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EXECUTIVE SUMMARY

Lifecycle Maintenance

We maintain the assets that comprise our electricity transmission network (Grid) to ensure it remains safe, secure, and reliable. Our Grid is managed to deliver an uninterrupted, safe transmission service, taking account of optimal Grid cost and the impact on New Zealand communities. These requirements are drawn from customers, service providers, regulators, our shareholder and other stakeholders.

Maintenance Work

Grid Maintenance covers all high-voltage, direct current (HVDC) and high-voltage alternating current (HVAC) transmission line and substation assets, excluding telecommunications assets. We manage Grid Maintenance under two main categories of work: Routine Maintenance and Maintenance Projects.

- **Routine Maintenance** is work to deliver preventive maintenance and condition-based work resulting from inspections and condition analysis. It also covers corrective work raised to rectify an unforeseen asset condition or performance issue. Corrective work includes our response to faults to ensure the timely return to service of transmission assets to minimise disruption to customers.

- **Maintenance Projects** is project work undertaken within maintenance typically concerns condition-based replacement of assets or components, and repairs of a scale beyond the scope of routine maintenance. Lines projects typically bundle identical work (such as attachment point replacement) throughout a line route. All project work undertaken within Maintenance is approved through the Integrated Works Planning (IWP) process.

Maintenance Activities

The activities that define our approach to maintenance are grouped into two areas: Maintenance Specification and Maintenance Delivery.

- **Maintenance Specification** is the specification of the maintenance to be delivered, the skills and resources required; and the inventory practices to be applied. Critically, this involves the analysis of work history, asset and performance data; and the application of reliability processes to continually improve our maintenance and supply requirements. It is supported by engineering teams that ensure our maintenance approach takes into account all asset design, servicing and compliance requirements.

- **Maintenance Delivery** is the delivery of all maintenance work by qualified staff in a controlled manner that ensures the safety of all stakeholders, and the timely provision of all necessary materials and parts. This includes the medium-range planning and scheduling of the work programme, together with the detail planning of Grid and land access, resources and work scope for each job, all supporting execution of the work.

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1 Maintenance of communications assets is described in the IT Portfolio Plan – ICT Network Services – IT Communication Services.
Safety of our people and the general public is our highest priority. It is considered when undertaking all maintenance activities. In addition, environmental and social impacts are key considerations. The activities are underpinned by dedicated specialists and decision support systems.

Objectives and Strategies

To achieve our asset management vision and deliver on our commitment to stakeholders, we have set out our asset management objectives in five main areas: safety, service performance, cost performance, communities, and asset management maturity and capability. Our maintenance objectives and strategies articulate how our maintenance activities support these objectives. They set priorities for our teams and service providers, and will govern how we interact with external stakeholders. The objectives for the five main areas are summarised below.

- **Ensuring safety**: Manage down the risk to safety of workers and the public at all times.

- **Service performance**: Deliver continuous improvement so that risk to network reliability and performance is reduced to required levels.

- **Cost performance**: Develop our capabilities to optimise our approach to deliver the service at an optimal whole-of-life cost, consistent with ensuring control of safety and network performance risks.

- **New Zealand Communities**: Ensure sustainable operations of the transmission network with minimum impact on the New Zealand environment and appropriate engagement of the local community.

- **Asset Management Capability**: Invest in our people through skills development, improved systems and management to continually improve our maintenance capabilities.

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2 We include all service providers and sub-contractors in our safety measures and initiatives.
1 INTRODUCTION

This chapter sets out the purpose, scope and strategic alignment of Transpower’s Maintenance Lifecycle Strategy.

1.1 Purpose

This Maintenance Lifecycle Strategy document describes the context for our maintenance practices, our current approach to maintenance, and our objectives and strategies for RCP2. This document has been developed based on good practice guidance from internationally recognised sources, including BSI PAS 55:2008 and will be aligned with the emerging requirements of ISO55000.3

More detailed plans for maintenance development over the five years from 2015 to 2020, including forecast expenditure, are set out in a complementary document, the ‘RCP2 Maintenance Plan’.

1.2 Scope

Grid Maintenance work covers all HVDC and HVAC transmission line and substation assets, excluding telecommunications.4 It is undertaken to address in-service deterioration of our assets, respond to transmission faults, proactively improve the assets and implement projects to replace asset components. We undertake Grid maintenance work as:

- routine maintenance
- maintenance projects.

1.2.1 Routine Maintenance

Together with our service providers, we carry out routine maintenance to keep assets in an appropriate condition, ensure that they operate as required, and to proactively manage failure risk. Routine maintenance also covers our response to failures and defects as these occur.

We classify routine maintenance within four work types introduced in July 2013:5

- preventive
- corrective
- predictive
- proactive.

The four work types are summarised below.

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3 ISO55000 International Standard for Asset Management.

4 Maintenance of communications assets is described in the IT Portfolio Plan – ICT Network Services – IT Communication Services.

5 We are currently transitioning to these categories. Reflecting this, we have developed our RCP2 forecast in terms of the two main categories – preventive and corrective. Predictive and proactive activities are not defined in the forecast. We will distinguish these categories further as our maintenance specification approach matures.
Preventive

Preventive maintenance is undertaken on a scheduled basis to ensure the continued safety and integrity of assets and to compile condition information for subsequent analysis and planning. It is generally our most regular asset intervention, so it is key to providing effective feedback to the overall asset management system. Preventive maintenance comprises three activities.

- **Inspections**: checks, patrols and testing to confirm safety and integrity of assets, assess fitness for service, and identify follow up work.
- **Condition assessments**: activities performed to monitor asset condition and provide systematic records for analysis.
- **Servicing**: routine tasks performed on the asset to ensure asset condition is maintained at an acceptable level, such as adjustment and lubrication.

