



2006

Western Power transmission and distribution annual asset management report

prepared by Asset Management Division

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Preface

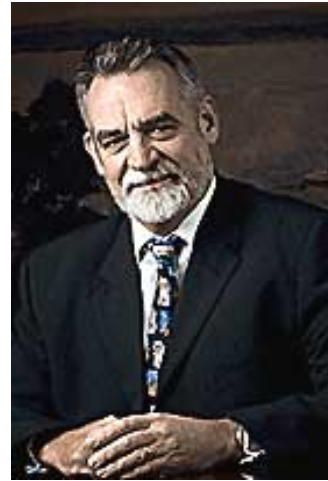
Welcome to the Western Power's Transmission and Distribution Annual Asset Management Report.

The 2006 Asset Management Report anticipates future requirements on Western Power to provide information to the Economic Regulatory Authority on our asset management systems and plans for the networks existing assets.

We have chosen to provide additional information on our current asset management plans, and to make this information more widely available.

As such, the information provided in this report is intended to be useful to all our stakeholders, and to provide an insight into our asset management system and processes, which have been quality certified to ISO 9001.

As the electricity market in Western Australia develops further, Asset Management Division is expected to play an important and transparent role in serving all network users, and this report joins the Generation Status Review and the Annual Planning Report public documents in making our system, processes and plans transparent to our stakeholders.



Doug Aberle
Managing Director
Western Power

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Executive summary

The purpose of this document is to provide details of Western Power's Asset Management System¹ for management of its existing assets as required under the Electricity Industry Act 2004. It also provides details of our current asset management plans for existing assets in the transmission, distribution, SCADA and communication networks.

Western Power's asset management

Western Power's Asset Management System and Processes for management of its existing assets have been quality certified to ISO 9001, the international quality management standard. As illustrated in Figure i, the Asset Management System includes:

Asset Management Policy: The policy establishes a clear description of the roles and functions of the asset owner, the asset manager and the service provider business areas. The asset manager is accountable for policy and decision-making on asset replacement and maintenance decisions, among others. Service providers are accountable for the efficient delivery of the resulting programmes.

These functional requirements are implemented in Western Power through a value chain organisational model as shown in Figure 2.2.

Asset Management Strategy: The strategy sets out the broad principles upon which asset management decisions will be based. For example, renewal plans are based (where practicable) on the asset's age and condition, probability and consequences (to system, customers and cost) of failure, its future role in the system (development plans), and so on;

Asset Management Model: The model consists of the processes, procedures and responsibilities for the delivery of Asset Management System outcomes. A simplified illustration of the model is provided in the Figure ii with more details presented in Chapter 2;

Asset Management Plan: The output from these processes includes annual asset management plans for existing transmission and distribution assets.

¹ Where system is meant in the widest sense.

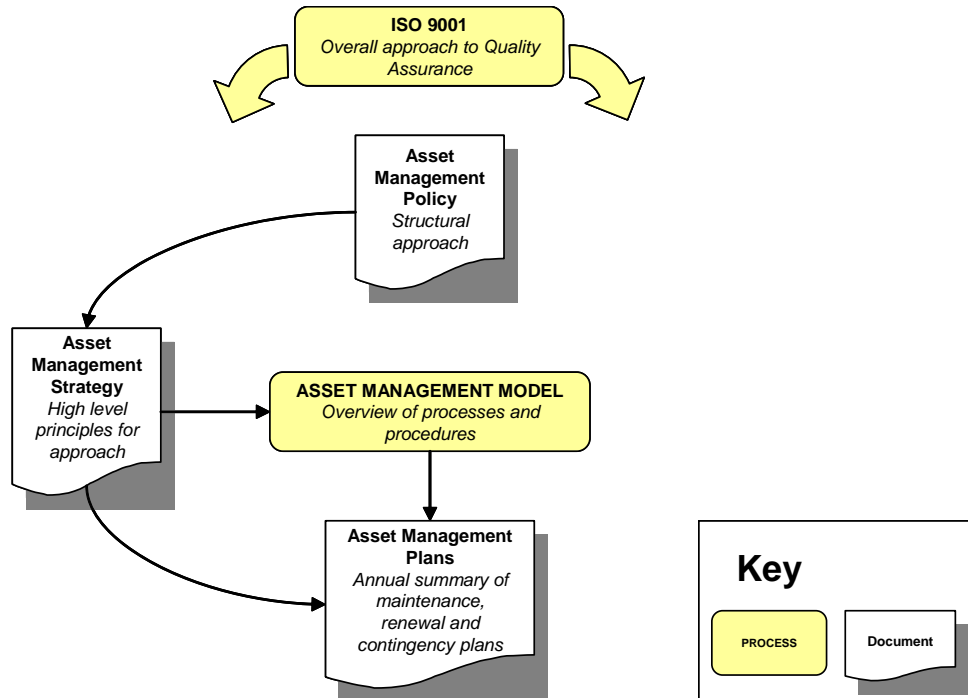


Figure i – Simplified overview of Western Power's Asset Management System
 A similar, although not identical, framework is used for SCADA and communication assets.

Western Power's processes for management of its existing assets

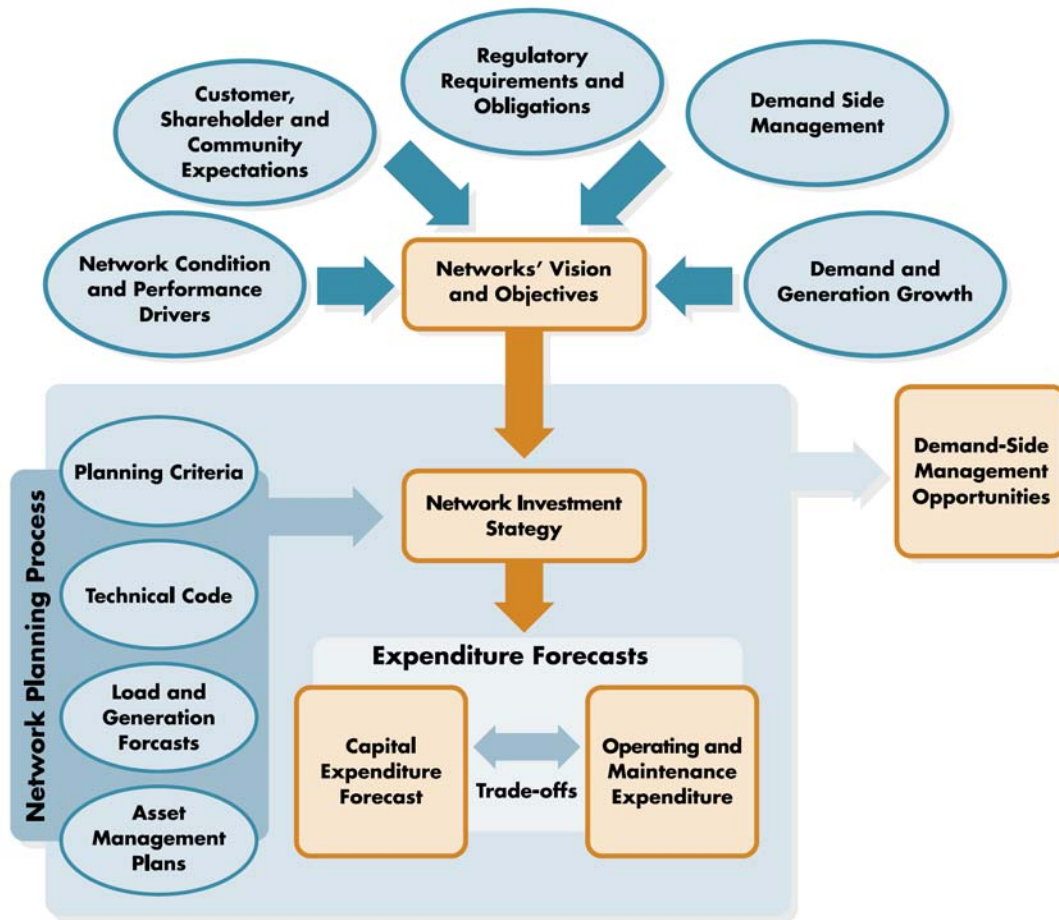


Figure ii – Simplified overview of asset management processes

Western Power’s main asset management processes are illustrated in Figure ii and as follows:

Asset strategy development: Reviewing each asset type to assess its population rate, current and expected future performance, system impact, age, condition, future development plans, and so on, and determining the most suitable management regime (maintenance; upgrade, replacement, contingencies, spares) in line with future system development plans;

Service standards: This input ensures that new service standards required with the new equipment, and legislative and industry knowledge and owner/corporate intents are incorporated into the future asset strategies in the above process;

Asset maintenance management: Developing and implementing maintenance regimes based on the above asset strategies for higher value and higher impact assets (some low value and low impact distribution assets may be designated as “run to failure” for certain periods of time);

Asset renewal management: Where an asset’s age, condition or performance require it to be replaced, or where safety requirements require capital expenditure, this process identifies and implements the most economic/technically suitable solution within overall system development;

Asset condition and performance monitoring and review: This process ensures that Western Power has a sound basis for the asset management decisions it takes;

Contingency planning: This process establishes contingency plans in light of the maintenance and replacement regimes, and includes strategic spare equipment definition and management;

Spares and equipment procurement: Western Power manages its own procurement function backed-up by its asset technical specialist to ensure it buys right and relevant equipment and ensures smooth introduction of such in its system;

Data management and document updating: Western Power manages millions of individual assets. It uses data management acquisition and document control systems to ensure that, as far as economic, Western Power has accurate records of its assets and their condition;

Process review: Western Power carries out audits and reviews of the overall asset management framework to ensure it is fit for purpose. External auditors are also commissioned to review and certify systems.

Throughout, methodologies based on sound risk management principles are applied. Similar, although not identical, processes are used for SCADA and communication assets.

Western Power's assets and condition

Western Power's assets include primary assets, secondary assets, conductors, structures and cables.

The Table i highlights the huge volume of distribution assets under active management.

Age is a useful initial indicator of an asset's condition. Many of Western Power's assets were installed in the 1960s and so are approaching the age where widespread replacement can be expected.

Further details of the Western Power's age profiles are provided in Chapter 4.

Some asset types have been identified as having higher defect rates or poorer condition than what is consistent with assets of a similar type/age. Where appropriate, and in line with system development plans, these assets have been flagged for replacement or have had changes made to their maintenance/contingency regimes.

Some assets have design flaws that give rise to safety concerns. Relatively higher potential for electric shocks or fires has been identified for limited safe clearances in substations, Lines crossing navigable waterways too low, pits, service connections, conductor clashing in bushfire risk areas and access to Western Power's electrical assets is subject to new more stringent guidelines.

Western Power has therefore instigated additional programmes to address these and other risks.

Table i – Western Power’s network assets

System	Substations	Primary Assets (#)	Conductor (km)	Structures (#)	Underground Cable (km)
Transmission	155	19,307	6,682	47,164	56
Distribution	9,967	221,149	68,461	616,119	10,209
Total	10,122	240,456	75,143	663,283	10,265

Transmission and Distribution Network Asset Management Plans

Network Asset management plans provide an annual summary of the various asset management issues for Western Power’s existing assets, which are outcomes and decisions arising from the various processes described in Figure ii. These generally include forward looking requirements for capital and maintenance expenditures within the system development plans, and necessary updates in documentation covering the asset management process, inspection and maintenance needs, and contingency/strategy spare plans.

Detailed regular inspection, maintenance and testing regimes have been developed for existing assets where it is economic or feasible to ensure their continued service. These maintenance regimes are reviewed and optimised where possible by taking into account the risk of failures and costs of the existing maintenance runs. Further proactive maintenance regimes are under development for assets currently operated as run to failure.

Given the age of some of its assets, Western Power has instigated additional condition testing methods and programmes to identify their condition and assess end of life to enable more precise determination of investment needs and produce suitable risk management plans.

Some assets are already of an age where replacement is likely to be required. Chapters 5 and 6 provide raw information on assets identified as urgently requiring replacement, as well as assets approaching the end of their expected lives.

This raw information is then subject to further investigation and business case analysis, to ensure that only priority assets are actually replaced. The resulting capital plan differs from the raw age based profiles due to risk management, predictions about the impact of the scheduled replacements within wider Western Power’s system development plans.

These asset replacement works are also expected to lead to some improvements in safety and reliability.

The Board approved the distribution and transmission proposed capital budget plans for 06/07 to 09/10 financial years on 10 January 2006. The Figure iii represents the new approved budget or State Budget Forecast (SBF).

The resulting capital expenditure programme for management of Western Power’s existing asset is consistent with and complements Western Power’s Strategic Development Plan that is required under the Electricity Corporation Act 1994.

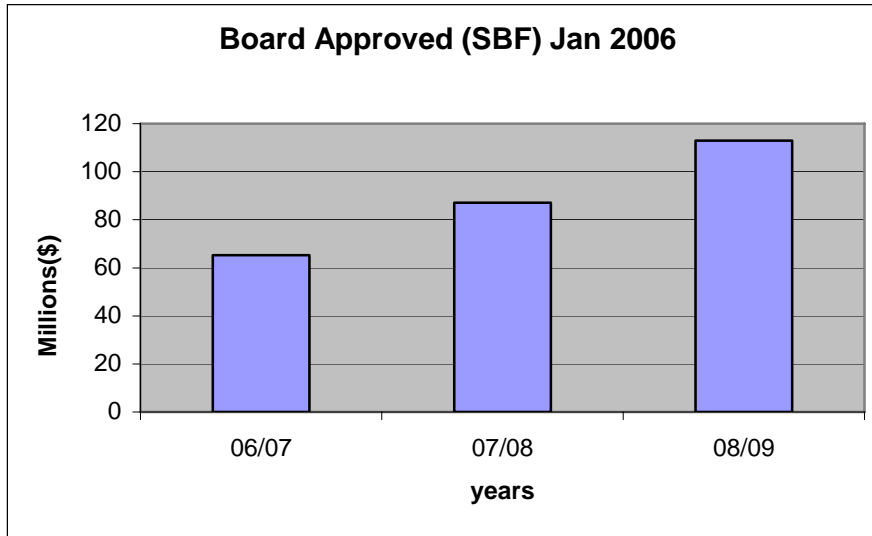


Figure iii –Current budgets for asset management of transmission and distribution plant for 06/07 to 08/09 financial years

SCADA/Communications Asset Management Plan

Among other things, the following capital expenditure programmes have been identified:

Communications capacity enhancement;
 Substation automation development; and
 Various asset replacements.

