

National Manual of Assets and Facilities Management

Volume 5, Chapter 21

Configuration Management Program Procedure

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Configuration Management Program Procedure

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1.0 PURPOSE

The purpose of this document is to provide guidelines and best practices to the Entity to manage the Configuration Management Program Procedure. In addition, its purpose extends to promote industry-accepted standards, its relation with other Configuration Management (CM) tools, and its association with key elements of Asset Management.

Configuration Management (CM) is an indispensable management discipline, which introduces a methodological approach to multi-variant combinations of hardware, software, and documentation. This identifies and organizes the work products, referred to as Configuration Items (CIs), and protects against destructive and uncontrolled changes.

The advantages of adopting and recognizing the benefits of CM include:

- Maintenance and management of the control of complex systems.
- Assurance of a safer change management process.
- Recording and documentation of the change.
- Ease of returning a system to a known datum/version.
- Providing various system observers with monitoring capabilities for improved awareness and understanding.

Systems Engineering (SE) and CM ease the management and understanding of complexity.

2.0 SCOPE

This document satisfies the requirements for Asset and Facility Managers for all Kingdom of Saudi Arabia (KSA) Entities.

These guidelines are to be observed by Asset and Facility Managers and relevant stakeholders pertaining to systems under inspection/scrutiny. The purpose is to provide the distinction between CM and Control of Drawings; these are detailed in Chapter 21 of the National Manual of Assets and Facilities Management (NMA&FM) Volume 5.

This document does not provide specific CM plans for any defined system due to the existing variety and complexity. This is an introduction to provide a framework for Senior Managers and stakeholders in implementing and controlling the systems. The details and sectors can be referred to in the associated volumes.

3.0 DEFINITIONS

Term	Definition
Asset	An item, component, or Entity that has potential or actual value to an organization. The value will vary between different organizations and their stakeholders. It may be tangible or intangible, financial, or non-financial. A resource regulated by an Entity as a result of past events and which future economic benefits are expected. Infrastructure Assets are a sub-class of property (non-current Assets with a life greater than 12 months and enable services to be provided).
Asset Database	List of Assets with associated information– the data is stored in an Asset Register (AR).
Asset Lifecycle	The sequence of stages that an organization's Asset goes through during the period of ownership (i.e., from planning and design to decommissioning/disposal).
Asset Management	The coordinated activity of an organization to realize value from Assets.
Asset Management Process	The method used to implement an Asset Management System.



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Term	Definition
Asset Management Software (AMS)	Dedicated software application utilized to record and track the lifecycle of an Asset (from procurement to disposal). It provides an organization with pertinent information (i.e., Asset location, Asset users, and maintainers). Additionally, it provides Asset information on utilization, performance, and associated relevant details.
Asset Register (AR)	List and relevant details of assets owned by an Entity. The register can identify the location, description, value, and age of the asset.
Configuration Item (CI)	A defined element within a system.
Entity (or Entities)	Kingdom of Saudi Arabia (KSA) Government organization which is responsible for the delivery of Government funded Operations & Maintenance (O&M) Projects.
Facilities Management	The organizational function that integrates people, places, and processes within the built environment, to improve quality of life and overall productivity.
Facility	An environment that is built installed or established to assist the organization in the delivery of operational objectives. This term is also utilized to describe specific/group buildings and/or the site itself (i.e., school, research establishment, hospital complex, training complex or, university campus).
Industry Best Practice	Method/technique that has consistently shown results as superior to those achieved by other means; also utilized as a benchmark.
National Manual of Assets & Facilities Management (NMA&FM)	Defines the minimum requirements to be followed in the planning, execution, and delivery of Operations & Maintenance (O&M) by KSA Entities.
Quality Management	Monitoring activities, tasks, and ensuring consistency; maintaining desired levels of excellence.
Acronyms	
AMS	Asset Management Software
ANSI	American National Standards Institute
AR	Asset Register
BIFM	British Institute of Facilities Management
BMS	Building Management Systems
BOD	Basis of Design
CC	Change Control
CI	Configuration Item
CIBSE	Chartered Institute of Building Services Engineers
CM	Configuration Management
CMMI	Capability Maturity Model Integration
CMU	Carnegie Mellon University
DOI	Digital Object Identifier
EIA	Electronics & Information Technology Association
GEIA	Government Electronics & Information Technology Association
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISBN	International Standard Book Number
ISO	International Organization for Standardization
IT	Information Technology
ITIL	Information Technology Infrastructure Library
KSA	Kingdom of Saudi Arabia
NAR	National Asset Register
NMA&FM	National Manual of Assets & Facilities Management
O&M	Operations & Maintenance
OEM	Original Equipment Manufacturer



