INDEX TO APPENDICES

Appendix A

[redacted]

Appendix B

List of documents reviewed

A. Transpower documents

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1.01	SS 02.11 Maintenance and construction of steel towers and tower foundations	
1.02	SS 02.12 Protective Coating of TL Structures and Foundations.pdf	
1.03	SS 06.10 Management requirements for to work on TP assets.pdf	
1.04	Contract with Omexom _ Electrix.msg	
1.05	SS 06.58 HSE reporting by SP contractors and consultants.pdf	
1.06	SS 01.01Reporting by service providers, contractors and consultants.pdf	
1.07	HSW 01.03a Health safety and wellbeing Incident Management Procedure.pdf	
1.08	Ventia RSA4 baseplate refurbishment procedures.pdf	
1.09	FL01.02 asset class strategy section screenshot.docx	
1.10	Maximo CA screenshots.docx	
1.11	Recollect Photos.docx	
1.12	SMP 02.98.201TLine Fall Arrest Attachment Point and Bent Plate Loop.pdf	
1.13	SMP 02.12.001 Installation, testing and refurbishment of earthing plates for portable earthing on painted towers.pdf	
1.14	SS 07.23 Work site and Mobile Plant temporary earthing and equipotential bonding of transmission lines.pdf	
1.15	SS 06.25 Minimum Training and Competency requirements for Transpower field work.pdf	
1.16	SS 06.40 Hazardous Substances on Transpower Sites.pdf	
1.17	SS 05.10 Environmental management.pdf	
1.18	SS 05.20 Stakeholder liaison.pdf	
1.19	MCG-02.98 Maintenance Companion Guide.pdf	
1.20	SS 02.98 Asset Maintenance Requirements.pdf	
1.21	AG 10.05 Drawing Management procedure.pdf	
1.21	HSW 01.02 Health and Safety Requirements.pdf	
1.22	CL 01.01 Construction and Modification.docx	
1.23	DL 01.01 Transmission Line Foundation Design Standard.pdf	
1.24	DL 12.01 Transmission Line Loading Code.pdf	
1.25	FL 01.01 TL Asset Class Strategy.pdf	
1.26	Maximo Work Order 9069621.pdf	
1.27	TE37252_1-6 tower baseplate refurb def type1.pdf	
1.28	TL Foundations 2023 Portfolio Management Plan.pdf	
1.29	Fleet strategy Foundations 2023.pdf	
1.30	SS 01 32 Management criteria for transmission line emergency kits.pdf	
1.31	Service improvement plan	
1.32	Email from [redacted] to [redacted] dated Monday 1 July 2024	
1.33	TP56552	
1.34	Grid Del Work Management Manual TP AG 50 01	
2.0 Audit assurance		
	2.1 Data	
	2.101	24 month TRIFR and HPIFR Omexom.xlsx
	2.102	Graphs and incident details - TRIFR and HPIFR for Omexom.docx
	2.103	Maximo incident numbers.xlsx
	2.2 ICAMs	
	2.201	Bushing removal procedure ICAM.pdf
	2.202	ML CT1 Replacement Polarity Error Short Form ICAM.pdf
	2.203	Duct fell on worker's back ICAM.pdf
	2.204	Electric shock received from socket outlet ICAM.docx
	2.205	Fallen Lightning Pole Short Form ICAM.pdf
	2.206	Fractured Finger ICAM.pdf
	2.207	ICAM Investigation Report Fallen Lightning Pole (revised version for NERG).pdf
	2.208	Livened with earths attached OTA Bus Disconnector 523 ICAM.docx
	2.209	LLMAD Encroachment Short Form ICAM 115731.pdf
	2.210	Low voltage cable livened ICAM.docx
	2.211	Strained Back Lifting Steel Short Form ICAM 105507.pdf
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2.3	TP Quality Audits of OMX 01 Jun 2022 to 27 Jun 2024: folder containing 192 Transpower audit reports	

2.4	11839 INV-ROX-B0133 Base plate refurbishment OMX Omexom RSC6 Compliance Letter.pdf	
2.5	Omexom final report August 2023.pdf	
2.6	14052024 CAR_Audit_No11813.pdf	
2.7	23052024 CAR_Audit_No11815 - v1.pdf	
2.8	22052024 CAR_Audit_No11880.pdf	
	2.9 SP and TP Audit programmes + APR Self-Audit Guidelines	
	2.9.01	EA 03 - SS 06.25 Minimum Training and Competency requirements.pdf
	2.9.02	EA 01 - GSCP - 8.2.3 Competency Management System - Electrix - Complete - v2.pdf
	2.9.03	EA 02 - GSCP - 8.2.4 Sub-Contractor Management System - Electrix - Complete - v2.pdf
	2.9.04	05a - GSCP - APR1 guidelines for SP Assurance Plan - v 27-Jul-2022.docx
	2.9.05	Electrix Self Audit Management Plan 2023 24 RSC1 and RSA6 (June report).xls
	2.9.06	OMX HSMS - CAR_Audit_No11572.pdf
	2.9.07	OMX QMS - CAR_Audit_No11536.pdf
	2.9.08	FY2324 audit plan - Electrix.xlsx
	2.9.09	APR Management Guideline
3.0 Communications		
	3.1 Minister and Govt	
	3.101	220kV back in service.msg
	3.102	CONFIDENTIAL - Further information (1).msg
	3.103	CONFIDENTIAL - Further information .msg
	3.104	Full security returned to Northland.msg
	3.105	IN CONFIDENCE - Press conference question prep.msg
	3.106	In confidence - statement for 1pm press conference.msg
	3.107	Information requested.msg
	3.108	Media release on Northland.msg
	3.109	Northland outage update - 9_35pm.msg
	3.110	Northland outage update (3).msg
	3.111	Northland outage update (4).msg
	3.112	Northland outage update.msg
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	3.115	Statement - confidential.msg
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3.2	Event log - communications.docx	
3.3	Media Interaction log Northland tower.xlsx	
3.4	24.6.24 Omexom media release - cause of transmission tower fall.pdf	
3.5	Media Statement 1 - 24 June 2024 1 pm rev1.docx	
4.0 Contracts		
4.5	SUP-15946 Electrix MGSC Issue 1 20220527.pdf	
4.6	SUP-15946-1 Electrix RSC1 Issue 1 20220527.pdf	
4.7	SUP-15946-3 Electrix SSC - Emergency Structures NI Issue	
4.8	MGSC summary of contracts.pptx	
4.9	Grid Services Contracting Project Board Familiarisation 20220525.pptx	
5.0 Omexom documents - Own Assurance Material & ICAM Scope		
5.1	24 06 24 - Request for independent ICAM investigator - Investigation information.msg	
5.2	Email from [redacted] to [redacted] dated Monday 24 June 2024	
5.3	Baseplate Quality Advisory 2024 Crew History.pdf	
5.4	Omexom Safety and Assurance Presentation 26 June 2024.pptx	
6.0 Statement of facts		
6.1	Email from [redacted] to [redacted] dated Sunday 23 June 2024	
7.0 Photos and videos		
7.1	Foundations, base plates and tower after fall: folder containing 26 photos.	
7.2	Restoration works including Lindsey Tower and three pole structures: folder containing 54 photos	
7.3	QA Photos - Baseplate repairs completed in June prior to the incident: folder containing before, during and after photos for towers HEN-MDN-A0173, HEN-MDN-A0181, HEN-MDN-A02194 and HEN-MDN-A0214	
7.4	QA photos - Tower 130 base plate refurbishment prior to incident: folder containing 7 photos	
7.5	Video from GridIMT Northland LOS June24.mp4	
9.0 Grid Skills		
	9.1 Pre. April 2023 training content	
	9.1.01	Foundations assessor guide.docx
	9.1.02	Foundations lesson plan.doc

	9.1.01	Foundations assessor guide.docx	
	9.1.03	Foundations - Pervious Version.docx	
	9.1.04	Foundations Block Course Assessmentv1.pdf	
	9.1.05	Foundations On-job assessment Pv1.2.pdf	
	9.1.06	Foundations Workbook Pv1.1.pdf	
		9.1.2 TL1 Assessments	
		9.1.2.01	TL1 Assessments note.docx
		9.1.2.02	TL 1 On Job Asssessment.3.pdf
		9.1.2.03	TL1 Assessor Guide Sep.pdf
		9.1.2.04	TL1_Essay questions.pdf
	9.2 May 2023 onwards		
	9.2.01	Climbing and Rescues (TLC).url	
	9.2.02	Foundations - Current Version.docx	
	9.2.03	Foundations OJA.pdf	
	9.2.04	Foundations Workbook.pdf	
	9.2.05	Safe Working (TLC).url	
	9.2.06	Working on Transmission Structures (TLC).url	
9.3	Learners All GridSkills Foundations 20240625.xlsx		
9.4	Learners Omexom Foundations Learners 20240625.xlsx		
9.5	Omexom Tech Experts Training Records20240625.xlsx		
9.6	Summary of Foundation Training.msg		
9.7	Omexom training dashboard.pdf		
9.8	Omexom Technical Experts Scope 20240625.xlsx		
9.9	Service Provider resource for reviewing the TE pool (002).pdf		
9.10	Technical Experts notes.docx		
9.11	Learners All Grid Skills Foundations Learners.pdf		
9.12	TLM_TSM Course Information		
9.13	Foundations Curriculum Information_Available till March 2023		
9.14	Overview of Grid Skills		
10.0 Incident Management Team files			
10.1	Northland event ELT IMT roster.docx		
10.2	NTHL Event ELT IMT 20 Jun 2024 12pm.docx		
10.3	NTHL Event ELT IMT 20 Jun 2024 130pm.docx		
10.4	NTHL Event ELT IMT 20 Jun 2024 330pm.docx		
10.5	NTHL Event ELT IMT 20 Jun 2024 530pm.docx		
10.6	NTHL Event ELT IMT 20 Jun 2024 830pm.docx		
10.7	NTHL Event ELT IMT 21 Jun 2024 1130am.docx		
10.8	NTHL Event ELT IMT 21 Jun 2024 630pm.docx		
10.9	NTHL Event ELT IMT 22 Jun 2024 1200pm.docx		
10.10	NTHL Event ELT IMT 22 Jun 2024 630pm.docx		
10.11	NTHL Event ELT IMT 23 Jun 2024 1200pm.docx		
10.12	NTHL Event ELT IMT 23 Jun 2024 630pm.docx		
10.13	NTHL Event ELT IMT 24 Jun 2024 2pm.docx		
10.14	NTHL Event ELT IMT 25 Jun 2024 12pm.docx		
10.15	NTHL Event ELT IMT 26 Jun 2024 5pm.docx		
11.0 Operations –			
11.1	Northland event - Operations Planning info.docx		
11.2	Northland LOS timeline 20 June 2024.xlsx		
11.3	PR-CP-638 Northland Region via 110kV Contingency Plan_PDF version of formal process.pdf		
12.0 Base Plate Restart Programme			
12.1	Base Plate Re-Start Approach July 24		

B. Omexom documents

Transfers from Omexom SP Site - Documents	
Before, during and after photos for all Omexom foundations base plate jobs undertaken nationally this year or last year	
1.	RSA 1: Folder containing "Before during and after" photos for 29 Towers
2.	RSA 6: Folder containing "Before during and after" photos for 9 Towers
List of Omexom personnel onsite	
3.	Personnel who were on site
Omexom documents relating specifically to the work for the site at Glorit	
4.	ELP-T414~05=Tower Foundation - Base Plate Refurb
5.	Plant Operation-Low Pressure Abrasive Blaster
6.	Tower Foundation - Base Plate Refurb
Omexom procedure for plate refurbishment	
7.	20201017 Minor Rev - TE37252_1-TYPE 1
8.	20201017 Minor Rev - TE37252_2-Type 2 & 2A
9.	20201017 Minor Rev - TE37252_3-Type 3
10.	20201017 Minor Rev - TE37252_4-TYPE 5
11.	20201017 Minor Rev - TE37252_5-TYPE 6A
12.	20201017 Minor Rev - TE37252_6-TYPE 6B
13.	ELP-T414~05=Tower Foundation - Base Plate Refurb
14.	METHODOLOGY
15.	Plant Operation-Low Pressure Abrasive Blaster
16.	Plant Operation-Low Pressure Abrasive Blaster
17	TE37252 - Baseplate Drawings
18.	Tower Foundation - Base Plate Refurb
Quality assurance documents held by Omexom for foundations base plate maintenance jobs this year and last year	
19.	All Audits from 01072023 with keyword foundation plate or bolt
20.	All Audits from 01072023
21.	RSA 1: folder containing quality assurance documents for 28 towers
22.	RSA 6: folder containing quality assurance documents for 61 towers
Training records for the Omexom staff onsite	
23.	Gridskills records
24.	Record of Achievement 1
25.	Record of Achievement 2
26.	Record of Achievement 3
27.	Training records 1
28.	Training records 2
29.	Training records 3
Other	
30.	Base Plate Refurbishment – completion dates and crew make up
31.	Competency certificate 1
32.	Competency certificate 2
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Terms of Reference: Investigation into Tower 130 incident

The Incident

1 On or about 11.03 am on Thursday, 20 June 2024, a 220 kV 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*).

2 One of Transpower's Service Providers, Electrix Limited (trading as Omexom New Zealand) (*Electrix*) was undertaking maintenance on the foundation of Tower 130 at the time of the incident. No workers were injured but the Incident is a H & S Incident for the purposes of the Master Grid Services Contract between Transpower and Electrix (*MGSC*).

3 Transpower issued an operational Grid Emergency Notice following the loss of supply. Transpower initially restored some power supply to the Northland region using its 110 kv network during the course of 20 June 2024, although this was insufficient to meet peak evening demand on at least 20 June. Restoration of one of the 220 kv circuits using a temporary tower was completed on Sunday, 23 June 2024, effectively restoring full supply to the Northland region. The second circuit is intended to be restored on Saturday, 29 June 2024.

Investigation

4 Transpower has appointed Daniel Twigg, consultant of Wellington, as its agent to conduct an investigation of the Incident and Transpower's response to the Incident (the *Investigation*). Specialist engineering advice will be provided to the Investigation by Beca. Legal advice and support will be provided to the Investigation by Chapman Tripp

5 The purpose of the Investigation is to gather and present information relating to the Incident and Transpower's response to the Incident for the purposes of assisting Transpower's legal advisors, David Knight, Executive General Manager Strategy, Regulation and Governance and Chapman Tripp, to prepare for potential litigation and provide legal advice to Transpower on the legal risks arising from the Incident and Transpower's response to it, and how best to respond to those risks.

Investigation scope

6 The Investigation is to gather relevant information and provide an objective report on the following:

6.1 What occurred in the Incident and Transpower's response, including a description of:

(a) what occurred to Tower 130 on 20 June 2024;

(b) the high level power system impact;

(c) Transpower's operational response at the time of the Incident to the restoration of the first 220kV circuit on Sunday, 23 June 2024 and the second 220 kV circuit on Saturday, 29 June 2024; and

(d) Transpower's response as system operator to the Grid Emergency.

6.2 Why Tower 130 fell, including an engineering description of what happened and why.

6.3 What work was authorised by Transpower to be undertaken on site at the time of the Incident and what work was undertaken or being undertaken.

6.4 Whether the work undertaken on the site at the time of the Incident complied with relevant Transpower standards and requirements for the work.

6.5 What Transpower's response was subsequent to Incident until the time the second 220 kV circuit was restored, expected to be on or about 29 June 2024, including communications with connected parties and the public.

7 The Investigation will not make findings on any health and safety compliance issues that may arise from the Incident but is intended to provide a comprehensive factual investigation of the Incident, including gathering of information and interviewing staff, as a H & S Incident.

Investigator's responsibilities

8 The Investigator will:

8.1 at all times during the investigation comply with these terms of reference;

8.2 act in accordance with procedural fairness; and

8.3 ensure that there is sufficient evidence to support any findings reached.

9 The Investigator may not broaden the scope of the investigation without first obtaining written approval to do so from Transpower.

10 At the conclusion of the investigation process, the Investigator will provide an objective report (*Investigation Report*) comprising of:

10.1 a description of the evidence obtained during the course of the Investigation, including all witness statements, interview records, and any other evidence collected, as well as any instances where the Investigator requested information and its was not provided;

10.2 an account of events in chronological order; and

10.3 the findings, and the basis for those findings, in relation to each of the matters within the investigation scope.

Confidentiality and privilege

11 These terms of reference are confidential, together with all versions of the report, and subject to legal advice privilege and litigation privilege.

12 During the course of the Investigation, all parties are required to maintain confidentiality over all aspects of the investigation. The Investigator will ensure that

each individual interviewed or who provides information is aware of these requirements. Any information provided to the Investigator is provided on the basis that it may be disclosed by the Investigator to Transpower and any other person involved in the Investigation.

13 If the Investigation Report makes adverse findings against any individual, they will be informed and will have the opportunity to respond to these proposed findings before the report is finalised. This may involve providing the individuals with a copy of all or part of the draft report for comment before the report is finalised.

Timing

14 The Investigator will provide his final report as soon as practical after the conclusion of the investigation process. He will endeavour to provide a draft report by 5 July 2024 and a final report by 12 July 2024.

Use of the Investigation Report and material

15 Transpower will use the report in its sole discretion, including whether to release some or all of the Investigation Report and information received by the Investigation.

Appendix D

1 Summary of contractual arrangement

1.1 This Appendix contains a summary of the contracting arrangements between Transpower and Omexom.

1.2 The MGSC contains several key controls in relation to work contracted to Omexom. In particular, Omexom has obligations to:

(a) use all due skill and care, and comply with Good Industry Practice, in the course of its activities in connection with its work;

(b) have suitably trained, experienced and certified personnel;

(c) maintain certain quality standards and have appropriate quality assurance systems in place;

(d) comply with all Transpower performance requirements (such as technical standards, procedures and service specifications);

(e) supply audits and reports on its services; and

(f) meet all health and safety requirements.

1.3 Transpower is able to request reporting and audit information from Omexom to monitor its performance under the contract.

1.4 Transpower and Omexom have also entered into Service Contracts. The relevant Service Contract for the work carried out to Tower 130 is the Regional Service Contract for Region 1 between Transpower and Omexom (contract number SUP-15946-1) (**RSC1**). The services provided by Omexom under RSC1 include:

(a) Custodial responsibility for stations;

(b) Fault response and restoration;

(c) Station operating services;

(d) Scheduled maintenance (including line patrols, scheduled condition assessments, access way maintenance and Preventative Maintenance);

(e) Unscheduled maintenance (including Predictive Maintenance, Corrective Maintenance and Proactive Maintenance); and

(f) Allocated Projects for the above services or refurbishment, replacement or enhancement relating to the lines and stations in the region.

1.5 The services that Omexom performs are divided into "Work Packages". The Work Packages that Omexom is expected to be engaged for are generally recorded in a 2-year Work Plan and Work Schedule and/or a 4-month work schedule.

1.6 The Work Package Contract is the document that gives Omexom authorisation to perform the Work Package (and creates an obligation for Transpower to pay for those works). A WPC can be created in a number of ways, including by Transpower issuing a Work Order. Work Orders are created and approved by Transpower in Maximo, Transpower's electronic maintenance management system. A Work Order creates a WPC as soon as it is approved by Transpower and sent to Omexom in Maximo.

Competence requirements

1.7 Omexom is required to:

(a) only use (and ensure its sub-contractors only use) suitably trained, experienced and certified personnel who meet the requirements of TP.SS 06.25 Minimum Training and Competency Requirements for Transpower Field work (TP.SS 06.25).

(b) ensure appropriate measures are in place to screen all personnel to ensure they have relevant competency and qualifications;

(c) ensure supervisors are suitably experienced and qualified to take on that role; and

(d) ensure all persons entering controlled or restricted areas or working on Transpower assets are competent, with a current competency certificate for the relevant work activity.

1.8 Omexom is responsible for determining the competence of its personnel and issuing competency certificates in accordance with TP.SS 06.25 (Competency Certificate). In issuing a Competency Certificate to a person, Omexom is providing a warranty to Transpower that the person is competent to carry out the activity specified in that certificate. Omexom must also maintain a management system to ensure its personal undertaken training and assessment in accordance with TP.SS 06.25.

Quality requirements

1.9 For all of its activities, Omexom must use due care and skill and comply with "Good Industry Practice", which means exercising a degree of skill, diligence, prudence and foresight which would reasonably and ordinarily be expected form a skilled and experienced person engaged in New Zealand in the same type of activity under similar circumstances.

1.10 Omexom must also, for all of its activities:

(a) maintain quality assurance systems; and

(b) use appropriate quality control techniques to ensure the work is carried out in accordance with the contract.

1.11 Omexom has responsibility for preparing Designs (ie. designs, drawings or similar) as part of a Work Package. When preparing those Designs, Omexom must apply all the skill, care and diligence that could reasonably be expected as a matter of Good Industry Practice to ensure that the Designs comply with Design Requirements (which are Transpower's instructions or requirements for Designs) and are consistent with Good Industry Practice (Cl 20.1)

Performance requirements

1.12 Omexom must comply with all relevant "Performance Requirements" that are Transpower's technical standards, procedures, service specifications and technical specifications identified in the agreement, available on specified portals or otherwise notified by Transpower to Omexom. Omexom is responsible for :

(a) maintaining a high degree of familiarity with all Performance Requirements;

(b) identifying the Performance Requirements applicable to any specific Services; and

(c) proactively requesting directions from Transpower as to the applicability of any Performance Requirements, where this is unclear to Omexom.

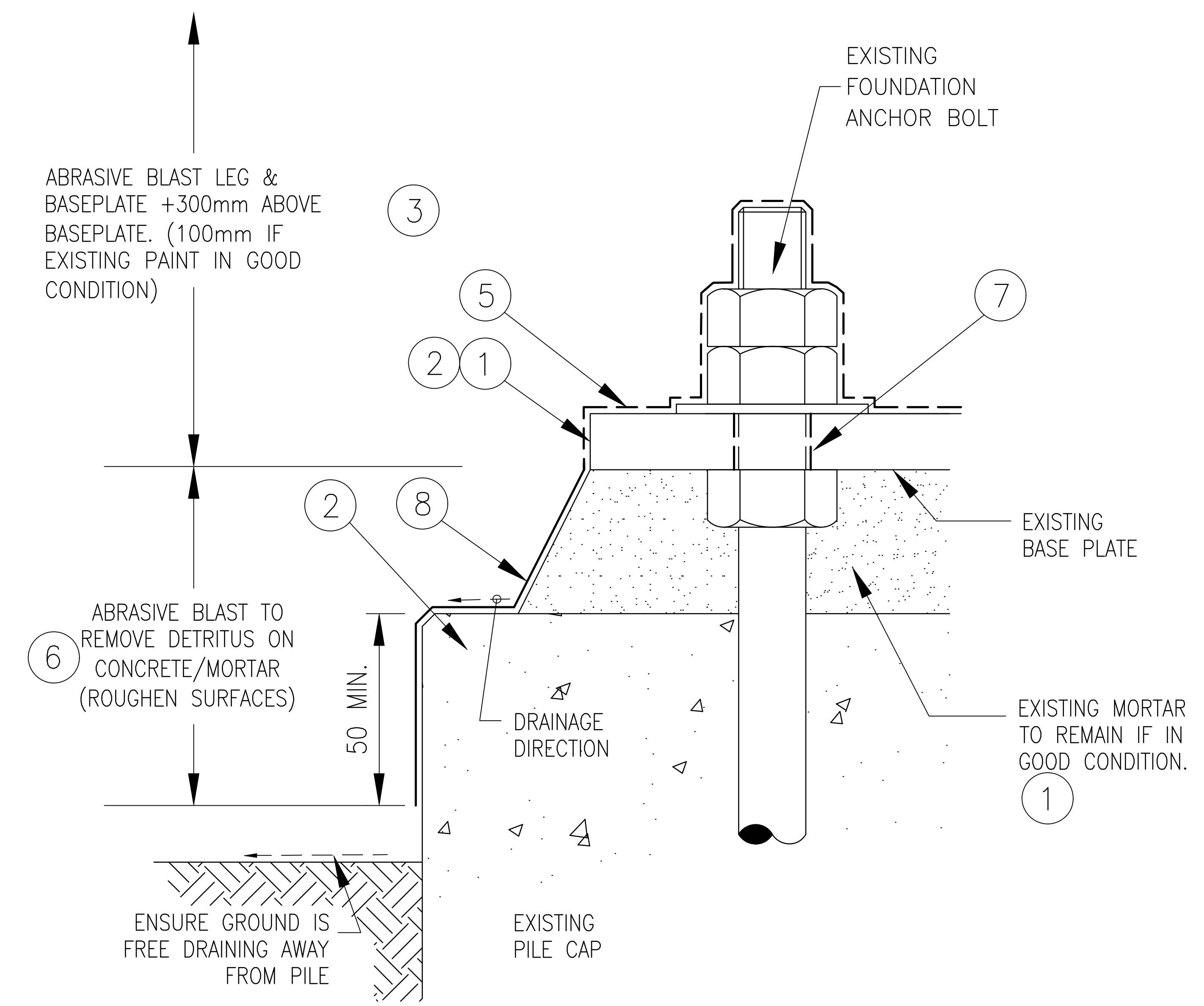
Audit and supervision

1.13 The MGSC imposes a number of obligations on Omexom to report on its performance of the Services (which again includes services supplied pursuant to RCS1 and WO 9069621, which fall within the definition of "Service" in the MGSC). It also provides Transpower with a number of rights of inspection and reporting.

1.14 Each year, Omexom is to submit a self-audit programme to audit its own level of compliance with the MGSC for the following year. Omexom must report its self-audit results quarterly to Transpower. The quarterly reports must include compliance statistics, material instances of non-compliance (including trends or systematic causes of non-compliance) and corrective actions identified or failed to be taken.

1.15 Transpower can carry out performance audits. Omexom must give Transpower full access to premises, personnel and systems, data, accounts documents and records to enable Transpower to verify the extent to which there is compliance with the agreement (Compliance Audits); the frequency is at Transpower's discretion.

Appendix E



TYPE 1 – EXISTING MORTAR IN GOOD CONDITION

NOTES

1. CHECK BASEPLATE/GROUT INTERFACE FOR SIGNS OF RUST. REMOVE NUTS AND WASHERS TO CHECK FOR RUST DUE TO WATER INGRESS. IF THERE ARE SIGNS OF WATER RETENTION BENEATH THE BASEPLATE THEN ADOPT TYPE 2A OR TYPE 2 REPAIR.

2. INSPECT, PHOTOGRAPH AND DOCUMENT IN THE QA FORMS THE CONDITION, AS PER TP.SS 02.17B, OF THE EXISTING BASEPLATE, ANCHOR BOLTS, STUB AND WELD CONNECTIONS TO THE BASEPLATE, AND PILE CAP CONCRETE.