Detailed maintenance regimes have been developed for critical communication items to ensure their continued service. These maintenance regimes are optimised, taking into account the risk of failures, costs of frequent maintenance runs and future development plans.

1 Introduction

The 2006 Transmission and Distribution Annual Asset Management Report (AMR) describes Western Power's current asset management systems and the arising asset management plans between 2006 and 2009 for its existing assets.

The report's structure is as follows:

Chapter 2 describes Western Power's overarching asset management approach;
Chapter 3 describes Western Power's asset management processes and standards;
Chapter 4 describes the status of the transmission and distribution networks from an asset management perspective²; and
Chapters 5, 6 and 7 set out the 2006 Asset Management Plans for transmission, distribution, and SCADA and communications assets respectively.

This report discusses technical matters. A short introduction to electricity network asset management is provided for the lay reader at Appendix A. This document refers to the networks that comprise Western Powers' South West Interconnected System (SWIS).

The remainder of this Introduction describes the purpose of this document more fully and how it interacts with the Annual Planning Report, the Strategic Development Plan and other Western Power's processes for capital expenditure planning. It concludes with an overview of the Western Power's role.

1.1 Purpose of this document

The purpose of this document is to provide details of our Transmission and Distribution Asset Management System for existing assets as required under the Electricity Industry Act 2004. It also provides details of our current asset management plans for the transmission, distribution, SCADA and communications networks.

Under S28 of the Electricity Corporations Act 1994, the functions of Western Power are:

“(a) to acquire, exchange, transport, distribute, market and otherwise supply electricity;
(b) to undertake, maintain and operate any works, system, facilities, apparatus or equipment required for any purpose referred to in paragraph (a).”

Under S31 of the same Act, Western Power is further required to

“(a) act in accordance with prudent commercial principles; and
(b) endeavour to make a profit, consistently with maximizing its long term value.”

As such, Western Power has implemented an effective asset management system, which seeks to deliver reliable long-term network services consistent with prudent commercial principles.

The AMR describes that asset management system, and this issue is published against a developing legislative background. The Electricity Industry Act 2004 envisages licences for the

² Network constraints are described in the 2006 Annual Planning Report, also published by Western Power.

construction and operation of transmission and distribution systems, publication of an access code and further regulations.

S.14 of the Act provides that:

- “(1) It is a condition of every licence, other than a retail licence, that the licensee must -
- (a) provide for an asset management system in respect of the licensee’s assets;
 - (b) notify details of the system and any substantial changes to it to the Authority³;
- and
- (c) not less than once in every period of 24 months (or any longer period that the Authority allows) calculated from the grant of the licence, provide the Authority with a report by an independent expert acceptable to the Authority as to the effectiveness of the system.
- (2) An asset management system is to set out measures that are to be taken by the licensee for the proper maintenance of assets used in the supply of electricity and in the operation of, and, where relevant, the construction of, any generating works, transmission system or distribution system.”

This report is intended to satisfy S.14 (1) (b) above for Western Power’s transmission and distribution systems. The publication of this report allows Western Power and the Authority to understand the information necessary to satisfy the requirements of the Act.

It should be noted nonetheless that the details of Western Power’s licence are still under development. These details will have a potentially significant impact on Western Power’s approach to asset management, and its resulting asset management plans.

The report provides details of Western Power’s future plans for management of its existing assets.

Western Power intends to publish this document each year, the future versions likely to include:

- Any improvements to our Asset Management System;
- Updates of the Asset Management Plan;
- Enhancements required by legislation and other statutory instruments;
- Response to feedback from all Western Power stakeholders.

1.2 Interaction with the Annual Planning Review

This report complements the role of the Annual Planning Review (APR), which focuses on network constraints and development of new network capability for the SWIS networks. This AMR focuses on the management of Western Power’s existing assets.

The AMR takes into account the plans for network development described in the APR. Asset replacement (that would otherwise be required) is not included in the Asset Management Plan where Western Power expects that the developments described in the APR will remove this requirement, thus AMR and APR are complementing one another.

1.3 Interaction with the Strategic Development Plan

³ Economic Regulation Authority (“ERA”).

Western Power is required by the Electricity Corporation Act 1994 to prepare a Strategic Development Plan (SDP) for agreement with the Minister. Among other things, the SDP sets out the financial objectives and associated capital and operating expenditure plans for Western Power.

This AMR provides further details than available in the current draft of SDP, but it is nonetheless consistent with the programme summarised there.

1.4 Interaction with other Western Power's expenditure programmes

This report focuses on management activities for Western Power's existing assets. It does not describe Western Power's complete capital expenditure programme, which also includes development plans discussed in 1.2 above and the following additional special programmes funded and managed under the auspices of the State Government:

- **Bushfire Management Plans:** Plans are prepared annually to give particular focus to bushfire mitigation activities. Activities are prioritised within Low, Moderate, High and Extreme Fire Risk areas. Activities include vegetation management, pole management, conductor management and lightning management. Design and plant review are within scope as are operational issues.
- **Rural Power Improvement Programme:** This \$48 million spending programme is funded equally by the State Government and Western Power and is in addition to funds allocated to other programmes to enhance power supplies in the regions. Over the next four years this fund will cover specially targeted projects that are difficult to justify under Western Power's normal prioritisation process because of their high cost compared with the relatively few customers in those areas. For further details, please see Western Power's website;
- **State Underground Power Programme:** In 1996, the State Government of Western Australia embarked on a programme to replace overhead system in older urban areas with underground power supplies. For further details, please see WA Office of Energy website (http://www.energy.wa.gov.au/3/3050/64/state_undergrou.pm).
- **40 Worst Feeder Programme:** The \$39 million spending programmed over the next 3 years is to focus on improving the reliability of the distribution network; primarily the 40 highest contributing feeders to SWIS SAIDI (refer to Appendix C for definition of SAIDI). This work includes (but not limited to) targeted network reinforcement and installation of equipment to increase the automata ion of field switching.

1.5 Role of Western Power

Western Power was established under the Electricity Corporation Act 1994. Western Power is responsible for operating, maintaining and expanding the electrical transmission and distribution network in the SWIS.

Western Power is accountable for the SWIS wires business, and has two primary responsibilities:

To manage the transport of electrical energy to good industry practice; and

To provide a non-discriminatory access to network capacity in Western Australia.

The first responsibility requires Western Power to plan, operate, manage, develop and augment the physical assets. The second responsibility is intended to facilitate competitive generation and retail markets. These two responsibilities are, of course, closely interrelated.

2 Western Power's management of its existing assets

This Chapter describes Western Power's management of its existing assets, as illustrated in Figure 2.1.

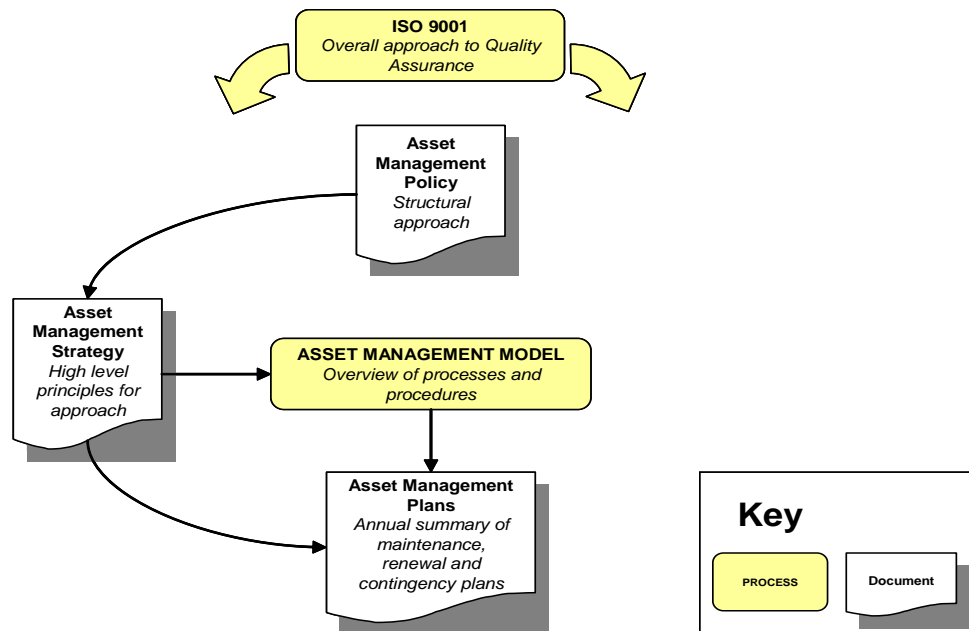


Figure 2.1 – Overview of Chapter

2.1 Overall quality assurance approach

Western Power has adopted ISO 9001 as the quality standard for its Asset Management System and Processes in managing its existing assets. ISO 9001 is a standard from the International Organisation for Standardisation's family of standards that covers quality management.

This quality management standard is intended to allow the organisation to consistently deliver services that:

- Meet customer's quality requirements;
- Meet applicable regulatory standards;
- Enhance customer satisfaction; and
- Achieve continual improvement in performance.

ISO 9001 requires the organisation to establish, document, implement and maintain a quality management system that, among other things, addresses:

Management responsibility: ISO 9001 requires management to demonstrate commitment to the quality system, develop a quality policy, support customer focus, support planning, define responsibilities and ensure review of the system;

Resource management: Compliance with ISO 9001 requires, among other things, the deployment of adequate resources, identification of the competency requirements and training to enable staff to deliver quality products or services;

Product realisation: The organisation must identify quality objectives for the product and the processes necessary to deliver that quality, including necessary record management systems;

Measurement, analysis and improvement: The organisation must have monitoring and measurement processes needed to demonstrate conformity of the product, ensure conformity to the quality management system and continually improve the effectiveness of the quality management system.

Western Power has received an external certification for its Asset Management System and Processes of Western Power Asset Strategy and Maintenance Section in managing its existing assets to the international standard on quality ISO 9001.

2.2 Asset Management Policy

The Asset Management Policy sets out the broad functional, high-level responsibilities and approach to asset management in Western Power for its existing assets.

These functional requirements are organisationally implemented in Western Power through a works engine organisational model.

Western Power has developed policies for transmission and distribution assets and for SCADA and communications assets.

2.2.1 Transmission and Distribution Asset Management Policy

The Transmission and Distribution Asset Management Policy establishes a clear distinction between the asset owner, the asset manager and service provider roles and functions:

The asset owner is accountable for the broad direction of the business, including regulatory requirements;

The asset manager is accountable for policy and decision-making in terms of asset replacement and maintenance regimes:

Developing maintenance and operational strategies to achieve asset performance objectives;

Optimising the life-cycle cost of assets⁴;

Monitoring asset performance;

Managing relevant risks;

Setting asset and network standards; and

Planning long-term asset maintenance and asset replacement.

Service providers are accountable for the efficient delivery of asset maintenance and renewal services, among other things.

⁴ Lifecycle costs take account of the totality of costs affecting an asset including service impacts, maintenance, replacement, refurbishment and disposal costs.

2.2.2 SCADA and Communications Vision

The need for SCADA and communications effectively follow growth of the transmission and distribution networks. As the protection and control requirements for these networks become more sophisticated, the SCADA and communications develop accordingly.

The asset management approach for SCADA and communications assets reflects this supporting role.

The vision is to provide SCADA and communication systems that are cost effective, robust and flexible, providing suitable capacity, reliability and redundancy to support Western Power's electricity business.

Given the specialised nature of the SCADA and communications function, both asset management and service delivery have been integrated within one functional unit.

2.3 Asset Management Strategy

2.3.1 Transmission and Distribution Asset Management Strategy

The Transmission and Distribution Asset Management Strategy has been expressed as a series of principles upon which asset management procedures and decisions are based to support the Western Power's Asset Management Policy:

Long term asset maintenance and renewal plans are prepared annually and are based on (where practicable):

- The asset's age and condition;
- The asset's expected system role taking into account the potential obsolescence;
- The probability and consequence of failure;
- The physical and system environment of the asset;
- Realistic asset decay predictions and subsequent life-cycle costs planning; and
- The need to ensure the long-term viability of the business, that is, to avoid reaching a situation where the overall condition of the network has declined to an unmanageable state.

Investment in the existing asset infrastructure is based on the need to:

- Maintain defined reliability and quality of supply to customers – for example in line with service standards established under proposed access arrangements;
- Reduce servicing and operating costs;
- Optimise the economic life of equipment;
- Ensure safe operation of assets; and
- Meet regulatory and environmental requirements.

All proposals for major expenditure are prepared using the standard corporate economic assessment and project approval processes. This includes a detailed operating and capital funding requirements review and prioritisation process, and feeding it into the overall Western Power budgeting framework. In time, these processes will be influenced by the commercial

incentives and service standards to be established under the new networks access regulatory arrangements.

Where economic, maintenance is completed for each type of equipment to:

- Achieve minimum maintenance costs;
- Ensure the condition is within acceptable limits;
- Operate the equipment at an acceptable level of risk;
- Meet required performance targets
- Defer capital expenditure

Maintenance plans take into account overall life-cycle plan for the assets, including renewal and disposal plans and future development plans.

Risk exposure is identified through due diligence programmes, asset audits, analysis of performance history and other specialised risk analysis projects. Critical assets are treated in a standard risk management procedure. Special contingency plans are developed for significant risk scenarios.

All asset management work is carried out in accordance with relevant legislation and national standards and industry guidelines (including occupational health and safety, environment and employment).

Information systems have been developed to enable:

- Registration of Western Power's existing assets and their characteristics;
- Recording and management of asset management procedures and activities; and
- Provision and review of asset performance statistics.

Key performance indicators are defined, measured and reported, and trends analysed (see Appendix C).

All field workers are trained to national competency standards.

Core skills and knowledge are retained within Western Power to enable efficient management of existing assets.

2.3.2 SCADA and Communications Strategy

The asset management strategy for SCADA and communications can be summarised as:

Ensuring the provision of adequate capacity, reliability and availability of the SCADA & communications networks through responsible design, installation, operation and maintenance methods; and

Undertaking a timely asset replacement programme to ensure the continued reliability of the SCADA and communications systems.

