technical manual, technical order
product structure	A hierarchical view of the composition, relationships, and quantities of a product and its components.	Bill of Material (BOM), drawing list, drawing tree, hierarchy, indentured drawing list, indentured listing, indentured parts list, product tree, pyramid, specification tree, top-down breakdown
release (verb)	To authorize for dissemination, a particular version of product and/or product information that is made available for a specific purpose.	
released (adj)	A status level indicating that a document and/or product under configuration change control has been reviewed and is authorized for use.	approved, issued
request for change	The means by which a change is proposed, described, justified, and submitted to the approval authority.	change proposal, change record, change request, contract change proposal, design change, engineering change memo, engineering change package, engineering change proposal, engineering change request, enterprise change request, proposed change, red line change package
request for variance	The means by which a manufacturer or supplier requests permission to depart from the product definition information for (1) a specific unit, (2) a specific number of units, or (3) a specific period of time without requiring revision of the product definition information.	alteration request, concession, deviation, engineering departure, exception request, nonconformance, production departure, request for deviation, request for waiver, waiver
requirement	(1) Need or expectation that is stated and obligatory; (2) Specified value for an essential product attribute.	specification shall statement

Neutral Term Used in This Standard	649 Definition	Related Terms
retrofit	The incorporation of a new design or a product modification resulting from an approved configuration request for change, into product units already produced.	modification, revision, rework, update
revision	The result of updating a product or product configuration information (also see Version).	issue, update, version
rework	A procedure applied to a nonconformance that will completely eliminate it and result in a product that conforms completely to the drawings, specifications, or contract requirements. The supplier must disclose that the rework occurred when outside the normal process to manufacture the part.	
supplier	An enterprise that provides a product (end products, enabling products, or both) or a group of products to an acquirer. The supplier (external or internal to the acquirer's enterprise) can be a provider that has a product that does not need development, or a developer that must develop the desired product.	contractor, developer, designer, distributer, manufacturer, producer, provider, seller, subcontractor, vendor
supply chain	(1) Suppliers and sub suppliers. (2) The linked activities associated with providing materiel from a raw material stage to an end user as a finished product.	
sustainment	(1) The provision of logistics and personnel services required to maintain and prolong operations of a product. (2) The portion of the product life cycle during which those services are provided.	logistics support
tailor	The manner in which configuration management principles, requirements, and processes are adapted for a particular purpose.	tailoring, tailored
unit	(1) The result of producing a tangible single instance of a product or (2) In software, the lowest separately compilable piece of code element within the software product structure, corresponding to a separately compilable piece of code.	product instance
unit identifier	A sequentially-issued character string (alphanumeric identifier) used to designate a specific unit of a product.	keel number, line number, manufacturing identifier, platform number, serial number, tail number, vehicle identification number (VIN)
validation	The confirmation that a product, service, or system meets the needs of the customer or other identified stakeholders.	audit
variance	A departure from approved product definition information, for a limited amount of time or for a specified effectivity, that does not require revision of approved product definition information.	alteration, departure, deviation, engineering departure, non-conformance, production departure, waiver, concession
verification	Confirmation by test, analysis, demonstration, simulation, or inspection that a specified requirement has been fulfilled by the product.	analysis, check, demonstration, inspection, proof, conformance, test, validation
version	A specific configuration of a product or document (see Revision).	configuration, issue, revision

4.2 Symbols and Abbreviations

The following symbols and abbreviations are used in this standard:

ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
CAD	Computer Aided Design
CAGE	Commercial and Government Entity
CCM	Configuration Change Management
CI	(Funct:) Configuration Identification; (Noun:) Configuration Item
CLIN	Contract Line Item Number
CM	Configuration Management
CMMI	Capability Maturity Model Integration
CMP	(Funct:) Configuration Management Planning & Management; (Noun:) Configuration Management Plan
CSA	Configuration Status Accounting
CSCI	Computer Software Configuration Item
CVA	Configuration Verification and Audit
DM	Data Management
DMS	Diminishing Manufacturing Sources
D-U-N-S	Data Universal Numbering System
EIA	Electronic Industries Alliance
FCA	Functional Configuration Audit
GEIA	Government Electronics and Information
F3I	Form, Fit, Function, and Interface
IEC	International Electro-Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
PCA	Physical Configuration Audit
PDM	Product Data Management
PLM	Product Lifecycle Management
SCM	Software Configuration Management
VIN	Vehicle Identification Number

5. CM FUNCTIONS AND PRINCIPLES

Principle CM-1. Configuration Management implementation requires a balanced and continuous application of CM functions and their underlying principles throughout the product life cycle.

The CM process described in this standard provides a flexible and comprehensive methodology for enterprises to manage and control the product configuration. It consists of five interrelated functions which, when collectively applied, maintain consistency between product configuration information and the product throughout conception, development, production, delivery, and support. The CM functions, shown in Figure 3 with their corresponding sections, are: 5.1, Configuration Management Planning and Management; 5.2, Configuration Identification; 5.3, Configuration Change Management; 5.4, Configuration Status Accounting; and 5.5, Configuration Verification and Audit.

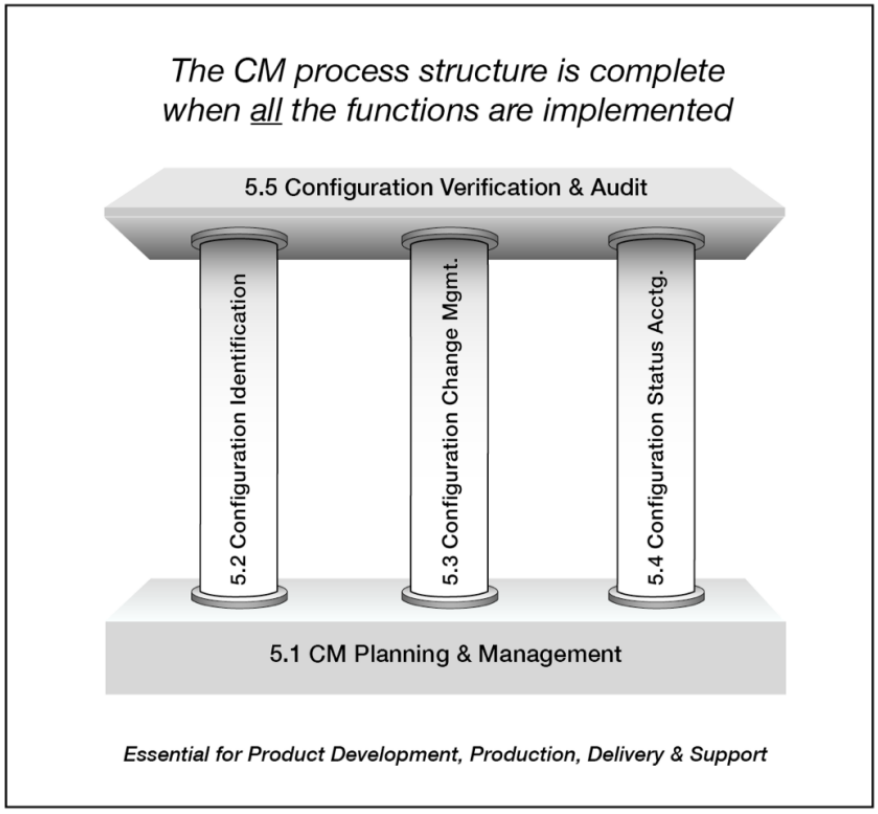

Figure 3 - CM functions

Configuration Management implementation requires a balanced and consistent application of the CM functions and their underlying principles. Although each function is described separately, its implementation is not performed in isolation. Maximum benefit from the CM process requires the five functions to work together seamlessly and continuously throughout the product life cycle.

To achieve consistency of a product's configuration and to ensure the ability to replicate it, functional and physical attributes are identified, documented, verified, and approved. The product configuration information becomes more detailed and definitive as the product is developed and matures. It is captured, retained, and maintained in a Configuration Status Accounting (CSA) system that provides the status of the product information and is used in generating baselines; providing the basis for managing changes; and for performing configuration management activities.

The consistency of product configuration information is maintained throughout the product's life cycle by identifying and evaluating the impact of all proposed changes through the configuration change management process and verifying that the product and all related product information have been updated.

Instructive information is provided to assist in CM implementation planning as follows:

- Annex A provides a tabulated summary of the CM principles.
- Annex B provides a list of other associated consensus standards.
- GEIA-HB-649 provides extensive guidance and illustrative examples.

5.1 Configuration Management Planning and Management

CM planning and management over the life cycle of a product are essential to achieving effective, predictable, and repeatable CM processes. CM processes shape the application of solid, practical procedures that result in cost avoidance and enhanced configuration quality and stability.

Comprehensive CM planning and management includes:

- Applying the appropriate level of CM functions throughout the product's life cycle.
- Implementing policies and procedures, resulting in effective configuration management.
- Assigning CM functional responsibilities to appropriate organizational elements.
- Training of CM personnel and any others who have CM responsibilities.
- Determining and applying adequate resources to implement the planned CM system.
- Establishing CM performance measures to serve as a basis for continuous improvement.
- Ensuring appropriate performance of Configuration Management by the supply chain through insight and oversight.
- Integrating the organization's product configuration information processes.

5.1.1 Identify Context and Environment

Principle CMP-1. The foundation for CM planning, which delineates the specific CM application methods and their levels of emphasis, is an understanding of the context and environment of the product to which the CM process is to be applied.

Identify the context and environment of the product so that CM Planning can be tailored to an appropriate level to meet the product requirements, complexity, and life cycle environment. Develop a clear understanding of the product and environment to which the CM functions and principles will be applied. This will ensure that the CM Plan and procedures will be appropriate to the product requirements, complexity, and the life cycle environment. Although all CM functions are necessary, many different factors influence the specific CM requirements, processes, tools, and the level of CM emphasis to be applied to a particular product. These factors may include:

- Product constraints, e.g., scope, importance, complexity, production quantity, quality requirements.
- Organizational constraints, e.g., number and size of organizations involved, budgets, schedules.
- The physical environment in which the product is to be used.
- Type of support to be provided; e.g., factory support, dealership support, independent maintenance center support, customer support, or no support required.

- Life cycle phase.
- Approval authority over the product configuration information.
- Contract requirements for the project, its products and, for configuration management.
- Access and control, i.e., Intellectual property rights and data distribution, Export Control, etc.
- Certification requirements.

Questions relating to the above factors that can be addressed include:

- What are the attributes of the customer's (including who is/are the customer[s]) and the end user's environments that need to be addressed by CM? (e.g., who will support and maintain the product: the customer, the supplier, the user, or another party?)
- What role will the customer play in decisions about changes?
- What is the current phase of the life cycle and what are the anticipated future phases?
- What is the technical complexity of the product?
- Are there product components that require separate management attention?
- Will it be necessary to conduct an FCA/PCA?
- What extent of configuration change management over supplier efforts will be necessary?
- Is the product, or its components, a new design, an existing design, or a modification to an existing design?
- How complex of a documentation package is necessary?
- If in the operational phase, what documentation is available, and does it reflect the current product?
- What level of change activity, if any, is anticipated?
- Are customers/users expected to request changes?
- What is the anticipated operational life of the product?
- What, if any, are the required attributes related to disposal; are environmental issues involved?
- What specific information will users, maintenance activities, or others require?

5.1.2 Document the Outcome of CM Planning

Principle CMP-2. CM Planning documents how the organization will implement CM throughout the applicable phases of the product life cycle to provide consistency between the product configuration information and the product.

CM Planning is a comprehensive approach that reflects efficient, appropriate application of configuration management principles and practices to the identified context and environment. The documented outcome, independent of format would normally include the following topics:

- General product definition and scope.
- Description of CM activities and procedures for each major CM function (Prin. CM-1).
- Organization, roles, responsibilities, and resources.
- Definitions of terms.
- Programmatic and organizational interfaces.
- Deliverables, milestones, and schedules.
- Subcontract flow down requirements.

The documented outcome of CM Planning should be assessed and updated periodically, as well as following any significant change affecting the context and environment (e.g., changes in suppliers, or supplier responsibilities, changes in diminishing manufacturing sources, part obsolescence, changes in resource availabilities, changes in customer contract, changes in the product and organizational changes). CM Planning should also be reviewed on a periodic basis to make sure that an organization's application of CM functions is current.

Unless required by the customer, the form and format of the CM planning documentation, whether included with other project planning or included in a stand-alone CM plan, is not critical. However, execution of Configuration Management per the planning documentation is essential to successfully maintain consistency between product configuration information and the product.

5.1.3 Apply Adequate CM Resources and Assign Responsibility

Principle CMP-3. To implement planned CM functions, resources are identified and applied, and responsibilities to perform CM activities are assigned.

To effectively and appropriately plan and implement Configuration Management in all phases of the product life cycle, it is essential to include adequate resources. Required resources may include but are not limited to: facilities, personnel, information systems, and equipment or tools. The resources may be distributed throughout an enterprise and its supply chain.

Factors such as the complexity of the project, the interfaces required with customers and suppliers, and other aspects of the project, all influence the roles and resources required to implement the CM functions. Each project, program, or organization must assess the varying level of CM resources required to support the product in each phase of the life cycle. CM resource planning addresses CM roles and associated responsibilities, authority and accountability, skills and level of effort required.

5.1.4 Establishment of Performance and Status Measurements

Principle CMP-4. The establishment and maintenance of CM performance and status measurements are necessary for all products where compliance with the Configuration Management planning and continuous improvement is critical.

In order to support program/project activities through continuous improvement, performance and status measurements are necessary for all product (and, if applicable, product components) configuration information and processes. Without measurements in place it is impossible to account for the status of the configuration and associated realization and/or sustainment activities.

Status lets one know where one is in the process while performance measurements communicate how efficiently and effectively activities are being performed. Configuration Status Accounting (see 5.4) and the opportunity it provides for communicating product information is impossible if measurements are not in place.

Status metrics and performance data from CM Processes are critical for establishing and maintaining consistent execution and incontrovertible information used to communicate Configuration Status Accounting. It is important to develop performance, quality and quantitative measures (metrics) for use in evaluating the effectiveness of enterprise and supplier CM processes, procedures, and tools. Metrics are selected as appropriate for the program environment and product's life cycle phase. The information derived from the metrics is used to understand problems and inefficiencies in the processes or tools, to assess the extent of those problems and inefficiencies, and to provide insight in making necessary corrections and improvements. CM metrics are discussed further in 5.4.

5.1.5 Establish, Implement, and Maintain Procedures

Principle CMP-5. CM Procedures document how each CM function is implemented to accomplish the intent of the CM planning.

CM procedures provide the detailed how-to steps to implement the CM functions. Procedures should be unambiguous, succinct, and written at a level of detail that is commensurate with the intended use. As with planning, procedures may be applied to a range of products, or tailored for individual products. Procedures must be carefully evaluated to ensure that they are consistent with CM planning and kept as simple as possible. While CM Procedures are described and referenced in the CM Plan, they represent standalone information sets outside the plan.

5.1.6 CM Training

Principle CMP-6. Provide CM training to assure that individuals understand their responsibility, authority, accountability, and the procedures for performing CM.

CM training provides an understanding of the fundamentals and principles of CM and the use of CM tools, procedures, and practices. CM training should be consistent with the training policies of the organization.

Training should be planned to address both performance of assigned CM tasks and cross-training to provide awareness of relationships and interactions with others having CM-related responsibilities. Personnel from many organizations within the enterprise and suppliers have CM roles to perform. Continuous on-the-job and formal CM training should be tailored to address needs based on the individual's position, experience level, and responsibility. For example, Design or System Engineers would need an overview of the CM functions, whereas an individual assigned to maintain a CSA database requires in-depth training on the status accounting tools being used by the enterprise.

Training is provided as needed to personnel as processes change, personal skills evolve, and new tools are introduced. In addition, experienced mentors aid the transition of new individuals into the CM discipline.

5.1.7 Assess Compliance and Effectiveness

Principle CMP-7. Periodic assessment of the effectiveness of CM procedures and tools and of compliance with the Configuration Management plan maintains the health of the CM process.

The Configuration Management process is reviewed to demonstrate compliance to, and effectiveness of documented CM plans, processes, procedures and tools, to ensure performance and to provide for continuous process improvement. These reviews are conducted as periodic assessments or when the need for an individual assessment is indicated by process metrics. Monitoring the health of the CM functions identifies improvement opportunities and ensures that problems are identified before they cause major impact to the program.

A CM assessment is accomplished by reviewing the implementation of each CM process. Reviewing CM processes and verifying their performance ensures CM processes and procedures exist, are adequately documented to address the applicable principles of this standard, and the execution of the process documentation is in compliance with the documented requirements. CM Process Verification in 5.5.1 provides additional information.

5.1.8 Supplier Configuration Management

Principle CMP-8. Performing configuration management includes responsibility for the configuration management performance of the supply chain.

Configuration management requirements appropriate to the product being acquired are passed down the supply chain, typically via purchase order or other subcontract agreement instrument. Tailoring CM requirements for the supply chain is a major CM planning activity. The flow down of CM requirements, including the requirement to monitor the acquirer's subcontractors and suppliers, provides an appropriate application of CM functions and principles to the entire supply chain.

The supply chain is monitored via governance defined by contract to include as appropriate:

- Data reviews - Typically include assessment of supplier plans, procedures, and product configuration information.
- Configuration change management participation - Typically includes the review of proposed changes to buyer approved or imposed product configuration information.
- Design reviews - Typically assess the supplier's progress and provide a level of confidence that the product, when developed, will meet its specified attributes.
- Product testing - Typically using results as positive or negative indicators that required attributes will, or will not be satisfied.
- Configuration audits (see 5.5.4) - Typically used to verify that the required attributes have been achieved, the design of the product has been accurately documented, and the configuration identification marking on the products matches the documentation. CSA Reports (see 5.4.1) are often used in an audit to verify that the product's approved configuration has the desired integrity and is a detailed extension of all that preceded it.
- CM surveillance - Typically oversight and reviews verifying the continuous application of supplier CM processes.

The level of CM governance and/or control exercised by the buyer on the supply chain ranges from none to total, depending on the nature of the product and the conditions of purchase.

