Transpower New Zealand Limited

Report of Investigation into 20 June 2024

Tower 130 Henderson to Marsden A Line Incident

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1 Executive Summary

1.1 On or about 11:03 am on Thursday, 20 June 2024, a 220 kV transmission tower on the Henderson to Marsden A line, adjacent to State Highway 16 near Glorit (**Tower 130**), carrying two 220 kV circuits between the Northland region and the remainder of the North Island fell, causing a loss of supply of electricity from the national grid into the Northland region (the **Incident**).

1.2 This report records the results of an investigation (the **Investigation**) undertaken by Daniel Twigg (the **Investigator**) into the Incident and Transpower New Zealand Limited's (**Transpower**) response to the Incident. The Investigation reviewed written material requested from, and provided by, Transpower and Transpower's service provider Electrix Limited (trading as Omexom New Zealand, **Omexom**), and conducted interviews with key Transpower and Omexom staff. No information that was requested was withheld. Lists of the documents reviewed and the individuals interviewed (with some names withheld for privacy) are listed in **Appendix A** and **Appendix B** to this report.

Context

1.3 The Northland region is supplied primarily by a double circuit 220 kV transmission line between the Huapai substation and Marsden/Bream Bay substations. There are also two 110 kV circuits running on a double circuit transmission line from Henderson to Maungatapere (via Wellsford and Maungaturoto), and on to Kaikohe and Marsden.

1.4 On 19 and 20 June 2024, Omexom was undertaking maintenance on the foundation baseplate of Tower 130 as part of a programme of maintenance of tower foundation baseplates in Northland.

1.5 Independently of the baseplate refurbishment work, one of the 220 kV circuits attached to Tower 130 was on planned outage to allow maintenance work to be undertaken to that circuit (this work was being undertaken at a different location along the circuit).

Tower foundation baseplate refurbishment works

1.6 The Tower 130 baseplate work had been included in a scheduled programme of routine maintenance work to be undertaken in financial year 2022/23, but due to events including Cyclone Gabrielle, it had been delayed. The delay was not a matter of concern as the work was non-urgent and had a two-year window for being completed; completion in June 2024 was within that window.

1.7 Baseplate refurbishment work on concrete foundations can require a range of activities and methodologies, depending on the condition of the baseplate, but will invariably involve:

(a) Removing the nuts and washers on top of the baseplate.

(b) Inspecting the bolts and baseplate holes for signs of corrosion.

(c) Preparing the steel surfaces by blasting and cleaning exposed surfaces, using sealant and applying a protective coating.

Drawings and Service Specifications are provided by Transpower for this and other types of work it contracts with service providers to carry out.

Transpower's maintenance contracts

1.8 Transpower contracts its transmission asset maintenance to four service providers, of which Omexom is one of the largest. Omexom has been a service provider to Transpower for many years. Transpower regards Omexom as competent and reliable. An audit of recently completed baseplate refurbishment work by Omexom in Southland showed its work there was compliant with Transpower's specifications for such work.

1.9 Contracts require the service provider – in the case of Tower 130, Omexom – to undertake work in accordance with the Transpower Service Specifications and drawings applying to that work, and carry out the work to its own requirements for training and competency of people working in the field. Work is expected to be delivered applying 'good industry practices'.[1]

1.10 Neither Transpower's specifications nor its drawings for baseplate refurbishment specify how many nuts are to be removed from the baseplate at the same time or in what order, during refurbishment. That detail is left to the contractor's procedure and judgement, to be developed in accordance with the specifications which apply. The relevant specifications in the case of tower foundation refurbishment include ensuring the stability of the tower at all material times.

1.11 The Omexom written procedure that applied to the baseplate refurbishment work at Tower 130 does not specify how many nuts are to be removed from the baseplate at the same time or the order of removal saying only "remove hold down nuts and washers."

Omexom's work practice at Tower 130

1.12 Omexom's standard practice, taught to its civil works field staff, was to remove all nuts from only one tower foundation leg at a time. This standard practice, which was taught to the Team Leader at Tower 130 during 2023, was not followed at Tower 130 on 20 June 2024.

1.13 At Tower 130, the Team Leader was engaged in sandblasting work while a relatively inexperienced team member was assigned the task of removing nuts

[1] Defined in Transpower's Master Grid Services Contract to mean "*in relation to any activity, the exercise of a degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected from a skilled and experienced person engaged in New Zealand in the same type of activity, under the same or similar circumstances*".

from tower foundation legs, as the sandblasting work moved from leg to leg. During this work the team member removed nuts above the baseplate from three tower legs. These actions did not comply with Transpower's specifications and service standards and did not meet standards of 'good industry practice'.

1.14 The team member who removed the nuts from the foundation legs was not adequately trained to perform the task and was not adequately supervised while performing the task.

1.15 Omexom completed four baseplate refurbishments in June 2024, before the team moved to Tower 130. At earlier jobs in June, the evidence suggests that nuts were removed from more than one tower foundation leg at a time.

Why the tower fell

1.16 Beca Limited (**Beca**), an engineering consultancy firm, concluded from an investigation commissioned by Transpower that the cause of the failure of Tower 130 was the removal of the nuts from Legs A and B by the Omexom field crew. Its analysis indicated removal of the nuts from legs A and B by the Omexom field crew, which were intended to resist tension forces on the tower, compromised the stability of the tower, causing it to rupture and ultimately caused the tower to fall.

Power restoration

1.17 Following the Incident, Transpower worked in both its roles as Grid Owner and System Operator efficiently and effectively to restore supply, and then security of supply, to the Northland region using temporary infrastructure. No issues have been identified by this review associated with the restoration efforts.

Baseplate work stopped

1.18 Transpower stopped all baseplate work across New Zealand. This was communicated to its service providers on 21 June. Baseplate work will not be restarted until reviews of the Incident have been completed and a Return to Work plan is in place.

1.19 In addition, as part of an ongoing internal review, Transpower will consider improvements to the Grid Skills course offered by it to service providers in relation to foundations.

Summary of Recommendations

1.20 Transpower should, before any baseplate refurbishment work is recommenced:

(a) Review and revise its drawings and specifications to ensure that in relation to baseplate refurbishment, they describe a methodology regarding nut removal and provide detailed recommendations as to when engineering advice should be obtained.

(b) Require each service provider to produce for Transpower's review a new work method or procedure for baseplate refurbishment work.

(c) Hold a refresher workshop with its service providers to introduce the changes it makes to its drawings and specifications.

1.21 Transpower should:

(a) Review and update its Grid Skills Foundations training course materials specifically to include baseplate refurbishment work, taking into account the changes Transpower makes to its drawings and specifications.

(b) Require service providers to have all people assigned to work on baseplate refurbishment sites as a team leader or supervisor undertake the revised Grid Skills Foundations course as soon as practicable after the course becomes available.

(c) Encourage service providers to have all other people assigned to work on baseplate refurbishment work undertake the revised Grid Skills Foundations course.

Advisors to the Review

1.22 As noted above, specialist engineering advice was provided to the Investigation by Beca. Legal advice and support was provided to the Investigation by Chapman Tripp.

2 Terms of Reference

2.1 The Investigator was appointed to conduct an independent investigation of the Incident and how Transpower responded to the Incident.

2.2 The Terms of Reference, setting out the scope of the investigation and the Investigator's responsibilities, is in **Appendix C**.

2.3 The following topics are outside the scope of the Investigation and will not be covered in this report:

(a) The impact of the outages following the Incident on residential and business end-users.

(b) Matters related to compensation under the Consumer Guarantees Act 1993.

2.4 Omexom is undertaking its own and separate Incident Cause Analysis Method (**ICAM**) review of the Incident. For this reason, no recommendations are directed to matters which are the direct responsibility of Omexom (such as employment, training, and health and safety).

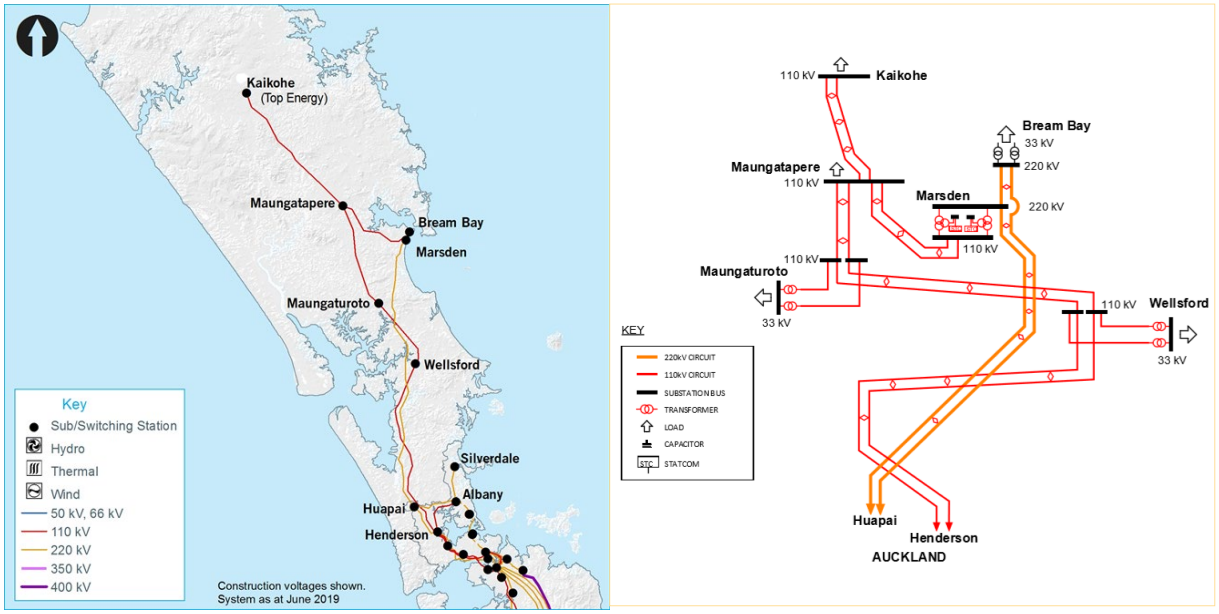
PART A: THE BACKGROUND

3 Overview of the Incident

3.1 Transpower is a State-owned Enterprise. It owns the national transmission grid (the **National Grid**) which connects generators to local distribution companies and some large industrial loads. Transpower also ensures the real-time co-ordination of the electricity system as the **System Operator**.

3.2 The Northland region is supplied primarily by two 220 kV circuits on a double circuit transmission line between the Huapai substation and Marsden/Bream Bay substations. There are also two 110 kV circuits running on a double circuit transmission line from Henderson to Maungatapere (via Wellsford and Maungaturoto), and on to Kaikohe and Marsden. Under normal conditions with all assets in service, this provides N-1 security (of electricity supply) to the Northland region. N-1 security describes the level of security where one asset can be removed from service without disruption to electricity supply.

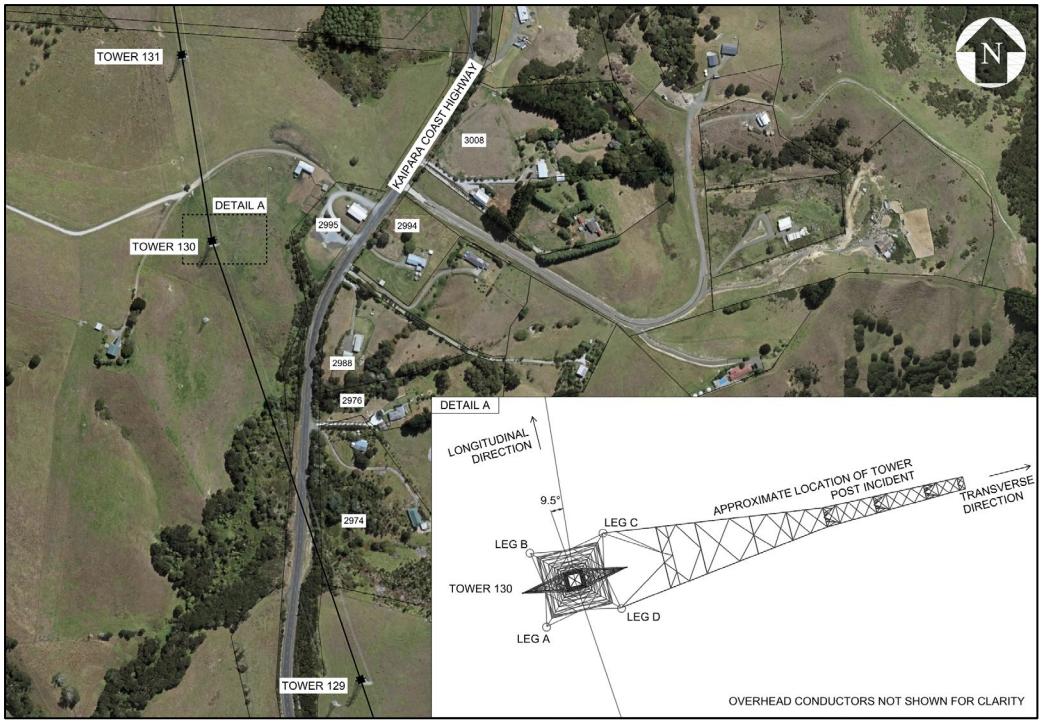
3.3 The configuration of the Northland region's transmission network is shown below (from the System Operator's report into the Incident[2]).



National grid configuration in Northland region

3.4 Tower 130 on the 220 kV Henderson-Marsden-A line was a standard C464 type C angle suspension tower, located on private farmland near State Highway 16. It carried two 220 kV circuits, one on each side of the tower. It is referred to as an angle tower because the transmission line changes direction at the tower, forming an angle. Details of the structure of the tower and the site are included in Beca's report. A picture of the location of Tower 130 prepared by Beca is shown below.

2 See **Appendix I**.



Location of Tower 130

3.5 Tower 130 was supported by four concrete pile foundations, one at each leg. The baseplate of each tower leg was connected to the concrete pile foundations by a system of eight bolts. In a normal configuration, each bolt has two nuts tightened above the baseplate. An example of a concrete pile with eight bolts from another tower is pictured below.

Photograph of concrete pile foundation with baseplate, bolts and nuts shown in normal configuration.

3.6 On 19 and 20 June 2024, Omexom, one of Transpower's service providers, was undertaking maintenance on the foundation baseplates of Tower 130 as part of a programme of proactive maintenance of tower foundation baseplates in the Northland region.

3.7 In addition, on 20 June 2024, one of the Bream Bay to Huapai 220 kV circuits attached to Tower 130 (the **BRB_HPI_1 220 kV circuit**) was on planned outage to allow maintenance work to be undertaken on the circuit. This maintenance

work was independent of the tower foundation baseplate work. While the circuit maintenance work was undertaken, the 110 kV circuits were configured to prevent overloading in the event of the remaining 220 kV circuit between Marsden and Henderson tripping.[3]

3.8 At approximately 11:03 am on 20 June 2024, Tower 130 fell. This immediately caused the remaining Bream Bay to Marsden, BRB_MDN_1 220 kV circuit to Northland to trip, causing a loss of approximately 159 MW of supply to the region.

Photograph of Tower 130 after the Incident

3.9 The System Operator issued a Grid Emergency Notice following the loss of supply. During the day, it restored some power supply to the Northland region using the 110 kV network with initial restoration occurring at 12:47 pm, although not all peak evening demand could be supplied, and some industrial loads could not be served or were restricted to essential supply.

3.10 Restoration of one of the 220 kV circuits using a temporary tower was effected on Sunday, 23 June 2024, allowing full restoration of power supply to the Northland region, though at reduced system security.

3.11 The second 220 kV circuit was restored using temporary poles at 6:18 pm on Thursday, 27 June 2024, returning the system to pre-Incident capacity and security.

[3] It was reported that this configuration with the 110 kV split is normal for an outage of one 220 kV circuit, is a standard arrangement and supports the Northland contingency plan for the loss of the other circuit.

4 Transpower's approach to asset management and field maintenance work

Tower maintenance

4.1 Towers are made of galvanised steel where the zinc coating protects the steel from premature corrosion. Transpower owns approximately 23,580 towers as part of the National Grid,[4] of which 15,059 are 220 kV towers. The weighted average age of transmission towers is approximately 53 years.[5]

4.2 Transpower's strategic approach is to maintain towers in perpetuity, unless an asset is clearly identified as being no longer required.[6] This strategy also applies to tower foundations. Transpower aims for no major failures of highly critical assets, and fewer than one-every-five-years on lower criticality assets.

