

INDEPENDENT TRANSPORT SAFETY REGULATOR

Sharing practice:

A discussion on the relationship between risk and asset management

NSW rail industry seminar paper - final



Contents

In	dustry participants1
Int	troduction2
Ba	ackground3
As Ris	set management
Fr	equently asked questions6
1. 2. 3. 4. 5. 6. 7.	What is the relationship between risk and asset management?
Pr	inciples of risk and asset management14
Ris Qu Ris Ris As	sk and asset management relationship
As	set and safety management systems25

This material may be reproduced in whole or in part, provided the meaning is unchanged and the source is acknowledged.

DISCLAIMER

The Independent Transport Safety Regulator (ITSR) has made all reasonable efforts to ensure that the contents of this document are factual and free of error, omission or inaccurate information. ITSR shall not be liable for any damage or loss that may occur in relation to any person taking or not taking action on the basis of this document

December 2012

ITSR

Industry participants

The Sharing Practice Seminar was attended by representatives from the following organisations:

- 3801 Limited
- Asset Standards Authority
- Australian Rail Track Corporation
- Asciano
- Bull Head Services
- Downer Rail
- DWH Risk Management
- El Zorro
- Fire and Rescue NSW
- Freightliner Australia
- Glenreagh Mountain Railway
- John Holland Rail / John Holland Rail, Country Regional Network
- NSW Rail Transport Museum
- Pacific National
- Perisher Blue
- Plateway
- RailCorp
- Reliance Rail
- Rhomberg Rail Australia
- SCT Logistics
- Southern Shorthaul Railroad
- Taylor Rail
- Thiess
- Transfield Services
- Transport for NSW
- UGL Unipart
- Valley Heights Steam Tramway
- Zig Zag Railway

Introduction

The first version of this paper was distributed prior to the Sharing Practice Seminar hosted by the Independent Transport Safety Regulator (ITSR) in Sydney on 22 November 2012. The purpose of the original discussion paper was to:

- stimulate debate within the NSW railway industry on the causal link between risk management and asset management
- support the realisation of the functions and objectives of the *Rail Safety National Law 2012*.

The paper was revised following the seminar with key discussion points from the event incorporated into the frequently asked questions (FAQs) section.

A risk-based approach is the foundation of the effective management of railway assets. Such an approach is both essential for safety and for the management of assets. It represents good established practice that has been demonstrated in many other asset-intensive industries, providing the tools and processes for the sustained achievement of business improvement.

The seminar associated with these proceedings was the second in a series of industry events on the topic of asset management. The aim is to inform the NSW railway industry about asset management and to facilitate debate and the sharing of ideas.

The subject at the core of this paper is the relationship between risk and asset management. The paper provides background information on the subject, followed by some FAQs and answers.

The final section of this paper provides additional information on the principles of risk and asset management. This section is supplementary, intended for those who wish to expand on the information presented under the background and FAQ sections.



Background

Asset management

Asset management is still a relatively new discipline, originating in the late 1980s in Australia and New Zealand. Since then its growth has been rapid with existing methods from other professions (for example, engineering and finance) being integrated to create a new discipline.

An early effort at formalising asset management was the British Standards Institute's *PAS 55* series first published in 2004. This specification, along with publications from other professional groups, has enabled the preparation of the imminent *ISO 55000* suite on asset management.

Asset Management: The coordinated activities of an organisation to realise value from assets.

ISO 55000 Draft

Asset management is a set of whole life practices that enables organisations to use assets to deliver their goals. To this end, the discipline unites an organisation's technical and financial capability to plan for the delivery of desired asset performance. Figure 1 shows a typical approach to the management of assets. This model is explained further in the section of this document titled *Principles of risk and asset management*.





¹ Used with permission of the Asset Management Council



It is important for asset management to have a purpose. This purpose is ultimately the satisfaction of both stakeholder needs and business needs. Identifying stakeholders, capturing their needs, and agreeing asset performance objectives are all fundamentally important for an effective and safe business.

Essential to achieving agreed performance is establishing a balance between desires, wants and needs across all stakeholders. Such a balance typically requires the use of risk-based decision making criteria to allow managers to make trade-offs between different future scenarios.

"...the rail industry...swings across the years from periods where you have engineers in charge, and they spend money like water, to periods when you have accountants in charge, and they don't spend any money at all. And as in most things, the sensible place you want to be is somewhere in the middle."