The expansion and development philosophy for communication systems is driven by SCADA and protection needs:

To provide redundancy for critical systems; and

To adopt network topologies, which are consistent with the level of redundancy and data capacity demands of the service.

2.4 Asset Management Model

The Asset Management Model provides an overview of the system, processes, procedures and responsibilities for the delivery of asset management outcomes.

A simplified overview of the Asset Management Model, and how it aligns with the policy and strategy, is provided in Figure 2.2.

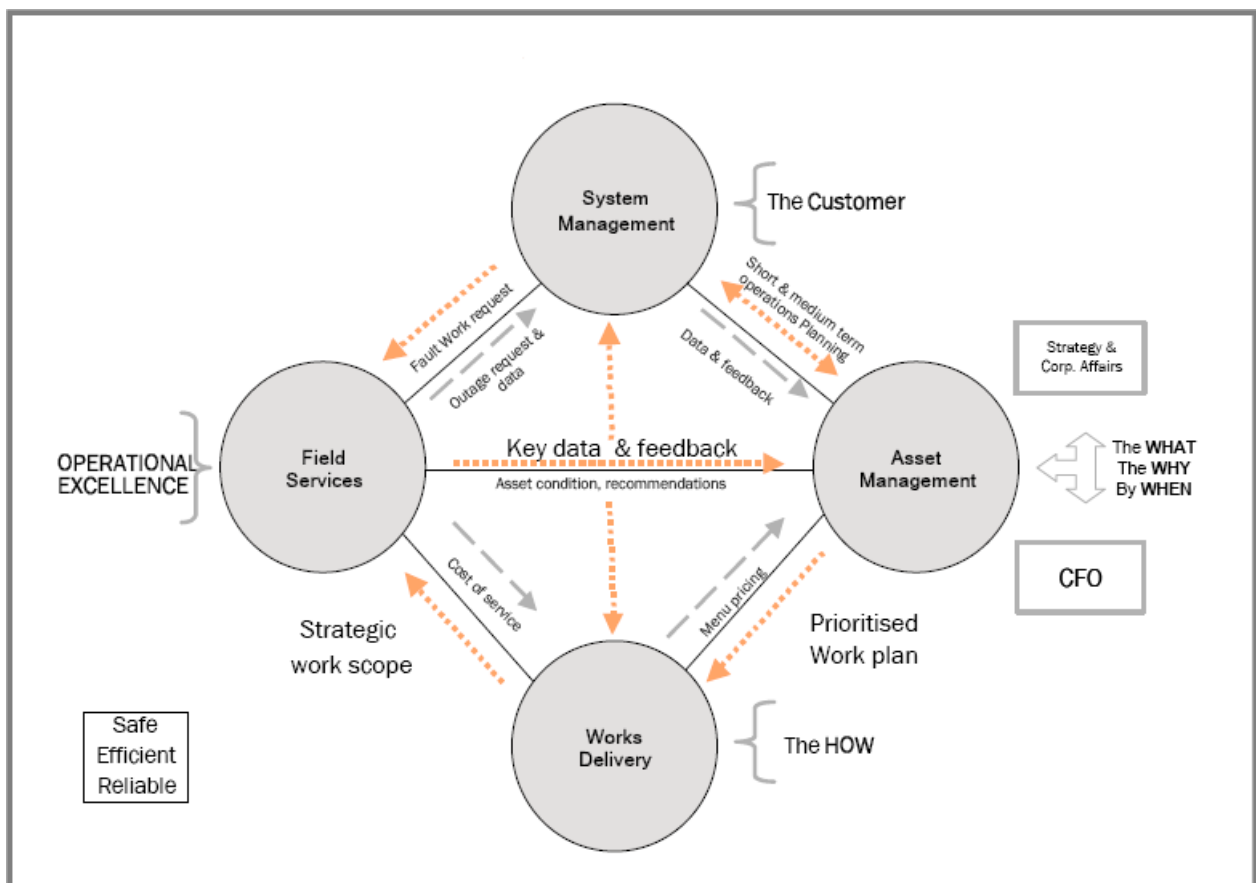


Figure 2.2 – Western Power Works Engine

The main processes illustrated in Figure 2.2 above are described further in the next chapter.

2.5 Asset Management Plan

Each year the Asset Management Plan is prepared, broadly based on the outputs from each of the processes illustrated in Figure 2.3. The Asset Management Plan summarises the intended maintenance, asset replacement and contingency plans for each asset, and provides detail on the expenditure associated with each of these plans. The process for developing the Asset Management Plan for each asset type is illustrated in more detail in Figure 2.4.

Summaries of the 2006 Asset Management Plans for transmission, distribution, SCADA and communication existing assets are provided in Chapters 5, 6 and 7 respectively.

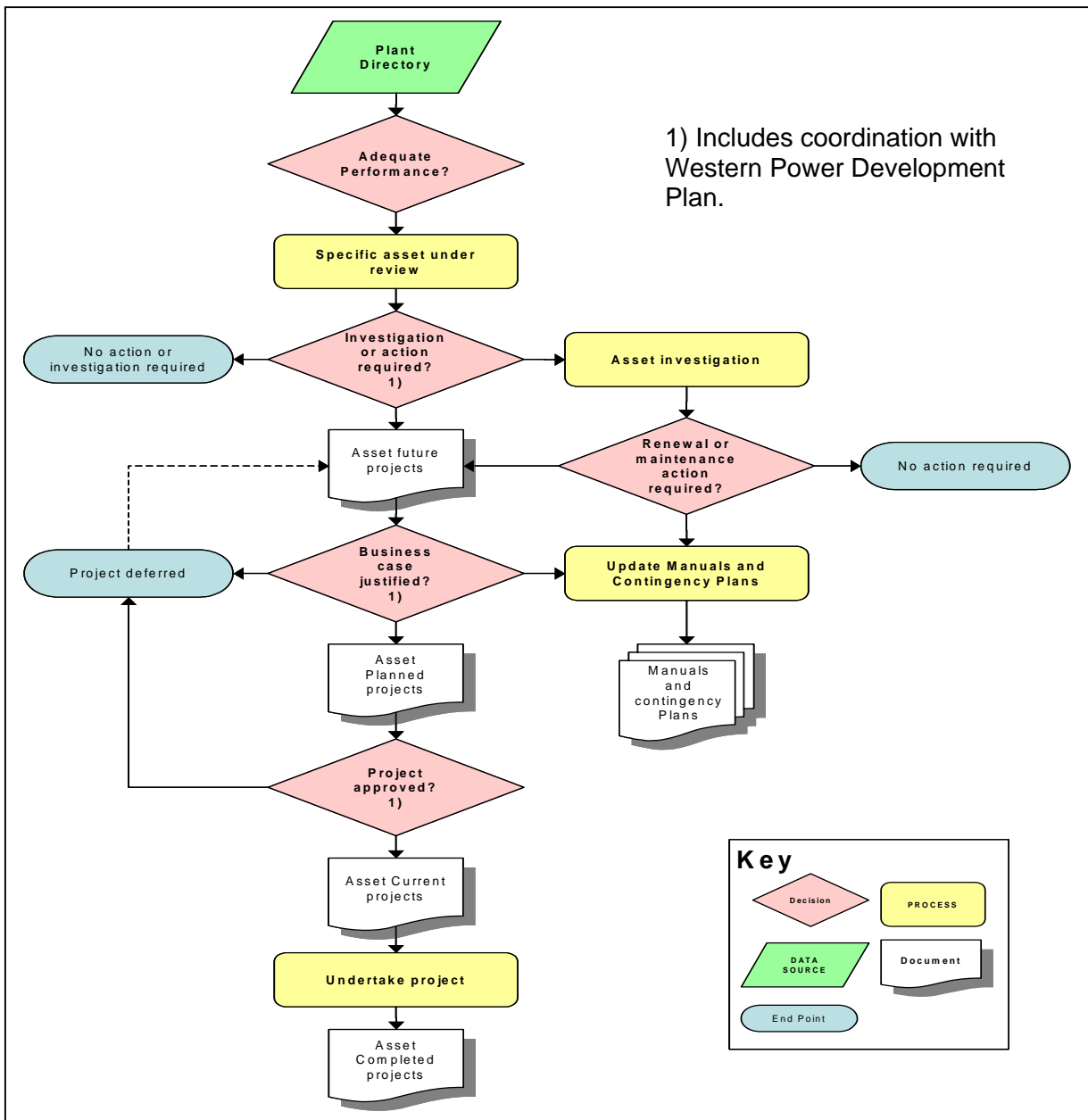


Figure 2.4 – Asset Management Plan Process

3 Western Power's asset management processes

This chapter provides details of the processes involved in Western Power's Asset Management System for managing its existing assets. These broad principles are used for SCADA/Communications although due to its specialised nature there are some detailed differences.

Risk management techniques are used throughout these processes to optimise the overall level of expenditure.

3.1 Asset strategy development

The process for developing asset strategies involves six main steps:

Assets definition: Assets are defined and grouped by a number of methods including their geographic and electrical location, as well as information required for accounting, taxation and maintenance purposes.

Asset performance target establishment: For each asset grouping, performance measures and targets are established taking into account historical performance and corporate objectives.

Performance gap analysis: The main causes for any failures to meet targets are analysed, taking into account failure modes, probabilities and consequences.

Strategy determination: Possible solutions to the main causes are identified, and a cost/benefit analysis undertaken. This cost/benefit analysis will, among other things, assess the practicality of solutions and the extent of risk reduction for different solutions, within framework of future development plans. For some low value and low impact distribution assets, the asset strategy will be "run to failure" for a specific period of time or age. This strategy is adopted where there are no practical, safety or commercial drivers to develop a more interventionist preventive strategy. Outputs from the asset strategy are asset missions (preferred asset management regime/combination of regimes for the assets), maintenance policies, operational and capital budgets, and asset renewal plans.

Approval: Where an asset strategy requires increased operating expenditure or capital expenditure, it is subject to the appropriate internal approvals, described further in 3.2 and 3.3. This provides an opportunity to ascribe priorities to the various programmes, taking into account Western Power's overall costs, regulatory constraints, budgets and future development plans.

Implementation: Following approval, the asset strategy will be handed over to the appropriate service providers and project managers for implementation.

3.2 Asset maintenance management

Asset strategies include maintenance plans for each asset, which has not been designated as "run to failure". Maintenance is described as preventative or corrective.

Preventive maintenance is planned maintenance of equipment with purpose to achieve and, if possible, improve equipment design life to avoid any unplanned maintenance activity through an inspection, cleaning, painting, lubrication, testing, adjusting, or minor component replacements.

Western Power's preventive maintenance program is based on:

- Time based periodic inspections;
- Operational/fault history;
- Pre-planned maintenance activities;
- Results of non-destructive testing;
- Planned maintenance to correct deficiencies found through inspections and/or testing.

The amount of preventive maintenance needed at a facility can vary greatly, ranging from walk-through inspections of facilities and equipment, noting deficiencies for their later corrections, through to a major overhaul of some plant.

Western Power's focus on the preventative maintenance for its assets seeks to reduce costs through:

- Reduced downtime, resulting in fewer outages and improved quality of supply;
- Better conservation of assets and their increased life expectancy, thereby eliminating their premature replacement;
- Reduced overtime costs and more economical use of maintenance staff due to working on a scheduled basis rather than on a crash basis to attend and repair breakdowns;
- Timely, routine repairs to circumvent subsequent large-scale repairs;
- Reduced cost of repairs by reducing secondary failures and damage, as often when plant failed in service, the debris would usually damage other adjacent plant;
- Reduced product rejects, rework and scrap due to better overall equipment condition;
- Identification of equipment with excessive maintenance costs, indicating the need for corrective maintenance, operator training, or replacement of obsolete equipment;
- Improved safety and quality conditions for staff, public and other adjacent plant;
- Improved continuity of supply and revenue stream.

Preventative and corrective maintenance plans are subject to a rigorous prioritisation to ensure their impact on emergency repairs and project/customer capital expenditures is well understood.

They are also closely linked and optimised with the Western Power's capital activities through an overall Asset Management Plan process, and are subject to the wider Western Power's budgeting process.

3.3 Asset renewal management

Where the asset strategy identifies the need for asset renewals (replacement, refurbishment or modification) the proposed renewal is subject to Western Power's Capital Project Approval (CPA) process. Broadly speaking, this requires the development of a business case to support the investment for an asset upgrade or replacement.

Among other things, the business case will address:

- Safety and productivity;
- Customer satisfaction, reliability and quality;

- Cost and Shareholder Value Added analysis; and
- Risk analysis, including technology, environmental and economic risks.

The asset renewal work plan heavily interacts with the Western Power Development Plan, to ensure there is no planned renewal schedules for assets that are to be upgraded or replaced in the looked-after timeframe within the Network Development Plan planned activities.

3.4 Asset performance and condition monitoring and review

The asset performance and monitoring process includes:

- Investigating asset incidents;
- Monitoring and analysing performance;
- Determining the condition of specific assets;
- Researching and assign plant ratings; and
- Performing power system measurements.

This information is fed back into the asset strategies to ensure suitable asset management actions are taken. Western Power has implemented a widespread investigation programmes given the current significant age of its some of its asset population.

3.5 Spares and equipment management and procurement

As the asset management plans are approved, it is necessary to procure spares and equipment for the new projects. Western Power has adopted appropriate procurement strategies depending on the value and complexity of the plant, including for example specific or periodic tenders.

3.6 Contingency planning

Contingency plans are developed to manage the risks associated with plant failures that allow for urgent replacement of the failed plant. Contingency plans include strategic spares, special tools, special arrangements (rapid response transformer or switchgear) and training regimes.

3.7 Data management and document updating

The processes described above rely on the acquisition, management and analysis of large amounts of data. This requires data management strategies and development projects, as well as procedures for the day-to-day updating of databases.

There are some assets for which data has yet to be gathered, mainly at the distribution level. In some cases this reflects inadequate information management in the past (many of these assets were installed in the days of paper based records) or the sheer volume of assets involved. Where there is a clear cost benefit, Western Power has implemented programmes to update its records.

Western Power uses the Document Management System to ensure that the trail of all documentation associated with its asset management processes is available to all appropriate

staff and internal and external auditors. This also facilitates the work on continuous reviewing and updating of the various asset strategies and plans.