4.3 Between 1946 and 2023 there have been 15 major tower foundation failures resulting in tower collapse. Five were caused by river scour or ground movement; the remaining ten were due to high wind events pulling the foundations from the ground.[7] Prior to 20 June 2024, there had never been a foundation failure due to human error leading to tower collapse on the National Grid.

4.4 The main foundation types are steel grillage, concrete over steel grillage, and concrete pile. Tower 130 is a concrete pile type foundation, one of 9,421concrete pile foundations, or approximately 40 per cent of all foundations as shown in the diagram below.[8] These foundations have a 90-130 year life expectancy.

Figure 1: Foundations—Population Diversity

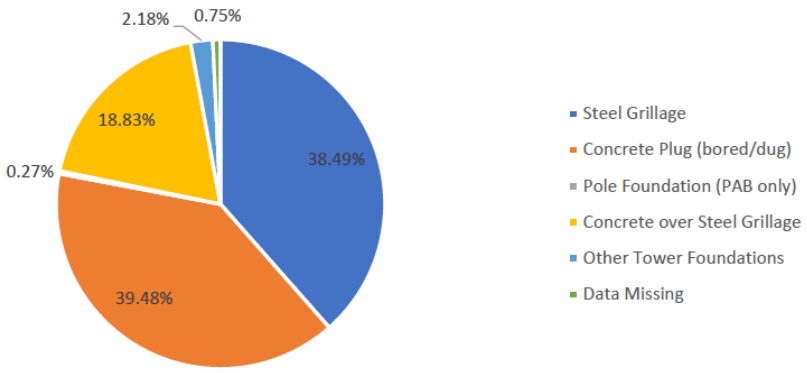


Diagram of Foundations – Population Diversity

4 TP.FL 01.01 Transmission Line Towers and Poles Asset Class Strategy, Issue 2.1, January 2019, at Table 1.

5 TP.FL 01.01 Transmission Line Towers and Poles Asset Class Strategy, Issue 2.1, January 2019, at p 7.

6 TP.FL 01.01 Transmission Line Towers and Poles Asset Class Strategy, Issue 2.1, January 2019, at p 24.

7 TP.FL 01.02 Foundations Asset Class Strategy, Issue 3, June 2023, at p 14-15.

8 TP.FL 01.02 Foundations Asset Class Strategy, Issue 3, June 2023, at p 12.

4.5 Transpower's foundations' asset strategy identifies several sources of risk to foundations, aiming to manage risks so the assets can be maintained in perpetuity.[9] One risk is component failure caused, for example, by moisture ingress into the grout under baseplates leading to corrosion of the anchor bolts and baseplates (invisible until grout is removed during refurbishment).

4.6 Transpower therefore programmes routine condition assessments (**CA**s) of all tower assets. CAs are carried out by service providers. The frequency of assessments depends on the criticality of the asset and the environment in which it is located. For example, towers in marine environments are more susceptible to corrosion and require more frequent assessments than those in alpine environments. Foundation works are then programmed if the tower is assessed at, or below, pre-determined CA scores (100 being the best score and 0 the lowest score).

4.7 For concrete pile baseplates, refurbishment selection is based on the minimum CA score of the four legs collected at each site. The typical threshold for programming refurbishment is CA 50, which is assigned before any significant rusting or loss of section occurs. Transpower analysis shows this to be the most effective refurbishment option in terms of life cycle costs.[10]

Programming and scheduling of tower baseplate refurbishment work

4.8 Once CAs are received, Transpower's asset planning team determines the sites at which it will intervene for a given year. This is followed by a validation process with service providers and Transpower's Service Delivery Managers (**SDM**s), for example to assess known issues such as site access. A work programme is then prepared.

4.9 Refurbishment of tower baseplates falls within Transpower's Predictive Maintenance (**PDM**) work programme[11] which is for work done on an asset before it deteriorates to an unsatisfactory condition. PDM-L denotes PDM work for large assets.

4.10 Once the PDM-L work programme is created by the asset planning team, the Maintenance Portfolio Manager reviews it against the overall maintenance programme for the year.

4.11 The PDM-L work programme is then loaded into Maximo,[12] which results in issuing work orders for each separate PDM-L job that is part of the same work package, at the same time. The work orders include a description of the work

9 TP.FL 01.02 Foundations Asset Class Strategy, Issue 3, June 2023, at p 18.

10 TP.FL 01.02 Foundations Asset Class Strategy, Issue 3, June 2023.

11 TP.AG 50.01 Grid Delivery Work Management Manual, Issue 3, March 2020, p. 16-18.

12 Maximo is Transpower's core asset management information system for all grid assets and is its core asset register and maintenance management tool.

and target date for completion. SDMs are then responsible for arranging for the work to be delivered by the service providers.

4.12 Although there is no specific rule, the asset planning team's expectation is that PDM-L work should generally be done within a two-year window. CA intervention points are set conservatively.

4.13 In total, Transpower scheduled 2379 PDM-L jobs for the financial years ended 30 June 2023 and 30 June 2024, of which 1852 were completed. Of the work completed, 252 were foundation baseplate refurbishments.

Contractor model

4.14 Transpower engages independent service providers to maintain its assets and to perform specialist field work services on the National Grid, including both condition assessments and field service work. This model allows Transpower to engage experienced and competent contractors to do work in areas where Transpower does not itself have expertise, and leverage scale and resources from contractors working across the electricity industry and, in some cases, globally.

4.15 The contract arrangements with each service provider are designed to achieve a balance between providing Transpower with assurance that work undertaken by service providers will achieve good outcomes, whilst affording service providers control over the manner in which those outcomes are delivered, reflecting the parties' relative expertise.

4.16 Since 2022, Transpower has contracted service providers within six regional service areas (**RSA**s). It engages a service provider to be the exclusive provider of certain 'in-scope services' for specified lines and stations in an RSA. Omexom is engaged as exclusive provider of certain services in both RSA1 (Northland) and RSA6 (the bottom half of the South Island). This includes tower foundations maintenance work in both RSAs. Northpower, Downer, and Ventia are engaged for the other RSAs.

4.17 Transpower also engages service providers for specialist services such as providing emergency structures, maintaining its substations, facilities and high voltage cables. Omexom is the service provider for the emergency structure contract (**ESC**) in the North Island as well as the Heavy Wiring contract.

4.18 Transpower has similar contract arrangements with all its service providers. These arrangements comprise:

(a) A Master Grid Services Contract (**MGSC**), which establishes the overall framework of the relationship and the terms that apply to the services to be provided by the service providers under separate Service Contracts and Work Package Contracts.

(b) Service Contracts (being Regional Service Contracts or Specialist Service Contracts), which establish the scope of the services to be provided and supplement the MGSC.

(c) Work Package Contracts, which provide authorisation for the service provider to deliver certain works, usually specified in a Work Order, and supplement the MGSC and Service Contracts.

4.19 The relevant Service Contract for the work carried out to Tower 130 is the Regional Service Contract for RSA1 between Transpower and Omexom (**RSC1**).

4.20 The MGSC contains several key controls in relation to work contracted to the service providers, which apply to work performed under Regional Service Contracts, Specialist Service Contracts and Work Orders. In particular, the service providers must:

(a) Use all due skill and care, and comply with 'good industry practice', in the course of their activities.

(b) Have suitably trained experienced and certified personnel.

(c) Maintain certain quality standards and have appropriate quality assurance (**QA**) systems in place.

(d) Comply with all Transpower performance requirements (such as technical standards, procedures and Service Specifications).

(e) Supply audits and reports on their services and grant Transpower full access to conduct compliance audits.

(f) Meet all health and safety requirements.

4.21 Transpower can request reporting and audit information to ensure compliance from service providers.

4.22 Details of the contract arrangements between Transpower and Omexom are in **Appendix D**.

How Transpower oversees field work, including foundation baseplate work

4.23 The MGSC between Transpower and its service providers sets out several key controls for Transpower to review the quality of the field work of contractors. The controls include preparation of Service Specifications documentation that service providers must meet, proactive contract management, audits, and imposing competency requirements.

4.24 The relevant structure of responsibilities within Transpower for managing its contractual relationship with Omexom is as follows:

(a) Transpower has Regional Service Mangers (**RSM**s). RSMs are focused on contract performance and overall issues with the services of the service provider in their region.

(b) Service Performance Managers (**SPM**s) and Service Delivery Managers (**SDM**s) are allocated to each RSA.

(a) SPMs are responsible for service provider contract performance and manage both lines and stations work.

(b) SDMs are responsible for delivery of the work, particularly focusing on defects work and work arising out of CAs performed by the service providers. SDMs are responsible for either lines or stations work.

(c) RSMs, SPMs and SDMs attend regular operational meetings with service providers. RSMs also meet quarterly with the management team of the service providers to go over safety, training plans and Key Performance Indicators. RSMs, SPMs and SDMs all spend time physically on site to observe service providers' work as part of their role.

(d) Transpower has a quality and compliance team responsible for quality audits of service providers' work. The team is managed by a Quality and Compliance Manager (**QCM**). Three full-time quality practitioners report to the QCM, together with several contractors. Prior to April 2024, only contractors carried out quality audits. Additionally, Transpower has a team of three health and safety practitioners who are primarily responsible for providing assurance and verifying that Transpower's critical risk controls are 'in place' with the service providers, as well as performing a variety of site-based activities including safety observations and conversations.

4.25 The detailed requirements for work on the National Grid are set out in controlled documents maintained by Transpower. There are different types of controlled documents, all of which constitute performance requirements (under the MGSC) for the service providers. Relevant controlled documents include:

(a) **Service Specifications (TP.SS)**: specifications for how work is to be carried out. This includes specifications for:

(a) Reporting by Service Providers, Contractors and Consultants (TP.SS 01.01).

(b) Minimum Training and Competency Requirements for Transpower Field Work (TP.SS 06.25).

(c) Asset Maintenance Requirements (TP.SS 02.98).

(d) Maintenance and Construction of Steel Towers and Tower Foundations (TP.SS 02.11).

(b) **Design Standards (TP.DL):** standards that define requirements for design and evaluation of components of the National Grid.

(c) **Technical Engineering Drawings (TE):** engineering drawings describing the outcomes Transpower requires to be achieved for work on its network. The drawings may include some details of the process to be followed.

(d) **Standard Maintenance Procedures (SMP):** approved procedures for certain maintenance work, primarily preventative maintenance activity (which includes servicing, inspections and condition assessments). Not all procedures a service provider may be required to carry out are the subject of SMPs, which are typically reserved for the most high-volume work types.

4.26 The key requirements relating to competency of service provider personnel undertaking work on the National Grid are:

(a) Service providers are responsible for determining the competency of their personnel and issuing them with competency certificates (a certificate endorsed by an employer defining functions an employee is competent to undertake).

(b) Service providers must only use suitably trained and experienced personnel who meet the requirements of TP.SS 06.25 Minimum Training and Competency Requirements for Transpower Field Work (**TP.SS 06.25**).

(c) In particular, for work at sites outside controlled or restricted areas the minimum requirements set by TP.SS 06.25 are:[13]

(a) Site-specific induction.

(b) Relevant work task competencies and competency certificate.

(c) Prescribed Electrical Work registered or employer licence as applicable.

(d) Supervision by a competent person (supervision may be direct or indirect depending on individual's competencies and level of risk).

(e) Work site safety plan and hazard briefing by competent person.

(d) Paragraph 5.1 of TP.SS 06.25 specifies that competency certificates must be issued by service providers to workers for the work they are competent to perform:

[13] TP.SS 06.25 Minimum Training and Competency requirements for Transpower field work, Issue 11, December 2022, at 2.2 (p 12).

(a) Following satisfactory completion of training as endorsed by an approved trainer, or

(b) Following satisfactory completion of refresher training, or

(c) When an employee commences work with a new employer and following satisfactory completion of appropriate refresher training.

(d) And when the worker has undergone sufficient experience in the discipline (under supervision) that demonstrates to the employer the competency certificate should be issued.

Those certificates are valid for a maximum of two years.

(e) TP.SS 06.25 also refers to Grid Skills training, with Grid Skills being Transpower's owned and operated training establishment which provides core industry training. The Grid Skills Line Training and Competency Pathways include the 'Foundations' pathway. TP.SS 06.25 sets a frequency for refresher training for certain competencies and pathways; there is no specified frequency for refresher foundations training.

4.27 Key audit control mechanisms of service provider work under the MGSC are:

(a) QA documents: under the MGSC, service providers must maintain QA systems.[14] The QA documents to be produced are two-fold: work information in Maximo, and 'before' and 'after' photographs in a photo library system called Recollect.

In relation to PDM-L work that is part of a work programme, 'before' and 'after' photographs and Maximo information are generally provided to Transpower after completion of an individual site. However, 'during' photographs are generally provided by the service provider to Transpower on request at the end of the PDM-L work programme, rather than after each individual job is completed.

(b) Service providers' self-audits: Service providers must carry out a programme of self-audits every year and submit their self-audits to Transpower in advance.[15] Transpower's Quality and Compliance team works with service providers to help target certain areas for self-audit, based on the work plan. Service providers report audit outcomes.[16]

(c) Transpower audits of service providers: Transpower has the right to audit service provider compliance with the MGSC at its discretion.[17] In practice, Transpower carries out several different audits including:

14 MGSC, Cl 3.1(g).
15 MGSC, Cl 7.1
16 MGSC, Cl 7.1
17 MGSC, Cl 7.2

(a) Quality audits in the field: The Quality and Compliance team identifies areas it wishes to audit based on the upcoming year's work plan and learnings from prior years, and creates an audit programme. A field audit generally involves a site visit, before which the auditor will review information available in Maximo. On site, the auditor will generally review all relevant service provider documentation, including site hazards and the work procedure. QA audit findings are shared internally with the RSA and other teams monthly. They are also shared monthly with the service providers. All non-compliances or opportunities for improvement are identified and issued to the provider for action.

(b) Management systems audit: Transpower audits the service providers' management systems every two years to verify service providers are able to deliver on their contractual obligations including competency and subcontract management.

(c) Other targeted audits: Various other sub-system or process audits, for example audits of competency management tools.

(d) Meetings: The MGSC requires Transpower and service providers to attend several meetings, including to discuss safety and QA. Those meetings include:[18]

(a) Relationship management meetings held quarterly (and at an executive level, six monthly) to discuss overall performance.

(b) QA meetings held quarterly to review progress to plan, findings, themes, and actions related to audit findings in relation to both the service providers' self-audit plan and Transpower's assurance programme or investigations.

(c) Meetings to discuss health and safety, including a Central Safety Leadership Team meeting every four months, and a Health and Safety Alignment Forum, held quarterly.

Transpower Grid Skills training for field work

4.28 Through its Grid Skills business, Transpower provides technical training for people working on transmission and distribution lines. Grid Skills (previously known as Transpower Training) was established in 2014. The rebranding to Grid Skills was to better reflect the specialised training and development programmes offered to support the National Grid.

4.29 Grid Skills is NZQA Category 1 registered and accredited, and several of its programmes can lead to a national qualification. Each training course relates to

[18] MGSC, Sch 3.

a particular subject matter and includes different learning and assessment activities.

4.30 Attendees are mainly people from transmission, distribution and service provider businesses; costs are met by attendees. Omexom staff have completed a variety of Grid Skills courses over the years and are involved as trainers of some of the courses.

4.31 Several courses touch on matters related to construction and maintenance of towers. The three-day Foundations block course (available until April 2023, when replaced by three online elearning modules[19]) ran once in 2019 and twice in 2021. From May 2023 courses relating to foundations have only been available online.

4.32 The Foundations course comprises a course (residential block course before May 2023 and from May 2023 e-learning modules) and an on-the-job assessment. The course content comprised the following:

(a) Until May 2023, the following topics were covered by the lesson plan: tower foundation types; foundation life expectancy; foundation condition assessment; assessment of steel structures and components; rigging; conducts excavation; painting steel; managing foundation concrete pour site reinstatement; anchor bolt refurbishment, and stub leg refurbishment. The lesson plan included several practical activities and assessments.[20]

(b) From May 2023: the course was split into three self-paced training and assessment elearning modules: Working on Transmission Structures, Safe Working, and Climbing and Rescues.[21]

4.33 Both before and after May 2023, learners were also provided with a Foundations Workbook (unchanged since November 2018),[22] although the workbook is noted as optional on the May 2023 Foundations course overview. The workbook covers the same topics as those in the lesson plan for the block course offered up until May 2023, listed above.[23]

4.34 Until May 2023, learners needed to complete nine Transmission Lines 1 (TL1) e-learning modules (including Transmission Lines and Equipment (TLE) and

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19 From May 2023 learners complete the self-paced training link to on-job training for the practical aspects of the training to prepare them to complete the on-job assessment under the supervision of a service provider technical expert (for whom assessment materials are provided by Grid Skills).