5.1.9 Product Configuration Information Processes

Principle CMP-9. Information processes, including collection and processing, controlling status, providing interoperability and exchange, and long-term preservation, are essential elements of effective CM planning and management.

Subsections 5.1.9.1 through 5.1.9.4 discuss the planning for the application of the following processes to product configuration information:

- Data Collection and Information Processing
- Information Status Control
- Information Interoperability and Exchange
- Preservation of Information

5.1.9.1 Plan for Data Collection and Information Processing

Data collection and information processing requirements guide the selection of the methods and enabling technology required to collect, manage, retain and provide access to product configuration information throughout the product's life cycle. Product data such as performance, interface, and design information; testing procedures and results; operational and maintenance procedures; delivered unit configurations; and as-maintained data, among many others, may be required. The data is collected from many sources or organizations including engineering, project management, manufacturing, quality assurance, support, customers, and users.

To ensure that the needed information is available, CM information requirements should be solicited from potential information users. Defined sources, depth, and scope of configuration management information and associated metadata to be collected guide the selection of tools for collection, storage, processing, and distribution.

5.1.9.2 Plan for Information Status Control

To ensure effective control and use of product configuration information, the status of each piece of information must be established, recorded and disseminated. Information status levels reflect the approval and allowable uses of the information. Initial status levels are assigned by the creator of the information but once a document is approved by the approval authority a status level of released is achieved, allowing it to be distributed beyond the originating organization (see 5.2.5).

5.1.9.3 Plan for Information Interoperability and Exchange

Interoperability and exchange of CM information requires that the information be in a format that is understandable and transferable between the exchanging parties. To ensure that the CM-related information is controlled and usable, it must be appropriately identified, compatible, access controlled, and complete; and in an accessible and usable form for defined user environments.

The interoperability and exchange of CM information may be by physical media, electronic data exchange, web access, or other means. The process employed to provide access, sharing, or exchange is accomplished by mutual agreement between exchanging partners and accomplished by using appropriate enabling technology.

5.1.9.4 Plan for Preservation of CM-Related Information

Product configuration information is often required beyond the life cycle of the technology used to create it. Accordingly, it is important to ensure continued usability of the product configuration information throughout the product's life cycle and, if necessary, beyond. Considerations include:

- Product: To determine what data must be retained and for how long, consider the life expectancy of the product as well as the applicable legal and regulatory requirements for retaining the product configuration information. This may be for a specified period after product disposal, or it may be indefinite.
- Application and Format: Plan to capture information about the technology (operating system and version, application software and version, and data format) used to create, store, retrieve, interpret, and accurately present the data in a human readable form and as applicable, in a modifiable form.
- Technology and Data: To ensure continued accessibility/readability/usability of the data, consider the expected life spans of the associated technologies and plan for an appropriate frequency of update of both the technology and, where necessary, the data.
- Information Backup and Recovery: Establish and maintain a plan for information backup and recovery in the event of a local disaster such as earthquake, flood or fire. Remote backup of data and information is essential in the case of data loss at the prime site.
- Also, refer to ANSI/GEIA-859 for more information.

5.2 Configuration Identification

The configuration identification principles address the composition of configuration information, how each document, product, and unit or group of units of a product is uniquely identified (identifiers); how relationships are maintained in product structures; how elements of the configuration are verified and released; how the product configuration and components of it is/are baselined for change management; how interfaces are defined and managed; and how Configuration Items (CIs) are assigned/designated.

The configuration identification function results in:

- Traceable configurations realized through unique identification of products and product configuration information.
- Organized composition of the product and associated information.
- Verified and released product configuration information.
- Defined, documented and baselined product configurations.
- Managed interfaces between products.
- Configuration Items where CM governance and control is designated.
- Consistency between a product and the information about the product over the product's entire life cycle.

Failure to implement proper identification techniques puts the enterprise and its relationships with suppliers at risk and may result in traceability and security issues, significant errors, additional costs, and schedule delays both in the production and sustainment that will follow the product throughout its lifecycle. The time and money expended to restore proper identification of the product configuration is likely to far exceed that which would have been expended to manage the information correctly from the outset.

5.2.1 Configuration Identification throughout the Product Life Cycle

Principle CI-1. Configuration identification is the basis from which the configuration of products is defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's life cycle.

The purpose of Configuration Identification is to incrementally establish and maintain a definitive basis for management, control and status accounting for a product and associated configuration information as it evolves throughout its life cycle. The configuration identification process ensures that at each phase in the product's life cycle, there is a controlled set of product configuration information that can be used as a basis for the other configuration management activities (i.e., planning, change management, status accounting, verification and audit), or for developing new products, modifying existing products or components, buying products for operational use, or providing support for products and their components.

5.2.2 Product Configuration Information

Principle CI-2. Product configuration information serves as the basis for development, production, operation and maintenance/support of the product.

Product configuration information is the subset of product information that consists of product definition information and product operational information as illustrated in Figure 4.

Product definition information is the result 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).

Product operational information is derived, in part, from the product definition information. Product operational information consists of procedures and technical information needed by operators and support personnel to operate, maintain and dispose of the product including operating procedures, security procedures, maintenance procedures, spare parts lists, and disposal methods. Product operational information may also include reports that identify product deficiencies discovered during operation, maintenance, repair, or overhaul of the product and data reports that may be the basis for requests for change that result in improved performance of the product (see 5.3).

In Figure 4, product build, test, and distribution information are shown overlapping the two domains because they are based on product definition information and contain elements of product operational information. For example:

- Product design definition is the foundation for product build information, which is a reference to product maintenance and overhaul information.
- Software build/installation/load information is used in both development and operation.
- Product test includes both development testing and operational testing.
- Product distribution information including such elements as delivery (e.g., physical shipping, electronic transfer, electronic storage media, etc.), deployment, and inventory control also depends upon the product definition.

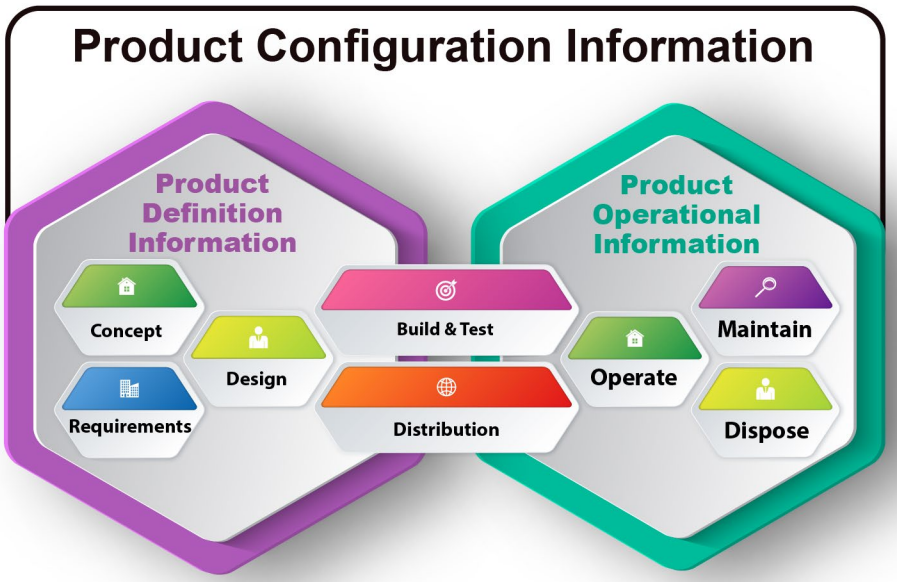

Figure 4 - Product configuration information

Establishing and maintaining product configuration information is important for safety and security reasons, and because time-consuming and expensive recovery may be necessary if the product configuration information does not exist or does not match the actual product units. For an existing product without adequate documentation, specific manpower-intensive actions may be necessary to recover the product configuration information, or to establish a workable set of product configuration information. The cost to restore control and consistency can exceed by many times the cost of continuous maintenance.

5.2.3 Identifying the Enterprise, Products and Product Configuration Information

Appropriately identifying and maintaining the identity of the Configuration throughout the product's life cycle enables traceability and management of the Configuration, which are a fundamental requirement of Information management, Quality, Program/Project management, Systems Engineering and Lifecycle Logistics best practice. The following identification elements are used to uniquely identify a product or product configuration information:

- An enterprise identifier providing the source of the product identifier.
- A product identifier of the item (e.g., name/number/rev for the part, software, document, model number, SKU, process ID).
- An individual product unit identifier (e.g., serial number).
- A group identifier for multiple items when necessary (e.g., lot number).

There are basically two levels of product and document identifiers: (1) the identifiers of the product and its component parts that are internally necessary for the developing and manufacturing activity to manage the configuration during the concept, definition, and build processes, and (2) the identifiers that are needed by a customer such as a maintainer or user of the product during the operational period including end of life.

The developer needs identifiers for all parts comprising the product and their related documents. This includes identifiers for manufacturing assemblies that, due to factors such as assembly sequence, are not identical to the design, and other identifiers for prototypes and items configured for testing.

The customer needs identifiers of the product, as well as all parts and documents, in order to assure safety, reliability, and resilience required for product sustainment, operation, and maintenance. This includes identifiers for items that can be ordered as spare, replacement, or accessory parts, and of any parts that have specific service life attributes (such as shelf life or limited period of operation) or specific warranties.

5.2.3.1 Enterprise Identifiers

Principle CI-3. Enterprise identifiers designating the responsible designer, manufacturer, or preparer provide uniqueness to the identifiers of products and product configuration information.

The designer's and/or manufacturer's name or code is used to identify the entity responsible for originating the product configuration information and for the design and/or manufacture of a product. The design activity for a product does not have to be the same as the manufacturing activity. Examples of some commonly used enterprise identifiers are D-U-N-S number, CAGE Code, and ISO/SAE WMI Code.[3]

5.2.3.2 Product Identifiers

Principle CI-4. Product identifiers are assigned so that one product can be distinguished from other products; one configuration of a product can be distinguished from another and the correct corresponding product information can be retrieved.

Managing the configuration of a product cannot be achieved unless the different components that comprise the product over its life have unique product identifiers. Also, when one product needs to be distinguished from other products or one configuration of a product needs to be distinguished from another, unique product identification down to the individual item or group facilitates traceability. The product identifier consists of a unique identifier. The product identifier, once issued to a specific product, should never be used again within that enterprise.

5.2.3.2.1 Hardware Identifiers

A hardware product and each of its component parts are assigned unique identifiers, as follows:

a. Unique identifiers are assigned to all new products down to the lowest level in each branch of the product structure for which that activity has development responsibility.

b. Already developed products used as components of the product retain their existing identifiers unless modified to the extent that interchangeability is affected.

c. Parts of a product typically have their numbering methodology determined and assigned by the "design activity" for the part. For example, Build-to-Print numbers are assigned by the acquiring enterprise that is the design activity. Parts, for which the supplier is the design activity, retain the unique identifiers assigned by the supplier unless the acquirer requires their own part numbers to be affixed to the supplier's parts. In this case, the acquirer and supplier should mutually agree who should retain a cross-reference between the supplier and acquirer's product identifiers to aid in future traceability and recall. If a part has special requirements, such as additional test or parts screening, there may need to be a unique identifier in addition to the existing identifier, to correlate the part to its specification document. The new identifier is necessary to distinguish a part meeting the special requirements from like parts that do not.

[3] D-U-N-S stands for "Data Universal Numbering System." D-U-N-S numbers are issued by Dun and Bradstreet (D&B). The Commercial and Government Entity (CAGE) Code, is a unique identifier assigned to suppliers to various government or defense agencies. The International Organization for Standardization ISO/SAE WMI code is a unique identifier assigned to world automotive manufacturers.

d. When a change is applied to a product or part of a product, its descriptive product definition document (engineering drawing, product model) is updated to reflect the change. The unique identifier assigned to a product, or part, and the marking on the part itself, is changed to distinguish it from other configurations of the part, when:

- The new or updated part will no longer be interchangeable functionally or physically with the existing part.
- The new part requires new or revised testing, maintenance, repair, training, operating procedures, equipment, or software.
- The part is altered, selected or is a source-controlled item (ASME Y14.24).
- The updated part has a different application, use, safety, or other restrictions.

When a part within a product is changed and re-identified, the rule is to re-identify the next higher assembly and all subsequent higher assemblies up to the level at which interchangeability is re-established, or an identifiable end product (against which configuration changes are tracked) is reached.

5.2.3.2.2 Software Identifiers

Software product identifiers consist of an enterprise identifier followed by a unique software artifact identifier. Unique software artifact identifiers consist of an assigned file name, version number, and build number.

A unique software identifier is assigned to each of the following software artifacts:

- A deliverable software product release package. If the deliverable product is composed of multiple artifacts, the deliverable product contains a list (such as a “read me" file) of the specific software artifacts and their unique software identifier.
- Utilities created for the software product release package. In addition to the executable software product, a release package typically includes any required support files (e.g., loaders and installers).
- Artifacts used in the software development lifecycle for the creation and verification of the software product (e.g., source code files, configuration files, data files, and test case files).
- Executable software embedded in a hardware component (e.g., firmware, embedded software, programmable logic) in addition to the unique hardware identifier.

5.2.3.2.3 Service/Process Identifiers

Services down to the level of capability, activity, process(es), subprocess(es), step(s)/task(s) and decisions also require unique identification so traceability of these items can be accurately determined.

5.2.3.3 Individual Product Unit Identifiers

Principle CI-5. Individual units of a product are assigned a unique product unit identifier when there is a need to distinguish one unit of the product from another.

When traceability of a part is desired or required, a unique product identifier assigned to individual units allows one unit of a product to be distinguished from other like products. A method of identifying an individual unit within a series of like units is by assigning a unique serial number to each unit and applying the manufacturer's identification (enterprise identifier) and that serial number to the unit. Some illustrative examples of when product units should be serialized are:

- When like products can be provided with customer options, serialization could provide the means to direct the customization and to maintain appropriate records if permitted by logistics requirements.
- When products have warranties, the serial number is used to correlate information concerning dates of manufacture and sale and the warranty period for each individual unit.
- Whenever each unit must be subject to individual functional and performance testing or screening, such as acceptance testing, serialization provides the means to correlate each unit to its test records.
- When units of the product require sustainment, operational, and maintenance reporting.
- When traceability of a part is desired or required (e.g., Serial Number, lot (batch) number).

Principle CI-6. When a product is modified, it retains its original product unit identifier, even though its part identifying number is altered to reflect a new configuration.

Although the part identifying number is altered to reflect a new configuration when a product is modified, the part retains its original serial number. This practice enables the history of each serialized part to be maintained. In order to achieve this level of integrity, it is essential that the serialization take place using a non-changing identifier as a base. The source of this non-changing base is dependent upon the internal procedures of the enterprise assigning the serial numbers. The complete part identifying number is usually not suitable because it must change if the configuration of the part is changed.

5.2.3.4 Product Group Identifiers

Principle CI-7. A series of like units of a product is assigned a unique product group identifier when it is unnecessary or impractical to identify individual units, but necessary to correlate units to a process, date, event, or test.

Typically, the manufacturer's enterprise identifier and batch or lot number identify groups of units. A batch or lot number distinguishes units to a lesser degree than a serial number. It enables an individual unit to be correlated with the test or process records for a quantity of units rather than an individual unit. In the event of a latent defect in the product, the lot or batch number enables the problem to be isolated to the number of units in a suspect lot or group of lots.

The lot or batch identifier can simply be a sequential number or a code with some significance. For example, in high volume production situations, the lot identifier might be a date code identifying the units produced on a given date. Other batch or group designators are assigned for convenience in referring to a collection of products. These discretionary indicators may or may not be marked on the products themselves. An example of a discretionary designator is a “block identifier” used to refer to a group of units of similar or identical configuration. Like serial numbers, it is essential that the lot or batch numbering takes place using a non-changing identifier as a base. When a product is modified, it retains its original product group identifier even though its part identifying number is altered to reflect a new configuration unless the modification process involves a new grouping.

5.2.3.5 Product Configuration Information Identifiers

Principle CI-8. Product configuration information is uniquely identified so it can be referred to precisely and made accessible.

Information related to a product is uniquely identified and linked (in a database or other cross-reference) to the specific product identifier and revision with which it is associated so that it can be referred to precisely and retrieved when necessary. Uniquely identifying product configuration information provides concise traceability to the information and knowledge. In addition, it enables the enterprise's ability to manage and sustain enterprise intellectual property. Uniquely identifying product configuration information reduces risk by enhancing information integrity, usefulness, and reuse.

Methods of identifying product configuration information can vary considerably; one method of identification includes both a unique identifier and the source of the identifier. It also includes a revision or version identifier, where applicable, so that the relationship to the product and its effectivity can be maintained.

5.2.4 Product Structure

Principle CI-9. Establishing product structure to organize product configuration information provides efficient application of the information over its life cycle.

Product structuring is the hierarchical decomposition of a product. Product structures show component relationships and enable visualization of a product in relation to its higher and lower level components, from any level. When effectively done, product structuring facilitates the "where used" requirement needed for both traceability and impact analysis.

Product structures are typically portrayed in a top-down manner starting with the end product and going down to the lowest level. Each level also includes the effectivity of each component (if assigned at that level) which enables the specific structure of each unit of the product or any component of the product to be retrieved. A product structure is complete when all parts and configuration information are included. The product structure representation may be graphical (see Figures 5 and 7) or as simple as an indentured listing (see Figures 6 and 8).

A product structure for hardware and/or software essentially is a composite (or master) bill of material with each level referencing product-defining documentation (e.g., engineering drawings, parts list, specifications, software requirements and design documents), and processes/procedures.

