Transport for NSW

T MU AM 01001 ST

Standard

Life Cycle Costing

Version 3.0

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Standard governance

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Document history

Version	Summary of changes
1.0	First issued 12 June 2014
2.0	Second issued 6 June 2017 – Applied new template
3.0	Third issue – Minor changes; Updated Figure 1, Figure 2, Figure 4 and Table 1

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Preface

The Asset Standards Authority (ASA) is a key strategic branch of Transport for NSW (TfNSW). As the network design and standards authority for NSW Transport Assets, as specified in the *ASA Charter*, the ASA identifies, selects, develops, publishes, maintains and controls a suite of requirements documents on behalf of TfNSW, the asset owner.

The ASA deploys TfNSW requirements for asset and safety assurance by creating and managing TfNSW's governance models, documents and processes. To achieve this, the ASA focuses on four primary tasks:

- publishing and managing TfNSW's process and requirements documents including TfNSW plans, standards, manuals and guides
- deploying TfNSW's Authorised Engineering Organisation (AEO) framework
- continuously improving TfNSW's Asset Management Framework
- collaborating with the Transport cluster and industry through open engagement

The AEO framework authorises engineering organisations to supply and provide asset related products and services to TfNSW. It works to assure the safety, quality and fitness for purpose of those products and services over the asset's whole-of-life. AEOs are expected to demonstrate how they have applied the requirements of ASA documents, including TfNSW plans, standards and guides, when delivering assets and related services for TfNSW.

Compliance with ASA requirements by itself is not sufficient to ensure satisfactory outcomes for NSW Transport Assets. The ASA expects that professional judgement be used by competent personnel when using ASA requirements to produce those outcomes.

About this document

This document aims to inform stakeholders of the framework for life cycle costing requirements.

This standard is the third issue.

The changes to previous content in this version include minor changes and updates to Figure 1, Figure 2, Figure 4 and Table 1.

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1. Introduction

The ASA is committed to effective and efficient management of TfNSW assets. The ASA collaborates with government and non-government organisations to continuously improve capability, performance and condition over the full life cycle of the assets.

This standard defines TfNSW life cycle costing (LCC) requirements. It is essential that service providers (including consultants, designers, maintainers, manufacturers and so on, that provide asset management related services for TfNSW) are able to demonstrate to TfNSW that physical assets are managed efficiently and that those assets will support service and project outcomes in the long term. LCC provides a framework for service providers to demonstrate the relationship between the performance of their physical asset portfolio and the services they deliver.

2. Purpose

This standard defines TfNSW LCC requirements that include frameworks. LCC is necessary to substantiate asset investment and maintenance decisions which support TfNSW asset management policies and strategies. This applies to those government and non-government organisations engaged in the provision of asset management services to TfNSW.

2.1. Scope

The LCC requirements and frameworks presented within this document cover whole-of-life management of assets that include but are not limited to the following aspects:

- proposed capital projects
- asset type approvals or sub-component type approvals
- new asset proposals either within an existing system or a new system
- significant configuration and operational changes include changes in asset strategy
- changes during the following:
    - the asset life cycle (such as changes in maintenance requirements)
    - system requirement development (includes changes throughout the project development and construction phase)

2.2. Application

The standard applies to life cycle asset acquisition, maintenance, operation and disposal across the asset life cycle. It applies to all life cycle costing activities that affect TfNSW assets or systems.

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This life cycle costing standard is mandated to be used by organisations, service providers or project developers that perform asset management related services to TfNSW, including their suppliers involved in defining, designing, building, implementing, commissioning, maintaining, integrating in to the operating network any new or altered assets or systems. This standard also applies to the decommissioning and disposal of assets.

This standard shall also be applied during the business case development stage. That is, choosing between options for individual sub-components or design alternatives that require additional cost analysis, including changes to assets or provision of new assets by Authorised Engineering Organisations (AEO).

Consistent application of LCC will allow for benchmarking, comparison and performance evaluation of cost plans between different investment decisions. Appendix A outlines the gateway stages described in the investment gating and assurance guidelines and where the life cycle costing would be expected to be completed.

This standard aligns with the AEO guide to engineering as well as the TfNSW asset management policy.

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.