Tim Collins, Shadow Minister of Transport UK, September 2003

Stakeholder requirements translate ultimately into asset management objectives. The core objectives of asset management fall into one of three fundamental categories:

- 1. safety for people and their environment
- service delivery can be agreed explicitly in contracts or implicitly in service charters or public promises
- 3. financial performance necessary to the continued viability of the organisation.

Failing to achieve any of the above objectives can be costly, and can jeopardise the future viability of an organisation. Hence, their achievement must be concurrent.

Often organisations inadvertently move from satisfying their objectives collectively to focusing on each one separately. This approach can establish a downward spiral: as one objective is individually achieved, it creates adverse outcomes for the others.

Asset management therefore requires organisations to understand (and be able to demonstrate) the balance between cost, risk and performance.

Risk

The notion of risk has been with us for centuries: its basic concepts were first published as far back as the mid 1600s.

"Fear of harm ought to be proportional not merely to the **gravity** of the harm but the **probability** of the event."

Antoine Arnauld, Port Royal Monastery Paris, 1662

The application of risk assessment and management techniques, applied to the political and scientific framework of a rapidly developing Europe, was arguably pivotal in the creation of our modern world.

The epitome of that development was the application of the principle of uncertainty (at the core of the notion of probability) to quantum mechanics, in the late 1920s. Since that date, a key defining characteristic of the modern world is the role and use of risk based tools - without which recent spectacular technological and sociological advances would not have been possible.

Risk management is defined by ISO 31000 as the effect of uncertainty on objectives.

Risk = Probability x Consequence ISO 31000 risk management Mathematics supported by statistics provides tools (such as reliability analysis) to enable the future performance of assets to be both predicted and achieved.



Figure 2 - Risk management model (ref ISO 31000)

Frequently asked questions

1. What is the relationship between risk and asset management?

Risk and asset management are connected in our focus upon the future - that is, the future performance of assets.

Asset management is used to plan for future asset performance. This is achieved by understanding stakeholder needs, understanding the risks associated with the delivery of those needs and developing appropriate mitigation to those risks to deliver safe and reliable performance.

Risk management provides the decision support processes and tools to deliver and sustain future asset performance.

In essence then, risk management provides the foundation upon which asset managers can "make the future come true", that is, predict the need for and deliver assets that are safe, meet the demanded service and achieve the required financial performance.

Discussion point

Understanding asset-related risks is a key element of an asset management system. Analysing and assessing risks, and identifying control mitigations helps us understand the asset management tasks that we need to undertake.

While it is important to understand risks and their mitigation, we must not forget to communicate and implement the practical tasks needed to deliver risk control. For instance, at times routine maintenance might not be completed: the impact of deferring maintenance should be communicated to stakeholders for risk-based acceptance and approval. Modified asset plans should be implemented to control risk and assure the ongoing safety of assets.

2. When should quantitative and qualitative analyses be used?

In general, *qualitative* type assessments help to compare options and select the most appropriate option: possibly for further, more detailed, analysis.

When greater understanding is required (for example, the potential consequences of failures) and when an absolute understanding of the outcomes are needed, then *quantitative* analytical tools should be used. In general, quantitative analyses are required to support the management of assets.

3. What published risk techniques are available for use in rail asset management?

Risk techniques for railway asset management are the same as those that are successfully applied to other industries.

ISO/IEC 15288 Systems Engineering is a key tool used to develop analytical processes and approaches when the risks associated with the project or activity are:

- complex and involve a multi-disciplinary approach to the development of solutions
- not obvious and/or are unknown (that is, a systematic approach is required to the identification and management of risks)
- a balanced solution set is required to be developed (nearly always in the case of assets).

As part of the implementation of a systems engineering approach, a series of detailed risk-based processes are available. The international standard *ISO/IEC 31010 Risk Management – Risk Assessment Techniques* is a useful guide for the selection of techniques and also explains the strengths, weaknesses and limitations of each. Some 31 types of risk assessment methods are described in the standard. This list is not extensive.

Some examples from the IEC 31010 standard are shown at Table 1.