20 Foundations Lesson Plan, February 2019, Version 1.0.

21 Foundations Course (current version from 21/04/2023).

22 Foundations Workbook, November 2018, Version 1.1.

23 Except for Anchor bolt refurbishment and Stub leg refurbishment which are covered in the lesson plan but are not topics in the Foundations Workbook.

Introduction to Electrical Theory) and a TL1 assessment as a pre-requisite to the Foundations course.[24]

4.35 There are other courses relevant to tower foundations which are part of a broader curriculum. For example, the Grid Skills Transmission Line Mechanic Course covers topics such as rigging and load limits, and replacement of tower structures, and the Grid Skills Tower Structure Maintenance Course covers tower maintenance.[25]

Baseplate refurbishment work and the Transpower requirements that apply

4.36 Baseplate refurbishment work on concrete foundations can involve a range of activities and methodologies, depending on the condition of the baseplate at the time refurbishment is undertaken. However, the work will invariably involve:

(a) Removing the nuts and washers on top of the baseplate.

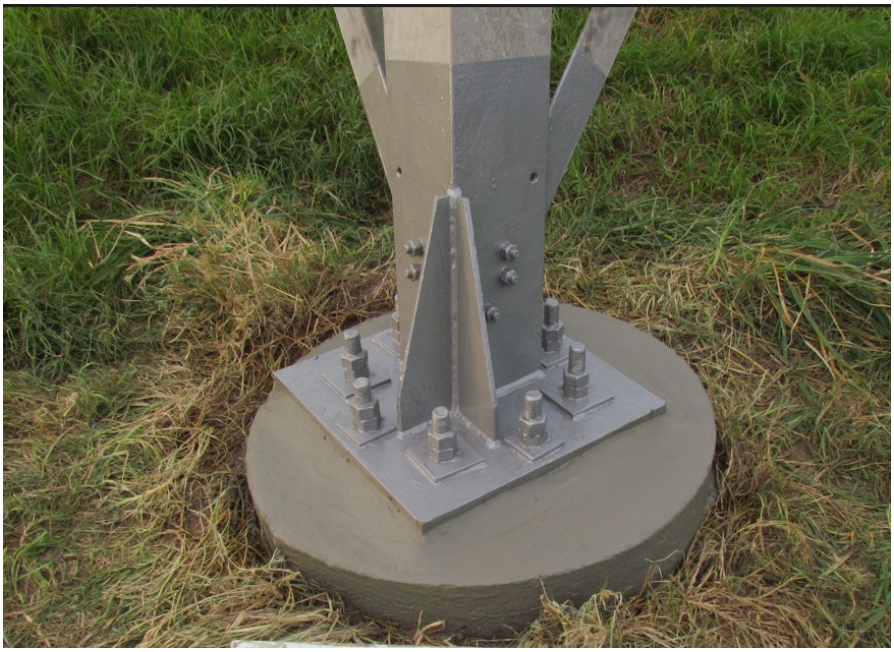
(b) Inspecting the bolts and baseplate holes for signs of corrosion.

(c) Preparing the steel surfaces by blasting and cleaning exposed surfaces, using sealant and applying a protective coating.

4.37 A necessary step in this process involves removing the nuts that sit over the baseplates so they can be checked for signs of corrosion and refurbished or, if necessary, replaced. The grout beneath the baseplate is sometimes removed as part of the refurbishment process, to refurbish the bolts and nuts underneath the baseplate, depending on the condition of the grout observed during the work.[26]

4.38 Below is an example of a completed refurbished baseplate:

[24] Foundations Course (previous version – ending 21/04/2023).
[25] TLM_TSM Course Information.
[26] Transpower drawings TE37252.



Refurbished baseplate

4.39 Transpower's requirements for baseplate refurbishment are found in specification standards TP.SS 02.98, TP.SS 02.11 and in drawings TE37252. TP.SS 02.12 is also relevant, relating to the application of protective coating as part of baseplate refurbishment. Drawing TE37252 is Transpower's most detailed information published about baseplate refurbishment; a copy is in **Appendix E** (and see paragraph 4.41(c) below).

4.40 There is no Transpower Standard Maintenance Procedure (**SMP**) for this type of work. It was reported that an SMP number was allocated several years ago for a maintenance procedure for baseplate foundation refurbishment, but was not progressed. this appears to be because the work was not considered sufficiently 'standard' to be the subject of a SMP.

4.41 The requirements applying to this type of work are:

(a) Transpower Service Specification TP.SS 02.98 outlines the maintenance requirements for lines. It refers to TP.SS 02.11 for the maintenance requirements for steel towers and foundations specifically.[27]

(b) TP.SS 02.11 has more detailed requirements about the maintenance of steel towers and their foundations. These include that maintenance of foundations is designed for site-specific loads and conditions, foundation stability during maintenance must not be comprised, and loads need to be determined to ensure stability.

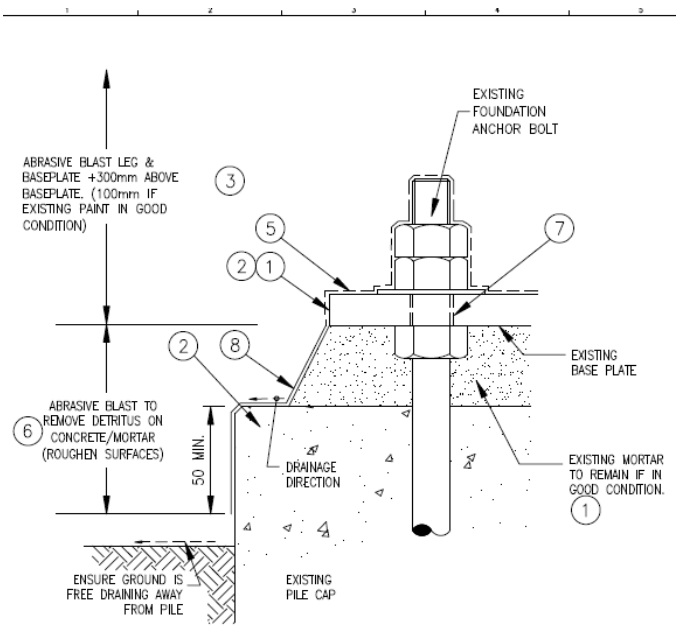
[27] TP.SS 02.09 Transmission Lines Asset Maintenance Requirements, Issue 2.2, November 2023, at 7.2 (p 30).

Several Transpower personnel interviewed took that requirement to mean that an engineering assessment should be obtained by service providers before undertaking baseplate refurbishment work (although there were differing views on whether this was required in all cases or only for certain tower types or if removing more than a certain number of nuts at once).[28] The key relevant section in TP.SS 02.11, Appendix C, at C4 'Foundation stability during maintenance repair' is:

> C4.1 Foundation stability during maintenance repair work shall not be compromised.
>
> C4.2 Maintenance and repair of foundations may reduce the load capacity of the foundation and consequently the stability of the tower. Tower loads need to be determined so as not to compromise the stability of the tower.
>
> C4.3 All designs shall be based on **TP.DL 12.01** and submitted to Transpower for approval.

(c) Drawings TE37252: Transpower drawings for tower baseplate refurbishment, referred to in TP.SS 02.11. There are six drawings for different types of repairs and maintenance. Service providers are responsible for determining which of the drawings are to be followed, based on the condition of the baseplate on the day. The Tower 130 work being carried out at the time of the Incident was of 'Type 1 – existing mortar in good condition protective coating'. The drawings for Type 1 contain the following diagram of the foundation and notes relevant to nuts (taken from TE37252):

[28] It is recorded that Omexom does not consider it to be clear that an engineering assessment was required. Omexom's procedure is discussed later in sections 6 and 8.



TYPE 1 – EXISTING MORTAR IN GOOD CONDITION

1. Check baseplate/grout interface for signs of rust. Remove nuts and washers to check for rust due to water ingress…

…

3.2 Prepare base plate steel: removing top nuts and washers to inspect bolt holes in the baseplate for signs of corrosion, removing debris, and then abrasive blasting and cleaning all exposed steel surfaces.

…

5. Fill baseplate bolt holts (around bolts) with Silkaflex-MS sealant. Replace nuts and washer then tighten (snug Tight + ¼ turn).

(d) TP.DL 12.01 – Transmission Line Loading Code Design Standard, also referred to in TP.SS 02.11, which defines the structural loading to be adopted for the design, evaluation and utilisation of transmission line components including foundations for existing assets.[29] In particular, Section 5.4 requires the structural suitability of existing supports to be ensured during construction and maintenance operations, to reflect that loss or reduction of component capacity which might arise due to performance of the works. For construction and maintenance works where components can be restored within one week of commencement,

[29] Transpower DL 12.01 Transmission Line Loading Code Design Standard, Issue 6.1, February 2021, at 1.1 (p 5).

the default climatic conditions and coincident temperatures to be used for assessment are set out in Table 14, extracted below.[30]

Table 14 Construction & Maintenance Loading and Capacity Criteria

Planned Duration of Works	Wind Only Loads *1	Ice / Snow & wind loads
CM1 **Duration < 1 week** **(General works)**	Everyday wind **100 Pa** SRF = **1.0** Temperature t_{cm} = **5 °C** *1 $\Phi_C.\Phi_T$ = **0.5**	Not applicable (subject to season)

4.42 Neither the specifications nor the drawings indicate or specify how many nuts are to be removed from the baseplate at the same time or in what order, during refurbishment. That detail is left to the contractor's procedure and judgement, to be developed in accordance with the general requirements that tower loads need to be determined and managed so as not to compromise the stability of the tower during maintenance activities.

4.43 It was noted that Transpower's specification standards and drawings are considered to be primarily outcome driven: they specify the outcome service providers are to achieve, rather than the process to carry out the task. Service providers are to design the details of a procedure which will deliver a compliant outcome.

4.44 There are some notes provided within the specification standards and drawings which provide additional detail for some aspects of the procedure a service provider should design. The notes in the TE37252 drawings describe steps a service provider should undertake for a Type 1 refurbishment, but are not a complete description of what is required to be done.

4.45 A service provider is required to develop specific work procedures for this work, including general procedures, task specific procedures covering foundations, and health and safety procedures.[31] These procedures are part of the documentation that Omexom personnel were required to have on the Tower 130 site (and available for audit).

4.46 While the service provider's procedure must comply with Transpower's specifications, Transpower does not approve, or routinely access, service provider procedures (although it has powers to request such procedures). They are reviewed during field work audits or where a procedure audit is specifically requested by Transpower.

4.47 Finally, service providers must also comply with all Transpower performance requirements, as set out in the MGSC. In addition to the specific requirements regarding baseplate foundation work noted above, there are other more general

30 Transpower DL 12.01 Transmission Line Loading Code Design Standard, Issue 6.1, February 2021, at 1.1, at 5.4.1 and 5.4.2 (p 19-20) and Table 14 (p 51).

31 As required by TP. SS 02.11, Appendix A.

specification standards and procedures that apply to field work, such as TP.SS 06.25 Minimum Training and Competency Requirements for Transpower Field work.

5 Omexom's history as a Transpower service provider

Background to Omexom

5.1 Omexom is a VINCI Energies brand, which was launched in 2000. VINCI Energies is a global company in the energy sector with 1,900 business units operating in 39 countries worldwide. Its history dates back to 1817, when its oldest company was founded in France. VINCI Energies has four internal brands focusing on different business functions, with Omexom focusing on infrastructure.

5.2 VINCI Energies acquired Electrix (now trading as Omexom New Zealand) in 2014. Prior to that, Electrix had been in business in New Zealand since 1955. Omexom New Zealand offers engineering, construction and maintenance services to asset owners across gas, transmission, substations, distribution and infrastructure. It has over 1,000 employees in 29 New Zealand locations nationwide and has long-standing relationships with Vector, Auckland Transport, and Firstgas, as well as Transpower.[32]

5.3 Omexom is Transpower's longest standing contractor, with a relationship dating back 30 years. Transpower also engages Northpower, Ventia and Downer as service providers. Omexom has one of the largest shares of Transpower's service provider work, being the contracted provider for RSA1, RSA6 as well as specialist service contracts. It carries out around 40 per cent of Transpower's service provider work, including its most complex work. Information provided indicates that Omexom has been instrumental in developing new transmission lines work techniques, such as the catenary support system now used for building and maintaining high voltage circuits which cross infrastructure such as highways and railways.

Quality of work and comparison with other providers

5.4 Transpower staff interviewed for this Investigation generally regarded Omexom as being at least equal to its other services providers in delivering quality work. No specific issues with Omexom's performance in relation to baseplate refurbishment had been identified prior to the Incident. Specific feedback provided is as follows.

(a) The upper North Island RSM stated:

(a) She was not aware of any major issues with Omexom in the last seven months since she became an RSM, nor had she received any reports from the SDMs or SPM regarding quality issues.

[32] This material has been taken from publicly available sources.

(b) Her general observation from site visits was that Omexom were following procedures and had good site practices.

(c) Each of the service providers in her region, Omexom and Northpower, had their strengths and weaknesses, relative to each other.

(b) The SDM for RSA1 (lines), whose responsibility for the last five years was Omexom's work and who regularly carries out site visits, noted he had not experienced any quality issues with Omexom's work and had held a high level of confidence in its CAs, defect identification and maintenance work.

(c) The SPM for RSA1 (who is relatively new to the role) noted that in her experience, including from site observations, the Omexom crews were good and appeared cautious about safety.

(d) The Executive General Manager Grid Delivery said he believed Omexom to have the widest capabilities of Transpower's service providers.

(e) The Quality and Compliance Manager stated he considered that Omexom's systems, documentation and ability to take on board feedback were as good as other service providers, and sometimes better. However, there were inconsistencies between RSA1 and RSA6.

(f) A Quality Practitioner was of the view that, overall, Omexom are the same as other providers in terms of quality audits, each provider being better or worse in different aspects.

(g) The Head of Health and Safety, based on a review of safety and critical risks audits over the last few years, considered that Omexom has very good practices and, as one of the largest providers, undergoes a substantial amount of audits. She said Omexom's incident rate is low considering the amount and complexity of work they do. She also noted that Omexom is very honest about its work and its reporting is very good compared to others.

5.5 None of the Transpower staff interviewed had observed baseplate refurbishment work performed by Omexom in RSA1 in 2023 or 2024.

Audit performance and prior incidents

5.6 On 27 March 2024 Transpower undertook an audit of Omexom baseplate refurbishment work in RSA6. The audit was carried out by a former lines mechanic with over 40 years' experience. The reporting letter (to Omexom) noted the audit was compliant and stated:

> A strong performance by [name of employee] and [name of employee] on site and pleased with the overall management of the foundation work by [name of Manager] who is very supportive of the team but also

encouraging to hear of her plans for the new seasons work to further improve QA, procedures and staffing.

5.7 The more detailed audit report repeated similar sentiments and noted the high standard of workmanship by the team. Some areas for improvement were noted, including that the QA documentation and work procedure needed to be adjusted to align with a new Transpower drawing.[33] (This did not concern nut removal from foundation bolts). The auditor was interviewed as part of this Investigation and confirmed that, on the site audited, only half the bolts had nuts removed on each foundation leg at any one time.[34] The auditor stated that if he had observed all the nuts being removed from a baseplate at once, he would have questioned the practice.

5.8 A Health and Safety Management System Audit Report was conducted on 17 August 2023 as a desktop audit. The report noted all policies, procedures and processes in place were well documented and regularly reviewed, and there were no non-compliances or identified opportunities for improvement.[35]

Quality Assurance documents

5.9 Prior to the Incident, the following QA records of baseplate refurbishment work undertaken by Omexom in RSA1 were available to Transpower:

(a) Information completed in Maximo.

(b) 'Before' and 'after' photographs for each site uploaded to Recollect.[36]

(c) QA forms[37] for each job, if/when uplifted from the service provider.