International standards

ISO 15686-5 Buildings and constructed assets – Service life planning – Part 5: Life-cycle costing

Australian standards

AS/ISO 55000:2014 Asset management – Overview, principles and terminology

AS/NZS 4536:1999 Life cycle costing – An application guide

Other reference documents

Australian National Audit Office, 2001, Life Cycle Costing – better practice guide

NSW Treasury, 2004, Total asset management – Life cycle costing guideline, TAM04-10

Office of the National Rail Safety Regulator, 2013, Preparation of a rail safety management system guideline

Transport for NSW, 2013, AEO guide to engineering management, TS 10504

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4. Terms and definitions

The following terms and definitions apply in this document:

AEO Authorised Engineering Organisation

ASA Asset Standards Authority

asset an item, thing or entity that has potential or actual value to an organisation. Physical assets usually refer to equipment, inventory and properties owned by the organisation. Physical assets are the opposite of intangible assets, which are non-physical assets such as leases, brands, digital assets, use rights, licences, intellectual property rights, reputation or agreements

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

capital maintenance referred to as renewals, is the refurbishment or replacement of an existing asset that has reached the end of its useful life, with a new asset capable of providing the current or agreed alternative level of service as the existing asset. Capital maintenance is funded from the CAPEX budget

CMC configuration management committee

configuration the interrelated functional and physical characteristics of a product defined in product configuration information

LCC life cycle costing is the process of assessing the cost of a product over its life cycle or a portion thereof

maintainability the probability that a given active maintenance action, for an item under given conditions of use can be carried out within a stated time interval when the maintenance is performed under stated conditions and using stated procedures and resources

maintenance the combination of all technical and associated administrative actions during the components service life with the aim of retaining it in a state in which it can perform its required functions

maintenance support the provision of resources, including labour and materials, necessary for maintaining the dependability of the asset during its service life (or ownership period)

RAMS reliability, availability, maintainability and safety

reliability the ability of an item of equipment or a system to perform a required function under stated conditions for a stated period of time or at a given point in time

system a combination of interacting elements organised to achieve one or more stated purposes

TAM total asset management

TfNSW Transport for NSW

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5. Asset life cycle

The LCC process applies to all stages of asset life (that is, the period from asset creation to asset end of life). These are defined from 'demand/need' through to 'dispose'. A model of the life cycle is shown in Figure 1.

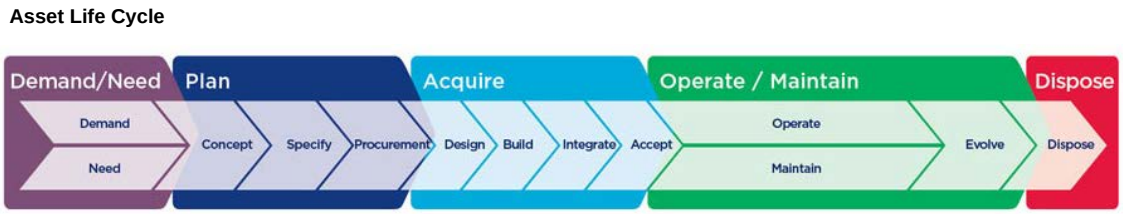

Figure 1 – Life cycle phases

LCC is most effectively applied in the project's early design phase to optimise the total development and maintenance costs. However, it should also be used during maintenance and operational phases of the life cycle to optimise maintenance strategies and facilitate efficient allocation of resources. Figure 2 outlines the costs and stages of the life cycle costs.