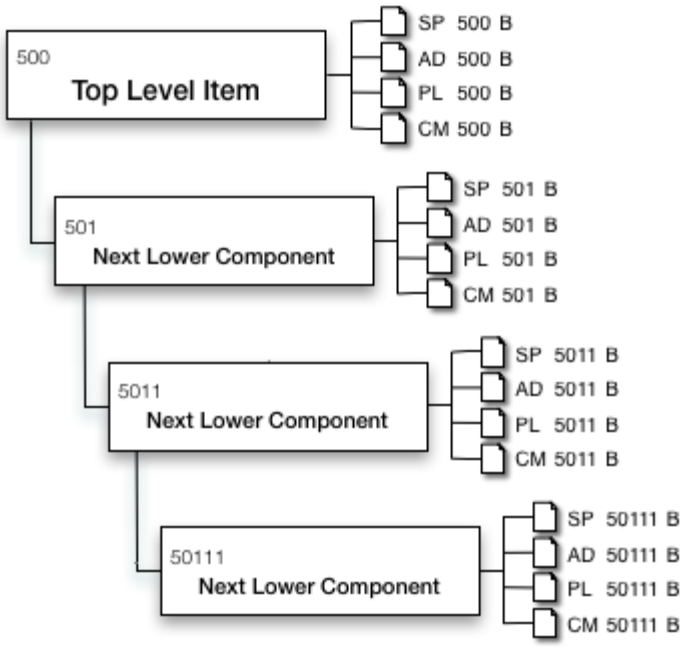

Figure 5 - Product structure, hardware and software (graphical view)

Part #/ID	L1	L2	L3	Nomenclature	Qty	Doc ID Current	Doc ID Future	Effective	Authorization
End Product				Top level item	1	SP 500 B AD 500 B PL 500 B CM 500 B	SP 500 C AD 500 C PL 500 C	01/15/2018 03/16/2018 05/13/2018	CO 2147 CO 2152 CO 2187
	Sub Component			Next Lower Component	1	SP 501 B AD 501 B PL 501 B CM 501 B			
		Sub Component		Next Lower Component	1	SP 5011 B AD 5011 B PL 5011 B CM 5011 B			
			Sub Component	Next Lower Component	1	SP 50111 B AD 50111 B PL 50111 B CM 50111 B			

Figure 6 - Product structure, hardware and software (indentured list view)

Product information for services and processes can be structured against the work breakdown of an activity. Activity structuring is essentially a composite (or master) bill of process with each level referencing activity defining processes, steps and decisions, as well as documentation detailing activity inputs, outputs, controls, and residents.

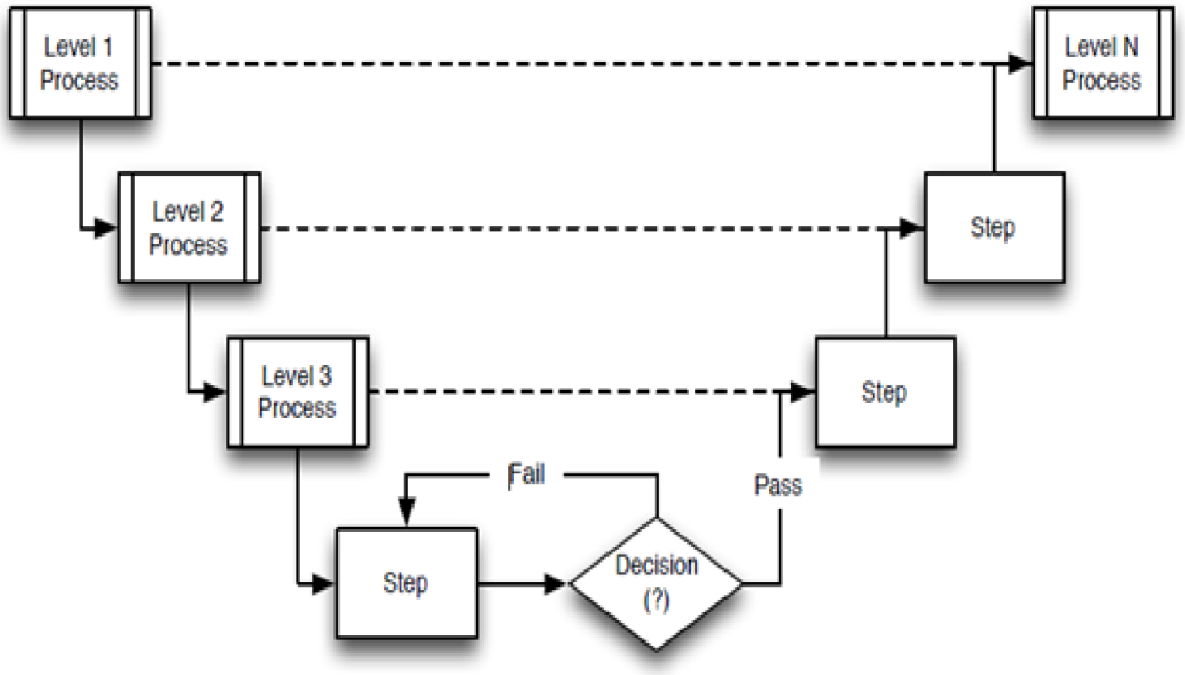

Figure 7 - Product structure, services and processes (graphical view)

Process/ID	L1	L2	L3	Nomenclature	Type	Qty	Inputs	Outputs	Controls	Residents	Chg/Var	Effective	Authorization
Level 1 Process				Top level item	Process	1	Data Material Objects Part	Data Material Objects Part	Governance Requirements Issues Best Practices	Equipment Role System Tool			
	Sub Process			Next Lower Component	Process	1							
		Sub Process		Next Lower Component	Process	1							
			Activity	Next Lower Component	Step	1							
			Review	Next Lower Component	Decision	1							

Figure 8 - Product structure, services and processes (indentured list view)

5.2.5 Release with Validation

Principle CI-10. Product release provides the appropriate process(es) and evidence necessary to validate the integrity of the product for its intended use.

Before any product/product configuration information is considered part of an approved configuration, it must be reviewed to ensure that the artifact is complete, valid and suitable for use. A release process is employed to validate the artifact's integrity. During the process of Validation and Release the status of each piece of information is established, recorded and disseminated to ensure the effective control and use of product configuration information. Initial status levels are assigned by the creator of the information but once a document is approved by the approval authority a status level of released is achieved allowing it to be distributed beyond the originating organization.

The major categories of status levels are:

- Working, which includes the state of in-process product configuration information during its creation, review and modification, while under the control of the origination team before it is placed into the release approval workflow.

- Pre-release (or In Review), which includes CM control during the process of review and internal approval up to but not including the final release approval, which is part of the Released status level.

- Released, which includes the final release approval, whether internal or external (i.e., Customer or Regulator), where the product definition information has been reviewed, approved and authorized for use, per the documented approval authority, and made available.

- Archived, which includes where historical product definition information no longer authorized for use by authorized personnel is retained for historical purposes in an "Inactive Archive".

Artifacts to be released are validated using appropriate standards (e.g., for an engineered product, the ASME suite of engineering practice standards; for software artifacts, release standards used for software; see Annex B).

Released artifacts are typically maintained in a structured repository (PDM/PLM) or within a federated data model that defines the relationships of the released artifacts to the product.

5.2.6 Configuration Baselines

Principle CI-11. A configuration baseline is established by agreeing to the definition of the attributes of a product at a point in time and identifies a known configuration to which changes are addressed.

Configuration Baselines (short form: baselines) provide affected parties an assurance of the stability and consistency of information needed for their subsequent activities. They provide a common communication of product definition and also a vehicle permitting transfer of authority over all or a portion of a product's definition. Examples could include the release of a requirements definition artifact(s) before beginning a product's design represents a baseline; the released detailed design, as production begins, represents another. The operational characteristics of an industrial plant or facility, against which performance deterioration is measured, could also represent a baseline. Conceptually, the release of each document establishes a baseline for that portion of the overall product definition and the release of each revision represents an update to the baseline.

A baseline may be quite simple and under internal control of a small group, or be formal, detailed and under external (i.e., contractual) control. Any agreed point of departure can represent a baseline. In creating a new product, the definition of desired performance and functional attributes will normally establish the initial baseline. To aid the management of complex developments, intermediate baselines may be used to allocate requirements to various subdivisions. These initial baselines are later supplemented with a detailed description (e.g., a set of drawings or models) of the resulting product. The adoption of incremental baselines usually occurs at project or contract milestones such as a design review or the decision to enter production.

Additional detailed baselines are established when the attributes of the sub-divisions stabilize, or when control of a greater level of design detail becomes necessary. Examples of such events may include the following:

- A facility becomes operational.
- Advertising of a product's features begins.
- Production begins.
- The customer approves the design concept.
- A major change or addition is approved.
- The product reaches its disposal point.

These events typically represent a need for stability by a larger or different group and therefore may also signify a transfer of change authority. The product definition information defining a product's configuration baselines must be mutually consistent and compatible. Each more-detailed baseline level must be traceable to, and be a detailed extension of, its predecessor(s).

Baselines frequently become formalized at the interface between customer and supplier, depending on the practices of the industry and the contractual involvement of the customer in the product change process (see 5.3).

Before any document or data set is considered part of a baseline, it must be reviewed to ensure that it is complete, valid and suitable for use. A release system/process is employed to validate the document and file integrity (see 5.2.5).

5.2.6.1 Configuration Baseline Types

For some environments, formal baselines are often categorized by the degree of detail defined or by the placement of authority for change approval (e.g., external customer baseline, program baseline, engineering baseline). For other environments, product life cycle phase transitions represent event opportunities where mutually agreed upon departure points can be established and maintained across the product's life, and throughout the enterprise. These and other baselines represent life cycle phase event opportunities where there is a need for stability and a desire to minimize the risks associated with using stale, uncontrolled and/or out of date information. Both process baseline types serve the CM purpose for baselines.

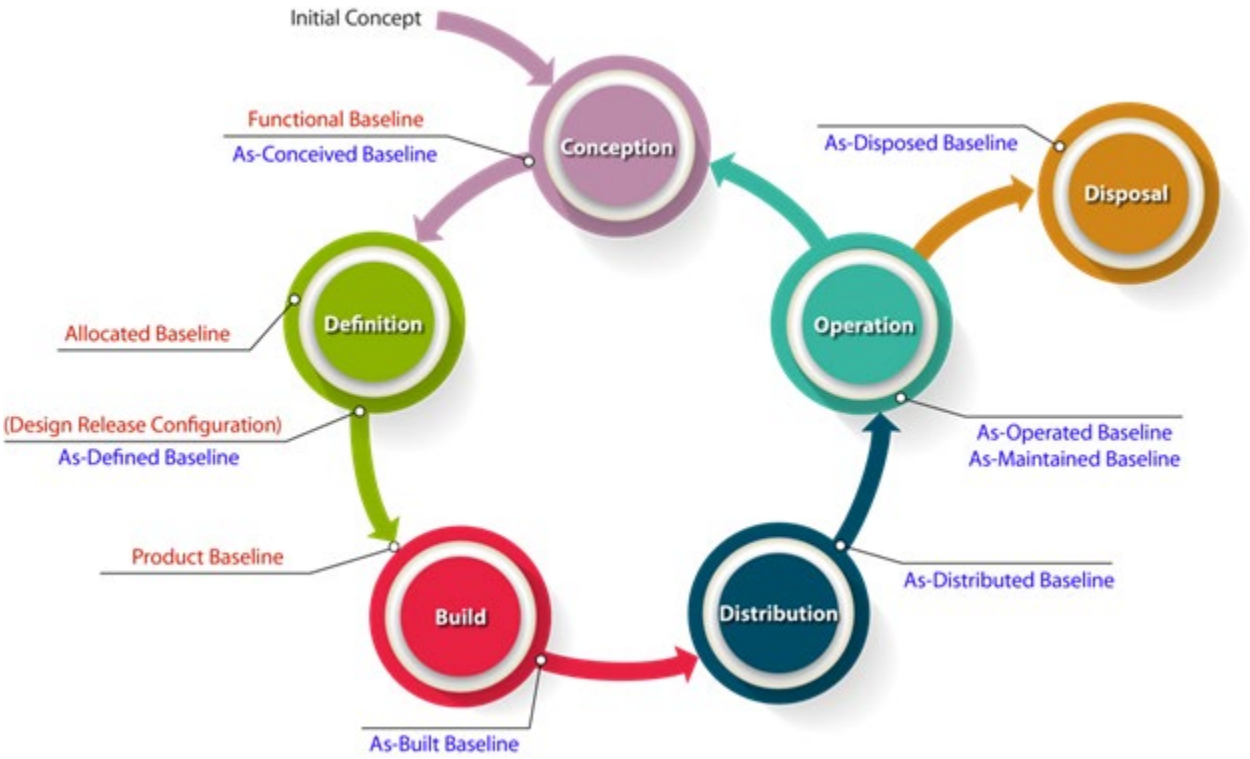

Figure 9 - Formal (red/above) and life cycle phase (blue/below) baselines examples

5.2.6.1.1 Formal Configuration Baselines

The Formal Configuration Baselines: Functional, Allocated, and Product baselines are serially aligned with recognized life-cycle phase events such as technical reviews and acquisition milestones. A Functional Baseline is established for a product when the contract or order is placed and represents the originating set of performance requirements for the product. Allocated Baseline(s) are established for major components of the product (e.g., configuration items) where the performance requirements of the product are “allocated” down via separate specifications and often establish the Functional Baseline for suppliers. As design information is released, it becomes part of the Design Release Configuration controlled by the developing activity. A Product Baseline is established after completion of design, development, and testing such that the original performance requirements have been proven to be successfully achieved and designated physical parameters confirmed; thus, leading to commencement of limited or full production (Formal Baselines are illustrated in Figure 9). At an appropriate point in each life cycle phase, a baseline is established to assure the stability, consistency, and accountability of the product, the information or both; and may indicate a change of authority.

5.2.6.1.2 Life Cycle Configuration Baselines

Life cycle baselines are usually created as the need is realized and includes sustainment life cycle phase events (e.g., As-Conceived, As-Defined, As-Built, As-Distributed, As-Operated, As-Maintained and As-Disposed Baselines illustrated above in Figure 9.) At an appropriate point in each life cycle phase, a baseline is established to assure the stability, consistency and accountability of the information; and may indicate a change of authority.

For a more exhaustive description of Formal and Life Cycle Baselines, please refer to GEIA-HB-649, “Configuration Management Standard Implementation Guide.”

5.2.6.2 Addressing Changes to Baselines

The authority to approve departures (changes) from a baseline is transferred when an expectation of stability is needed by others. For example:

- When a drawing is completed and released, a designer relinquishes control (i.e., can no longer make changes unilaterally) so that others can be assured of stability while creating related dependent drawings.
- The authority for approval of changes to a product baseline may be transferred to program management when significant investment in production tooling and facilities is committed.
- A customer may need to review changes to a product's detailed design to ensure compatibility with other products, or with the same product acquired from other suppliers.

Configuration change management, described in 5.3, is essentially a process for managing baselines. Baselines are tools to match the need for consistency with the authority to approve changes. A configuration management system or plan must recognize:

- What baselines are to be established.
- When and how they will be defined.
- The process for assuring document and file integrity.
- The authority to approve baseline changes.
- If and when change authority will transfer.
- The process by which proposed changes will be dispositioned.

5.2.6.3 Current Approved Configuration

Principle CI-12. A baseline for any product, or any document, plus the approved changes, is the current approved configuration.

A baseline or the current approved configuration becomes the basis for the next change. Baselines are normally established within the enterprise developing and manufacturing a product (see 5.3).

5.2.7 Interface Management

Principle CI-13. Interfaces between products are managed by mutually agreeing to defined common product attributes, making them part of the product configuration baselines for each product, and applying a process to maintain interface integrity.

A product's interfaces, including systems, equipment, software, and data are identified and documented in product configuration information so that their integrity may be maintained through a disciplined configuration change management process. In some cases, a formal interface management process must be employed. Interface management, also referred to as interface control, ensures that:

- The requirements for, and the detailed design of, co-functioning items contain the necessary information to enable the items, when individually designed and produced, to work together (as the 115-volt plug to the 115-volt electrical outlet), and

- If either item needs to be changed for any reason, the performance, functional or physical attributes that are involved in the interface, act as constraints on the design change.

Analyzing interface information as follows, categorizes their context and environment so that the appropriate measures to define and manage each interface, can be determined:

a. Product interface type and relationship. *Is the interface at the system, CI, assembly, or part level?*

Figure 10 illustrates many of the possible interfaces that may exist between systems or products and within a system or a product. Interfaces include external interfaces with other systems, internal interfaces between CIs that comprise the system or product, and internal interfaces of components within CIs. Interfacing items may require parallel design and development, or one or both may be an existing item (non-developmental) item. Physical interfaces may be mechanical, electrical, electronic, installation, power, hydraulic, pneumatic, or space. Performance interfaces may include requirements for such items as operating range, frequency, transmission rate, or capacity. Software and data interfaces may include language, interoperability, development, and test standards and facilities.

Table 3 shows the type of interfaces that exist at each of the configuration baselines and the related documents defining interface requirements and design. The documentation of interfaces varies from performance or detailed specifications to item, assembly, or installation drawings, to interface control documents/drawings. Interfacing parts within a CI and interfaces between CIs that are within a product are documented and managed within the design process. To facilitate quality control of interfaces, interface characteristics are highlighted for inspection in the design documentation. Interfaces between products may require specific types of formal interface management activity, depending upon the contractual relationship.