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Term	Definition
PPE	Personal Protective Equipment
SAMP	Strategic Asset Management Plan
SE	Systems Engineering
SEI	Software Engineering Institute
SOS	Sequence of Operations
USA	United States of America
VA	Virginia

Table 1: Definitions

4.0 REFERENCES

- 828-2012 IEEE Standard for Configuration Management in Systems and Software Engineering. 2012
- ANSI EIA-649-C 2019 Configuration Management Standard
- ANSI/EIA-649-1998 National Consensus Standard for Configuration Management
- ANSI/GEIA. 2005. Implementation Guide for Configuration Management. Arlington, VA, USA: American National Standards Institute/Government Electronics & Information Technology Association, GEIA-HB-649. October 2005
- ISO 10007:2003 Quality management systems – Guidelines for configuration management
- ISO. 2003. Quality Management Systems – Guidelines for Configuration Management. Geneva, Switzerland: International Organization for Standardization (ISO), ISO 10007:2003
- ISO/IEC/IEEE. 2015, Systems and Software Engineering-- System Life Cycle Processes, Geneva, Switzerland: International Organization for Standardization / International Electro-Technical Commissions. ISO/IEC/IEEE 15288:2015
- Systems Engineering Fundamentals, Chapter 10, Configuration Management

5.0 RESPONSIBILITIES

Role	Description
Building/Facility Owners	The entity that has ownership/responsibility of the Facility/building and shall be informed of matters pertaining to Configuration Management (CM) that affect their systems.
Director, General Manager	Responsible for running the main business activities, and CM Authority is provided to a suitably qualified person (Senior Management level).
Asset Management Team	The team is responsible for maintaining records of the Asset's condition and overall systems.
Operations Team	The team responsible for operational ownership of the repaired, replaced, altered, or extended Asset/system.
Expro	Establishes standards and performance measures for public buildings and infrastructure assets throughout KSA. Provides support and advice on performing Condition Assessments to Entities.
Entity	Prepares plans for Condition Assessment, including frequency. Ensures that Condition Assessments are aligned with Government Regulations and the details laid out in the National Manual of Assets & Facilities Management (NMA&FM). Identifies/sources the appropriate resources to perform specific tasks/exercises. Train/brief selected resources to ensure uniformity across asset categories and ensure conformity with the NMA&FM. Liaises with selected resources to ensure the implementation of efficacious programs (required shutdowns and access requirements). Manages and supervises the delivery of the Condition Assessment activity in accordance with the approved strategy and plans. Assists in the collation of the Condition Assessment report, specifically for the prioritization of assets and possible future requirements for the



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	utilization of Assets. Plans and implements recommendations established by the Condition Assessment report.
In-house Resource/Contractor	Responsibilities include: understand, develop, and prepare requirements to implement the Condition Assessment exercise. Provide competent personnel to conduct the Condition Assessment. Follows agreed to procedures in delivering surveys (specifically access and shutdown requirements). Performs assessments safely utilizing appropriate tools, equipment, and Personal Protective Equipment (PPE). Provides reports and advice based on the Condition Assessment data in conjunction with the Entity.

Table 2: Responsibilities

6.0 PROCESS

In order to maintain the intended level of integrity, performance, and suitability for utilization and/or output, the functionality of any critical “system” that contains a set hierarchy of interdependent sub-systems, should have some form of Configuration Management (CM) assigned (i.e., Information Technology (IT), projects, and processes).

Systems Engineering (SE), a vital component of CM, is demonstrated in numerous engineering projects and IT system infrastructures; it is critical to maintain the integrity of a system’s configuration in mitigating risks. Altering the system configuration will result in a direct/indirect characteristic change in performance (undesirable for risk aversion systems).

With complex systems (installed in buildings, production facilities, and IT), substantial effort is invested in CM to ensure the integrity of projects, processes, and system design; these elements are controlled in a manner parallel to required safety and quality management levels (i.e., fit for purpose). CM has an added advantage, as part of a robust system configuration design, the principles of CM are transferable to other applications.

The purpose of CM is to establish and maintain the integrity of identified outputs and behaviors of a project, process/system, and ensuring data availability to Senior Management and relevant stakeholders.

Projects, processes, or systems shall have an established critical baseline, and depending on the assigned priority, should determine the level of CM necessary for maintaining acceptable deviation levels (i.e., Risk Management).