   2.1 DOCUMENT PILE CAP CONCRETE CONDITION NOTING THE FOLLOWING (AFTER BLASTING):
   A. CRACKING WIDTH SIZE: [(a) HAIRLINE; (b) FINE: 1mm–1.5mm; (c) MEDIUM: 1.5mm–3mm; (d) WIDE: >3mm]; CRACKING PATTERN & APPEARANCE & LOCATION ON PILE: [VERTICAL / HORIZONTAL, UNIFORM OR NON–UNIFORM PATTERN, DEPTHS];
   B. RUST STAINS COMING FROM CRACKS.
   C. SCALING & SPALLING (EXPOSED REO.), HONEYCOMBING OR WEAK 'BONEY' SOFT PATCHES.
   D. DAMAGED CONCRETE, SOFT CONCRETE (STRIKE WITH HAMMER AND NOTE SOUND), DISCOLORATION (AFTER BLASTING), SIGNS OF WATER PENETRATION, DELAMINATION.

   NOTE: UNDER ITEM–2 ABOVE, IF ANY OF THESE ITEMS AS FOUND (EXCEPT IF ALL CRACKS FOUND ARE <3mm) CONTACT TP ENGINEER BY EMAIL AND PROVIDE SUPPORTING DOCUMENTATION (PHOTOS & QA FORMS). TP ENGINEER IS TO DETERMINE IF THERE IS A CASE TO REVERT TO THE TYPE–5 REPAIR.

   –[NOTE: COMPLETE TYPE–5 REPAIR WORK BEFORE PROCEEDING WITH FOLLOWING INSTRUCTIONS]–

3. FOLLOWING THE REQUIREMENTS OF TP.SS 02.12, ISSUE–5.4, OCT. 2020 (MFR. PAINT SPECIFICATIONS). PREPARE TOWER LEG AND BASEPLATE STEEL, WITH ABRASIVE BLASTING TO EXPOSE STEEL, FOR APPLICATION OF APPROPRIATE PAINT SYSTEM (SEE TABLES C3.6 & C3.7 IN TP.SS 02.12) AS FOLLOWS:

   3.1 PREPARE TOWER LEG STEEL: 300mm ABOVE BASEPLATE. NOTE: IF EXISTING PAINT LOOKS IN GOOD CONDITION THEN ONLY PREPARE BOTTOM 100mm OF LEG STEEL.

   3.2 PREPARE BASEPLATE 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.

4. ABRASIVE BLAST TOP OF CONCRETE PILE CAP AND FACE OF EXISTING MORTAR IN PREPARATION FOR APPLICATION OF SIKATOP–107 PROTECTIVE COATING.

5. FILL BASEPLATE BOLT HOLES (AROUND BOLTS) WITH SIKAFLEX–MS SEALANT. REPLACE NUTS AND WASHER THEN TIGHTEN (SNUG TIGHT + 1/4 TURN).

6. APPLY PAINT TO PREPARED BASEPLATE STEELWORKS AND TO THE TOWER LEG STEEL AS PER TP.SS 02.12 . DO NOT APPLY PAINT TO CONCRETE.

7. APPLY 2 COATS OF CONCRETE PROTECTIVE SIKATOP–107 COATING OVER THE SURFACE EXPOSED GROUT SURFACES AND TO TOP OF THE EXISTING PILECAP CONCRETE. THE COATING IS TO EXTEND A MINIMUM OF 50mm DOWN SIDE OF PILECAP OR DOWN FURTHER AS NEEDED TO COVER CONCRETE CRACKS. THE SIKATOP–107 COATING IS TO BE INSTALLED AS PER MANUFACTURERS INSTRUCTIONS; DO NOT APPLY OVER STEELWORK.

F

THIS DRAWING SUPERSEDES TE37252/–

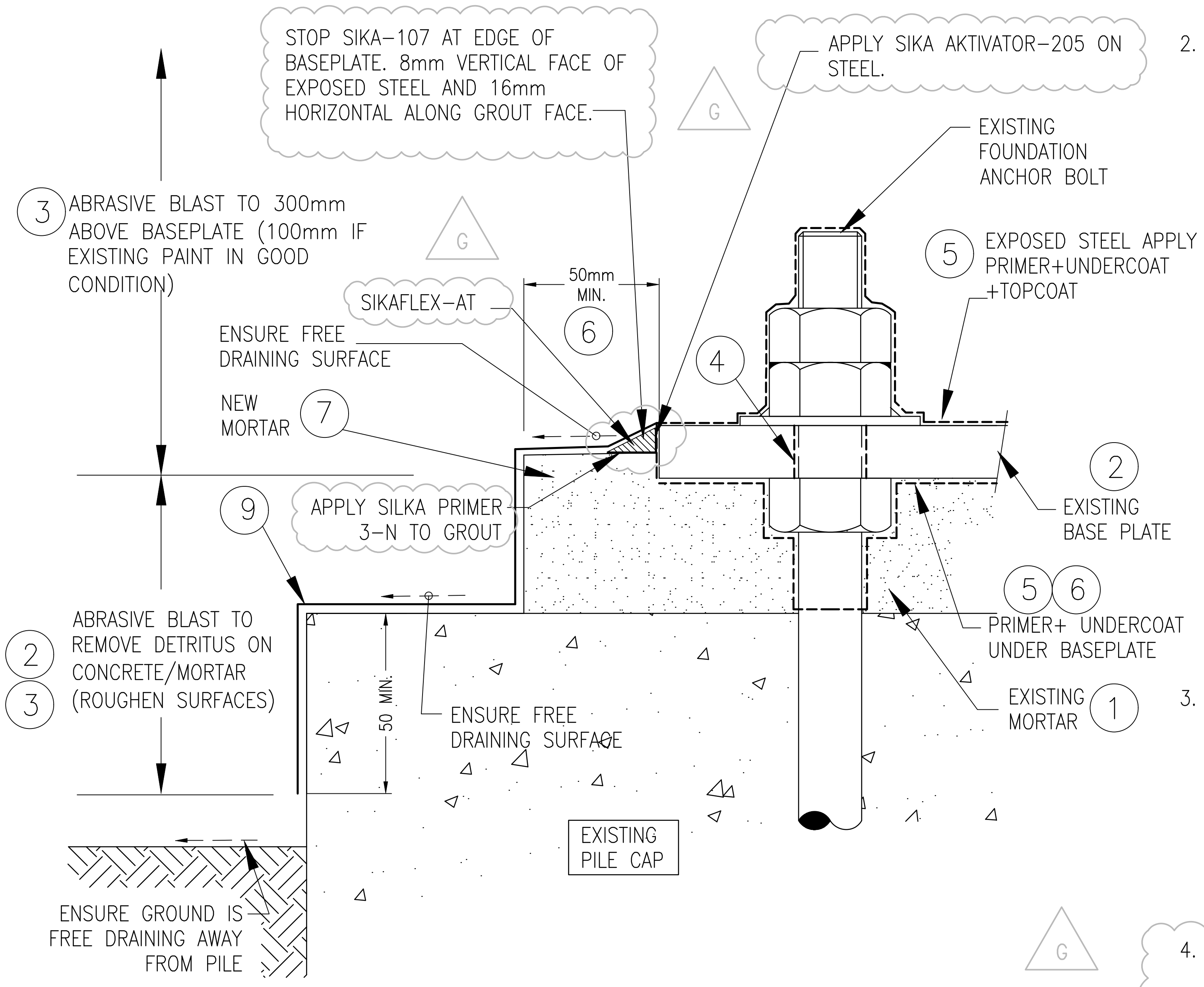
REV	REVISION DESCRIPTION	CONSULTANT CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	TP APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRAISIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	UPDATE NOTES AND FOLDER REFERENCE	TPNZ	DM	10/20	LP	10/20	KR	12/20		–	DM	7/23
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–
–	–	–	–	–	–	–	–	–	–	–	–	–

TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER BASEPLATE REFURBISHMENT DETAILS
TYPE 1 – EXISTING MORTAR IN GOOD CONDITION
PROTECTIVE COATING

TRANSPOWER PROJECT CODE: IP_2021_242_05
FOLDER: GEN/101.7B
DRAWING NUMBER: TE37252
SHEET: 1
REVISION: F
DRAWING CREATED BY: Transpower New Zealand Ltd http://www.transpower.co.nz
SCALE: N.T.S.



- TYPE 2 – EXISTING MORTAR IN POOR CONDITION AND TO BE COMPLETELY REMOVED & REPLACED.

- TYPE 2A – SIMILAR TO TYPE 2 REPAIR BUT ONLY REPLACE OUTER MORTAR THAT IS IN POOR CONDITION AND OR TO A DEPTH TO OBSERVE CONDITION OF ANCHOR BOLTS (NOTE: MORTAR THAT IS TO REMAIN MUST BE HARD WITH NO CORROSION FOUND UNDER BASEPLATE OR ON EXPOSED ANCHOR BOLTS).

NOTES

1. BEFORE REMOVING ALL OF THE EXISTING GROUT FROM BENEATH BASEPLATE BY MEANS OF AN IMPACT DRILL AND/ OR HAMMER. FIRST REMOVE ENOUGH GROUT TO DETERMINE IF LEVELING NUTS ARE PRESENT BENEATH THE BASEPLATE. IF LEVELING NUTS ARE NOT PRESENT THEN INSTALL NEW PACKING SHIMS (STEEL OR PROPRIETARY PLASTIC) OR PROP THE TOWER LEG.

   NOTE: ON APPROVAL BY TRANSPOWER ENGINEER (TP): IF IT IS FOUND THAT THE EXISTING GROUT BENEATH THE BASEPLATE IS TOO DIFFICULT TO REMOVE BY STANDARD METHODS THEN REPAIR MAY BE REVERT TO A TYPE-2A REPAIR IF EXISTING MORTAR IS IN GOOD CONDITION. THE TYPE-2A REPAIR IS SIMILAR TO THE TYPE-2 REPAIR EXCEPT ONLY THE OUTER MORTAR IS REMOVED TO A DEPTH TO BE ABLE TO ASSESS THE CONDITION OF THE ANCHOR BOLTS).

2. INSPECT, PHOTOGRAPH AND DOCUMENT IN THE QA FORMS THE CONDITION, AS PER TP.SS 02.17B, OF THE EXISTING BASEPLATE, ANCHOR BOLTS, STUB AND WELD CONNECTIONS TO THE BASEPLATE, AND PILE CAP CONCRETE. NOTING THE FOLLOWING:

   2.1 ASSESS ANCHOR BOLTS IF FOUND TO HAVE EXCESSIVE SECTION LOSS AS PER TP.SS 01.17B SECTION D3.6.1 PROCEED TO TYPE-3 & 3A ANCHOR BOLT REPAIR. COORDINATE REPAIR METHODOLOGY WITH TYPE-5 REPAIR AS REQUIRED.

   2.2 DOCUMENT PILE CAP CONCRETE CONDITION NOTING THE FOLLOWING (AFTER BLASTING):
   CRACKING WIDTH SIZE: [(a) HAIRLINE; (b) FINE: 1mm–1.5mm; (c) MEDIUM: 1.5mm–3mm; (d) WIDE: >3mm];
   A. CRACKING PATTERN & APPEARANCE & LOCATION ON PILE: [VERTICAL / HORIZONTAL, UNIFORM OR NON-UNIFORM PATTERN, DEPTHS];
   B. RUST STAINS COMING FROM CRACKS.
   C. SCALING & SPALLING (EXPOSED REO.), HONEYCOMBING OR WEAK 'BONEY' SOFT PATCHES.
   D. DAMAGED CONCRETE, SOFT CONCRETE (STRIKE WITH HAMMER AND NOTE SOUND), DISCOLORATION (AFTER BLASTING), SIGNS OF WATER PENETRATION, DELAMINATION.

   2.3 DETERMINE IF THERE IS SUFFICIENT SPACE BENEATH THE BASEPLATE TO ALLOW FOR ABRASIVE BLASTING.

   NOTE: UNDER ITEMS 2.2 & 2.3 ABOVE, IF ANY OF THESE ITEMS ARE FOUND (EXCEPT IF ALL CRACKS FOUND ARE <3mm) CONTACT TP ENGINEER BY EMAIL AND PROVIDE SUPPORTING DOCUMENTATION (PHOTOS & QA FORMS). TP ENGINEER IS TO DETERMINE IF THERE IS A CASE TO REVERT TO THE TYPE-5 REPAIR.

   NOTE: COMPLETE TYPE-5 REPAIR WORK BEFORE PROCEEDING WITH FOLLOWING INSTRUCTIONS]–

3. FOLLOWING THE REQUIREMENTS OF TP.SS 02.12, ISSUE-5.4, OCT. 2020. PREPARE TOWER LEG AND BASEPLATE

   3.1 PREPARE TOWER LEG STEEL: 300mm ABOVE BASEPLATE. NOTE: IF EXISTING PAINT LOOKS IN GOOD CONDITION THEN ONLY PREPARE BOTTOM 100mm OF LEG STEEL.

   3.2 PREPARE BASEPLATE 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, THIS INCLUDES THE UNDERSIDE OF THE BASEPLATE AND THE EXPOSED BOLTS & LEVELING NUTS BENEATH.

4. FILL BASEPLATE BOLT HOLES (AROUND BOLTS) WITH SIKAFLEX-MS SEALANT. REPLACE NUTS AND WASHER THEN TIGHTEN (SNUG TIGHT + 1/4 TURN).

5. APPLY PAINT TO PREPARED BASEPLATE STEELWORKS (ABOVE & BELOW BASEPLATE) AND TO THE TOWER LEG STEEL. THE UNDERSIDE OF BASEPLATE STEELWORKS IS ONLY TO BE PAINTED WITH PRIMER AND UNDERCOAT. DO NOT APPLY PAINT TO CONCRETE.

6. PLACE GROUT FORMWORK ENSURING A MINIMUM 50mm GAP AROUND THE PERIMETER OF THE BASEPLATE BEING SURE TO SEAL THE BASE OF THE BOXING WITH WET SAND OR SIMILAR.

7. PREPARE SELF LEVELING SIKA-215 GROUT (OR SIKA-212HP MIXED TO HIGH FLUIDITY) PER MANUFACTURERS INSTRUCTIONS AND POUR FROM ONE SIDE UNTIL IT FILLS TO 5mm BELOW THE TOP OF THE BASEPLATE. MAKING SURE THAT NO AIR VOIDS FORM BENEATH THE BASEPLATE.

8. REMOVE FORMWORK AFTER 24 HOURS. GRIND ANY SHARP EDGES.

9. APPLY 2 COATS OF CONCRETE PROTECTIVE COATING SIKATOP-107 OVER THE SURFACE EXPOSED GROUT SURFACES AND TO TOP OF THE EXISTING PILECAP CONCRETE. THE COATING IS TO EXTEND A MINIMUM OF 50mm DOWN SIDE OF PILECAP OR DOWN FURTHER AS NEEDED TO COVER CONCRETE CRACKS. THE SIKATOP-107 COATING IS TO BE INSTALLED AS PER MANUFACTURERS INSTRUCTIONS; DO NOT APPLY OVER STEELWORK.

THIS DRAWING SUPERSEDES TE37252/–

REV	REVISION DESCRIPTION	CONSULTANT									TP	
		CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRAISIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	CHANGE NOTE REFERENCE TO NOTE 10 ON DETAIL A TITLE, UPDATE FOLDER REFERENCE	TPNZ	DM	9/18	LP	10/20	DM	9/18	–	–	DM	9/18
G	REMOVED DTL-A | REV. NOTES (UPDATE SIKA PRODUCTS & ADDRESS CONC. CRACKING ISSUES)	TPNZ	DM	10/20	LP	12/20	KR	12/20	–	–	DM	7/23
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–	–	–	–	–	–	–	–	–	–	–	–	–

TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER BASEPLATE REFURBISHMENT DETAILS
TYPE 2 AND TYPE 2A
GROUT REPLACEMENT

TRANSPOWER PROJECT CODE	FOLDER
IP_2021_242_05	GEN/101.7B

DRAWING NUMBER	SHEET	REVISION
TE37252	2	G

DRAWING CREATED BY:
Transpower New Zealand Ltd
http://www.transpower.co.nz

SCALE N.T.S.

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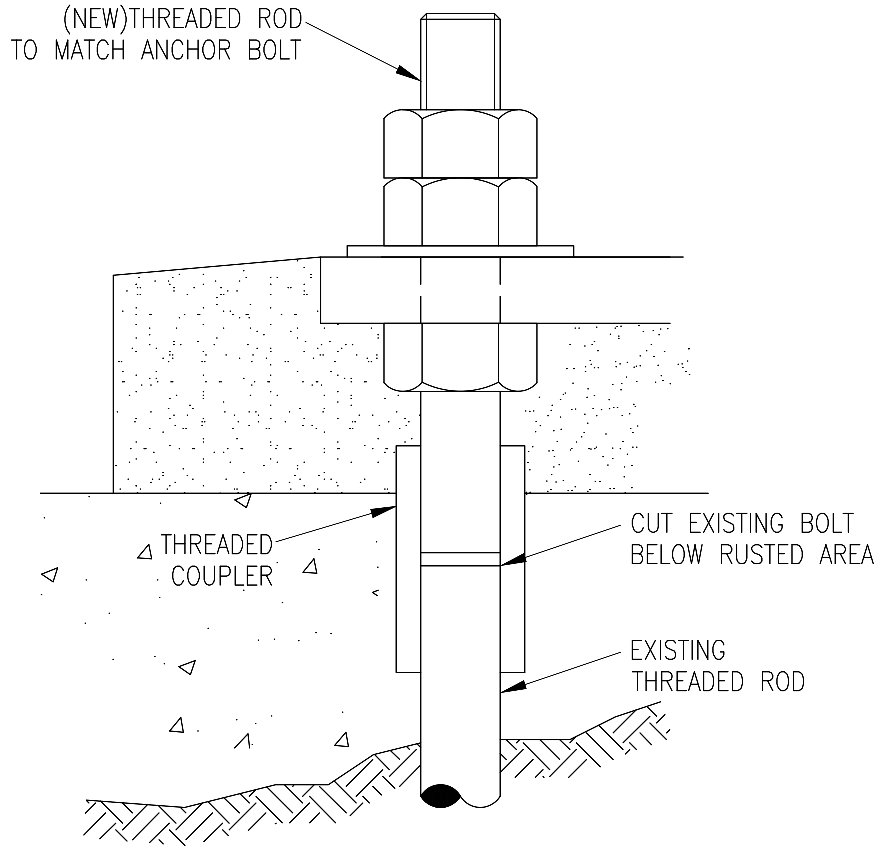
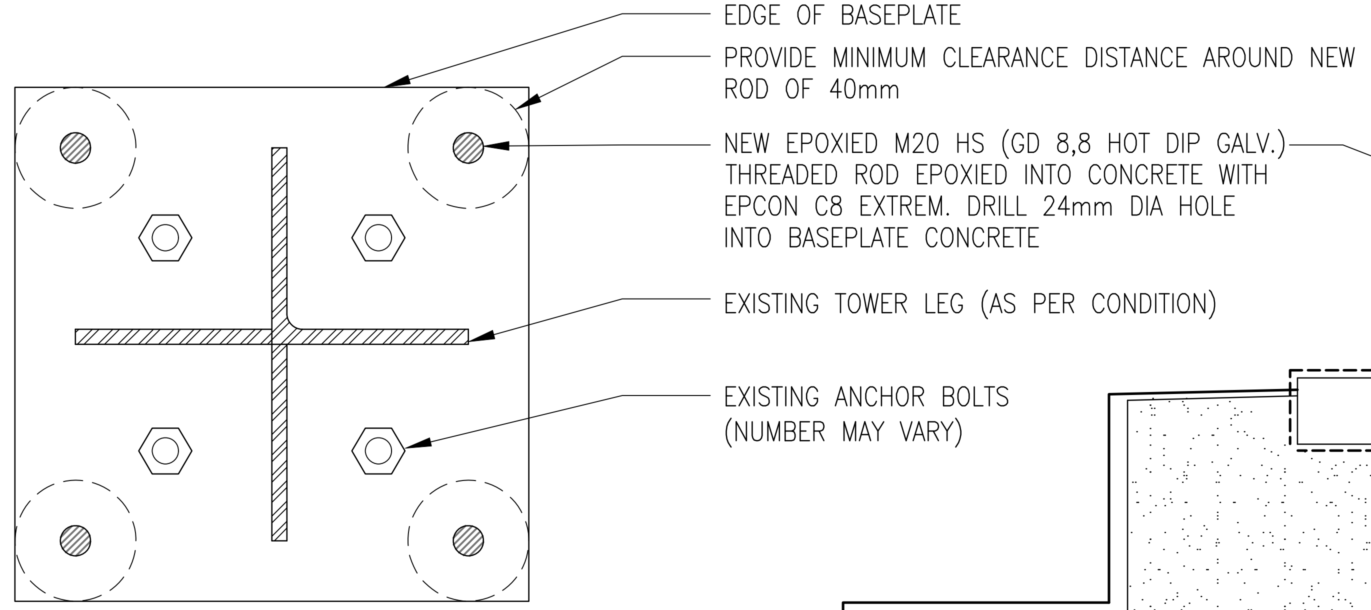


NEW THREADED ROD TO BE ATTACHED TO EXISTING ANCHOR BOLT WITH COUPLER

TYPE 3

NOTES FOR TYPE 3

1. BREAK OUT CONCRETE TO ALLOW SUFFICIENT WORKING SPACE
2. CUT BOLT BELOW RUSTED AREA AND CLEAN THREADS.
3. REMOVE EXISTING NUTS, WASHERS AND BOLT TOP. CLEAN INSIDE OF BOLT HOLE.
4. APPLY ZINC RICH PAINT TO SEAL END OF CUT BOLT AS PER TP.SS 02.12.
5. THREAD A COUPLING NUT ONTO EXISTING BOLT TO HALF WAY. COUPLER TO HAVE "WITNESS HOLES" TO BE ABLE TO VERIFY THAT BOLT THREADS ARE FULLY ENGAGE INTO COUPLER.
6. INSERT NEW GALVANIZED THREADED ROD OF THE SAME SIZE AND GRADE AS EXISTING (ADOPT G8.8 IF IN DOUBT) AND LEVELLING NUT AND THREAD INTO COUPLING NUT UNTIL IT MEETS THE EXISTING BOLT. POSITION THE LEVELLING NUT TO THE UNDERSIDE OF BASEPLATE.
7. REPAIR PILE CAP, MORTAR AND BASEPLATE WITH A TYPE 5 REPAIR AS PER TE37252 SHEET 4.
8. INSTALL NEW WASHER AND DOUBLE TOP NUTS AS PART OF THE TYPE-5 REPAIR PROCESS.



BASEPLATE PLAN VIEW (EXAMPLE)

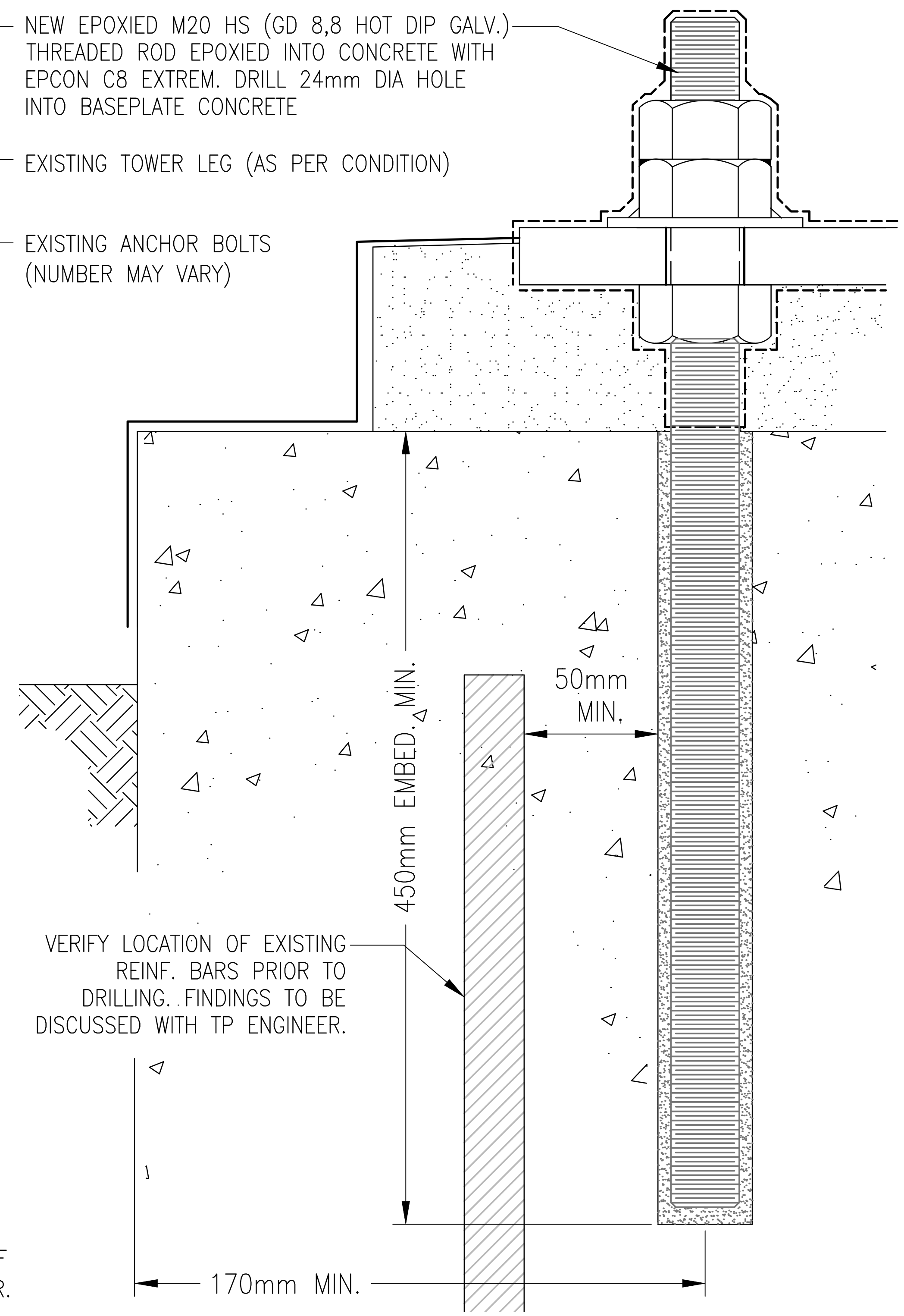
GENERAL NOTES

1. BREAK OUT GROUT AND/OR CONCRETE TO ALLOW SUFFICIENT WORKING SPACE UNDER AND AROUND BASEPLATE. RECORD SECTION LOSS OF ANCHOR BOLTS AS PER TP.SS 02.11, TP.SS 02.12 AND TP.SS 02.17B SECTION D3.6.1. REMOVE EXISTING NUTS AND WASHERS AT THE TOP OF THE BOLT. CLEAN INSIDE OF BOLT HOLES IN ORDER TO ASSESS THE CONDITION OF STEEL.
2. EMAIL TP ENGINEER A DIMENSIONED SKETCH OF BASEPLATE WITH BOLT SECTION LOSS DATA AND PROVIDE PHOTOS SHOWING FULL 360° VIEWS OF FOUNDATION, BASEPLATE AND BOLTS.