Table 1: Risk assessment techniques for asset management

Type of risk assessment technique	Description	Can provide quantitative output?				
	Methods which focus on causes, failure modes and risk factors					
Failure mode and effect analysis and failure mode and criticality analysis (FMEA and FMECA)	 FMEA is a technique which identifies failure modes and mechanisms, and their effects. FMEA may be followed by a criticality analysis which defines the significance of each failure mode, qualitatively, semi-qualitatively, or quantitatively (FMECA). The criticality analysis may be based on the likelihood that the failure mode will result in system failure, or the level of risk associated with the failure mode, or a risk priority number. 	Yes				
Hazard and operability studies (HAZOP)	A general process of risk identification to define possible deviations from the expected or intended performance. It uses a guideword based system. The criticalities of the deviations are assessed.	No				
Fault tree analysis	A technique which starts with the undesired event (top event) and determines all the ways in which it could occur. These are displayed graphically in a logical tree diagram. Once the fault tree has been developed, consideration should be given to ways of reducing or eliminating potential causes / sources. The tree can be quantified to give the probability of the head event or of causal pathways	Yes				
Root cause analysis / single loss analysis (RCA)	A single loss or gain that has occurred is analysed in order to understand contributory causes and how the system or process can be improved to avoid such future losses. The analysis should consider what controls were in place at the time the loss oir gain occurred and how controls might be improved.	No				
Cause and effect analysis	An effect can have a number of contributory factors which may be grouped into different categories. Contributory factors are identified often through brainstorming and displayed in a tree structure or fishbone diagram.	No				



Type of risk assessment technique	Description	Can provide quantitative output?
	Methods which focus on causes, failure modes and risk factors	
Human reliability analysis (HRA)	Human reliability assessment (HRA) deals with the impact of humans on system performance and can be used to evaluate human error influences on the system.	Yes
Reliability-centred maintenance (RCM)	A method to identify the policies that should be implemented to manage failures so as to efficiently and effectively achieve the required safety, availability and economy of operation for all types of equipment.	Yes

4. Where might we look to identify what asset management tools and processes are available?

Asset management is the integration of a series of processes across the whole life of asset systems. Typical asset lifecycle stages and processes are illustrated below in Figure 3.





The above processes are further developed in the Asset Management Council's (AM Council), Capability Delivery Model, which provides more detailed guidance for effective asset management – this model is explained further in the *Principles of risk and asset management* section of this document. Standards and handbooks provide further information. Table 2 lists some examples for the application of risk and asset management techniques.

Table 2: Typical asset management tools and processes

Discipline	Standards	Handbooks
Systems engineering	ANSI/GEIA 632	INCOSE Systems Engineering Handbook
	IEEE 1220	Systems Engineering Fundamentals - Defence Systems management College
	ISO/IEC 15288	NASA Systems Engineering Guide - LAPG 7122.1
Configuration management	ISO 10007	WSA 08—2008 Water Industry Guideline for Configuration Management
	ANSI/EIA 649-A	MIL-HDBK-61
	FAA STD 1800	
	NASA Configuration Management Standard	Rail Services Australia, Configuration Management Policy Manual 1998
Integrated support	MIL-STD-1388-1 and 2	MIL-HDBK-502 Acquisition Logistics
		Integrated Logistic Support Handbook - James Jones



5. What might the content of an asset management plan contain and why?

Sample asset management plans are available from a number of industry bodies such as the AM Council and the Institute of Public Works Engineering Australia (IPWEA).

Asset management plans need to be relevant to the organisation and its unique needs. However, an asset management plan typically comprises three main elements:

- context including items such as objectives, existing assets, performance, asset condition profiles and assessed risk
- financial Opex and Capex financial requirements, also key performance indicators and targets to demonstrate the progress of plan delivery
- governance arrangements for financial and technical delegations and organisational responsibility.

Discussion point

Understanding asset condition (see Figure 9) underpins our approach to the management of assets. An effective asset management system should recognise how asset condition impacts on the needs of an organisation and its stakeholders.

For instance, improving track condition can improve reliability and lead to a reduction in temporary speed restrictions. This is in turn can result in an increased number of train paths and enhance the capacity of the rail network. Potentially, having knowledge of the network's capacity limitations and track asset condition could lead to targeted infrastructure works that improve both safety and network capacity.

6. What is the relationship between asset management and a Safety Management System?

It is a legislative requirement (*Rail Safety National Law 2012*) that a safety management system includes an asset management policy and support processes that address all phases of the asset life stages of rail infrastructure, rolling stock and associated support service infrastructure.