6.1 Configuration

The configuration of a plan, project, process, or system that has a hierarchy of critical interdependencies, and a desired output/behavior value level will have a Basis of Design (BOD) and Sequence of Operations (SOS). Figure 1 illustrates a working configuration that has critical interdependencies; if disrupted/altered, could lead to an undesirable outcome.

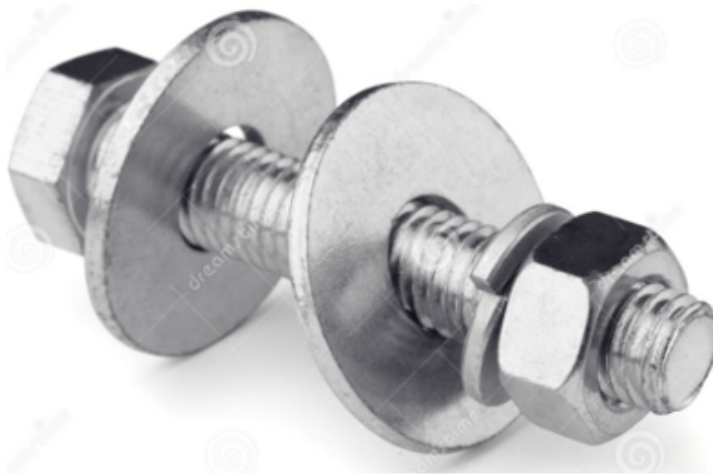


Figure 1: An example of a Sub-System with CIs

Figure 1 provides an understanding of a critically configured assembly. A change anywhere in a sub-system will have implications for the overall system, and consequently, the application of CM is justified.

The integrity of complex systems requires a strict approach of CM (mitigate degradation risk of Basis of Design (BOD) and/or Sequence of Operations (SOS)).

Maintain an acceptable level of “order” with critical Configuration Items (CIs); CM achieves this by the following:

- Identifying CIs – (Configuration Identification)
- Controlling changes to CIs – (Configuration Control)
- Determining that a system complies with its specifications – (Configuration Audit)
- Documenting the development status of all CIs – (Configuration Status Accounting)

CM focuses on the following queries to illustrate IT system examples:

- What versions of software modules comprise the release of a software product?
- What design description correctly describes this software module?
- Did we prove that this software or systems' product complies with its specification? Does it meet the requirements of the customer?
- Is this system component subjected to a change request?
- Who is authorized to approve changes to this component?

CM identifies current configurations, maturity levels, compliance with defined specifications, and whether changes to its CIs are required.

6.1.1 Baseline

A baseline is a defined reference point in the configuration development life cycle marked by the completion and formal approval of a set of predefined order of CIs (work products). The objective of a baseline is to reduce a system's vulnerability to uncontrolled change; any subsequent threat of change will be formally controlled via a standardized and robust process of Change Control (CC). Baselines can also be used to identify the aggregate of differing (software and hardware) components that form a specific release (output) of a system.

6.1.2 Baseline Purpose

- Measurable progress points within the system development lifecycle (i.e., milestones).



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- A basis for Change Control (CC) in subsequent levels of system maturity.
- A stable reference for future work.
- Intermediate and final points for evaluating the practicality of future baselines.

6.1.3 Effective Baseline Characteristics

- A baseline must be associated with the production and physical deliverable (formally approved), i.e., a document/hardware/software component, specifically concerning Operations & Maintenance (O&M).
- All items associated with a baseline must be placed under formal CC and be visible to relevant managers.



6.1.4 Examples of Baselines

- The statement of system requirements (functional baseline)
- High-level design (allocated baseline)
- Detailed design (design baseline)
- The software product after the system test (product baseline)
- The software product in its operational environment (operational baseline)

6.2 Operations & Maintenance (O&M) - Configuration Management

Basis of Design (BOD) shall not be changed without the approval of its designated Asset Owner/Manager and should be considered as an essential part of the Asset Management strategy.

Strategic Asset Management Plan (SAMP) shall have, at its core, an Asset Register (AR) for visibility, control purposes, and to manage O&M activities. Changes to either the list/asset will have a direct impact on the delivery of valuable O&M activities. As a result, it is prudent to establish and define parameters of Configuration Items (CI) within the confines of O&M for the given Entity.