Corrective

Corrective maintenance is undertaken to restore an asset to service, make it safe or secure, prevent imminent failure or address defects. The key distinguishing feature is that the work is initiated in response to unforeseen damage, degradation or an operational failure. Corrective work is usually identified as a result of a fault or during preventive inspections. Failure to undertake urgent corrective work may result in reduced network reliability. Less urgent repairs are able to be scheduled at the appropriate time when access, resources and parts are available.

Corrective work activities include:

- **Fault restoration**: immediate response to a fault, or urgent repairs to equipment that has safety, environmental or operational implications
- **Repairs**: unforeseen work necessary to repair damage, prevent failure or rapid degradation of equipment
- **Corrective Inspections**: patrols or inspections used to check for public safety risks or conditions not directly related to the fault in the event of failure.

Predictive

Predictive maintenance is scheduled in response to condition-based inspection and monitoring programmes. This includes activities to replace components or repair assets to correct defects, wear and tear to return the asset to a defined standard that keeps it operational. Predictive maintenance also includes any additional targeted condition monitoring (such as thermographic imaging) to validate an existing condition assessment or predict likelihood of failure.

Proactive

Proactive maintenance is improvement work initiated as a result of formal analysis and investigation by the engineering or reliability teams to reduce risk or provide an efficiency gain. Examples are asset modifications, one-off adjustments to scheduled activities, and condition monitoring programmes to provide more information or validate findings.
1.2.2 Maintenance Projects

‘Maintenance Project’ is the term we use for a programme of works that addresses prevalent asset condition issues identified within routine maintenance. Maintenance Projects will typically consist of programmes of small repairs or replacements of certain components of larger assets which are scheduled annually, distinguishing these works from routine maintenance. An example of where this might occur is where a common failure mode has been identified for an asset, leading to the need to replace or repair the same component on many assets.

These works also differ from capital projects because they involve replacing components of assets rather than the assets themselves (such as attachment points on a steel tower). Unlike refurbishment, which is capital expenditure (Capex), these works would not be expected to extend the useful life of the larger asset but rather restore the asset to expected condition. These works are typically managed as planned projects and are budgeted for and scheduled in advance. Undertaking maintenance works as a formal project rather than as a large number of individual activities ensures the works programme is optimised and delivered more efficiently.

1.3 Strategic Alignment

This Maintenance Lifecycle Strategy sits within the suite of asset management core documents below and supports the ‘line of sight’ from our corporate objectives and strategy through to the asset management plans and subsequent asset interventions.

![Figure 1: Position of this Strategy within the Transpower Asset Management Hierarchy]

1.4 Document Structure

The rest of this document is structured as follows.

- Chapter 2 provides an overview of the context within which we undertake maintenance.
- Chapter 3 sets out our current maintenance approach.

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6 Asset Management Framework Definition, Transpower, April 2013.
Chapter 4 explains how maintenance contributes to our asset management objectives, and sets out maintenance-specific objectives, strategies and indicators for tracking our improvement.
2 CONTEXT

Effective asset management relies on the links between Maintenance and the other lifecycle activities: planning, project delivery, operations and disposal. The interaction between Maintenance and the other lifecycle activities is outlined below.

2.1 Interaction with other Lifecycle Activities

2.1.1 Planning

We take a whole-of-life approach to managing our assets. This requires us to consider maintenance implications at the time we make planning decisions for establishing new assets, facilities and systems. During the operating life of these assets, we then consider the trade-off in costs and risks between continued maintenance and capital refurbishment or replacement.

Key considerations which are factored in include operational demand, network security/robustness, risk management, new technology opportunities, and community impacts. To support the planning process, maintenance activities represent a source of information on condition and costs of ownership.

2.1.2 Project Delivery

Project delivery is responsible for implementing investment projects that have been approved as part of the planning process. There are interactions between Maintenance and Project Delivery at different stages of the project delivery process:

- At the project planning stage, Maintenance reviews the scope of work to check that the scope incorporates our engineering and maintenance standards, and that specified equipment and installations can be practically maintained.
- Project delivery assures the integrity and completion of new installations at commissioning and fulfils all documentation, asset record and handover requirements to the satisfaction of Maintenance and Operations teams.

2.1.3 Operations

The link between Operations and Maintenance is fundamental and visible on a daily basis. Operations manages the access to equipment that enables maintenance to be safely carried out. Operations also coordinates the maintenance response to unplanned events and is dependent on the Maintenance workforce for manual switching and for information feedback from the field.

Both Maintenance and Operations are dependent on sharing information on equipment condition, the operational state of the Grid, work being undertaken and unforeseen events.

2.1.4 Disposal

In general the decision to dispose or divest of an asset is made as part of a wider project or programme during the planning phase. This decision is informed by the knowledge of the asset gained through maintenance activities.
3 MAINTENANCE APPROACH

3.1 Introduction

This chapter provides an overview of our maintenance approach. It also provides a backdrop for the strategies that are described in Chapter 4.

The role of maintenance

Maintenance is the care of assets to ensure they will provide their required capability in a safe and reliable manner from their commissioning through to their disposal, and can evolve as the condition and performance requirements of the assets change through that time. Maintenance involves monitoring and managing the deterioration of an asset as it is operated over time or, in the case of a defect or failure, restoring the condition of the asset. Maintenance activities may also include modifications to assets to improve performance and reliability.

We maintain the Grid to meet network operational and security requirements, taking into account safety, statutory compliance, sustainable operations and overall cost. These requirements are drawn from the shareholder, customers, regulators, and other stakeholders (such as the communities in which we operate).