The purpose of the asset management system is to implement the life stage processes required for the effective management of an organisation's assets. The asset lifecycle stages (see Figure 1) and the relationship to a safety management system are highlighted in Figure 4.



Figure 4 - Asset lifecycle processes and safety management system

However, it is important that a rail transport operator documents as part of the safety management system:

- the asset management processes and procedures to be used by the operator for each of the lifecycle stages in Figure 3 (where applicable)
- the competency and capacity of the organisation to implement those procedures
- what assets are used to deliver the rail operations (either owned or leased)
- what the asset is expected to do (in performance terms) under what operating conditions.

The asset management processes and procedures, as part of the safety management system, should apply a risk-based approach to understand the relationship of:

- how an asset can fail and/or what components can fail in the delivery of the stated performance
- what causes the failure
- what happens when the failure occurs
- what the probability is of that failure
- the consequence(s) of that failure
- the risks from that failure (consequence and probability)
- the identification of mitigation tasks and actions (such as maintenance, operating tasks, training, sparing etc); for that failure
- the analysis of those proposed tasks and actions so that the identified risks have been mitigated so far as is reasonably practicable.

Within the safety management system, asset management provides a risk-based approach to the:

- development of appropriate risk mitigation tasks (maintenance, training, spares etc)
- subsequent achievement of appropriate safety, financial and asset performance outcomes.

Further information can be found in the *Principles of risk and asset management* section of this document.

Discussion point

During the 'Acquire' phase, risk mitigation will involve engineering activity to address a particular asset problem: for example, installation of replacement switches to improve an unreliable turnout. An organisation may have a list of remedial works to be completed: risk assessment helps us to determine which tasks have to be done for safety, operational or other business reasons.

The risk will only be mitigated once the Acquire phase engineering activity is completed. It is important to realise that the asset management system covers the entire lifecycle of the asset and that other risks controls should be implemented until the new works are completed. For instance, this may involve enhanced maintenance or inspection regimes.

7. Is every accredited operator required to implement asset management in the same manner?

No. However, every accredited operator is required to implement an asset management system.

It is a legislative requirement (*Rail Safety National Law 2012*) that a safety management system includes an asset management policy and supporting processes that address all phases of the asset life stages of rail infrastructure, rolling stock and associated support service infrastructure.

A typical set of asset lifecycle stages are noted in Figure 3. These asset stages are plan, acquire, operate and maintain and dispose.

How each operator chooses to comply (document the risk-based decision making processes) and to reduce risk so far as is reasonably practicable is subject to a number of key influences – such as the level of complexity and quantum of risks associated with the use of assets in their business. The availability of resources can also affect the manner of how an operator controls these risks.

Many a good asset management system has been implemented using a paper-based or spreadsheet approach. Many a good asset management system has been implemented by organisations that number less than six employees. In fact, it is the case that fewer people can often implement effective asset management systems very quickly and more easily than larger organisations.

Of course, it is also true that many good asset management systems have been implemented using the latest software and latest hardware, including GPS and CDA technologies. Whatever the technology used by an operator, it is up to that operator to ensure that their asset management system is, and remains, fit for purpose and suitable for their business.

Discussion point

A number of standards exist for certifying management systems, such as ISO 9001, 14001 and 180001. Currently no such standard exists for asset management, but in 2014 a new standard (ISO 55001) will be published, along with its supporting principles (ISO 55000) and guidance (ISO 55002).

ISO 55001 is available as a draft international standard and provides useful guidance to the rail industry on the requirements for an asset management system.



Principles of risk and asset management

Risk and asset management relationship

The Risk Management Vocabulary *ISO/IEC Guide 73*, defines risk as the "effect of uncertainty on objectives". This simplistic view is expanded in that guide, which captures three important aspects of risk:

- 1. an effect is a deviation from the expected positive and/or negative
- 2. **risk** is often expressed in terms of a combination of the consequences of an event and the associated likelihood of occurrence
- 3. **uncertainty** is the state of deficiency of information related to, understanding or knowledge of, an event, its consequence, or likelihood.

Asset management also has many definitions. A common definition used in the NSW rail industry over the past 16 years is:

The lifecycle management of physical assets to achieve organisational objectives.

The latest draft of *ISO 55000 Asset Management System* contains a definition of asset management that extends this arguably constrained view to a much bigger picture with a focus on all assets in the organisation (physical, human, financial, information and intangibles):

The coordinated activities of an organisation to realise value from asstes.