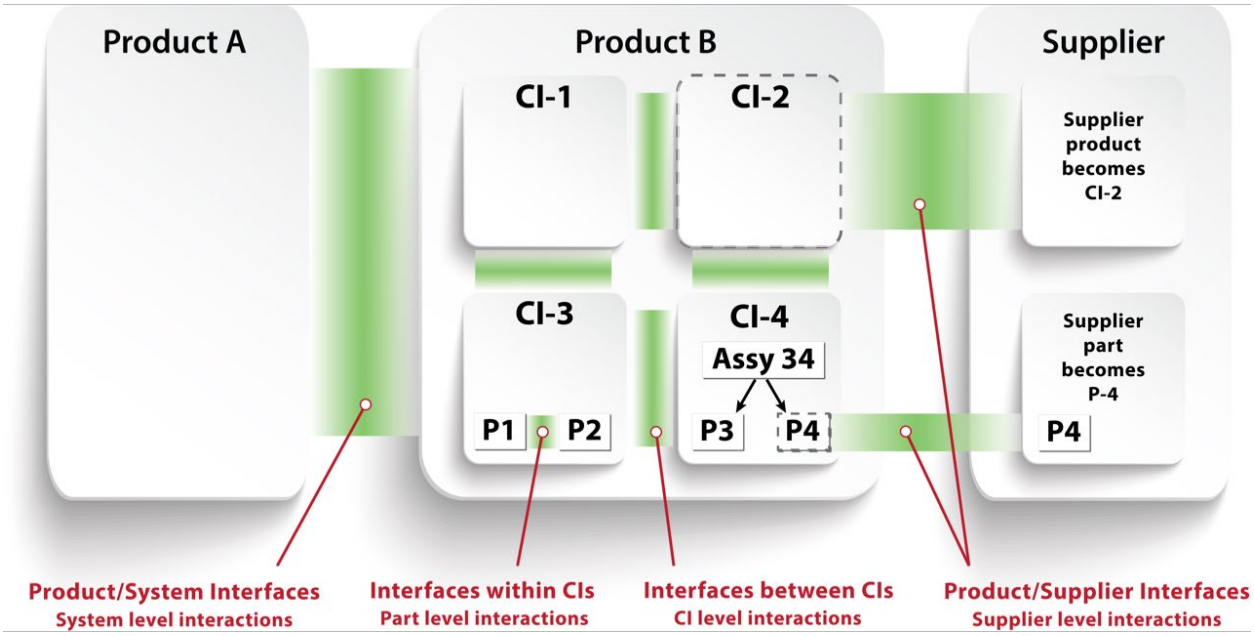

Figure 10 - Multiple levels of interface

Table 3 - Interface documentation related to configuration baselines

Configuration Baseline	Type of Interfaces	Interfaces Documented in
Functional As-Conceived	Top level system interface requirements	• System Specification • Interface Control Document
Allocated	Subsystem and CI interface requirement	• Subsystem and CI Specifications • Interface Control Documents • Software Requirements Documents • Software Interface Requirements Documents
Product As-Defined As-Built	Verified interfaces at all system/product/CI/CSCI/ component part levels	Functional and Allocated interface requirements implemented in design: • Assembly, Installation Drawings • Design Drawings/Part Models with interface characteristics noted • Software Design Documents • Software Interface Design Documents • Version Description Documents • All Product Definition Information above with interface information

b. Contractual relationship. *Is there a contractual relationship (such as a contract or purchase order) between the parties for the interface?*

If there is a contractual relationship, including a teaming arrangement, between two or more parties to an interface, there is already a vehicle for definition and control. In an Acquirer/Supplier relationship, the interface definition is included as part of the purchase agreement (e.g., by reference to a defined catalog item, or by use of a specification and/or control drawing). However, where there is no contractual relationship, a separate interface agreement may be necessary to provide a mutual understanding that both parties rely upon.

The interface agreement (also referred to as an associate contractor agreement) defines the interface process and provides for protection of proprietary information. It delineates procedures for defining and maintaining the common interface and coordinating proposed changes. The mutually agreed upon interface definition (including performance, functional, and physical attributes), detailed in an interface control document/drawing, or a version-controlled database, is included in the Functional or Allocated Baselines for the interfacing products.

c. Customer relationship. *Is the same customer responsible for both interfacing items or are different customers involved?*

Where two or more different customers or users of interfacing interoperable items are involved, an interface agreement or memorandum of agreement among them may be necessary to define the authority and responsibility for coordinating and approving changes affecting the interface and how non-technical contractual issues that cannot be resolved, will be arbitrated.

5.2.8 Configuration Items

Principle CI-14. Configuration Items are designated where distinct control is appropriate.

Configuration Item's (CI) are designated for special (additional) CM activity distinct from that which is appropriately applied to every product. The CI identifier is applied to a designated complex product or major component within the product structure of a complex product, that provides significant functions of importance to the end item product. The additional CM activity and attention applied, gives CI's more opportunity for success in meeting their requirements and intended purpose. The CI designation is a convenient way to refer to items that have separate requirements and specifications, may be separately developed, and are an item to which the effectivity of changes to its components is addressed.

NOTE: In many business environments (e.g., government acquisition, transportation), a complex deliverable end item is always designated as a CI.

Configuration items are separately identified and receive distinct control which can include:

- Acquirer participation in the change/variance process (5.3.1.3).
- Designated design reviews and configuration audits (5.5.4).
- Acquirer oversight/surveillance of the designated item and the supplier's CM processes (5.5.1).

Configuration Item and Computer Software Configuration Item (CSCI) determinations are made as the product requirements are analyzed and decomposed to form an initial product structure. The CI/CSCI designation is relative to the position in the supply chain. What is considered a CI to a product developer is, at the same time, the CI supplier's highest-level product.

5.3 Configuration Change Management

Principle CCM-1. Changes to an approved configuration are accomplished using a systematic, measurable change process.

The configuration change management function includes managing both changes to and variances from the approved product configuration information, using a systematic, measurable process. The configuration change management function applies to all types of products and all program phases.

If changes to a product or its current, approved configuration information are done in an uncontrolled manner, the product and its product configuration information can easily become un-synchronized, jeopardizing product integrity, delivery, reproducibility, safety, security, reliability, and resilience, as well as putting at risk operation, maintenance and sustainability. Changes must be documented, coordinated, evaluated, dispositioned and approved. The only changes that should be incorporated into a product and its product configuration information are those that have been coordinated with impacted areas of responsibility and approved for incorporation by the appropriate change approval authority. The threshold for making a change is that there is significant value in doing so, whether correcting a defect, adding a capability or seizing an opportunity for improvement. 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 both the impact and decision processes.
- 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.
- Assuring any required follow-up study to identify and correct conditions that led to a need for a variance.

The purpose of configuration change management is to ensure that:

- Traceability is maintained for the life of the product.
- Configuration baselines are maintained and controlled.
- Product and product configuration information are kept consistent.
- Changes and variances are documented, controlled and communicated in an orderly manner.
- Changes and variances are evaluated for cost impacts and alternative solutions.
- Change or variance decisions are based on knowledge of the complete product and operational impact.
- Approved changes are limited to those which are necessary or offer significant benefit.
- Approved variances are limited to the documented effectivity.
- Customer and/or government regulatory agency interests are considered.
- Product interfaces are controlled.
- Products continue to be supportable throughout the life cycle.
- Requested changes address the impact of the change, including which units of each product are impacted and how the change will be implemented in each unit.
- Approved changes have been implemented into all configuration information and each unit of each product impacted.

5.3.1 Manage Requests for Changes

Managing requests for change requires diligence in controlling and documenting the product and its product configuration information from the initial release of the configuration information to the product's end of life. A systematic change process effectively screens, controls and categorizes requests for changes and captures all needed information about the change.

The configuration change management process model shown in Figure 11 is valid for either enterprise configuration change management or management of changes to products under customer control. The configuration change management process addresses:

- Permanent changes documented as requests for change which provide new, approved product configurations.
- Temporary departures from the approved configuration documented in requests for variance which allow delivery of the non-conforming units of the product. Processing a variance is similar to Figure 11 except that approved variances do not create a new current approved configuration (see 5.3.4).

Developing a request for a change to the current baseline consists of the following actions:

- Justifying the need for change.
- Issuing a unique identifier for the change.
- Determining the change classification and the corresponding approval authority documenting the change.

- Documenting the change.
- Coordinating and evaluating the change for technical, schedule and cost considerations as needed.

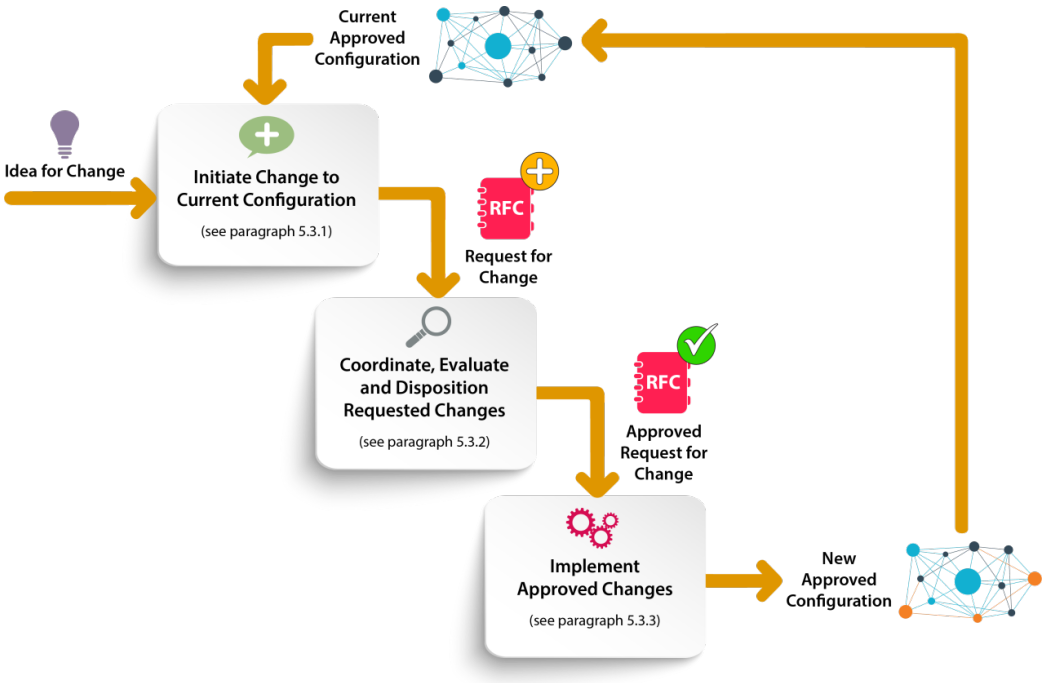

Figure 11 - Configuration change management process model

5.3.1.1 Provide Change Justification

Principle CCM-2. Justifying the need for a change provides the rationale to commit resources required to document, process, and if approved, implement the change.

Justifying the need for a configuration change should be accomplished through coordination of the envisioned request for change with affected personnel and interfacing organizations from both the technical (i.e., can we do it) and business (i.e., should we do it) perspectives. Consider coordination with, as applicable, requirers, designers, manufacturers, customers, and organizations responsible for such areas as safety, quality, planning, scheduling, cost, test, reliability, maintainability, resilience and producibility. This coordination should be conducted to provide a preliminary assessment of benefits and risks and determine if the expenditure of the time and effort to complete a request for change is warranted. It provides the justification to commit the resources required to document, process, and if approved, implement the change.

5.3.1.2 Identify the Change

Principle CCM-3. A unique change identifier enables tracking of the request for change and the status of implementation and verification of the approved change.

When the need for change is justified, a unique identifier is assigned to the request for change, It serves both as a document identifier for the request and as an identifier for the implementation and verification of the change itself. All product configuration information generated during the preparation of the request for change and all supporting information developed during the preparation, proposing, reviewing, approving implementation and verification of the change are associated with the request for change by relating the request for change identifier to the document, e.g., in a change block. The use of a unique identifier for each change within the enterprise enables access to information about, the status of, and relationships among all in-process, approved and archived changes throughout the life cycle of the product.

5.3.1.3 Classify a Change

Principle CCM-4. Classification of a requested change determines the appropriate level of review and the applicable change approval authority.

Change classification categorizes the impact of a requested change and indicates the appropriate approval authority required to make the approval or disapproval decision. The use of change classification varies depending on the environment the change is occurring in.

In some environments change classification is determined by conditionally evaluating some or all of the attributes contained on the request for change and using this information in order to determine the appropriate levels of impact analysis and review, as well as the appropriate change approval authority.

In other environments, the use of change classification categorizes the impact of a proposed change to a deliverable or end item (i.e., CI, CLIN, Product, service, etc.) after the item has achieved a formal baseline status (Functional, Allocated, Product) and indicates the appropriate approval authority required to make the approval or disapproval decision. Major, Minor, and Administrative change categories communicate the severity and impact of a change between the Acquirer and Supplier, including changes within an Enterprise. In simple terms:

- A Major classification indicates that the configuration change has impacted the function, performance and/or interchangeability characteristics of the item such that the Acquirer will need to take action.

- A Minor classification indicates that the configuration change has no impact to the performance and/or interchangeability characteristics of the item and that the change is transparent to the Acquirer requiring no action on the Acquirer's part.

- An Administrative classification indicates a basic documentation correction that has no impact on the delivered item and is transparent to the Acquirer (fixing spelling errors, grammar corrections, updating an address, etc.).

Agreement of the change classification by the acquiring and supplying parties is critical to the appropriate determination of the classification. Acquirers and suppliers must agree on the change classification via a mutually agreed upon method. Change classification occurs after a formal baseline is established and requires both parties to be involved in the configuration management process. Both parties have a vested interest in the change impact severity indicated by the classification and will need to take action as determined by the classification, the associated impact analysis, and the change implementation plan.

The traditional view of a change classification is that proposed changes that impact a formally baselined deliverable or end item's form, fit, function or interface (F3I) are classified as a Major change and conversely, changes that do not impact a formally baselined deliverable or end item's F3I are Minor changes. The key to utilizing this classification approach is founded on the totality of the impacts of the proposed change on formally baselined deliverable or end item. Said another way, Major changes have a significant impact on aspects like the end item's contract, safety, functional performance, physical attributes, and interface with other items. Minor changes do not have such impacts.

Table 4 provides typical change classification criteria to be used to determine if a change should be classified as a major, minor or administrative change. It may be cited as the standard or may be tailored in consideration of specific contractual and/or regulatory requirements applicable to the industry, customer, enterprise, program or product. However, if there are multiple customers, care should be exercised to avoid the imposition of multiple sets of change classification criteria on the same product or product line.

Table 4 - Typical change classification criteria for the acquirer/supplier environment

Major Change Criteria
— A change that affects specified and approved requirements for product attributes, including safety, reliability, and supportability. — A change, after the establishment of the product baseline, i.e., the baseline for implementation of the product design, that affects compatibility with interfacing products, including such products as test equipment, support equipment, software, and products furnished by a customer or that affects one or more of the following: ▪ Delivered operation or servicing instructions. ▪ Required calibration to the extent that product identification should be changed. ▪ Interchangeability or substitutability of replaceable products, assemblies, or components. ▪ Change to add a previously non-qualified supplier, where supplier selection is specified. ▪ User skills or user physical attributes. ▪ Operator or maintenance training. ▪ Requires retrofit of delivered products; e.g., by product recall, modification kit installation, attrition, replacement during maintenance using modified spares. — A change that does not impact the above criteria and would otherwise be classified as minor but does impact cost/price/delivery to customer(s), including incentives and fees, guarantees, warranties, and contracted deliveries or milestones.
Minor Change Criteria
Indicates no impact to the functional, performance and/or interchangeability characteristics of the item and that the change is transparent to the Acquirer requiring no action on the Acquirer's part.
Administrative Change Criteria
Indicates a basic documentation correction that has no impact on the delivered item and is transparent to the Acquirer (fixing spelling errors, grammar corrections, updating an address, etc.).

5.3.1.4 Document a Change

Principle CCM-5. As the primary vehicle for referencing and managing a change, the request for change must be clear and comprehensive from technical, cost and scheduling perspectives.

To define a change and facilitate proper reviews, inputs and informed decisions, the requested change should include:

- A clear statement of the change.
- Change classification for the requested change.
- What product(s) components and interfacing products are affected by the requested change.
- What product configuration information is affected by the requested change.
- Scope and description of the requested change, including all technical and operational impacts such as security, specified performance, test, qualification, operation, maintenance, servicing, operation and maintenance training, repair parts, support and test equipment.
- Reason or justification for the requested change, including a risk analysis on both implementing the change and maintaining the status quo (i.e., consequences, if any, of not implementing the change).
- Proposed effectivity of the change.
- Estimated cost increase or savings associated with the change.
- Implementation plan and delivery schedules for the requested change.
- Requirements, if any, for retrofitting products.

- Change approval date.
- Dispositioning authority identification (e.g., signature).
- Disposition of existing pre-change inventory (i.e., Rework, Scrap, Use up, Restricted use).
- Any supporting documentation that further defines the need for the change.

5.3.2 Coordination, Evaluation, and Disposition of Requested Changes

Principle CCM-6. Prior to approval, a requested change is evaluated for all impacts and risk considerations including technical, operational, support, schedule, and cost, as well as the consequences of not approving the request.

Principle CCM-7. After considering all impacts and risk factors, change approval decisions are made by an appropriate authority who can commit resources to implement the change.

Every requested change to a product should be presented to and coordinated with all affected parties for evaluation and to secure their inputs in order to provide a complete request for change. The change coordination, evaluation and disposition process modeled in Figure 12 encompasses reviewing the preliminary impact assessments; determining the required change effectivity; establishing the reoccurring and non-reoccurring costs, the rollup price; and providing the approval authority with the necessary information to review the request for change and make an informed disposition decision. Coordination and input from affected functional areas is required throughout the process as shown in the figure.

Change Boards are a means of achieving the necessary coordination, evaluation, and decision making. Change boards go by many aliases, but whether it is a committee, team, program review board, configuration control board, change review board, or some other name, it should be chaired by someone with the authority to disposition changes and commit resources of the enterprise, within defined fiscal limits, to implement them. It should be noted that there may be multiple levels of change boards with approval authority delegated to lower level boards by change type or classification based on documented criteria. The evaluation and disposition of a change may require the participation of multiple change approval authorities, such as the developing enterprise and the customer.

The impacts and commitments captured in requests for change, including change revisions, provides configuration status accounting the history of each change and an audit trail to facilitate verification testing, analysis of product failures and for use in other product decisions (see 5.4).

The coordination, evaluation, and disposition actions in Table 5 are key to the success of the process.