5.10 The information available in those records is focused on the outcome of the work (such as paint thickness, steps completed, condition of the concrete and baseplates), rather than the work method and process followed during the work.

5.11 There was nothing in the QA records (including the photographs provided by Omexom) for RSA1 received by Transpower for baseplate refurbishment work completed by Omexom which indicated, or would have led a reader to a conclusion, that more nuts were removed during a refurbishment than was prudent or required to meet 'good industry practice'.

5.12 The 'during' photographs are not provided by Omexom to Transpower as a matter of course after completion of individual jobs. They are provided at the

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33 See 11839 INV-ROX-B0133 Base plate refurbishment OMX Omexom RSC6 Compliance Letter and CAR_Audit_No11839.

34 Something a work methodology document used in RSA6 permitted; this matter is commented on later in the report.

35 See Omexom final report August 2023.

36 Omexom also takes and retains photographs during the course of the work ("during" photographs).

37 An example of the Omexom QA form for a baseplate job is in **Appendix H**.

end of the work programme, if requested by the SDM or as a result of an audit. As the work programme of baseplate refurbishment in RSA1 in FY23 and FY24 was ongoing at the time of the Incident, Transpower had not yet requested or seen the 'during' photos.

5.13 Following the Incident, Transpower requested 'during' photographs from Omexom for its baseplate work in 2023 and 2024, which show the refurbishment work in progress at the various sites. Those photographs show a work practice of removing all nuts from one tower leg at a time had been employed earlier in RSA1 at least since October 2023.

PART B: INCIDENT – WHAT HAPPENED

6 Baseplate refurbishment work on Tower 130

How the work was planned and scheduled

6.1 A CA of Tower 130 was carried out on 2 March 2021 by Northpower, the service provider for the region at the time. This assessed the condition of each tower leg and the interface of the foundations with the legs. Two tower legs were assessed as CA 70; two as CA 50. The intervention threshold is CA 50 (CA 100 being the best score and CA 0 the lowest score). It was also identified that soil was covering some of the baseplates.[38] This is a defect as soil coverage can increase corrosion of the baseplate.

6.2 As a result, Transpower programmed two activities for Tower 130, to remove the soil covering of some of the legs of the baseplate and refurbish the baseplates of each tower leg.

6.3 The work was programmed initially for completion in the financial year ended 30 June 2023 as part of a wider package of refurbishment of RSA1 baseplate foundations works. Work Orders were issued on 16 September 2021[39] for the programme.

6.4 Omexom completed baseplate refurbishments on 24 towers in RSA1 between September and December 2023, and four in June 2024 (excluding Tower 130).[40]

6.5 The work for Tower 130 was created by Work Order form number 9069621 (**WO 9069621**) issued in Maximo[41] with the title TL Foundation Non-Grillage Interface Refurbishment, work type PDM-L.

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38 Maximo CA screenshots.

39 The work orders were originally issued to Northpower in September 2021 for completion in the financial year ended 30 June 2023 and then cancelled and assigned (by new work orders) to Omexom when the service provider contract changes occurred in 2022.

40 Based on photographs provided by Omexom "Before, during and after photos for all Omexom foundations baseplate jobs undertaken nationally this year or last year", folder titled "RSA1". However, Transpower's records indicated 26 jobs had been completed by Omexom in 23/24.

6.6 The long description in WO 9069621 was:

> Anchor Bolt / Base Plate foundation interface refurbishment to Transpower Service Spec TP.SS.02.11 & Standard Drawing TE37252. The Transpower Delivery Manager and Asset Planning are to be notified of works completion or where a decision to delay or cancel the works has been made. Service providor [sic] to ensure Maximo data fields and work status is updated by 30th June 2023.

6.7 As the description reflects, timing of delivery of the works was subject to uncertainty. In the event, the works were not undertaken in FY23 and the works were rescheduled. The planning and scheduling manager indicated the work had been rescheduled due to service provider resourcing constraints brought about by Cyclone Gabrielle. The work was to be carried out within a two-year window of being first scheduled FY22 (therefore to be completed by the end of the 2024 financial year), which was within the timeframe the Transpower asset planning team expected it would be completed.

How the work was to be undertaken

6.8 Transpower's requirements for the work on Tower 130 are set out in the MGSC (the contract governing all activities carried out by Omexom pursuant to an RSC or Work Order), RSC1 (the contract governing specifically the in-scope services in RSA1) and WO 9069621.

6.9 In this case WO 9069621 expressly referred to Transpower specification standard TP.SS 02.11 and Drawing TE37252. The drawings in turn refer to Transpower specification standard TP.SS 02.12 (refer to paragraphs 4.36-4.47 above regarding how baseplate refurbishment work is expected to be carried out in accordance with those standards).

6.10 Any other Transpower specification standards applicable to the work were also to be followed, whether or not referred to in the Work Order. This included TP.SS 06.25 (relating to the minimum competency of Omexom staff: refer to paragraph 4.26 above regarding the competency requirements under that standard).

What happened on site on 19 and 20 June 2024

6.11 The Omexom RSA1 civil works crew attended the site of Tower 130 on 19 and 20 June 2024 to carry out the baseplate refurbishment work, as part of a programme of baseplate refurbishment work that had commenced in RSA1 in September 2023.

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[41] Maximo is Transpower's asset management system, included in which is a scheduling and work order system accessible by service providers.

The Omexom team

6.12 The civil works crew comprised a Team Leader and two Trade Assistants (so called by Omexom).

6.13 The Team Leader was experienced in transmission lines and civil works and had been working on Transpower contract works for more than 10 years in two periods of employment with Omexom. In the first period, he had completed several Grid Skills courses including line mechanic courses and the Foundations block course (in person).

6.14 After leaving Omexom for a short stint in Australia, he re-joined Omexom as a lineman in May 2023 with a view to becoming a team leader in the civil works team after undergoing a period of supervision. In October 2023, he became a team leader for the civil works foundations crew.

6.15 He carried out 28 baseplate refurbishment jobs between 11 September 2023 and 18 June 2024. The first 18 jobs were under the direct supervision of an Omexom supervisor (**Supervisor**) who was part of the make-up of the crew for those jobs. The Supervisor was part of the crew on site for five more jobs in December 2023. There were no baseplate refurbishments undertaken in RSA1 in the first five months of the year.

6.16 Information gather during the Investigation makes it clear, the Team Leader is well regarded by Omexom.

6.17 The Trade Assistants were less experienced. One Trade Assistant (**TA1**) had joined Omexom in May and went immediately into foundations work after his induction training. His first baseplate refurbishment job for Omexom was on 4 June 2024, the first of four such jobs in June before Tower 130. He had worked in the electricity industry before (overseas) but had no prior experience of foundations refurbishment work. The third team member (**TA2**) joined Omexom nine months before the Incident and had worked on 22 baseplate refurbishments since 4 October 2023.[42]

6.18 Neither Trade Assistant had completed any Grid Skills training for carrying out foundations work. Their knowledge and experience of refurbishment work appears to only have been what they gained on the job.

Omexom procedure

6.19 The Omexom written procedure applicable to baseplate refurbishment used in RSA1 is set out in an Omexom procedure document (ELP-T414, Issue 5, dated 18 August 2022) included at **Appendix J**. It contains a method for baseplate refurbishment, involving the following steps:

[42] Omexom data shows its civil works team carried out 24 baseplate refurbishment jobs between 11 September 2023 and 15 December 2023, and 4 between 4 June 2024 and 18 June 2024 (excluding Tower 130).

(a) Prepare baseplate, including:

(a) "Remove hold down nuts and washers. Sand blast anchor bolt voids, bolt threads, nuts and washers if corrosion is present."

(b) "Apply sealant (Sikaflex AT Façade or similar approved sealant) to bolt voids and either side of the washer and nuts so that sealant oozes out as the nut is tightened. Nuts should be tightened until snug plus 1 quarter turn."

(One of the photographs under this step shows two of three nuts taken off a tower leg).

(b) Paint steel.

(c) Install new grout under baseplate.

(d) Minor pile cap damage (if required) (and consequential steps).

(e) Clean and reinstate site.

6.20 All Transpower drawings, including Standard Drawing TE37252, were available to the Omexom team on an Omexom tablet and referred to periodically during the work programme. It was reported that no engineering advice was provided to the team or sought by it for any of the jobs they carried out.

6.21 The Omexom procedure does not specify the number of hold-down nuts and lock nuts (the two types of nuts above the baseplate; these can be seen in the TE37252 drawing at 4.41(c) above) to be removed at any one time. The Omexom Supervisor (who had trained the Team Leader and was on site with the RSA1 civil crew for baseplate refurbishment jobs in 2023) reported that the Omexom practice in RSA1 was to remove all nuts above the baseplate from one leg at a time. He said that removing all nuts from one leg was how he was trained, and this was the standard procedure which Omexom had followed before and after the 2022 contract rearrangements.[43]

6.22 At Tower 130 the team departed from that standard practice. This departure is described in the following paragraphs, as reported by the team members and from what can be gleaned from photographic records.

The work undertaken

6.23 On 19 June 2024, work commenced on Leg D of Tower 130. All nuts were removed from the bolts on Leg D, and sandblasting was completed. The work was interrupted by weather and finished early. All tower leg nuts were

[43] In the 2022 changes Omexom took on RAS1 – essentially, North Auckland and Northland – in lieu of what was NL2, an area running from South Auckland to Taupo.

reattached overnight. The following photograph[44] is of Leg D, with what appears to be all nuts removed, evidently before the end of work for the day.

Tower 130 Leg D

6.24 For the second day of Tower 130 work, TA1 was assigned the task of baseplate nut removal, after he completed some digging work on Leg C. This was the first time he had undertaken the task by himself without working directly with the Team Leader. The leg nuts had to be inspected (for rust) and prepared for sandblasting. Normally, the nuts would have been placed onto a purpose-built metal frame to facilitate blasting. This frame was not available for the Tower 130 work, so the nuts were assembled on a string attached to the tower steel frame to undergo sandblasting. This can be seen in Photograph B.11 in Attachment B to the Beca report.

6.25 The Team Leader operated the sandblasting equipment and was in a protective suit and visor, required to be worn when carrying out sandblasting. The Supervisor told me the suit and visor make it difficult to see what other team members are doing on site, and hearing from external sources is difficult. Consequently, the Team Leader's ability to observe TA1's work was likely to be limited. TA2 was managing the sandblaster hopper and the line feeding sand to the equipment operated by the Team Leader as well as a line from an air compressor to the suit.

6.26 The sandblasting work started on tower Leg A, blasting the available surfaces, including the nuts then still attached to the Leg A bolts. During this time TA1 finished the digging work on Leg C to expose the baseplate. When the sandblasting moved to Leg C, TA1 removed the nuts from Leg A (these were to

[44] The photograph was taken by the Omexom team as part of the QA process the company follows, described earlier in the report.

be separately sandblasted); all nuts were removed from each bolt - 16 nuts for each leg. The team's photograph recording the Leg A work (below), shows six bolts with nuts removed (it was reported that all nuts were removed).

Leg A showing six bolts with nuts removed

6.27 When sandblasting on Leg C was finished, TA1 moved to Leg C (diagonally opposite leg A) and removed the nuts. Sandblasting then moved on to Leg B and when that was finished TA1 removed nuts from Leg B. There is some uncertainty, as to whether all nuts above the baseplate were removed from Leg B.

6.28 The nuts removed were not replaced on the bolts from any of the three legs.

6.29 It was at this point in the operations that Tower 130 collapsed.

Engineering analysis of cause of the failure

6.30 Transpower engaged Beca to provide expert engineering support to this investigation. Beca were asked to:

(a) Carry out a site visit of Tower 130 and the site of the Incident.

(b) Undertake calculations and loading assessment to determine the tower load compared with capacity and confirm the failure mode of the structure.

6.31 Beca's report (in **Appendix F)** includes the following observations from site:

(a) There was no evidence of sabotage or corrosion to the steel tower.

(b) The Tower 130 foundations did not appear to have been disturbed, except for several washers and one nut being placed back on the holding down bolts of Leg B. As there was no obvious damage to the holding down bolts or baseplate of Leg B, these items must have been put back on the bolts after the tower had fallen.

(c) The holding down bolts of Legs A and B did not show any clear signs of damage, such as damaged bolt threads or bent bolts, that would indicate the nuts were still on when the tower fell. The baseplates of Legs A and B also had no clear damage. This implies that the nuts from these legs were taken off before the tower fell, allowing the baseplates to lift off the holding down bolts cleanly during the fall.

(d) All nuts had been removed from the holding down bolts of Leg C. The five holding down bolts on the eastern side of the footing were bent towards the west, with the bolt furthest to the east broken in two places. There was no obvious damage to the three bolts on the western side. None of the eight bolts showed damage to the threads that would be consistent with overloading of the nuts, which indicates the nuts were removed prior to the tower fall. The damage to the five eastern bolts is suspected to have occurred as the tower fell and the tower legs and baseplate lifted from the bolts.

(e) All nuts were in place on Leg D. The stub leg had ruptured immediately above the welded stiffeners connecting the leg angle and baseplate.

(f) Eight nuts and eight square washers were tied with a rope to a bracing member on Leg A. This shows that multiple nuts were removed at one time, however, it is unclear whether these are from one leg or multiple legs.

(g) When inspected by Beca, all nuts had been removed from Legs A, B and C (with one nut placed back on Leg B apparently post the tower fall). There was no obvious damage to holding down bolt threads that would be consistent with overloading of the nuts. This indicates that it is likely that the tower did not immediately fall as the nuts were being removed.

6.32 Beca have identified the cause of failure of Tower 130 as the removal of the nuts from Legs A and B.

6.33 Beca's report says:

(a) Loading on the tower occurs from the self-weight of the structure and conductor, tension loads from the conductors and wind pressure on the tower and conductors. As Tower 130 is an angle tower, the foundations situated on the outside of the deviation angle (Legs A and B) will encounter tension forces depending on the wind direction. The bolts and nuts connecting the baseplate to the foundation resist these forces, where necessary, by transferring them to the foundation when properly installed.

(b) Removing all nuts from the holding down bolts on Legs A and B effectively eliminated their tension capacity. This would not necessarily cause immediate collapse, as it will depend on the particular tension forces on the tower, in particular caused by the wind. Beca noted that on 20 June

2024, there was likely wind on site from an east north-east direction which would have reduced the tension forces on Legs A and B. However, if the wind dropped or changed direction, this would increase the unconstrained tension forces on the baseplate at each of Legs A and B.

(c) Unconstrained tension on Legs A and B will cause redistribution of forces within the tower structure. Beca conclude that the removal of the nuts from Legs A and B, which were intended to resist tension forces, compromised the stability of the tower, ultimately causing the tower to fall.

(d) To comply with the requirements of TP.DL 12.01 and TP.SS 02.11, a method should have been established to preserve the tension capacity in the tower legs. This could have been provided by either retaining an adequate number of nuts or implementing an alternative method to support tension, such as temporarily anchoring the leg to concrete blocks.

6.34 Beca's report concludes:

(a) That all nuts had been removed from the holding down bolts on Legs A, B, and C of Tower 130 prior to the tower fall, as shown by the absence of damage to the hold down bolts. Leg D was still fixed to the foundation but ruptured.

(b) Its analysis indicated that the removal of the nuts from Legs A and B, which were intended to resist tension forces, compromised the stability of the tower, which caused it to rupture, ultimately causing the tower to fall.

(c) The loading assessment and calculations undertaken show that Legs A and B had the potential for tension forces under the construction and maintenance load cases specified by Transpower standards, and therefore removing the tension capacity for these legs did not comply with the requirements of TP.SS 02.11.

6.35 Beca's description of the failure mechanism accorded with the explanation provided by all the experienced Transpower engineering and line service staff interviewed. Several interviewees commented that it was common sense that, for an angle tower holding a significant weight of conductor lines, removal of all nuts from the baseplate on the outer legs (Legs A and B) would cause the Tower to fall towards the angle of the lines.

Omexom procedure followed in previous RSA1 baseplate refurbishments

6.36 Interviews with the Omexom field staff involved in the Incident were difficult; the team members were very evidently significantly distressed by the Incident, especially so the Team Leader. They did their best to answer questions but there were questions they could not answer. They were willing to participate in the interviews and were not reluctant to answer questions, even when unable

to recall events on the day or about earlier refurbishment jobs they had been on. See more in section 8.

