



Standard

Maintenance Concept Definition

Version 1.0

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Standard governance

Owner: Manager Asset Planning, Asset Standards Authority
Authoriser: Principal Manager Network and Asset Strategy, Asset Standards Authority
Approver: Executive Director, Asset Standards Authority on behalf of the ASA Configuration Control Board

Document history

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1.0	First issue

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Preface

The Asset Standards Authority (ASA) is an independent unit within Transport for NSW (TfNSW) and is the network design and standards authority for defined NSW transport assets.

The ASA is responsible for developing engineering governance frameworks to support industry delivery in the assurance of design, safety, integrity, construction, and commissioning of transport assets for the whole asset life cycle. In order to achieve this, the ASA effectively discharges obligations as the authority for various technical, process, and planning matters across the asset life cycle.

The ASA collaborates with industry using stakeholder engagement activities to assist in achieving its mission. These activities help align the ASA to broader government expectations of making it clearer, simpler, and more attractive to do business within the NSW transport industry, allowing the supply chain to deliver safe, efficient, and competent transport services.

The ASA develops, maintains, controls, and publishes a suite of standards and other documentation for transport assets of TfNSW. Further, the ASA ensures that these standards are performance-based to create opportunities for innovation and improve access to a broader competitive supply chain.

This document specifies the requirements for developing maintenance concept definitions (MCD) for transport projects.

This standard has been approved by the ASA Configuration Control Board and is the first issue.

Foreword

This maintenance concept definition (MCD) standard is placed within the context of systems engineering to support the TfNSW asset management framework.

This standard forms part of the systems engineering document hierarchy in development by the ASA. This standard and T MU AM 06008 ST *Operations Concept Definition* are subsets of T MU AM 06006 ST *Systems Engineering*.

The development of an operations concept and maintenance concept are closely linked and dependant on each other.

The MCD and operations concept definition (OCD) are carried out in conjunction with each other to support the development of a robust business case and business requirements.

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1. Introduction

Development of maintenance concepts for new or altered systems is undertaken in conjunction with an operational concept definition (OCD) at the concept stage of the system life cycle. The maintenance concept definition (MCD) is an input to the subsequent design stages and is required to conceptually understand how an evolving operational concept should be maintained and supported over the system life cycle in a cost effective manner. The MCD for a new or altered system is referenced by designers at the later design stages to derive design solutions associated with the maintenance and support of the system across all stages of its life cycle.

The MCD is not a maintenance plan. In general terms the MCD describes the types of maintenance and maintenance support capabilities for systems. The MCD does not provide the detail of exactness in number and distribution of personnel, depots, workshops, facilities, parts stocking levels or supply chain times. A maintenance plan is a definition of the follow-on requirements for system support based on a known design configuration and the result of the supportability analysis.

The MCD is developed in alignment with the *TfNSW Asset Management Framework Overview*. The MCD for a new or altered system is prepared early in the system life cycle, before TfNSW Configuration Management and Asset Assurance Committee gate 1 so as to inform and be part of the final business case and business requirements specification. For further information on the configuration management gates refer to T MU AM 04001 PL *TfNSW Configuration Management Plan*.

2. Purpose

The purpose of this standard is to provide a structured, repeatable approach for developing MCDs on transport programs and projects for new or altered systems ranging from simple to complex.

2.1. Scope

This standard defines key requirements for ensuring that the whole of life maintenance of new or altered systems are considered and conceptually defined at the MCD level prior to the development of a supportable business case. However, it does not describe how life cycle costs are derived. For information on how life cycle costs are derived refer to T MU AM 01001 ST *Life Cycle Costing*.

2.2. Application

This standard applies to parties involved in the development of the MCD during the concept stage for new or altered systems for transport investments of different complexity and scales within the TfNSW Transport Network.

3. Reference documents

The following documents are cited in the text. For dated references, only the cited edition applies. For undated references, the latest edition of the referenced document applies.