Routine maintenance work types

Routine Maintenance is categorised into four work types, which are being introduced from July 2013. The work types distinguish how the work is initiated and are fundamental to our approach to maintenance improvement. Work types are described in Section 1.2.1 and summarised in Table 1 below.

<table>
<thead>
<tr>
<th>Work Type</th>
<th>Description</th>
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<tr>
<td>Preventive</td>
<td>Routine servicing or inspections to prevent failure or understand asset condition in line with an established schedule (PM Schedule).</td>
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<tr>
<td>Corrective</td>
<td>Unforeseen maintenance to respond to a fault, or correct failed equipment and defects.</td>
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<tr>
<td>Predictive</td>
<td>Maintenance performed based on known equipment condition, identified by remote monitoring or preventive maintenance inspections.</td>
</tr>
<tr>
<td>Proactive</td>
<td>Improvements initiated by reliability or engineering analysis.</td>
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Table 1 Routine Maintenance work types

The new categorisation of work will enable more granular tracking of maintenance interventions, their costs and their drivers. The analysis of work history is an important tool within reliability improvement and cost control.

We are in the process of completing our transition to the above categories. Due to the timing of our RCP2 forecasting process, we have presented the forecasts in terms of the

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7 The Preventive Maintenance Schedule is a live matrix in MAXIMO that assigns SMPs to individual assets and calculates the dates for the corresponding maintenance.

8 The process to develop our RCP2 forecast was largely complete by July 2013 prior to finalising activities within each category.
two main categories – preventive and corrective. It should be noted that we have not included predictive and proactive activities in the forecast.

**Service providers**

We deliver maintenance activities through the efforts of a large number of people in wide ranging and interdependent roles. Some are direct employees but the majority are external service providers contracted through various arrangements. We have several different long-term service provider arrangements. These outsourced contracts are divided broadly into:

- **lines** covering lines, towers and fibre optics on towers
- **stations** covering our substations and underground cables
- **others** such as submarine cables, high-voltage (HV) cables and facilities (buildings and grounds).

Service provider work teams are administered by our Maintenance managers who retain day-to-day budget control and are accountable for the approval of all work.

### 3.1.2 Changes to our Maintenance Approach

During RCP1 we have made significant changes to improve the way we maintain our assets. These changes are part of an ongoing broader asset management improvement programme. These improvements include:

- requiring minimum safety requirements from service providers, an active focus on safety performance including reporting and follow-up of incidents, regular engagement with service providers and the industry to identify best practice work methods and monitoring of key safety performance indicators to identify any areas requiring improvement
- achieving closer integration of Operations and Maintenance, made possible by returning operational control activities to our direct control
- refocusing service provider arrangements to support improvements in maintenance practices, work management, and landowner engagement
- introducing an enhanced asset management information system, MAXIMO, enabling future improvements in work and inventory management, and reliability improvement
- improving our workforce training programme by introducing a new ‘Grid Skills’ training programme aimed at building specialist skills in the New Zealand workforce
- developing our reliability improvement systems and capabilities.

### 3.1.3 Maintenance Activities

As described in Section 1.2.2, we group our maintenance activities under two headings: Maintenance Specification and Maintenance Delivery.

- **Maintenance Specification** is the specification of the maintenance to be delivered, the skills and resources required; and the inventory practices to be applied. Critically, this involves the analysis of work history, asset and performance data; and the application of reliability processes to continually improve our maintenance and supply requirements. It is supported by engineering teams that ensure our
maintenance approach takes into account all asset design, servicing and compliance requirements.

- **Maintenance Delivery** is the delivery of all maintenance work by qualified staff in a controlled manner that ensures the safety of all stakeholders, and the timely provision of all necessary materials and parts. This includes the medium-range planning and scheduling of the work programme, together with the detail planning of Grid and land access, resources and work scope for each job, all supporting execution of the work.

Maintenance Specification and Maintenance Delivery are interdependent within an improvement cycle:

- Maintenance Specification activities define our technical and quality requirements governing Maintenance Delivery
- Maintenance Delivery is the planning and execution of the work
- the outcomes of Maintenance Delivery (costs, equipment condition and performance, new work) are assessed within our Maintenance Specification activities to improve our maintenance requirements and provide advice to address reliability and performance risks.
Enablers

Enablers provide essential support to our maintenance activities.

- Safety underpins all our activities and is our top priority when undertaking maintenance work.
- Maintenance involves work in hazardous environments and with risks to personnel and public safety. Our people capability assures the specialist skills to support effective and safe delivery.
- Our Service Providers undertake our maintenance work and we seek long-term respectful contractual relationships with them.
- Our systems capability is the key to managing our extensive asset and performance information, and planning and work transactions.

The component activities illustrated in Figure 2 above are described in the rest of this section.
3.2 Safety Management

Maintenance and project field work inherently involves hazards that must be continuously managed, most notably those associated with high voltage, using mobile equipment and working at heights.

Achieving a safe workplace and zero harm to any person as a result of maintenance activities is our pre-eminent corporate objective. Effective safety assessment and management underpins everything both we and our service providers do.

Service providers are selected taking into account their level of operational expertise, which includes a mature and continually improving safety culture. We require high standards of safety performance through our contract terms and monitoring of field work. Our safety standards represent a minimum acceptable level that service providers are required to meet or exceed. As part of contractual compliance, we have adopted a collaborative approach aimed at achieving zero harm through faultless work management and practices.

Our management has lifted safety standards throughout the business over the last few years through concerted improvements in safety governance and leadership, procedural effectiveness and reporting. All stakeholders have made material improvements in the total recordable injury frequency rate over the last five years and raised safety to a high level of consciousness in all work teams.

To drive further improvements, we are focusing on two areas: safety leadership and our safety management system.