ISO 55000 Asset Management

Both risk management and asset management have underpinning models that use an iterative approach of plan, do, check and act (PDCA). These elements and their application are simplified as:

- the plan sets verifiable objectives along with the processes describing how they are to be achieved
- the do implements the plan and collects data necessary to verify and improve the plan
- the **check** function assesses the collected data for compliance to the plan and achievement of the intent of the plan. Opportunities for improvement are identified during this activity
- the **act** function takes those opportunities through to implemented change or rejection for inclusion in the next iteration of the plan.

The risk management process model was developed in Australia as *AS4360 Risk Management* and remains valid today in *ISO 31000*. The defining model for both is shown at Figure 5, with the PDCA loops articulated over the model.



An asset management process model was also developed in Australia around the same time and formalised by the AM Council. This model, known as the Capability Delivery Model, and is shown at Figure 6.

The main processes used in this model are:

- demand management
- systems engineering
- configuration management
- acquisition
- operations and maintenance
- continuous improvement.





Figure 6: Asset management capability delivery model²

Qualitative and quantitative risk assessment

Analyses associated with risk or asset management fall into three categories:

- 1. **qualitative** using word descriptions of likelihood and consequence, with only one outcome for each risk criteria and exposure
- 2. **semi-quantitative** a hybrid of quantitative and qualitative where matrices (typical of qualitative assessments) are given quantitative ranges that may be numerical or descriptive in nature
- 3. **quantitative** where numerical values for likelihood and consequence are established and risk exposures are calculated and quantified.

It is strictly not valid to apply mathematical formulae to ordinal scales. ... The fact that the output is a numerical value for risk may be misinterpreted and misused, for example in subsequent cost/benefit analysis.

² Used with permission of the Asset Management Council



An example of a qualitative and semi-quantitative risk method is shown at Figure 7 with a typical risk matrix for criteria of staff safety and financial loss. This basic qualitative matrix highlights a problem: that the use of words alone to describe the likelihood and consequence is open to interpretation making the process inadequate for consistency and repeatability. The text box below the risk matrix shows the extension of the method into semi-quantitative risk where each defining word in the qualitative matrix is given a general quantitative description.

		Consequences						
		1	2	3	4	5		Risk ratings
	Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic		Extreme
А	Almost certain	A1	A2	A3	A4	A5		Immediate action required High Senior management attention needed Moderate Management responsibility must be specific
в	Likely	B1	B2	В3	B4	B5		
С	Possible	C1	C2	C3	C4	C5		
D	Unlikely	D1	D2	D3	D4	D5		
Е	Rare	E1	E2	E3	E4	E5		Low Manage by routine procedures
	LIKELIHOO A Almost cert B Likely C Possible D Unlikely E Rare	DD tain Occurs Occurs Occurs Occurs Never I	several times several times in XYZ in industry neard of in indu	per year at loc per year in XY. ıstry	ation Z			
	CONSEQUENCES 5 Catastrophic Death, multiple severe industries, huge financial loss 4 Major Extensive injuries, major property damage, major system damage 3 Moderate Injury – medical treatment required, high financial loss, minor property damage, minor system da 2 Minor Minor injury – on site first aid only required, minor property damage, minor system/equipment da 1 Insignificant No injuries, low financial loss			age, minor system damage system/equipment damage				

Figure 7: Qualitative risk matrix and semi-quantitative banding



Quantitative risk uses numeric values for likelihoods and consequences to allow mathematical operations in both. An example of quantitative risk assessment is a Cause - Consequence Diagram shown at Figure 8 below. The probability of the Loss of Control of Energy (LOCE) is determined from the fault tree on the left hand side of the LOCE point, while the consequence is determined on the right hand side (event tree).



Figure 8: Cause consequence diagram

An example of quantitative risk assessment is the determination of maintenance task periods for highrisk failures (those with low reliability and/or high consequence). The set of curves at Figure 10, derived from the model at Figure 9, show the use of risk to determine the trade off between the increasing cost of preventive condition-based maintenance (done more often or with improved quality) and the subsequent reduction of functional failures (more rectified potential failures that have a less costly impact than functional failures).