3.8 Process Review

The asset management processes are subject to a number of reviews and internal and external audits, helping to ensure their continuous improvement. Some recent examples include:

Internal Western Power's reviews to optimise asset management processes and outcomes;

Western Power Internal Audit reviews on pole management and substation maintenance;

Technical and economic regulator reviews;

Environmental audits;

Insurers' bi-annually independent reviews of strategies and policies and their execution;

PB Power, UMS, Logica and other independent reviews;

SAI Global audits to verify ISO 9001 certification.

4 Western Power's assets and condition

This Chapter provides an overview of the condition, age and technical performance of the transmission, distribution, SCADA and communication networks existing assets.

It does not discuss the capacity and augmentation of the transmission and distribution networks, as this information is provided in the Annual Planning Report.

4.1 Transmission network assets and condition

4.1.1 Transmission assets

Transmission assets operate at very high voltages and the consequence of their failure has the potential to affect many customers. Equally, compared to distribution, there are relatively few transmission assets, and their age and condition are generally well understood.

Transmission network assets fall into three broad categories:

Primary substation assets: The very high voltage equipment that allows the management of power flows through substations;

Primary line and cable assets: The very high voltage equipment that carries power between substations. The lines refer to overhead lines on wood poles or steel pylons, where the cables refer to underground facilities. Lines consist of conductors and structures.

Secondary substation assets: Low voltage equipment concerned with the protection and control of the primary assets, often referred to as 'relays' or 'protection' (includes batteries).

Table 4.1 provides a summary of the various primary assets used on the transmission network. A description of these assets is provided in Appendix A.

For simplicity, the table excludes a number of plant types.

Table 4.1 – Overview of primary substation assets

Plant Item	66kV and below	132kV	220kV	330kV	SWIS Total
Power Transformer	111	182	10	13	316
Circuit Breaker	1,440	488	17	32	1,977
Disconnecter	5,016	3,279	111	327	8,733
Reactor	514	15	-	-	529
Capacitor	238	5	-	-	243
Current Transformer	2,367	1,577	72	117	4,133
Voltage Transformer	400	803	36	86	1,325
Surge arrester	554	939	33	150	1,676
Other primary assets	258	93	4	20	375
Total	10,898	7,381	283	745	19,307

Table 4.2 – Overview of primary line assets

Voltage	Conductors	Structures						Total
	Length (km)	Concrete	Lattice	Tubular	Other non-wood	Wood	Aux. structures	
330kV	776	-	2,342		11	-	2	2,355
220kV	655	-	1,608	2	10	-	-	1,620
132kV	4,187	1,485	2,278	3,523	499	16,973	8,979	33,737
66kV and below	1,065	67	77	1,304	157	7,154	692	9,452
Total	6,682	1,552	6,305	4,829	677	24,127	9,673	47,164

Table 4.3 – Overview of primary cable assets

Voltage	Active cables	Length (km)
330kV	-	-
220kV	-	-
132kV	17	17
66kV and below	13	39
Total	30	56

Table 4.4 – Overview of transmission secondary assets

Main Protection Relays				Auxiliary Relays	Metering I.e. transducers	Transformer Devices	Ancillary Equipment
Overcurrent	Differential	Distance	Other				
5254	2112	502	1425	14043	2147	1182	4975

4.1.2 Transmission assets age and condition

The age of the network provides a useful indication of the need for asset renewal. While there are other factors that will determine the need to renew a particular asset (including physical location, loading, suboptimal maintenance and any design faults), age provides a useful trigger to consider the need for replacement.

The age profiles for power transformers and major substations are illustrated below in Figures 4.1 and 4.2.

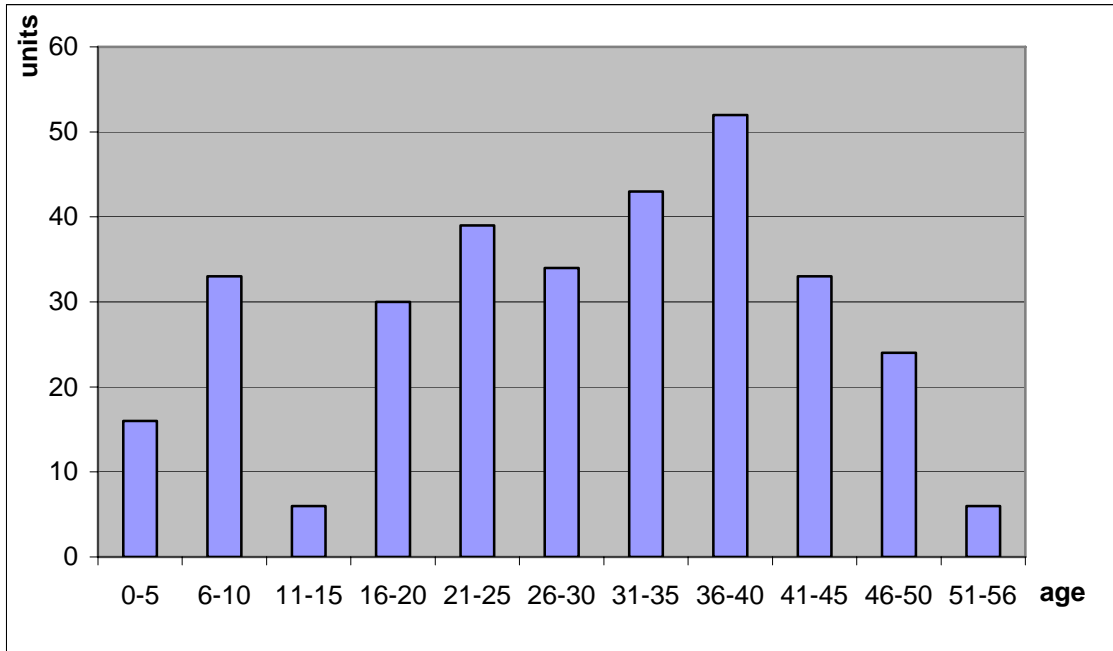


Figure 4.1 – Age profile for transmission power transformers

Western Power expects power transformers to have an economic life of 45 years. It can be seen from Figure 4.1 that a small number of assets are already operating beyond this age, and also that a significant number of these assets will exceed this age in the next ten years. Further details of the recommended actions to address these transformers can be found in Chapter 6.

Western Power has instigated programmes to address the ageing population, as described in the following chapters.

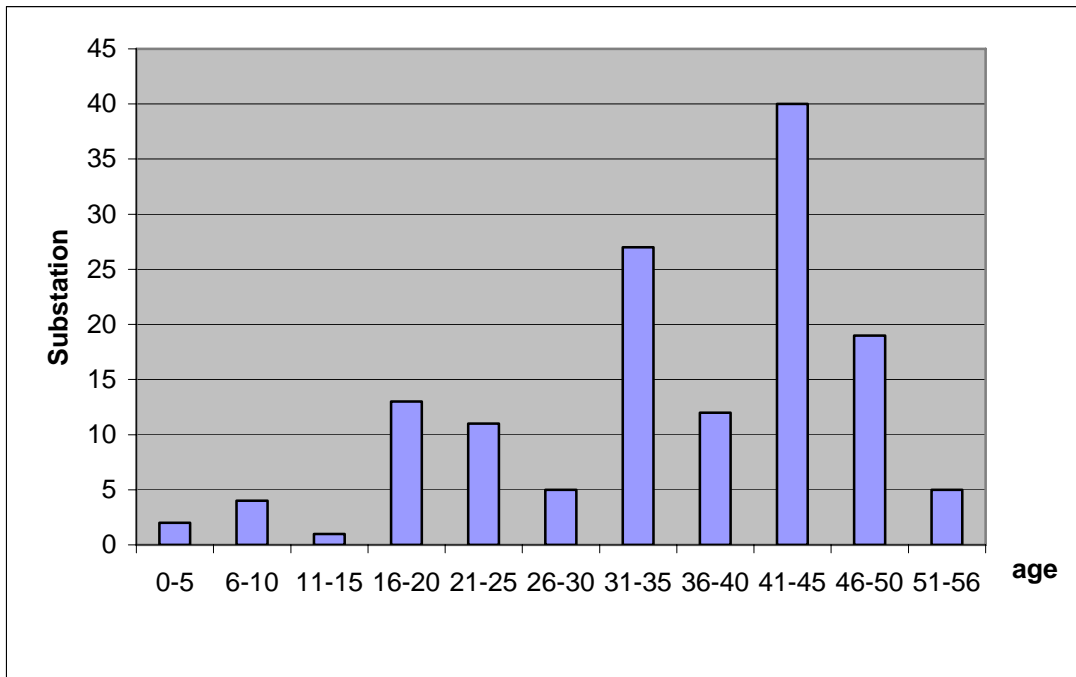


Figure 4.2 – Age profile for major transmission substations

Similarly, Western Power expects substations to have an economic life of 45 years. Again, a small number of major substations are operating beyond their economic life. These have been identified as requiring urgent replacement or decommissioning.

Of more importance in establishing asset management plans is the wave of substations approaching 45 years of age.

These are reflected in current plans, and will likely require renewal in the next five to ten years, as described in the following chapters.

4.1.3 Challenges with specific asset types

A number of assets have suffered from safety and unreliability or enhanced defect rates and so require earlier attention than the age would otherwise suggest:

Circuit breakers: High defect rates and repair costs have led certain circuit breaker types (with different manufacturers and voltages) to be selected for early replacement or trend monitoring. Particular problems have included oil and gas leaks and hydraulic operating mechanism defects.

Surge arrestors: A number of surge arrestors have been found to perform poorly under test conditions. Surge arrestors are designed to operate under fault conditions to protect other equipment. Unsatisfactory mechanical condition and poor test results suggest that there is a high risk of their failure under fault conditions and they are selected for replacement.

Current transformers: A number of current transformers have been found to perform unsatisfactorily under test conditions. Further tests are being carried out to identify whether these results indicate a widespread problem. Other types of current transformer have been found to suffer from oil leaks. As refurbishment of their oil gasket is difficult and expensive and has proved unsatisfactory, they are selected for replacement to prevent them failing in service.

Voltage transformers: A number of voltage transformers have been found to be in poor electrical condition. Further testing is required to identify how many in-service units are affected by this problem, poor units will be selected for replacement to prevent them failing in service.

Power Transformers: Work is proceeding on one type of 132KV 20/27MVA power transformers to upgrade their winding support structure for 26 units located in 14 transmission substations. Six failures in recent years are attributed to a latent design defect found in the support structure.

Substations: In addition, access to our substations and improving physical security to align with forthcoming more stringent industry guidelines would require a significant investment over the next 5 years. Problems with substandard drainage are also being addressed.

These assets have been included in renewal plans, subject to further investigations as required.

4.2 Distribution network assets and condition

4.2.1 Distribution assets

Distribution assets operate at lower voltages than the transmission network. There are many more distribution assets than transmission assets and, in some cases the records on distribution assets are less comprehensive than transmission assets. The sheer volume of distribution assets provides its own asset management challenges.

Some asset types and conditions (eg: insulators, connectors and crossarms) are not yet captured in the equipment register. Work is underway to proactively manage all assets with an inherent safety risk. Progressively the number of “run to failure” assets will decrease over time as resources permit. As the name implies, they are replaced on failure, and their full listing is provided in Appendix B.

Table 4.5 provides details on the number of the remaining SWIS distribution assets that are actively managed. Actively managed assets are subject of the remainder of this section.

Table 4.6 provides details of the length of overhead distribution lines and underground distribution cables.

Distribution assets are often in closer proximity to the general public, and so safety is a major consideration, discussed further in sections 4.2.3 and 4.2.4 below.

Table 4.5 - Distribution assets

Asset Type	SWIS Population
Wood poles	616,119
Distribution transformers	57,928
Distribution substations	9,813
Switch disconnectors (including pole top)	17,444
Fuse switches	4,127
Drop out fuse	30,099
Recloser	1,287
Fuse disconnecter, underground	32,943
Fuse disconnecter, overhead	37,925
Disconnecter, high voltage overhead	2,434
Fault indicator	1,645
Reactor	90
Surge divertor	9,764
Sectionaliser	773
Lights	200,637
Service Connections	421,110
Other	14,877
Total	837,268

Table 4.6 – Distribution lines and cables

Carrier	Length (km)
High voltage overhead lines	56,362
High voltage underground cable	2,665
High voltage miscellaneous type	2,287
Low voltage overhead	8,631
Low voltage underground	7,544
Low voltage miscellaneous type	1,181
Total	78,670

4.2.2 Distribution assets age and condition

Table 4.7 provides an overview of distribution age profiles for various distribution assets.

Pole top switches, wood poles and drop out fuses are nearing the age where they may begin to contribute to a decline in reliability.

All other asset types exhibit an average age within acceptable levels.

Table 4.7 – Distribution age profiles

Equipment type	Average asset age (years)	Current economic life⁵ (years)	Average remaining life (years)
Wood Poles (reinforced)	23	40 (60)	37
Austpole Reinforced Wood Poles	27	55	28
Distribution Transformer	17	45	28
Auto Transformer	24	45	21
Switch Disconnecter	14	50	36
Pole Top Switch Disconnecter	23	35	12
Fuse Switch	15	50	35
Drop Out Fuse	21	35	14
Recloser	13	45	32
Fuse Disconnecter Overhead	20	45	25
Fuse Disconnecter Underground	19	45	26
Disconnecter High Voltage Overhead	24	50	26
Fault Indicator	12	45	33
Reactor	19	45	26
Surge Divertor	12	35	23
Sectionaliser	19	50	31
High Voltage Overhead Carrier	25	55	30
High Voltage Underground Carrier	17	65	48
Low Voltage Overhead Carrier	33	55	22
Low Voltage Underground Carrier	22	65	43

4.2.3 Specific assets with public safety implications

As noted above, distribution assets are often in close proximity to the public and service failures on most of these assets give rise to public safety concerns.

⁵ The current economic life is based on:

- Ongoing maintenance costs
- current knowledge;
- an assumption of continued reliable performance; and
- existing refurbishment and maintenance plans.

Actual achieved ages could vary for a variety of reasons including for example environmental conditions or manufacturing faults.

Chapter 6 includes Western Power's programmes to address the following concerns:

Overhead Service Wires With Twisties

The double fatality in Wyndham in 2002 prompted a capital replacement program to replace services with twisty connections.

All new or upgraded overhead service cables must be replaced with Cross Linked Polyethylene (XLPE) service cable and terminated using the approved wedge type clamp.