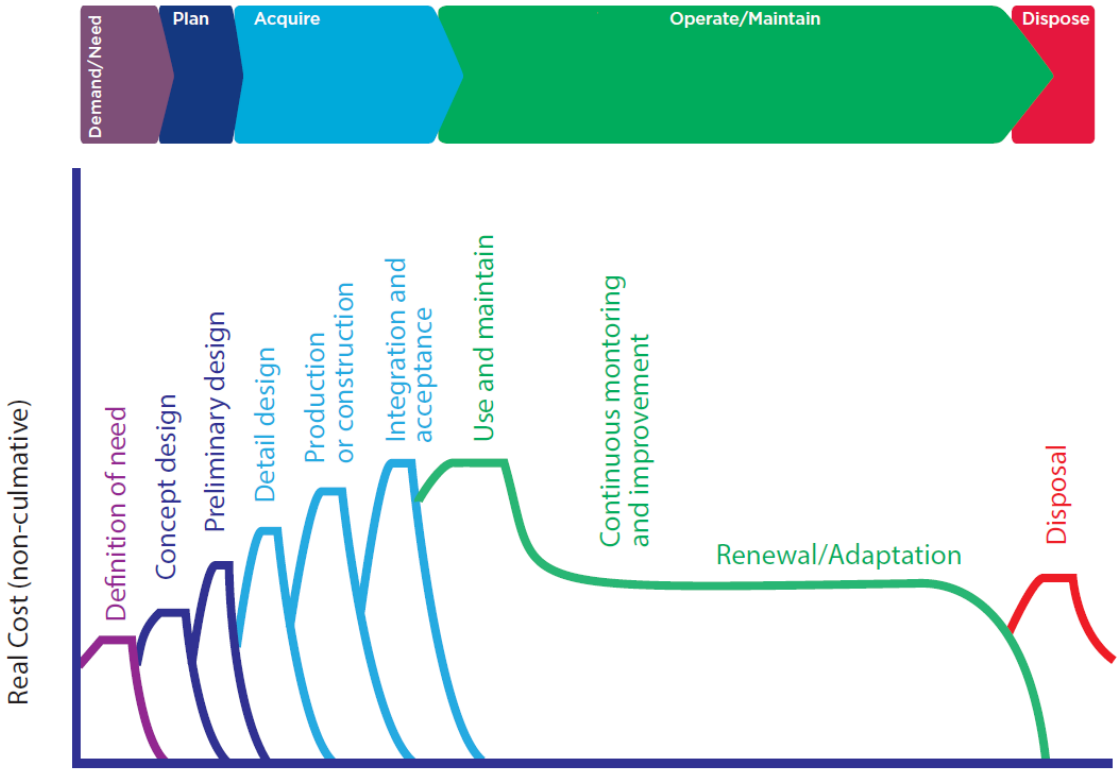

Figure 2 – Costs and stages of the life cycle

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In general, the life cycle cost of an asset may be expressed by the simple formula shown in Figure 3.

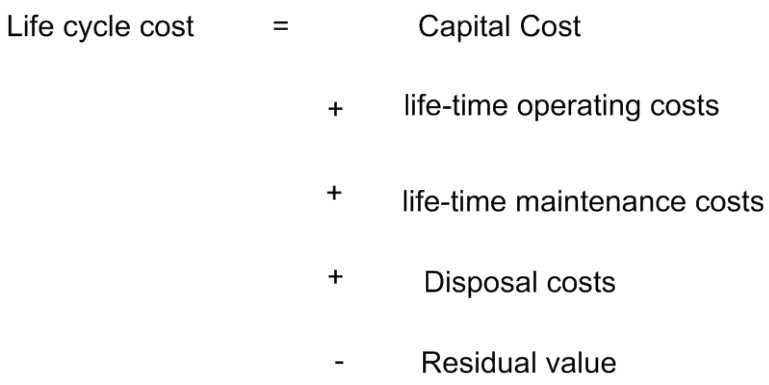

Figure 3 – Life cycle cost formula

The initial capital outlay cost is usually clearly defined and is often a key factor that can influence the choice of a particular asset given a number of alternatives from which to select. The initial capital outlay cost is, however, often only a small portion of the costs over an asset's life cycle that needs to be considered in making the right choice for asset investment and maintenance decisions. In addition there are the life time operation costs which refer to labour/training, materials and consumables, energy (power, fuel), equipment and facilities; and engineering modifications incurred over the expected life of the asset/system. Life time maintenance costs refer to general maintenance that includes recurrent maintenance and capital maintenance (upgrading) costs. Disposal costs refer to system shutdown; disassembly and removal; recycling or safe disposal related costs.

6. Life cycle costing process

AS/NZS 4536 *Life cycle costing – An application guide* shall be used for the development of the LCC process.