PROCEED WITH ANCHOR BOLT REPAIR TYPE 3 OR 3A ONCE THE RETROFIT APPROACH HAS BEEN APPROVED BY THE TP ENGINEER:

NOTES FOR TYPE 3A

1. PRIOR TO DRILLING HOLES IN CONCRETE, VERIFY THE LOCATION OF THE EXISTING REINFORCING BARS IN FOUNDATION TO AVOID THEM WHILE DRILLING. DRILL HOLES IN THE BASEPLATE AND CONCRETE AS REQUIRED BY THE TP ENGINEER FOR THE NEW EPOXIED THREADED ROD ANCHOR BOLTS. AFTER DRILLING HOLES IN THE FOUNDATION CONCRETE TO THE PRESCRIBED DEPTHS, THOROUGHLY CLEAN HOLES WITH COMPRESSED AIR (AIR VELOCITY: 4 SEC. MIN.) AND WITH A WIRE BRUSH TO REMOVE ALL DUST. PLACE EPOXY IN HOLES (1/2-2/3 FULL) STARTING FROM THE BOTTOM OF HOLE (AVOID CREATING AIR BUBBLES). THEN INSTALL THREADED ROD, TURNING SLOWLY UNTIL BOLT CONTACTS THE BOTTOM OF THE HOLE. DO NOT DISTURB BOLT UNTIL FULLY CURED (SEE EPOXY MFR. PROCEDURES). CLEAN UP EXCESS EPOXY AROUND BOLT ON TOP OF CONCRETE. ALLOW EPOXY TO CURE 48 HRS BEFORE PULL TEST. PULL TEST ONE OF THE EPOXIED ANCHORS PER LEG TO 100kN (RECORD TEST RESULTS ON QA DOCUMENTS).
2. REPAIR PILE CAP, MORTAR AND BASEPLATE WITH A TYPE-5 REPAIR AS REQUIRED. TOP NUTS AS PART OF THE TYPE 5 REPAIR PROCESS.



NEW EPOXIED THREADED ROD ANCHOR BOLTS INTO EXISTING CONCRETE

TYPE 3A

THIS REPAIR IS PERFORMED WHEN IT HAS BEEN DETERMINED (BY INSPECTION PER TP. SS 02.17B) THAT ANCHOR BOLTS HAVE SIGNIFICANT SECTION LOSS.

REV	REVISION DESCRIPTION	CONSULTANT									TP	
		CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRAISIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	EPOXY ANCHOR BOLT OPTION (TYPE 3A ADDED)	TPNZ	DM	10/20	KR	10/20	DM	10/20	–	–	DM	10/20
G	REV. UPDATED NOTES, FOLDER REFERENCE AND BORDER	TPNZ	DM	12/20	LP	12/20	KR	12/20	–	–	DM	7/23
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TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER BASEPLATE REFURBISHMENT DETAILS
TYPE 3 & 3A
ANCHOR BOLT REPAIR

TRANSPOWER PROJECT CODE	FOLDER
IP_2021_242_05	GEN/101.7B

DRAWING NUMBER	SHEET	REVISION
TE37252	3	G

DRAWING CREATED BY:	SCALE
Transpower New Zealand Ltd http://www.transpower.co.nz	N.T.S.

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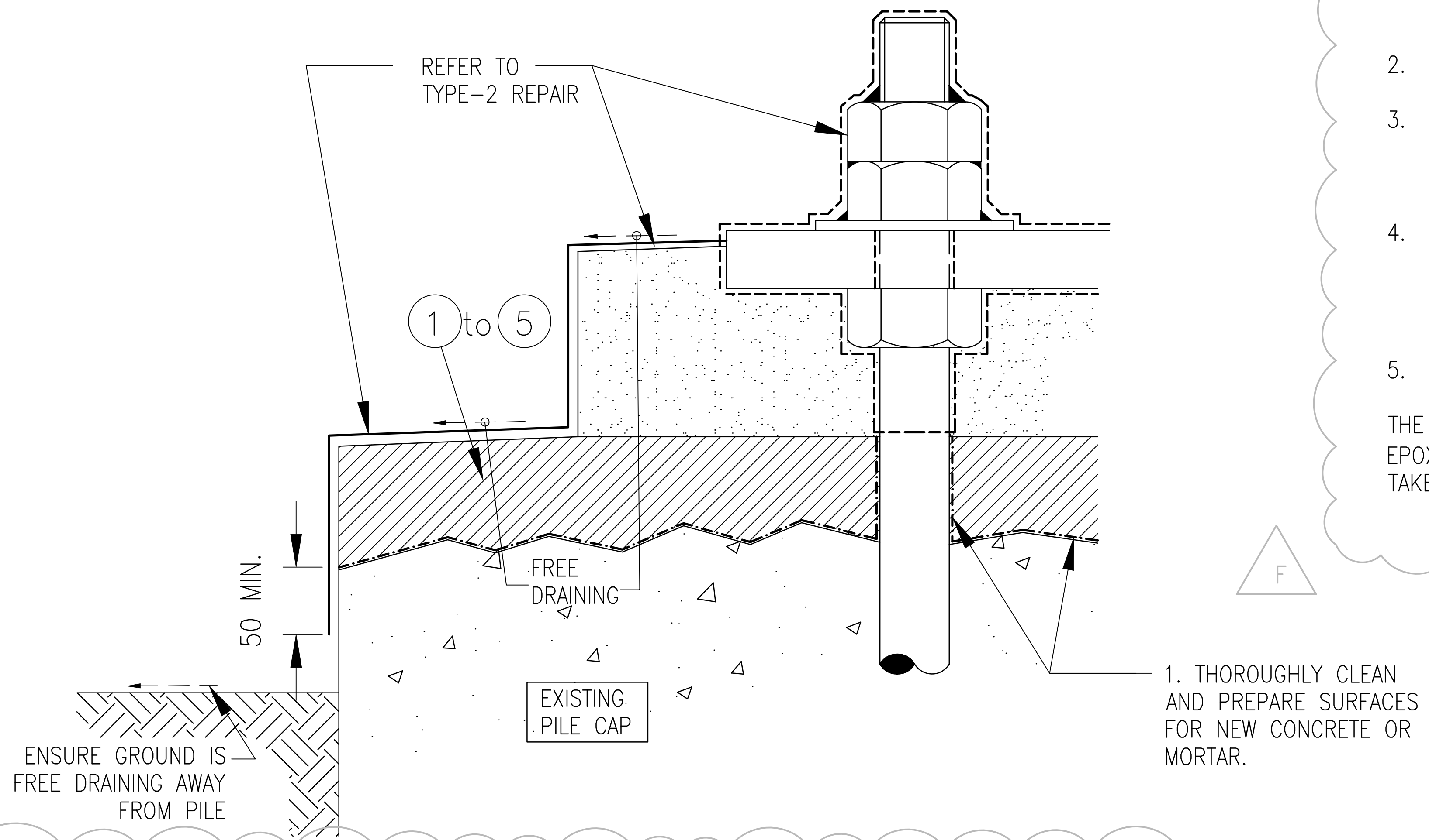
NOTES

IF IT IS FOUND THAT IT IS NECESSARY TO BREAKOUT THE EXISTING PILE CAP CONCRETE THE FOLLOWING IS TO BE PERFORMED PRIOR TO PROCEEDING WITH TYPE-2 REPAIRS.

1. BREAK OUT THE TOP OF THE PILECAP TO REMOVE DAMAGED/SOFT CONCRETE AND EXPOSE BELOW THE EXTENT OF RUST ON THE STUB LEG. PREPARE BROKEN OUT SURFACE OF CONCRETE AS FOLLOWS: ROUGHEN SURFACE, REMOVE LOOSE CONCRETE PIECES, AND THOROUGHLY CLEAN CONCRETE AND ANCHOR BOLT SURFACES.
2. PLACE FORMWORK AGAINST EDGES OF PILECAP.
3. APPLY SIKA-32 TO PROPERLY PREPARED BROKEN OUT CONCRETE AND STEEL INTERFACE SURFACES THAT WILL BE IN CONTACT WITH PILECAP REPAIR MORTAR OR CONCRETE (SEE ITEMS 4 AND 5 BELOW).
4. IF REPAIR THICKNESS < 75MM THEN MIX AND APPLY HIGH BUILD MORTAR, AS PER MANUFACTURERS INSTRUCTIONS, TO BUILD PILECAP TO ORIGINAL LEVEL ENSURING A FALL FROM THE EDGE OF THE LEG STEEL TO THE EDGE OF THE PILECAP. APPROVED HIGH BUILD MORTAR IS SIKA MONOTOP 352N.
5. IF REPAIR THICKNESS > 75MM THEN MIX AND POUR 35 MPa SMALL AGGREGATE CONCRETE TO BUILD PILECAP TO ORIGINAL LEVEL ENSURING A FALL FROM THE EDGE OF THE LEG STEEL TO THE EDGE OF THE PILECAP. CONTACT TP ENGINEER TO SEE IF STARTER BARS ARE REQUIRED TO BE EPOXIED INTO THE EXISTING PILE CONCRETE. THREE TEST CYLINDERS (100x200mm) ARE TO BE TAKEN AND TESTED FOR ALL SITES EXCEPT FOR DIFFICULT TO ACCESS AREAS FOR COMPRESSION STRENGTH AFTER 28 DAYS AND RESULTS ARE TO BE SENT TO TP ENGINEER FOR REVIEW.

F



TYPE 5 – PILECAP REPAIR AND NEW PILECAP GROUT REPLACEMENT
(AN EXTENSION OF TYPE-2 REPAIR DUE TO POOR CONDITION OF PILE CAP CONCRETE AND/OR IF THERE IS INSUFFICIENT SPACE UNDER BASEPLATE TO ACCOMPLISH TYPE-2 REPAIRS)

THIS DRAWING SUPERSEDES TE37252/-

REV	REVISION DESCRIPTION	CONSULTANT: CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	TP: APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRAISIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	UPDATE NOTES AND FOLDER REFERENCE	TPNZ	DM	10/20	KR	10/20	LP	12/20	–	–	DM	7/23
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TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER BASEPLATE REFURBISHMENT DETAILS
TYPE 5
PILECAP REPAIR AND GROUT REPLACEMENT

TRANSPOWER PROJECT CODE: IP_2021_242_05
FOLDER: GEN/101.7B
DRAWING NUMBER: TE37252
SHEET: 4
REVISION: F
DRAWING CREATED BY: Transpower New Zealand Ltd http://www.transpower.co.nz
SCALE: N.T.S.

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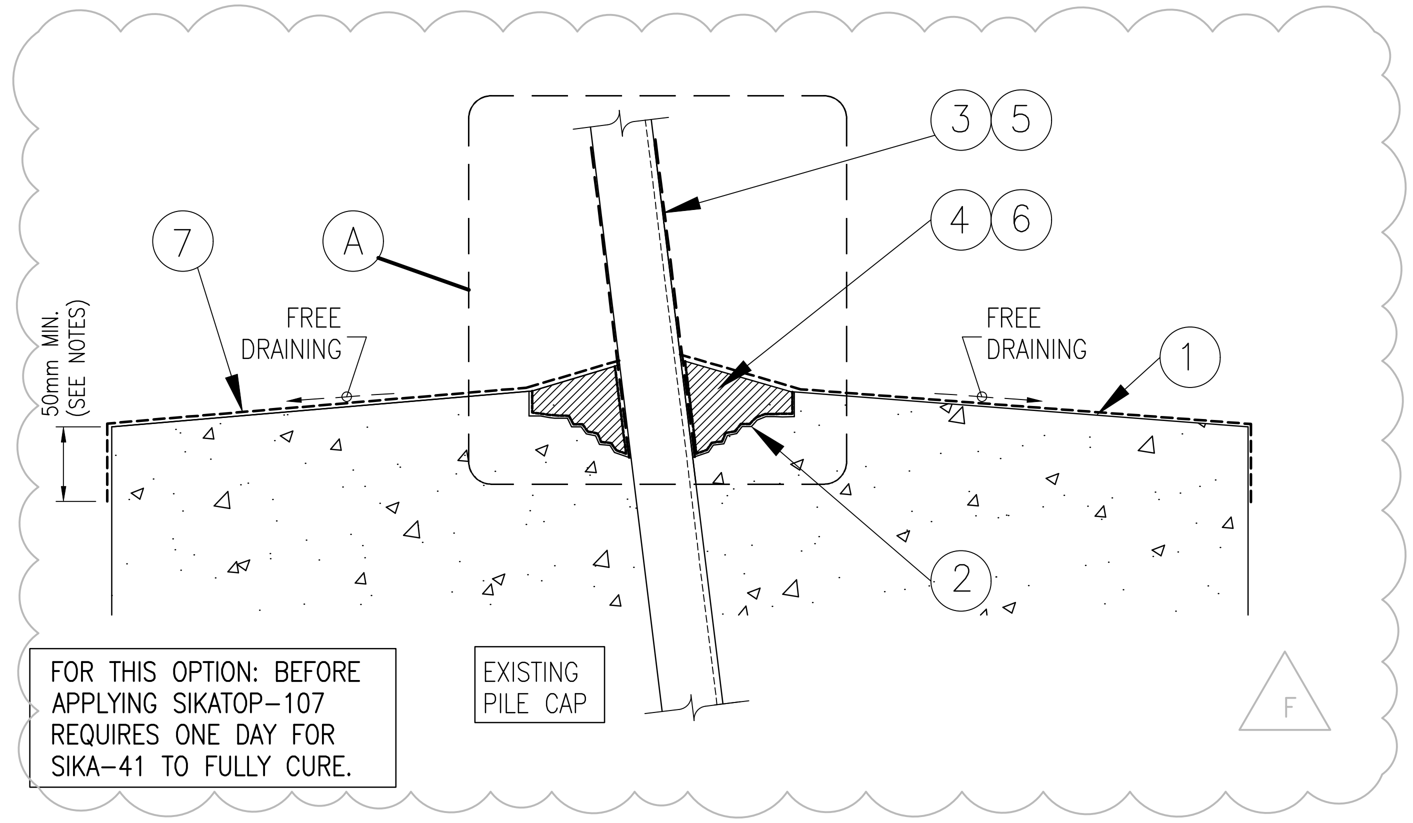
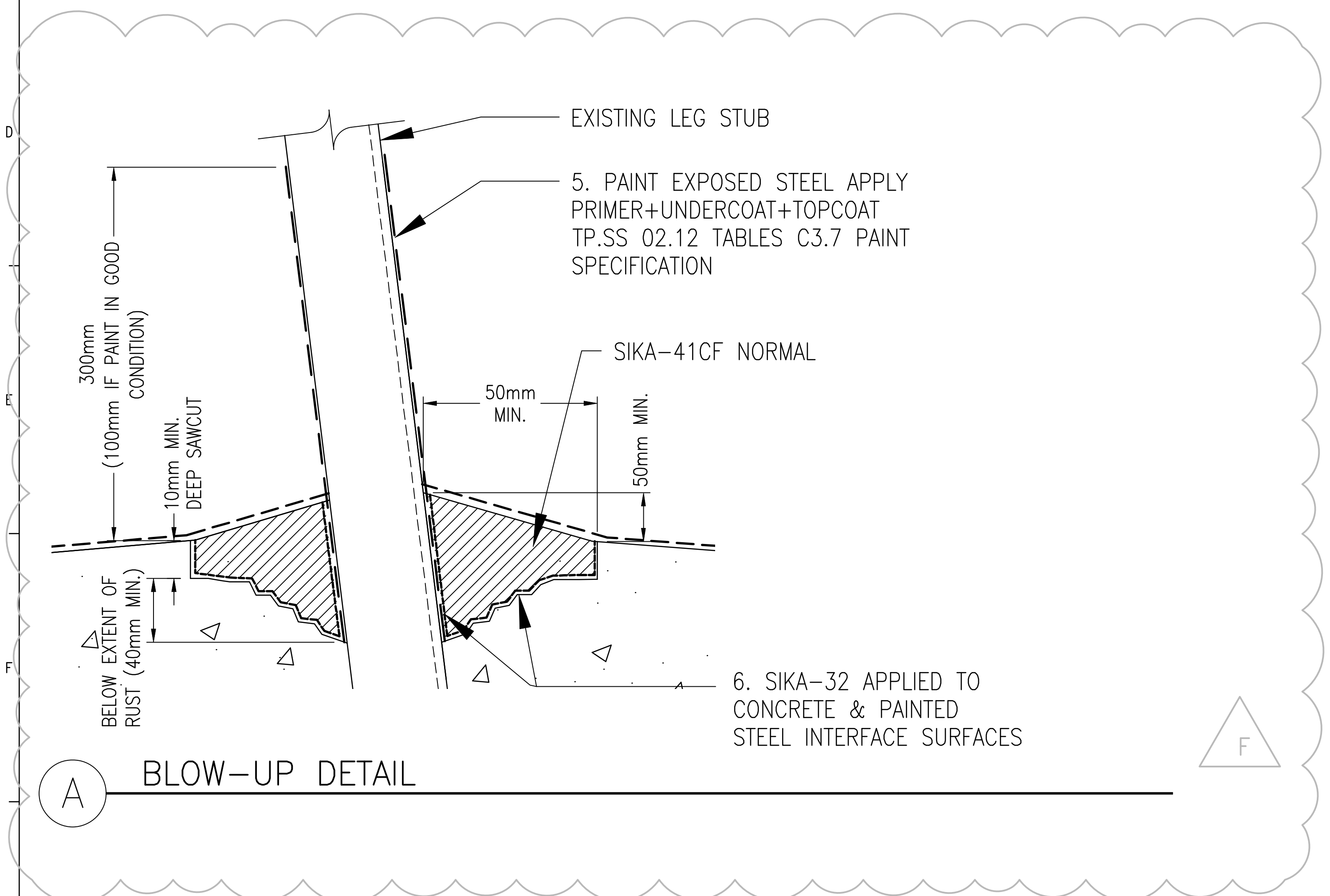


STUB LEG/PILECAP INTERFACE REPAIR



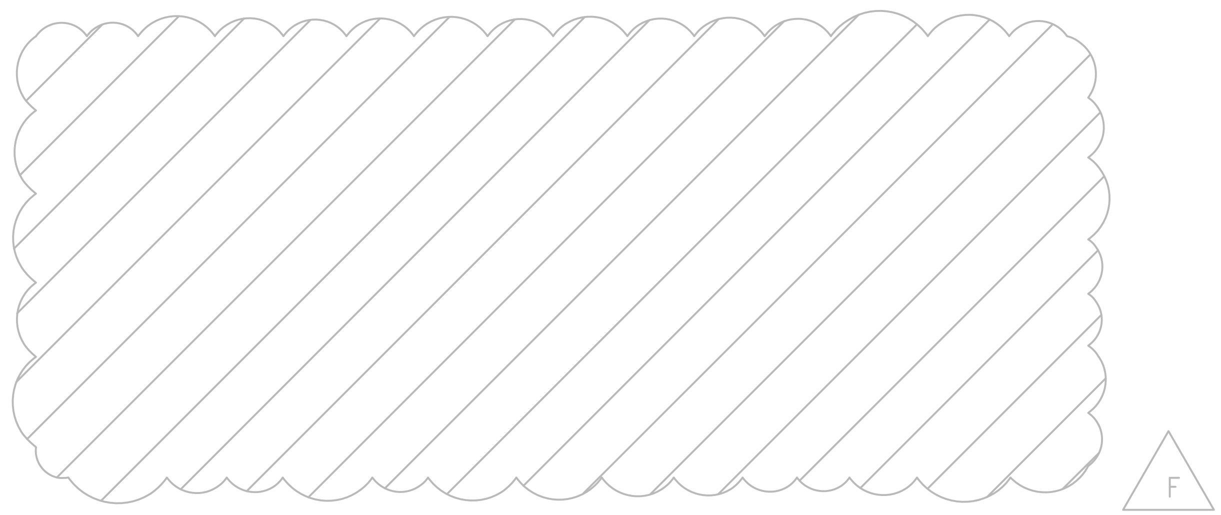
A BLOW-UP DETAIL

NOTES – TYPE 6A

1. INSPECT, PHOTOGRAPH AND DOCUMENT IN THE QA FORMS THE CONDITION, AS PER TP.SS 02.17B, OF THE EXISTING STUBE AND PILE CAP CONCRETE.
   1.1 DOCUMENT PILE CAP CONCRETE CONDITION NOTING THE FOLLOWING (AFTER BLASTING):
   A. CRACKING WIDTH SIZE: [(a) HAIRLINE; (b) FINE: 1mm–1.5mm; (c) MEDIUM: 1.5mm–3mm; (d) WIDE: >3mm]; CRACKING PATTERN & APPEARANCE & LOCATION ON PILE: [VERTICAL / HORIZONTAL, UNIFORM OR NON-UNIFORM PATTERN, DEPTHS];
   B. RUST STAINS COMING FROM CRACKS.
   C. SCALING & SPALLING (EXPOSED REO.), HONEYCOMBING OR WEAK 'BONEY' SOFT PATCHES.
   D. DAMAGED CONCRETE, SOFT CONCRETE (STRIKE WITH HAMMER AND NOTE SOUND), DISCOLORATION (AFTER BLASTING), SIGNS OF WATER PENETRATION, DELAMINATION.

NOTE: UNDER ITEM-1 ABOVE, IF ANY OF THESE ITEMS AS FOUND (EXCEPT IF ALL CRACKS FOUND ARE <3mm) CONTACT TP ENGINEER BY EMAIL AND PROVIDE SUPPORTING DOCUMENTATION (PHOTOS & QA FORMS). TP ENGINEER IS TO DETERMINE IF THERE IS A NEED BREAKOUT PILECAP AS PER TYPE-6B.

2. BREAKOUT CONCRETE AROUND STUB LEG AS PER DRAWING DETAIL-A.
3. ABRASIVE BLAST 300mm UP FROM THE ORIGINAL TOP OF PILE LEVEL UNTIL STEEL IS EXPOSED (NOTE: IF EXISTING PAINT LOOKS IN GOOD CONDITION THEN ONLY PREPARE BOTTOM 100mm OF STUB LEG STEEL).
4. CLEAN OFF ALL DUST & LOOSE MATERIAL FROM EXPOSED CONCRETE & STEEL SURFACES.
5. PREPARED AND PAINT STUB LEG STEELWORK FOLLOWING THE APPROVED PAINT SYSTEM GIVEN IN TP.SS 02.12 TABLE C3.7. NOTE: STEEL SURFACES TO BE PREPARED PER MFR. SPECIFICATIONS. DO NOT PAINT CONCRETE.
6. AFTER PAINT HAS CURED APPLY SIKA-32 TO CONCRETE AND PAINTED STEEL SURFACES THAT WILL BE IN CONTACT WITH SIKA-41CF NORMAL. WHILE THE SIKA-32 IS STILL TACKY TO THE TOUCH PLACE SIKA-41CF NORMAL FOLLOWING THE MANUFACTURERS INSTRUCTIONS.
7. AFTER 24 HOURS APPLY SIKATOP-107 CONCRETE PROTECTIVE COATING TO TOP OF THE EXISTING PILECAP CONCRETE. THE COATING IS TO EXTEND A MINIMUM OF 50mm DOWN SIDE OF PILECAP OR DOWN FURTHER AS NEEDED TO COVER CONCRETE CRACKS. THE SIKATOP-107 COATING IS TO BE INSTALLED AS PER MANUFACTURERS INSTRUCTIONS; DO NOT APPLY OVER STEELWORK.



THIS DRAWING SUPERSEDES TE37252/-

REV	REVISION DESCRIPTION	CONSULTANT CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	TP APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRASIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	REMOVED OPTION OF NOT APPLYING SIKATOP-107, UPDATE FOLDER REFERENCE	TPNZ	DM	10/20	KR	10/20	LP	12/20	–	–	DM	7/23
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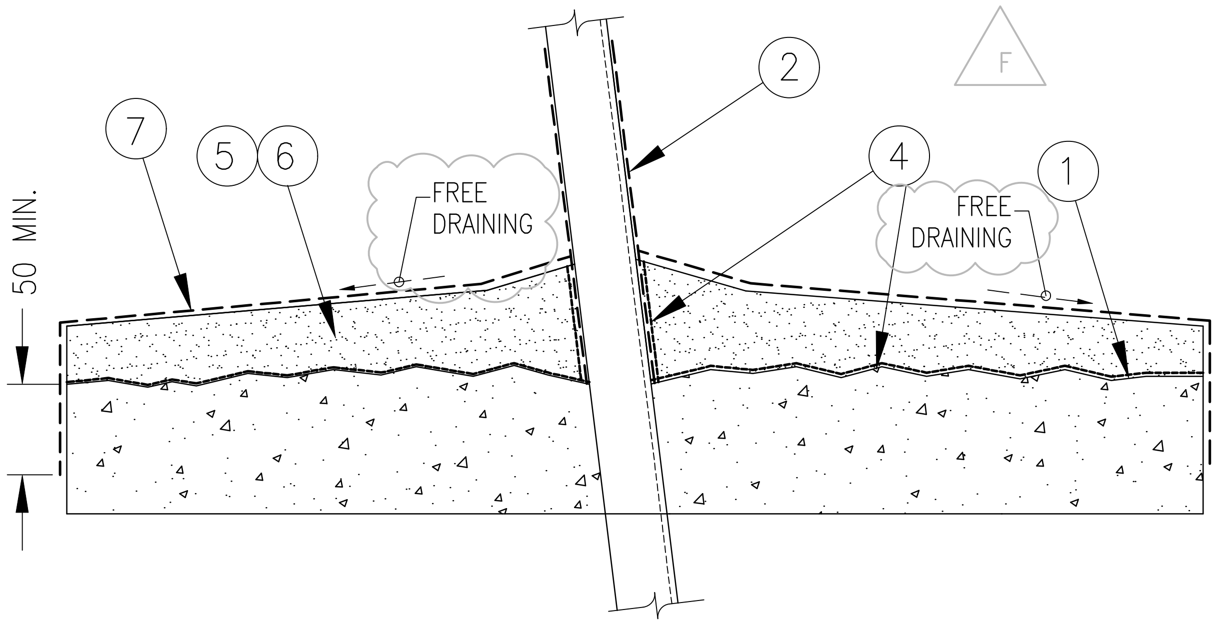
TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER STUB REFURBISHMENT DETAILS
TYPE 6A
STUB LEG PILECAP REPAIR

TRANSPOWER PROJECT CODE	IP_2021_242_05
FOLDER	GEN/101.7B
DRAWING NUMBER	TE37252
SHEET	5
REVISION	F
DRAWING CREATED BY:	Transpower New Zealand Ltd http://www.transpower.co.nz
SCALE	N.T.S.