All Polyvinyl Covered (PVC) overhead service cables disconnected from the customer's point of attachment must be replaced with Cross Linked Polyethylene (XLPE) service cable and terminated using the approved wedge type clamp.

Progress to date:

- A survey of overhead customer service connections by meter readers commenced in late February 2004, which identified the extent of some of the key issues within the WP distribution network. The survey was a WP wide inspection and covered some of the key issues that can be identified visually. The survey in Metro area was completed in May 2004 and Country area survey was completed in April 2006.
- A CPA was completed in early March 2004 based on the expected results from the meters survey of overhead customer service connections. Several replacement options were considered and the replacement option that was selected will ensure that "Overhead Customer Service Connections" found faulty are brought in line with the current Standard.
- An IT project was initiated for the incorporation of customer service connections as an asset in DFIS/DFMS, which went live in April 2005. Customer Service Attachment (CUSA) and Low Voltage Customer Service Line (LVCL) carrier are defined as assets in DFIS/DFMS as the result.
- A document is currently being prepared which will outline a complete management plan for Overhead Customer Service Connections (Asset Mission). This plan covers inspection, preventative maintenance, condition based maintenance, refurbishment or replacement of the asset. (DMS# 1765516)
- There are two stages to this safety project:
 - Stage 1 is to establish better costing and identify technical issues. Budget of \$736k for replacing 2,500 units in financial year 2004/05 was approved in August 2004. This was completed during the 2005/06 financial year.
 - The CPA submission for Stage 2 was done in March 2005. Currently, the target replacement of Overhead Customer Service Connections is 42,000 units over 18 months. The remaining 238,000 units will be upgraded over the next 6.5 years period under separately staged projects. Thus, the total replacement in Stage 2 is 280,000 units over 7 years.

Capital expenditure of \$33.8M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Conductive Metal Streetlight Poles

A number of electric streetlight shock incidents have been experienced by members of the public from contact with metal streetlight structures. These incidents seem to have been due to inadequate earthing and/or deterioration or damage of insulation through abrasion inside the metal streetlight arm or luminaire thereby energizing the metal structure.

Progress to date:

A 'design-out' solution has been developed for all new and replacement metal streetlight poles and an inspection program undertaken to identify and rectify any existing metal street light poles with either inadequate earthing or wiring with deteriorated insulation. All new installations, including the luminaires will be double insulated. There are approximately 60,000 existing metal streetlight poles in the SWIS which are being inspected and where necessary upgraded. Capital expenditure of \$5M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Distribution Conductive Power Poles Step and Touch Potential Mitigation

This risk was highlighted during the investigation of 3 potentially fatal electric shocks to members of the public in the Perth metropolitan area. An estimated 51,000 poles in the SWIS are at special or frequented locations that need to meet the ESAA C(b))1 limits for touch and step potential. The risk is likely to be greater at locations far from the source of supply because the fault level will be lower and there will be less chance of detecting and clearing a fault. The rectification of this safety issue is also clearly required under the provisions of the Electricity (Supply Standards & System Safety) Regulation 2001.

Progress to date:

A replacement/bonding (CMEN) program is planned to address the problem. Capital expenditure of \$2.3M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

URD Cable Pits

There are an estimated 6000 below-ground cable pits with insulated piercing connectors (IPC's) used to supply power mainly to residential customers that have been installed in the SWIS as part of the Retrospective Underground Power program. A number of electric shock incidents have been reported by the public and Western Power Networks employees resulting from such installations. These incidents were caused by either the degradation of the IPC insulation or the incorrect installation of the IPC where not all the available connections were required to be used.

Progress to date:

A program to determine the level of remedial work to address the safety issues was undertaken. As a result a pit refurbishment program was commenced. Under the refurbishment program pillars may be used to replace existing pit installations where refurbishment is not possible and the alternative is more practical. The completion of this project is scheduled to be September 2007.

Capital expenditure of \$1.1M has been budgeted for this project for the regulatory period 2006/07 – 2008/09

Henley Cable Boxes

There has been a number of Henley cable box explosive failures in public areas resulting in shrapnel (metal) spread over a wide area. Such failures could have serious consequences, especially in high traffic areas (e.g. shopping centre car parks) where there is a high risk of injury to the public or damage the vehicles. There are an estimated 2,000 Henley cable boxes, which need to be replaced based on site location and traffic with the more critical known sites being resolved first.

This is an industry wide issue and the replacement of the Henley cable boxes would be required in accordance with the provisions of the Electricity (Supply Standards & System Safety) Regulation 2001.

Progress to date:

Since the commencement of this project in the last quarter of 2003/04, 61 cable boxes have been replaced. Capital expenditure of \$6M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Cattle Care

The aim of the project is to deny cattle access to the Aldrin/Dieldrin that was applied to the base of wooden poles of power lines that were built prior to 1986. The project is largely reactionary and based on farms that are seeking quality assurance systems.

The project has been initiated to comply with prudent avoidance requirements of Quality Assurance Accreditation Schemes and mitigate the risk of potential contamination of beef with chlorinated hydrocarbon pesticides. The consequences of not taking action include potential loss of shipments of beef at market door (eg. USA) and potentially disastrous flow on effects for the export market in this commodity and possibly other farm produce.

Progress to date:

Latest estimates indicate that 8,000 poles need to have concrete collars fitted on the ground around them in order to prevent cattle stirring up and ingesting chemicals that were once used to treat the poles against termites. The project aims to replace 2,000 poles per year over four years and is currently in its third year of operation.

Capital expenditure of \$1.4M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Pole Top Switch (PTS) Earthing Mats

This project is part of the ongoing programme, as agreed with Energy Safety, to refurbish high voltage (HV) PTS's in the SWIS network. PTS's are an essential component required to safely and efficiently isolate and interconnect the HV overhead distribution network. Accordingly, it has a direct impact on supply restoration and the reliability and the quality of the customer supply, and hence network performance. There are approximately 12,800 PTS's in the SWIS Network, 60% are over 20 years old.

Progress to date:

The work involves replacing the associated switch components such as flexible tails, springs and crimp lugs to meet current standards and installing earth mats (as appropriate) to ensure effective earthing is currently in progress.

Capital expenditure of \$6.7M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Live-frame Shrouding

Many of the LV frames in district substations have exposed bare live copper busbars. This has been recognised as hazardous to personnel accessing the site and must be rectified so as to protect switching operators and substation inspectors from unnecessary risk of electrocution. The program will involve shrouding the busbars or installing barrier boards. Initial estimates suggest that around 2,500 units will require upgrading.

The solution agreed with the ESD involves shielding the exposed unprotected live busbars to prevent inadvertent contact and revising access locking and permit requirements.

The rectification of this safety issue, which has already caused one electrocution, is also clearly required under the provisions of the Electricity (Supply Standards & System Safety) Regulation 2001.

Progress to date:

The project is currently in progress. Capital expenditure of \$1.75M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Inadequate Reinforcing of Transformer Poles

Recently a transformer pole with limited reinforcement fell over into the middle of a suburban street. Western Power has engaged GHD to re-evaluate the strength of its pole top substation structures and they have indicated that these structures need to be reinforced by installing additional ground line reinforcements.

It is estimated that around 3,000 poles may not be suitable for carrying the weight of 50kVA or larger transformers, and need to be refurbished. This will upgrade the mechanical strength of the respective structures preventing failure with the attendant damage to transformers and reduction of risk to public.

The removal of this safety issue is clearly required under the provisions of the Electricity (Supply Standards & System Safety) Regulation 2001.

Progress to date:

The number of pole structures requiring additional reinforcement has been identified using DFIS information. Capital expenditure of \$2.57M has been budgeted for this project for the regulatory period 2006/07 – 2008/09.

Padmount Transformer Noise

The project consists of the construction of noise barriers around padmount substation transformers to reduce noise emissions such that they comply with the requirements of the Environmental Protection (Noise) Regulations. The program of noise mitigation work is to be completed at 26 substations over a 4-year period and is to be completed by the end of 2008.

Non compliance with the requirements of the Western Australian Noise Regulations to reduce the impact of noise emissions on substation neighbours could result in fines of \$25000 and \$5000 per day under Section 51 of EP Act or fines of \$5000 under Sections 79, 80, 81 and 82 of EP Act.

Progress to date:

This project is scheduled to commence in financial year 2006/07. Capital expenditure of \$4M has been budgeted for this project for the regulatory period 2006/07 – 2008/09

River Crossings

The ESD has advised Western Power that it requires all bare conductor river crossings to be either placed underground or in some agreed circumstances replaced with Hendrix cables installed with substantially increased height above MHW.

Progress to date:

The following upgrades have been carried out on lines crossing navigable waterways:

- Conductor markers have been installed on all river crossings in the metropolitan area and installation is in progress on the country lines (as per Energy Safety Code).
- Marker buoys have been installed in waterways either side of the power line for all navigable crossings (as per Energy Safety Code).
- Signage at bridges and boat ramps has been installed (as per Energy Safety Code).
- The Serpentine and two Murray River crossings at Mandurah have been undergrounded (as per Energy Safety Code).

The 54 crossings identified are to be modified over a 4-year program which commenced in the 2003-2004 financial year. Capital expenditure of \$670K has been budgeted for this project for the regulatory period 2006/07 – 2008/09

Bushfire Mitigation

This project has been instigated as a result of the desire of both the Western Australian Government and Western Power to reduce the potential for either loss of life and/or property as a result of bush fires initiated by either the transmission or distribution network infrastructure.

All of the individual projects that in combination comprise the Bushfire Mitigation works would fall under the provisions of the Electricity (Supply Standards & System Safety) Regulation 2001.

Progress to date:

The number of bushfires has decreased from 2004/05 (from 48 bushfires in 2004/05 to 34 bushfires in 2005/06) and the cumulative effects of many capital and operational programmes are beginning to pay dividends. Some of the milestones achieved in 2005/06 include:

- Completion of 18 000 LV Spreader installations in Extreme and High Bushfire areas.
- Implementation of 12 000 silicone solutions for Pole Top Fires in EFR and HFR areas
- Completion of Distribution Planning Guidelines for EFR and HFR areas
- Completion of Transmission Planning Guidelines for EFR and HFR areas
- Completion of trial for the Corona Camera to predict Pole Top Fires
- Completed Wildlife Proofing Asset Strategy

- Completion of procedure for liaising with Emergency Response Groups
- Completed HV Distribution Aerial Conductor Audit Survey
- Completion of fire communications protocol
- Completion of Vegetation cutting in EFR and HFR areas

As well as completing the above projects, a number of longer-term bushfire initiatives began in 2005/06 and have progressed significantly. These projects address long-term strategic bushfire mitigation, and include;

- HV Conductor clashing
- Distribution Planning in Bushfire areas
- Transmission Planning in Bushfire areas
- Wildlife Proofing

Western Power partnership with FESA/CALM Bushfire Threat Analysis Project that will improve significantly the SWIS bushfire risk classifications in 2006/07 to enable better risk prioritisation of capital and operational programmes.

4.2.4 Regulatory compliance

Western Power must comply with safety legislations. In Western Australia, the Director of Energy Safety within the Energy Safety Division of the Department of Consumer and Employment Protection (DOCEP) has statutory responsibilities to, broadly speaking, regulate energy safety⁶.

Western Power works closely with the Energy Safety Division of DOCEP to implement a range of solutions to enhance public safety.

4.3 SCADA and communications network status

As noted above, the challenge associated with the SCADA and Communications Asset Strategy is to provide cost effective, robust and flexible capacity to support the distribution and transmission networks.

As SCADA and communication technologies have developed so quickly over the past 20 years, the asset management focus has not been on asset age and condition (as is appropriate for transmission and distribution assets), but rather the networks suitability for purpose.

The main asset management priorities for the SCADA and communications networks are:

Robust interconnection of key sites: Connecting major terminals, generators and control centres through ring topologies with adequate capacity.

⁶ For further information see http://www.energysafety.wa.gov.au/new/html/information/director_esd.html

Access to substation data: Given the large distances in Western Australia, there is a need for cost effective access to timely substation data to assist with system disturbance analysis and timely reconfiguration of secondary systems.

Distribution monitoring and control: The provision of data and control to enable more effective metro and country distribution management through remote switching and detection of faults.

5 Transmission Asset Management Plan

In this chapter, we provide a summary of the 2006 Transmission Asset Management Plan.

5.1 Capital expenditure

Figure 5.1 provides an overview of raw projections of urgent and routine renewal, based on the age profiles provided in Figures 4.1 and 4.2 and further analysis. By 'raw' we mean that it has not been subject to business case analysis - a risk management and prioritisation process, taking into account any financial impacts, leading to approval for the project to proceed.

This raw data arises out of the Asset Renewal Management and Asset Performance Monitoring Processes in Figure 2.3, but is subject to business case analysis.

Assets classified as urgent have already exceeded their expected asset life. Assets classified as routine are approaching their expected asset life. However, detailed review of these programmes has allowed some prioritisation of expenditure - this is discussed further below.

Figure 5.2 provides the proposed smoothed expenditure for transmission plant and equipment to minimise large capital requirements versus the available SDP.