As an example, risk assessment can be applied to analysing maintenance intervals for a population of mainline turnouts using cost data for maintenance and failure. The cost of maintenance can include the time taken for a team to set up an appropriate safe system of work, then undertake inspection, test and maintenance activities (for example, set up a possession, perform a facing point test, gauge measurement, lubrication, etc).

The cost of failure needs to consider potential performance and safety impacts. Typically, this includes the cost of sending a team to rectify a failure, the cost of associated train delays and, for safety-critical failure modes (for example, switch rail locked and detected closed when open), the cost of resultant injuries and derailments. Failure costs consider the probability of both the failure and a particular consequence occurring (see Figure 10).



Figure 9: Condition-based maintenance model

Figure 10 can present the costs associated with the above scenario. In this example, with increasing intervals the maintenance costs reduce (teams are inspecting the turnouts less often) but the cost of failure increases (the turnouts are receiving less attention and so the probability of failure increases). The lowest point in the total cost curve identifies an optimal interval for balancing maintenance activities against failure impacts.



Figure 10: Quantitative risk curves of cost to maintenance interval

Quantitative analyses provide excellent material for formal business cases and allow comparison of alternatives from a business, safety and economic view. For example, the Cause-Consequence Diagram provides a picture of the issue under consideration and all its causal factors while listing multiple outcomes and their expected probability. Should a scenario result in unacceptable risk exposure, then additional defences can be added and the cost of those additions compared to the resultant reduction in consequence (risk exposure). With the additional costs and the benefits known, then a cost benefit ratio can be easily calculated.

Risk matrices have some difficulty demonstrating that movement from unacceptable (red area) to acceptable (green area) provides a reduction in risk commensurate with the expected cost. Additionally, if an outcome is unable to reach the green area is it acceptable to stay in a yellow area? Was this alternate outcome also cost effective in reducing risk exposure? Qualitative methods such as rank ordering and risk matrixes cannot answer the question – *"did the amount spent achieve an equivalent value in risk reduction?"* Some argue that quantitative analysis cannot handle intangibles, such as loss of amenity or personal inconvenience. Techniques such as willingness to pay, stakeholder surveys and expert judgement can be useful in such situations but can be time consuming. Other techniques such as stakeholder proxy consensus can be cheaper and still provide superior justification to qualitative methods.

In crafting decisions as to future actions, both risk management and asset management processes can use qualitative and quantitative techniques. Each technique can provide a useful and cost effective tool at certain stages of the asset life and under certain conditions. Fundamental to their selection is a considered view that qualitative is better used for comparative assessments (that is, how to spend a pre-determined budget) while quantative is better used for absolute stand-alone decisions (that is, what should the budget be?).

Risk analysis tools

Global standards such as *ISO 31000: Risk Management System*, are supported by other standards and handbooks that provide greater detail on the risk methods. For example, *IEC 60812: Failure Modes and Effects Analysis*, provides a detailed description of a core asset related risk management technique intended to discover how designed systems might fail. Such analyses can be undertaken on spreadsheets, although more complex applications will usually require the support of commercial software.

Risk processes such as cause-consequence diagrams can be constructed using spreadsheets; again commercial software is available to improve efficiency in large and complex assessments. Care needs to be taken to assure that the software used complies with the standard.

Risk assessment related standards can be readily applied to asset management processes. For example, the capability delivery model has been mapped to many of the listed standards³. Figure 11 is a subset of the model and shows how IEC and other technical standards and associated handbooks (at Table 3) can be applied to assuring asset system capability by mapping the integrated support portion of the capability delivery model to some of those standards.

³ See www.amcouncil.com.au/asset-management-body-of-knowledge.html for further information





Figure 11: IEC process standards for integrated support and lifecycle costing

Table 3: Support analysis methods - standards and handbooks

Analysis Process	Standards	Handbooks
Failure Mode Efects Analysis	IEC 60812:2008	MIL-HDBK-338B
Reliability Prediction	IEEE 1413:2011	MIL-HDBK-217E
Reliability Verification	GEIA-STD-0009	MIL-HDBK-338B
Reliability Growth Programs	IEC 61014:2004	MIL-HDBK-338B
Maintainability Program	IEC 60300-3-10	MIL-HDBK-470B
Maintainability Prediction	MIL-STD-472	MIL-HDBK-472
Supportability	IEC 60300-3-14	MIL-HDBK-59C
Level of Repair Analysis	MIL-STD-1390D	MIL-HDBK-502
Reliability Centered Maintenance	IEC 60300-3-11	MIL_HDBK-2173AS

A challenge for any industry is the extent to which standards are drawn from other, often unrelated, industries and applied to extend their historic thinking. For instance, the application of military standards to the development of a number of rail related initiatives in NSW during the 1990s demonstrated a 'thinking outside the box' approach. Standards in areas such as Configuration Management, Systems Engineering and Reliability Centred Maintenance were applied successfully in the New Southern Railway (Airport Link) under a systems assurance program.