AS/NZS 4536 defines the following objectives of LCC:

- calculate a dollar value that represents the LCC of a product as an input to a decision making or evaluation process, together with other inputs. The cost is based on a defined need associated with the systems/subsystems/assets
- support management considerations that affect decisions during any life cycle phase
- identify the attributes of the product which significantly influence the LCC (cost drivers) of the systems/subsystems/assets so that they can be properly managed

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Figure 4 gives an indication of how the process steps integrate within the life cycle:

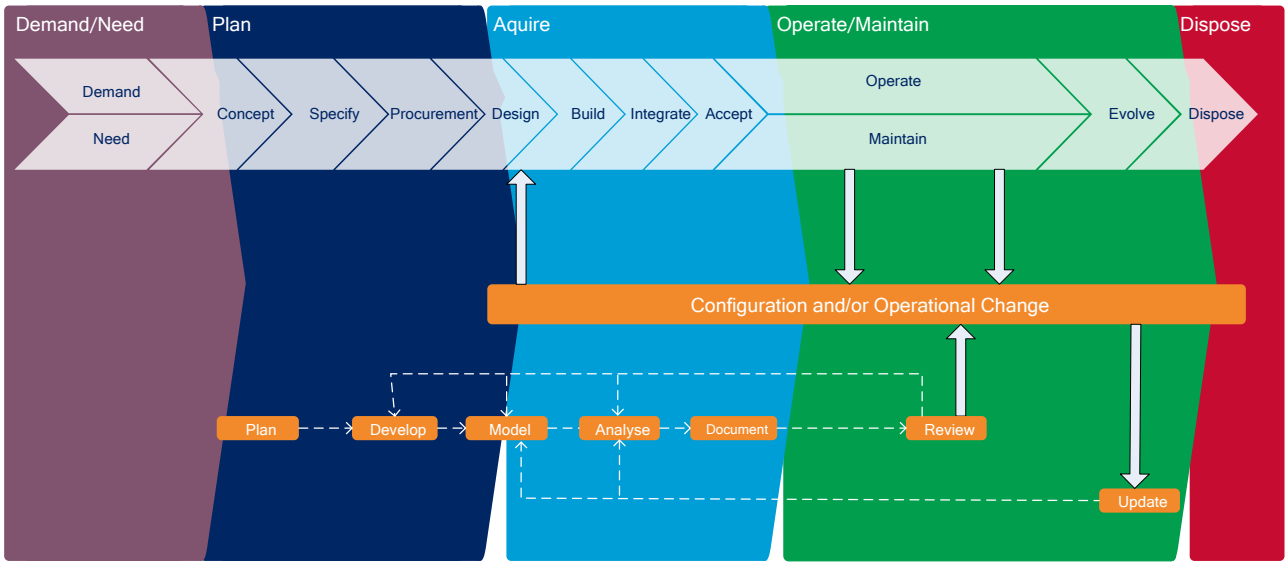

Figure 4 – Life cycle and costing process

In line with AS/NZS 4536, any life cycle cost analysis shall be conducted in a structured and well-documented manner using the following steps:

a) development of a life cycle cost analysis plan

b) development or selection of a life cycle cost model

c) analysis of the model

d) analysis of LCC documentation

e) review of LCC results

f) update of the life cycle cost analysis

The above steps may be performed in an iterative fashion if efforts at any stage indicate a need to revisit and modify work accomplished at earlier stages.

Assumptions made at each step shall be documented to facilitate such iterations and to aid in interpreting the results of the analysis.

The analysis shall identify and consider the following:

- system interfaces to the asset option being considered and their effect on the life cycle cost evaluation. An example is the effect on a networks power supply system demand by introduction of new equipment to the network
- use of the assets during the operation stages of the life cycle
- maintenance of the asset in particular considerations concerning the reliability, availability, maintainability and safety of the asset (RAMS)

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- access to the asset during installation, operations and maintenance activities, for example any special conditions for access to the rail infrastructure via the rail operator
- introduction of new or novel technology
- energy consumption costs where applicable and foreseeable
- recycling or safe disposal of the assets and considerations for asset requirements to facilitate disposal
- impact on rail heritage

If a new or altered asset is introduced, the service provider shall develop a life cycle cost. Where operation and maintenance data is a requirement the service provider may request advice from TfNSW (ASA).