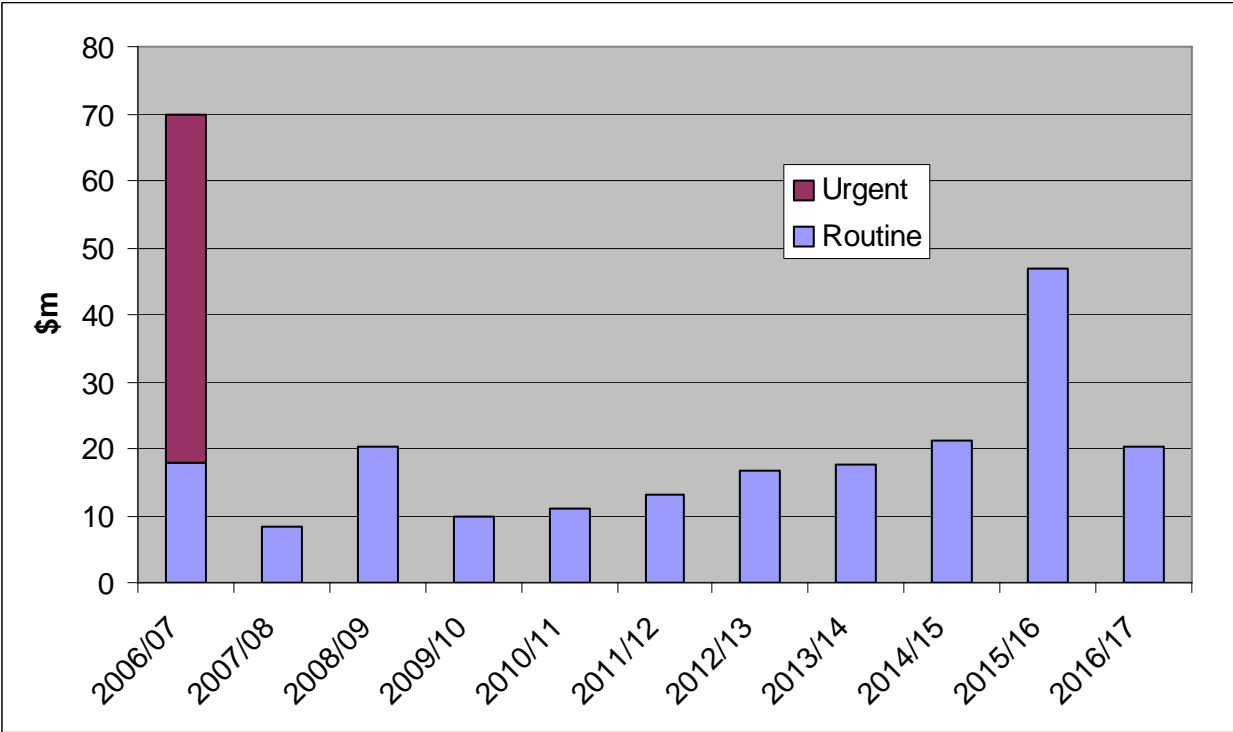


Figure 5.1 – Raw projections of transmission asset renewal requirements

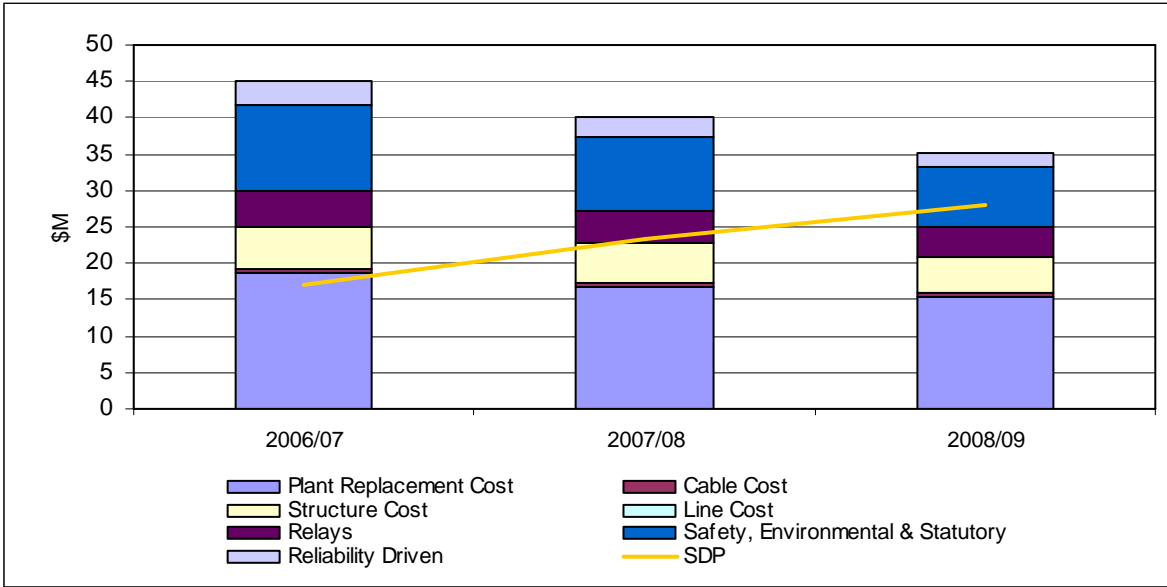


Figure 5.2 - Raw projections of transmission smoothed asset renewal requirements

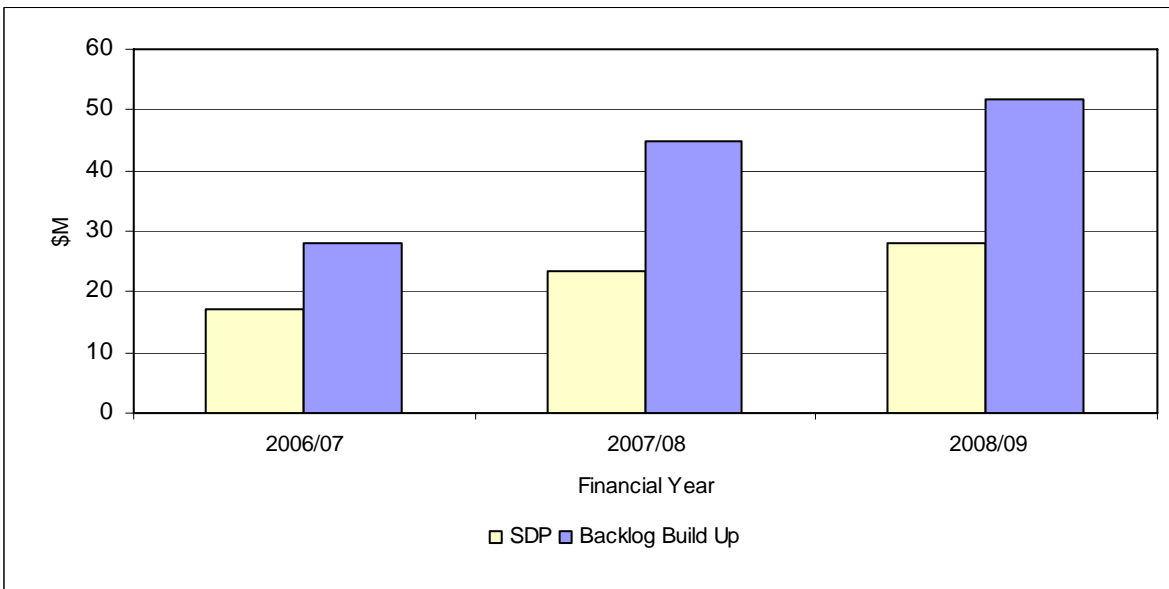


Figure 5.3 - Raw projections of rise in backlog based on current SDP allocations

In the establishment of the SDP, these raw projections have been subjected to a rigorous risk management process and, in the near term, the capital plan approval process.

This is the business case analysis step in Figure 2.3, including expectations of condition assessment results. The asset replacement plans consequently included in the SDP are illustrated in Figure 5.4.

The business case analysis includes consideration of the 66kV network. While its age suggests that imminent replacement is required, its condition is considered relatively acceptable.

Furthermore, it is intended that eventually the 66kV network will be superseded by a 132kV network. On this basis, the SDP does not include for the replacement of 66kV assets.

5.2 Maintenance regimes

The following documents define the transmission maintenance regimes:

- Transmission Maintenance Responsibilities;
- Transmission Line/Cable Maintenance Criteria;
- Switchgear Maintenance Criteria;
- Power Transformers Maintenance Criteria;
- Instrument Transformers Maintenance Criteria;
- Disconnectors/Earth Switches Maintenance Criteria;
- Batteries/Battery Chargers Maintenance Criteria;
- Surge Arresters Maintenance Criteria;
- Other Equipment Maintenance Criteria;
- Maintenance and Operational Plan for Four Rapid Response Spare Transformers.
- Transmission Lines Washing Policy;
- Transmission Lines and Cables Preventative Maintenance Policy;
- Maintenance Criteria for Steel Lattice Tower Transmission Lines;
- Wood, Steel and Concrete Pole Transmission Lines Maintenance Policy; and
- Transmission Lines Vegetation Policy.

Maintenance regimes manuals and procedures have also been updated to reflect the outcomes from asset investigations.

Transmission operating expenditure is shown in Fig 5.4 and consists of many different activities, broadly grouped into preventive and corrective types.

The corrective type is made of emergency and post-emergency repairs.

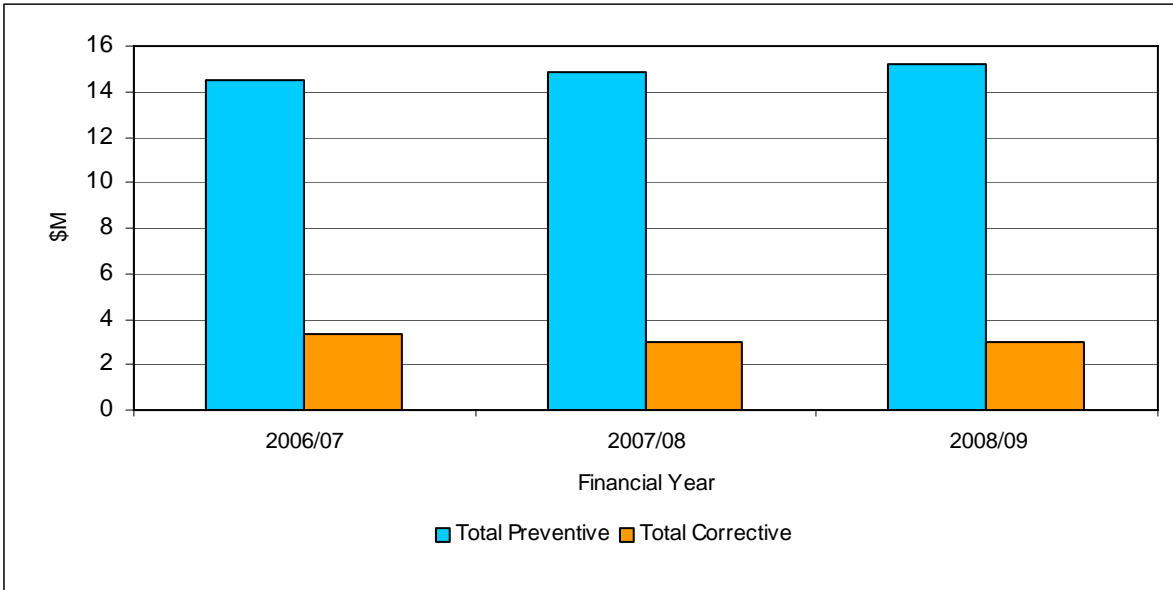


Figure 5.4 – Transmission operating expenditure

The major transmission preventive maintenance activities consist of:

Pole base inspection and treatment

This activity includes the preventive routine maintenance of pole bases, on a four yearly cycle, such as the inspection and chemical treatment for wood rot and termite infestation associated with 'Good Wood' testing.

Line insulator washing

This activity includes the washing of line insulators dead or alive from elevated platform vehicles (EPV) or helicopters, except as outlined below.

This covers most critical transmission lines close to the coast to reduce the number of outage incidents, which have a significant impact on the networks performance and often can represent fire and public risks.

Silicone coating of insulators of selected transmission lines has also been conducted. There may be a requirement to re-apply the silicone coating in the future years.

Pole top inspection and line patrol

This activity covers all transmission lines each year, and includes the inspection of overhead lines and pole top hardware (as listed below) from EPVs, helicopters or light aircrafts:

- Conductors and earth-wires;
- Cross-arms and insulators;
- Cable terminations.

This is an important activity as it detects sagging or aged conductors, long bays or poor condition pole tops so action can be taken to correct these before they cause conductors clashing, conductors dropping on the ground or pole top fires.

Substation primary plant maintenance

This activity includes preventive routine maintenance of switchgear, disconnectors, transformers and other associated transmission primary plant in order to meet the defined Asset Strategy and Performance, and Maintenance Criteria requirements.

Secondary equipment maintenance

This activity includes the preventive routine maintenance of protection relays and other protection equipment in order to meet the defined Asset Strategy and Performance, and Maintenance Criteria requirements.

Substation battery maintenance and inspection

This activity includes the preventive routine maintenance of batteries and battery chargers in order to meet the defined order to meet the defined Asset Strategy and Performance, and Maintenance Criteria requirements.

Substation inspection

This activity includes the preventive routine detailed substation site inspections in order to meet the defined Asset Strategy and Maintenance Criteria requirements.

Line easement vegetation maintenance

This activity includes the clearing of naturally occurring vegetation infringing the safety clearance zone that has been identified from inspections or other preventive routine maintenance tasks.

Plant and building modification and refurbishment

This activity includes any extensive works to bring plant or buildings up to an acceptable condition, based on a proper review within Asset Management Plan and Western Power business case and risk assessment principles.

Some examples include the following:

- Re-clamping windings on specific transmission power transformers;
- Removal of redundant old transmission lines, conductors or poles;
- Refurbishment of pole top cross-arms on an existing transmission line.

All this is done to ensure the life of these assets are reached in a safe and an economical way.

5.3 Contingency plans

Western Power has in place a System Generic Contingency Plan and many specific contingency plans for certain assets or service areas for a limited time period to cater for special requirements in addition to the Generic Contingency Plan.

The Generic Contingency Plan for Transmission Lines and Substation Plant has been updated prior to the establishment of the 2006 Asset Management Plan.

Examples of some specific contingency plans established for certain situations are given below:

Rapid Response Transformer Setup (RRTS);
Rapid Response Switchgear System (RRSS); and
Emergency Spare Tower Structures (ESTS).

6 Distribution Asset Management Plan

In this chapter, we provide a summary of the 2006 Distribution Asset Management Plan.

The sheer volume of distribution assets provides a challenge for the asset management function. As such, many of the activities are concerned with gathering good information on the existing asset base, so that informed decisions can be taken on asset renewal, refurbishment and maintenance.

6.1 Capital expenditure

Figure 6.1 provides an overview of the raw projections and SDP for asset management capital expenditure on distribution, based on the age profiles provided in Table 4.7 and further analysis. By 'raw' we mean that it has not been subject to business case analysis - a risk management and prioritisation process, taking into account any financial impacts, leading to approval for the project to proceed.

This raw data arises out of the Asset Renewal Management and Asset Performance Monitoring processes in Figure 2.3, but is subject to business case analysis.

Figure 6.1 highlights the urgency of the current funding allocation. It should be clear that only safety and some compliance projects could be carried out until the year 2007/08.