TYPE 6B – STUB LEG REFURBISHMENT AND PILECAP REPAIR

NOTES

IF IT IS FOUND THAT IT IS NECESSARY TO BREAKOUT THE EXISTING PILE CAP CONCRETE FOLLOWING A TYPE-6A CONCRETE CONDITION ASSESSMENT THEN THE FOLLOWING REPAIRS ARE TO BE UNDERTAKEN:

1. BREAK OUT THE TOP OF THE PILECAP TO REMOVE DAMAGED/SOFT CONCRETE AND EXPOSE BELOW THE EXTENT OF RUST ON THE STUB LEG. PREPARE BROKEN OUT SURFACE OF CONCRETE AS FOLLOWS: ROUGHEN SURFACE, REMOVE LOOSE CONCRETE PIECES, AND THOROUGHLY CLEAN SURFACE.

2. PREPARE STUB LEG STEEL BY ABRASIVE BLASTING 300mm UP FROM THE ORIGINAL TOP OF PILE LEVEL UNTIL STEEL IS EXPOSED (NOTE: IF EXISTING PAINT LOOKS IN GOOD CONDITION THEN ONLY PREPARE BOTTOM 100mm OF STUB LEG STEEL); FOLLOWING THE REQUIREMENTS OF TP.SS 02.12, ISSUE-5.4, OCT. 2020 FOR APPLICATION OF APPROPRIATE PAINT SYSTEMS AS GIVEN IN TABLE C3.7.

3. AFTER PAINT HAS CURED PLACE FORMWORK AGAINST EDGES OF PILECAP.

4. APPLY SIKA-32 TO PROPERLY PREPARED BROKEN OUT CONCRETE AND STEEL INTERFACE SURFACES THAT WILL BE IN CONTACT WITH PILECAP REPAIR MORTAR OR CONCRETE. SPECIFICATIONS (SEE ITEMS 5 AND 6 BELOW).

5. IF REPAIR THICKNESS < 75MM THEN MIX AND APPLY HIGH BUILD MORTAR, AS PER MANUFACTURERS INSTRUCTIONS, TO BUILD PILECAP TO ORIGINAL LEVEL ENSURING A FALL FROM THE EDGE OF THE LEG STEEL TO THE EDGE OF THE PILECAP. APPROVED HIGH BUILD MORTAR IS SIKA MONOTOP 352N.

6. IF REPAIR THICKNESS > 75MM THEN MIX AND POUR 35 MPa SMALL AGGREGATE CONCRETE TO BUILD PILECAP TO ORIGINAL LEVEL ENSURING WITH A FALL FROM THE EDGE OF THE LEG STEEL TO THE EDGE OF THE PILECAP. SIKA MONOTOP-438R CAN BE USED INSTEAD OF STANDARD CONCRETE MIX UP TO A LAYER THICKNESS OF 300mm MAX. (500mm WHEN BULKED UP WITH 10kg SIKA PEA METAL PER 25kg BAG OF SIKA MONOTOP-438R) FOLLOWING MANUFACTURES INSTALLATION INSTRUCTIONS. NOTE: CONTACT TP ENGINEER TO SEE IF STARTER BARS ARE REQUIRED TO BE EPOXIED INTO THE EXISTING PILE CONCRETE. THREE TEST CYLINDERS (100x200mm) ARE TO BE TAKEN AND TESTED FOR ALL SITES, EXCEPT FOR DIFFICULT TO ACCESS, FOR COMPRESSION STRENGTH AFTER 28 DAYS AND THE RESULTS ARE TO BE SENT TO TP ENGINEER FOR REVIEW.

7. AFTER 24 HOURS APPLY SIKATOP-107 CONCRETE PROTECTIVE COATING TO TOP OF THE NEWLY PLACED PILECAP CONCRETE. THE SIKATOP COATING IS TO EXTEND DOWN SIDE OF THE PILECAP 50mm MIN. BEYOND NEW BOTTOM OF NEWLY PLACED CONCRETE. THE SIKATOP-107 COATING IS TO BE INSTALLED AS PER MANUFACTURERS INSTRUCTIONS; DO NOT APPLY OVER STEELWORK.

THIS DRAWING SUPERSEDES TE37252/-

REV	REVISION DESCRIPTION	CONSULTANT									TP	
		CONSLT	DSN	DATE	DRN	DATE	CHK	DATE	APP	DATE	APP	DATE
D	FOR CONSTRUCTION	LTC	ID	6/16	ID	6/16	PG	6/16	PG	6/16	DM	9/17
E	CHANGE WATER BLASTING TO ABRAISIVE BLASTING	TPNZ	ID	6/16	ID	6/16	DM	11/17	–	–	DM	11/17
F	UPDATE NOTES AND FOLDER REFERENCE	TPNZ	DM	10/20	KR	10/20	LP	12/20	–	–	DM	7/23
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TRANSPOWER

GENERAL – TOWER SPECIFICATION

TOWER STUB REFURBISHMENT DETAILS
TYPE 6B
STUB LEG PILECAP REPAIR

TRANSPOWER PROJECT CODE	FOLDER
IP_2021_242_05	GEN/101.7B

DRAWING NUMBER	SHEET	REVISION
TE37252	6	F

DRAWING CREATED BY:
Transpower New Zealand Ltd
http://www.transpower.co.nz

SCALE
N.T.S.

A3

Appendix F

Beca

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23 July 2024

Attention: Tim Smith

Dear Tim

Privileged and Confidential - Northland Event - Technical Support

Introduction

On or about 11.03 am on Thursday 20 June 2024, Tower 130 of the 220 kV Henderson to Marsden A (HEN-MDN A) line, adjacent to State Highway 16 near Glorit, 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).

One of Transpower New Zealand Limited's (Transpower) Service Providers, Electrix Limited (trading as Omexom New Zealand) (Contractor) was undertaking maintenance on the foundation of Tower 130 at the time of the Incident.

On Monday 24 June 2024, Transpower chief executive Alison Andrew and Omexom New Zealand managing director Mornez Green, in a joint press conference, confirmed during the maintenance works, too many nuts were removed from the base plates and the tower fell over.

Beca's Instructions

Transpower has subsequently engaged Beca Limited (Beca) to provide engineering expert support to their investigation regarding the Incident.

Beca's scope of engagement consists of the following:

1. Carrying out a site visit of Tower 130 and the site of the Incident;
2. Undertaking calculations and loading assessment to determine the tower load compared with capacity and confirm the failure mode of the structure;
3. Providing other support to the Investigation team as agreed between Beca and Transpower.

This letter documents the findings of the engineering investigation undertaken by Beca.

Information relied on or reviewed

The following information has been received and relied on for the investigation:

- PLS-CADD model of the existing HEN-MDN A transmission line, *hen-mdn-a underclearance as-built lumen 20220920.bak*, received from Transpower

make everyday better.

- PLS-CADD model survey conductor and ambient temperatures, *HEN-MDN-A_Temperature.xls*, received from Transpower
- TOWER modelling input data for tower contract No. 464, Type C tower, *C464-C TOWER Data Input rB.xlsx*, received from Transpower
- As-built drawings of the HEN-MDN A transmission line, sourced from Transpower's RedEye drawing management system:
  - Route Plan Structures 117 – 132, *EAK1142_10_0.tif*
  - Route Plan and Profile Structures 128 – 132, *EAK1220_33_0.tif*
  - Concrete Footings for Angle Tower Contract 464, *F7613_-_0.tif*
  - Contract No. 464 Type C Tower, Grillage Footing – Concrete Footing, *P34754_-_1.tif*
- Schematic of the HEN-MDN A transmission line, *Lines Asset Drawings - RSA1.pdf*, sourced from the Transpower website (https://www.transpower.co.nz/)
- Transpower standards and service specifications, sourced from the Controlled Documents portal on the Transpower website (https://www.transpower.co.nz/)
  - Service Specification TP.SS 02.11, Maintenance and construction of steel towers and tower foundations, Issue 3, December 2019
  - Service Specification TP.SS 02.12, Protective Coating of Transmission Line Structures and Foundations, Issue 6, October 2022
  - Service Specification TP.SS 02.98, Transmission Lines Asset Maintenance Requirements, Issue 2.2, November 2023
  - Design Standard TP.DL 12.01, Transmission Line Loading Code, Issue 6.1, February 2021
- Transpower Tower Baseplate Refurbishment Details drawing, *TE37252_1-6.pdf*, sourced from Transpower's RedEye drawing management system.
- Weather station data for 19 and 20 June 2024, supplied by National Institute of Water & Atmospheric Research Ltd (NIWA)
  - *Wind_Temp_Data.xls*
  - *HourlyWind.xlsx*
- Photos of the site from 20 and 21 June, supplied by [redacted] Transpower.

The PLS-CADD model and TOWER model input data referred to above have been prepared and reviewed by other engineering consultants. As these elements have been previously used and verified, we consider them approved for use by Transpower. We have also conducted a high-level review of the model and TOWER input data to check for any obvious errors or omissions.

Relevant Transpower Specifications

The relevant Transpower specifications and drawings for the foundation maintenance works being undertaken were as follows:

- Service Specification TP.SS 02.11, Maintenance and construction of steel towers and tower foundations, Issue 3, December 2019
- Service Specification TP.SS 02.12, Protective Coating of Transmission Line Structures and Foundations, Issue 6, October 2022
- Service Specification TP.SS 02.98, Transmission Lines Asset Maintenance Requirements, Issue 2.2, November 2023
- TE37252_1-6, Tower Baseplate Refurbishment Details drawing

TP.SS 02.11 specifies how to keep the tower stable during maintenance and repair activities. The clauses that apply are:

- C1.2 Options considered for maintenance of tower foundations need to be designed for site-specific loads and site-specific conditions.

- 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.

Brief Description of Site / Tower

Tower 130 of the HEN-MDN A transmission line is located adjacent to 2995 Kaipara Coast Highway (State Highway 16), Glorit, Auckland.

The route plan and profile drawing for the asset (EAK1220, sheet 33), show the tower is a contract no. 464 Type C, angle suspension tower. The height from ground to the top of the tower is approximately 42 m. The transmission line generally runs in a north-south direction and has a deviation angle (where the transmission line changes direction) at Tower 130 of 9.5 degrees to the east.

The HEN-MDN A transmission line supports two 220 kV circuits, one on each side of the tower. The western side of Tower 130 supports the BRB-HPI 1 circuit, with simplex (single) Zebra ACSR conductors. The eastern side of the tower supports the HPI-MDN 1 circuit, with duplex (twin) Zebra ACSR conductors. The tower also supports two overhead 7/3.05mm SC/AC earthwires.

Tower 130 is supported by four concrete pile foundations. As shown in Figure 1, legs A and B are located on the western side of the tower, outside of the deviation angle. Legs C and D are located on the eastern side of the tower, inside of the deviation angle.

The tower drawing (P34754) shows each leg is connected to the concrete foundation via steel base plates and eight holding down bolts. An extract of drawing P34754 is given in Figure 2.

Figure 1 - HEN-MDN A Tower 130 site layout and approximate location of tower post Incident

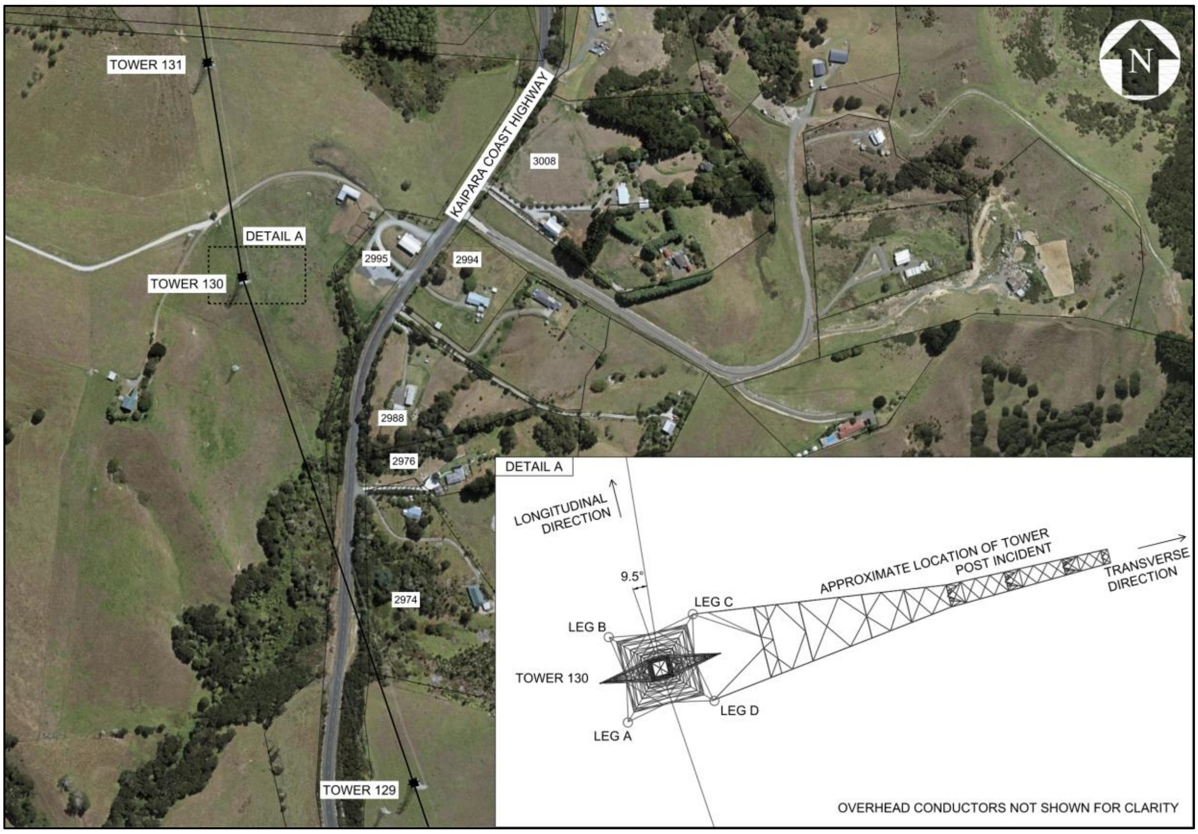
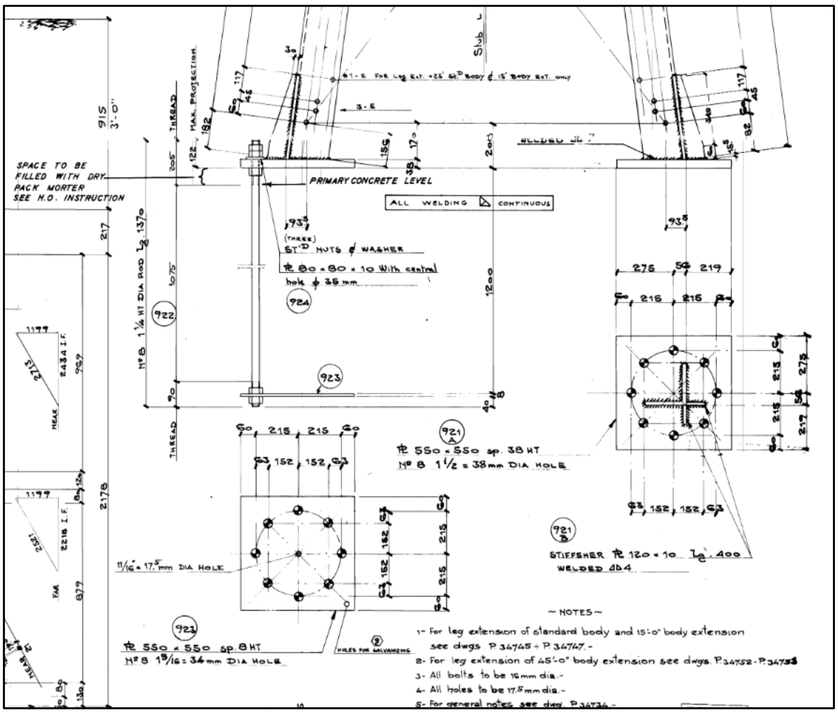


Figure 2 - Extract of tower contract 464 type C tower drawing P34754 showing holding down bolt arrangement



Site Visit Observations

Beca visited the site at 3pm on Tuesday, 25 June 2024, approximately five days after the Incident occurred. Photos from the site can be found in Attachment A. Our observations and interpretations from the site visit are recorded below.

- The tower location, type and arrangement appeared consistent with the existing as-built drawings of the asset.
- Temporary restoration works of the HEN-MDN A transmission line were well advanced. Tower 130 had been relocated from the fallen location to make way for the temporary restoration structures. The location where the Tower 130 hit the ground had been disturbed by the restoration works.
- 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. Refer to photo A.4 in Attachment A. As there was no obvious damage to the holding down bolts or base plate of leg B, these items must have been put back on the bolts after the tower had fallen.
- 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 base plates of leg 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 base plates to lift off the holding down bolts cleanly during the fall.
- All nuts had been removed from the holding down bolts of leg C. The five holding down bolts on the eastern side of 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. Refer leg C foundation photos A.8 to A.11 in Attachment A. 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 base plate lifted from the bolts.
- All nuts were in place on leg D. The stub leg had ruptured immediately above the welded stiffeners connecting the leg angle and base plate. Refer to photos A.12 to A.15 in Attachment A.

- There were signs of sand blasting to base plates, bolts and nuts on leg D, as shown by the presence of surface rust. Refer to photos A.12 to A.15 in Attachment A.
- There were signs of sand blasting to the base plates on legs A and C, as shown by the presence of surface rust. Refer photos A.17 and A.21 in Attachment A. As surface rust was not present where the square washers would have been located, it indicates sand blasting was undertaken prior to the removal of the square washers and nuts.
- Sand blasting may have been undertaken to leg B, however the presence of surface rust was less visible in the site photos captured compared to other legs. Refer to photo A.24 in Attachment A.
- There were no indications that corrosion or sabotage might have played a role in the fall of the tower.

[redacted] Service Delivery Manager – RSA1 Lines & HV CABLES Transpower, provided his photos of the site which were taken between 3.05pm and 4.24pm on the day of the Incident. Relevant photos are included in Attachment B. Observations, additional to those above, from these photos are as follows:

- Fallen tower legs C and D were located next to their foundations, which indicates the tower fell approximately in the transverse direction to the east, normal to the line, as shown in Figure 1.
- 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 not clear whether these are from one leg or multiple legs.

Analysis Undertaken

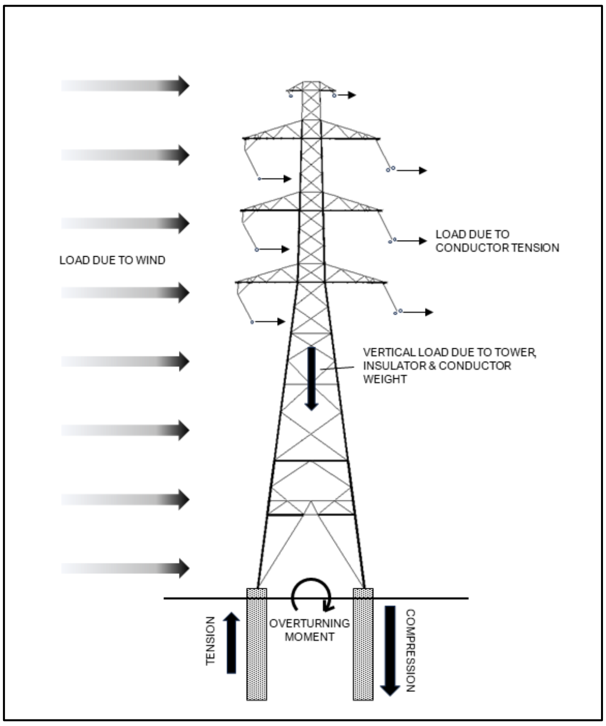
The foundations of transmission line towers are normally subjected to three types of forces; compression (downwards), tension (upwards), and lateral (sideways) forces in both transverse and longitudinal directions.

Loading on the tower occurs from the self-weight of the structure and conductors, tension loads from the conductors and wind pressure on the tower and conductors. These forces are transferred from the tower into the foundations which resist these loads.

When loads are applied on the tower, it generates an overturning moment at the base of the tower. This moment is reacted by tension and compression forces in the foundations. Foundations situated on the outside of the deviation angle or on the windward side of the tower during wind conditions may encounter tension forces. This is shown in the diagram in Figure 3.

At Tower 130, the design of the tower uses holding down bolts and a base plate to transfer these loads to the foundation. The deviation angle of the structure induces compression force in legs C and D, and tension force in legs A and B.

Figure 3 - Diagram of forces acting on a tower



For towers which use steel base plates with holding down bolts, compression forces are supported by the base plate bearing on levelling nuts/packers and grout at the top of the concrete foundation. Tension forces are resisted by the nuts on the holding down bolts.

Removing the nuts from the holding down bolts removes the capacity of the foundation to support tension forces. Some adhesion would exist between the steel base plate and the grout, however this is considered negligible.

When the legs that are intended to resist tension forces lose their tension capacity, the foundations no longer counteract the overturning moment with tension and compression forces. Instead, bending moments occur in the remaining leg(s) that are still attached to the foundation. This bending capacity does not contribute any material capacity to withstand the overturning moment. The damage to Tower 130 leg D, which was still fixed to the foundation, is consistent with the bending capacity being exceeded.

We have undertaken calculations and loading assessments for Tower 130 for three cases:

1. The construction and maintenance load case applicable for the works undertaken as per Transpower standards.
2. Assessment of foundation loads under still air conditions (no wind).
3. Assessment of foundation loads under wind conditions as obtained from the closest NIWA weather station.

As observed during the site visit, all nuts had been removed from legs A, B (with one nut replaced on leg B post the tower fall) and C. 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. To investigate why the fall may not have immediately occurred, cases 2 and 3 have been assessed to replicate the conditions that may have been present on site. No load factors have been applied for these cases to approximate actual loads.

The assessment has been undertaken using software packages PLS-CADD and TOWER. The PLS-CADD software package is used to model the transmission line and to calculate forces acting on the transmission line and structures. An existing PLS-CADD model of the HEN-MDN A transmission line was supplied by Transpower and has been used for the assessment.

The TOWER software package is used to model the lattice tower structure. This model is used to determine the forces in the foundations due to loading on the tower.

While calculations are based on well-established scientific principles and empirical data, many variables in the real world cannot be precisely quantified. Factors like material imperfections, environmental conditions, and unforeseen stresses mean that the exact loads differ slightly from calculated loads.

A description and findings from the assessment of the three cases are as follows:

1. Standard construction and maintenance load case

Appendix C of Transpower Service Specification TP.SS 02.11 specifies that tower loads need to be determined so as to not compromise the stability of the tower during maintenance/repair. TP.SS 02.11 clause C4.3 specifies that all designs shall be based on TP.DL 12.01 and submitted to Transpower for approval.

Transpower document TP.DL 12.01 (Transmission Line Loading Code – Design Standard'), specifies the climatic conditions and coincident temperatures to be assessed for construction and maintenance (C&M) activities of varying durations, refer Section 5.4. For C&M works where components can be restored within one week of commencing the works, CM1 case applies. This requires the consideration of a 100 Pa wind (equivalent to a wind speed of 46.5 km/hr) with coincident temperature of 5°C. The application of load case CM1 is approved by Transpower on the basis that C&M methodologies and procedures adopt suitable weather watch measures together with emergency plans to temporarily restore capacities should the works be delayed, the weather worsens, or other unforeseen circumstances.

Using the PLS-CADD and TOWER models, an assessment has been undertaken to estimate the foundation loads for Tower 130 under the CM1 case. Foundation loads have been calculated with the 100 Pa wind applied from the left and right sides of the line and with differential winds applied to back and ahead spans, in line with requirements of TP.DL 12.01. Maximum tension and compression loads for each leg under all wind directions are given in Table 1, below. Table 1 shows, by calculation, that both legs A and B experience tension loading under the CM1 case.

Table 1 – Tower 130 foundation loads under standard construction and maintenance load case CM1

Leg	Maximum Tension Force (kN)	Maximum Compression Force (kN)
A	58	-
B	42	16
C	-	172
D	-	149

Given the potential for tension forces, removing all nuts from the holding down bolts on legs A and B effectively eliminates their tension capacity. This action does not meet the criteria outlined in TP.DL 12.01 and, therefore, does not comply with the requirements of TP.SS 02.11.

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.

2. Assessment of foundation loads under still air conditions

The foundation loads under still air conditions are given in Table 2. Legs A and B are calculated to have tension forces.

Table 2 – Tower 130 foundation loads under still air conditions

Leg	Tension Force (kN)	Compression Force (kN)
A	30	-
B	12	-
C	-	141
D	-	121

This assessment shows that under a still air condition there are tension forces on legs A and B. By removing the nuts, the tower would likely fall under this condition.

3. Assessment of foundation loads under wind conditions as obtained from the closest NIWA weather station

The closest weather station, which records wind data, is in Leigh, approximately 39 km east-northeast of Tower 130. The hourly winds speeds recorded at the approximate time of the Incident and the two hours prior are given in Table 3, supplied by NIWA. While the hourly wind speeds leading up to the event were relatively constant in speed and direction, the conditions at Tower 130 may have been quite different given the significant distance, and possibly exposure, from the Leigh weather station, located on the east coast.

Table 3 - Hourly wind data from Leigh 2 EWS, supplied by NIWA

Date and time of recording	Wind speed (km/hr)	Wind direction bearing (°)
20/06/2024 9 am	37.4	69
20/06/2024 10 am	36.0	67
20/06/2024 11 am	39.6	68

PLS-CADD and TOWER models were used to calculate foundation loads for Tower 130 under a wind speed of 39.6 km/hr (72.6 Pa) coming from a bearing of 68°, approximately an east-northeast direction, which is the reading at the Leigh 2 EWS weather station at the approximate time of the Incident. The calculated foundation loads are given in Table 4. Leg A is calculated to be the only leg with a tension force. As the wind is coming from the east-northeast direction, it provides restorative forces opposing the lateral load from the deviation angle.

Table 4 – Tower 130 foundation loads under wind conditions as obtained from the closest NIWA weather station (Leigh 2 EWS)

Leg	Tension Force (kN)	Compression Force (kN)
A	5	-
B	-	8
C	-	115
D	-	102

This evaluation indicates that under the NIWA weather conditions, legs A and B experience minimal forces of tension or compression. Calculations show that if the nuts on these legs are removed, the tower stability would be marginal, and it is inconclusive if the tower would fall due to the many variables.

Conclusions

The site visit on 25 June 2024 revealed 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 holding down bolts. Leg D was still fixed to the foundation but ruptured. The 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 ultimately causing the tower to fall.

The loading assessment and calculations undertaken show that legs A and B had the potential for tension forces under the C&M 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.

Yours sincerely

Mark Borkin

Technical Director - Transmission Line Engineering

on behalf of

Beca Limited

Phone Number: +64 9 300 9669
Email: Mark.Borkin@beca.com

Copy
Mark Ryall – Transpower
Daniel Twigg – c/o Transpower

A

Attachment A – Site Notes and Photographs from 25 June 2024

Photo A.1: Temporary restoration works. Western circuit supported by Lindsey tower (right), eastern circuit restoration using three steel monopoles in progress (middle), Tower 130 relocated from fallen location (left).