A list of typical considerations for the analysis may be found in Table F1 in Appendix F of AS/NZ 4536:1999. A summary for the total life of the asset shall be created as per Table 1 (an example is shown in Appendix A.2). The italics in the table are examples of the costs typically involved in the life cycle stages however the cost activities identified can vary as appropriate for the life of the asset or system.

Table 1 – Life cycle cost summary table

Life cycle stage	Year 1	Year 2	Year 3	Year 4	…	…	Year x
1. Demand / Need • *identify demand/need* • *analysis and forecasting of functional demand* • *research possible alternatives to satisfy the demand*							
2. Concept and definition (concept, feasibility) • *market research* • *project management* • *system concept and design analysis* • *preparation of a requirement specification of the product*							

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Life cycle stage	Year 1	Year 2	Year 3	Year 4	…	…	Year x
3. Design and development (procurement, design) • *project management* • *system and design engineering including reliability, maintainability and environmental protection activities* • *design documentation* • *prototype fabrication* • *software development* • *testing and evaluation* • *productivity engineering and planning* • *vendor selection* • *demonstration and validation* • *quality management*							
4. Manufacturing and installation (build, integrate) Non-recurring – • *industrial engineering and operations analysis* • *construction of facilities* • *production tooling and test equipment* • *special support and test equipment* • *initial spares and repair parts* • *initial training* • *documentation* • *software* • *testing (qualification testing)* Recurring – • *production management and engineering* • *facility maintenance* • *fabrication (labour, materials and the like)* • *quality control and inspection* • *assembly, installation and checkout* • *packaging, storage, shipping and transportation* • *ongoing training* • *insurance*							
5. Operation and maintenance							

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Life cycle stage	Year 1	Year 2	Year 3	Year 4	…	…	Year x
a) Recurrent maintenance (routine and cyclic) • *labour/training* • *facilities* • *contractor services* • *IT support*							
b) Capital maintenance (upgrading/replacement)							
c) Operational costs • *labour/training* • *materials and consumables* • *energy (for example, power, fuel)* • *equipment and facilities* • *engineering modifications*							
6. Disposal • *system shutdown* • *disassembly and removal* • *recycling or safe disposal* • *product residual value*							

7. Life cycle costing model

TAM reflects priorities for whole-of-life asset management, extended planning requirements for new works, and new relationships between services planning and asset procurement activities. Initial provisions made to manage whole-of-life costs should be evaluated and updated before committing to one alternative. A LCC model provides a mechanism to compare these costs (treasury total asset management plan).

The primary objective of the LCC model is to analyse alternative options for implementing a project, for example, technology, performance levels, maintainability and so on as well as to determine the option that provides the best value on a whole-of-life basis.

AS/NZS 4536 proposes that in order for the model to be realistic it shall:

- represent the characteristics of the asset being analysed including its intended use environment, maintenance concept, operating and maintenance support scenarios, and any constraints or limitations
- be comprehensive enough to include and highlight all factors relevant to LCC
- be simple enough to be easily understood and allow for its timely use in decision making, and future updates and modification
- be designed in such a way as to allow for the independent evaluation of specific elements of the LCC

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Depending on the purpose of the analysis, different ways of expressing the cost may be appropriate, that is, real cost, nominal cost, and discounted cost, the appendices in AS/NZS 4536 provide examples on how to use the different cost methods.

LCC is part of the criteria to be considered when evaluating system options. All feasible options require a life cycle cost to be developed. In order to estimate the total life cycle cost, it is necessary to break down the asset costs into separate cost components.

In the development of cost data, the requirements may vary considerably depending on the program phase. During the early planning and conceptual design phases of asset development, where the available data is limited, then cost analyst may need to adopt varying life cycle cost estimation techniques.

The cost may be estimated by using one of the following methods as appropriate:

- **engineering cost method** – involves direct estimation of a particular cost element by examining the project component by component or part-by-part. It uses standard established cost factors
- **analogous cost method** – involves cost estimation based one experience with similar project and technology. It uses historical data, updated to reflect cost escalation and effect of technology advances
- **parametric cost method** – uses significant parameters and variables to develop cost estimating relationships which are usually in the form of equations. A parameter may be a price (cost per man hour) or an empirically derived ratio

Further explanation and examples on these cost estimation techniques may be found in AS/NZ 4536:1999, Appendix D.