Risk and asset management references

The capability delivery model includes high level processes for asset management. These are already well documented in existing standards and handbooks, for example:

 systems engineering – a formal approach to the capture and management of stakeholder requirements during the creation of a system and their translation into a balanced and verified design solution. Supporting tools include processes such as Functional Flow Block Diagrams, Reliability, Availability, Maintainability and Safety engineering analysis, and specification writing practices.

System engineering is a robust approach to the design, creation, and operation of systems. In simple terms, the approach consists of identification and quantification of system goals, creation of alternative system design concepts, performance of design trades, selection and implementation of the best design, verification that the design is properly built and integrated, and post-implementation assessment of how well the system meets (or met) the goals."

NASA Systems Engineering Handbook, 1995

- integrated support identifying the future capabilities required to sustain the Maintenance Requirements Analysis and then applying tools such as Reliability Centred Maintenance, Level of Repair Analysis, and Task Analysis and Documentation.
- **acquisition** transitioning of assets from design into operational service. This can also include the design and construction functions for in house design/build/operate solutions.
- **continuous improvement** collecting technical and cost data for failures and then applying root cause analysis to remove systemic drivers of loss.
- configuration management a formal approach to capture and manage all information defining the asset's functional requirements and physical characteristics. It also provides a connection between the design and the required future support such as maintenance plans, spares, skills, training, tools, facilities, etc.

There are a host of risk and asset management standards and specifications available to support your asset management needs. When using standards, it is useful to consider adopting a precedence of use approach where the highest level is used unless such standards at that level do not exist or are not suitable, for example:

- International (ISO/IEC)
- Australian Standard (AS/NZS)
- Other National Standard (for example, ANSI, EN)
- Industry Institution Standard (for example, GEIA or IEEE)
- Corporate standards (for example, RailCorp)

When you apply standards, a responsible person for the selection and application of those standards should be nominated. This is the design authority. The automatic application of standards, without consideration of context and applicability, can introduce unforeseen risks. The selection and application of a standard should be a decision made by competent and authorised staff.

The use of asset management and risk standards should regularly be reviewed to ensure they remain valid for the asset risks they are controlling. In particular, maintenance standards that define defects and repair actions should be reviewed, taking cognisance of asset performance data.

Asset management plans

Asset management plans are the primary vehicle through which budgetary submissions necessary to the achievement of asset value are given substance. Ideally, their development process should be justifiable, meaning that every activity in the plan is demonstrably traceable to an agreed stakeholder requirement in a verifiable manner.

To achieve the above, asset management plans would typically have the following attributes:

- fact and risk-based
- fully traceable to asset output requirements
- demonstrably good practice (uses appropriate standards)
- compliant with statutory and regulatory requirements
- · implemented by competent staff
- supported by verified technology (information and decision systems)
- transparently and verifiably costed (sound estimation method)
- deliverable in the agreed timeframe.

The core elements of an asset management plan are shown in Table 4.



Table 4 - Elements of an asset management plan

Preamble	Description and intended use		
	Applicable documents		
	Preparation instructions		
Context	Scope Assets in and not in scope Timeframe 		
	Definitions		
	Business drivers • Governance framework • Statutory requirements • Regulatory requirements • Australian and/or international requirements • Organisation policies and plans		
	Identification of assets Asset systems Asset types and populations Asset age profiles Asset management system 		
	 Management responsibility and interfaces Organisational structure Key roles and responsibilities and interfaces and relationships Supplier requirements 		
	 Asset condition and technology issues Condition issues Technology issues Asset and service risks Asset integrity Asset integrity reporting requirements 		
Financial and reporting requirements	 Operating expenditure requirements Determination of maintenance requirements Maintenance plan resource requirements 		
	 Capital expenditure requirements for new or modified assets Capital requirements - new or modified assets Capital requirements - asset replacements Asset disposal plans 		
	 Asset reporting requirements to meet plan Asset performance criteria, KRA and KPI reporting Asset risk and financial reporting 		
Governance	 Asset assurance requirements Management board - risk and asset sub-committee AM processes and comeptencies AM information and data Benchmarking Review and audit program needs Asset plan approval Approval processes and recording requirements Complimentary requirements 		