- **Safety Leadership:** all staff and service providers must take personal ownership of safety management. We are addressing the engagement and commitment of service provider personnel directly through internal training and leadership. Recent senior level appointments in safety management are further driving these initiatives.

- **Safety Management System:** Multiple safety management systems are being consolidated into an improved national safety management system that is consistent and highlighted throughout our operations. Part of this development is the extension of our new asset management information system MAXIMO and its integrated safety management module.

3.3 Maintenance Specification

Maintenance specification activities involve:

- **Maintenance requirements:** the development, stewardship and assurance of the detailed technical definition of the asset maintenance that is required, and how and when that maintenance work is to be undertaken. This includes the monitoring and assurance of the quality of maintenance being delivered by the field teams in accordance with the relevant specifications. The definition of our maintenance practice extends to the specification of supply management procedures.

- **Reliability improvement:** activities which involve the analysis and interpretation of asset condition information in order to refine our maintenance practices and deliver improved reliability.

- **Performance Improvement:** activities which involve assessment of performance information to optimise the management of risks in a cost effective manner
The specialist knowledge and capability within our engineering function underpins maintenance specification. It undertakes technical investigations, establishing the asset lifecycle implications of proposed changes, and finalising improvement recommendations.

3.3.1 Maintenance Requirements

To plan our preventive maintenance, we need to understand what asset maintenance is required and how and when it is to be undertaken. We also must assure that maintenance is undertaken as specified. We have established a Maintenance Authority to oversee the development, upkeep and assurance of our maintenance requirements.

Maintenance practices

We have an extensive suite of Service Specifications that are the cornerstone technical reference specifying what maintenance is required. Our engineering teams maintain the Service Specifications.

Historically we relied on these high-level technical specifications alone to describe our maintenance requirements, with service providers operating day-to-day using their own work procedures. We have now developed a suite of Standard Maintenance Procedures (SMPs). The SMPs define current appropriate practice for preventive maintenance on all asset types. They provide for consistent practices over a diverse asset base, by a field workforce that is geographically spread and managed by different service providers.

We use the SMPs, applied across our asset base, to establish our preventive maintenance schedule. This baseline plan sets out what preventive maintenance is required and how often across our whole network.

Delivery of preventive maintenance in compliance with this baseline provides certainty in the minimum standard of care being applied assets, and confidence that improvements to preventive maintenance practices are implemented across the asset base. These are pre-requisites for effective reliability engineering, and ensuring long-term improvement of our maintenance requirements.

Our maintenance must be undertaken in a manner that is sensitive to the New Zealand environment and also to the expectations of the local communities where our assets are located. This is particularly the case with access to landowner property to enable work on our lines assets.

Supply practices

Our maintenance requirements include the specification of supply management procedures that will improve the delivery of parts and material on time and at best purchase price, plus manage obsolescence and critical spares requirements.

During RCP1 we transferred our inventory management system to MAXIMO to combine work management and inventory management on the same platform. We have ongoing work to develop our inventory management system to fully align to our work management practices.

Quality Management

We have field assessors who determine quality levels within Service Provider field teams, and enable a focused quality management exercise that ensures the teams are aware of and comply with the standards for their work practices. Quality Management addresses:
• skills and competency deficiencies
• substandard work practices
• non-compliance to maintenance requirements
• non-compliance to supply requirements.

Asset configuration

Maintenance requirements also encompasses assurance that the asset configuration defined in asset information systems is up to date, and that the transmission Grid capability information required by the System Operator is accurate at all times.

3.3.2 Reliability Improvement

Reliability improvement refers to the ‘tactical improvements’ that incrementally refine our maintenance practices, and the provision of advice to Operations and to Maintenance delivery based on defect or failure events or asset specific issues.

Extensive information regarding the condition and status of assets is generated every day in the form of condition indicators, failure sequences, corrective work requests and operating parameters. Reliability improvement involves the interpretation of this detailed asset information to forecast and manage the future condition and capability of the assets and to refine our maintenance practices.

Reliability improvement involves:

• **Operations support**: bringing to bear all relevant information to address emerging operational risks, and to limit the impact of events – for the tactical support of our Operations and Maintenance teams. Our Engineering teams provide a crucial support role here.

• **Reliability analyses**: assessments of work history and other data to identify poor reliability equipment and systems, and support maintenance delivery with benchmarking.

• **Fault and event analysis**: ongoing systematic recording and analysis of faults and events to recognise trends, short-term reviews through daily operational meetings, regional events review meetings and investigations of major incidents.

• **Defect management**: root cause analyses and other investigations of significant failures to ensure these problems do not re-occur.

• **Preventive maintenance optimisation**: recommended improvements to our Service Specifications and SMPs.

• **Condition assessments**: assessments of condition data and test results to inform predictive maintenance requirements and our asset health measures.

This integrated approach to reliability improvement is relatively new and constantly developing. Initial work has centred on a mix of better use of existing data to identify asset deficiencies; and improved engagement between the engineering, reliability and maintenance teams for tactical support. This is developing well and within a few years will mature into a consistent reliability-focused approach within our maintenance strategy.
### 3.3.3 Performance Improvement

Performance improvement activities weigh maintenance costs against risks to our performance to optimise our maintenance efforts and expenditure. Ultimately we will employ cost-risk modelling at an asset level to inform our preventive maintenance optimisation. Performance improvement activities are a developing initiative and include the following.

- Reliability and performance assessment to understand the likelihoods and impacts of asset failures and the direction needed to optimise whole-of-life asset value.
- Operating a 3-year view of the Asset Management Plan (that incorporates salient asset risks) to support decision making for the annual works plan and maintenance budget.
- Specification of data requirements for our asset management information systems to support reliability improvement.
- Strategic performance and reliability reporting, including benchmarking exercises to assess the performance of the business compared to peer organisations.