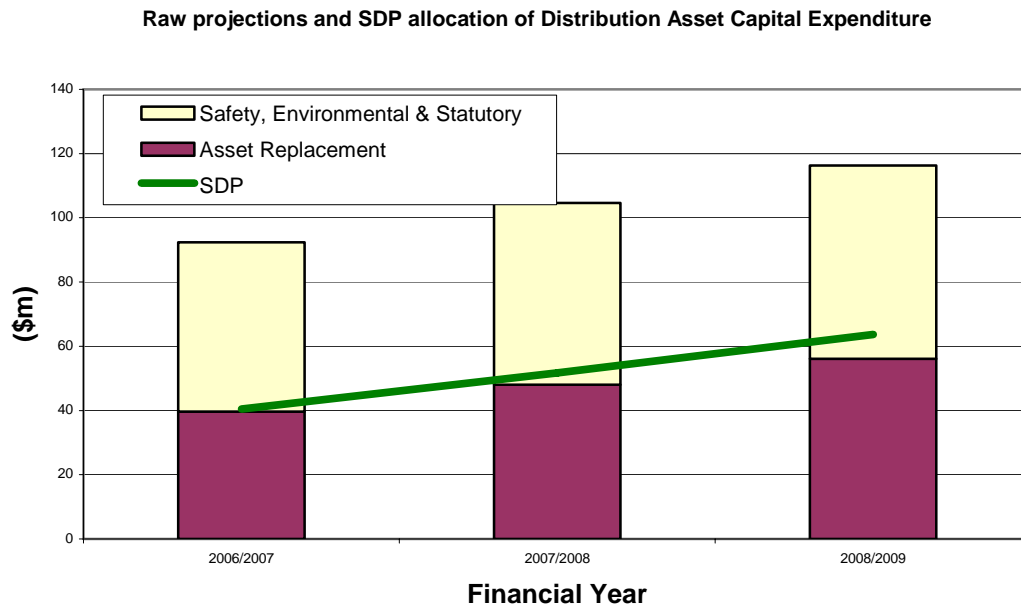


Figure 6.1 – Raw projections and SDP allocation of distribution asset expenditure

Build-up of backlog for Distribution CAPEX

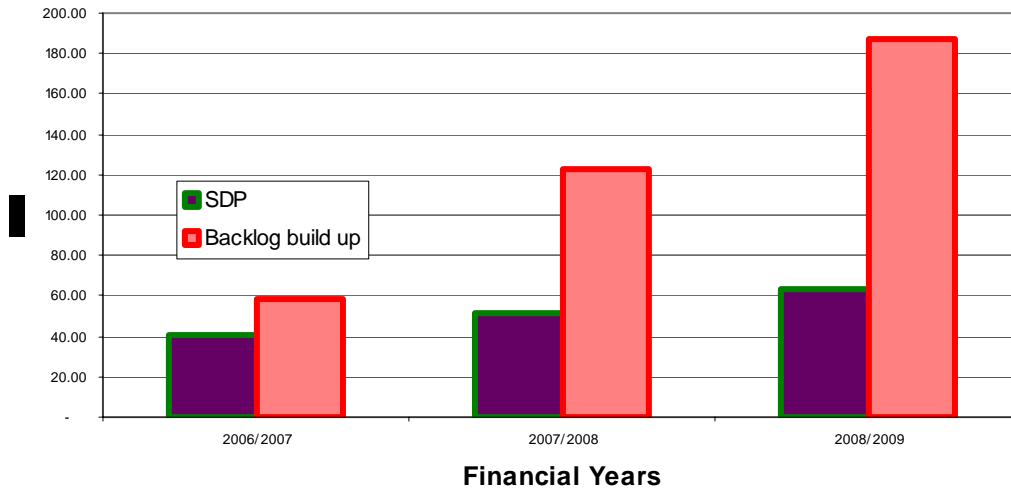


Figure 6.2 Build-up of backlog with Nov 2003 SDP allocation

Figure 6.2 shows the build-up in the backlog.

6.2 Maintenance regimes

The asset missions primarily determine asset maintenance regimes, and have been established for the following asset classes:

- Sectionalisers;
- HV feeder minimum reliability;
- Cable pole terminations;
- Crossarms and Insulators;
- Capacitor banks;
- Poles;
- Drop out fuses;
- HV ground mounted switchgear;
- Pole top switches;
- Reclosers;
- Regulators and AVRs;
- Surge diverters;
- Overhead conductors;
- Transformers; and

- Overhead service connections.

A number of other asset types have been identified as significant in terms of maintenance workload (as well as public safety) and so asset missions are being prepared for, among others:

- Earthing of equipment and transformers;
- Distribution transformers
- Street lighting, and street poles; and
- Overhead service wires.

Inspection and response plans are required for the following maintenance issues:

- Recording and inspection of fault indicators on poles;
- Inspection of the general condition of blades;
- Detailed switchgear inspection in coastal areas;
- Conductive pole earthing;
- Reinforcing incorrectly reinforced poles (particularly those with transformers);
- Low service wires and wires crossing roads and rivers;
- Pole labelling on critical structures; and
- Graffiti and rubbish cleaning.

Distribution operating expenditure is shown in Fig 6.3 and consists of many different activities, broadly grouped into preventive and corrective types.

The corrective type is made of emergency and post-emergency repairs.

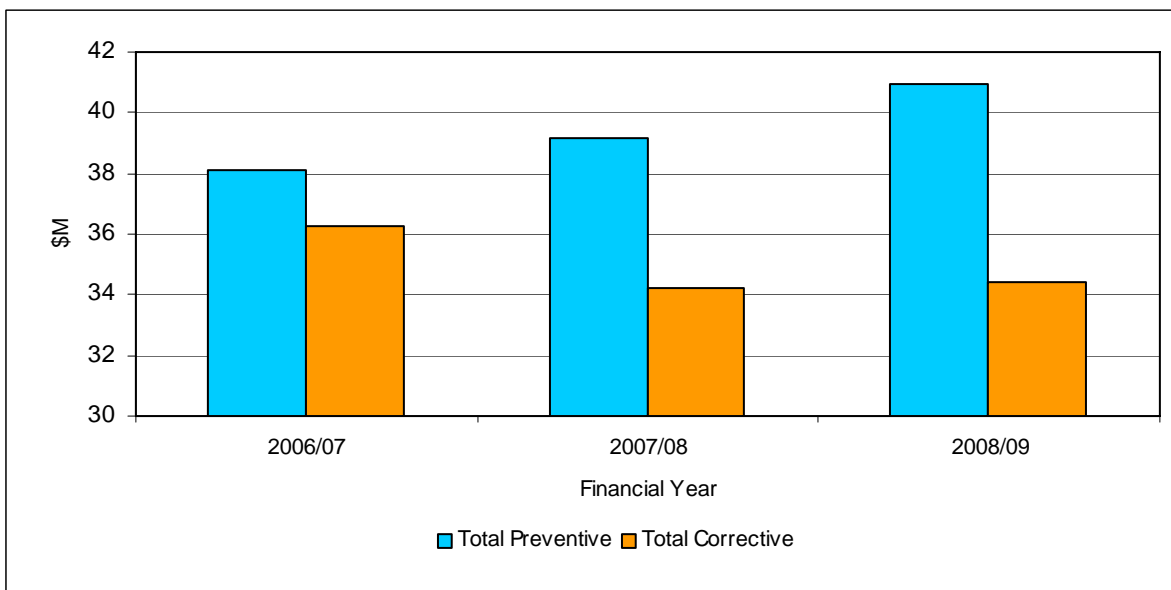


Figure 6.3 – Distribution operating expenditure

The major distribution preventive maintenance activities are:

Pole base/top inspection and treatment

This activity includes the preventive routine inspection of pole tops and bases, on a four yearly cycle, and maintenance and chemical treatment for wood rot and termite infestation associated with 'Good Wood' testing.

Bulk globe replacement (BGR)

This activity includes the replacement of globes in bulk on a four yearly cycle as per the BGR annual programmes. This is proven to be a better-cost option and is a contractual obligation with the local governments.

Vegetation inspection

This activity includes routine 'vegetation spotting' patrols aimed to identify vegetation encroaching the clearance zone around overhead line conductors, with a special emphasis on all extreme and high fire risk areas, with some medium and low fire risk areas also targeted. A significant proportion of line faults are due to wind-borne objects, which makes this activity essential in efforts to reduce such incidents, and thus increasing networks performance levels.

Insulator silicone coating

This activity includes the application of silicon grease to insulators in order to reduce the incidence of pole top fires, and covers most critical feeder sections close to the coast or in significant pollution zones.

The reduction in number of pole top fire incidents has a significant impact on the networks performance and reduces fire and public risks.

Pole top inspection and line patrol

This activity includes the inspection of overhead lines and pole top hardware:

- Conductors and earth-wires;
- Cross-arms and insulators;
- Cable terminations;
- Capacitor banks;
- Surge arrestors; and
- Transformers.

This activity covers approx. 200 feeders annually, representing one quarter of the feeders on a four-year cycle.

This is an important activity as it detects sagging or aged conductors, long bays or poor condition pole tops so action can be taken to correct these before they cause conductors clashing, conductors dropping on the ground or pole top fires.

Ground mounted switchgear and substation inspections

This activity covers the inspection of substations and HV/LV ground mounted switchgear housed in indoor substations, compounds and kiosks. It includes oil sampling and analysis of oil filled equipment. It also covers the four yearly routine maintenance of ring main units (RMU).

Line easement vegetation maintenance

This activity includes the clearing of naturally occurring vegetation infringing the safety clearance zone that has been identified from inspections or other preventive routine maintenance tasks.

Pole maintenance

This activity includes the necessary condition-based pole maintenance identified from inspections or preventive routine maintenance activities, and may include:

- Minor pole top maintenance;
- Burnt/broken line tap repair;
- Conductor clashing, corrosion & spreader installation and maintenance;
- Conductor annealing, damage & bird-caging maintenance;
- Pole top hardware overhaul;
- Retro-fitting of high pollution insulators;
- Surge arrestor maintenance;
- Vibration of long bays – correction; and
- The verification of customer reports of white ants in poles and any subsequent treatment.

Many of the above activities are included as important components of the Western Power's Bush Fire Management Plan.

6.3 Contingency plans

The Generic Contingency Plan for Distribution Lines and Substation plant has been updated prior to the establishment of the 2006 Asset Management Plan.

Specific contingency plans have been established for certain situations.

7 SCADA/Communications Asset Management Plan

This chapter provides a summary of the 2006 SCADA/communications Asset Management Plan.

7.1 Capital expenditure

The need for the following capital expenditure programmes has been identified, among other things:

Communications capacity enhancement: As new facilities are installed on the transmission and distribution networks, communication facilities have been upgraded. A specific programme has been identified to ensure that the remaining key links between major nodes are upgraded to avoid bottlenecks.

Substation automation development: This programme is to pilot study a number of substation automation alternatives to ensure that a well understood substation automation programme can be developed. The pilot studies will allow the assessment of the benefits of increased automation including reduced construction, operations and maintenance costs, improved reliability and faster restoration of supplies following faults.

Various asset replacements: Where equipment has become obsolete and manufacturer's support is withdrawn or where reliability is suspect, asset replacement programmes are instituted.

7.2 Maintenance regimes

Detailed maintenance regimes exist for the following communication equipment types:

- Fibre optics;
- Analogue multiplexes
- Digital multiplexes;
- Mobile radios;
- Power line carrier;
- Analogue bearer – multi channel;
- Supervisory equipment;
- Teleprotection systems; and
- Voice Frequency equipment.

These maintenance regimes are optimised, taking into account the likelihood of failures and costs of frequent maintenance runs.

7.3 Contingency plans

Western Power are preparing a Disaster Recovery Plan for its major communication sites. This Disaster Recovery Plan will require the deployment of back-up equipment. Detailed requirements and procurement plans are being prepared.

Appendix A) Introduction to networks asset management

Planning and operating electricity networks

Electricity networks are used to transport electricity from the power station to the customer.

The transmission network allows the bulk transport of power across long distances at high voltages, while the distribution network delivers electricity from the transmission substation to the end customer, usually over shorter distances and at lower voltages.

The planning, design, operation, maintenance and augmentation of electricity networks must ensure that each individual piece of network equipment is operated within its design limits. This requires voltage and power transfer for each asset to be assessed under a wide range of potential conditions, including for example modelling the effect of faults on the network.

This is illustrated in Figure A1. Failure to meet voltage design limits can result in malfunction or damage to customer equipment, while exceeding power transfer limits creates potential safety and reliability hazards.

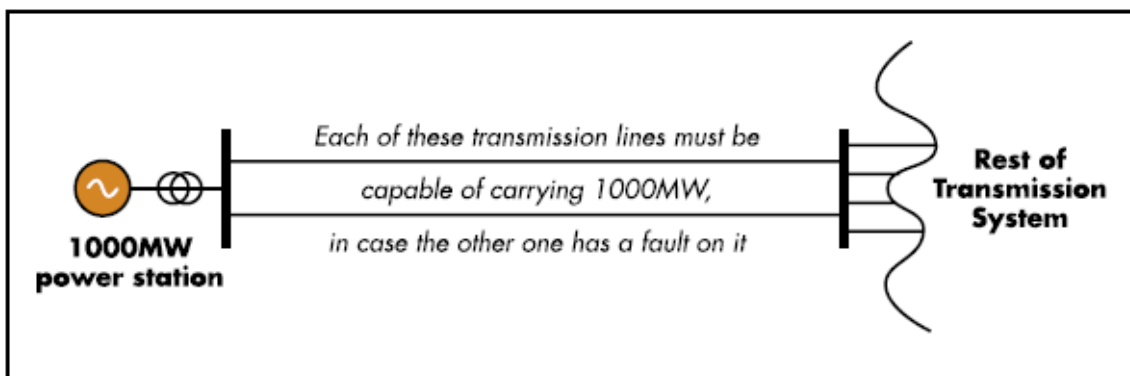


Figure A1 - Need for back-up facilities

The network can withstand credible faults and unplanned outages. A fault is considered credible if it is considered likely given the prevailing circumstances. For example, a simultaneous fault on two adjacent circuits might be considered credible in a severe storm, but not in normal weather conditions. If there is a credible fault or unplanned outage, all plant must still operate within its design limits and the network must continue to deliver its required performance. Required performance will be related to the underlying economics.