Photo A.2: Leg A foundation underwater upon arriving to site, prior to being drained.

Photo A.3: Leg A foundation after being drained. No holding down bolts with nuts installed. No damage to bolt threads observed.

Photo A.4: Leg B foundation holding down bolts. Square washers and nut suspected to be placed back on bolts after tower fall. No damage to bolt threads observed.

Photo A.5: Leg B foundation holding down bolts. No damage to bolt threads observed.

Photo A.6: Leg B foundation holding down bolts. No damage to bolt threads observed.

Photo A.7: Leg C foundation underwater upon arriving to site, prior to being drained.

Photo A.8: Leg C foundation after being drained. No holding down bolts with nuts installed. Five holding down bolts on the eastern side bent towards the west, with the bolt furthest to the east broken in two places. No obvious evidence to suggest that the nuts had been stripped from any of the holding down bolts.


Photo A.9: Leg C foundation after being drained.


Photo A.10: Leg C foundation after being drained.


Photo A.11: Leg C foundation after being drained.


Photo A.12: Leg D ruptured. No nuts removed. Sign of sand blasting to base plate, bolts and nuts.


Photo A.13: Leg D ruptured. No nuts removed.


Photo A.14: Leg D ruptured. No nuts removed.


Photo A.15: Leg D ruptured. No nuts removed.


Photo A.16: Legs A and B of fallen tower (top of image). No obvious damage observed from ground level. Approx. 8 nuts and square washers tied via rope to leg A.

Photo A.17: Leg A (top, left). Sign of sand blasting on leg A prior to removal of square washers, as shown by presence of surface rust on the top of the base plate and paint removed on the leg members.

Photo A.18: Leg C of fallen tower. Damage to k-brace member.

Photo A.19: Underside of baseplate of leg C. Some damage to the bolt hole closest to the ground (eastern side of base plate), which aligns with broken bolt.

Photo A.20: Underside of baseplate of leg C. Some damage to the bolt hole closest to the ground (eastern side of base plate), which aligns with broken bolt.

Photo A.21: Top side of leg C base plate. Sign of sand blasting, as shown by presence of surface rust on the top of the base plate and paint removed on the leg members.

Photo A.22: Leg D of fallen tower. Ruptured from stub leg attached to foundation.

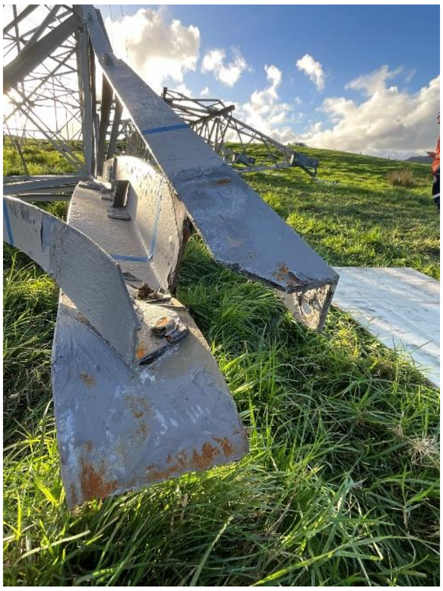


Photo A.23: Leg D of fallen tower. Ruptured from stub leg attached to foundation.

Photo A.24: Leg A (top, left) and leg B (top right)

B

Attachment B – Site photos supplied by Transpower from 20 June 2024

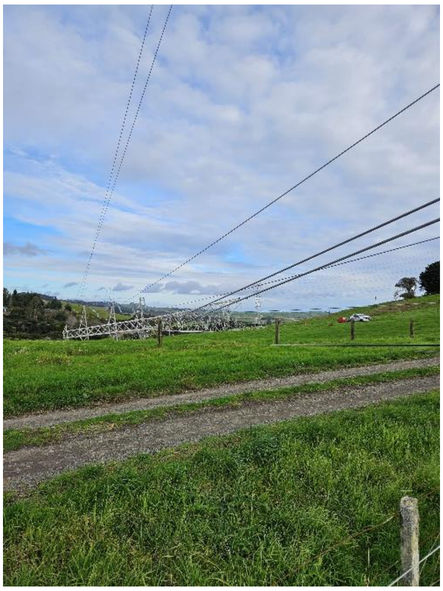


Photo B.1: Tower in the fallen location.

Photo B.2: Tower in the fallen location. Legs C and D are in close proximity to foundations indicating the tower fell square with the line in the transverse direction.

Photo B.3: Leg A foundation.

Photo B.4: Leg B foundation.


Photo B.5: Leg C leg and foundation.


Photo B.6: Leg C leg and foundation.


Photo B.7: Leg C leg and foundation.


Photo B.8: Leg D ruptured leg and foundation.


Photo B.9: Leg D ruptured leg and foundation.


Photo B.10: Leg D ruptured leg and foundation.


Photo B.11: Eight nuts and square washers tied with rope to leg A.


Photo B.12: Spade tied to leg B.

Photo B.13: Tower crossarm embedded in the ground from tower fall.

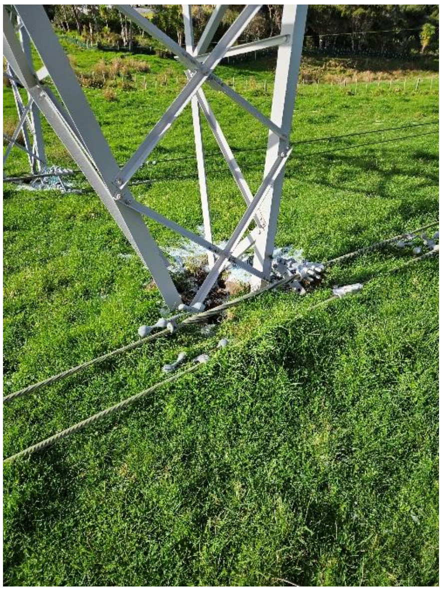


Photo B.14: Tower crossarm embedded in the ground from tower fall.

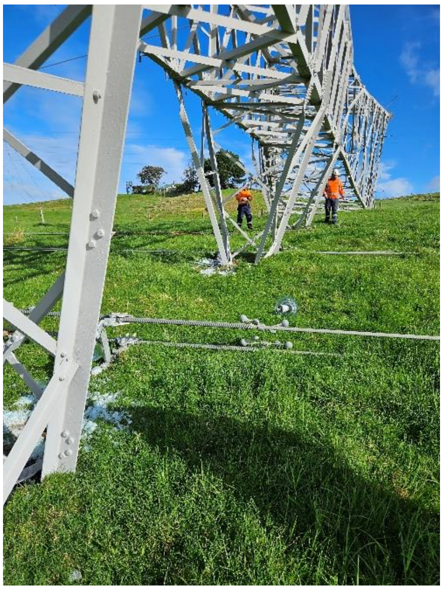


Photo B.15: Tower crossarms embedded in the ground from tower fall.

SEARCH

Appendix G

NEWS / **Northland Without Power After Fault**

Northland without power after fault

20 Jun 2024

Type: General news

Northland is without power after a Transpower tower fell near Glorit at 11am this morning.

A Transpower service provider is on site to assess the damage and the expected return to service time.

The tower fell while a second transmission circuit supplying these areas was out of service for scheduled maintenance. Transpower is assessing how long it will take to return that circuit to service.

More details will be provided on Transpower's website and Facebook page. Consumers should also check the websites of their retailers and local lines companies for up-to-date outage information.

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- NZX announcements
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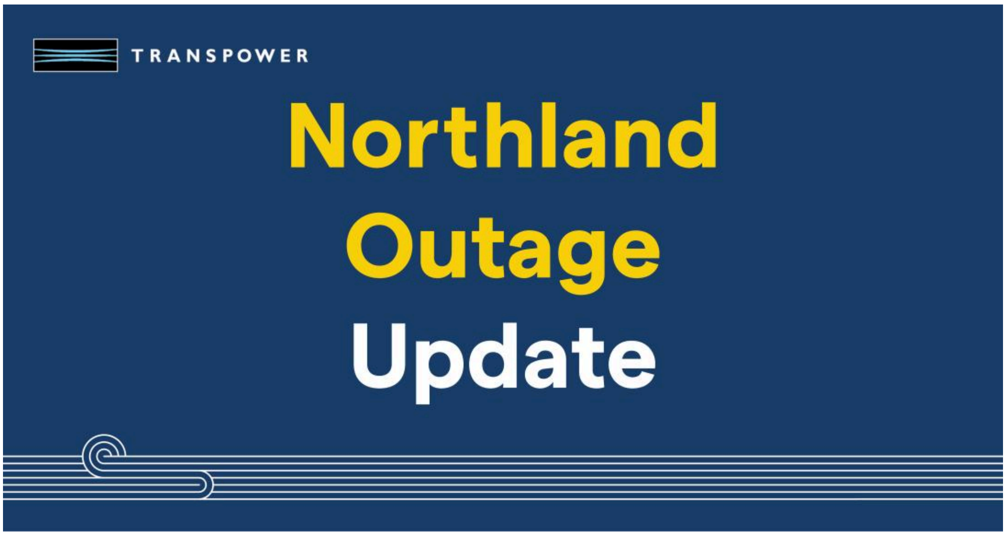
NEWS / **Update On Northland Power Outage - 2.30pm, 20 June**

Update on Northland power outage - 2.30pm, 20 June

20 Jun 2024

Type: General news



Partial power restoration is on the way for Northland and some people have already been reconnected.

Around 11am, a 220 kV transmission tower in a field near Glorit fell unexpectedly. The tower carries two separate high capacity circuits, carrying most of Northland's power needs, so it caused a power outage to Northland. Transpower is restoring as much capacity as possible through its lower capacity 110 kV network. However, until one of the larger 220 kV circuits is returned to service there will be insufficient electricity available to fully power the region.

Transpower's crews are on the site of the fallen tower, working through options to restore further power to Northland.

Transpower in its System Operator role has been able to reconfigure the power system to provide power including from local sources, such as the geothermal generation at Ngāwhā.

Transpower has issued an operational Grid Emergency Notice, which gives a timeframe for the emergency to 12 noon tomorrow as an interim period, and it will be updated prior to 12 noon based on further assessments. A return to service time for the impacted circuits has not been confirmed.

Transpower has made the area where the tower fell safe and is working hard to return a 220kV circuit to service. At this stage we do not know what the cause for the tower falling was. There will be a full investigation, but our priority now is restoring power to the region.

More details will be provided on Transpower's website and Facebook page. People can also check the websites of their retailers and local lines companies for up-to-date outage information.

ENDS

A correction: Earlier today we said the tower that fell was near Kumeu, however it is further north on SH 16 near Glorit.

For more information, call Transpower's media phone: 021 195 861

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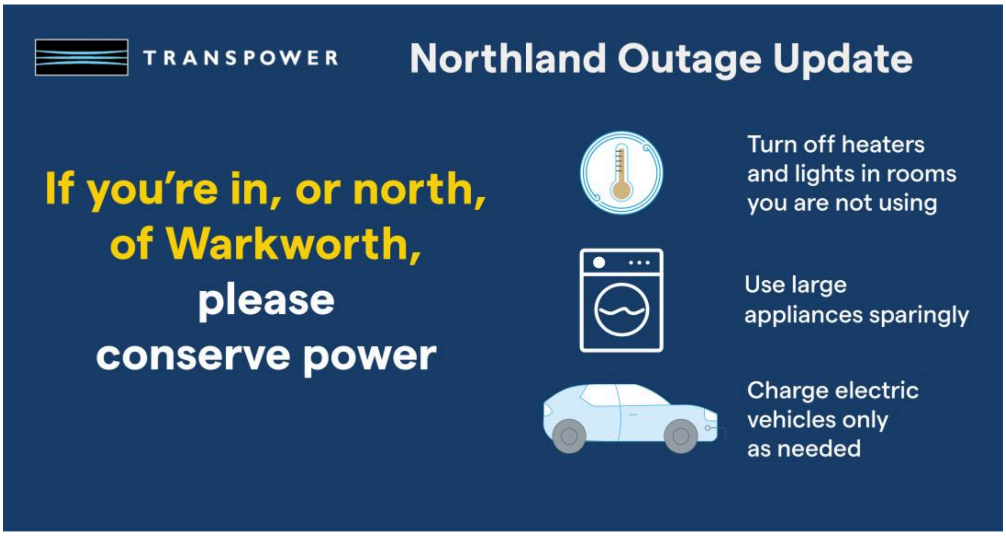
NEWS / **Update On Northland Power Cuts – 5.30pm**

Update on Northland power cuts – 5.30pm

20 Jun 2024

Type: General news



Transpower is calling on those in areas from Warkworth northwards who have power to conserve it until full electricity supply can be restored to the region, which will be tomorrow afternoon at the earliest.

Transpower has been able to restore some power to Northland after supply to the region was cut this morning. However, it is unable to supply all of the region and will instruct local lines companies to reduce power use on their networks where necessary.

A time for returning full supply has not yet been determined but it will take until late tomorrow at the very earliest. We will provide an update tomorrow morning when we have further advanced engineering of options.

People from Warkworth northwards who do have power can help by conserving power, enabling the available supply to go further.

Some examples of how those in impacted areas who do have power can help are:

- turn off heaters and lights in rooms you are not using
- use large appliances sparingly (such as washing machines, dryers and dishwashers)
- charge electric vehicles only as needed.

People with power should stay warm by heating rooms they are using. However, they could consider turning down the temperature slightly (1-2 degrees).

Transpower has launched a full investigation into why the tower fell. The tower was undergoing routine maintenance at the time. The crew doing the work are safe and unharmed. We are grateful for the patience and support of the landowners whose property we are working on.

We apologise for the inconvenience caused and assure those impacted that we are working to restore power to everyone as quickly as possible.

More updates will be provided on Transpower's website and Facebook page. People can also check the websites of their local lines company (Top Energy, Northpower or Vector) for up-to-date outage information.

For more information, call Transpower's media phone: 021 195 8613.

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NEWS

/ Update On Tower Replacement To Restore 220 KV Transmission Line Into Northland

Update on tower replacement to restore 220 kV transmission line into Northland

22 Jun 2024

Type: General news

Transpower made good progress raising a temporary tower to restore one of its two 220 kV transmission lines (circuits) into Northland today.

However, it was not able to complete the transfer of all the conductor wire to the new tower before dark so has decided to delay the final phase of the work until Sunday morning out of concern for crew safety.

Transpower Executive General Manager Grid Delivery Mark Ryall said that with residents in Northland having sufficient supply to meet weekend demand through the 110 kV circuits, crew safety took priority.

“We had hoped to get the circuit restored today,” Mr Ryall said. “But it is complex and challenging work and we have encountered delays that mean we weren’t able to complete the work before it got dark and the weather deteriorated.

“To ensure the crews can complete the work safely the final works will be delayed until tomorrow morning.”

Mr Ryall said crews are still on track to meet Transpower’s Sunday deadline and boost capacity into Northland ahead of demand rising again from Monday morning.

“We thank Northland communities for their continued patience. I know it makes a big difference to our crews putting in the hard work on the ground.”

For further information contact:
Transpower's media phone
021 195 8613
communications@transpower.co.nz

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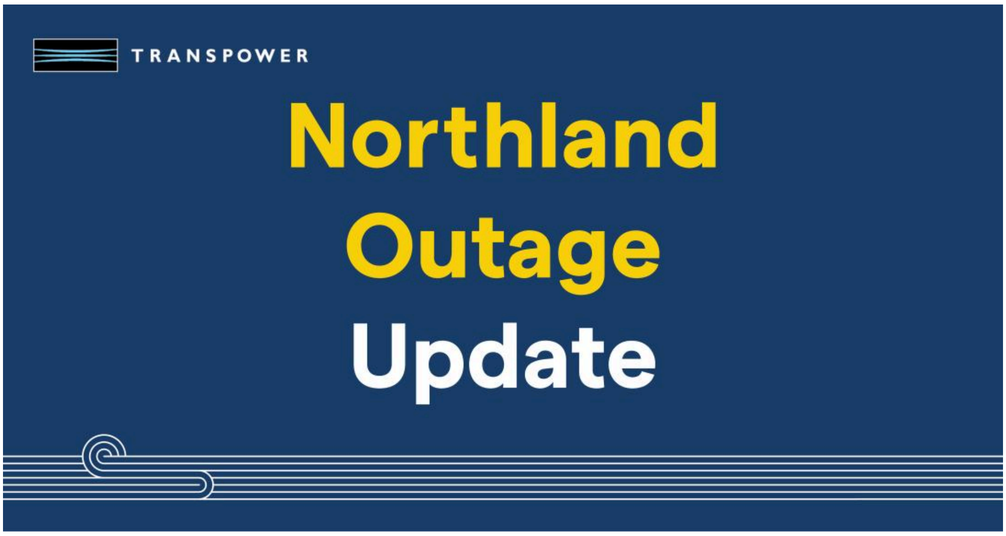
NEWS
/ **Momentary Power Losses Possible To Some Areas of Northland As Transpower Re-livens 220 KV Circuit**

Momentary power losses possible to some areas of Northland as Transpower re-livens 220 kV circuit

23 Jun 2024

Type: General news



Transpower advises that there may be a momentary loss of power between 2pm and 2.30pm in some areas from Warkworth north today as it re-livens its 220 kV circuit carrying electricity into the area.

Transpower will work with local generators and its lines company partners Top Energy, Northpower and Vector to re-liven the circuit with as little impact on consumers as possible. It apologises for any inconvenience.

More information on the repair work will follow once the 220 kV circuit is re-livened.

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NEWS
/ **Transpower Completes Temporary Tower Replacement To Restore Further Northland Electricity Capacity**

Transpower completes temporary tower replacement to restore further Northland electricity capacity

23 Jun 2024
Type: General news

Transpower has restored further electricity supply into Northland this evening after erecting a temporary tower and transferring one of its two 220 kV transmission lines (circuits) across.

The work restores more electricity supply capacity into the affected parts of New Zealand from Warkworth north after a transmission tower on farmland near Glorit fell at 11am Thursday morning.

Transpower Chief Executive Alison Andrew apologised to impacted areas for the disruption to supply.

"What happened was unacceptable and we apologise to all those that have been impacted by the outage caused by the fallen tower," she said.

"It is never easy to be without electricity and we know that Northland has been through a lot in recent years. We also know it's a resilient part of New Zealand and we'd like to extend our thanks to local communities and leaders, civil defence and our lines company partners and local generators for their support and assistance."

Supply was cut off at 11am Thursday while routine maintenance was under way. Working with local lines company partners Northpower, Top Energy and Vector, Transpower was able to begin restoring power through its parallel 110 kV network from around midday the same day.

Most of Northland was connected later that afternoon, but supply was limited and a number of households remained without power for a time. Some major industrial users stayed shut to ensure available supply went further.

Transpower Executive General Manager Grid Delivery Mark Ryall said design engineers and service providers worked at incredible speed to get the work done ahead of demand ramping up again from Monday morning, which he said would have put pressure on the electricity supply that Transpower had re-routed through its 110 kV network.

"Our internal team and our service providers worked around the clock to design, and deliver the solution within significantly compressed timeframes" Mr Ryall said. "With electricity supply into Northland at reduced levels, it was critical we got this tower up and supply restored through our 220 kV network over the weekend.

"Our design engineers worked through the night Thursday to plan the work and once we had necessary equipment in place Friday our crews began the complex and challenging work of putting up the tower and transferring the transmission line across."

Work was completed and the circuit re-livened shortly after 2pm. Mr Ryall expressed his thanks to everyone working on the replacement tower along with local lines companies Northpower, Top Energy and Vector and local generators Ngawha, Manawa and KTA Solar for their assistance in managing the situation and getting to this point.

"We'd also like to thank the landowner for facilitating access to the site, especially given the extent of the civil works required," he said. "And the local Glorit community has been fantastic with their support for our team on the ground."

Mr Ryall noted that while transmission capacity has been restored, full security of supply will not be restored until the second 220 kV circuit is returned to service. Additional temporary structures need to be installed and the remaining circuit transferred to them. This circuit is under the fallen tower and the work is more complex than for the first circuit.

“We will be doing everything we can to get this completed as quickly as possible and hopefully before Friday,” Mr Ryall said.

“This means there is increased risk of short power cuts if faults happen to one of our three circuits currently supplying Northland but, depending on the cause, any disruption is likely to be short lived.”

Investigation underway

Ms Andrew said that there has rightfully been a lot of interest in what caused the tower to fall and that Transpower would turn its full attention to that now that supply into Northland has been restored.

“Something has gone terribly wrong for a tower to fall over, and we need to make sure it doesn’t happen again,” she said.

“From the beginning we have been committed to doing a thorough investigation once power is restored. We have appointed an external party to lead that work and we will announce more details of that in coming days.

“But as we have said all along, it was unhelpful to speculate on the cause while we were focused on restoring electricity supply as quickly as possible for the people of Northland. That had to be our priority. It is complex and challenging work, we were moving at pace, and distractions would not have helped.

“We have been gathering information about what happened in parallel, but it is critical that we take a measured and informed approach to our investigation.”

The Electricity Authority announced Friday that it is also conducting a review after being instructed by the Minister for Energy.

“We welcome the review and will work closely with the Authority to ensure everyone understands what happened and we can take the lessons to prevent something like this happening again,” Ms Andrew said.

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NEWS / **Statement From Transpower Chief Executive**

Statement from Transpower Chief Executive

24 Jun 2024

Type: General news

On Thursday 20 June Transpower's service provider in the Auckland and Northland regions, Omexom, had a crew completing routine maintenance on a tower near Glorit.

Part of that maintenance included work on the base plates which secure the tower to the ground.

Our view is that the specifications and procedures for this type of work were not followed. All the nuts securing the tower to the base plate on three legs have been removed which has caused the tower to lift off the base plate and fall.

It is unprecedented and inconceivable that so many nuts were removed at once.

We have appointed an external party to undertake a full investigation into the cause of the fallen tower. While not complete, the investigation is now at a point where we can release some information, acknowledging the significant public and media interest in what caused the tower to fall.

While we are very grateful that no one was hurt when the tower fell, the failure to follow procedure resulted in a significant power outage that had a real impact on the people of Northland.

The ongoing investigation will look in more detail at what happened and why the correct procedures were not followed.

We are committed to learning from this event and implementing any additional controls that may be identified.

Finally, we know it is never easy to be without electricity and we know that Northland has been through a lot in recent years. We also know it's a resilient part of New Zealand and we'd like to extend our thanks to local communities and leaders, civil defence and our lines company partners and local generators for their support and assistance.

I would also like to thank the Transpower staff, service provider crews, design engineers and everyone who has put in a massive effort to get the power back on for the region. A huge thanks also to the landowner and Glorit community.

For further information contact:
Transpower's media phone
021 195 8613
communications@transpower.co.nz

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NEWS

/ **Transpower Restores Second 220 KV Circuit Into Northland**

Transpower restores second 220 kV circuit into Northland

26 Jun 2024

Type: General news

Transpower has restored full security of electricity supply into Northland this evening after installing additional temporary structures and returning the second 220 kV circuit to service.

Transpower Executive General Manager Grid Delivery Mark Ryall said Transpower's crews have been working as quickly and safely as possible to reconnect the second circuit.

"Restoring the second circuit was more complex given its position under the fallen tower," he said.

"Our crews have managed to transfer the conductor to the three additional poles erected over the last few days. Northland now has full security of power supply with this circuit returned to service."

Mr Ryall said work will now start on designing a permanent solution to replace the temporary structures.

"Our temporary structures will be replaced in due course with a new, permanent tower," he said.

"That design work has started already. The temporary structures are sufficiently robust and resilient to provide for security of supply until the permanent fix is in place.

"We'd like to thank the people of Northland again for their patience while we restored full security of supply. Thank you also to everyone in our engineering and service provider teams who have worked hard to design and deliver this solution."

Investigations underway

Mr Ryall said there has rightfully been a lot of interest in what has caused the tower to fall, and now that power has been fully restored to Northland, Transpower continues to turn its attention to focus on those investigations.

"While we have announced what went wrong, we now need to undertake a full investigation to understand why and the wider circumstances that led to the tower falling," he said.

"We are committed to learning from this event, and implementing any recommendations that may be identified. We will also cooperate with the Electricity Authority as it investigates independently, and any other external reviews."