Asset and safety management systems

Rail transport operators should adopt a strategic approach to delivering safe operations of their assets, as part of their risk management framework and as documented in their safety management system. Under this framework, a risk management approach should be applied in each stage of an asset's lifecycle from development of the concept or need, through to and including its design, construction, procurement, commissioning, operation, maintenance and decommissioning phases.

As a discipline, asset management is concerned with all aspects of the delivery of the asset capability as illustrated in Figure 3.

It is a legislative requirement that the safety management system includes an asset management policy and support processes that address all phases of the asset life stages of rail infrastructure, rolling stock and associated support service infrastructure.

The purpose of the asset management system is to implement the life stage processes required for the effective management of an organisation's assets.

The asset life stages, such as appear in Figure 3, give no indication of the safety management system processes that operate across the asset life stages and how they might be connected. Further, those life stages give no pointer as to the quality or standard to which such processes ought to comply. Each organisation should choose the appropriate processes at each life stage and the associated quality of those processes.

The intent of this approach to asset management is to manage risk within:

- the plan and acquire life stage with respect to the selection, design and acquisition of the organisation's assets and the technical management of the supporting processes
- the operate and maintain and dispose stages with respect to equipment failure and the impact on the intended operations and personnel safety (both now and into the future).

For example, within the plan stage, the provision of detailed information on known asset failure related risks will enable designers to design out potential problems thus improving safety and improving the reliability of operations during the life of the asset.

An effective configuration management approach, as part of the safety management system, will assist in tracking any changes made to the asset (both functional and physical) during its life and ensure the correct operating context is considered during design, manufacture and operation.



The asset management policy should provide detail of the principles by which the organisation will enact the management of its assets, the configuration management requirements for its assets to ensure continuity throughout the various life stages and the organisation's responsibilities and accountabilities associated with the management of its assets.

It is important for a rail transport operator to document what assets are used to deliver the rail operations (either owned or leased), what the asset is expected to do under what operating conditions. The asset management processes and procedures, as part of the safety management system, should use a risk-based approach to understand the relationship of how an asset can fail, what causes the failure, what happens when the failure occurs, what the probability of that failure is and the consequences of each failure.

Failures can be predicted, so the practice of identifying asset related risks as part of the design and acquisition process and the close monitoring of in service asset performance and emerging failure modes can provide information on both known and emerging risks and thus better manage safety. For example, if a rail transport operator detects an increase in a type of failure, then the operator is in a sound position to deal with the failure and thus mitigate the associated risks. This approach enables rail transport operators to demonstrate that risks have been mitigated so far as is reasonably practicable.

It is important that there is clear accountability for asset related risks, including safety up to and including the CEO, including processes to capture and report risk related data to support a strategic approach. There should be clear and allocated engineering authority over standards, procedures, engineering waivers and deviations and the management of asset configuration data. The competencies for all these roles should be considered, documented and managed to ensure that only those persons deemed competent by the rail transport operator, have the authority to make decisions and thus accept risk on behalf of the rail transport organisation.

With a clear understanding of how the asset can be managed to realise the required operations (one that understands the relationship between cost, risk and performance) the rail transport operator can allocate the appropriate resources throughout each asset life stage. As an integral part of that resource allocation, the needed competencies of staff and contractors involved in each of the life stages should be identified together with the required capacity of each competency to support each life stage.

Sharing practice: A discussion on the relationship between risk and asset management – NSW rail industry seminar paper - final

© ITSR 2012 ISBN 978-0-9872426-7-9

Independent Transport Safety Regulator

201 Elizabeth Street Sydney NSW 2000

PO Box A2633 Sydney South NSW 1235

Telephone:02 8263 7100Facsimile:02 8263 7200

Email: contact@transportregulator.nsw.gov.au Web: www.transportregulator.nsw.gov.au

Business and service hours

ITSR's business hours are 9.00am to 5.00pm, Monday to Friday (except public holidays). Reception is open from 8.30am to 4.30pm.