6.37 The team did their best to answer questions but for some they either could not provide answers or recall information needed to provide clear answers.

6.38 For this reason, it has not been possible to determine why the removal of nuts from more than one tower leg and, in the case of Tower 130, three tower legs, occurred. Nor has it been possible to determine exactly when the team had (prior to the Tower 130 work) begun removing nuts from more than one tower leg at a time.

6.39 However, on reviewing the information provided, it is more likely than not that nuts were removed from more than one tower leg at a time on baseplate refurbishments carried out in June 2024 before the work at Tower 130.

6.40 The following recollections were provided:

(a) The Team Leader said he had removed all nuts from a tower leg on earlier occasions but could not remember if he had done so on more than one leg at a time.

(b) TA1 could not recall what he was told to do in relation to nut removal on the day but described his approach to removing the nuts on Tower 130 "as just the usual process" and that it had been the sequence of work he had been shown on earlier jobs since he started work on baseplate refurbishment on 4 June 2024.

(c) TA2 said he had seen nuts being removed from tower legs at earlier jobs, but it was never his task to do that. On the day of the Incident, he saw TA1 taking the nuts off the first two tower legs (Legs A and C) but did not pay any attention to what TA1 was doing after that. He did not see the nuts from Leg B being removed. It did not occur to him that too many nuts might be being taken off. He also said he had previously seen towers with all nuts removed from two opposite tower legs, but not more than two legs at a time.

(d) A member of the lines team who also assists the RSA1 civil team with foundations work (who was not working on Tower 130 but had worked on the first two jobs in June at Towers 214 and 194 when TA1 joined the team)[45] (**TA3**) said he was trained by the Team Leader and the Supervisor to remove all nuts from one tower leg at a time. In fact, he said he had been specifically told not to touch the nuts on a second leg until nuts on the first leg were replaced. He had not observed nuts being removed from more than one leg at a time.

[45] On the first two jobs, Tower 214 and Tower 194, there were three people on site: the Team Leader, TA3 and TA1. At the next job, Tower 181, TA2 replaced TA3. As re-constituted, the team remained unchanged for work on towers 173 and 130.

(e) The Supervisor who oversaw several baseplate refurbishment jobs with the Team Leader, TA2 and TA3 in 2023[46] stated his practice was to remove all nuts from one leg at a time. He said this was the practice he had been trained in, and that he then instructed his team members to follow. The Supervisor had never seen all the nuts taken from more than one tower leg at a time.

6.41 Omexom's QA records are completed and signed out on a form called 'Base Plates Repairs/Refurbishments – Transpower AMIS and QA Records', recording the work completed and the condition of the foundations. Separately, 'before', 'during' and 'after' photographs are taken for each work site.

6.42 Prior to the incident, Transpower had not requested the 'during' photographs[47] for refurbishment work completed by Omexom in 2023 and 2024. After the Incident, the 'during' photographs were obtained.

6.43 These photographs have been reviewed. They tend to confirm the recollection of TA1 and TA2 that in RSA1 refurbishment jobs completed in June 2024, all of the nuts from more than one tower leg were removed (although generally at least one bolt is obscured in each photograph so it is not possible to be certain). The metadata obtained for these photographs indicates the time and date when the photographs were taken, and show:

(a) Tower 181: 17 June 2024. The photographs, taken between 4:04 pm and 4:28 pm on the day, show all nuts were removed from at least three of the four bolts on each of the four legs. Assuming accurate timings, this appears consistent with TA1 and TA2's recollection that nuts were removed from two legs at the same time on earlier towers. It is possible that some nuts might have been replaced in the interval between the times the photographs were taken.

(b) Tower 173: 18 June 2024. The photographs, taken between 1:42 pm and 1:51 pm on the day, show all nuts removed from at least three of the four bolts on each of the four legs. Assuming accurate timings, this appears consistent with TA1 and TA2's recollection that nuts were removed from two legs at the same time on earlier towers. It is possible that some nuts might have been replaced in the short interval between the times the photographs were taken.

6.44 The towers mentioned above are not angle towers and use only four bolts per leg. The only angle tower baseplate refurbishment carried out in June was Tower 194 on 6 and 7 June 2024. The photographs reviewed were taken over a longer time period than the two non-angle towers (181 and 173). From the photographs at Tower 194, nuts appear to have remained in place on at least

[46] The Supervisor was not on any of the sites in June 2024; his supervision activities of the team in June were office or yard based.

[47] Refer to the description of the QA process in section 5 and the retention of work site photographs.

some of the bolts for some of the legs. For example, the photograph below of Leg B after the application of silicone shows several nuts still in place.

Leg B after application of silicone shows several nuts still in place

6.45 The metadata for the photographs (below) of Legs D and C indicates the photographs were taken within two minutes of each other. For Leg D, the photograph appears to be taken after sandblasting and appears to show all nuts removed (one bolt is obscured). The Leg C photograph appears to be taken after silicone was applied and shows a similar number of nuts removed to Leg D. The photographs, assuming accurate timings, suggest Legs C and D had all or most of the nuts removed at the same time.

Photographs of Legs D and C taken within two minutes of each other

6.46 A similar analysis of photographs supplied for baseplate refurbishments shows practices in 2023 which are generally consistent with the Omexom standard practice of removing all nuts from bolts on one leg at a time. There are a small

number of instances where the timing of the photographs could suggest that nuts of multiple legs had been removed at the same time on baseplate refurbishments in RSA1, but the photographs are not definitive and no corroborating evidence of this was heard. To the contrary, the firm recollection of the Supervisor and TA3 was that this had not occurred while they were on site (note that neither of them attended the sites for the work on Tower 181 and 173 referred to above).

6.47 Ultimately, however, whether or not the team had developed a practice in June 2024 of taking nuts off more than one tower leg at a time, the uncontested fact remains that too many nuts were removed from the foundations of Tower 130, causing the tower to fall.

PART C: TRANSPOWER'S RESPONSE

7 Transpower's response to the Incident

Restoration of loss of supply

7.1 The key events from loss of supply to restoration were as follows:[48]

(a) On 20 June 2024 at 11:03 am, the Huapai-Marsden HPI_MDN_1 circuit tripped, causing losses of:

(a) Supply to Bream Bay (**BRB**) Kaikohe (**KOE**), Marsden (**MDN**) and Maungatapere (**MPE**) substations.

(b) ~159 MW of supply to Northland.

(c) Connection to Ngawha geothermal generation stations (**NGA/GNB**).

(b) The circuit tripping happened at a time when the second 220 kV circuit supplying the region, the BRB_HPI_1 220 kV circuit, was out of service for planned maintenance. System splits on the 110 kV circuits at Maungatapere were in place to mitigate potential overloading of the Henderson_Maungatapere 110 kV transmission circuits.

(c) At 11:17 am, a verbal Grid Emergency Notice was declared by the System Operator for loss of supply to the Bream Bay, Kaikohe, Marsden and Maungatapere substations. Restoration was initiated using its PR-CP-638/V3 – Northland Region via 110 kV Contingency Plan.

(d) The 110 kV bus at Maungatapere was livened at 11:38 am, supply at Bream Bay substation restored at 12:28 pm, and supply to Kaikohe

[48] Based on a Transpower-supplied spreadsheet titled "Northland LOS timeline 20 June 2024" and System operator preliminary report: Northland loss of supply, version 1.0, 5 July 2024.

substation restored at 12:47pm. By 12:47 pm, restricted supply was therefore restored to Bream Bay, Maungatapere and Kaikohe Substations.

(e) A written Grid Emergency Notice (in email form, as is standard practice) was published to industry participants at 2:41 pm, noting that while managed restoration of supply had occurred load restrictions were likely to be required at peak load times. The initial end time on the Grid Emergency was 21 June 2024 at 6:00 pm. The notice was subsequently revised, and the end time extended three times, up to 23 June 2024 at 4:00 pm.[49]

(f) On 23 June at 2:16 pm, the BRB_HPI_1 220 kV circuit into Northland was returned to service, enabling full restoration of supply to Northland shortly after, but leaving the region on N security. Shutting down Ngawha A and B generation was required at 2:00 pm to enable this reconnection. Meetings were held with Top Energy, Northpower, Ngawha Generation, Vector, the System Operator's National Coordination Centre (**NCC**) and system operator management to coordinate the restoration plan; local load reductions were required.

(g) On 26 June at 6:18 pm, the second 220 kV circuit (HPI_MDN_1 circuit) into Northland was restored via temporary pole structures (the three poles seen on the left in the cover photograph). N-1 security was thereby restored to Northland.

Incident management by Transpower

Incident Management Team and engagement of Omexom and Lumen for emergency response

7.2 Once Transpower was advised of the loss of supply, the Grid Owner rapidly established an incident management team (**GOIMT**) including representatives from communications, landowner and stakeholder liaison, health and safety, and engineering teams. The GOIMT provided guidance for the operational response to the Incident and restoration. It was led by the RSM.

7.3 Shortly after the loss of supply, the RSM received a call from the Grid Owner's national grid operations control centre (**NGOC**) advising of the loss of supply.

7.4 The RSM for the North Island was the Grid Owner's Incident Controller. He immediately advised the Executive General Manager Grid Delivery, who was also Transpower's Duty General Manager (**DGM**)[50] and overall company lead for the Incident, and the NGOC Duty Operations Manager, who became the Duty

[49] See **Appendix I**, System Operator preliminary report: Northland loss of supply, version 1.0, 5 July 2024.

[50] Duty GM duties were handed to another General Manager to allow the Executive General Manager Grid Delivery to concentrate on responding to the Incident.

Operations Manager for the Incident. The DGM had already received an automated message informing him of the loss of supply.

7.5 An Executive Incident Management Team (**EIMT**) was established by Transpower's Chief Executive, to provide high level guidance and support for all parts of Transpower, and to engage with stakeholders.

7.6 The GOIMT and EIMT met every few hours on 20 June 2024, with minutes taken at each meeting. The Grid Owner reported and provided updates to the EIMT.

7.7 The EIMT first met at 12:00 pm on 20 June. At that stage, the information received was that the tower had come down, with the conductors lying across State Highway 16. The DGM informed the EIMT there was an Omexom crew working on Tower 130 doing baseplate work and no one was injured.[51]

7.8 The first GOIMT meeting was at 1:00 pm, with the following points discussed:[52]

(a) Lindsey tower to be sourced from Bunnythorpe.

(b) Discussion held around running the 110 kV lines on N-security, with engineering review sought.

7.9 At the second EIMT meeting at 1:30 pm, the DGM reported the tower was down, but the conductor was not on the road and a team was on site to determine next steps to restore power.[53]

7.10 The focus of the immediate response was on ensuring no one was injured and getting a circuit back to supply power. Early in the response, Omexom, as service provider, was engaged under the Emergency Structure Contract (**ESC**) to respond to the Incident, and a Transpower-approved engineering consultant (Lumen) was engaged to design the required emergency structures.

7.11 Initially, several options were considered to restore supply, including standing-up the collapsed tower. This was quickly dismissed and by around 3.00 pm, Lumen consultants had been engaged to engineer and provide a design for erecting an emergency Lindsey tower.

7.12 Lindsey towers are temporary structures that can be rapidly erected to provide tower support for fallen circuits. Transpower had three Lindsey towers available in the North Island (others were already in use elsewhere, after other towers were damaged during Cyclone Gabrielle). These towers are stored in containers, ready for rapid deployment to an emergency site. Storing the Lindsey towers in containers and spreading them geographically is an approach established as a result of learnings from an incident some years earlier at Ruakura. In this case, the Lindsey tower arrived on site even before site access had been completed.

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51 Minutes of EIMT meeting on 20 June 2024 at 12:00 pm.

52 Northland event Grid IMT Situation report – full report, status update 1.

53 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.

7.13 The second GOIMT status meeting was at 3:00 pm and included discussion of:[54]

(a) Whether other grid asset works underway elsewhere could affect restoration activities and might need to be stopped.

(b) Conducting preliminary design of replacement tower and poles being delivered from Hamilton.

7.14 At the 3:30 pm EIMT meeting, the DGM reported that Lindsey towers and spare poles were on the way and engineers were on site determining next steps.[55]

7.15 At the 5:00 pm third GOIMT status meeting, the update included:[56]

(a) Updates from a meeting with engineers to discuss restoration options.

(b) Review of progress in assembling the requisites for erecting the Lindsey tower the next day (crane, traffic management, access weather, site engineering etc).

(c) Assessing other grid asset works which could affect restoration activities.

7.16 At the 5:30 pm EIMT Meeting, the DGM reported that a 7:00 pm engineering consultant meeting would consider matters related to erecting the Lindsey tower, whether concrete poles could be used to temporarily hold conductors up, the use of cranes on site and weather considerations. It was noted the existing tower had been damaged beyond repair.[57]

7.17 At 8:00 pm, the fourth GOIMT status meeting update included that the first 220 kV circuit was expected to be ready on 22 June and the crane and access were now ready.[58]

7.18 At the 8:30 pm EIMT meeting, the DGM reported that:[59]

(a) The team was mobilising the Lindsey towers and working on access tracks.

(b) The Lindsey tower was expected onsite around midday the following day. The engineering team would be working through the night.

7.19 The Lindsey tower design was delivered by Lumen around 11:37 pm.[60]

7.20 The next day, 21 June, the GOIMT met at 9:00 am, 11:00 am and 6:00 pm.

7.21 At the 11:30 am EIMT meeting, the RSM reported that:[61]

54 Northland event Grid IMT Situation report – full report, status update 2.
55 Minutes of EIMT meeting on 20 June 2024 at 3:30 pm.
56 Northland event Grid EIMT Situation report – full report, status update 3.
57 Minutes of EIMT meeting on 20 June 2024 at 5:30 pm.
58 Northland event Grid IMT Situation report – full report, status update 4.
59 Minutes of EIMT meeting on 20 June 2024 at 8:30 pm.
60 Northland event Grid IMT Situation report – full report, status update 5.
61 Minutes of EIMT meeting on 21 June 2024 at 11:30 am.

(a) The Lindsey tower was on track to arrive by midday (it arrived a little after midday).

(b) The plan was to undertake all enabling works that day (access tracks, concrete blocks) so the tower could be erected the next day.

7.22 By 6:30 pm, the DGM and RSM reported to the GOIMT that good progress had been made on site with the Lindsey tower then three quarters constructed and ready to be put up the next day.[62]

7.23 On 22 June, the GOIMT met at 11:30 am. The status update was that anchor locks (ground-based anchors to hold down the guy wires) were in place and the Lindsey tower was assembled, the crane was in lifting position and a meeting with landowners had been held.[63]

7.24 On 22 June 2024 at 12:00 pm, the DGM and RSM reported to the EIMT:

(a) The temporary tower was being raised and the crew were preparing for raising the conductors.

(b) Detailed designs were being completed for a pole option for the other circuit.[64]

7.25 At a 5:30 pm GOIMT meeting the update was that:[65]

(a) Deteriorating weather resulted in health and safety-related delay to work.

(b) Work was expected to be completed on 23 June.

(c) A decision had been made to use steel poles from the Otahuhu yard for the second circuit, instead of concrete poles.

7.26 A further update at 6:30 pm was that the Lindsey tower had gone up in the afternoon and the first phase circuit was completed.[66]

7.27 Erection of the Lindsey tower and poles are pictured below:

62 Minutes of EIMT meeting on 21 June 2024 at 6:30 pm.
63 Northland event Grid IMT Situation report – full report, status update 8.
64 Minutes of EIMT meeting on 22 June 2024 at 12:00 pm.
65 Northland event Grid IMT Situation report – full report, status update 9.
66 Minutes of EIMT meeting on 22 June 2024 at 6:00 pm.

Lindsey tower being erected

Temporary poles being erected

Three temporary poles erected

7.28 On 23 June 2024, at 10.30 am, the GOIMT status update included:[67]

(a) The team expecting the 220 kV circuit to be back in operation around 11:00 am (actually occurring at 02:16 pm).

(b) The engineering design for the second circuit was complete (with by-pass poles to be erected).

(c) The existing tower 130 would be cut into sections and removed from the position where the new poles would be set up.

(d) The Glorit community were supporting the team on the ground.