The first stages in this initiative have been to develop a better understanding of the likelihoods and impacts of asset failure. This includes using emerging asset health indices to inform our planning, and using an asset criticality model to look at the impact on customer continuity of supply of parts of our network. We will extend this to individual assets and include safety criticality.

Our focus is now on:

- building on our asset health and criticality approaches to establish comprehensive asset risk profiles
- implementing an optimisation framework using the asset risk profiles to help us prioritise and make trade-offs between investment and maintenance interventions
- building improved corporate reporting on the trends and outlook for asset reliability and technical performance, expenditure and risk
- developing the capability to use our asset risk profiles to provide support to both Planning and the Maintenance work planning processes.

### 3.4 Maintenance Delivery

Maintenance delivery involves:

- **Works planning**: collating and scheduling upcoming maintenance work and expenditure.
- **Work management**: delivering maintenance work on Grid assets.
- **Inventory management**: supporting work management by the purchasing and issue of inventory as required.

Maintenance delivers a high volume of small-to-medium sized projects as this can be efficiently managed under our maintenance service provider contracts. This includes a number of small replacement (Capex) projects programmes identified under our fleet.

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9. Asset health indices estimate remaining asset life using information such as asset usage, age, and condition.
strategies. All project work undertaken via Maintenance is subject to approved business cases managed within the IWP process.

The specialist knowledge and capability within our Engineering function underpins maintenance delivery. Operational aspects include specialist support to identify and resolve equipment issues and failures, the commissioning of new equipment entering service, and the management of critical spares.

### 3.4.1 Works Planning

Works planning involves collating and scheduling upcoming maintenance work and expenditure. In contrast, works management involves more detailed planning for the actual delivery of maintenance jobs and projects. Works planning consolidates the work specified as routine maintenance and our maintenance projects.

Our routine maintenance plan is made up of the baseline preventive maintenance and forecasts for corrective work. This takes account of year-by-year variations in preventive maintenance schedules, changes to the asset base, changes to our maintenance approach and projected efficiencies. Routine maintenance expenditure is approved within our annual business planning round.

We manage the progressive approval and prioritisation of maintenance project work within the IWP\textsuperscript{10} process, which culminates in the issuing of a schedule of projects for the coming year within the annual planning cycle.

**Resource planning**

All work across the Grid generally draws on the same contracted workforce, so resource planning is an important input for service provider planning and our assessment of delivery risk. This is a key improvement area for maintenance.

**Outage coordination**

Currently around 60% of all maintenance work requires network outages to isolate the equipment. Outages of parts of the Grid reduce the security of the system, and may increase risk to customer supply. In some parts of the Grid, outages of equipment lead directly to interruptions of supply. Planned outages must therefore be kept to a minimum consistent with enabling appropriate maintenance work to be undertaken.

Outage planning and coordination is an Operations activity, and we progressively build the outage plan based on known works information. Wherever possible, the scheduling of maintenance work on several items of equipment within an affected network branch is grouped to use available outages efficiently.

Historically the works planning time frame provided for a 12-month work forecast, four months ahead of the start of each planning year to enable annual budgeting and advance outage coordination.

With the introduction of Financial Transmission Rights (FTRs) we have moved to a longer-range maintenance works plan to enable a 24-month outage plan for all outages on the Grid. The extended timeframe will enable better advice to the market and customers on network outages and provide more opportunity for refining works and outage scheduling.

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\textsuperscript{10} The Integrated Works Plan also includes Enhancement, Replacement and Investments.
The accuracy and stability of our maintenance plans are important in delivering a stable Outage Plan for all work over the Grid. The main risks to our plans are resourcing and environmental factors such as poor weather.

3.4.2 Work Management

Work management governs the methods and approach used to ensure maintenance work is approved, planned, scheduled, and then closed out correctly.

Work management involves delivering the maintenance works plan. The challenge is to effectively manage the different work types with their inherently different lead times and the changes in the schedule due to weather or system considerations. Service providers must confirm the outages scheduled for undertaking maintenance work within their detail job planning.

Routine maintenance is based on a forecast schedule plus scheduled condition-based repairs justified from inspection results. Even ad hoc corrective maintenance work should not require urgent scheduling, provided we remain up to date with our tracking of asset condition. Where corrective maintenance requires additional network outages, these are requested in advance to allow security analysis and other operational checks.

Fault response is the exception, where urgent work is triggered to return the Grid to full availability and minimise the impact of any forced outage. This work is expedited as a special case.

Project work is integrated with other scheduled maintenance work to ensure there are sufficient resources to undertake the work along with required parts and materials.

During the last few years we revised our approach to work management. We have introduced three stages for scheduling work to provide more rigour and visibility in progressing work orders.

- **Backlog**: provides full visibility of identified new work. Previously, the detail of this work resided in service provider systems. Work in backlog has been validated (that it is necessary), but awaits detailed planning. The number of jobs and trends are indicators of whether work management planning is effective and we are managing resources efficiently.

- **Forward log**: the forward schedule of all approved work required for service provider resource planning and for outage approval. Managing the forward log allows several important benefits, including clear visibility when work will start, whether network outages are necessary and when they will be required, and assurance on resource availability.

- **Monthly schedule**: month-by-month schedule locked in one month in advance. It provides a definitive schedule for service providers to complete detailed execution planning, finalise outage arrangements and the basis for monthly budget approvals.

We are building on these recent improvements. Our focus is on introducing more systematic processes for prioritising or rescheduling work to encourage work management stability and to reduce rework.

Information systems
Work management is enabled by internal information systems and those of our service providers. These support the necessary technical and commercial transactions, budgeting and cost control and importantly support the coding of asset and works records.