Australian standards

AS IEC 60300.3.10-2004 – Dependability management - Application guide - Maintainability

AS IEC 60300.3.14-2005 – Dependability management - Application guide - Maintenance and maintenance support

AS/NZS IEC 60300.1:2015 Dependability management Part 1: Guidance for management and application

Transport for NSW documents

T MU AM 01001 ST Life Cycle Costing

T MU AM 04001 PL TfNSW Configuration Management Plan

T MU AM 06006 ST Systems Engineering

T MU AM 06008 GU Operational Concept Definition (guide)

T MU AM 06008 ST Operations Concept Definition (standard)

4. Terms and definitions

The following terms and definitions apply in this document:

ASA Asset Standards Authority

availability measure of the percentage of time that an item or system is able to perform its designated function

BRS business requirements specification

level of maintenance (as defined in AS IEC 60300.3.14-2005) set of maintenance actions to be carried out at a specified indenture level

Note - Examples of a maintenance action are replacing a component, a printed circuit board, a subsystem.

life cycle the scope of the system or product evolution beginning with the identification of a perceived customer need, addressing development, test, manufacturing, operation, support and training activities, continuing through various upgrades or evolutions, until the product and its related processes are disposed of.

maintainability (as defined in AS/NZS IEC 60300.1:2015) <of an item> ability to be retained in, or restored to a state to perform as required, under given conditions of use and maintenance

Note 1 to entry: Given conditions would include aspects that affect maintainability, such as: location for maintenance, accessibility, maintenance procedures and maintenance resources.

Note 2 to entry: Maintainability may be quantified using appropriate measures.

maintenance concept (as defined in AS IEC 60300.3.10-2004) application of a general maintenance policy to a specific item

maintenance policy (as defined in AS IEC 60300.3.14-2005) a general approach for provision of maintenance and maintenance support based on objectives and policies of owners, users and customers.

maintenance support (as defined in AS/NZS IEC 60300.1:2015) provision of resources to maintain an item

Note 1 to entry: Resources include human resources, support equipment, materials and spare parts, maintenance facilities, documentation and information, and maintenance information systems.

MCD maintenance concept definition

OCD operations concept definition

reliability (as defined in AS/NZS IEC 60300.1:2015) <of an item> ability to perform as required, without failure, for a given time interval, under given conditions

Note 1 to entry: The time interval duration may be expressed in units appropriate to the item concerned, e.g. calendar time, operating cycles, distance run, etc., and the units should always be clearly stated.

Note 2 to entry: Given conditions include aspects that affect reliability, such as: mode of operation, stress levels, environmental conditions and maintenance.

Note 3 to entry: Reliability may be quantified using appropriate measures.

rotable an item that is capable of being repaired or overhauled in a workshop environment, to return the item to a condition that is equivalent to new

safety the safety of people, including passengers, rail safety workers, other users of railways, users of rail or road crossings and the general public

system a collection of interrelated parts, physical or procedural

TfNSW Transport for NSW

TfNSW Transport Network the transport system owned and operated by TfNSW or its operating agencies upon which TfNSW has power to exercise its functions as conferred by the Transport Administration Act or any other Act

5. MCD and OCD interrelationship

The MCD shall support the OCD developed for a new or altered system. The OCD addresses topics including operational performance capability, operational constraints and operational service levels. The OCD and MCD shall not be developed in isolation from each other. The OCD and MCD shall form a coherent overall picture of how a system or asset will be operated and maintained over the expected life cycle.

For information on how to develop an OCD refer to T MU AM 06008 ST *Operations Concept Definition* standard and T MU AM 06008 GU *Operational Concept Definition* guide.

6. System life cycle description

Figure 1 represents the common asset life cycle model adopted by TfNSW. The model illustrates the asset or system life cycle phases and stages from identification of demand and need through to disposal. The stages are categorised under the following five distinct phases:

- demand and need
- plan
- acquire
- operate and maintain
- dispose

The business requirements specification (BRS), the OCD and the MCD and an accompanying business case for a new or altered system are developed during the concept stage within the plan phase of the system life cycle and form an input to the system specification and design process. A program or project-specific systems engineering management plan refers to a documented asset strategy planning process that describes the steps undertaken to produce program specific BRSs, OCDs, MCDs and business cases.