Uncontrolled/undocumented changes can have serious implications upon the delivery of a successful project. Most notable are the controls attributable to changes in specification/cost control. One of the most notable impacts is upon delivery timescale overruns that reduce the availability of systems at key stages of the product cycle/reputational damage due to delays.

6.2.1 O&M Configuration Item Examples

6.2.1.1 Asset Register (AR)

The AR is a fundamental element of the Asset Management portfolio and consists of numerous Configuration Items (CIs) whose hierarchal structure is based on an agreed protocol; its relevance to what exists forms the baseline for suitable and sufficient O&M activities. The structure and form of any AR are predetermined by a set code of hierarchies and the relevance of asset classifications. The execution of an asset survey will have strict codes to delineate the configuration of relationships, and the integration of new assets, introduced by projects, will follow the same code to ensure that a common procedure is followed. System updates should be a key deliverable so that future integrations and operations are effective.

Identical procedures can be followed for service take-over and tendering processes. When the AR is accurate, the evaluation of contractual requirements is streamlined and minimizes the potential for errors to be discovered.

All Kingdom of Saudi Arabia (KSA) ARs are centered on identical baselines (common language), this ensures control of configurations. Asset Managers and Project Managers shall consider appropriate management practices during projects/implementations and ensure protocols of CM are followed in a defined manner.

6.2.1.2 Asset Management Software (AMS)

The AMS is a configured IT system that requires strict CM principles to be applied. Applications for change should be authorized through a robust configuration control process and baseline. As a result, the operational element should consider wider implications across all Facilities Management disciplines (hard and soft services).

Full reference to the AMS is available in Volume 8; however, the following are the benefits:

- A dedicated software application used to record and track an Asset throughout its life cycle, from procurement to disposal.
- Provides an organization with essential information (i.e., Asset location, Asset users, and maintainers) and how Assets are being utilized; other functions can be configured/customized as per Entity requirements.



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- How assets are performing and the associated relevant details; this allows for procedural and financial decisions to be considered.

6.2.1.3 Building Management Systems (BMS)

Most buildings and facilities are reliant on IT configured management systems whose baseline is essential to the operation and maintenance requirements. A small change to the BMS's Configuration Item (CI) can harm a large number of systems and sub-systems, potentially creating risky situations and uncontrolled building configurations. This will have a negative impact on the profile of the Facilities Management schedules and plans (i.e., surplus/insufficient resources are assigned).

A longer-term impact will be prevalent: life cycle costs, energy usage, and the consumption of consumables. (i.e., installation of a 24/7 data center plant, when the initial requirement was for business usage/12 hours). Effective CM would capture the potential miscalculation and mitigate associated risks accordingly.

6.2.1.4 Resource Planning

The configuration of the engineering and operational support for any defined asset/Facility should be processed through appropriate Change Management protocols (which may not be considered as part of the Asset/infrastructure requirement). Additional requirements could include the number of personnel engaged upon the shift pattern, competency levels of personnel in each shift, leave patterns, and overall management structure.

The provision of staff training shall be considered, specifically if new technology is implemented. This may involve external resources to be part of the original considerations and factored in within key milestones for the project when equipment is available as part of the construction/installation.

6.2.1.5 Communications

Configuration Items (CIs) in most communication systems can be complex with serious implications if the Basis of Design (BOD) is altered without measured approval through the CM process (i.e., the CI in a communications system matrix is complicated, containing interdependencies across a multi-tiered configuration structure). CI encompasses hardware, software, processes, interfaces, and protocols to enable suitable functionality. Communication is essential to a successful O&M.

6.2.2 Documentation

Providing succinct and coherent information is a prime deliverable of the Kingdom of Saudi Arabia (KSA) Asset Management and Quality Management system. The hierarchy applied to the structure of O&M documents follows a strict logical path. The naming convention is a result of deliberations pertaining to the requirement for access to specific volumes and chapters. The hierarchy of documents generally follows a strict protocol of the parent-child relationship, and this adheres to CM protocols.

Protection of documentation and the associated configuration can be assisted with the use of digitally protected systems (i.e., limiting the access to specified individuals effectively minimizes the ability of non-authorized personnel from making changes). Adopting this methodology protects the CM process, and robust steps can be implemented, ensuring authority, acceptance criteria, and securing gateways.