As discussed above, we have recently introduced a new asset management information system (MAXIMO) and a new outage management system (IONS). In parallel, we have redefined the works management processes to align with these. This should lead to better record keeping, and enable improved analysis of impending and completed work. These initiatives will improve schedule control and remove waste associated with the management of schedule changes, and enhance reporting for better decision support.

### 3.4.3 Inventory Management

Inventory management involves the procurement, stock management and materials supply for maintenance. Stock holdings should represent the minimum required to ensure reliable operations and enable planned work to proceed on time.

Our stock includes a significant holding of strategic spares of major equipment, which require controls ensuring their availability. These strategic spares are assets such as transformers which we hold in reserve to use when we need to take assets out of service for refurbishment or for unexpected events.

During RCP1 we transferred our inventory management system to MAXIMO to establish work management and inventory management on the same platform. We have ongoing work to develop our inventory management system to fully align with our work management practices.

In broad terms, this involves establishing new data standards for inventory, re-cataloguing our inventory and developing reports and analysis that improve the value of spares. Ultimately we will be able to link goods movement history to individual assets and asset types, and optimise the cost of maintaining inventory against operational risk.

### 3.5 Enablers

#### 3.5.1 People Capability

Delivery of maintenance activities is dependent on skilled and specialised personnel, particularly in our field workforce, engineering and analytical roles.

In RCP1 we established basic systems and tools for a competency management programme that links the competencies we need for our maintenance requirements. To support training and to maintain the required competencies for staff and service provider personnel, we are continuing to develop our learning management systems.

Our training initiatives, one to support developing core skills (Grid Skills) and one to support training required for new equipment or systems (Technology Training) are described below.

**Grid Skills**

Competent field workers are required to design, build, maintain and operate the transmission system safely, efficiently and reliably with zero accidents, human errors and power system incidents. These skills are in short supply, with the added complexity of an ageing workforce and changes in technology driving different ways of working. Our provision of field workforce training within a managed framework is essential to meeting our skills requirements and to developing the next generation of field workers.
Through Grid Skills we provide and fund all core training to build skills and knowledge. Service providers build on this by providing the requisite on-the-job experience for their staff that culminates in competency achievement and certification. Our staff undergo periodic refresher training in all relevant competencies.

**Technology Training**

Technology training is associated with the introduction of new business systems (for example, work and outage management processes) and new Grid equipment (for example HVDC power electronics). We are formalising all new training material as a technology training resource for the industry within our learning management systems, accessible to our own staff and service providers.

### 3.5.2 Service Providers

We have a long-term relationship with our service provider organisations. This is recognised in agreements, which describe shared safety and quality values, joint ownership for the continuous improvement of maintenance, effective planning, and a sustainable business proposition for the service providers.

We established new commercial agreements with our maintenance service providers in 2012. These envisage a more collaborative relationship with the shared goal of the delivery of service to our customers and stakeholders, facilitated by extended lead-time planning and accurate work and project management. We and our service providers recognise that sustained improvement in maintenance practice will be a product of attitudinal change as much as technical approach.

The ongoing development of our relationship with our service providers is termed ‘One Team’, which represents light-handed but conscious leadership and change management by Transpower to oversee, refresh and steer relationship initiatives to the point that relationship improvement is self-sustaining.

Our contracts with our service providers cannot stand still. Knowledge gained from monitoring the effectiveness of routine maintenance and projects work will inform contract review, as provided for in the current terms.

### 3.5.3 Systems capability

**Information Systems**

Maintenance relies on a range of asset management information systems, particularly our Asset Management Information System (MAXIMO) and Outage Management Systems (IONS).

MAXIMO provides access to technical asset data, work history and maintenance financial transactions, and we depend on it to support work management, inventory management and cost control.

IONS provides the means for maintenance to request safe access to the Grid so that maintenance work requiring a network outage can be undertaken.

We have an ongoing change programme which is delivering a range of business system improvements supporting asset management. The programme is pivotal to maintenance improvement enabling benefits in the reduced cost of routine maintenance through improved work management and better use of asset and work information. Development of our information systems is a key enabler for this programme.
The main information system deliverables of this programme include operational risk management, enhanced reporting and information views.

- Operational risk management incorporates event and hazard management into MAXIMO to provide the links between work and assets necessary for effective risk management.
- Enhanced reporting introduces a broadly accessible reporting and analytics platform that allow us to efficiently combine information from our major asset management applications; initially IONS, MAXIMO, PI system and ACI.
- Information views provide alternative views of information appropriate to particular maintenance roles. Initial emphasis will be on geospatial visualisation of works and asset information from MAXIMO.
4 MAINTENANCE OBJECTIVES AND STRATEGIES

To achieve its asset management vision and deliver on its commitment to stakeholders, Transpower has set out its asset management objectives in five main areas. The first four relate to aspects of Transpower’s performance that can be directly observed by external stakeholders. The fifth area relates to Transpower’s internal asset management processes and capability.

1. Safety
2. Service Performance
3. Cost Performance
4. New Zealand Communities
5. Asset Management Capability

This chapter explains how maintenance contributes to the asset management objectives and sets out maintenance objectives, strategies and improvement indicators.

The maintenance objectives articulate where maintenance should be to achieve the asset management objectives. The strategies explain what we will do, and the improvement indicators will track our progress.

4.1 Safety

Maintenance has a significant influence on our safety performance through assurance that the Grid’s systems, assets and components are maintained in a fit-to-operate and safe state. Maintenance work involves a significant workforce undertaking physical tasks at operational and potentially hazardous sites – all critically dependent on safety controls for the avoidance of harm.