The MCD should be reviewed and refined as the system definition progresses and should be finalised when the asset or system solution has been sufficiently defined.

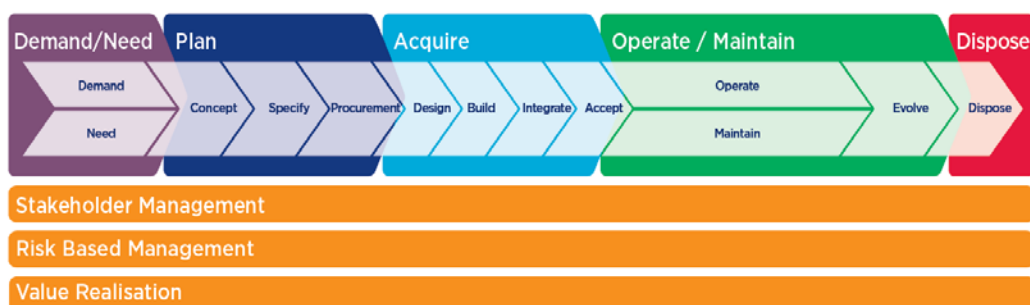


Figure 1 – TfNSW asset life cycle model

The design manager is responsible for ensuring that all relevant information is obtained in conjunction with nominated representatives of TfNSW. This happens during the development of maintenance and maintenance support concepts, and during incorporation of the concept design into the detailed design. This is to ensure that all relevant information is obtained, that the level of support required for the proposed system is fully understood and that any changes needed are identified.

Any changes to the maintenance and maintenance support capabilities would include trade-off studies (such as life cycle costing analyses) as part of the total design synthesis.

Refer to T MU AM 06006 ST *Systems Engineering* for further information on the system life cycle.

7. MCD requirements

During the development of the MCD for a new or altered system at the concept stage of the system life cycle, the nominated program or project manager shall ensure that the following:

- authorised and relevant stakeholders are consulted
- the MCD is reviewed and approved by the authorised and relevant stakeholders
- maintenance concepts and associated maintenance and maintenance support approaches defined in the MCD are developed and verified using suitable transport performance modelling tools as required (generally reliability, availability and maintainability related tools)
- the development of individual program and project MCDs are coordinated and integrated with other MCDs that are in development or existing, to ensure that optimisation of one element of the network does not adversely affect other elements of the network

Section 7.1 through to Section 7.9 describe the key requirements for the development of the MCD.

7.1. Levels of maintenance

The MCD shall identify and describe the levels of maintenance for specific items or subdivision thereof and the attributes relating to maintenance, such as location, type, time, skills and tools.

While considering (and defining) the levels of maintenance and associated support attributes, consideration shall be given to the safety and regulatory requirements associated with the item, including the maintenance policy, maintenance requirements analysis, obsolescence management, and disposal requirements.

The MCD shall identify and describe the levels of maintenance under normal, degraded and emergency modes of operation. Under the mode of operation defined the following shall be addressed:

- access to operational assets under live conditions
- communication and coordination arrangements
- protection arrangements

While making decisions pertaining to levels of maintenance, maintenance strategies or tasks the following shall be defined:

- decision support process and methodology
- decision criteria such as mean time to repair, mean time to restore system, mean time between maintenance, mean preventative maintenance time and similar
- decision support tools such as software, hazard and operability study, failure mode and effect analysis, fault tree analysis, human reliability analysis and similar

7.2. Maintenance and operational interfaces

While making decisions pertaining to levels of maintenance, maintenance strategies or tasks the following shall be identified and described in relation to maintenance and operational interfaces:

- operators and maintainers at the interfaces
- communication methods and systems
- coordination arrangements between asset disciplines
- communication and coordination with operations
- communication and coordination with external parties

7.3. Information and information management systems

One of the objectives of maintenance activities is to collect and analyse information to support continuous improvement of maintenance and maintenance support approaches and asset performance. In addition, information and information management systems are used to plan, schedule and manage maintenance activities.