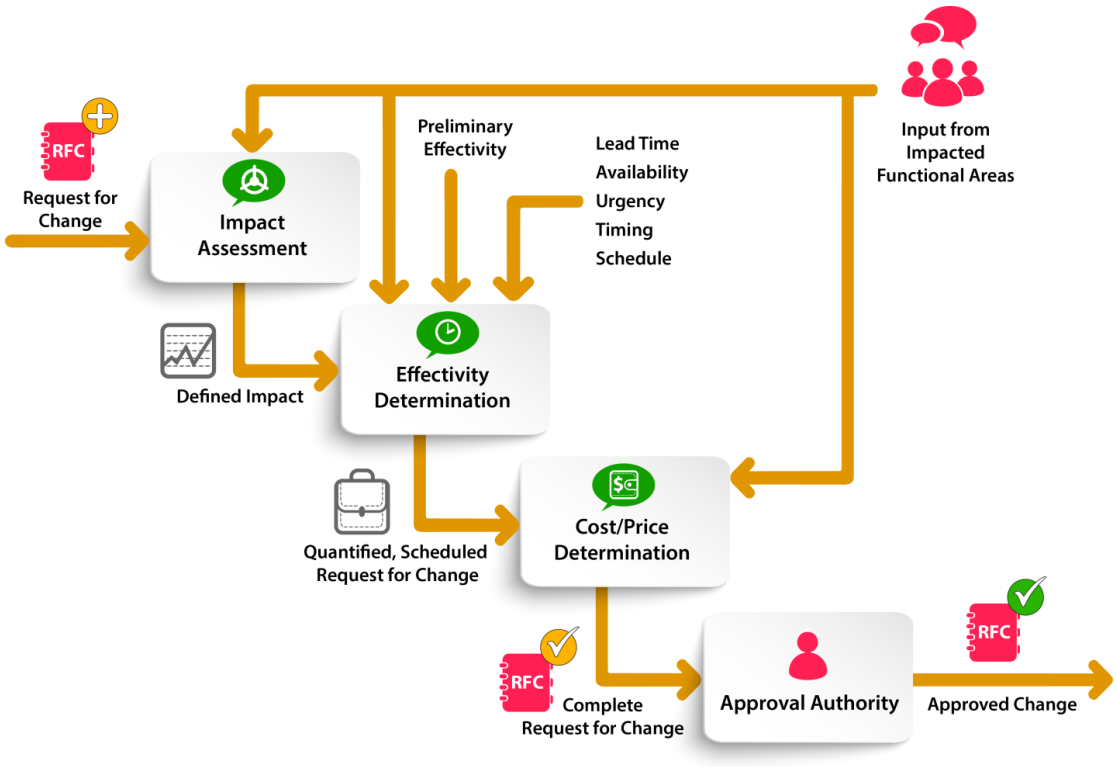

Figure 12 - Change coordination, evaluation, and disposition process model

Table 5 - Coordination, evaluation and disposition actions

Coordination
— Coordinate the requested change with all program participants who may be impacted by the proposed change; obtain a commitment to: ▪ Evaluate the proposed change and define their impacts. ▪ Confirm or validate the content of the proposed change from their perspective.
Evaluation
— Instruct stakeholders to evaluate the requested change and provide input: ▪ Documenting how it impacts them from a technical, cost, risk and schedule perspective. ▪ Documenting how it impacts them if the change was not made. ▪ Identify impacted products, components, and product configuration information. — Determine implementation schedule including new or revised release dates, cut-in points and effectivity range for each affected unit (i.e., Delineate which units of the product are to be changed), supplier delivery dates, new or revised dates for design reviews and audits, and critical path analysis of total program schedule impact. — Develop proposed implementation cost estimates to include administration, engineering, development, prototyping, planning, manufacturing, testing, increased/decreased costs for new parts, scrapping or rework of parts on hand, new or revised tooling, new or revised software, recall and retrofit of already purchased or delivered units, increased/decreased effort and resources required to fulfill service requirements for customers, and disposal. — Evaluate, affirm, and integrate (coordinate corrections as required) the technical, product configuration information, cost, and schedule inputs into the request for change.
Disposition
— The integrated request for change, including all technical, schedule, and cost impacts, is presented to the approval authority. — The approval authority evaluates and dispositions the requested change as either approved, deferred for more research, or disapproved, and it directs implementing actions. The decision can also modify the initial documented scope and/or effectivity of the requested change. — The disposition results are disseminated to stakeholders and action items are tracked.

5.3.3 Implementation of Approved Changes

Principle CCM-8. An approved change is implemented in accordance with documented direction approved by the appropriate level of authority.

Change implementation is the execution of the actions described in an approved request for change into the affected product(s) and product configuration information in accordance with the approval authority decision documentation to accomplish its scope and intent. The implementation of each approved change is verified as described in 5.5.3 to ensure that the product and product configuration information are properly updated.

Planning for, and implementing, a change can be very simple or can involve many complex and interrelated considerations. Approved change implementation requires coordination with those directly implementing the change and with impacted support and maintenance functions. The basic planning for implementation of the change is accomplished before the change is approved when it is being evaluated to determine its scope and impact. Once the change is approved detailed implementation planning and instructions consistent with the basic planning, are normally required.

As shown in Figure 13, a sample model for change implementation and verification, implementation involves the release of new or revised product definition information including requirements and design information. It may involve identification and release of new or revised operation and maintenance information, build and test information, and could also affect sales information (e.g., catalogs, marketing literature), as well as customer information (e.g., user manual). This process should correlate the document revisions to the changes approved for incorporation. Choosing effectivity and planning implementation requires knowledge not only of the lead times associated with changing the product (whether in production or by retrofit, recall or other means) but of the actions and lead times necessary to update software and effect the associated change in all impacted support areas (such as the update of support software, availability of spare and repair parts, or revision to operating and maintenance instructions). Other factors involved in choosing effectivity and planning implementation are:

- The urgency of the change (e.g., is safety involved?).
- Parts and materials on hand (an implementation be delayed until they are depleted, can they be modified, or do they need to be scrapped?).
- The need to support multiple configurations because all existing units of the product will not be updated, or will not be updated at the same time.
- The timing of the introduction of the changed product with respect to customer preferences and needs, competition, marketing strategies, etc.

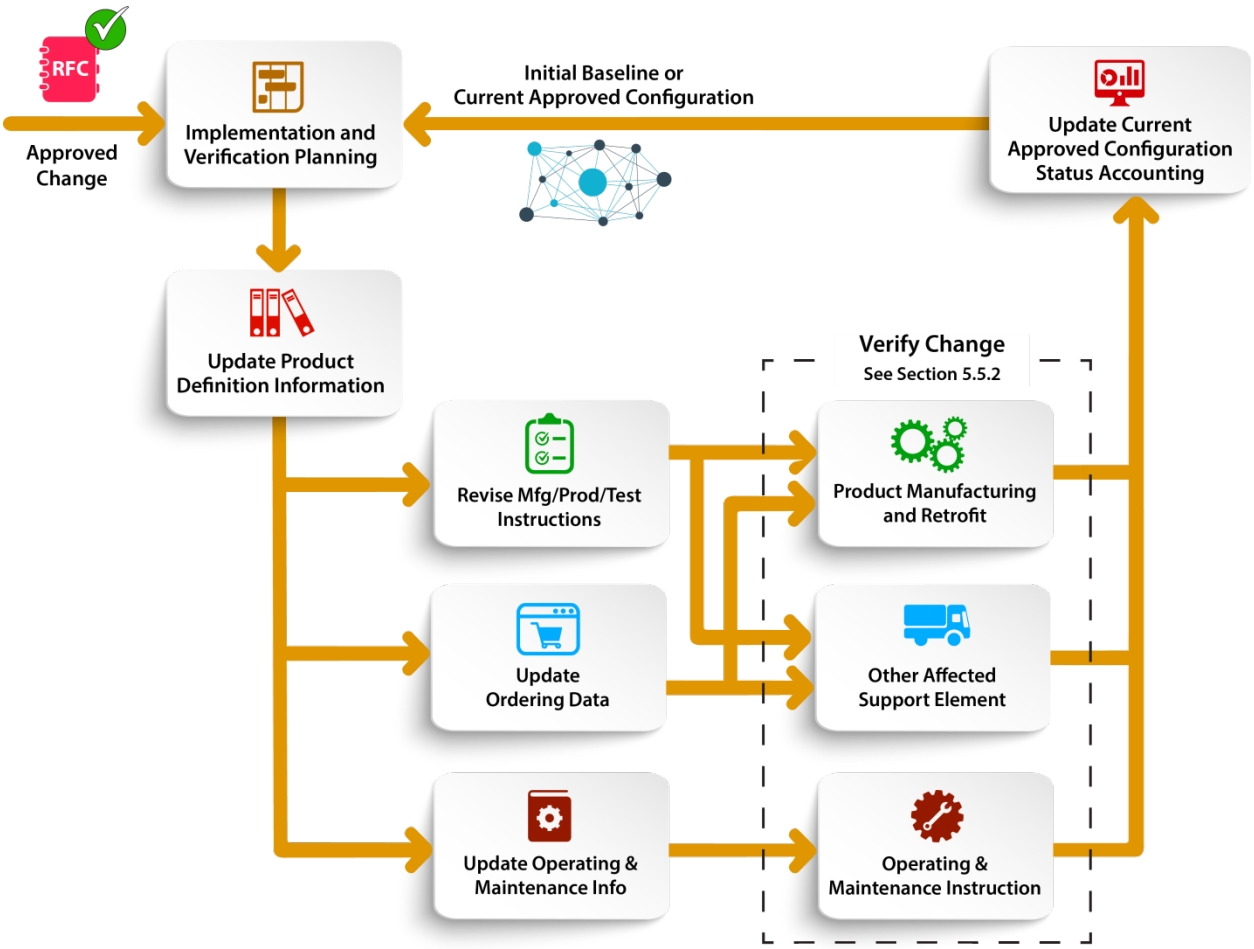

Figure 13 - Change implementation and verification model

5.3.4 Manage Requests for Variance

Principle CCM-9. If it is necessary to temporarily depart from approved product configuration information, a request for variance is identified, classified, documented, coordinated, evaluated and dispositioned.

A request for variance is required when a departure from approved product configuration 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 faults, material recalls and for various other reasons. A request for variance differs from a request for change as it does not require a change to the approved product configuration information from which it temporarily departs. If other than a temporary departure is needed, approved product configuration information must be permanently modified using a request for change.

Any request for variance must be documented, coordinated, evaluated, and dispositioned by the appropriate approval authority.

It is important to determine the cause of the variance and to determine what corrective action will be taken to prevent the need for a variance; e.g., change the product configuration information for inclusion of design variations, improve manufacturing quality, or revise inspection/test procedures.

A request for variance should be evaluated to determine the appropriate level of approval required for authorizing the requested variance and for directing the action to be taken to prevent recurrence.

Creating a request for variance consists of the following actions:

- Justifying the need for a variance.
- Issuing a unique identifier for the request for variance.
- Determining the classification of the request for variance.
- Documenting the request for variance.
- Coordinating and evaluating the request for variance for technical, schedule and cost considerations and corrective action, as needed.
- Trace the variance for corrective action, as needed.

5.3.4.1 Justifying the Need for a Variance

Justifying the need for a variance should be accomplished through coordination of the envisioned request for variance with affected personnel and interfacing organizations from both the technical (i.e., can we do it) and business (i.e., should we do it) perspectives. In evaluating whether a requested variance should be approved for implementation and incorporation in a product or for “use as is”; all potential impacts, including technical, operational, support, schedule and costs relative to its supporting configuration information should be considered. The justification should include the exceptional or extraordinary circumstances that apply to this variance such that it should not be considered as a permanent change to the approved product configuration information.

5.3.4.2 Identify, Classify, and Document a Request for Variance

Uniquely identify each request for variance. A uniquely identified request for variance facilitates the review and decision-making process, the configuration status accounting, and the follow-up and corrective actions to close each variance.

The classification of a request for variance is the categorization of its effect on function, performance, interchangeability, safety, security, health, environment, cost, and schedule while also being useful in prioritizing resolution and determining the processing and approval method. The use of the request for variance classification differentiates between variances with various degrees of impact, as follows:

- Critical variances impact safety, security, health, or environmental factors. (Note: critical variances are normally not permitted by authorizing acquirers).
- Major variances have a significant impact on product characteristics such as performance, operational limits, interface, structural strength, or qualification and may impose limits on product use, or operation, or cause the temporary use of alternate items for the restoration of interface(s) and capabilities.
- Minor variances are any variances not considered critical or major.

Each request for a variance document should include:

- Variance description and scope, including its effects.
- Request for variance classification.
- What product(s) components and interfacing products are affected.
- Reason or justification for the request for variance.

- Effectivity of the request for variance.
- Priority and urgency of the request for variance.
- Proposed consideration, if any, for accepting the request for variance.
- Identification of limitations created by the non-conforming product.
- Proposed method of variance closure, if required (for example approval of a request for change that eliminates the variance).
- Requested variance approval date.
- Dispositioning authority identification (e.g., signature).

The recording of request for variances, both proposed and approved, provides the configuration status accounting function an audit trail to facilitate the analysis of product non-conformances and allows for use in future product decisions (see 5.4).

5.3.4.3 Coordinate, Evaluate, and Disposition of a Request for Variance

The process to coordinate, evaluate and disposition a request for variance, encompasses assessing the impacts, determining effectivity and costs, and providing all the information necessary to make a decision to approve, defer, or disapprove the request for variance and disseminate that disposition, as follows:

- Clearly articulate a justification for the needed request for variance. Preliminary coordination with affected personnel should be conducted to analyze the scope and impact of the identified departure from the product configuration information, to provide justification to commit the resources required to document and process the request for variance.
- Identify and evaluate the potential impacts of a request for variance in coordination with the affected areas of responsibility to help ensure that all are identified. Identify any required corrective actions as part of the evaluation process. All variances should be evaluated and justified consistently across the enterprise subject to any unique contractual and/or regulatory requirements associated with a division, program, or project.
- Affirm the effectivity to which the request for variance applies. A request for variance should be limited to a specific unit or group of units or specified time frame. If the intent is to cover all units to be produced, a request for change is used.
- Investigate how the request for variance affects the financial aspects of the product for both the customer and the enterprise. Customer cost considerations and additional penalties and fines may be required as a result of providing a nonconforming product.
- Provide the proposed request for variance to the designated approval authority for disposition. The approval authority may disposition the request for variance, convene a change board to approve or disapprove it, or defer the decision for further analysis and re-disposition, subject to contractual and/or regulatory requirements. An approval decision may also be predicated on updates to the variance prior to its dissemination (approval with direction to make specific changes such as modification of the initial documented scope and/or effectivity). In addition, the disposition of the variance may address the resolution of contractual and/or regulatory issues resulting from the dispositioned variance.
- Formalize, document, and disseminate to the affected parties the results of the request for variance disposition and action items that are required to be performed.
- Track the variance for corrective action, as needed.

5.4 Configuration Status Accounting

Configuration Status Accounting (CSA) consists of the recording and reporting of information needed to trace and manage a configuration effectively by providing information and process status, as well as CM process performance data. The purpose of CSA is to capture, record, retrieve and report status and performance information about the product under configuration management and make the information accessible to support program/project activities as needed. Measurement of CM activities gives insight into their effectiveness and efficiency. Metrics and key performance indicators derived from CSA information can be used to evaluate and improve CM process effectiveness and efficiency for the benefit of the Enterprise. A failure to put appropriate status and performance measurements in place will result in inconsistent CM process execution, which places both the product and the enterprise at risk.

Principle CSA-1. Configuration Status Accounting (CSA) provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle.

Configuration Status Accounting is the CM function, which supports program/project activities including configuration management, information and data management, quality management, program management, systems engineering, manufacturing, software development and maintenance, logistic support, modification, and product maintenance, by 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 revision and/or version of the product (refer to ANSI/EIA-836) and to the current approved configuration of any product (see 5.2).
- The CSA system enables capture of meaningful metrics to be used to improve the CM process (see 5.1.4).

As illustrated in Figure 14, CSA information is a cumulative collection that expands as the product life cycle evolves from the need for a product through its conception, definition, build, distribution, operation and maintenance, and disposal phases of its life.

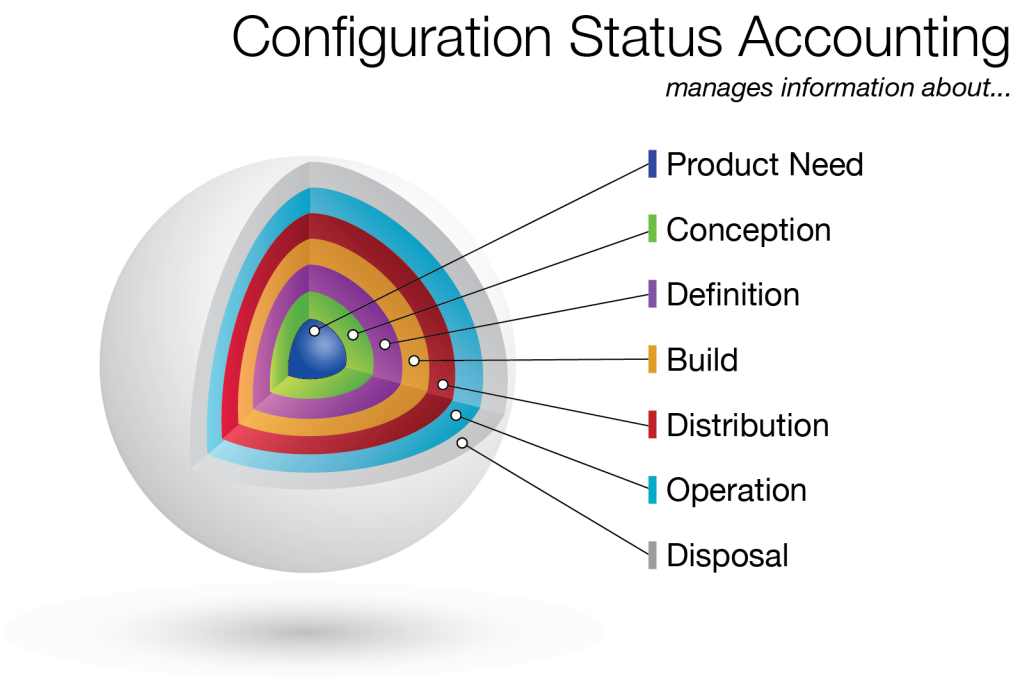

Figure 14 - CSA information evolves throughout the product life cycle

5.4.1 CSA Information Capture and Reporting

Principle CSA-2. Information about the product and the product configuration information are captured as CM tasks are performed; reporting is accessible to support program/project activities as needed.