7.1. Stakeholder management

The service provider that proposes a change in asset or sub-asset components shall consult with the system maintainer regarding issues related to logistical support, training and maintenance delivery. In addition, the service provider shall manage all input information into the life cycle model.

7.2. Assurance

The service provider shall assure application of LCC process has been executed to its intended use. That is evaluation of options has been completed adequately and be able to provide supporting documentation.

Audit plans will be planned and completed to address the validation of the application of LCC in the evaluation of option in investment and maintenance decision making. AEO's shall ensure

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projects are applying adequate due process in progressively assuring its deliverables through its life cycle phases.

ASA will provide ongoing surveillance of AEO's and ensure ongoing compliance with the LCC process. ASA will provide advice where required concerning this standard.

7.2.1. Sensitivity analyses

In order to facilitate an effective risk analysis, AS/NZ 4536 recommends a sensitivity analyses be performed. The results of such sensitivity studies shall be assessed in detail. The degree of verification of the analysis should correspond with the value of the decision.

8. Safety considerations

Safety is a critical requirement to take into account as part of the options consideration. This shall be borne out in the life cycle calculations where applicable.

9. Sustainability considerations

To further develop sustainability oriented LCC, the LCC analysis shall consider environmental and social costs from concept, operations through to disposal in order to minimise the impact on the environment and the community.

10. Risk

LCC is part of the risk assessment evaluation to a change in asset as it outlines all impacts associated with the change to the asset or new asset. The practice of comparing life cycle costs will bring future maintenance needs into the decision, it enables valid cost comparisons to be made not just comparisons of initial costs.

11. Record keeping

Detailed records of the LCC and associated analysis shall be maintained. Records shall comprise of the following:

- details of each of the life cycle cost analysis steps
- documents substantiating and providing evidence of LCC analysis
- assumptions made (and documented), including uncertainty and risks associated with the established model. That is the model evaluation to ensure that the inputs have been accurately established, the model has been used correctly, the results (including those of sensitivity analysis) have been adequately evaluated and discussed and that the objectives of the analysis have been achieved

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- considerations made of interfaces to the system or asset during selections of options and analysis of associated costs
- engineering considerations pertaining to RAMS
- costs associated with access to assets
- costs associated with alternate operations of systems during asset maintenance activities

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Appendix A Gateway stages

A.1. TfNSW's capital investments

The gating and assurance process applies to each capital investment (program or project) within TfNSW's capital investment portfolio. There are interdependencies between the investment gating and assurance process, the TAM / budget cycle and the prioritisation process that determines, through prioritisation, the optimal portfolio of investments (extracted from the *Transport for NSW Investment Portfolio Management Framework – Investment Gating and Assurance Guidelines*).

Investment gating for TfNSW's capital investments are as follows:

- gate 0 – initiation
- gate 1 – strategic business case
- gate 2 – preliminary business case
- gate 3 – final business case
- gate 4 – contract award
- gate 5 – readiness for service & operations
- gate 6 – post implementation

LCC shall take place prior to gate 2 – preliminary business case as part of the options analysis. The life cycle cost should then be reassessed at the handover for service and that is gate 5 – readiness for service & operations.

In addition to capital investment requirements, the TfNSW rail assets configuration management plan addresses the application of configuration management principles to TfNSW’s requirement to manage the configuration of its railway assets. A configuration change request is a formal request to add or change an asset that is subject to configuration control at any stage of the project lifecycle. It is an activity for control of the product after formal approval of its baseline.

AEOs are required to provide adequate evidence for the TfNSW configuration management committee (CMC) to consider change requests at critical stages of a project. In particular the CMC are involved at both the concept configuration change request stage (that is, CMC control gateway 1) and asset acceptance configuration change request stage (that is, CMC control gateway 5) of a project which would correspond to the gateways of TfNSW to consider the life cycle costs.

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A.2. Case study example

Application of LCC can be seen in the case study below. Please note although based on a real life case and extracted from a real business case, some of the data has been adjusted.