7.29 At 12:30 pm, the EIMT update was that the conductors were now in the air with circuits now available for the NGOC staff to authorise livening.[68] It was confirmed at the 6:30 pm EIMT meeting that the first circuit was back up.[69]

67 Northland event Grid IMT Situation report – full report, status update 10.

68 Minutes of EIMT meeting on 23 June 2024 at 12:30 pm.

69 Minutes of EIMT meeting on 23 June 2024 at 6:30 pm.

7.30 The minutes for the 6:30 pm EIMT meeting also note the following discussion point: "Omexom are our biggest contractor and usually most competent. Check on resourcing, supervisor level etc. Do we need to stand them down? Thought is no, they are still most competent and best with the complex jobs, done amazing work getting Lindsey etc. up."

7.31 Between 23 June and 26 June 2024, the GOIMT and EIMT met several times with the DGM and RSM providing updates about restoration work for the second circuit.

7.32 At the EIMT meeting on 26 June at 5:00 pm, the update was that all work was complete on site and supply would go up that night (which it did, at 06:18 pm).[70]

7.33 On 20 June, Transpower stopped all baseplate work across New Zealand by all service providers. This was communicated to service providers on 21 June. In addition:

(a) All other work on tower structures was required to have confirmation of engineering checks completed before any work continued.

(b) Baseplate work was to only be reinstated after a full internal review had been undertaken, and the completion of this Review and one underway by the Electricity Authority.

(c) At the time of writing, the criteria for restarting baseplate refurbishment work has not yet been defined, but the Return to Work process, will include:[71]

(a) Reviewing the service providers' procedures against existing Service Specifications and drawings.

(b) Reviewing Transpower standards, including specification standards, drawings and controlled documents to ensure fitness for purpose (including seeking engineering advice to define its on-going approach (but not limited) to minimum number of nuts removed).

(c) Updating Grid Skills Foundations' training materials with updated specifications and drawings.

(d) Providing a refresher training programme for staff undertaking baseplate refurbishment work.

(e) Requiring a competency assessment by the service providers.

70 Minutes of EIMT meeting on 26 June 2024 at 5:00 pm.

71 Base Plate Re-Start Approach July 24.

Communication with third parties

7.34 Once Transpower was informed of the loss of supply, the communications team, the Executive and members of the EIMT were in touch with several third parties, in accordance with Transpower's incident management protocol.

7.35 Transpower's 'Event log – communications' and the minutes of the EIMT meetings record that:

(a) *Ministers:* Transpower's Head of Communications was advised about the outage at 11:11 am and immediately notified the Minister for Energy's office and the Minister for State-owned Enterprise's office.

(b) *Electricity Authority:* At 11:30 am, the Head of Communications notified the Head of Communications at the Electricity Authority. By 1:30 pm, Transpower's Chief Executive had also sent a text to the Chief Executive of the Electricity Authority offering any further information. [72] The Electricity Authority attended a 2:00 pm teleconference with Transpower, Northpower, Top Energy and Vector.

(c) *Media:* Transpower issued its first press release at 11:54 am, with an update at 2:43 pm. Multiple other press releases were issued in the following days. The press releases issued at the time are in **Appendix G.**

(d) *WorkSafe*: By 1:30 pm, Transpower had notified WorkSafe.[73]

(e) *Electricity Distribution Businesses (**EDB**s)*: By 1:30 pm, all EDBs had been reached and the System Operator was continuing to work with the three affected EDBs regarding load limits for varying times of the day.[74] In response to concerns (mainly from EDBs) regarding restoration timeframes, a joint meeting with Northpower, Top Energy and Vector was arranged for 2:30 pm on 20 June 2024.[75] Several additional meetings were held with the EDBs in the following days.

(f) *Civil Defence:* A meeting with Northland Civil Defence was arranged for 3:00 pm.[76]

(g) *Commerce Commission*: by 8:30 pm on 21 June 2024, Transpower had responded to a request for information from the Commerce Commission.[77]

(h) A livestreamed press conference was held on 24 June 2024, with Chief Executive Alison Andrew and the General Manager Grid Delivery Mark

72 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.
73 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.
74 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.
75 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.
76 Minutes of EIMT meeting on 20 June 2024 at 1:30 pm.
77 Minutes of EIMT meeting on 20 June 2024 at 8:30 pm.

Ryall attending for Transpower, and Managing Director Mornez Green for Omexom.

PART D: OBSERVATIONS

8 Observations on what happened at Tower 130 and the cause of the Incident

8.1 As part of the Investigation, meetings were held with the three Omexom team members who were undertaking the work at Tower 130 (the Team Leader, TA1 and TA2) the team's Supervisor, a fourth civil works staff member (TA3), and Omexom's Senior Contract Manager – Line Services Northern:

(a) The team's Supervisor who trained the Team Leader in October 2023 in baseplate refurbishment work joined Omexom in 2011, is a qualified linesman and also very experienced in foundations civil work. He continues as the Team Leader's supervisor (and is one of two line managers).

(b) The Supervisor said that when he was trained, he was taught the practice of removing all nuts from (only) one tower leg at a time and therefore believed it was a structurally safe process to follow (having had no occasion to doubt the practice). He would not have approved taking nuts off more than one tower leg.

(c) TA1 joined Omexom in May 2024 and the team in June 2024. His first refurbishment job was at Tower 214 on 4 June and he was trained on the job by the Team Leader. TA1 does not have English as a first language, but there is no evidence to suggest that language on the site was a contributory factor to the Incident occurring.

(d) TA2 joined the team in October 2023 while the Team Leader was undergoing supervised training for baseplate refurbishment work.

(e) TA3 worked in the civil team on 14 baseplate refurbishment jobs between 11 September 2023 through to 5 June (at tower 214), including at several when the Team Leader was being trained.

(f) The Senior Contract Manager, responsible for delivery of Transpower's maintenance in RSA1).

Departure from Omexom standard practice

8.2 The work at Tower 130 departed from Omexom's standard RSA1 practice of removing all nuts from only one leg at a time (**the standard practice**).

8.3 The standard practice was confirmed by other Omexom staff, including the Supervisor and the Senior Contract Manager. Feedback given was that the standard practice dated from before Omexom became the RSA1 service provider in 2022 and had been used by Omexom's NL2 contract for the Auckland-Taupo region prior to the contract changes in 2022. The Supervisor and TA3 clearly understood that the standard practice was how the removal of baseplate nuts should be undertaken, as part of the refurbishment work process. It was also clear that the Manager believed the Omexom standard practice was how the work should be carried out by the company, notwithstanding a different approach was taken at the company's RSA6 region in the lower South Island.[78]

8.4 Omexom provided its work procedure, 'Tower Structure: Foundation Repairs Base Plate Repairs (Transpower Specification)', issued in August 2022. The procedure is a composite one, for use with both type 1 and type 2 refurbishment maintenance (in drawings TE37252, where type 2 requires additional work to refurbish the bolts, nuts and grout underneath the baseplate). Notably, the method says to "remove hold down nuts and washers". There is no additional detail.[79]

8.5 The RSA6 baseplate work method was provided, which more explicitly details how to remove baseplate nuts. Feedback indicated that this method was prepared for a specific team leader in RSA6 and is not used in RSA1. It specifies a sequence for removing baseplate nuts as follows:

(a) 1 man sets up blaster and gates on A leg, 1 man removes ½ the nuts from A leg.

(b) 1 man blasts ½ the nuts on A leg, 1 man removes ½ the nuts on B leg.

1 man blasts ½ the nuts on B leg, 1 man replaces nuts on A leg and removes the other nuts on A leg

(and so on).

8.6 The Manager reported that the document reflected that (RSA6) team's preferred practice, not necessarily the only acceptable practice, and other service providers would have their own methods.

8.7 Omexom therefore uses two different baseplate work methods. It appeared to be comfortable having both.

8.8 It is accepted there may be differences in work practices between Omexom's RSA1 and RSA6 teams doing similar work, in geographically separate regions. It

[78] The Omexom standard practice was being followed when Omexom (then trading as Electrix) held the NL2 area (Auckland to Taupo) under the pre-2022 contracts with Transpower.

[79] The method includes what appears to be a helpful series of photographs of various stages of the type 1 and type 2 work, albeit that none are directed at removal of tower leg nuts.

is also accepted that these two different work methods, one in RSA1 and one in RSA6, could (and should) result in the same outcomes.

8.9 However, the work method actually followed on the site of Tower 130 was not the standard practice and was clearly far from being so.

8.10 It appears that removing all of the nuts from more than one tower leg at a time (**the non-standard practice**) had likely been used by this team before it arrived at the site of Tower 130 – see Section 6, above.

8.11 The Supervisor reported that:

(a) He did not observe this non-standard practice when he was training or supervising the Team Leader in the field in 2023.

(b) He had not been in the field with the team during 2024.

(c) During the Team Leader's training, removal of nuts from one leg was discussed multiple times and he reminded the Team Leader that "he should be doing a leg at a time" as he was taught.

8.12 Due to interview limitations, it could not be determined why the non-standard practice developed. However, it seems probable it was developed by the team in June 2024.

Departure from Transpower's requirements

Departure from Transpower's technical specifications

8.13 The work carried out at Tower 130 – removing the nuts from three tower legs at once – clearly also departed from 'good industry practice'.[80] No one to date has suggested otherwise.

8.14 A Transpower auditor with over forty years' experience working on lines and towers reported:

> "When someone told me about it [removal of nuts from three legs], I couldn't believe it. I have never seen a human error like this causing a catastrophic fall."

8.15 Another Transpower manager, also with over forty years' experience working on lines and towers said he was "dumbfounded" when told of the Incident.

8.16 One said that in their view no more than one nut (meaning a set of lock nut and hold down nut)[81] should be removed at one time; the other said no more than half the nuts on a leg could be removed at one time. He also said that baseplate refurbishment work was low risk, if 'good industry practice' was being followed.

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80 Omexom, in a 24 June 2024 press release, accepted its staff removed too many nuts and the tower fell over.

81 See the drawing at paragraph 4.41 above.

8.17 The drawings in TE37252 do not specify a particular method of foundation nut removal. Instead, the specifications, standards and drawings for the refurbishment work in Transpower's controlled documents, when combined with the MGSC requirements for service providers to use suitably trained, experienced and competent personnel following good industry maintenance practices, will result in quality maintenance works.

8.18 As noted in section 4, one of the requirements in TP.SS 02.11 is to ensure the stability of tower during maintenance work. In particular:

(a) C4.1: Foundation stability during maintenance repair work shall not be compromised.

(b) C4.2: Maintenance and repair of foundations may reduce the load capacity of the foundation and consequently the stability of the tower. Tower loads need to be determined so as not to compromise the stability of the tower.

8.19 Beca have concluded that removal of the nuts from Legs A and B compromised the stability of the tower. To comply with the requirements of TP.DL 12.01 and TP.SS 02.11, a method should have been established to preserve the tension capacity in the tower legs before the nuts from the Leg A and Leg B were removed. This could have been provided by either retaining an adequate number of nuts or implementing an alternative method to support tension, such as temporarily anchoring the legs to concrete blocks.

Departure from Transpower's specifications regarding competency and training

8.20 It appears that no member of the team at Tower 130 recognised the risks to tower structural safety, the departure from standard practice may have created.

8.21 It seems surprising the Team Leader did not recognise the risk to tower structural safety, given his training and experience as a lines' mechanic, the formal training he had, his general experience of foundations work, and the specific advice from his Supervisor to "do a leg at a time".

8.22 It is not surprising the Trade Assistants did not appear to appreciate the risks given their limited training about tower structures. TA1, TA2 and TA3 all appeared to know little about different tower types.

8.23 The Supervisor reported that when doing sandblasting it is very difficult to see what other people on the site are doing, stating that when "you are sandblasting you are focused on one job only"; your "visibility would be minimal", and "if you need to see something beyond what you are doing, you need to stop and have a proper look". Further, it "was probably not the best" for the Team Leader to be sandblasting while he had trainees on site, and he

agreed that in the absence of a suitable record on TA1's competency certificate, TA1 would have required direct oversight while removing nuts from a tower leg.

8.24 It therefore seems reasonable to conclude that the Team Leader's sandblasting activities at Tower 130 on the day of the Incident may have contributed to him giving insufficient oversight of what TA1 was doing, including that nuts had been removed from two legs and were being removed from a third leg.

8.25 Notwithstanding the limitations of the interviews with team members, and taking into account information provided by Omexom and Transpower regarding formal training, it is concluded that:

(a) The Team Leader had completed recognised and relevant training courses including the following Grid Skills courses: TP.SS 06.20 Transmission Lines (V2), TP.SS 06.20 Foundations, E1 Transition Course, the Transmission Line Mechanic (TLM) Block Course, Transmission Line Mechanic (TLM) Curriculum and the Transmission Line Mechanic Transition (TLM-T) Curriculum.

(b) The Team Leader held an NZQA New Zealand Certificate in Electricity Supply (Transmission Line Maintenance) (Level 4), Line Mechanic, Transpower Grid Skills.

(c) It was not possible to verify what level of knowledge and understanding the Team Leader held of tower construction and structural loads matters, though it might be reasonable to believe that from his formal training and earlier work as a lines mechanic he would have at least some relevant knowledge.

(d) The Team Leader had completed the Grid Skills foundations training a decade earlier in 2014, but that the content of that course then and now is inadequate for the purposes of baseplate refurbishment work.

(e) The supervised training the Team Leader received in October 2023 was in the Omexom standard practice, allowing removal of all nuts from above the baseplate on a tower leg (but not more than one tower leg at a time). This was confirmed by the Supervisor.

(f) TA1 was trained by the Team Leader by in-person supervised work on the job during work at up-to four tower sites in June (before Tower 130). He said he was always with the Team Leader removing nuts until Tower 130.

(g) The Omexom crew makeup for the five towers at which work was undertaken in June is as follows:

Tower	Dates	Crew members
HEN-MDN-A Tower 214	4/06/2024* - 5/06/2024	Team Leader; TA1; TA3
HEN-MDN Tower 194	6/06/2024 - 7/06/2024	Team Leader; TA1; TA3
HEN-MDN Tower 181	17/06/2024 - 18/06/2024	Team Leader; TA1; TA2
HEN-MDN Tower 173	18/06/2024	Team Leader; TA1; TA2
HEN-MDN Tower 130	19/06/2024	Team Leader; TA1; TA2

* Note: 4 June was a preparation day spent in Omexom's yard; no field work was undertaken. The Supervisor was present in the yard on 4 June but not part of the crew members who undertook the baseplate refurbishment on 5 June.

(h) No conclusion can be reached regarding whether TA1 was trained only in the Omexom standard practice. TA1 may also have been trained in the non-standard practice. The evidence seems clear that nuts were removed from more than one tower leg during the period the Team Leader trained TA1.

(i) The Supervisor was not on any of the sites the team worked at during June.

(j) It appears that on the Tower 130 site the Team Leader's role was effectively to oversee the work of the Trade Assistants.

8.26 On the site of Tower 130 the Team Leader was operating sandblasting equipment requiring attention to the task being performed; the Omexom materials reviewed regarding the use of sandblasting[82] make it plain the task creates several hazards during operations, including dust hazards and restrictions to vision created by the safety suit and visor being worn. It seems

[82] Omexom's procedure document: Plant/Equipment Operation: Low Pressure Abrasive Blaster, Issue 04, 11 July 2023.

probable this work would make oversight of other activities on the site difficult, even though the work area is small.

8.27 TA1, the Trade Assistant who carried out the nut removal on Tower 130, was relatively inexperienced and new to refurbishment work. TA1 had joined Omexom only two and a half months before the Incident and did his first of four baseplate jobs in June before working on Tower 130.

8.28 Consequently, it is concluded that:

(a) TA1 was inadequately trained for the task of removing nuts from tower legs. He was therefore required to be under direct supervision given that lack of training.

(b) TA1's work on the Tower 130 site was not adequately overseen.

8.29 It is also concluded that the Team Leader failed to act as a competent team leader given the conclusions above.

8.30 TP SS 06.25 (Minimum Training and Competency requirements for Transpower field work) requires, amongst other things that:

(a) Omexom maintain and keep up-to-date a competency register and records supporting verification of individuals' competencies e.g. training records, work history, on the job assessments and task observations.

(b) Omexom ensure its workers only carry out activities for which they are competent and as specified in the competency certificate.

(c) A worker and site supervisor are responsible for: holding a valid competency certificate as required for the work being undertaken and for the supervision role (if site Supervisor), and to carry out only activities within the scope of the competency certificate held or while under adequate supervision if not currently competent.