Figure 15 models the CSA information capture and reporting process, illustrating the CSA activities providing inputs to the process, the CSA tasks, and the types of output resulting from the process. Table 6 amplifies the figure by providing more detailed examples of the information sources and outputs that occur in each phase of a generic product life cycle.

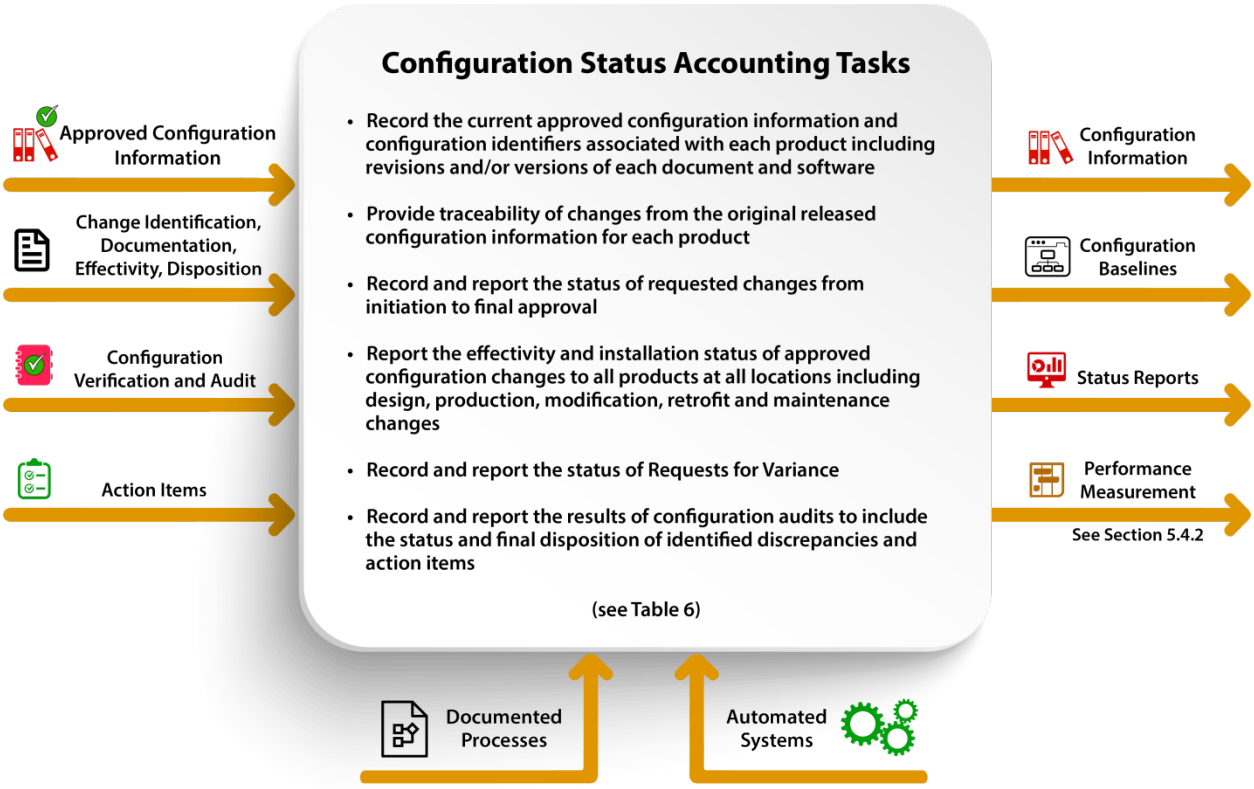

Figure 15 - CSA information capture and reporting model

Status accounting information may be captured through various means depending on the complexity and volume of data, and the availability of resources and tools. CSA information can be captured through a system designed specifically for collecting and reporting configuration information. CSA for system and hardware configuration may be integrated in an enterprise material requirement planning application and may draw from a purchasing system, a manufacturing system, logistics application, or any other applications used within an organization. CSA may also be maintained in a PDM/PLM data base or spreadsheet.

Table 6 - Example CSA input sources and outputs over the product life cycle

Program Phase	Typical Information Sources	Typical Outputs
Conception	• Baseline performance/ cost/schedule goals • System requirements documents • Preliminary system performance specifications • Requests for change	• Current revision/version of each document • Approval status for each document • As-Conceived configuration, current and as of any prior date
Definition and Development	• System performance specification • Performance specifications • Detailed specifications • Engineering drawings and associated lists • CAD files • Test plans/procedures and results • Audit plans • Audit reports • Audit certifications • Requests for change • Requests for Variance • Engineering orders, change notices, etc. • Installation and as-built verification • Removal and re-installation	• Approval authority for each document • Release and approval status of each document • Current baseline • Baselines as of any prior date • As-defined configuration, current and as of any prior date • As-tested configuration, current and as of any prior date • Status of requests for change, and variances in process • Effectivity and incorporation status of approved changes and variances, including retrofit effectivity • Test and certification requirements to be completed prior to milestones such as reviews, demonstrations, tests, trials, delivery • Verification and audit status and action items
Build/Production and Deployment	• All Development Phase Items • System/Component location by traceable number • Support equipment and software • Spares • Trainers • Training Material • Operating and Maintenance Manuals • Delivery dates and warranty data • Shelf life or Operating limits on components with limited life or limited activations, etc. • Operational history (e.g., for aircraft - take-offs and landings) • Verification/Validation of Retrofit Instructions, Retrofit Kits • Incorporation of Retrofit Kits • Installation of spares, replacements by maintenance action	• All Development Phase Items • As-built configuration, current up to time of delivery, and any prior date • As-delivered configuration • Current configuration of all Systems in all locations • Required and on-board configuration of all Support Equipment, Spares, Trainers, Training, Manuals, Software, Facilities needed to operate and maintain all systems or components at all sites • Status of all requested, in process and approved changes and variance requests • Authorization and ordering actions required to implement approved changes, including recurring retrofit • Warranty status • Predicted replacement date for critical components • Retrofit actions necessary to bring any traceable items to the current or any prior configuration
Operation and Support	• All Production and Deployment Phase Items	• All Production and Deployment Phase Items • As-maintained configuration, current and as of any prior date • If needed, As-disposed configuration, current and as of any prior date

ANSI/EIA-836, “CM Data Exchange and Interoperability,” and ANSI/GEIA-859, “Data Management” are useful resources to assist in implementing CSA systems and processes. ANSI/EIA-836 provides information on the transfer of controlled CSA information and data required to perform CM functions throughout a product's life cycle. It provides reference information to facilitate CM data exchange and interoperability regardless of specific data encoding and transport methods. CSA, which focuses on the product life cycle, is a foundational function to “Data Management” (DM), as outlined in ANSI/GEIA-859, which addresses the entire range of enterprise information.

CSA information that is accessible to key functional areas such as development, production and sustainment, as well as program management, Quality, Systems Engineering and Logistics, should be readily viewable and/or extractable, adequately secured, safeguarded, and retrievable after extended storage.

A Supplier’s ability to quickly and effectively provide accurate CSA data to an Acquirer, increases the confidence the Acquirer has in the supplier and the provided product. In addition, accurate, readily available CSA data facilitates the verification and audit processes.

Software configuration information, status, and meaningful Software Configuration Management (SCM) metrics, are typically compiled using an automated SCM tool within a software engineering environment. CSA for software products is the by-product of:

- Code Management
- Build Status
- Application Performance
- Quality Management
- Project Issue Tracking
- Time Management
- Change management related to software versions and their documentation.

5.4.2 Configuration Status Accounting Performance Measurements

Principle CSA-3. Metrics derived from configuration status accounting information are used to evaluate and improve CM process effectiveness.

CM process metrics measure the performance of configuration management process, support evaluation of its effectiveness, and provide insight into process improvements. Use metrics as necessary to find the cause of suspected problems or when there appears to be an opportunity for process improvement. One metric may not tell the whole story. Integrating metrics from several viewpoints may be needed to get a complete picture. There should be a balance in the number of metrics to be taken. Before selecting what metrics to collect, define the desired results to be achieved.

Before beginning any metric or measurement collection effort, it is important to plan the collection process and have a clear idea of what the end use of the information will be used for and what organization might be using the collected metrics.

CM process performance and status types of metrics can be used to support problem resolution and process improvement initiatives on any given project. CM process metrics can be tailored as necessary to fit the needs of the project.

5.5 Configuration Verification and Audit

The Configuration verification and audit function establishes that:

- Appropriate CM processes are in place and that they are effectively operating to maintain consistency between the product and its product configuration information throughout the product life cycle.
- The approved product configuration information is complete, accurate and current to produce the product, and applicable operation 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.

Activities within Configuration verification and audit include:

- Continuous CM process verification.
- Verification of the initial product configuration to assure that it meets its documented configuration requirements.
- Verification of the incorporation of approved changes.
- Functional and Physical Configuration Audits or their equivalent.

5.5.1 CM Process Verification

Principle CVA-1. Verify CM processes to ensure appropriate consistency is established and maintained in their execution.

Verification of CM processes provides that surveillance is maintained to ensure that the processes are adequately documented, that the process documentation is being followed and that the process execution is in compliance with requirements. The outcome of CM process verification is used to make recommendations on how to maintain and continuously improve them while keeping in mind the goal of consistent conformance to CM principles.

Verification includes review of CM processes to demonstrate compliance to, and the effectiveness of documented CM plans, processes, procedures and tools, as well as to ensure their performance. These reviews are conducted as periodic assessments or when the need for an individual assessment is indicated by process metrics. Monitoring and evaluating the health of CM processes identifies continuous improvement opportunities and ensures that problems are identified before they cause negative impact to the capability (see 5.1.7).

CM process verification and measurements may include:

- Verification that CM processes are documented.
- Verification that CM processes are implemented.
- Verification that CM processes are reviewed on a periodic basis.
- Verification that CM processes are effective.
- Verification that appropriate CM tools are being used within CM processes.
- Verifications to demonstrate and confirm achievement of CM requirements.

5.5.2 Verifying Product Configuration

Principle CVA-2. Verifying a product's compliance with the physical, functional, and interface requirements in approved product configuration information confirms the basis for managing product configuration.

A product is verified to ascertain that it has achieved specified requirements and the design of the product is accurately and completely documented in configuration information. Verifying the documentation determines that it is adequate for its intended purposes and accurately reflects a design compliant with the product's functional and physical requirements. A product should be able to be produced from its documentation with confidence that it will meet all requirements without further design effort. Beyond this fundamental requirement, other factors (such as the need to procure from other sources or operation and maintenance needs) may influence the documentation content and formality. A software product should also be in compliance with published design and coding standards, so it can be maintained, modified and upgraded.

Verification methods, including product tests, analyses, inspections, demonstrations and simulations, should be carefully planned to ensure all requirements are addressed and the individual verification methods chosen are appropriate. A single verification method or a combination of verification methods is acceptable based on the complexity of the product. Once selected, and approved, the verification method(s) are considered part of the released product configuration information and are not subject to arbitrary change. Verification of complex designs may require a documented plan that may be subject to customer approval.

Requirements analysis and test tools facilitate the verification process. They account for and verify all product attributes. Results are typically recorded in a matrix indicating each discrete requirement, its method of verification, and reference to its verification procedure and the documented verification results.

Conceptually, the product configuration verification occurs in sequence by first determining the acceptability of the design and then confirming that the documentation portrays that design. In practice, an effective method is to verify requirements and product configuration incrementally during the course of product development and manufacturing by making the verification an integral and continuous part of the process. Using an incremental approach avoids the possibility of having to perform a "tear down" later, avoids schedule delays, and methodically provides data for configuration audit.

5.5.3 Verifying Incorporation of Approved Changes

Principle CVA-3. Verify the implementation of each change to ensure consistency is maintained between the product, its configuration information, and related support assets.

Once a product's initial configuration has been verified, approved changes to its configuration must also be verified. Implementation of a change in the product should be verified to ensure consistency between the product, its documentation and its support elements. Verifying incorporation of approved changes includes, but is not limited to:

- Verification that all impacted documentation has been changed to reflect the incorporation of approved changes and to satisfy the requirements for traceability of variances and engineering changes.

- Verification required to demonstrate the achievement of specified functional, interoperability, and interface characteristics.

5.5.4 Configuration Audits

Principle CVA-4. Configuration audits are a summation of the configuration verification process, where necessary to establish approved configurations at key points in the product life cycle.

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 production. 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 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.

A robust well-documented in-process product configuration verification process (5.5.1, 5.5.2, and 5.5.3) results in definitive evidence of compliance with requirements, consistency of product to documentation, and incorporation of approved changes. The effectiveness of the process builds customer confidence and is directly related to the ease with which configuration audits are conducted, or in some cases are even necessary.

Configuration audits include performance verification (functional configuration audit or equivalent, 5.5.4.1) and design verification (physical configuration audit or equivalent, 5.5.4.2). Other types of configuration audits are conducted in various phases of a product life cycle. Some examples are: (1) an audit to determine the currently installed configuration of equipment in an operational facility or a vehicle; and (2) an audit to assess the quantities and configurations of spare parts in inventory.

Audit of a complex product may be accomplished in a series of incremental audits and is often accomplished via a check of a representative sample of the records produced. Audits may be conducted by the organization responsible for the product development or production, by the customer, or by a designated third party. In order to maintain the effectiveness and objectivity of an audit, a person should not be allowed to audit their own work. Lead Auditors and a representative of each affected party to the audit participate in audit planning and preparation. Audit plans and agendas are reviewed and agreed to prior to the audit. They provide for facilities to house the audit team, documentation library of product configuration information, access to the product(s), tools and equipment, and personnel appropriate for the type and scope of the audit.

During the conduct of an audit, auditors record non-conformances and areas in need of improvement. Prior to, or while audit is occurring, the client and/or other parties may observe and/or supply information as appropriate. The client reviews audit findings and determines the root cause, as well as appropriate corrective action(s) to be taken. Affected parties agree to action items and the plan for their successful closure. Audit minutes provide a record of the audit, the audit findings, and corrective actions taken. Follow-up occurs until all required action items are complete.

5.5.4.1 Functional Configuration Audit

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

In simple terms, an FCA validates that the product requirements are achieved by the product's design in the applicable product definition information. 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. The tests include verification/qualification and acceptance tests verifying all hardware and software functions. The FCA is often facilitated by requirements analysis and test tools and a verification matrix (see 5.5.2).

In some cases, especially for large, complex CIs and systems, the FCA may be accomplished in increments. Each increment may address a specific functional area of the system/CI and document any discrepancies that are found in the performance capabilities of that increment. After all increments are completed, a final (summary) FCA addresses the action items identified in the incremental audits, completes action on system functions not covered incrementally, and documents the status of the FCA in minutes and certifications.

Although an FCA is normally required only once for each product, a number of FCA-like activities may be accomplished at other times during the life cycle of the CI or system in conjunction with approved configuration changes such as major modifications or service life extensions. If a major Request for Change (RFC) incorporates a new design, the performance of the product with the change incorporated must be verified to ensure that it will not degrade the product's specified performance. Although a complete retest and FCA are not required for each approved change, the verifications specified in the RFC are required. They may vary from a simple analysis of the similarity to the old design to a lengthy program of testing similar to the original verification testing. If an RFC or a modification program incorporates a new CI, the results of the verification testing of the CI, might be checked at an FCA. Results of retesting of the existing system elements with the new CI incorporated could also be subject to a review similar to an FCA.

5.5.4.2 Physical Configuration Audit

The objective of Physical Configuration Audit (PCA), or equivalent, 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 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.
- Supporting processes used in producing and managing the product are valid.

Normally the first units created with production facilities and processes are subjected to a PCA conducted by the developer/producer or, in the case where all units are acquired by a single customer such as a government agency, by the customer. If a later production unit is designated for PCA, then it may be necessary to retrofit the prior units to the approved product baseline.

The PCA allows the establishment of a Product Baseline for the CI reflecting the design that will be delivered to customers and will require support. The PCA provides confidence that any future redesign will be based on accurate information.

PCAs for large, complex CIs and systems are typically accomplished in increments with each increment addressing a specific major CI or set of CIs. A final (summary) PCA addresses the action items identified in the incremental audits, completes action on system functions not covered incrementally, and documents the status of the PCA in minutes and certifications.

Comparison of the documentation with the physical product can often be accomplished during assembly of the article, to avoid the need for later disassembly. These verifications are considered complete upon resolution of discrepancies or departures found and correction of related configuration information.

From a logistics standpoint, it is essential that support activities know the exact configuration so that correct spares can be acquired, and maintenance, repair and modification actions can be facilitated.

NOTE: Without continuous maintenance of the product baseline in the actual operation and maintenance environment, this basic goal can be compromised. Expediency, unauthorized changes, cannibalization, overwork, failure to maintain records, carelessness, and gaps in funding can cause the documented configuration of operational software or hardware to become inaccurate. In some situations, a unit cannot be maintained or modified until its configuration is determined. In such cases, it is necessary to inspect units against approved product configuration information, as in a PCA, to determine where differences exist. Then the unit can be brought back into conformance with the documentation, or records corrected to reflect the actual unit configuration.

6. APPLICATION NOTES

a. SAE/EIA-649 is a global consensus standard that may be used as a source for applicable information to prepare such items as a request for proposal or an evaluation or certification checklist. The application of properly tailored CM functions to a product, on a project, or the enterprise, enables the user to plan, document, and implement an appropriate Configuration Management program for that environment.

b. Configuration Management functions and principles should be applied to a degree commensurate with the products complexity and application environment. A Configuration Management practice should not be implemented solely because an evaluation standard, such as the CMMI, ISO-9000, and ISO 10000 Family of Quality Standards, addresses the subject. In circumstances where portions of a given CM function are not necessary, evidence of Configuration Management planning that provides a rational basis for application of appropriate CM practices, should be adequate to satisfy the evaluation criteria.

c. This standard should be used to plan, design, implement, and sustain CM processes that effectively serve the purposes of the enterprise. Because this standard contains the basic principles, it can be used to guide and evaluate the effectiveness of planned or implemented CM processes. Examples of users are:

- An auditor writing evaluation criteria.
- An evaluator who is selecting a supplier.
- An author drafting a CM plan.
- An enterprise whose goals are efficiency, effectiveness and lean operation.

d. This standard provides the basic principles and terminology for configuration management and has been harmonized as much as practical with SAE1001, ANSI/EIA-836 and ANSI/GEIA-859 to ensure standard use of terms and definitions.