Worked example

A general example is a hypothetical analysis of the LCC associated with a project for the purchase and installation of new type approved equipment for a substation. The existing type approval has an initial cost of $300,000 whereas the new type approval has an initial cost of $400,000.

Initially we would be more inclined to not include a new type approval as the initial cost is higher, however, applying the life cycle cost formula will determine if the new type approval is truly more cost-effective than the existing type approval.

- Cost estimates are expressed in real cost terms. Escalation factors employed are real, that is, they exclude inflation.
- Assumptions and financial considerations.
- The discounted cash flow (DCF) technique was employed to account for the time value of money. The discounted cost has been calculated for each option.

  For any future capital project cases In terms of economic appraisals, NSW Treasury recommends "While there may be no universally accepted 'correct' discount rate, interpretation of appraisal results will be impossible if different agencies use different discount rates. The solution is the application of a standard set of real discount rates of 4 per cent, 7 per cent and 10 per cent to see if the outcome is sensitive to such variations and, if it is, to make the critical 'break-even' rate clear in the analysis results. The central real discount rate is therefore 7% with sensitivity tests on the use of 4% and 10%.

LCC model analysis

Outcome

- The new technology option attracts a higher initial capital cost and a better resale at disposal. The existing type approval option attracts a higher total cash flow over the years than the new option but has a lower initial purchase cost.
- The discounted cost of the new option over the expected 30 years operating life was assessed to be approximately $4 million. The discounted cost for the second option was approximately $5 million.
- The assumptions applied in the analysis are conservative and are taken over a typical 30 year equipment usage.

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- In many instances the experience has been that the end of life for the equipment is largely driven by change in technology.

The major difference is the difference in cash flow over the life of the investment and the initial up-front cost. Cost growth of outgoings has been assumed to grow at a constant rate, for both options (see Table 2 for Option 1 and Table 3 for Option 2) are assumed to compound annually at 1.5% in real terms.

Table 2 – Option 1 LCC analysis

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	.....	.....	Yr 30	Cost to PV
1. Concept and Definition (Concept, Feasibility)	19																	19
- *Market research.*	2																	2
- *Project management.*	5																	5
- *System concept and design analysis.*	4																	4
- *Preparation of a requirement specification of the product.*	8																	8
2. Design and Development (Procurement, Design)	55																	55
- *Project management.*	8																	8
- *System and design engineering including reliability, maintainability and environmental protection activities.*	5																	5
- *Design documentation.*	6																	6
- *Prototype fabrication.*	10																	10
- *Software development.*																		0
- *Testing and evaluation.*	12																	12
- *Productivity engineering and planning.*	10																	10
- *Vendor selection.*	4																	4
- *Demonstration and validation.*																		0
- *Quality management.*																		0
3. Manufacturing and Installation (Build, Integrate)	2	2319																2321
Non-recurring -																		0
- *industrial engineering and operations analysis;*	2																	2
- *construction of facilities;*		1776																1776
- *production tooling and test equipment;*		76																76
- *special support and test equipment;*		10																10
- *initial spares and repair parts;*		20																20
- *initial training;*		51																51
- *documentation;*		89																89
- *software; and*		0																0
- *testing (qualification testing).*		305																305
Recurring -		51																51
- *production management and engineering;*		10																10
- *facility maintenance;*		12																12
- *fabrication (labour, materials and the like);*																		0
- *quality control and inspection;*																		0
- *assembly, installation and checkout;*																		0
- *packaging, storage, shipping and transportation;*																		0
- *ongoing training; and*																		0
- *insurance.*																		0
4. Operation and Maintenance	0	121	129	130	132	134	136	137	139	141	142	145	147	148		149	151	2081
a) Recurrent Maintenance (Routine and Cyclic)																		0
- *labour/training;*	0		5	5	5	5	5	5	5	5	5	6	6	6		6	6	75
- *facilities;*	0	96	98	99	101	102	104	105	107	108	109	110	112	113		114	115	1593
- *contractor services; and*	0	25	26	26	26	27	27	27	27	28	28	29	29	29		29	30	413
- *IT support.*																		0
b) Capital Maintenance (Upgrading)																		0
c) Operational Costs																		0
- *labour/training;*																		0
- *materials and consumables;*																		0
- *energy (for example, power, fuel);*																		0
- *equipment and facilities; and*																		0
- *engineering modifications.*																		0
5. Disposal																		0
- *system shutdown;*																		0
- *disassembly and removal;*																		0
- *recycling or safe disposal; and*																		0
- *product residual value.*																		0
Cost Totals	152	4961	258	260	264	268	272	274	278	282	284	290	294	296		298	302	9033
Present value factor @ 7%	1	0.93	0.9	0.8	0.7	0.6	0.6	0.5	0.4	0.3	0.25	0.24	0.23	0.2	0.2	0.2	0.14	8.015
Annual Discounted Cost	76	2353	125	127	113	112	107	106	102	101	103	135	100	95	96	94	90	4035