Consideration should be given to a Document Management System. This has the following advantages:

- Version Control
- Reduction in Emails between Stakeholders
- Security of Documents
- Reduction in Printed Costs
- Data Archiving

Upon completion of the project/change, relevant information should be stored and made available to building staff that requires the data to complete tasks:



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- Financial Details of Project Costs
- Materials for Spares and Consumables
- O&M Manuals
- As-Built Drawings
- Description of Operations
- Interface Details
- Contractual and Warranty Information
- Conformance and Compliance Documentation

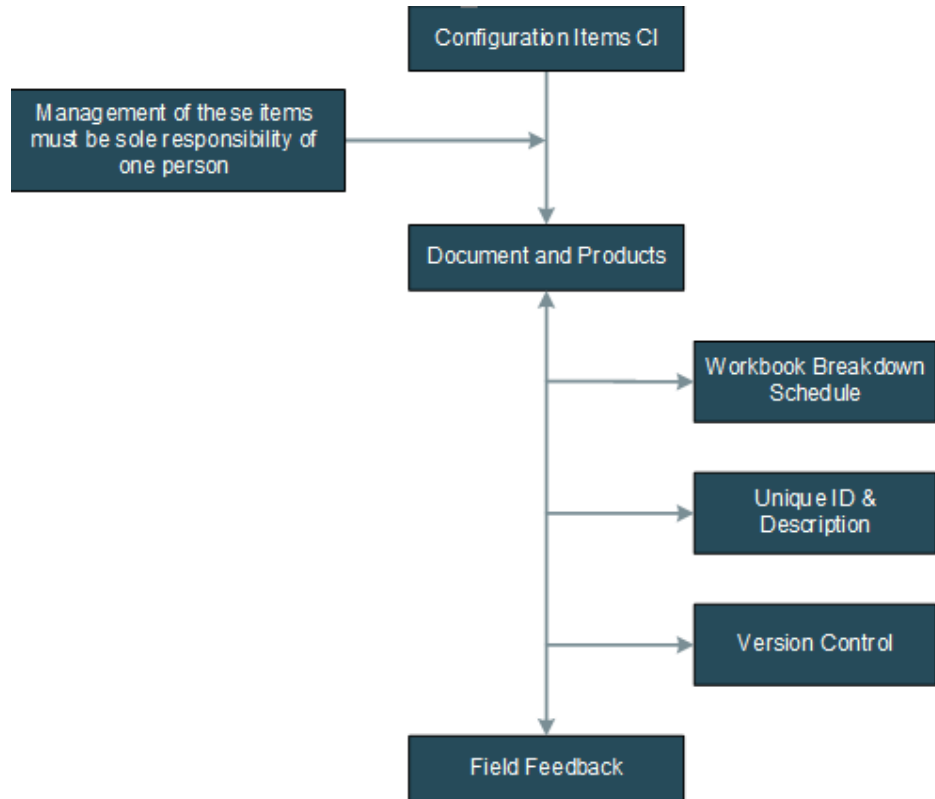


Figure 2: High-level Document Hierarchical Configuration

6.3 Who and How?

CM shall be applied across all Kingdom of Saudi Arabia (KSA) Entities to a level appropriate with the criticalities and priorities of specific Assets/Facilities. Due to the magnitude and scope of CM, the method of managing configuration to an acceptable standard is to share the responsibilities cross-functionally (local management).

For instance, the profile of systems within local Assets and Facilities will delineate the ownership of CM responsibilities. Asset Managers will take accountability for CM within their Asset portfolio and will discharge the responsibility to the most appropriate disciplines within their management structure. Appropriate Senior Engineers are best allocated to take ownership of CM as they understand the concept, importance, and the required outcome of the subject concerning the suite of Assets. The same is true of Senior Operational Managers for non-Engineering systems.

There may be potential scenarios where CM will involve disciplines from Operational and Engineering backgrounds (i.e., Life Safety Systems, in these situations, the preference is Engineering takes the lead in the CM process).



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Figure 3: Basic CM Process Flow

It is strongly recommended that Senior Engineers and Operations Managers become familiar with the above Figure 3 flow chart to understand the basis for managing configuration. For every application, the best practice is to refer to the specific reference which applies to the System, Process, Project, or Operation to ensure complete suitability of execution.

6.4 Summary

Asset Management is a complex endeavor, and Configuration Items (CIs) of Asset Management cannot be viewed in isolation. It is a systematic methodology that contains countless interdependencies across many functional tiers – as a result, Systems Engineering (SE) is adopted as a guiding principle. It is designed for managing complexity and utilized for the management and control of configurations.

A successful outcome can be defined as the process of identifying the requirement and involving relevant stakeholders. This should help to reduce the level of change processes that have traditionally been shown to hamper the process of projects and lead to considerable cost overruns.