7. NOTES

7.1 Revision Indicator

A change bar (I) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE COMMITTEE G-33, CONFIGURATION MANAGEMENT

ANNEX A - CONFIGURATION MANAGEMENT PRINCIPLES

This annex summarizes the CM principles contained in ANSI/EIA-649 herein after referred to as 649.

Table A1 provides the 649C principles arranged by the sections (clauses) in which they appear and the CM functions to which they apply. Table A2, maps the principles depicted in the revisions of the 649 standard (649 - 1998, 649A - 2004, 649B - 2011, and the current 649C).

Table A1 - CM principles in 649C

5. CM Functions and Principles (CM)
Principle CM-1. Configuration Management implementation requires a balanced and continuous application of CM functions and their underlying principles throughout the product life cycle.
5.1 Configuration Management Planning and Management (CMP)
Principle CMP-1. The foundation for CM planning, which delineates the specific CM application methods and their levels of emphasis, is an understanding of the context and environment of the product to which the CM process is to be applied. Principle CMP-2. CM Planning documents how the organization will implement CM throughout the applicable phases of the product life cycle to provide consistency between the product configuration information, and the product. Principle CMP-3. To implement planned CM functions, resources are identified and applied, and responsibilities to perform CM activities are assigned. Principle CMP-4. The establishment and maintenance of CM performance and status measurements are necessary for all products where compliance with the Configuration Management planning and continuous improvement is critical. Principle CMP-5. CM Procedures document how each CM function is implemented to accomplish the intent of the CM planning. Formerly CMP-4. Principle CMP-6. Provide CM training to assure that individuals understand their responsibility, authority, accountability, and the procedures for performing CM. Formerly CMP-5. Principle CMP-7. Periodic assessment of the effectiveness of CM procedures and tools and of compliance with the Configuration Management plan maintains the health of the CM process. Formerly CMP-6. Principle CMP-8. Performing configuration management includes responsibility for configuration management performance of the supply chain. Formerly CMP-7. Principle CMP-9. Information processes, including collection and processing, controlling status, providing interoperability and exchange, and long-term preservation, are essential elements of effective CM planning and management. Formerly CMP-8.
5.2 Configuration Identification (CI)
Principle CI-1. Configuration identification is the basis from which the configuration of products is defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's life cycle. Principle CI-2. Product configuration information serves as the basis for development, production, operation and maintenance/support of the product. Principle CI-3. Enterprise identifiers designating the responsible designer, manufacturer, or preparer provide uniqueness to the identifiers of products and product configuration information. Principle CI-4. Product identifiers are assigned so that one product can be distinguished from other products, one configuration of a product can be distinguished from another, and the correct corresponding product information can be retrieved. Principle CI-5. Individual units of a product are assigned a unique product unit identifier when there is a need to distinguish one unit of the product from another. Principle CI-6. When a product is modified, it retains its original product unit identifier, even though its part identifying number is altered to reflect a new configuration. Principle CI-7. A series of like units of a product is assigned a unique product group identifier when it is unnecessary or impractical to identify individual units, but necessary to correlate units to a process, date, event, or test. Principle CI-8. Product configuration information is uniquely identified so it can be referred to precisely and made accessible. Principle CI-9. Establishing product structure to organize product configuration information provides efficient application of the information over its life cycle. Principle CI-10. Product release provides the appropriate process(es) and evidence necessary to validate the integrity of the product for its intended use. Principle CI-11. A configuration baseline is established by agreeing to the definition of the attributes of a product at a point in time and identifies a known configuration to which changes are addressed. Principle CI-12. A baseline for any product, or any document, plus the approved changes, is the current approved configuration. Principle CI-13. Interfaces between products are managed by mutually agreeing to defined common product attributes, making them part of the product configuration baselines for each product, and applying a process to maintain interface integrity. Principle CI-14. Configuration Items are designated where distinct control is appropriate. Formerly CI-10

5.3 Configuration Change Management (CCM)
Principle CCM-1. Changes to an approved configuration are accomplished using a systematic, measurable change process. Principle CCM-2. Justifying the need for a change provides the rationale to commit resources required to document, process, and if approved, implement the change. Principle CCM-3. A unique change identifier enables tracking of the request for change and the status of implementation and verification of the approved change. Principle CCM-4. Classification of a requested change determines the appropriate level of review and the applicable change approval authority. Principle CCM-5. As the primary vehicle for referencing and managing a change, the request for change document must be clear and comprehensive from technical, cost and scheduling perspectives. Principle CCM-6. Prior to approval, a requested change is evaluated for all impacts and risk considerations including technical, operational, support, schedule, and cost, as well as the consequences of not approving the request. Principle CCM-7. After considering all impacts and risk factors, change approval decisions are made by an appropriate authority who can commit resources to implement the change. Principle CCM-8. An approved change is implemented in accordance with documented direction approved by the appropriate level of authority. Principle CCM-9. If it is necessary to temporarily depart from approved product configuration information, a request for variance is identified, classified, documented, coordinated, evaluated and dispositioned.
5.4 Configuration Status Accounting (CSA)
Principle CSA-1. Configuration Status Accounting (CSA) provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle. Principle CSA-2. Information about the product and the product configuration information are captured as CM tasks are performed; reporting is accessible to support program/project activities as needed. Principle CSA-3. Metrics derived from configuration status accounting information are used to evaluate and improve CM process effectiveness.
5.5 Configuration Verification and Audit
Principle CVA-1. Verify CM processes to ensure appropriate consistency is established and maintained in their execution. Principle CVA-2. Verifying a product's compliance with the physical, functional, and interface requirements in approved product configuration information confirms the basis for managing product configuration. Formerly CVA-1. Principle CVA-3. Verify the implementation of each change to ensure consistency is maintained between the product, its configuration information, and related support assets. Formerly CVA-2. Principle CVA-4. Configuration audits are a summation of the configuration verification process, where necessary to establish approved configurations at key points in the product life cycle. Formerly CVA-3.

Table A2 - 649 revisions principle map

649	649A	649B	649C	Rationale
CM Functions and Principles (CM)				
		CM-1. Configuration Management implementation requires a balanced and continuous application of CM functions and their underlying principles throughout the product life cycle.	Principle CM-1. Configuration Management implementation requires a balanced and continuous application of CM functions and their underlying principles throughout the product life cycle.	
Configuration Management Planning and Management (CMP)				
1. Plan CM processes for the context and environment in which they are to be performed and manage in accordance with the planning: assign responsibilities; train personnel; measure performance; and assess measurements/trends to effect process improvements. 2. To determine the specific CM value adding functions and levels of emphasis for a particular product, identify the context and environment in which CM is to be implemented. 3. A configuration management plan describes how configuration management is accomplished and how consistency between the product definition, the product's configuration, and the configuration management records is achieved and maintained throughout the applicable phases of the product's life cycle. 4. Prepare procedures to define how each configuration management process will be accomplished. 5. Conduct training so that all responsible individuals understand their roles and responsibilities and the procedures for implementing configuration management processes.	1-1 Identify the context and environment for a product to which CM is to be applied to determine specific CM application methods and levels of emphasis. 1-2 Document how the Organization will implement CM functions to provide consistency among the product requirements, the product's configuration information, and the product throughout the applicable phases of the product's life cycle. 1-3 Identify resources required to implement the CM functions and ensure they are applied throughout the product's life cycle. 1-4 Establish procedures to define how each CM function will be accomplished. 1-5 Conduct training so that individuals understand their responsibility, authority, accountability, and the procedures for performing specified CM tasks. 1-6 Use performance measures to assess the CM plan in terms of implementation and the effective performance of CM functions. 1-7 Delegate appropriate CM requirements to suppliers and monitor for CM functional performance. 1-8A Establish product configuration information status levels.	CMP-1. The foundation for CM planning, which delineates the specific CM application methods and their levels of emphasis, is an understanding of the context and environment of the product to which the CM process is to be applied. CMP-2. CM Planning documents how the organization will implement CM throughout the applicable phases of the product life cycle to provide consistency among the product requirements, product configuration information, and the product. CMP-3. To implement planned CM functions, resources are identified and applied, and responsibilities to perform CM activities are assigned. CMP-4. CM Procedures document how each CM function is implemented to accomplish the intent of the CM planning. CMP-5. CM Training assures that individuals understand their responsibility, authority, accountability, and the procedures for performing specified CM tasks. CMP-6. Periodic assessment of the effectiveness of CM procedures and tools and of compliance with the Configuration Management plan maintains the health of the CM process. CMP-7. Performing configuration management includes responsibility for the configuration management performance	Principle CMP-1. The foundation for CM planning, which delineates the specific CM application methods and their levels of emphasis, is an understanding of the context and environment of the product to which the CM process is to be applied. Revised Principle CMP-2. CM Planning documents how the organization will implement CM throughout the applicable phases of the product life cycle to provide consistency between the product configuration information, and the product. Principle CMP-3. To implement planned CM functions, resources are identified and applied, and responsibilities to perform CM activities are assigned. New Principle CMP-4. The establishment and maintenance of CM performance and status measurements are necessary for all products where compliance with the Configuration Management planning and continuous improvement is critical. Principle CMP-5. CM Procedures document how each CM function is implemented to accomplish the intent of the CM planning. Formerly CMP-4. Revised Principle CMP-6, Provide CM training to assure that individuals understand their responsibility, authority, accountability, and the	Principle revised to clarify intent. Principle added to address in Planning the lack of measurements outside of change process being used for plan compliance and continuous improvement. Addresses question; If you're not measuring how do you know if you're getting better or not? Principle revised to change voice and intent.

6. Assess the effectiveness of CM plan implementation and performance of the configuration management discipline with defined metrics (performance indicators). 7. Performing configuration management includes responsibility for the configuration management performance of subordinate activities (e.g., subcontractors, suppliers). 44. Apply configuration management principles to ensure the integrity of digital representations of product information and other data. 45. Apply digital data identification rules to maintain document, document representation, and file version relationships. 46. Apply business rules using data status levels for access, change management, and archiving of digital data documents. 47. Maintain relationships between digital data, data requirements, and the related product configuration to ensure accurate data access 48. Apply disciplined version control to manage document review electronically. 49. Ensure that a transmitted digital data product is usable. 50. Effective digital data access fulfills requirements, preserves rights, and provides users with data they are entitled to in the correct version.	1-8B Ensure that transmitted product configuration information is usable. 1-9 Plan for long-term data preservation by addressing the information technologies used to store, retrieve, and interpret data.	of subcontractors and suppliers. CMP-8. Information processes, including collection and processing, controlling status, providing interoperability and exchange, and long-term preservation, are essential elements of effective CM planning and management.	procedures for performing CM. Formerly CMP-5. Principle CMP-7. Periodic assessment of the effectiveness of CM procedures and tools and of compliance with the Configuration Management plan maintains the health of the CM process. Formerly CMP-6 Revised Principle CMP-8. Performing configuration management includes responsibility for configuration management performance of the supply chain. Formerly CMP-7. Principle CMP-9. Information processes, including collection and processing, controlling status, providing interoperability and exchange, and long-term preservation, are essential elements of effective CM planning and management. Formerly CMP-8.	Principle revised to clarify intent of reference to “subcontractors and suppliers” to include members of the entire supply chain and all entities participating in it.

Configuration Identification (CI)				
8. Configuration identification is the basis from which the configuration of products is defined and verified; products and documents are labeled; changes are managed; and accountability is maintained. 9. Configuration documentation defines the functional, performance, and physical attributes of a product. Other product information is derived from configuration documentation. 10. The product composition (i.e., relationship and quantity of parts that comprise the product) is determinable from its configuration documentation. 11. All products are assigned unique identifiers so that one product can be distinguished from other products; one configuration of a product can be distinguished from another; the source of a product can be determined; and the correct product information can be retrieved. 12. Individual units of a product are assigned a unique product unit identifier when there is a need to distinguish one unit of the product from another unit of the product. 13. When a product is modified, it retains its original product unit identifier even though its part identifying number is altered to reflect a new configuration. 14. A series of like units of a product is assigned a unique product group identifier when it is unnecessary or impracticable to identify individual units but nonetheless necessary	2-1 Define the attributes of a product and its interfaces in the product definition information and use it as the basis for product operational information. 2-2 Define a product composition which matches its Product Configuration Information. 2-3A Use enterprise identifiers on products as well as related product configuration information, to designate the responsible designer or manufacturer. 2-3B Assign unique identification to products. 2-3C Change product identifiers to reflect a revision to the product configuration. 2-3D Assign a unique unit identifier to individual units of a product when there is a need to distinguish one unit of a product from another. 2-3E Assign a unique product group identifier to a series of like units of a product when it is unnecessary to identify individual units. 2-3F Uniquely identify product configuration information so that it can be correctly associated with the applicable product. 2-4A Establish each baseline by approving the stated definition of a product's attributes. 2-4B Define each configuration baseline by approving product definition information at a point in time providing a known configuration from which changes are addressed. 2-4C Update the current configuration baseline by incorporating any approved change into the previously approved	CI-1. Configuration identification is the basis from which the configuration of products is defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's life cycle. CI-2. Product configuration information serves as the basis for development, production, operation and maintenance/support of the product. CI-3. Enterprise identifiers designating the responsible designer, manufacturer, or preparer provide uniqueness to the identifiers of products and product configuration information. CI-4. Product identifiers are assigned so that one product can be distinguished from other products; one configuration of a product can be distinguished from another; the source of a product can be determined; and the correct corresponding product information can be retrieved. CI-5. Individual units of a product are assigned a unique product unit identifier when there is a need to distinguish one unit of the product from another. CI-6. When a product is modified, it retains its original product unit identifier, even though its part identifying number is altered to reflect a new configuration. CI-7. A series of like units of a product is assigned a unique product group identifier when it is unnecessary or impractical to identify individual units, but necessary to correlate units to a process, date, event, or test. CI-8. All documents reflecting product performance, functional, or physical requirements and other product information are uniquely identified so	Principle CI-1. Configuration identification is the basis from which the configuration of products is defined and verified; products and their product configuration information are labeled; changes are managed; and traceability is maintained throughout the product's life cycle. Principle CI-2. Product configuration information serves as the basis for development, production, operation and maintenance/support of the product. Principle CI-3. Enterprise identifiers designating the responsible designer, manufacturer, or preparer provide uniqueness to the identifiers of products and product configuration information. Principle CI-4. Product identifiers are assigned so that one product can be distinguished from other products; one configuration of a product can be distinguished from another and the correct corresponding product information can be retrieved. Principle CI-5. Individual units of a product are assigned a unique product unit identifier when there is a need to distinguish one unit of the product from another. Principle CI-6. When a product is modified, it retains its original product unit identifier, even though its part identifying number is altered to reflect a new configuration. Principle CI-7. A series of like units of a product is assigned a unique product group identifier when it is unnecessary or impractical to identify individual units, but necessary to correlate units to a process, date, event, or test.	Principle revised to remove the statement: "the source of a product can be determined". Reference was to an outdated identifying technique.

to correlate units to a process, date, event, or test. 15. All documents reflecting product performance, functional, or physical requirements and other product information are uniquely identified so that they can be correctly associated with the applicable configuration of the product. 16. A baseline identifies an agreed-to description of the attributes of a product at a point in time and provides a known configuration to which changes are addressed. 17. Baselines are established by agreeing to the stated definition of a product's attributes. 18. The configuration of any product, or any document, plus the approved changes to be incorporated is the current baseline. 19. Maintaining product information is important because time consuming and expensive recovery may be necessary if records of operational units of a product do not match the actual units (as reported by maintenance activities) or such records do not exist. 20. For product interfaces external to the enterprise, establish an interface agreement and a mutually agreed to documentation of common attributes.	baseline. Retain prior configuration baselines as appropriate. 2-5 Identify interfaces and establish mutually agreed-to control of common attributes for product boundaries.	that they can be correctly associated with the applicable configuration of the product. CI-9. A product structure, determined from product configuration information, represents the composition, relationships and quantities of a product and its components. CI-10. Products and product components that receive special CM attention because of their requirements, functionality, or product relationships are referred to as configuration items. CI-11. A baseline is established by agreeing to the definition of the attributes of a product at a point in time and identifies a known configuration to which changes are addressed. CI-12. The configuration of any product, or any document, plus the approved changes, is the current baseline. CI-13. Interfaces between products are managed by mutually agreeing to defined common product attributes, making them part of the product configuration baselines for each product, and applying a process to maintain interface integrity.	Revised Principle CI-8. Product configuration information is uniquely identified so it can be referred to precisely and made accessible. Revised Principle CI-9. Establishing product structure to organize product configuration information provides efficient application of the information over its life cycle. New Principle CI-10. Product release provides the appropriate process(es) and evidence necessary to validate the integrity of the product for its intended use. Revised Principle CI-11. A configuration baseline is established by agreeing to the definition of the attributes of a product at a point in time and identifies a known configuration to which changes are addressed. Revised Principle CI-12. A baseline for any product, or any document, plus the approved changes, is the current approved configuration. Principle CI-13. Interfaces between products are managed by mutually agreeing to defined common product attributes, making them part of the product configuration baselines for each product, and applying a process to maintain interface integrity. Revised Principle CI-14. Configuration Items are designated where distinct control is appropriate. Formerly CI-10.	Principle revised to clarify message and remove reference to outdated identifying technics. Principle revised as it is currently viewed by the CMSWG as a definition and not a fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning. Principle added to address "gap" that is alluded to three times in current standard. Needed to help eliminate draft items found on released information. Principle revised to clarify intent. Principle revised to reflect baseline intent of being "non-rolling". Principle revised as it is currently viewed by the CMSWG as a definition and not a fundamental truth or proposition that serves as the foundation for a system of belief or behavior or for a chain of reasoning.