Maintenance safety strategies support our core safety objectives and are also a fundamental influence in improving work quality and our ‘One Team’ behavioural approach across Transpower and our service providers.

4.1.1 Maintenance Safety Objectives and Strategy

Within maintenance, our approach to safety for RCP2 will focus on supporting our corporate workplace safety goals.

**Safety Objective 1**

We will undertake maintenance activities in a way that continually reduces the risk of harm to our workforce and the public.

We will achieve this objective by:

- achieving a safety leadership position and proactive safety attitudes and behaviour with our service providers
- achieving safety and health alignment and consistency with our service providers and subcontractors (including ensuring that service provider are complying with agreed safety management systems)
implementing our existing requirement for appropriate best practice investigation and corrective action of the root cause of all safety incidents, including sustainable resourcing.

**Improvement Indicator 1**

In relation to our workforce, our objective is to ensure:

- Zero fatalities
- Zero injuries causing permanent disability
- A sustained, declining trend in medical treatment injuries.

### 4.2 Service Performance

Maintenance specification and delivery have a critical influence on service performance and asset reliability. Refinement of the preventive programme limits the incidence of failures and interruptions. Failures, defects and corrective work are a source of valuable new information, the analysis of which drives the cycle of reliability improvement. Maintenance planning and work management are pivotal in limiting the duration of periods of reduced security to a minimum, and the rapid recovery from interruptions when they do occur.

The Maintenance objectives for service performance reflect each of these influences, with the key emphasis being the development of reliability engineering practice – covering maintenance specification and reliability improvement activities.

#### 4.2.1 Service Performance Objectives and Strategies

**Service Performance Objective 1**

Our preventive/condition based maintenance practice is justified according to asset risk evaluated at the failure mode level.

We will achieve this objective by:

- completing SMPs to assure the preventive maintenance baseline
- applying a Failure Mode and Effect Analysis (FMEA) methodology based maintenance regime to quantify asset risk at the failure mode level
- defining the strategy for the optimal use of preventive maintenance versus remote condition monitoring to manage the risks associated with failure modes
- implementing a reliability-centred approach, where justified for critical assets
- ultimately implementing a full risk-based maintenance approach, including quantifying the trade-off between the cost of undertaking maintenance and the increasing risks associated with deterioration over time of our most critical assets.

The application of FMEA to the refinement of the preventive maintenance regimes for the most critical assets is a representative milestone for Transpower’s adoption of this fundamental reliability toolset.
Improvement Indicator 1
By 2016 preventive maintenance plans are revised and implemented (based on consideration of risk at failure mode level) for all assets classed as high impact.\(^1\)

Service Performance Objective 2
We have a mature reliability improvement framework and methods consistent with the requirements of an optimised approach to preventive/condition based maintenance, and maintenance works management.

We will achieve this objective by:
- improving the accuracy and completeness of asset failure data, including reducing the number of events attributed to ‘unknown’/‘other’
- applying appropriate, investigation, root cause analysis and corrective and preventive action processes to forced and fault outage events and defects
- a consistent approach to condition assessment by fleet and asset criticality
- embedding monitoring and improvement metrics in business-as-usual (BAU) processes
- having specifications for asset fleets that are based on reliability, availability and maintainability, to support procurement.

Improvement Indicator 1
From 2015 systematic corrective and preventive actions will have been assessed and established for the top 20% (ranked by total cost) preventive maintenance drivers.

This measure reflects systematic application of root cause analysis and structured corrective and preventive actions of network interruptions. This is typically associated with operational events, maintenance costs, mean time between work, and field assessment non-compliance.

Improvement Indicator 2
From 2014 systematic corrective and preventive actions are assessed for forced and fault outage events that cause supply interruptions.

This is an equivalent indicator applied to actual supply interruption events to target the immediate and direct effects on our customers.

Service Performance Objective 3
We can demonstrate leading practice for inventory management.

To support the reliability and availability of the network for our customers, we have set an objective to define, justify and maintain optimal spare stock levels and their continued monitoring using a more sophisticated, best practice and cost-risk balanced approach. This is a key improvement to be achieved within our inventory management and reliability improvement initiatives.

\(^1\) High impact is one of the three criticality categories that will be assigned to all assets.
- We will establish a cost-risk justified approach to determine strategic spares holding needs (co-developed within the Planning and Maintenance Lifecycle activities).

- We will upgrade our inventory processes to assure that stock holdings represent the minimum required to enable reliable operations and that planned work can proceed on time, with parts and materials staged to where they are needed.

- As a priority within this upgrade, we will address assurance of the actual holding strategic spares, consistent with defined thresholds for re-order. We will also address the compliant maintenance of strategic spares.

**Improvement Indicator 1**

By 2015 the requisite level of strategic spares is justified and stock levels maintained at a demonstrably optimal level.

### 4.3 Cost Performance

The specification, planning and delivery of maintenance work have a significant influence on our annualised and whole-of-life costs. The costs associated with maintenance are often the most significant lifecycle cost for long-lived assets.

The overall objective is to minimise whole-of-life costs within a mature, fully integrated asset management approach across the various asset lifecycle phases as set out in the Asset Management Strategy.

The achievement of demonstrable maintenance cost-risk optimisation through development of reliability engineering (covering maintenance specification, reliability improvement and optimisation activities) and works management practice is a key emphasis of our cost performance strategies.

The immediate emphasis within maintenance will be cementing consistent good practice in work and budget control within our new work management environment. Our early focus on targeted cost reduction is a key catalyst in mobilising new capabilities in these areas.

One of the next improvements planned for the criticality framework is to develop the tools to allow us to quantify the effects of different levels of asset performance on reliability across the whole network quickly and efficiently. We are also working to develop models for forecasting future asset performance based on expenditure on the asset. Combining the two approaches will help us optimise lifecycle costs.