The MCD shall identify maintenance and maintenance support information and information management systems.

The MCD shall describe the pertinent information and information management systems to ensure that maintenance information is integrated with other asset management activities and that record keeping arrangements are considered and defined if required.

The MCD shall identify the following at a conceptual level:

- record types
- either electronic or hard copy records or both
- location of records
- business continuity, security arrangements and redundancy
- record-holding validity periods
- communication to asset owner (including information related to the level of detail, frequency and participants)

7.4. Tools, equipment, instruments and facilities

The MCD shall identify and describe the approved implements required to undertake the maintenance and maintenance support activities safely and effectively.

These implements shall include either of the following:

- tools, equipment, facilities and instruments owned or leased by the organisation
- tools, equipment, facilities and instruments owned by sub-contractors

Description of the maintenance facilities shall identify and describe the following:

- positioning of maintenance facilities on the TfNSW Transport Network relative to operations
- size of facilities and depots
- whether these are multi-disciplinary depots or asset discipline based depots
- the level of maintenance offered at the depots including the types of maintenance offered (such as inspection, test, repair or refurbishment)
- co-location with operations facilities

7.5. Documentation and training

The MCD shall identify and describe the pertinent maintenance and maintenance support related documentation (that is, manuals and procedures) and training for maintainers to effectively perform the maintenance and maintenance support activities that support operational equipment.

7.6. Logistics

The MCD shall identify and describe the following deliverables associated with packaging, handling, storage and transportation of parts and consumables related to maintenance and maintenance support:

- where spare parts and consumables will be held
- how spare parts and consumables will be maintained in a condition ready for use
- how spare parts and consumables will be protected from damage or deterioration whilst in storage or during transportation to site

7.7. Spare parts strategy

The MCD shall identify and describe the strategies for acquiring and managing the appropriate levels of spare parts and consumables to support maintenance and maintenance support activities. The acquisition and management of spare parts includes the following:

- parts used to replace items that have failed in service but are not economical to repair and will be disposed of appropriately
- rotatable parts which can be economically managed through a process where they are collected, sent as a batch for repair by an authorised repairer and returned to a working and serviceable condition to be stored for future use

While establishing spare parts strategies, descriptions shall be provided of the following:

- product support by suppliers
- short, medium, long-term strategic spare parts arrangements
- obsolescence management
- TfNSW procurement policy

7.8. Maintenance personnel

TfNSW uses service providers to undertake maintenance activities on the TfNSW Transport Network by accredited maintenance personnel.

In view of the maintenance and maintenance support approaches selected the following activities shall be identified:

- appropriate staff levels (based on asset type, population and geographic distribution). This should be used to determine if additional resources are needed or if the maintenance activity should be contracted out
- the levels of competency required (including associated staff assessments and certifications) to undertake the maintenance activities that will be needed to support the design
- the gap between current competencies and those required so that changes to training curriculum can be initiated and delivered prior to the commencement of operations
- a methodology associated with capturing of lessons learnt and knowledge management

7.9. Access arrangements

The MCD shall identify and describe the access requirements for maintainers to effectively perform the maintenance and maintenance support activities that support operational equipment.

In view of the maintenance and maintenance support approaches selected access arrangements to the items shall be defined within the MCD. This should include how these arrangements fit within the existing possession framework, especially for major maintenance activities that may not need to be performed for some decades into the life of the item.

Appendix A Suggested reading

The following documents have not been directly referred to in this standard, they are included here as suggested reading. These documents may assist with providing important background information.

International standards

AS ISO 55001 - Asset management – Management systems - Requirements

AS/NZS ISO/IEC/IEEE 15288 - Systems and software engineering - System life cycle processes

EN 50126-1 - Railways Applications – the Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - Part 1: Basic Requirements and Generic Process

ISO/IEC/IEEE 29148 - Systems and software engineering – Life cycle processes – Requirements engineering

Transport for NSW documents

T MU AM 01002 MA Maintenance Requirements Analysis Manual

Other

Systems Engineering and Analysis, Benjamin S. Blanchard, Wolter J. Fabrycky