For example, in the Central Business District a fault or unplanned outage on the transmission system should not result in a loss of supply as the large number of customers connected to the system justifies back-up systems. In a rural distribution network, a fault may result in a loss of supply but this should be for a limited load and a limited time.

There are contingency plans to restore supplies after a fault, but where smaller customer numbers are connected large back-up systems are not likely to be justified.

Quality of supply is maintained to the appropriate standards. Quality of supply is a term that embraces voltage, frequency and other technical aspects of power supply.

Potential for future growth is adequately provided for, where economically viable to do so ensuring that Western Power electricity networks do not impede Western Australia's economic development. This means that in some circumstances installing 'larger' plant than is immediately required would be necessary to cater for expected load growth over the next, say, ten years. Environmental impacts must be always responsibly managed.

In planning and operating the system, it is important to distinguish between system security and supply to individual customers.

For example, the system is insecure, even if all customers are currently being supplied, if there is a credible fault that would lead to widespread loss of supply. The system is secure, even if some customers are currently without power, if the system can withstand a credible fault.

The most famous example of this paradox was in California in early 2001 where suburbs were subjected to rolling blackouts to maintain overall system security.

Overall, a secure system is likely to lead to more reliable supplies to customers.

Faults on electricity networks

A 'fault' on the electricity network may be caused, among other things, by lightning strikes, catastrophic failure of equipment, debris falling on lines or vegetation touching lines. A fault will tend to result in:

A very high current flowing towards the location of the fault, many times the normal rating of the network equipment, known as the fault current; and

A very low voltage (tending towards zero) near the location of the fault.

If a network fault were not addressed immediately, it could eventually blackout the whole system. As such, networks are designed to immediately isolate the faulted network element from the rest of the network. For example, if a crane were to stray too close to a distribution line and cause a fault, the distribution line would be automatically switched out of service.

Short-lived faults are known as transient faults. For example, a lightning strike will cause a temporary fault on the network. To ensure that equipment is not needlessly out of service, transmission equipment will automatically reenergize the network element after a short delay. This is known as 'reclosing'. If the fault is still present, the network element will be automatically isolated once more. The network element will remain isolated until the fault has been investigated and repairs effected.

Circuit breakers are used to switch out the faulted elements. Clearly, circuit breakers must be capable of interrupting the very high currents safely. To this end, circuit breakers (and associated equipment) have fault current ratings. Complex calculations are carried out to identify the potential fault currents at different locations on the network, and the circuit breakers installed must have a fault current rating that is greater than the potential fault current.

Similarly, all other network equipment must have a fault withstand capability greater than the potential fault current at its network location. That is, it must be able to safely carry fault current, albeit for a very short time. The extremely short-lived nature of fault current explains why plant can carry fault current many times its rating in normal use.

Two things primarily affect the potential fault current at a point on the network: the proximity to generation and the impedance of the local network. Fault current is 'fed' by generation, and so the nearer the network element is to a power station, the greater the potential fault current. Impedance can be described as an object's opposition to the flow of electric current. A low impedance network will therefore give rise to a high fault current, where a high impedance network will limit fault currents.

The isolation of faulted equipment will, generally, increase flows on other network elements. If this contingency would overload another network element, so-called 'pre-contingent' action will be taken. This means that the network will be operated less efficiently to allow for the possibility of a contingency or fault.

Meshed and radial networks

An electricity network is described as highly meshed when each substation is connected to a number of other substations, as illustrated in Figure A2.

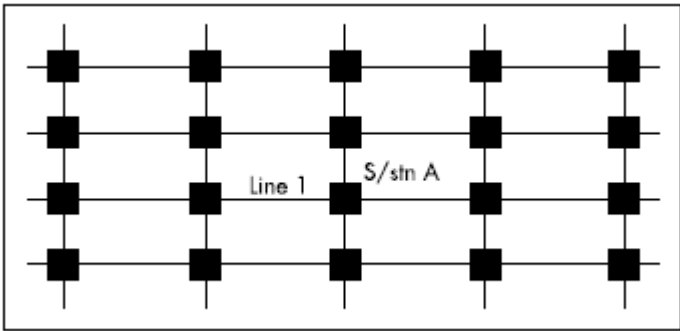


Figure A2 - Highly meshed network

The main advantage of a highly meshed network is clear - if line 1 were taken out of service, substation A would still be supplied by three other lines. The meshed network provides a secure supply. However, a network as highly meshed as in Figure A2 would be extremely expensive to develop. This expense is often justified on the transmission network.

A radial network is illustrated in Figure A3.

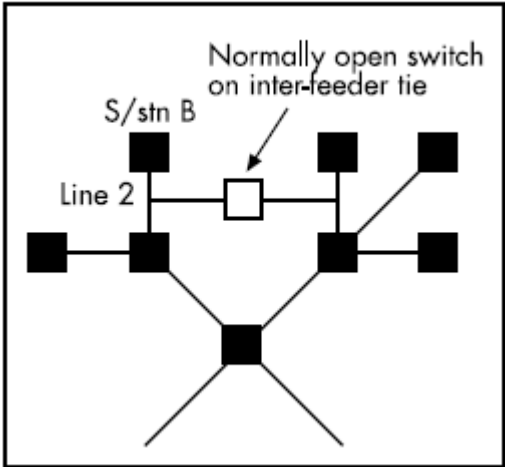


Figure A3 - Meshed network

It can be seen that the radial network is inherently less secure - if line 2 is lost, substation B would lose its supply. Nonetheless a radial network is much cheaper than a meshed network and so is suitable for distribution networks.

Furthermore, a meshed distribution network could give rise to very high fault currents.

Inter-tie feeders are used to provide fast restoration of supplies following faults. Following a fault, the affected network will be switched out of service, and the normally open switch energised. The switch is normally open as to have it energised before the fault would give rise to very high fault currents.

Transmission assets

Table A1 describes the main transmission assets referred to in this report:

Table A1 – Description of main transmission assets

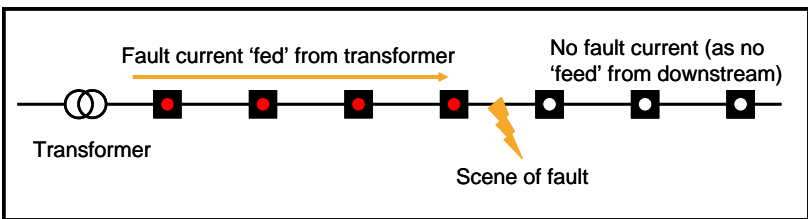
Asset	Description
Power transformer	A large transformer that allows voltages to step-up and step-down. High voltage equipment is expensive to purchase but is the most economical way to carry large power flows over long distances. Voltages are stepped-up from power stations to transmission voltages (by a generator transformer), transmitted over long distances and then stepped-down to distribution voltages by a power transformer.
Circuit breaker	A device that is capable of making and interrupting normal power flows, also interrupting the very high currents found under fault conditions.
Disconnecter	A device that is capable of preventing power flows by 'disconnecting' two circuits. A disconnector cannot make or interrupt normal or fault current – it is used only after a circuit breaker has interrupted the power flow.
Reactor	A device that provides reactive power. Alternating current systems consume or generate reactive power. Certain points on the network require inputs of reactive power to allow normal power flows.
Capacitor	A device that consumes reactive power. Alternating current systems consume or generate reactive power. Certain points on the network require reactive power to be consumed to allow normal power flows.
Current transformer	A device that transforms currents very accurately. Transmission equipment is protected by sophisticated electronic protection systems that require voltage and current information. A current transformer reduces the transmission current to protection levels very accurately.
Voltage transformer	A device that transforms voltages very accurately. Transmission equipment is protected by sophisticated electronic protection systems that require voltage and current information. A current transformer reduces the transmission voltage to protection levels very accurately.
Surge arrestor	Surge arrestors are placed next to devices that would be unable to cope with high fault currents. The surge arrestor diverts the fault current to earth, reducing the impact on the protected device.
Overhead lines and structures	Overhead lines are strung between structures. These structures may be steel lattice towers, tubular towers, concrete poles or wood poles. High

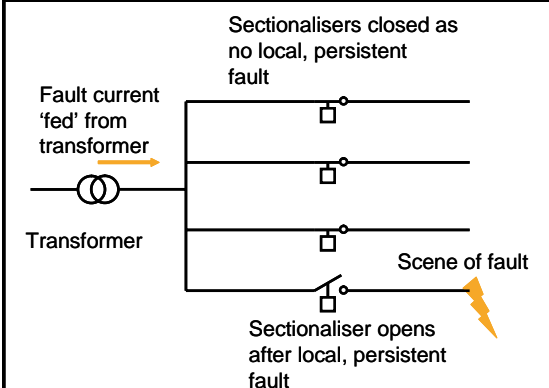
Asset	Description
structures	voltage overhead lines are insulated by air, and so their height above the ground and the likely traffic underneath road and river crossings are crucial safety matters.
Underground cables	Underground cables are insulated, buried in trenches and often armoured.
SCADA	Supervisory control and data acquisition. Essentially SCADA is a software package designed to display information, log data and show alarms.

Distribution assets

Table A2 describes the distribution assets referred to in this report. Description of assets also found at transmission voltages is omitted as they are described in Table A1.

Table A2 – Description of main distribution assets

Asset	Description
Distribution transformers	Distribution voltage power transformers.
Distribution substations	Distribution voltage substations.
Switch disconnectors (including pole top)	A distribution voltage disconnector that can make and break normal current, but not fault current. Some variants are mounted on the tops of wooden poles.
Fuse switches	A switch capable of making and breaking normal current. When faults occur, the fuse operates.
Drop out fuse	A back-up protection that operates under persistent fault conditions. The fuse melts under a sustained fault, causing a spring-loaded arm to operate and so extinguish any arcing current.
Recloser	Equipment that opens and recloses following a transient fault (for example, a lightning strike). If there is a sustained fault, the recloser will close on to the fault a fixed number of times (3 or 4 times) and then stays open.
Fuse disconnector, underground and overhead	A fuse disconnector can break fault current (when the fuse operates) and isolate the faulted circuit.
Fault indicator	<p>A fault indicator assists with the location of faults in remote locations. The fault indicator is activated when it detects fault current.</p>  <p>On the distribution network, the fault is 'fed' from the higher voltage transformer (there is only demand downstream), so fault indicators provide a clear indication of the fault location, as illustrated above.</p>

Asset	Description
Sectionaliser	<p>A sectionaliser opens under two conditions: If fault current flows through the sectionaliser; and If the fault current remains for two cycles.</p> <p>These conditions help ensure that the sectionaliser only operates for local and persistent faults (and not, for example, lightning strikes). In turn this means that more of the network, which has not been affected by the fault, remains in service, as illustrated below.</p> 

SCADA and communications assets

Table A3 describes the main communication assets found in this report.

Table A3 – Description of main SCADA/Communication assets

Asset	Description
Fibre optics	Communication links based on fibre optic technology.
Digital multiplexes	A device for combining several digital signals into an aggregate digital signal.
Power line carrier	Technology that superimposes a communication frequency signal on a power line, and reads the resulting signal at the remote end.
Supervisory equipment	Equipment that supervises remote terminal units and so on.
Analogue multiplexes	A device for combining several analogue signals into an aggregate signal.
Analogue bearer – multi channel	An analogue communication link that nonetheless is capable of transmitting more than one signal simultaneously.
Teleprotection systems	Communication systems that interface directly with protection systems to assist with the prompt removal of persistent faults from the network.
Voice Frequency	Equipment that works in the frequency range traditionally used to

Asset	Description
equipment	transmit speech.

Appendix B) Run to failure assets

- Circuit breaker disconnecter
- High voltage cable joint
- Cable joint
- Low voltage circuit breaker
- Low voltage overhead disconnecter
- Overhead disconnecter
- Underground disconnecter
- Isolating transformer
- Underground joint
- Joint
- Kiosk
- Low voltage cable pole termination
- Non-load break connector
- Concrete pole
- Pillar
- Street light control box
- Tee junction
- Distribution transformers up to 200kVA

Appendix C) Typical balance scorecard performance indicators

Table C1 – Balance scorecard indicators

<p>Deliver power system Q & R</p>	<p>SAIDI (System Average Interruption Duration Index). The average total sustained interruption time (minutes) each customer experienced over a 12 month period</p> <p>CAIDI (Customer Average Interruption Duration Index). The average duration time (minutes) for each sustained interruption that a customer experienced over a 12 month period.</p> <p>SAIFI (System Average Incident Frequency Index). The average number of sustained interruptions that customers experienced over a 12 month period.</p> <p>System minutes lost due to asset failure</p>
<p>Optimise existing asset performance</p>	<p>Preventative maintenance index- transmission primary</p> <p>Preventative maintenance index- transmission secondary</p> <p>Preventative maintenance index- S&C</p> <p>Preventative maintenance index</p> <p>Distribution emergency maintenance index</p> <p>Transmission primary emergency maintenance index</p> <p>Transmission secondary emergency maintenance index</p> <p>S&C emergency maintenance index</p> <p>Distribution asset integrity index</p> <p>Transmission lines asset integrity index</p> <p>Substation equipment integrity index</p> <p>Pole condemned rate</p> <p>Distribution poles inspection programme</p> <p>Distribution pole Integrity index</p> <p>Bushfire mitigation</p>
<p>New asset integration</p>	<p>Project completion by due date</p> <p>Project completion within CPA</p> <p>Data base update average duration</p>
<p>Good corporate citizenship</p>	<p>Number of Energy Safety orders</p> <p>PQ complaints time</p> <p>PQ complaints reliability</p> <p>No of fires over \$5,000 by network assets</p> <p>No. of fires by network assets</p> <p>Energy Safety reporting - reports overdue 1-30 days</p>

30-60 days over 60 days

Glossary

AMR	Asset Management Report
APR	Annual Planning Report
EPA	Environmental Protection Authority
ERA	Economic Regulation Authority
ERTF	Electricity Reform Taskforce
KA	Kilo Amperes (measure of electrical current)
KV	Kilovolts (measure of electrical potential)
MVA	Megavolts-ampere (measure of electrical demand)
MW	Megawatts (measure of the active component of electrical demand)
RPIP	Rural Power Improvement Programme
SCADA	Supervisory Control and Data Acquisition
SECWA	State Energy Commission of Western Australia
SDP	Strategic Development Plan
SWIS	South-West Interconnected System
TNSP	Transmission Network Service Provider