8.31 The certificates for TA1 and TA2 did not show any competencies for carrying out foundation work. On their face, the competency certificates for TA1 and TA2 suggest both were, effectively, trainees. It is accepted that trainees might not have a full range of competencies while learning on the job, but it is reasonable to expect they would be working with adequate supervision, provided by someone with the right competencies, experience and training. It is not evident that there was adequate supervision of TA1 at Tower 130.

8.32 Omexom's training records for TA1 and TA2 suggest each is undertaking what appears to be a standard series of training modules relevant to working at Omexom. The content of the modules has not been looked at as part of this Investigation.

8.33 It has been concluded that during the work being carried out at Tower 130, Omexom did not meet its obligations to Transpower under TP SS 06.25. TA1 was not under adequate supervision at the time of undertaking the work.

Appropriateness of Omexom's standard practice

8.34 During the interview with the Senior Contract Manager, a professional contract and project manager with fourteen years tenure with Omexom, he said that there was "no issue with taking all the nuts off one leg" and the Service Specifications and drawings did not proscribe such action. He said he believed that removing all nuts from a tower leg was no different than repairing a concrete encasement where "you dig up a whole leg". In essence he believed the standard practice was acceptable and met Omexom's contractual obligations to Transpower.

8.35 However, the Senior Contract Manager said it would not be a standard practice to remove the nuts from two opposite tower legs at the same time, though he said if that were done then it would only be to remove the lock nuts (meaning the holding down nut would remain in place above the baseplate). He said "traditionally work would be carried out one leg at a time".

8.36 As to obtaining engineering advice for baseplate refurbishment work, he advised that Omexom considered the engineering documents for baseplate work were the Transpower drawings (TE37252), which was taken to mean as being the only engineering input Omexom needed to make reference to for baseplate work. The interviewee had not been involved in obtaining an engineering assessment for any baseplate jobs and noted that Transpower provided a site-specific engineering document for each 'concrete over grillage' work it contracted to Omexom.

8.37 The Manager's views are at odds with the rather more cautious views expressed by Transpower engineers and audit staff interviewed. Perhaps unsurprisingly, Transpower staff had a range of views about the number of nuts that could be taken off a leg during refurbishment work. [83] The engineers and field staff interviewed seemed to allow that only after suitable engineering review would the Omexom standard practice be an acceptable one, and getting engineering advice would be especially important in the case of an angle tower (such as Tower 130).

8.38 One engineer said he would be very wary of taking all the nuts off an angle tower foundation (with large transverse loads) on the uplift side and engineering advice would be needed to determine the loads on the tower legs to establish if taking all nuts off was safe. He believed a service provider should obtain engineering input before it starts a programme of refurbishment works,

[83] One of whom would expect one nut to be removed at a time, and perhaps two at most. An experienced audit contractor expected no more than 50% of the nuts would be removed at a time.

looking at all the included towers to identify which towers required special attention to maintain structural integrity.

8.39 However, it is acknowledged that the Omexom Manager is highly experienced in managing this type of work; he did not present in any sense other than as professional in how he spoke about the work, nor was he dismissive of the need to get the work done safely and according to Transpower's requirements.

8.40 The baseplate refurbishments work methods used by Northpower and Ventia in their respective RSA regions has been reviewed as part of this process. Both are different with observations being that:

(a) Northpower requires "tower stability to be engineered prior to works beginning" and to check that documentation is available in the job pack (before leaving the yard). There are no instructions about removal of baseplate nuts. Drawing TE37252 is referred to (amongst others).

(b) Ventia requires the holding down nuts to be loosened one at a time and checked for rust etc. Although not explicit, the method implies that one nut (comprising both hold down and lock) is to be checked, refurbished, replaced and sealed before moving to the next. Drawing TE37252 is referred to, but no other Transpower documents are.

(c) Neither of these, or any other service providers, have been interviewed about their actual practices in the field.

8.41 In conclusion, it would be helpful for Transpower and its service providers to adopt one consistent practice for removing tower leg foundation nuts that accords with 'good industry practice'. This may improve the probability that adequate engineering oversight is taken for such work and that practices do not arise which are not in line with 'good industry practice'. It is recorded that Omexom's view is that there should be an SMP which provides clear direction on engineering requirements.

9 Observations about Transpower's response to the Incident

Grid Owner's response (restoration of transmission assets)

9.1 The operational interactions between the System Operator and Grid Owner (and connected parties) were represented by the relevant Operations Managers as consistent with normal practice under such circumstances and reflect the kinds of interactions which can be expected when returning assets to service under such conditions, including when normal system security has not been established and there is a need to manage load across different time periods. The System Operator's control room voice recordings from the time of the Incident have been reviewed (by the System Operator); they report that the recordings disclose nothing of concern regarding the quality of the operational communications between NCC and the NGOC.

9.2 Section 7 summarises the establishment of the GOIMT and EIMT and meetings that took place between 20 and 26 June 2024, as well as the key events from 'loss of supply' to 'restoration'. Not all actions taken by the Grid Owner during the Incident have been listed rather the manner in which the event was managed and overseen has been described, and a general record of the steps taken by Transpower in the restoration, provided.

9.3 From interviews held with those directly involved with the restoration work, it is apparent that decision-making about how to recover supply from the Incident began immediately by those responsible (primarily the RSM and the SDM for RSA1 and the DGM) together with other experts and experienced staff within Transpower. For example, when it became known Tower 130 had fallen, optioneering for replacements began immediately with several options considered, including reinstatement of the tower (regarded as unlikely), use of a pole, or use of a Lindsey tower all being considered.

9.4 It was decided soon into the response that using a Lindsey tower would be the most practicable way to allow a 220 kV circuit to be reinstated efficiently. This set off a chain of actions to obtain engineering advice, locate and have a Lindsey tower dispatched from storage (the nearest was in Bunnythorpe), set in action the service provider response under the ESC and consider the large number of related matters that would need to be in place to effect the restoration of service.

9.5 Under the North Island ESC, Omexom is required to supply personnel and equipment to attend sites such as that in the Incident, and provide the response needed to restore assets to service. The contract requires working with Transpower's spares warehousing and storage arrangements to ensure reasonably foreseeable events can be managed. Critically, Omexom must have appropriately experienced and skilled personnel available to effect required work. Feedback provided was that Omexom does in fact have a highly regarded team of lines workers based at its Palmerston North facility. That team has provided ongoing support of work around the North Island, such as that required in the aftermath of Cyclone Gabrielle. It is understood that it was this team that erected the temporary towers at Glorit replacing the fallen Tower 130.

9.6 Operational decision-making for the Incident was through IMTs. A review of the records of the GOIMT meetings found them to be a helpful record of how the Grid Delivery Team supported the people actively involved in restoring electricity to Northland. It appears that the matters the GOIMT looked across were comprehensive and appropriate. The RSM reported that the Incident was the first major event she had had to manage; she also said she quickly became comfortable with her role in doing so, noting the level of support she and her team received from across Transpower.

9.7 A review of the minutes of the EIMT is summarised in section 7. It received status advice from the Grid Owner, the System Operator and the IST teams and other relevant personnel, and could then act to support the company's activities when required with advice, decisions and mobilisation of resources as needed. The EIMT was able to support stakeholder interactions appropriately using the status information it was receiving.

System Operator response (restoration of power system)

9.8 Two main documents regarding the System Operator's actions on the day of the event and up-to return of the second 220kV circuit on 26 June 2024 have been reviewed. These are:

(a) The event log entries recorded during the event by both the System Operator NCC and the Grid Owner NGOC.

(b) The System Operator preliminary report: Northland loss of supply dated 5 July 2024 (**System Operator Report**).[84] This report sets out what happened when the event occurred (from a power system perspective) and how the power system was thereafter restored by the System Operator's coordination of grid owner control functions and its own power system and market management functions, in conjunction with distribution and generator companies in Northland and Auckland.

9.9 The real time Grid Owner and System Operator Operations Managers who were on duty at the time of the event, have been interviewed. From their perspectives, the information in the log entries and the System Operator Report can be verified. The System Operator Operations Manager said the Northland region contingency plan[85] was used for restoring power on 20 June 2024 and the plan worked effectively. In hindsight, he believed the plan required only minor changes and nothing relevant to the effectiveness of the restoration.

9.10 The Operations Managers said they felt the Northland and Auckland distribution businesses (Top Energy, Northpower and Vector) and generator companies understood their respective roles well in the restoration activities on the day and subsequently, and there were no delays caused by a lack of understanding of what to do. One Operations Manager believed the industry is well prepared to manage similar events, noting the value of industry simulation practices the System Operator has held annually since the 9 August 2021 event (when a lack of available generation resulted in some load shedding), believing these had helped the industry better understand each other's roles during emergencies.

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84 The System Operator Report is in **Appendix I**; this includes an incident timeline in the report's Appendix C.

85 PR-CP-638 Northland Region via 110kV Contingency Plan (dated 18 January). This contingency plan restores supply to the Northland region via the 110kV system and is used in the event of a loss of supply to the Northland region where restoration via the 220kV system is not achievable (as was the case in this Incident). A periodic review of the plan was completed in January 2024.

9.11 Transpower has received positive comments about how the restoration activities were carried out. Early in the initial restoration one industry participant asked if the System Operator would run an industry conference regarding the situation; after assessing priorities and deciding a conference would not have assisted restoration, it was decided not to hold a conference, given the regional nature of the event. Several telephone conferences were held with the Northland distribution companies.

9.12 As to learnings from the event, both of Transpower's Operations Managers said the restoration went well and no significant procedural issues arose. The System Operator Operations Manager said that determining load limits on the available circuits in the aftermath of the initial restoration, as demand in the region varied across the day, was not straight forward and required effort to resolve across throughout the period between the initial restoration through the 110 kV circuits and the return of the first 220 kV circuit on the afternoon of 23 June. Northpower also noted the settling of load limits was an issue, though it was resolved satisfactorily on the second day of the restoration. It has been reported that trying to develop load management plans ahead of an event occurring is impracticable given the variety of circumstances of when and where an event may occur and the transmission and distribution assets that may be available.

9.13 Transpower's views of how things went have been cross-checked with Northpower's Operations Manager who confirmed the restoration actions were generally well done (see further comment in paragraph 9.17). On this basis, there appears to be no material evidence to suggest the System Operator acted otherwise than as a reasonable, prudent and well-practiced System Operator, which effected a prompt and efficient system restoration. There is nothing to suggest that a wider review (including speaking with other industry participants or affected customers) would be especially worthwhile.

9.14 While it is noted that Northland customers were badly affected by the loss of electricity arising from the Incident, notably two major industrial customers, Golden Bay Cement and Fonterra Cooperative Group Limited, the outage was not caused by any actions of the System Operator and are attributable directly to the tower collapse, something beyond the System Operator's control.

Summary of Transpower's operational response

9.15 In summary, it is concluded that the nature, and timeliness, of Transpower's restoration actions to recover supply from the Incident were appropriate, well executed and creditable, by both the Grid Owner and the System Operator. This includes the actions of its operational and corporate support teams, and Omexom, its North Island ESC service provider.

9.16 This conclusion was tested with two representatives from Northpower, each of whom said Transpower responded to the event very well, and had shared

information openly and in a manner which was focussed on getting consumers reconnected as soon as possible and which helped Northpower communicate effectively with its customers.

9.17 Operationally, Northpower were surprised how quickly the restoration through the 110 kV system was effected; they had initially been planning to introduce rolling cuts that could have extended across Northland for up-to three days. Meetings held with Transpower were effective, especially on day two after a meeting about load limits at grid exit points across the region, from which better load limits for Northpower's substations became available. Load limits on day one decided by the System Operator had left some power at Bream Bay unutilised which could otherwise have been made available to industrial customers who were then on minimum loads; this was resolved on day two. Northpower said the System Operator's annual simulation training events had proven their usefulness, especially with regard to incident communications.

9.18 One Northpower manager said the response to the Incident was the best managed they had experienced. Several weeks before the Incident, Northpower's communications personnel had attended a meeting with Transpower regarding event communications which they felt proved of real value in this event. It was reported that at a Northland Lifelines meeting held several weeks after the event Transpower's response actions were praised and the event was seen as a really good exercise.

9.19 It does not appear necessary to make wider industry inquiries to further test the views expressed by Transpower and Northpower personnel. Nothing takes away the inconvenience suffered by the loss of service to Northland consumers and the extended period of loss of service suffered by some industries. But the extent to which the Grid Owner was able to re-establish service and then reset security to expected levels, points to Transpower having good procedures and practices in place to manage major events.

9.20 There are lessons able to be learned from any major event. Reviews by Transpower teams had not taken place at the time of the interviews conducted with its staff for the purpose of this Investigation.

Lindsey towers and poles

9.21 Transpower uses specialist Lindsey towers for effecting emergency restorations where a tower has fallen and a tower, as distinct from a pole, will provide the best power system outcome pending availability of a permanent replacement. The Lindsey tower erected to temporarily and partially replace Tower 130 is the single tower to the right in the photograph below:

Lindsey tower on the right in this photograph; temporary poles on the left.

9.22 Transpower's spares policy[86] defines its replacement structure and line spares holding strategy and requires it to maintain a store of emergency structures, located at geographically strategic locations throughout the country, to facilitate timely response to any reasonably foreseeable failure events. A variety of structures are held; Lindsey towers for AC lines, BICC towers (for HVDC lines) and some AC flattop towers, and large concrete poles for both AC and DC use. The Lindsey towers are containerised and are the easiest to deploy, ship and install quickly.

9.23 In the North Island, three Lindsey towers are normally held in Auckland and three in Bunnythorpe; in the South Island three are held in Islington and three in Dunedin. The three Auckland towers are currently deployed while repairs are undertaken from damage caused by Cyclone Gabrielle (one is scheduled to become available in November). The three Lindsey towers at Bunnythorpe were immediately sent to Auckland as part of the Tower 130 response, in case it was decided all three were required; one has since been returned to Bunnythorpe. Currently, there are two available towers in the North Island and six in the South Island.

86 Transpower GL 26.01 Transmission Lines Spares Policy, Issue 1.1, December 2023.

9.24 Soon after the Incident occurred and it was decided to erect a Lindsey tower, Transpower engaged Lumen, an engineering consultancy, to develop the engineering behind the erection of a Lindsey tower at the site of Tower 130. Work commenced immediately and ultimately the engineering advice was delivered quickly and caused no delays in the restoration. However, the ESC places the engagement action with the service provider, potentially delaying engineering work commencing. Transpower staff will always be part of deciding what engineering outcome – in this case, what type of emergency tower will be deployed. It makes sense for Transpower to manage this specialist engagement. One interviewee said this contractual arrangement had delayed a response in an earlier incident.

Stakeholder communications

9.25 Transpower communications with shareholding Ministers, the Minister of Energy and regulators have been criticised in past major events, notably after the North Island loss of supply event on 9 August 2021.[87] Transpower's communications protocols, procedures and practices were refreshed immediately after the 2021 event and this Investigation sought to establish if expected improvements had been demonstrated during this Incident.

9.26 On examination, it appears that communications were delivered in a timely manner, were appropriate and in accordance with Transpower procedures. It has been reported that no communication issues about the restoration efforts have been raised with Transpower by any electricity distribution businesses and generators. As noted above (paragraph 9.16) Northpower regarded Transpower's communications as very good.

9.27 Feedback has been that public responses through social media at the time of the restoration process were mainly about Transpower's reluctance to talk about the cause and about when power would be restored. The latter was not something Transpower could provide detail about given distribution companies' efforts to manage load and prepare for restoration.

9.28 Transpower was criticised during the Incident when it communicated what had happened and the consequences, and what its restoration plans were, but refused to comment on why the tower collapsed. This led to speculation on social and traditional media. Feedback as part of this Investigation has been that Transpower's approach is to avoid speculation about event causation until there has been adequate opportunity to understand what actually has happened and why, however high profile an event might be. In the immediate aftermath of a power system event, restoration actions take precedence, which in this case was to restore power to Northland customers.

[87] Several reviews of that event were undertaken, notably the Investigation into Electricity Supply Interruptions of 9 August 2021 chaired by the David Caghill CNZN, as well a review by the Electricity Authority.

9.29 Avoiding speculation is a practice which seems self-evidently sensible, given that a full investigation may determine a cause or causes to be something other than what might initially appear 'to be obvious'.