For further information contact:
Transpower media phone 021 195 8613 or
communications@transpower.co.nz

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Appendix H

Base Plates Repairs/Refurbishments
Transpower AMIS and QA Records

Date:	19 / 10 /2023	Job Number:	~~TN~~ NZ0200663206
Line ID:	ALB - HPI - A	Structure:	0404
Work Type:	BASE PLATE REFURB	Circuit:	
Structure Asset Number:			

Remove Existing Grout

Checks/Records	A	B	C	D
All grout removed? (☑Yes ☒No)	—	—	—	—
Comments				

Repairs or Lowering of Pile Cap

Checks/Records	A	B	C	D
Does pile cap need repairs? (☑Yes ☒No)				
Does pile cap need to be lowered? (☑Yes ☒No)				
Area removed (mm X mm)	____x____	____x____	____x____	____x____
Depth removed, average (mm)	mm	mm	mm	mm
Comments				

Sand Blast Base Plates, Anchor Bolts and Tower Legs

Checks/Records		A	B	C	D
Tick (√) if OK (less than 10% loss) or record % of cross sectional loss	Anchor Bolt 1	✓	✓	✓	✓
	Anchor Bolt 2	✓	✓	✓	✓
	Anchor Bolt 3	✓	✓	✓	✓
	Anchor Bolt 4	✓	✓	✓	✓
	Anchor Bolt 5				
	Anchor Bolt 7				
	Anchor Bolt 8				
Are all bolts better than R/C? (☑Yes ☒No)		✓	✓	✓	✓
Repair method: (√ the box if tap & die is used, otherwise write it in the box)		—	—	—	—
Base plate sufficiently blasted? (☑Yes ☒No)		✓	✓	✓	✓
Anchor bolts sufficiently blasted? (☑Yes ☒No)		✓	✓	✓	✓
Sand blasted 300mm up leg? (☑Yes ☒No)		✓	✓	✓	✓
Base plate condition code (C.A. = 0 to 100)		70	60	60	70
% of metal loss to base plate		0 %	0 %	0 %	0 %
Blasting sand used (kg.)		100 kg	125 kg	100 kg	100 kg
Comments					

Prime Base Plates and Tower Legs

Checks/Records	A	B	C	D
Primer application within 4 hours of blasting and prior to onset of oxidisation? (☑Yes ☒No)	✓	✓	✓	✓
Temperature is above 0°C? (☑Yes ☒No)	✓	✓	✓	✓
Primer covers whole base plate and 300mm up tower leg? (☑Yes ☒No)	✓	✓	✓	✓
Paint thickness (microns)	175 µm	178 µm	182 µm	180 µm
Paint used (litres)	1.5L TOTAL	L	L	L
Comments				

Undercoat Base Plates and Tower Legs

Checks/Records	A	B	C	D
Undercoat application prior to the onset of rusting? (☑Yes ☒No)	✓	✓	✓	✓
Temperature is above 0°C? (☑Yes ☒No)	✓	✓	✓	✓
Undercoat covers whole base plate and 300mm up tower leg? (☑Yes ☒No)	✓	✓	✓	✓
Paint thickness (microns)	184 µm	187 µm	180 µm	179 µm
Paint used (litres)	1.5L TOTAL	L	L	L
Comments				

Reinstate Pile Cap

Checks/Records	A	B	C	D
Bonding coat applied? (☑Yes ☒No)				
Grout mixed and applied according to data sheet? (☑Yes ☒No)				
Temperature above 5°C? (☑Yes ☒No)				
Bonding coat used (litres)	L	L	L	L
Repair mortar used (bags)	bags	bags	bags	bags
Comments				

Pour Base Plates

Checks/Records	A	B	C	D
Grout mixed and applied according to data sheet? (☑Yes ☒No)				
Free draining chase formed? (☑Yes ☒No)				
Temperature above 5°C? (☑Yes ☒No)				
Bonding coat used (litres)	L	L	L	L
Grout used (bags)	bags	bags	bags	bags
Comments				

1st Protection Coat to Pile Caps

Checks/Records	A	B	C	D
Sealant chase cleaned out? (☑Yes ☒No)	✓	✓	✓	✓
Mixed and applied according to data sheet? (☑Yes ☒No)	✓	✓	✓	✓
No misses or pin holes? (☑Yes ☒No)	✓	✓	✓	✓
Temperature above 8°C? (☑Yes ☒No)	✓	✓	✓	✓
Protection product used (litres)	20KG TOTAL	~~L~~	~~L~~	L
Comments				

2nd Protection Coat to Pile Caps and Top Coat Base Plates

Checks/Records	A	B	C	D
Mixed and applied according to data sheet? (☑Yes ☒No)				
No misses or pin holes? (☑Yes ☒No)				
Temperature above 8°C? (☑Yes ☒No)				
Protection product used (litres)	L	L	L	L
Paint quantity used (litres)	L	L	L	L
Comments				

Seal Mortar Chase

Checks/Records	A	B	C	D
Chase clean and formed correctly? (☑Yes ☒No)				
Primers applied? (☑Yes ☒No)				
Bond breaker tape installed? (☑Yes ☒No)				
Temperature above 5°C? (☑Yes ☒No)				
Sealant used (sausages)? (☑Yes ☒No)				
Comments				

Post Work C.A. *(Record the worst condition)*

C.A. Meter Readings *(0-100)*				
Meter	A	B	C	D
Concrete Foundation Condition *(TOFO_LEG_CONDITION)*	100	100	100	100
Base Plate Condition *(TOFO_LEG_CONNEC_COND)*	100	100	100	100
Comments				

Final Sign Off

Checks/Records	A	B	C	D
All waste removed for site? (☑Yes ☒No)	✓	✓	✓	✓
Site reinstated? (☑Yes ☒No)	✓	✓	✓	✓
Legs completed to specification? (☑Yes ☒No)	✓	✓	✓	✓
Legs free from defects? (☑Yes ☒No)	✓	✓	✓	✓
Photos taken? (☑Yes ☒No)	✓	✓	✓	✓
Comments				

Checked by (Crew member): [redacted]
(Print name and sign)

Approved (Team Leader): [redacted]
(Print name and sign)

Approved (Job Manager): ____________________
(Print name and sign)

Field Checked? ☐ Yes ☐ No

(All sheets must be signed by Job Manager/Supervisor)

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TRANSPOWER

System operator preliminary report: Northland loss of supply

This document outlines the initial summary facts around the Northland loss of supply incident which occurred on 20 June 2024

Version: 1.0

Date: 05/07/2024

Version Control

Version	Description	Author/s	Reviewer	Approver	Date
1.0	Approved for publication	JB, LT	MC, CB	JC	05/07/24

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Executive summary

At 11:03 on 20 June 2024, the Huapai_Marsden_1 220 kV circuit tripped causing a 159 MW loss of supply to the Northland region. The circuit tripping happened at a time when the second 220 kV circuit supplying the region, Bream Bay_Huapai_1 220 kV circuit, was out of service for planned maintenance; 110 kV system splits at Maungatapere were in place to mitigate potential overloading of the Henderson_Maungatapere 110 kV transmission circuits.

A grid emergency was declared at 11:17 by the system operator and remained in force until 16:00 on 23 June 2024.

Key

Huapai_Marsden_1 220 kV circuit tripping

110 kV system splits at Maungatapere

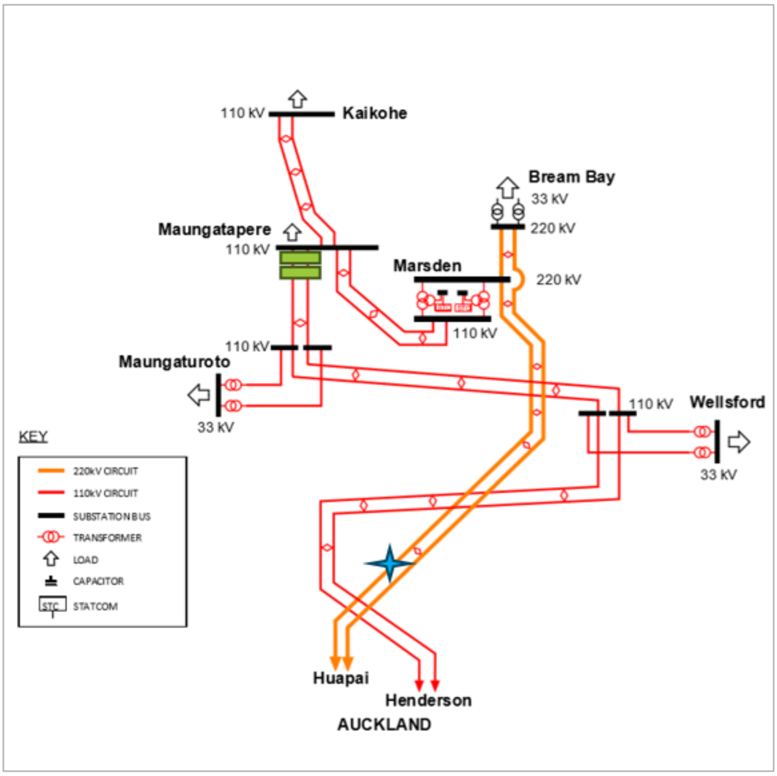

Figure 1: Schematic of the Northland system

Due to a tower failure (T130 on the Henderson-Marsden A double circuit 220 kV transmission line), auto-reclose was unsuccessful in restoring supply and a manual re-close of the Huapai_Marsden_1 220 kV circuit was not an option. Similarly due to the tower failure there was no way to return the Bream Bay_Huapai_1 220 kV circuit to service either. This tower failure was the basic root cause of this incident.

A managed restoration of electricity supply to Northland using the 110 kV transmission network and a preprepared contingency plan was employed.

Careful coordination of load restoration activities between Transpower as both the system operator and grid owner and the regional electricity distribution company control centres (Top Energy, Northpower, Ngawha generation and Vector) enabled a restoration of electricity supply to Northland (Bream Bay, Maungatapere and Kaikohe). Note that Maungaturoto and Wellsford did not lose supply due to the 220 kV circuit tripping.

The loss of supply lasted for approximately 104 minutes, with a restricted supply, via the 110 kV transmission network, restored to the region by 12:47 on 20 June 2024. Load was gradually increased into the region throughout the afternoon to match local generation and time-driven demand within the capacity limits of the remaining 110 kV network.

Load was managed within capacity limits over the following days, with the support of local demand side participation. This included the use of controllable load, batteries, and local backup diesel generation to enable supply to as many consumers as possible.

Restoration of a 220 kV circuit into Northland took place on Sunday 23 June 2024. Prior to the restoration of the Bream Bay_Huapai_1 220 kV circuit, a meeting took place between Top Energy, Northpower, Ngawha generation, Vector, the system operator National Coordination Centre and system operator management to discuss and agree on a plan for the restoration of the Northland 220 kV. This included coordinating the shutting down of Ngawha A and Ngawha B generation at 14:00 to enable the reconnection of the 220 kV circuit into Northland.

The Bream Bay_Huapai_1 220 kV circuit was restored, via a temporary tower, ending the Grid Emergency at 15:04 on 23 June 2024.

This event disrupted many people and businesses in Northland. Supply was limited and many consumers remained without electricity for a time. Some major industrial users stayed shut to ensure available supply went further.

Contents

1 Introduction

The two 220 kV circuits (Huapai_Marsden_1 and Bream Bay_ Huapai_1) provide the main electricity supply to the Northland region from Huapai, with additional 110 kV circuits able to supply some load, but not all. The two 220 kV circuits are carried on what is known as a double circuit transmission line, which has a single set of transmission towers holding up both circuits. Both 110 kV circuits are also carried on another double circuit transmission line. This type of transmission line configuration is commonly used across New Zealand and the rest of the world.

On 20 June 2024, Transpower had an outage on one of the two 220 kV circuits into Northland (Bream Bay_Huapai_1 and Henderson_Huapai_1) to undertake planned maintenance work. During such an outage the 110 kV system is split at Maungatapere (on the two Henderson_Maungatapere 110 kV circuits) to prevent the 110 kV lines overloading in the case of a fault on the remaining 220 kV circuit. For the outage on 20 June, this left the region being solely supplied via the remaining 220 kV circuit (Huapai_Marsden_1) i.e. what is known as being on N-security.

At 11.03, the Huapai_Marsden_1 220 kV circuit tripped causing a loss of 159 MW of supply to the Northland region. The loss of supply lasted approximately 104 minutes. Restricted supply was progressively restored at different Grid Exit Points (GXPs) with Maungatapere restored within 35 minutes and finally Kaikohe by 12:47. Note that Maungaturoto and Wellsford did not lose supply due to the 220 kV circuit tripping.

A grid emergency was declared at 11:17 by the system operator and remained in force until 16:00 on 23 June 2024.

While there was no material impact on the market or operation of the remaining power system, this incident disrupted many consumers in the Northland region. Supply was limited and a number of households remained without electricity for a time. Some major industrial users stayed shut to ensure available supply went further.

Based on the details of the incident it has been classified as a ‘Major’ event under the system operator procedure ‘Significant Incident Reporting’ (PR-RR-770).

1.1 Purpose

This report has been produced for the Electricity Authority (Authority) in response to a ‘Major’ incident and in accordance with the system operator procedure ‘Significant Incident Reporting’ (PR-RR-770). Its purpose is to provide an initial fact-based summary of the incident to date.

This report is intended for an audience familiar with the structure and operation of the New Zealand power system.

1.2 Roles

Transpower New Zealand has two key roles within the electricity industry, the system operator and grid owner, as defined and outlined in the Electricity Industry Participation Code 2010 (Code). The following report was prepared by the system operator.

2 Scope and approach

2.1 Scope

In scope for this report are the:

- facts leading up to, during and after the incident
- basic root cause of the incident
- actions taken by the system operator leading up to and in response to the incident.

Out of scope for this report are the:

- identification of the cause of the tower failure
- assessment of the performance of the system operator and other industry participants leading up to and in response to the incident.

2.2 Approach

This report, commissioned by Transpower in its role as system operator, is intended to provide an initial fact-based summary report (preliminary report).

The preliminary report will be published on the system operator website as outlined in the system operator procedure 'Significant Incident Reporting' (PR-RR-770).

This preliminary report precedes a final investigation report which will be produced by Transpower within 90 days of the incident. The reports are centred around the system operator National Coordination Centre (NCC) and the management of the power system during the incident.

Information for this report has been provided from across the system operator, including from:

- Head of Grid and System Operations
- Duty Operations Manager (OM) - Security
- Security Coordinator (SC) on duty during the incident
- Energy Coordinator (EC) on duty during the incident

Relevant process/procedural documentation, internal situation intelligence, market system data and logs were used to support the contents of this preliminary report.

3 Pre-event system conditions

3.1 Northland power system

The Northland region is supplied primarily by a 120 km long 220 kV double circuit transmission line between Transpower's substations at Henderson and Marsden, with tee offs into the Albany and Huapai substations, refer to Figure 2.

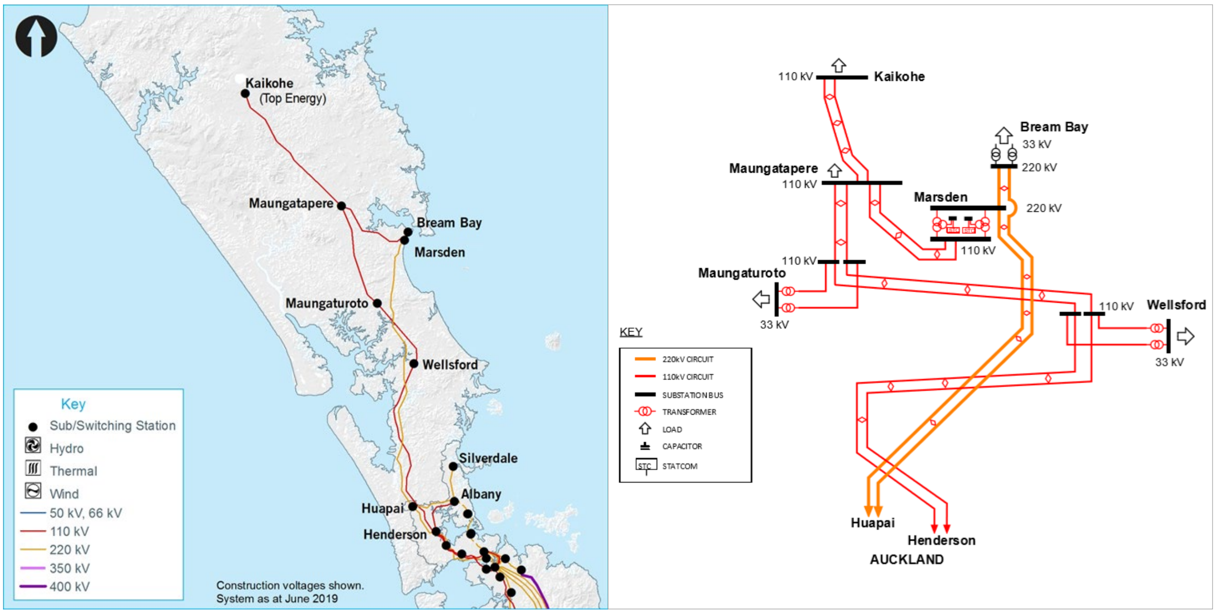

Figure 2: Northland area transmission network

In addition to the 220 kV network, 110 kV circuits run on double circuit transmission lines from Henderson to Maungatapere (via Wellsford and Maungaturoto), and on to Kaikohe and Bream Bay. The Ngawha geothermal generating station (NGA) is embedded into Top Energy's 33 kV network at Kaitaia. A second Ngawha geothermal station is directly connected to the 110 kV network at Kaikohe. Other, smaller generators are embedded at Maungatapere and Bream Bay. The 110 kV and 220 kV networks are interconnected by two interconnecting transformers at Marsden.

Under normal conditions with all assets in service, this configuration provides N-1 security to Northland. This means that tripping of one of the 220 kV circuits would not result in loss of supply, as the second circuit has enough capacity to supply all the load. In the event one of the 220 kV circuits tripped, auto-reclose settings on the circuit (normally enabled) would attempt to reclose the circuit within 60 seconds and if successful, restore N-1 security to the Northland region.

In the Northland area, when a 220 kV circuit (either Huapai_Marsden_1 or Bream Bay_Huapai_1) is taken out of service for a planned outage, a system split in the 110 kV network at Maungatapere is also required. This is to prevent overloading of the 110 kV circuits during high load periods. Under this configuration, Bream Bay, Marsden, Maungatapere and Kaikohe are supplied via the 220 kV system only.

The Northland grid supplies the following three customers:

- Northpower has supply offtakes at Bream Bay, Maungatapere and Maungaturoto substations. Approximately 101 MW was lost from Bream Bay (16 MW) and Maungatapere (85 MW) substations during the event. Maungaturoto was not impacted.
- Top Energy has a supply offtake at Kaikohe substation. Top Energy supplies customer connections in the upper Northland region and was being supplied with a load of 58 MW prior to the incident. There was a total loss of supply to Top Energy and a loss of connection to both Ngawha generation sites (NGA and NGB).
- Vector has a supply offtake at Wellsford substation. Wellsford had a load of 26 MW prior to the incident, and the Wellsford substation was not impacted.

At the time of the incident the following key assets in the region were on outage:

Table 1: Key assets on outage in the region at the time of the incident

Outage	Names	Start	End	Nature *	Comments of work
BRB_HPI_1	Bream Bay – Huapai 220kV circuit	18/06/2024 7:30	21/06/2024 18:30	RS	PDM-L works spacer (Preventative maintenance on the line/circuit). End time will be extended as necessary.
HEN_HPI_1	Henderson – Huapai 220kV circuit	18/06/2024 7:30	21/06/2024 18:30	RS	PDM-L works dampers (Preventative maintenance on the line/circuit). End time will be extended as necessary.
MDN_STC_6	Marsden Statcom	17/06/2024 7:30	20/06/2024 18:00	RS	Scheduled substation maintenance
MDN_T6	Marsden Transformer (220 kV/110 kV)	17/06/2024 7:30	20/06/2024 17:00	RS	Scheduled substation maintenance
MPE_CB_252	Maungatapere 110 kV circuit breaker	20/06/2024 6:00	20/06/2024 12:00	OPE	System split on the 110 kV to facilitate work on the 220 kV circuit
MPE_CB_292	Maungatapere 110 kV circuit breaker	20/06/2024 6:00	20/06/2024 12:00	OPE	System split on the 110 kV to facilitate work on the 220 kV circuit

* RS - Removed from Service – Not available

OPE – Open Ended: Removed from Service – Can be made available if required

3.2 Loads

The SCADA readings at the Northland GXPs for the 11:00 trading period, during which the incident happened, are shown in Table 2.

Table 2: Loads before the tripping

Substation	Distributor	Actual readings @ 11:00 20/6/24	
		Load (MW)	Reactive power (MVar)
Kaikohe	Top Energy	58 MW	+1 MVar
Maungatapere	Northpower	85 MW	+6 MVar
Bream Bay	Northpower	16 MW	+1 MVar
Maungaturoto	Northpower	14 MW	- 3 MVar
Wellsford	Vector	24 MW	- 7 MVar

Note: Maungaturoto and Wellsford did not experience a loss supply as a result of the tripping, but have been included for completeness.

3.3 Weather conditions and NGOC risk assessment

On Thursday 20 June 2024, a slow-moving trough over Northland was forecast to bring periods of heavy rain. Localised downpours and thunderstorms were also possible. A Severe Thunderstorm Watch for localised downpours was also in force for Northland. People were advised to stay up-to-date with forecasts. The MetService issued a severe weather warning for Northland.

This severe weather warning for Northland and National Grid Operating Centre (NGOC) risk assessment issued that day can be found in Appendix G.

4 Event, response and restoration

4.1 Event and summarised timeline

On 20 June 2024, the Bream Bay_Huapai_1 220 kV circuit was on planned outage to allow maintenance work to be undertaken on the circuit.

At 11.03 the remaining 220 kV circuit to Northland, Huapai_Marsden_1, tripped causing a loss of 159 MW of supply to the region.

The tripping occurred because of the failure of tower 130 on the Henderson-Marsden A transmission line, which caused an earth fault on the circuit which could not be cleared. This failure also prevented the return to service of the Bream Bay_Huapai_1 circuit. This tower failure is the basic root cause of the incident.

The loss of supply lasted for approximately 104 minutes, with a restricted supply restored to the region by 12:47.

A grid emergency was declared at 11:17 by the system operator and remained in force until 16:00 on 23 June 2024. See Appendix D for the issued GEN notice and revisions.

A high-level summarised version of the sequence of events is shown in Table 3below, with key events in bold and highlighted in yellow. This is a filtered table of the Manual Operator Log (MOL) and Grid Operations Log (GOL) entries. A fuller timeline is included in Appendices B and C.

Table 3: Summary incident timeline

Date	Time	Incident Time	Event / Action Description
20-Jun	**11:03**	**00:00:00**	**HPI_MDN_1 Tripped. Loss of Supply to Northland. Loss of supply (LOS) to BRB, KOE, MDN, MPE (159MW). Loss of connection (LOC) to NGA/NGB and KTS.**
20-Jun	**11:17**	**00:00:14**	**Grid Emergency verbally declared for loss of supply to BRB, MDN, MPE, and KOE. Restoration will use PR-CP-638/V3 Northland Region via 110 kV Contingency Plan.**
20-Jun	11:17	00:00:14	HPI_MDN_1 Change to Offer (CTO) submitted from NGOC to NCC the planned end date/time 20-jun-2024 18:00:00.
20-Jun	11:19	00:00:16	Initial SMS message sent. Loss of supply to BRB 16MW, MDN, MPE 84.8MW, and KOE 57.95MW.
20-Jun	11:20	00:00:17	Confirmed disconnection of NGB and BRB diesel generator for Northland 110 kV restoration
20-Jun	11:33	00:00:30	Updated Police about the reported structural failure on HPI-MDN-1 Tower 130 at 2995 Kaipara Cost Highway.

Date	Time	Incident Time	Event / Action Description
20-Jun	11:34	00:00:31	Contingency Plan - PR-CP-638, Steps 4c completed. NGOC - Prepare Maungatapere Substation for livening through the 110 kV system
20-Jun	**11:38**	**00:00:35**	**PR-CP-638, Steps 4f completed. Maungatapere 110 kV bus restored, 11:38.**
20-Jun	11:39	00:00:36	CTO 20-jun-2024 11:39:03 MPE_CB_252 and 292 Change to Offer (CTO) for 21-jun-2024 12:00:00 Planned end date/time was 21-jun-2024 18:30:00 now 21-jun-2024 12:00:00. Maungatapere CB 252 and 292 - change to asset offer to return the CBs to service and close the 110 kV split to connect the HEN 110 kV to Maungatapere
20-Jun	11:43	00:00:40	PR-CP-638, Step 5C completed. Maungatapere 292 closed and returned to service
20-Jun	11:42	00:00:39	Confirmed disconnection of Kaitaia Solar Farm via TOP network CB143392
20-Jun	11:47	00:00:44	KOE1101 NGB0 Discretion Clause 13.70, Part 13 ENR Max: 0 Start: 20-Jun-2024 11:47 End: 20-Jun-2024 14:00 Notes: Loss of power to Northland. Last Dispatched: Mw: 17.5 ResF: NULL ResS: NULL
20-Jun	11:56	00:00:53	PR-CP-638, Step 5d completed. Maungatapere Substation limited to 10MW Restore limited supply to Maungatapere 110 kV bus
20-Jun	12:09	00:01:06	PR-CP-638, Steps 6a to 6f completed. Prepare for connection at Marsden and Bream Bay Substations
20-Jun	12:16	00:01:13	PR-CP-638, Steps 7a to 7b, and 7d completed. Restore supply to Marsden
20-Jun	12:24	00:01:21	PR-CP-638, Steps 8a, 1 and 2 completed. NGOC - Instruction to start Marsden STC6) Marsden STC5 not available.
20-Jun	**12:28**	**00:01:25**	**PR-CP-638, Steps 9a and 9b completed. Bream Bay restored at 12:28**
20-Jun	**12:47**	**00:01:44**	**Supply restored with restrictions to Bream Bay, Maungatapere and Kaikohe Substations. Kaikohe restored at 12:47**
20-Jun	**14:14**	**00:03:11**	**NGB tripped. KOE1101 NGB0 Bonafide ENR Max: 0 Start: 20-Jun-2024 14:14 End: 20-Jun-2024 14:30 Notes: bf Last Dispatched: Mw: 17.5 ResF: NULL ResS: NULL**
20-Jun	14:15	00:03:12	RTCA violation. HEN_MPE1/2, HEN_MPE2/1, 120%. NPW instructed via NGOC to hold load at BRB and restrict load at MPE to 10MW.
20-Jun	14:23	00:03:20	NPW load. Instruct NPW to limit MPE load to 10MW following NGB generation tripping.
20-Jun	14:35	00:03:32	NPW load. Previous load limits rescinded given operating to N security. Load limits are MPE 20MW and BRB 10MW as instructed during the restoration.