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Table 3 – Option 2 LCC analysis

	Yr 0	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	.....	.....	Yr 30	Cost to PV
1. Concept and Definition (Concept, Feasibility)	19																	19
- Market research.	2																	2
- Project management.	5																	5
- System concept and design analysis.	4																	4
- Preparation of a requirement specification of the product.	8																	8
2. Design and Development (Procurement, Design)	55																	55
- Project management.	8																	8
- System and design engineering including reliability, maintainability and environmental protection activities.	5																	5
- Design documentation.	6																	6
- Prototype fabrication.	10																	10
- Software development.																		0
- Testing and evaluation.	12																	12
- Productivity engineering and planning.	10																	10
- Vendor selection.	4																	4
- Demonstration and validation.																		0
- Quality management.																		0
3.Manufacturing and Installation (Build, Integrate)	2	2319																2321
Non-recurring -																		0
- industrial engineering and operations analysis;	2																	2
- construction of facilities;		1776																1776
- production tooling and test equipment;		76																76
- special support and test equipment;		10																10
- initial spares and repair parts;		20																20
- initial training;		51																51
- documentation;		89																89
- software; and		0																0
- testing (qualification testing).		305																305
Recurring -		51																51
- production management and engineering;		10																10
- facility maintenance;		12																12
- fabrication (labour, materials and the like);																		0
- quality control and inspection;																		0
- assembly, installation and checkout;																		0
- packaging, storage, shipping and transportation;																		0
- ongoing training; and																		0
- insurance.																		0
4.Operation and Maintenance	0	121	129	130	132	134	136	137	139	141	142	145	147	148		149	151	2081
a) Recurrent Maintenance (Routine and Cyclic)																		0
- labour/training;	0		5	5	5	5	5	5	5	5	5	5	6	6	6	6	6	75
- facilities;	0	96	98	99	101	102	104	105	107	108	109	110	112	113		114	115	1593
- contractor services; and	0	25	26	26	26	27	27	27	27	28	28	29	29	29		29	30	413
- IT support.																		0
b) Capital Maintenance (Upgrading)																		0
c) Operational Costs																		0
- labour/training;																		0
- materials and consumables;																		0
- energy (for example, power, fuel);																		0
- equipment and facilities; and																		0
- engineering modifications.																		0
5. Disposal																		0
- system shutdown;																		0
- disassembly and removal;																		0
- recycling or safe disposal; and																		0
- product residual value.																		0
Cost Totals	152	4961	258	260	264	268	272	274	278	282	284	290	294	296		298	302	9033
Present value factor @ 7%	1	0.925	0.85	0.775	0.7	0.625	0.55	0.475	0.4	0.325	0.25	0.24	0.23	0.2	0.18	0.15	0.14	8.015
Annual Disocunted Cost	61	1762	169	164	153	222	193	133	200	127	124	182	115	112	109	55	50	3931

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Appendix B Recommended reading

The following documents supplement the information provided in this standard:

- AS/ISO 55000:2014 *Asset management – overview, principles and terminology*
- AS/NZS 4536:1999 *Life cycle costing – application guide*
- ISO 15686-5 *Buildings and constructed assets – service life planning*
- *Life Cycle Costing – better practice guid*e (December 2001) – Australian national audit office
- *Preparation of a Rail Safety Management System – Guideline* (January 2013) – Office of the national rail safety regulator
- TAM04-10 *Total asset management – Life cycle costing guideline* (September 2004) – NSW Treasury
- TS 10504:2013 *AEO guide to engineering management*

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