Configuration Change Management (CCM)				
21. Changes to a product are accomplished using a systematic, measurable change process. 22. Each change is uniquely identified. 23. Changes represent opportunities for improvement. 24. Classify requested changes to aid in determining the appropriate levels of review and approval. 25. Change requests must be clearly documented. 26. Consider the technical support, schedule, and cost impacts of a requested change before making a judgment as to whether the change should be approved for implementation and incorporation in the product and its documentation. 27. Determine all potential effects of a change and coordinate potential impacts with the impacted areas of responsibility. 28. Change documentation delineates which units of the product are to be changed. Change effectivity includes both production break-in and retrofit/recall, as applicable. 29. A changed product should not be distributed until support and service areas are able to support it. 30. The decision-maker is aware of all cost factors in making the decision. 31. Change approval decisions are made by an appropriate authority who can commit resources to implement the change. 32. Implement an approved change in accordance with documented direction approved by the appropriate level of authority. 33. Verify implementation of a change to ensure consistency between the product, its documentation	3-1A Establish criteria for initiating requests for change to assure changes add value. 3-1B Document and uniquely identify each request for change. 3-1C Classify requested changes to aid in determining the appropriate levels of review and approval. 3-2A Evaluate the technical, support, schedule, and cost impacts of a requested change before approval or implementation or incorporation in the product or product configuration information. 3-2B Assess potential effects of a change and coordinate impacts with the impacted areas of responsibility. 3-2C Determine the effectivity of a change so that the total impacts of the change can be quantified, and the change can be priced and scheduled. 3-2D Ensure the decision maker is aware of the complete cost impact of the change. 3-2E Identify an appropriate change approval authority that can approve any change and commit resources for implementation. 3-3A Implement each change in accordance with the approved change information. 3-3B Coordinate change implementation with support, maintenance, and all other impacted areas before and during change implementation.	CCM-1. Changes to a product are accomplished using a systematic, measurable change process. CCM-2. Justifying the need for a change provides the rationale to commit resources required to document, process, and if approved, implement the change. CCM-3. A unique change identifier enables tracking of the request for change and the status of implementation and verification of the approved change. CCM-4. Classification of a requested change determines the appropriate level of review and the applicable change approval authority. CCM-5. As the primary vehicle for referencing and managing a change, the request for change document must be clear and comprehensive from technical, cost and scheduling perspectives. CCM-6. In evaluating whether a requested change should be approved for implementation and incorporation in a product and its configuration information, all potential impacts including technical, operational, support, schedule and cost should be considered. CCM-7. Change approval decisions are made by an appropriate authority who can commit resources to implement the change. The decision-maker must be aware of all impacts and cost factors. CCM-8. An approved change is implemented in accordance with documented direction approved by the appropriate level of authority. CCM-9. If it is necessary to temporarily depart from specified baseline requirements, a request for variance is identified, classified, documented,	Revised Principle CCM-1. Changes to an approved configuration are accomplished using a systematic, measurable change process. Principle CCM-2. Justifying the need for a change provides the rationale to commit resources required to document, process, and if approved, implement the change. Principle CCM-3. A unique change identifier enables tracking of the request for change and the status of implementation and verification of the approved change. Principle CCM-4. Classification of a requested change determines the appropriate level of review and the applicable change approval authority. Principle CCM-5. As the primary vehicle for referencing and managing a change, the request for change document must be clear and comprehensive from technical, cost and scheduling perspectives. Revised Principle CCM-6. Prior to approval, a requested change is evaluated for all impacts and risk considerations including technical, operational, support, schedule, and cost, as well as the consequences of not approving the request. Revised Principle CCM-7. After considering all impacts and risk factors, change approval decisions are made by an appropriate authority who can commit resources to implement the change. Principle CCM-8. An approved change is implemented in accor-dance with documented direction approved by the appropriate level of authority.	Principle revised to reflect maturity requirement for a product before engaging change process. Principle revised to clarify wording. Principle revised to clarify wording.

and its support elements. 34. If it is considered necessary to temporarily depart from specified baseline requirements, a variance is documented and authorized by the appropriate level of authority.	3-3C Verify implementation of a change to ensure consistency among the product, the product configuration information and the product support elements. 3-4 Document and use the appropriate level of authority to approve any temporary departures from approved configurations.	coordinated, evaluated and dispositioned.	Revised Principle CCM-9. If it is necessary to temporarily depart from approved product configuration information, a request for variance is identified, classified, documented, coordinated, evaluated and dispositioned.	Principle revised to reflect the need to identify and control full life cycle non-conformances.
Configuration Status Accounting (CSA)				
35. An accurate, timely information base concerning a product and its associated product information is important throughout the product life cycle. 36. Configuration information, appropriate to the product, is systematically recorded, safeguarded, validated, and disseminated. 37. Configuration information content evolves and is captured over the product life cycle as tasks occur. 38. Data collection and information processing system requirements are determined by the need for configuration information.	4-1 A Systematically capture, record, safeguard, validate, and disseminate data about the product and product configuration information. 4-1B Capture data about the product configuration and the product configuration information as it is created over the product life cycle. 4-1C Provide controlled access to CSA information. 4-2 Determine the system requirements for data collection and information processing based upon the need for data about the product configuration and the product configuration information.	CSA-1. Configuration Status Accounting (CSA) provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle. CSA-2. Information about the product and the product configuration information are captured as CM tasks are performed; reporting is accessible to support program/project activities as needed. CSA-3. Metrics derived from configuration status accounting information are used to evaluate and improve CM process effectiveness.	Principle CSA-1. Configuration Status Accounting (CSA) provides an accurate, timely information base concerning a product and its product configuration information throughout the product life cycle. Principle CSA-2. Information about the product and the product configuration information are captured as CM tasks are performed; reporting is accessible to support program/project activities as needed. Principle CSA-3. Metrics derived from configuration status accounting information are used to evaluate and improve CM process effectiveness.	
Configuration Verification and Audit				
39. Verification that a product's requirement attributes have been met and the product design meeting those attributes has been accurately documented is required to baseline the product configuration. 40. Verification that a design achieves its goals is accomplished by a systematic comparison of requirements with the results of tests, analyses or inspections. 41. Documentation of a product's definition must be complete and accurate enough to permit reproduction of the product without further design effort.	5-1 Verify the product's baselined performance attributes through a systematic comparison with the results of the associated product tests, analyses, inspections, demonstrations and simulations. 5-2 Verify that a product's design attributes are correctly reflected in the product definition information. 5-3 Maintain surveillance over the configuration management process to ensure that the process is adequately documented, that the process documentation is being followed and that the process	CVA-1. Verifying a product's compliance with the physical, functional, and interface requirements in approved product definition information confirms the basis for managing product configuration. CVA-2. Each change must be verified to ensure consistency is maintained between the product, its configuration information, and related support assets such as test equipment and spare parts. CVA-3. Configuration audits, when performed, are a means to assure that configuration verifications have been accomplished and to establish baselines at key points in the product	New Principle CVA-1. Verify CM processes to ensure appropriate consistency is established and maintained in their execution. Revised Principle CVA-2. Verifying a product's compliance with the physical, functional, and interface requirements in approved product configuration information confirms the basis for managing product configuration. Formerly CVA-1. Revised Principle CVA-3. Verify the implementation of each change to ensure consistency is maintained between the product, its configuration information,	Principle added to address "gap" in current standard alluded to by Principle CMP-7. Principle revised to clarify intent of verification/certification activities, i.e., how we keep from "burning the toast". Principle revised to remove non-value-added references to test equipment and spare parts.

42. Where necessary, verification is accomplished by configuration audit. 43. Periodic reviews verify continued achievement of requirements, identify and document changes in performance, and ensure consistency with documentation.	execution is in compliance with requirements.	life cycle.	and related support assets. Formerly CVA-2. Revised Principle CVA-4. Configuration audits are a summation of the configuration verification process, where necessary to establish approved configurations at key points in the product life cycle. Formerly CVA-3.	Principle revised to give a more active voice to the intent.

ANNEX B - RELATED STANDARDS, HANDBOOKS AND PROCESSES

This standard provides a comprehensive set of principles that when appropriately implemented will allow an enterprise to effectively and efficiently manage the configuration of any product. The following are nonbinding supplemental information that can further assist an enterprise in understanding, defining and implementing a configuration management program.

- SAE1001, “Integrated Project Processes for Engineering a System (IPPES).” This provides a basic, conceptual-level description of engineering management disciplines that relate to the development and life cycle management of a system. Configuration Management is addressed in Chapter 10.

- ANSI/EIA-836, “Configuration Management Data Exchange and Interoperability.” This standard logically extends the Configuration Management (CM) principles of ANSI/EIA 649. It provides for interoperability between trading partners by establishing a common language for the exchange of data between dissimilar databases.

- ANSI/GEIA-859, “Data Management.” This Industry/Government performance-based consensus standard consists of the disciplined processes and systems that plan for, acquire, and provide stewardship for product data and product-related business data, consistent with requirements, throughout the product and data life cycles.

- ISO/IEC/IEEE 24765:2017(E), “ISO/IEC/IEEE International Standard - Systems and software engineering - Vocabulary.” This document provides a common vocabulary applicable to all systems and software engineering work.

- ISO/IEC/IEEE 29148:2011(E), “ISO/IEC/IEEE International Standard - Systems and software engineering - Life cycle processes - Requirements engineering.” This document contains provisions for the processes and products related to the engineering of requirements for systems and software products and services throughout the life cycle. It defines the construct of a good requirement, provides attributes and characteristics of requirements, and discusses the iterative and recursive application of requirements processes throughout the life cycle.

- ASME Y14.100, “Engineering Drawing Practices.” This standard establishes engineering drawing practices and ties together the engineering drawing and related documentation practices in the ASME Y14 series.

- GEIA-HB-649, “Configuration Management Standard Implementation Guide.” This handbook is intended to assist the user in interpreting SAE/EIA-649, Configuration Management Standard, and in the planning and implementation of effective CM. The handbook provides a framework for making prudent and cost-effective choices about CM requirements, based on project or product size and complexity, customer, and business objectives. Note: The GEIA-HB-649A version of the handbook is a consolidation of Industry/Commercial and the Government/Department of Defense (DoD) community implementation guidelines derived by combining the content of GEIA-HB-649, “Implementation Guide for Configuration Management”, industry published handbook in October 2005, and the MIL-HDBK-61A (SE), “Configuration Management Guidance”, military published handbook in February 2001.

- EIA-649-1, “Configuration Management Requirements for Defense Contracts” provides guidance that generates, manages and is controlled by the non-government standard body with Defense membership to provide requirements specific for Defense contracts. This standard is for placing tailored Configuration Management requirements on Defense contracts.

- EIA-649-2, “Configuration Management Requirements for NASA Enterprises” provides a resource that standardizes Configuration Management requirements specific to National Aeronautics and Space Administration (NASA) agreements and design activities.

- MIL-STD-31000, “Technical Data Packages.” This standard provides requirements for the deliverable data products associated with a technical data package (TDP) and its related TDP data management products.

- IEEE Standard 828-2012, “IEEE Standard for Configuration Management in Systems and Software Engineering.” This standard establishes the minimum requirements for processes for Configuration Management (CM) in systems and software engineering. The application of this standard applies to any form, class, or type of software or system. This revision of the standard expands the previous version to explain CM, including identifying and acquiring configuration items, controlling changes, reporting the status of configuration items, as well as software builds and release engineering.

- ISO/IEC 12207, “Systems and Software Engineering - Software Life Cycle Processes.” This International Standard establishes a common framework for software life cycle processes, with well-defined terminology, that can be referenced by the software industry. It contains processes, activities, and tasks that are to be applied during the acquisition of a software product or service and during the supply, development, operation, maintenance and disposal of software products.

- ISO/IEC 15288, “Systems Engineering Life Cycle Processes.” This International Standard establishes a common framework for describing the life cycle of systems created by humans. It defines a set of processes and associated terminology. These processes can be applied at any level in the hierarchy of a system's structure. Selected sets of these processes can be applied throughout the life cycle for managing and performing the stages of a system's life cycle.

- ISO 9000 Family of Quality Standards and their ASQ equivalents are used to evaluate and validate a contractor’s quality program. Within these standards there are broadly stated requirements that are met if the contractor has an adequate Configuration Management program implemented using the principles in ANSI/EIA-649.

- ISO 10007, “Quality management - Guidelines for configuration managemen,” provides broad general guidelines that can easily be mapped to the principles in EIA-649.

- Software Engineering Institute’s Software Development Capability Maturity Model Integrated (CMMI). CMMI is a process improvement approach that provides organizations with the essential elements of effective processes that ultimately improve their performance. CMMI can be used to guide process improvement across a project, a division, or an entire organization. Two of the process areas addressed are ‘requirements management’ and ‘configuration management’.

ANNEX C - ALPHABETICAL LIST OF COMMONLY USED CM TERMS

Table C1 provides an alphabetical list of related terms cross-referenced to the neutral terms defined in Table 2. This allows the user to quickly find the term used within the standard where the name of the neutral term is different from what the user is familiar with.

Table C1 - Alphabetical listing of common CM terms

Related Term	649 Neutral Term
customer	acquirer
acquisition activity	acquirer
Allocated Baseline	configuration baseline
analysis	verification
approved	released
assembly	product
associated lists	product definition information
attributes	functional attributes
attributes	physical attributes
authority	customer
batch number	effectivity
batch number	group identifier
Bill of Material (BOM)	product structure
block number	effectivity
block number	group identifier
break-in point	effectivity
build baseline	configuration baseline
buyer	customer
CAGE Code	enterprise identifier
change control board chairperson	approval authority
change applicability	effectivity
Change approval authority	approval authority
change control	configuration change management
change control board	change board
change management	configuration change management
change proposal	request for change
change record	request for change
change record	request for variance
change request	request for change
change review board	change board
characteristics	functional attributes
characteristics	physical attributes
check	verification
class I change	major change
class II change	minor change
company	enterprise
component	product
Computer Software Configuration Item (CSCI)	Configuration Item
Computer Software Configuration Item (CSCI)	product
concession	request for variance
configuration change	approval authority
configuration change management authority	approval authority
configuration conformance check	configuration audit
configuration control	configuration change management
configuration control	configuration governance
configuration control board	change board
configuration database	configuration status accounting

Related Term	649 Neutral Term
configuration information	product configuration information
configuration object	Configuration Item
configuration records	configuration status accounting
conformance	verification
conformity inspection	configuration audit
contract change proposal	request for change
contractor	enterprise
contractor	supplier
change control board chairperson	approval authority
dash number	product identifier
data attributes	metadata
date	group identifier
date code	group identifier
decision authority	authority
demonstration	verification
departure	variance
design	configuration
design activity	enterprise
design authority	enterprise
design basis	product definition information
design change	request for change
design documentation	product definition information
design information	product definition information
design output	product definition information
designated item	Configuration Item
designer	supplier
Design Release Baseline	design release configuration
developer	supplier
developmental configuration baseline	design release configuration
developmental baseline	configuration baseline
developmental baseline	design release configuration
deviation	request for variance
deviation	variance
distributer	supplier
document identifier	product identifier
drawing list	product structure
drawing tree	product structure
D-U-N-S Number	enterprise identifier
end item	product
engineering change	configuration change
engineering change memo	request for change
engineering change package	request for change
engineering change proposal	request for change
engineering change request	request for change
engineering departure	request for variance
engineering departure	variance
engineering drawing	product definition information
engineering user	customer
enterprise change management	configuration change management
enterprise change request	request for change
exception request	request for variance
external end user	customer
facility	product
Form, Fit, Function and Interface (F3I)	configuration

Related Term	649 Neutral Term
Functional Baseline	configuration baseline
functional configuration audit	configuration audit
hardware	product
hierarchy	product structure
incorporation date(s)	effectivity
indentured drawing list	product structure
indentured listing	product structure
indentured parts list	product structure
inspection	verification
interface attributes,	interface information
interface control document	interface information
interface control document	product definition information
interface control drawing	interface information
interface document,	product definition information
interface specification	interface information
internal user	customer
ISO/SAE WMI Code	enterprise identifier
issue	revision
issued	release, released
item	product
item name	product identifier
keel number	unit identifier
line number	unit identifier
logistics support	sustainment
lot number	effectivity
lot number	group identifier
maintenance instructions	product operational information
management	customer
management authority	approval authority
manufacturer	enterprise
manufacturer	supplier
manufacturing identifier	unit identifier
marketing department	customer
material	product
model	product identifier
model-based definition/product model	product definition information
modification	retrofit
name	product identifier
nomenclature	product identifier
nonconformance	request for variance
nonconformance	variance
operation instructions	product operational information
operational information	product operational information
organization identifier.	enterprise identifier
organization,	enterprise
organized data	information
part	product
part name	product identifier
part number	product identifier
physical configuration audit	configuration audit
platform number,	unit identifier
procuring activity	customer
producer	supplier
product	Configuration Item

Related Term	649 Neutral Term
Product Baseline	configuration baseline
product configuration verification	configuration audit
product consistency verification	configuration audit
product information	product configuration information
product instance	unit
product tree	product structure
production departure	request for variance
production departure	variance
program review board	change board
project manager	approval authority
proof	verification
proposed change	request for change
provider	supplier
pyramid	product structure
release record	design release configuration
request for waiver	request for variance
request for deviation	request for variance
requirements	functional attributes
requirements	physical attributes
requirements document	product definition information
revision	retrofit
rework	retrofit
seller	supplier
serial number	effectivity
serial number	unit identifier
series	effectivity
service	product
set	product
shall statement	requirement
software	product
software design document	product definition information
software product specification	product definition information
software requirements specification	product definition information
specification	product definition information
specification	requirement
specification activity	customer
specification tree	product structure
status accounting	configuration status accounting
subcontractor	supplier
supplier	enterprise
system	product
system verification review	configuration audit
tail number	unit identifier
technical data	product definition information
technical data package	product definition information
technical manual	product operational information
technical order	product operational information
test	verification
title	product identifier
top-down breakdown	product structure
unit	product
update	revision
update	retrofit
validation	verification

Related Term	649 Neutral Term
vehicle identification number (VIN)	unit identifier
vendor	supplier
version	configuration
version	product identifier
version	revision
waiver	request for variance
waiver	variance