Date	Time	Incident Time	Event / Action Description
20-Jun	15:10	00:04:07	New load limits for MPE of 30MW (was 20MW) & for KOE of 20MW (was 10MW).
20-Jun	**15:12**	**00:04:09**	**NGB generation back on and to ramp up load at MPE to maximum of 30MW and 20MW at KOE.**
20-Jun	15:51	00:04:48	Manawa GC advises BRB diesel units starting up with approx run time of 30-40 hrs
20-Jun	15:55	00:04:52	New load limits for MPE of 50MW (was 30MW) and for BRB of 15MW (was 10MW). No change for KOE (20MW).
20-Jun	16:28	00:05:25	New load limits for MPE of 60MW (was 50MW) and KOE of 25MW (was 20MW). No change for BRB.
20-Jun	16:40	00:05:37	New load limits for MPE of 70MW (was 60MW) and KOE of 45MW (was 25MW). No change for BRB.
20-Jun	17:28	00:06:25	Contacted NGB and TOP to see if any voltage assistance available using NGB MVAr or KTA Caps. Network controller looking at it
20-Jun	18:05	00:07:02	Request HEN_HPI_1 is recalled. NCC advised and see no security issue that requires this CCT to be RTS. Duty Protection advised and advice sought.
20-Jun	18:38	00:07:35	Load limits confirmed for Friday evening peak. MPE = 75MW, MTO = 15MW & BRB = 15MW (combined Northpower total of 105MW). KOE = 45MW. WEL = best endeavours to stay as low as possible without shedding real load (expect around 31-32MW).
20-Jun	19:47	00:08:44	NCC want to reconfigure the grid to enhance security. The plan is 1. OPE WEL T1 and MTO T2 2. OPE MDN_MPE 2 3. OPE KOE_MPE 1 4. OPE MPE FDRs 282 and 302 5. OPE MPE 288 (Split MPE Bus) Protection, NPW and VLD advised.
20-Jun	20:37	00:09:34	Advise NGOC to inform Northpower they can restore controllable load at MPE, provided they remain below the current MPE load limit of 75 MW.
20-Jun	20:51	00:09:48	PTP to Disable AR on HEN_MPE_1 and 2 - Unsure if NGA Anti island will operate
20-Jun	21:22	00:10:19	HPI_MDN_1 - P & A Duty Eng advised that he has been told by his manager that this reconfiguration won’t be taking place tonight and that has come from Primary Assets. NCC advised, but has heard nothing so will contact their Duty Ops Manager
20-Jun	21:56	00:10:53	NCC confirm the grid reconfiguration won't happen tonight. They also request NNI advise CP to restore all load up to KOE 45 MW, BRB 15 MW and MPE 75 MW. NPW, TOP and VLD advised.
21-Jun	6:40	00:19:37	Request from Top Energy to advise them if they are getting close to their 45MW load limit as they don't have visibility of their current load. They will contact us regularly to get updates.
21-Jun	11:46	01:00:43	HPI_MDN_1 end time change to offer from 21/6 1800hrs to 22/6 23:00hrs

Date	Time	Incident Time	Event / Action Description
21-Jun	15:04	01:04:01	As it is now believed that protection will not work to clear an overload of one HEN_MPE circuit for the loss of the other (Protection setting changes required). Delegated Authority has been given to NGOC North to act as follows: If HEN_MPE_1 trips, Open MPE_CB_252; If HEN_MPE_2 trips, Open MPE_CB_292; If HEN_MPE_2 trips, Open MPE_CB_292
21-Jun	17:10	01:06:07	New load limits for MPE of 75MW (was 70MW) and KOE of 45MW (was 25MW). No change for BRB of 15MW
21-Jun	17:55	01:06:52	Protection setting (Prot 1) changes applied to HEN_MPE _1 and 2
21-Jun	19:28	01:08:25	21-jun-2024 19:28:02 HEN_MPE_2_PROT1 Change to Offer (CTO) Planned end date/time now 21-jun-2024 23:59:00. Protection relay setting change, testing between 2300 and 2359hrs.
22-Jun	1:10	01:14:07	Instruction to NGOC NNI desk to enable I/Trip 1 on HEN CB 302 (HEN-MPE1) after protection settings change testing.
22-Jun	2:24	01:15:21	Instruction to NGOC NNI desk to enable I/Trip 1 on HEN CB 322 (HEN-MPE2) after protection settings change testing.
22-Jun	5:53	01:18:50	Delegated Authority given to NGOC North regarding HEN_MPE tripping's is rescinded.
22-Jun	20:34	02:09:31	Requested conditional splits, MPE_CB_252 and CB_292 OPEs from 12:30 23 Jun to 18:00 28 Jun for the duration of HPI_MDN RS after BRB_HPI RTS.
23-Jun	**13:44**	**03:02:02**	**BRB_HPI Restoration. Reduce NPW load to agreed level (52MW)**
23-Jun	**13:45**	**03:02:03**	**BRB_HPI Restoration. Reduce TOP load to agreed level (33MW)**
23-Jun	**13:45**	**03:02:03**	**BRB_HPI Restoration. Reduce VLD load to agreed level (18MW)**
23-Jun	**14:10**	**03:02:28**	**BRB_HPI Restoration. Shut down NGA and NGB**
23-Jun	14:11	03:02:29	KOE1101 NGB0 Discretion Clause 13.70, Part 13 ENR Max: 0 Start: 23-Jun-2024 14:11 End: 23-Jun-2024 15:30 Notes: BRB_HPI restoration Last Dispatched: Mw: 31 (NGB shutdown in prep for BRB_HPI_ 1 RTS)
23-Jun	**14:16**	**03:02:34**	**BRB_HPI Restoration. RTS BRB_HPI_1; 220 kV circuit into Northland livened**
23-Jun	**14:18**	**03:02:36**	**BRB_HPI Restoration. Restore NGA and NGB generation**
23-Jun	**14:20**	**03:02:38**	**BRB_HPI Restoration. Restore NPW load to nominal value**
23-Jun	**14:20**	**03:02:38**	**BRB_HPI Restoration. Restore TOP load to nominal value**
23-Jun	**14:21**	**03:02:39**	**BRB_HPI Restoration. Restore VLD load to nominal value**
23-Jun	**15:58**	**03:04:16**	**GEN revised; end time changed to 16:00. Ref 5462633550**
23-Jun	**16:16**	**03:04:34**	**GEN report issued, ref 5462453197**
23-Jun	**21:41**	**03:09:59**	**MPE CB252 and 292 closed to provide N-1 to Northland**

Date	Time	Incident Time	Event / Action Description
26-Jun	**18:18**	**06:06:36**	**Second 220 kV circuit (HPI_MDN_1) restored (via temporary structures) on Wednesday 26/06/2024 at 18:18hrs. N-1 security restored to Northland.**

4.2 Power system response

The power system response to the loss of the Huapai_Marsden_1 circuit was as expected. The trip caused a loss of 159 MW of load in the Northland region and can be seen in Figure 3 below.

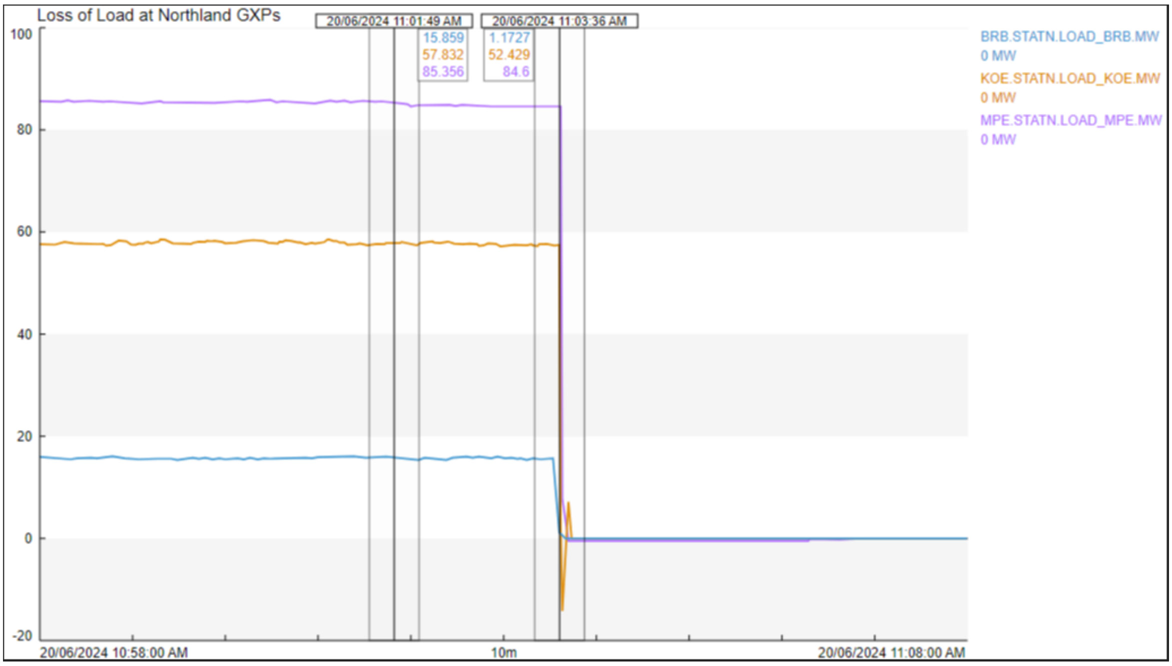

Figure 3: Northland load (MW)

Figure 4 and Figure 5 show the North Island frequency and HVDC responses to the incident respectively. There was a 0.38 Hz increase in frequency to 50.364 Hz and a 121 MW decrease in the amount of power flowing north through the HVDC. This response aligns with what would be expected for a load loss of approximately 159 MW in the North Island. Other than the normal frequency keeping response, no other ancillary services were activated in response to the event.

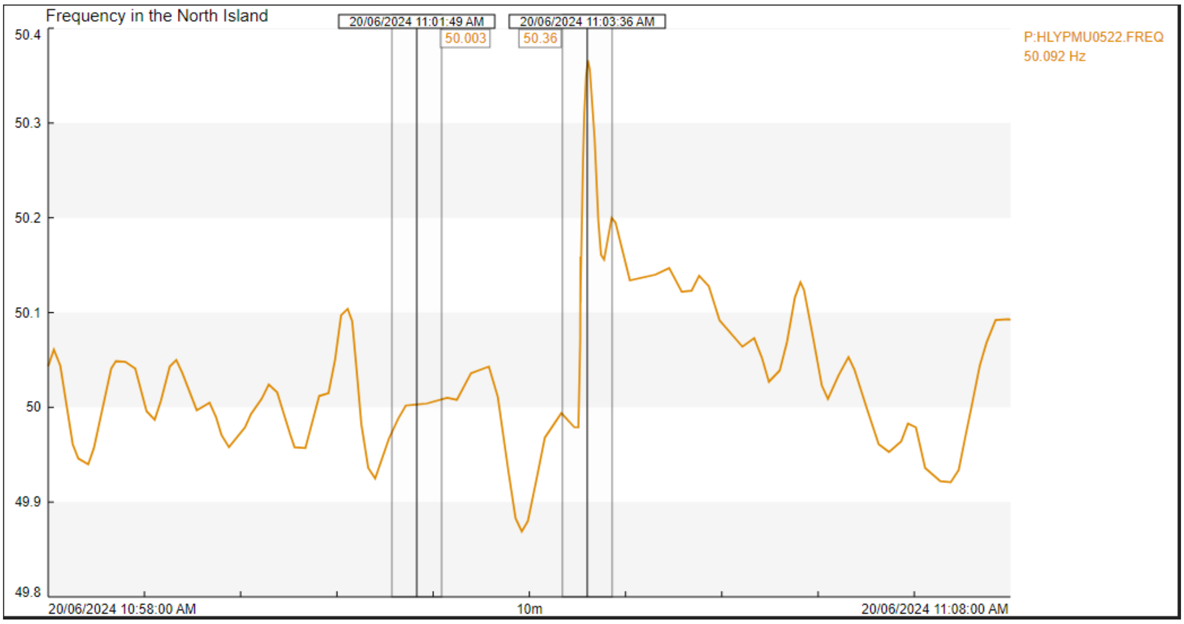

Figure 4: North Island frequency at Huntly (Hz)

Figure 5: HVDC transfer, positive values represent north flow (MW)

4.3 Market response

As a result of the loss of supply in the Northland region and disconnection of local Ngawha A and B generation and Kaitaia Solar, prices decreased slightly in the next trading period. Table 4 below shows reference prices in the North and South Islands before and after the incident. The loss of load impact appears to have been mitigated to some extent by the loss of local generation.

Table 4: Prices at island reference nodes and affected Northland nodes

Trading Period	Energy Price (HAY2201)	Energy Price (BEN2201)	Average Energy Price (BRB0331, KOE1101, MPE1101)	Timing relative to incident
10:30	$261.61	$259.67	$282.47	Prior
11:00	$241.78	$239.96	$246.94	During
11:30	$229.21	$227.51	$209.45	After
12:00	$255.52	$253.63	$308.40	After
12:30	$243.97	$242.17	$298.43	After
13:00	$250.75	$248.90	$290.15	After

An initial market analysis is included in Appendix F. At this early stage there has been no evidence of any negative market impacts such as market constraints or real time pricing issues arising from the incident.

The amount of lost load in the Northland region and the time to partially restore service through a restricted 110 kV transmission network means the estimated value of lost load (VoLL) will be large. A calculation of VoLL will be included in the final report.

4.4 Restoration

4.4.1 Initial restoration

Due to the tower failure, a manual re-close of the Huapai_Marsden_1 220 kV circuit was not an option. A managed partial restoration using the Northland 110 kV transmission network was undertaken in accordance with a preprepared contingency plan.

Careful coordination of load restoration activities between Transpower as both the system operator and grid owner and the regional electricity distribution company control centres (Top Energy, Northpower, Ngawha generation and Vector) enabled a partial restoration of power supply to Northland (Bream Bay, Maungatapere and Kaikohe). The loss of supply lasted for approximately 104 minutes, with a restricted supply, via the 110 kV transmission network, restored to the region by 12:47 on the 20 June 2024.

Load was gradually increased into the region throughout the afternoon to match local generation and time-driven demand within the capacity limits of the remaining 110 kV network. Load was managed within capacity limits over the following days, with the support of local demand side participation. This included the use of controllable load, batteries, and local backup diesel generation to enable supply to as many consumers as possible.

More detailed load charts by substation are shown in Appendix E.

4.4.2 Full restoration

Restoration of a 220 kV circuit into Northland took place on Sunday 23 June 2024.

Prior to restoration of the Bream Bay_Huapai_1 220 kV circuit, a meeting took place between Top Energy, Northpower, Ngawha generation, Vector, the system operator National Coordination Centre and system operator management to discuss and agree on a plan for the restoration of the Northland 220 kV. This plan required the coordination of parties to reduce load from 14:00 to enable NGA and NGB generation to be shut down prior to the reconnection of the 220 kV circuit into Northland. This was due to concerns raised by Ngawha Generation around the stress on their generators which could occur due to phase angle differences arising when the 220 kV circuit is returned to service.

Bream Bay_Huapai_1 220 kV circuit was returned to service at 14:16, enabling the full restoration of supply to Northland shortly after but leaving the region on N security. The Grid Emergency was ended at 16:00 on 23 June 2024.

The second 220 kV circuit Huapai_Marsden_1 was returned to service at 18:18 on Wednesday 26 June 2024. This restored N-1 security to the Northland region.

The following chart summarises the Northland GXP load over the 220 kV circuit outage period, and the estimated load management that took place during that time.

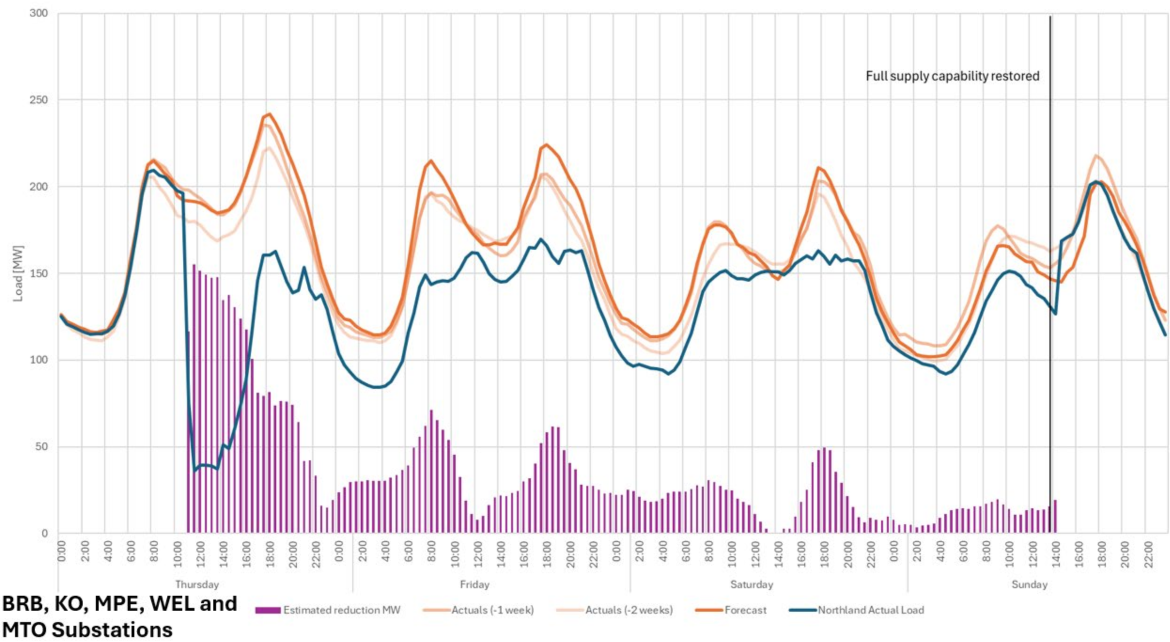

Figure 6: Northland GXP load over the 220 kV circuit outage period and estimated load management

Appendix A: Glossary

Acronym	Description
ALB	Albany substation
AR	Automatic Reclose
BEN	Benmore substation
BRB	Bream Bay substation
CAN	Customer Advice Notice sent out by the system operator
Cap	Capacitor
CB	Circuit Breaker
CCT	Circuit
CIMS	Critical Incident Management System
CP	Connected Party
CSS	Control Sequence Schedular (SCADA application that enables automatic switching)
CTO	Change to Offer
DTF	Distance to fault tool
EC	Energy coordinator for the system operator
EDB	Electricity Distribution Business (also referred to as distributors)
EMS	Energy Management System applications are used by the system operator for monitoring the system in real-time and for assessing outages on the system
GAC	Grid Asset Controller for the grid owner
GEN	Grid emergency notice
GM	General Manager
GOL	Grid Operations Log
GOP	Grid Operations Planner
GXP	Grid exit point, any point of connection on the grid at which electricity predominantly flows out of the grid.
HAY	Haywards substation
HEN	Henderson substation
HPI	Huapai substation
HVDC	HVDC, means the converter stations at Benmore in the South Island and Haywards in the North Island and the high voltage transmission lines and undersea cables linking them.
Hz	Hertz, unit of measure for frequency
ICCP	Inter Control-centre Communications Protocol, data exchange protocol used to pass information between the participant and system operator control rooms.

Acronym	Description
IPS	Island Power System
ITC	Interruption to Connection report published by Transpower as grid owner
IONS	Integrated Outage Notification System
KEN	Kennsington substation, embedded off Maungatapere
KTA	Kaitaia substation, embedded off Kaikohe
kV	Kilo-volt, unit of measure for voltage in volts using 000's
LOC	Loss of Connection
LOS	Loss of Supply
MOL	Manual Operator Log
MPE	Maungatapere substation
Mvar	Mega volt amps (reactive), unit of reactive power
MW	Mega-watts, unit of measure for energy in watts using 000's
MWh	Mega-watt hour, unit of electrical energy
NCC	National Coordination Centre for the system operator. There are two located in Hamilton and Wellington
NGA	Ngawha geothermal generation station
NGB	Ngawha geothermal generation station (dispatchable)
NGOC	National Grid Operations Centre for the grid owner. There are two located in Auckland (RCN) and Christchurch (RCS)
NNI	Northern North Island
NPW	Northpower
OM	duty Operations Manager for the system operator
OPE	Open (request)
OR	Operational Request - submitted to outage planners/GOPs by SS
OW	Outage windows
P&A	Protection and Automation
PDM	Predictive Maintenance
PMU	Phasor measurement unit
PPO	Principle performance obligation
PPS	Planning and Project Support (team within Operations Planning)
PR-CP-638/V3	Process document - Northland Region via 110 kV Contingency Plan
PROT	Protection Relay Settings
RCP	Reclose Block
RTCA	Real Time Contingency Analysis
RTNET	Real Time Network
RTS	Returned to Service

Acronym	Description
SC	Security coordinator for the system operator
SCADA	Supervisory Control and Data Acquisition tool used to provide visibility of the power system in real-time
SMS	Station Management System
SNOR	Short Notice Outage Request
SP	Service Provider
SS	System Security (team within Operations Planning)
STC	Static compensator
STNET	Study time network tool. An EMS/SCADA application for performing power system studies
T#	Transformer #, where # represent the transformer identification number i.e. 1, 2, 3, etc
the Authority	Electricity Authority
the Code	Electricity Industry Participation Code
TOC	Transfer of Control
TOP	Top Energy Limited
TSAT	Transient stability assessment tool, provided by Powertech
UNIRPC	Upper North Island Reactive Power Controller
VLD	Vector
VoLL	Value of lost load

Appendix B: Pre-event planning timeline

<table>
<tr><th>Date</th><th>Event / Action Description</th></tr>
<tr><td>25/01/2023</td><td>BRB_HPI_1 and HEN_HPI_1 outage windows for 18/06/2024 – 21/06/2024 lodged

Entered outage windows as part of the 23/24 Annual Outage Plan, with 510 days lead time</td></tr>
<tr><td>12/05/2023</td><td>BRB_HPI_1 and HEN_HPI_1 outage windows for 18/06/2024 – 21/06/2024 approved

The outage becomes approved as part of the published 23/24 annual outage plan. Outage block comments in IONS:

HEN_HPI_1: Forces out BRB_HPI_1. system splits are required at MPE_CB252 and MPE_CB292. A contingency of ALB_HPI will result in voltage collapse in the Northland area and overloading of the HEN_MPE circuits as the system attempts to supply Northland via the 110 kV. To alleviate this issue system splits are required at MPE_CB252 and MPE_CB292. As a result, ALB 220 kV, HPI, BRB, MDN, MPE, KEN, KOE & KTA are on N-Security.

BRB_HPI_1: Required Splits: MPE_CB_252 & MPE_CB_292.
n-security to: Marsden, Bream Bay, Kaikohe, Maungatapere
System splits required on MPE_MTO 1 & 2, by opening MPE CB 252 and MPE CB 292. Splits to be entered in planning time however may be reversed close to real-time depending on loads.</td></tr>
<tr><td>11/04/2024</td><td>Planning and project support team (PPS) handed over the week of 17/06/2024 to System Security team (SS) after all technical studies were completed.

The handover had the following information regarding the outages in question:

Northland is on N-security from Mon 17/06 – Fri 21/06 due to:

MDN_T6 (17/06 – 20/06) which also removes MDN_STC_6 for the duration and BRB_MDN_1 on 17/06 and MDN_MPE_2 from 19/06 – 20/06.

BRB_HPI_1 + HEN_HPI_1 (18/06 – 21/06). Just as a note – the MPE-MTO splits are in IONS for the entire duration of required but are associated with the MDN work. If this is to shift/cancel, splits may need to be put in for BRB_HPI_1 + HEN_HPI_1 outage.

Explanation: Studies by PPS are completed on time, 10 weeks ahead of the outage start time. These studies only look at power flow tools. The System Security Team (SS) pick up the outage studies from 6 weeks ahead using more refined tooling and modelling that is available closer to the start date.</td></tr>
</table>

Date	Event / Action Description
15/04/2024	First significant outage report sent highlighting missing risk and mitigation plan. This report was then sent every Monday highlighting the missing risk and mitigation plan until the outage was completed in IONs. The Job Manager in the Grid Delivery team is responsible for attaching risk and mitigation plans in ION for all outages on N security prior to the outage taking place. It is not part of the Operations process to check this prior to releasing the outage. It is understood a Risk and mitigation plan was created but never attached in IONs. The implications of this will be considered in the final report but was not a material issue in relation to restoration.
28/05/2024	Operational Requests (ORs) added to outages OR added by Omexom to outage windows for Predictive maintenance – Lines, works dampers (with lead time of 21 days from outage start)
29/05/2024	Outage windows consolidated Outage windows consolidated to ensure length of windows aligns with OR requirements. This is usually done at least 6 weeks prior to the start of the outage, but the SP only submitted the OR 3 weeks prior to the start of the outage. Submitted on 28/5/24 and consolidated on 29/5/24.
29/05/2024	Notifications sent to Northpower and Top Energy Notifications advise customers of the outage impact (sent with lead time of 20 days from outage start) This outage is for the following reason: PDM line work spacers System splits at MPE_CB_252 & 292 are for those outages as well as MDN_T6 (17-21/06/2024) The impact of this outage will be: N Security at: Marsden, Bream Bay, Maungatapere, Huapai and Kaikohe
14/06/2024	SS handed over the Monday outages to NCC. All outages and requirements met and in place. Concurrent outages were identified, studied and agreed to proceed.
17/06/2024	MPE_CB_252 and MPE_CB_292 OPE outage windows entered for 18/06/2024 – 21/06/2024 System splits added by NGOC ahead of the outage the following day. These outage windows were ended and re-entered in real-time by NGOC on 19/06/2024
18/06/2024	BRB_HPI_1 and HEN_HPI_1 RS outage windows and MPE_CB_252 and MPE_CB_292 OPE outage windows released (Northland on 'N' security).

Appendix C: Full Incident timeline

Timeline notes:

1. Key timeline events highlighted in yellow with bold text.
2. Additional explanations provided in blue text to supplement log entries
3. Other North Island system activity included in light grey text, without an incident time. This is to provide context of other activity being managed in the control room during the incident.

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
20-Jun	**11:03**	**00:00:00**	**Huapai_Marsden_1 circuit (HPI_MDN_1) Tripped. Loss of Supply to Northland. LOS to BRB, KOE, MDN, MPE (159 MW). LOC to NGA and KTS.**
20-Jun	11:06	00:00:03	Security Coordinator advised duty NCC OM of event (this will be recorded)
20-Jun	11:08	00:00:05	NCC OM advises Grid and System Operations Manager
20-Jun	11:09	00:00:06	HPI_MDN_1 tripping. NGOC advised Police about loss of supply to BRB 16MW, MDN, MPE 84.8MW, and KOE 57.95MW.
20-Jun	11:10	00:00:07	NCC OM advises duty Executive General Manager (EGM)
20-Jun	11:13	00:00:10	NCC OM discusses with duty NGOC OM
20-Jun	**11:17**	**00:00:14**	**GEN (verbal) declared for loss of supply to BRB, MDN. MPE. and KOE. To NGOC RCN, from now until 18:00 for Northland to effect restoration via the 110 kV network. Restoration will use PR-CP-638/V3 Northland Region via 110 kV Contingency Plan.**
20-Jun	11:17	00:00:14	HPI_MDN_1 (Change to offer) CTO submitted. Change To Offer (CTO) submitted from NGOC to system operator (NCC) the planned end date/time was unknown now 20-jun-2024 18:00:00.
20-Jun	11:19	00:00:16	Initial SMS sent. Loss of supply to BRB 16MW, MDN, MPE 84.8MW, and KOE 57.95MW.
20-Jun	11:20	00:00:17	Confirmed disconnection of NGB and BRB diesel generator with respective GC's for Northland 110 kV restoration
20-Jun	11:33	00:00:30	Updated Police about the reported structural failure on HPI-MDN-1 Tower 130 at 2995 Kaipara Cost Highway. Police event number P059108560.
20-Jun	11:34	00:00:31	Contingency Plan - PR-CP-638, Steps 4c completed. Explanation: NGOC - Prepare Maungatapere Substation for livening through the 110 kV system.
20-Jun	11:38	00:00:35	PR-CP-638, Steps 4f completed. Explanation: NGOC - Prepare Maungatapere Substation for livening through the 110 kV system - continued.
20-Jun	11:39	00:00:36	CTO 20-jun-2024 11:39:03 MPE_CB_252 and 292 Change to Offer (CTO) for 21-jun-2024 12:00:00 Planned end date/time was 21-jun-2024 18:30:00 now 21-jun-2024 12:00:00 Explanation: Maungatapere CB 252 and 292 - change to asset offer to return the CBs to service and close the 110 kV split to connect the HEN 110 kV to Maungatapere
20-Jun	11:40	00:00:37	Meeting: SO Northland LoS IMT meeting
20-Jun	**11:38**	**00:00:35**	**20-jun-2024 11:40:32 MPE_CB_252 Returned to Service (RTS)** Explanation: Maungatapere CB 252 returned to service. Maungatapere 110 kV bus livened at 11:38
20-Jun	11:41	00:00:38	NCC OM event discussion with Northpower to see how they were getting on.