### 4.3.1 Maintenance Cost Objectives and Strategies

**Cost Objective 1**

We can optimise the cost of asset maintenance with respect to the level of asset performance (and so optimise network reliability) within a mature, whole-of-life cost approach to asset management.

We will achieve this objective by:

- coordinating maintenance and capital planning to enhance the current Capex/Opex trade-off approach and whole-of-life cost analysis approach to further optimise the balance between design, configuration and ongoing maintenance costs
together with asset criticality and asset health initiatives, implementing cost-risk optimisation across the asset base to inform the optimisation of preventive/condition-based maintenance. This will include the development or procurement of the appropriate decision-support tools to establish the optimum intervention programme spanning capital and maintenance interventions.

The improvement indicators for Cost Objective 1 are the same as those for Cost Objective 2 below.

**Cost Objective 2**

We comprehensively understand the cost drivers within our maintenance delivery processes, and use this knowledge to drive prioritised improvement.

We will achieve this objective by:

- realising the Integrated Works Planning and Maintenance work management approach to drive delivery efficiencies and rigorous budget control
- introducing a reliability-based programme to realise targeted cost savings within maintenance delivery (initially the targeted opportunities will be identified though work order analysis)
- establishing enhanced output and productivity monitoring of routine maintenance delivery and maintenance project contractors to identify appropriate contractual changes, incentive mechanisms and measure and refine our unit costs
- establishing an innovation and smarter working programme to capture best external practices and also source continuous improvement options from the tacit knowledge of our workforce (internally and across our service providers).

**Improvement Indicator 1**

By 2016 corrective maintenance costs are reduced by 5%, normalised for variations in the asset base.

**Improvement Indicator 2**

By 2018 preventive maintenance costs are reduced by 4%, normalised for variations in the asset base.

The two improvement indicators reflect expenditure reduction for corrective and preventive work based on:

- near-term reductions in corrective work through improved work management and cost reduction initiatives
- year-on-year savings in preventive maintenance expenditure associated with refining preventive maintenance standards
- progressive long-term reduction in corrective work based on more effective preventive maintenance and a maturing condition assessment programme
- long-term improvements in whole-of-life management and cost optimisation across the asset base.
4.4 New Zealand Communities

We are committed to asset management approaches that seek to protect natural and cultural environments. This includes complying with consent conditions, phasing out avoidable practices that have adverse environmental impacts and mitigating the risk posed by hazardous materials.

We are also committed to demonstrating a sense of social responsibility by having regard to the interests of the community in which we operate. Relationships with landowners, communities and connected customers are of great importance to us, as maintenance related activities have potentially significant effects on their day-to-day lives, and frequently require access across private land to undertake work on the assets.

Improving environmental compliance and stakeholders relationships are integral aspects of Maintenance practice within the framework set out in this strategy, and important factors in efficient work management. The steady improvement of the methods and systems employed to manage the relationships with landowners has been an important focus within the last few years, and is gaining increasing community acknowledgement. As the approach is integrated within our BAU activities, Maintenance does not have headline improvement objectives and strategies specific to New Zealand communities.

4.5 Asset Management Capability

Transpower aims to be recognised as a leading asset management company. To achieve this we have set out a number of maturity and capability related objectives. The maintenance function plays a pivotal role within the wider corporate approaches to asset management, risk management, training and competency, asset knowledge, and continuous improvement.

- **Asset management**: where we are actively working to assure and demonstrate clearer and more direct line-of-sight between our maintenance interventions and the overall corporate objectives, as well as ensuring the optimal balance between Capex and Opex.

- **Risk management**: our preventive/condition based maintenance approach and our monitoring and management of asset related risks (both safety and performance) are aligned with the company’s wider risk management framework.

- **Training and competency**: improvements in organisational capability within maintenance are targeted at the maintenance field workforce skills and competency development articulated in the Technical Workforce Capability strategy, and delivered as our ‘Grid Skills’ programme.

- **Asset knowledge**: we are building on the implementation of a best practice asset information management system during RCP1 to enable and drive improvements in the specification, collation, management and use of maintenance data within an enterprise wide system.

- **Continuous improvement**: Maintenance has established clearly defined plan-do-check-act management loops for maintenance specification and delivery, which align with best practice such as PAS 55, to ingrain continuous improvement within the function via our reliability improvement approach.

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12 Grid Skills – Vision and Strategy; Technical Workforce Capability October 2012
4.5.1 Maintenance Maturity and Capability Objectives and Strategies

As well as supporting our wider corporate objectives and strategies, we are targeting maintenance workforce skills and competency development.

**Maturity and Capability Objective 1**

We have assurance that the qualifications and competency of our workforce meet the needs of Grid maintenance, and have the ability to sustainably manage this.

Our strategies to achieve this objective complement and extend the ‘Competency Development’ element of the Grid Skills programme. They address our ability to actively monitor and manage skills training and ‘in-the-field’ experience to assure a satisfactory and sustainable competency profile across our operations.

Specifically, we will achieve this objective by:

- establishing a mandatory practical experience monitoring system, to be applied by all service provider organisations, to assure that assessment of the real-world field experience of each individual in the workforce is consistently applied within the competency framework
- establishing a single repository for individual worker training and competency records for both Transpower delivered skills training and service provider delivered experiential training, including refresher status
- establishing a forecasting model for the assessment of workforce capability and training requirements, through the matching of an assessed forward competency profile with tracked competency records, accounting for attrition and recruitment patterns.

**Improvement Indicator 1**

By 2016 the competency profile of our Maintenance workforce is actively monitored and assessed against our Competency Framework requirements.