9.30 When dealing with the immediate aftermath of a power system event, it was said that obtaining correct information from the field can take time and sometimes incorrect information is initially received about the status of transmission assets. In this Incident, initial reports from the field suggested the tower had fallen onto a public road. Time was taken to evaluate and check the information rather than immediately communicate to potentially affected parties; it transpired the information was wrong.

9.31 It would have been unfortunate had the initial information been taken at face value and steps been taken to unnecessarily close the public road and cause public alarm. It illustrates the need to ensure information being passed to all parties is verified, is as accurate as possible, is measured and is not speculative.

9.32 Transpower's Chief Executive said she believed it was very difficult in the age of social media to manage stakeholder and public communications effectively about a high-profile event, especially one which occurs in an area (such as near a main highway at Glorit) where there is public access to take photographs and see what is occurring. She believed Transpower did its best to provide useful information to consumers about restoring service but felt some anguish at the media speculation about the cause of the Incident which could not be answered while investigations got underway. Apart from acknowledging the dilemma, no recommendations can be made here that might realistically address the problem.

Internal review and path to resumption of baseplate refurbishment work

9.33 Transpower executives reported that Transpower will initiate a comprehensive review of training for service provider field workers, its technical documents, its audit and assurance processes (both field and health and safety) to identify and effect improvements.

9.34 It is also developing a Return to Work Plan for baseplate refurbishment work which will identify the matters that must first be addressed before work recommences. Drafting the plan is underway and it will take into account outcomes from this review.

10 Observations regarding Grid Skills training

10.1 Several interviewees with long industry experience expressed the view that attending Grid Skills training courses is an essential element in the development of service providers' people to be competent to work on transmission equipment. While the service providers are required to assess employee competency, an element of competency is likely to include having undertaken

training through Grid Skills, supplemented by the service providers own training and on-the-job training.

10.2 It follows that the training which touches on tower foundations and the maintenance of tower foundations offered by Grid Skills is a matter of direct relevance to this investigation. It appears that knowledge of what is involved in foundation refurbishment and how the work should be undertaken would be essential knowledge to have available when the work is planned and to have on site when the work is carried out. It is expected that having knowledge of tower structures and loadings would also be important.

10.3 The Grid Skills Foundations training materials regarding construction and maintenance of tower foundations, including materials from block courses run prior to May 2023, and those currently used in the online course, have been reviewed as part of this Investigation.

10.4 The conclusion is that these materials do not adequately cover tower foundation refurbishment work; they seem only incidentally to reference baseplate refurbishment. For instance, the Transpower documents referred to in the Foundations lesson plan[88] include eight Service Specification documents but do not include drawing TE37252, the most relevant and detailed technical document published for such work. While course participants can be expected to gain relevant knowledge of foundation types, construction and maintenance from the documents which were referenced, it appears the Grid Skills training materials do not provide clear guidance regarding baseplate refurbishment.

10.5 This does not mean the gaps in training offered by Grid Skills were causative of or even contributed to the Incident. Competency is a combination of work experience, on-the-job training, employee oversight, formal training and other factors. But it seems clear that the Grid Skills training course should be improved to include specific content about tower baseplate refurbishment work.

10.6 The Omexom manager believed Grid Skills no longer ran its Foundations course and was unaware it was now available online.

11 General matters raised during the review

11.1 During the course of the interviews several other matters were raised which are considered relevant to the Incident, though not causative. These are noted completeness with some recommendations made, given their relevance.

[88] Foundations lesson plan.

The extent to which Transpower should direct the manner in which maintenance works are to be carried out

More prescription of maintenance methods or status quo?

11.2 A range of views were expressed by Transpower employees regarding the extent to which Transpower should impose prescriptive maintenance practices on its service providers. The views ranged from those wanting more prescription (reflecting Transpower's ownership of the assets and need to define how its assets are maintained) to those wanting the status quo (essentially, requiring outcomes from service providers expected to use 'good industry practice').

11.3 It is understood that in some types of work, such as in its substations, Transpower imposes detailed maintenance regimes. For other work, it relies on far less detailed regimes. There was nothing to suggest the different approaches cannot co-exist happily, with more prescription where needed, and less prescription elsewhere.

11.4 But it does appear that more should be prescribed for baseplate refurbishment work, given the recent events at Tower 130.

11.5 No further comment can be made regarding where the line should be drawn between more or less detail for maintenance procedures; that is a matter for Transpower to consider.

Does the maintenance outsourcing model deliver good outcomes?

11.6 Several people described Transpower's long standing approach to contracting out its capital build and maintenance programmes, noting the practice is adopted in other parts of the industry including by electricity distribution companies and generator companies.[89]

11.7 This contracting approach was considered, including whether the fact that Transpower does not directly engage employees to undertake maintenance works had any bearing on the circumstances which led to the Incident. The outsourcing model is long standing, widely used in the industry and there was no suggestion made that this has resulted in poor practices or delivery of services.

11.8 To the contrary, it was reported that the service providers in the industry (notably those providing services to Transpower, including Omexom) are generally highly specialised, display good skills and reliably deliver expected outcomes to a high level of quality. Several very experienced personnel described their complete astonishment regarding the circumstances of the Incident and its unprecedented nature. In each case, they reported that though the event itself was hard to explain, it did not diminish their view that overall

[89] Some of Transpower's service providers – including Omexom – are also service providers to distribution companies (EDBs), including Vector and PowerCo.

service provider delivery – including that from Omexom - was of a high standard.

11.9 Accordingly, there is no evidence to suggest the maintenance outsourcing model employed by Transpower is a contributory factor to the Incident, notwithstanding the fact a service provider clearly failed to deliver services at Tower 130 to a 'good industry practice' standard.

Controlled documents and drawings libraries

11.10 During the investigation, Transpower's large library of technical documents which service providers must understand and deliver services having regard to, was observed first-hand. In reviews of some prior grid incidents an issue has been raised concerning the number and complexity of technical documents which Transpower uses relating to the manner in which its assets are built and maintained, and the standards required for building and maintaining them.

11.11 However, the number of documents especially relevant to the baseplate work and the relevant specifications and standards was relatively limited and were reasonably easily identified.

11.12 It is unlikely that technical document volume and complexity was directly relevant to the Incident. Nor does this issue seem a reason for Transpower decline to prescribe a more detailed maintenance baseplate refurbishment procedure.

PART E: CONCLUSIONS

12 Conclusions

12.1 Tower 130 collapsed due to removal of nuts from the bolts holding down Legs A and B of the tower by an Omexom team of civil works employees when they were undertaking baseplate refurbishment work on the tower foundations.

12.2 Omexom does not, as a matter of course, obtain engineering assessments of each baseplate refurbishment job or series of jobs it is assigned by Transpower. It did not obtain an engineering assessment of Tower 130 regarding the intended baseplate work.

12.3 Omexom's standard work method for baseplate refurbishment in RSA1 was for all of the nuts from one tower leg to be removed at a time.

12.4 The Omexom team went beyond Omexom's standard work method in RSA1 and removed nuts from three legs at the same time, including Legs A and B.

12.5 The removal of the nuts from legs A and B, which were intended to resist tension forces, compromised the stability of the tower, ultimately causing the tower to fall.

12.6 There was no evidence of sabotage to the tower, nor evidence of structural failure arising from a cause other than removal of the nuts from the foundation bolts on Legs A and B.

12.7 In removing the nuts from three legs at the same time, the team at Tower 130 did not act in accordance with 'good industry practice' nor in compliance with applicable Transpower standards (TP.SS 02.11) which required the stability of the tower to be maintained during the works.

12.8 On 20 June 2024, the Team Leader was engaged in sandblasting work when the nuts were removed and was more likely than not, unable to adequately oversee the team member assigned to remove the nuts.

12.9 Neither Trade Assistant appears to have been certified by Omexom as being competent to perform the tasks they were assigned on the site in the absence of direct supervision.

12.10 One of the Trade Assistants had worked on 23 prior refurbishment sites and was probably reasonably familiar with the work required, though had not been assigned the task of removing the nuts at any site.

12.11 One of the Trade Assistants was on his fifth refurbishment job at Tower 130 and was tasked with removed the nuts, doing so for the first time without direct supervision.

12.12 TA1 was inadequately trained for the task of removing nuts from tower leg foundations and therefore required supervision.

12.13 TA1's work on the Tower 130 site was inadequately supervised or overseen.

12.14 The Team Leader failed to act as a competent team leader.

12.15 Limitations affecting interviews with the Omexom team members (at the time the team members were available) meant it was not possible to discover why the team went beyond Omexom's standard practice and removed nuts from more than one tower leg at Tower 130 (or on earlier occasions). Nor was it possible to identify clearly when this practice arose.

12.16 It is likely that the team had removed nuts from a second tower leg (and possibly from three legs) without replacing the nuts of the first leg on more than one occasion, without incident, during baseplate refurbishment work in June 2024.

12.17 The Incident was unprecedented; no Transpower tower has previously fallen as a consequence of poor maintenance practices.

12.18 The Grid Owner and the System Operator responses to the Incident (and resultant widespread loss of electricity to Northland consumers and industrial users) were, in general, handled effectively and efficiently.

12.19 Changes to practices and procedures, including communications, made by the System Operator after a major power system event in 2021 appear to have improved the electricity industry's ability to restore services when a major power system event occurs.

12.20 Transpower's communications with stakeholders during the Incident were generally well received, with the exception of its reluctance to speculate publicly on event causation. Regardless, the position taken is appropriate.

12.21 There is no evidence to suggest Transpower's long-standing maintenance out-sourcing model was a contributing factor to the Incident.

12.22 There is no evidence to suggest there is a material or widespread issue with the quality of work Transpower's service providers are delivering.

12.23 Transpower's maintenance contracting arrangements are extensive and require service providers to deliver to a wide range of standards and specifications, as well as develop their own work methods to deliver the contracted work, including baseplate refurbishment work.

12.24 The standards and specifications applicable to baseplate refurbishment work are found in several documents, including drawings, none of which define a comprehensive work method.

12.25 Transpower requires, and therefore relies on, its service providers to develop work methods which will deliver the required work correctly and safely and in accordance with its standards, specifications and drawings, and with 'good industry practice'.

12.26 The work carried out at Tower 130 by Omexom failed to comply in a number of respects with Transpower's standards and requirements for the work, including (but not limited to) the requirements of:

(a) TP.SS 02.11, in particular Appendix C, Cl. C4 (Foundation stability during maintenance /repair).

(b) TP SS 06.25 (Minimum Training and Competency Requirements for Transpower Field Work), in particular the required outcomes (Purpose, sections 1.1, 1.11 and 1.111) and the Site Supervisor responsibilities (Responsibilities, section entitled Worker and Site Supervisor).

12.27 The work methods for baseplate refurbishment work vary from one service provider to another and none of those reviewed provided a clear, complete and comprehensive methodology for removing nuts from tower foundation bolts.

12.28 Grid Skills Foundations training materials are not adequate in relation to baseplate refurbishment work.

PART F: RECOMMENDATIONS

13 Recommendations

13.1 In relation to tower baseplate refurbishment work, and before any tower baseplate refurbishment work is recommenced, Transpower should:

(a) Review and revise its drawings (including Drawings TE37252 and other specifications and standards) (the **Revisions**) to ensure they:

(a) Describe a methodology about how nut removal and replacement is to be carried out, especially concerning the sequence of nut removal and replacement, and

(b) Provide more detailed recommendations as to when engineering advice should be obtained before work commences.

(b) Discuss the Revisions with an experienced employee of each of the service providers to identify practicability issues which might be found in the field.

(c) Require each service provider to produce for Transpower's review, a new work method or procedure (**New Baseplate Work Procedure**) for the service provider to use when undertaking such work. Transpower's review will be to assure itself that the New Baseplate Work Procedure fully reflects the Revisions arising from recommendation 13.1(a). Note: it is not intended that Transpower's review would be of those elements of the work methods which are the service provider's responsibility.

Note: It is understood that service providers use different tools to undertake similar work. This suggests care will be needed to ensure sufficient flexibility exists in the Revisions.

(d) Convene a refresher workshop (**Baseplate Workshop**) to which attendance by at least one subject matter expert from each of its service providers is required. The subject matter experts should be familiar with baseplate refurbishment work. The Baseplate Workshop should form part of the Return to Work Plan (see 9.34 above). The workshop should be designed to:

(a) Introduce attendees to the Revisions.

(b) Consider what changes should be made to the Grid Skills training curriculum for the Foundations work training courses relevant to baseplate refurbishment work.

(c) Consider if TP.SS 06.25 should be amended to require refresher training for those who have completed Grid Skills courses and, if so, what the return time for refresh training should be.

(d) Consider how 'good industry practice' and supervision practices can be assured when undertaking baseplate refurbishment work.

13.2 In relation to training and competencies, Transpower should:

(a) Review and update Grid Skills training Foundations course materials (including workbooks and assessment materials) specifically to include baseplate refurbishment work, taking into account the Revisions (noted in 13.1(a)). The training materials (**Revised Training Materials**) should cover at least the following matters:

(a) The nature of the work.

(b) Engineering considerations relevant to such work. This will include matters such as tower types (standard, angle, strain etc.), foundation types, tower structural loadings, tower stability and restraint systems, and, if necessary, the engineering inputs which should be obtained before work is initiated.

(c) How work should be carried out to ensure tower structural security is maintained at all times.

(d) What risks or issues may arise around the time work is to commence or is underway. This will include matters such as weather.

(b) Require service providers to have all Team Leaders and Supervisors, assigned to work on baseplate refurbishments sites, undertake the revised Grid Skills Foundations course as soon as practicable after the course becomes available.

(c) Encourage service providers to have all other people assigned to work on baseplate refurbishment work undertake the revised Grid Skills online version of its foundation baseplate refurbishment course (after it becomes available) and require reassessment of competency before baseplate work is undertaken.

(d) Increase the scope of Transpower's service provider audits to verify (through sampling) that competency certificates accurately reflect the work a certificate holder actually undertakes on a site.

(e) Ensure that availability of Grid Skills courses is actively and regularly made known to service providers.

13.3 In relation to service provider audits, Transpower should:

(a) Consider if the Quality Assurance forms[90] used by service providers should incorporate check points to record relevant work methods required to be

[90] These are the Transpower AMIS and QA Records forms used to record the work service providers carry out on each job. A sample of the form currently used is in **Appendix H**.

followed on a job, in addition to the quality information currently included. For example, this might include checklist requirements to confirm receipt of engineering advice prior to start of work; that nuts were removed in a particular sequence and at a removal rate per tower leg not greater than a specified rate etc.

13.4 In relation to an internal review, Transpower should:

(a) Initiate and complete the internal review (**Internal Review**),[91] which Transpower has stated it will commence, of:

(a) Its Grid Skills training materials for Foundations and consider the best method of teaching (e.g. online or block course methods).

(b) If and how its audits can be changed to more likely identify inappropriate work practices.

(b) Ensure the Internal Review considers:

(a) Whether a specific form of audit sheet for tower foundation maintenance works should be developed for use by field auditors.

(b) How Transpower can better ensure changes to its technical documents (Service Specifications, drawings etc.) flow into:

(A) The audit forms used by Transpower auditors, and health and safety personnel.

(B) Service providers' procedure and work method documents.[92]

13.5 Emergency Structures Contract

(a) Consider changing the procedure in the Emergency Structure Contract which currently calls for the contracted emergency structure service provider to engage engineering support for designing towers that are required for erection prior to a restoration. The current arrangements

[91] This ongoing internal review, which at the date of this report is in planning, will be commenced as soon as this Report has been published. The recommendations cover much of the ground in the Internal Review, though with some more explicit requirements.

[92] Transpower has a significant number of technical documents and drawings which are retained in a comprehensive Controlled Documents system. Importantly, many of the documents have cross references to other documents, which means that updating one document can require a cascade of updates to other documents. It was reported that the updating process works reasonably effectively and this Investigation therefore makes no recommendation that the controlled documents process should be considered in the Internal Review, except in so far as the content of those relating to tower foundation maintenance is concerned. Field auditors stated that the cascade of changes into service provider documents is not always up to date, something apparent across all service providers, including Omexom. For completeness the technical drawings fall into a different library system than Controlled Documents – the RedEyeDMS system - which has its own scheduled review process, including cross referencing into the Controlled Documents system.

have potential to cause delay in engaging the engineering support which in turn could delay a restoration.

13.6 Agree a timetable for, and ensure reporting of progress on, completing those recommendations which are adopted.