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
20-Jun	11:43	00:00:40	PR-CP-638, Step 5C completed. Explanation: MPE 292 closed and returned to service
20-Jun	11:42	00:00:39	Confirmed disconnection of Kaitaia Solar Farm via TOP network CB143392
20-Jun	11:47	00:00:44	KOE1101 NGB0 Discretion Clause 13.70, Part 13 ENR Max: 0 Start: 20-Jun-2024 11:47 End: 20-Jun-2024 14:00 Notes: Loss of power to Northland. Last Dispatched: Mw: 17.5 ResF: NULL ResS: NULL
20-Jun	11:56	00:00:53	NCC OM event discussion with TOP to see how they were getting on.
20-Jun	11:56	00:00:53	PR-CP-638, Step 5d completed. Maungatapere Substation limited to 10MW Explanation: NGOC - Restore limited supply to MPE 110 kV bus
20-Jun	12:00	00:00:57	Meeting: Northland Emergency Exec IMT meeting #1
20-Jun	12:09	00:01:06	PR-CP-638, Steps 6a to 6f completed. Explanation: NGOC - Prepare for connection at Marsden and Bream Bay Substations
20-Jun	12:16	00:01:13	PR-CP-638, Steps 7a to 7b, and 7d completed. Explanation: NGOC - Restore supply to Marsden
20-Jun	12:24	00:01:21	PR-CP-638, Steps 8a, 1 and 2 completed. EC Explanation: NGOC - Instruction to start Marsden STC6, MDN STC5 not available.
20-Jun	12:28	00:01:25	NCC OM discussion with Grid Delivery EGM. Need to ascertain maximum load but approval given to run to N
20-Jun	**12:28**	**00:01:25**	**PR-CP-638, Steps 9a and 9b completed.** Explanation: NGOC - Bream Bay restored at 12:28
20-Jun	**12:47**	**00:01:44**	**Supply restored with restrictions to Bream Bay, Maungatapere and Kaikohe Substations.** Explanation: KOE restored at 12:47
20-Jun	12:57	00:01:54	Updated Police - supply restored to Connected Party
20-Jun	13:00	00:01:57	Meeting: GD led IMT 1pm update
20-Jun	13:00	00:01:57	HPI_MDN_1 OCR transferred to Service Provider
20-Jun	13:01		Routine valve stroking at THI
20-Jun	13:06	00:02:03	Duty NCC OM discussion with TOP. Ascertain how much embedded generation in their network and status of NGA
20-Jun	13:15	00:02:12	Meeting: SO Northland Event Catch Up
20-Jun	13:30	00:02:27	Meeting: Northland Emergency Exec IMT meeting #2
20-Jun	13:38		Routine valve stroking at OKI
20-Jun	13:38	00:02:35	Duty NCC OM discussion with Manawa. Ascertain status of diesels, fuel availability and intentions
20-Jun	**14:14**	**00:03:11**	**NGB tripped. KOE1101 NGB0 Bonafide ENR Max: 0 Start: 20-Jun-2024 14:14 End: 20-Jun-2024 14:30 Notes: bf Last Dispatched: Mw: 17.5 ResF: NULL ResS: NULL**
20-Jun	**14:15**	**00:03:12**	**RTCA violation. HEN_MPE1/2, HEN_MPE2/1, 120%. NPW instructed via NGOC to hold load at BRB and restrict load at MPE to 10MW.**
20-Jun	14:22	00:03:19	Meridian rang duty NCC OM to discuss event and whether we going to hold an industry conference
20-Jun	**14:23**	**00:03:20**	**NPW load. Instruct NPW to limit MPE load to 10MW following NGB generation tripping.**
20-Jun	**14:30**	**00:03:27**	**NCC OM posted this on teams channel:** ***NGA B has tripped so now we have N-1 violations. Grid Delivery EGM was happy to run as N but we'd want to be sure there's no safety concerns***

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
20-Jun	14:30	00:03:27	Meeting: Northland Outage (TP/EDB meeting arranged by Grid Delivery)
20-Jun	14:33	00:03:30	Duty NCC OM discussion with Grid Delivery EGM. Updating of situation and possible N outcome once loads high enough.
20-Jun	14:34	00:03:31	Discussion and decision around running the remaining system at N. Executive directive that we do what we can to supply Northland with as much capacity as possible.
20-Jun	**14:35**	**00:03:32**	**NPW load. Previous load limits rescinded as we will operate to N security. Load limits are MPE 20MW and BRB 10MW as instructed during the restoration.**
20-Jun	**14:41**	**00:03:38**	**Written GEN published Ref 5456034462**
20-Jun	14:56	00:03:53	Duty NCC OM discussion with NNI SDM. Circuit should handle overloads with potential loading issues restricted to substation equipment. Concluded not a safety issue then. Actual loadings still well below maximums.
20-Jun	15:00	00:03:57	Meeting: GD led IMT Update 2 - Northland LOS
20-Jun	15:04	00:04:01	Duty NCC OM event discussion with Vector. Vector noted availability of battery at WEL for over the peak.
20-Jun	**15:10**	**00:04:07**	**New load limits for MPE of 30MW (was 20MW) and for KOE of 20MW (was 10MW).**
20-Jun	**15:12**	**00:04:09**	**NGB generation back on and to ramp up load at MPE to maximum of 30MW and 20MW at KOE.**
20-Jun	15:14	00:04:11	Duty NCC OM event discussion with TOP to see how they were getting on and ability to meet the peak
20-Jun	15:15	00:04:12	Meeting: SO Northland Event Catch Up
20-Jun	15:30	00:04:27	Meeting: Northland Emergency Exec IMT meeting #3
20-Jun	15:37	00:04:34	Duty NCC OM event discussion with Northpower to see how they were getting on and ability to meet the peak
20-Jun	**15:51**	**00:04:48**	**Manawa GC advises BRB diesel units starting up with approx run time of 30-40 hrs**
20-Jun	**15:55**	**00:04:52**	**New load limits for MPE of 50MW (was 30MW) and for BRB of 15MW (was 10MW). No change for KOE (20MW).**
20-Jun	16:03		20-jun-2024 16:03:32 EDG_KAW_1 Reclose Block Returned (RCB)
20-Jun	16:05		20-jun-2024 16:05:02 EDG_KAW_2 Reclose Block Returned (RCB)
20-Jun	16:08	00:05:05	RTNET value for "MPE 110LOAD_2" has been overridden to use a more realistic value. The modelled value in RTNET was consistently reading high when compared to real time SCADA values. MPE tabular showed that the "MPE 110LOAD2" value was suspect and was using a calculated value which was too high and giving us inaccurate RTCA violations. Fixed at 16:21.
20-Jun	**16:28**	**00:05:25**	**New load limits for MPE of 60MW (was 50MW) and KOE of 25MW (was 20MW). No change for BRB.**
20-Jun	**16:40**	**00:05:37**	**New load limits for MPE of 70MW (was 60MW) and KOE of 45MW (was 25MW). No change for BRB.**
20-Jun	17:00	00:05:57	Meeting: GD led IMT Update 3 - Northland LOS
20-Jun	17:14	00:06:11	There was 92 MW across both circuits. Duty NCC OM sent email to Grid Delivery EGM, RSM, and SPM Lines outlining consequences of 200% overload (which is likely to occur over peak as circuits are loaded to max) and potential alternative option of splitting the bus at MPE and creating two spurs. Grid Delivery EGM passed on to protection engineering managers, asking for impact of overloads and viability of split.
20-Jun	17:15	00:06:12	Meeting: SO Northland Event Catch Up
20-Jun	17:28	00:06:25	Contacted NGB and TOP to see if any voltage assistance available using NGB MVAr or KTA Caps. Network controller looking at it
20-Jun	17:30	00:06:27	Meeting: Northland Emergency Exec IMT meeting #4
20-Jun	17:39	00:06:36	NCC OM update discussion with Vector.

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
20-Jun	**17:40**	**00:06:37**	**At some stage that afternoon Primary Assets OM and Protection & Automation OM communicated to the duty NCC OM that there were thermal settings of 389 amps in place on the HEN CB's which would trip the circuits within 4 seconds of reaching that limit. They were also not comfortable with the MPE split option until some protection studies could be carried out (possibly Friday)**
20-Jun	17:42	00:06:39	MDN STC 6 RTS
20-Jun	18:05	00:07:02	Request HEN_HPI_1 is recalled. NCC advised and see no security issue that requires this CCT to be RTS. Duty Protection advised and advice sought.
20-Jun	**18:38**	**00:07:35**	**Load limits confirmed for Friday evening peak. MPE = 75MW, MTO = 15MW & BRB = 15MW (combined Northpower total of 105MW). KOE = 45MW. WEL = best endeavours to stay as low as possible without shedding real load (expect around 31-32MW).**
20-Jun	19:47	00:08:44	NCC would like to reconfigure the grid to enhance security. The plan is 1. OPE WEL T1 and MTO T2 2. OPE MDN_MPE 2 3. OPE KOE_MPE 1 4. OPE MPE FDRs 282 and 302 5. OPE MPE 288 (Split MPE Bus) Protection, NPW and VLD advised.
20-Jun	19:49	00:08:46	Adjusted UNIRPC 220 kV step to 0.5kV to "massage" northland
20-Jun	20:00	00:08:57	Meeting: GD led IMT Update 4 - Northland LOS
20-Jun	20:30	00:09:27	Meeting: Northland Emergency Exec IMT meeting #5
20-Jun	20:37	00:09:34	NGOC had request from Northpower if they can restore controllable load at MPE. Advise NGOC to inform Northpower they can restore controllable load at MPE, provided they remain below the current MPE load limit of 75 MW.
20-Jun	20:51	00:09:48	PTP to Disable AR on HEN_MPE_1 and 2 - Unsure if NGA Anti island will operate
20-Jun	20:53	00:09:50	Duty NCC OM event discussion with Northpower to see how they got on over evening peak ability to meet the morning peak
20-Jun	21:22	00:10:19	HPI_MDN_1 - P & A Duty Eng advised that he has been told by his manager that this reconfiguration won't be taking place tonight and that has come from Primary Assets. NCC advised, but has heard nothing so will contact their Duty Ops Manager
20-Jun	21:22		ARG1101 BRR0 Bonafide ENR Max: 0 Start: 20-Jun-2024 21:22 End: 20-Jun-2024 21:30 Notes: gen tripped Last Dispatched: Mw: 6 ResF: NULL ResS: NULL
20-Jun	21:37		MHO0331 MHO0 Bonafide ENR Max: 0 Start: 20-Jun-2024 21:37 End: 20-Jun-2024 22:00 Notes: null Last Dispatched: Mw: 11.24 ResF: 0 ResS: 0
20-Jun	21:02	00:09:59	Duty NCC OM event discussion with TOP to see how they were getting on and ability to meet the peak
20-Jun	21:56	00:10:53	NCC confirm the grid reconfiguration won't happen tonight. They also request NNI advise CP to restore all load up to KOE 45 MW, BRB 15 MW and MPE 75 MW. NPW, TOP and VLD advised.
21-Jun	0:51		SCADA IPS Selected
21-Jun	5:23	00:18:20	Set KOE SDV Load Data Source Config Source 1 to SE. Was S1 Meter, S2 Scada, S3 blank. (right click, check configuration)
21-Jun	6:07		21-jun-2024 06:07:02 ATI_WKM_1 Reclose Block Issued (RCB)
21-Jun	**6:40**	**00:19:37**	**Request from Top Energy to advise them if they are getting close to their 45MW load limit as they don't have visibility of their current load. They will contact us regularly to get updates.**
21-Jun	7:00	00:19:57	Meeting: SO Northland Event Catch Up
21-Jun	9:00	00:21:57	Meeting: GD led IMT Update 5 - Northland LOS
21-Jun	9:43	00:22:40	Duty NCC OM event discussion with Northpower to see how they got on over the peak and ability to meet tonight's peak.
21-Jun	9:52	00:22:49	Duty NCC OM discussion with Grid Delivery EGM
21-Jun	10:00	00:22:57	Meeting: SO Northland Event Catch Up
21-Jun	**10:35**	**00:23:32**	**GEN revised, end time changed to 22/6 23:59. Ref 5457861173**
21-Jun	10:53	00:23:50	NCC OM discussion with Northpower

Date *(dd/mm)*	Time *(hh:mm)*	Incident Time *(dd:hh:mm)*	Event / Action Description
21-Jun	11:00	00:23:57	Meeting: GD led IMT Update 6 - Northland LOS
21-Jun	11:04	01:00:01	NCC OM event discussion with TOP and advising of 11:30 teams conference between EDB's
21-Jun	11:10	01:00:07	NCC OM advising Northpower of 11:30 teams conference between EDB's
21-Jun	11:30	01:00:27	Meeting: Northland Emergency Exec IMT meeting #6
21-Jun	11:30	01:00:27	Meeting: Northland Event - Operations Managers Briefing
21-Jun	**11:30**	**01:00:27**	**Meeting between duty NCC OM, Grid and System Ops Mgr, NCC OM (Wellington), TOP Energy, Northpower and Vector. Good discussion on status, ability to keep going as is, impact on customers, and the need to work together to minimise impact on customers. Industrial/commercial and controllable load bearing the brunt of load reductions.**
21-Jun	11:46	01:00:43	HPI_MDN_1 end time change to offer from 21/6 1800hrs to 22/6 23:00hrs
21-Jun	12:57		Test start HAY_SC9.
21-Jun	**14:09**	**01:03:06**	**Teams meeting between duty NCC OM, Protection & Automation OM, HVDC & Operational Engineering Manager, and Primary Assets Engineering OM to advise the 389-amp limit of circuits probably wouldn't trip them. They went on to advise new settings had been identified and given to protection to implement on HEN CB's. They were on their way to site. They also advised the MPE split option wasn't viable from a protection perspective.**
21-Jun	14:30	01:03:27	Meeting: Northland LOS - update (TP/EDB meeting arranged by Grid Delivery)
21-Jun	**15:04**	**01:04:01**	**Delegated authority given to NGOC's to manually open the MPE CB on the overloaded HEN MPE circuit if the other HEN MPE circuit tripped. This would stay in place until setting had been applied on the HEN CBs.**
21-Jun	**15:04**	**01:04:01**	**As it is now believed that protection will not work to clear an overload of one HEN_MPE circuit for the loss of the other (Protection setting changes required), Delegated Authority has been given to NGOC North to act as follows: If HEN_MPE_1 trips, Open MPE_CB_252; If HEN_MPE_2 trips, Open MPE_CB_292; If HEN_MPE_2 trips, Open MPE_CB_292** [From NCC Ops Mgr. - Initially told by protection engineers that HEN MPE circuits would trip at 386 amps. This alleviated safety/asset concerns from potential overloads. The engineers later revised that advice, saying it was unlikely. They also had a plan for implementing settings that would trip the circuit at 375 amps. These were implemented around 17:55 and tested around midnight (so a circuit tripping wouldn't overload the other one as increased risk of trip)
21-Jun	15:11		TOC OTA C31 (#202405281714) from NGOC NNI to NCC.
21-Jun	16:03		TOC from NGOC NNI to NCC of TMU_C1 and TMU_C2.
21-Jun	16:40		Test start PEN_STC1A.
21-Jun	16:47		Job logged by NOC for Ops Divert App not working. Has been escalated to P2 by EC. TSD 12372919.
21-Jun	**17:10**	**01:06:07**	**New load limits for MPE of 75MW (was 70MW) and KOE of 45MW (was 25MW). No change for BRB of 15MW**
21-Jun	17:31		21-jun-2024 17:31:32 ATI_WKM_1 Reclose Block Returned (RCB)
21-Jun	17:43		OTA_C30 tripped on close, NGOC advised. Tagged. SP to look at in morning. Outage created until 06 Jul 18:00
21-Jun	**17:55**	**01:06:52**	**Protection setting (Prot 1) changes applied to HEN_MPE _1 and 2**
21-Jun	18:00	01:06:57	Meeting: GD led IMT Update 7 - Northland LOS
21-Jun	18:10	01:07:07	To re-enable Intertrip 1 on HEN_CB_322.
21-Jun	**18:30**	**01:07:27**	**Protection settings applied to HEN CB's. Testing to occur later tonight or early in morning when loads are low enough to cater for one circuit tripping.**
21-Jun	19:23		21-jun-2024 19:23:32 EDG_KAW_1 Reclose Block Returned (RCB)

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
21-Jun	19:24		21-jun-2024 19:24:32 EDG_KAW_2 Reclose Block Returned (RCB)
21-Jun	**19:28**	**01:08:25**	**21-jun-2024 19:28:02 HEN_MPE_2_PROT1 Change to Offer (CTO) Planned start date/time was unknown now 21-jun-2024 23:00:00 Planned end date/time was unknown now 21-jun-2024 23:59:00.** Protection relay setting change, testing between 23:00 and 23:59.
21-Jun	19:42		Mercury phoned NCC to enquire if we had any comm's work/issues. None known so they will follow up their end.
21-Jun	19:49		To Mercury. GOR KWD & LTN TUR dispatches taking a long time to acknowledge. Alarm to say undelivered but looks like delivery is happening at the same time as the alarm
21-Jun	20:18		To Mercury. WTO dispatch disabled due to undelivered dispatches. Phone dispatch until resolved
21-Jun	20:56		SNOR. OTA_C30 RS immediately following earlier trip on close (17:39).
21-Jun	21:05		TOC. OTA C30 from NCC to NGOC NNI (#202406212100).
21-Jun	23:01		Time error. Set HAY Hz offset from HMI to 5mHz
21-Jun	23:49		Time error. Set HAY Hz offset from HMI to -0.1 mHz
22-Jun	0:37		Voltage. Select HPC RP at BEN and HAY to MP. Select HAY HPC switch level to increased
22-Jun	**1:10**	**01:14:07**	**Instruction to NGOC NNI desk to enable I/Trip 1 on HEN CB 302 (HEN-MPE1)** after protection settings change testing.
22-Jun	**2:24**	**01:15:21**	**Instruction to NGOC NNI desk to enable I/Trip 1 on HEN CB 322 (HEN-MPE2)** after protection settings change testing.
22-Jun	**5:53**	**01:18:50**	**Delegated Authority given to NGOC North regarding HEN_MPE trippings is rescinded.**
22-Jun	11:30	02:00:27	Meeting: GD led IMT Update 8 - Northland LOS
22-Jun	12:30	02:01:27	Meeting: Northland Emergency Exec IMT meeting #8
22-Jun	**14:00**	**02:02:57**	**Lots of discussion between TOP/NGA and NCC re having (or wanting) to come off when the 220 circuit connects to BRB, planned for Sunday. SO Power Systems Group Engineer engaged to have a quick look at impacts etc.**
22-Jan	14:03		Override of 0MW added to MOK in MOI due to a broken ramp rate trying to ramp it from the -6MW prior to connection up to 0MW. Removed as they cannot start and have removed their offers.
22-Jun	**19:12**	**02:08:09**	**GEN revised, end time changed to 23/6 23:59. Ref 5460538633**
22-Jun	17:30	02:06:27	Meeting: GD led IMT Update 9 - Northland LOS
22-Jun	18:30	02:07:27	Meeting: Northland Emergency Exec IMT meeting #9
22-Jun	20:34	02:09:31	Requested conditional splits, MPE_CB_252 and MPE_CB_292 OPEs from 12:30 23 Jun to 18:00 28 Jun for the duration of HPI_MDN RS after BRB_HPI RTS.
23-Jun	6:06		HLY G5. BF out of frequency keeping due to on site issues.
23-Jun	8:48		KPU_T3 Tripped. LOS to KPU of 30MW. RTS at 09:48. Omexom advised of KPU_T4 redundant cable cutting and removal, attached to KPU_T3 protection caused the tripping, now disconnected. Duty Ops advised
23-Jun	9:24		ARI_BOB_1 tripped. TP requested full line patrol from tower HAM-MER-A0087 to A03438 (outside of the cable section). Flags: Zone 1 from ARI, B PH and Earth Fault.
23-Jun	10:00	02:22:57	Meeting: Northland LOS - update (TP/EDB meeting arranged by Grid Delivery)
23-Jun	10:15	02:23:12	Meeting: SO Northland Event Catch Up
23-Jun	10:30	02:23:27	Meeting: GD led IMT Update 10 - Northland LOS
23-Jun	12:00	03:00:57	Meeting: Northland Event - Ops Manager Restoration Discussion
23-Jun	**12:00**	**03:00:57**	**Discussion between TOP/NGA/Northpower/Vector/Grid & System Ops Mgr/NCC Duty OM/NCC OM (Wellington)/NCC SC's, and agreement on the plan for**

Date (dd/mm)	Time (hh:mm)	Incident Time (dd:hh:mm)	Event / Action Description
			restoration of BRB_HPI_1 and the coordination of the shutting down of NGA/NGB at 14:00 to enable the reconnection of the 220 kV circuit into Northland.
23-Jun	12:30	03:01:27	Meeting: Northland Emergency Exec IMT meeting #10
23-Jun	13:00	03:01:57	Meeting: SO Northland Event Catch Up
23-Jun	13:44	03:02:02	BRB_HPI Restoration. Reduce NPW load to agreed level (52MW)
23-Jun	13:45	03:02:03	BRB_HPI Restoration. Reduce TOP load to agreed level (33MW)
23-Jun	13:45	03:02:03	BRB_HPI Restoration. Reduce VLD load to agreed level (18MW)
23-Jun	14:10	03:02:28	BRB_HPI Restoration. Shut down NGA and NGB
23-Jun	14:11	03:02:29	KOE1101 NGB0 Discretion Clause 13.70, Part 13 ENR Max: 0 Start: 23-Jun-2024 14:11 End: 23-Jun-2024 15:30 Notes: BRB_HPI restoration Last Dispatched: Mw: 31 ResF: NULL ResS: NULL
23-Jun	**14:16**	**03:02:34**	**BRB_HPI Restoration. RTS BRB_HPI_1** Explanation: 220 kV circuit into Northland livened
23-Jun	14:18	03:02:36	BRB_HPI Restoration. Restore NGA and NGB generation
23-Jun	14:20	03:02:38	BRB_HPI Restoration. Restore NPW load to nominal value
23-Jun	14:20	03:02:38	BRB_HPI Restoration. Restore TOP load to nominal value
23-Jun	14:21	03:02:39	BRB_HPI Restoration. Restore VLD load to nominal value
23-Jun	**15:58**	**03:04:16**	**GEN revised, end time changed to 16:00. Ref 5462633550**
23-Jun	**16:16**	**03:04:34**	**GEN report issued, ref 5462453197**
23-Jun	18:30	03:07:27	Meeting: Northland Emergency Exec IMT meeting #11
23-Jun	20:35		MKE Unit tripped from 45MW. NI Voltage Excursion notice sent.
23-Jun	21:41	03:09:59	MPE CB252 and 292 closed to provide N-1 to Northland
23-Jun	22:09		Call from Fire Emergency NZ about a vehicle fire with smoke going through lines near Matahina. Passed him on to NGOC NNI to dispatch service provider if needed.
23-Jun	22:45		KAW0112 ONU0 Bonafide ENR Max: 31 Start: 23-Jun-2024 22:45 End: 23-Jun-2024 23:00 Notes: null Last Dispatched: Mw: 42 ResF: NULL ResS: NULL
26-Jun	**18:18**	06:06:36	**Second 220 kV cct (HPI_MDN_1) restored (via temporary structures) on Wednesday 26/06/2024 at 18:18. N-1 security restored to Northland.**

Appendix D: Grid emergency notices

TRANSPOWER GEN

Grid Emergency Notice

To:	GEN NZ Participants	**From:**	The System Operator
Sent:	20-jun-2024 14:41	**Telephone:**	0800 488 500
Ref:	5456034462	**Email:**	NMData@transpower.co.nz

Revision of:

Cause:	Unplanned outage Top of North Island
Region or GXP affected:	Top of North Island
Starting:	20-jun-2024 11:17
Ending:	21-jun-2024 18:00

Tripping of Huapai Marsden circuit 1, concurrent with other Northland circuit outages.

Consequences on the power system:

Risk of exceeding grid assets offered capability.

Risk of exceeding AOPO n-1 voltage limits.

The system operator advises:	**At:**
Managed restoration of supply has occurred	North Auckland / Northland
Grid reconfiguration has occurred	North Auckland / Northland

Load restrictions are likely to be required at peak load times.

Demand Allocations:	**Total**	**Notes**

Consequences if insufficient responses by participants:

For more information contact the Security Coordinator on 0800 488 500

This notice is issued in accordance with Technical Code B - Emergencies, Schedule 8.3, Part 8

A revision of this notice will be issued if there is any change to the situation above.

Transpower New Zealand Ltd The National Grid

Figure 7: GEN 20 Jun 2024 14:41

TRANSPOWER GEN

Grid Emergency Notice Revision

To: GEN NZ Participants
Sent: 21-jun-2024 10:35
Ref: 5457861173

From: The System Operator
Telephone: 0800 488 500
Email: NMData@transpower.co.nz

Revision of: **GEN, 5456034462, 20-jun-2024 14:41, Unplanned outage**

Cause:	Unplanned outage Top of North Island	
Region or GXP affected:	Top of North Island	
Starting:	~~20-jun-2024 11:17~~	20-jun-2024 11:17
Ending:	~~21-jun-2024 18:00~~	22-jun-2024 23:59

Tripping of Huapai Marsden circuit 1, concurrent with other Northland circuit outages.

Consequences on the power system:

Risk of exceeding grid assets offered capability.

Risk of exceeding AOPO n-1 voltage limits.

The system operator advises:	**At:**
Managed restoration of supply has occurred	North Auckland / Northland
Grid reconfiguration has occurred	North Auckland / Northland

Load restrictions are likely to be required at peak load times.

Demand Allocations:	**Total**	**Notes**

Consequences if insufficient responses by participants:

For more information contact the Security Coordinator on 0800 488 500

This notice is issued in accordance with Technical Code B - Emergencies, Schedule 8.3, Part 8

A revision of this notice will be issued if there is any change to the situation above.

Transpower New Zealand Ltd The National Grid

Figure 8: GEN 21 Jun 2024 10:35

TRANSPOWER

Grid Emergency Notice Revision

To:	GEN NZ Participants	**From:**	The System Operator
Sent:	22-jun-2024 19:12	**Telephone:**	0800 488 500
Ref:	5460538633	**Email:**	NMData@transpower.co.nz

Revision of: GEN, 5457861173, 21-jun-2024 10:35, Unplanned outage

Cause:	Unplanned outage Top of North Island	
Region or GXP affected:	Top of North Island	
Starting:	~~20-jun-2024 11:17~~	20-jun-2024 11:17
Ending:	~~21-jun-2024 18:00~~	23-jun-2024 23:59

Tripping of Huapai Marsden circuit 1, concurrent with other Northland circuit outages.

Consequences on the power system:

Risk of exceeding grid assets offered capability.

Risk of exceeding AOPO n-1 voltage limits.

The system operator advises:	**At:**
Managed restoration of supply has occurred	North Auckland / Northland
Grid reconfiguration has occurred	North Auckland / Northland

Load restrictions are likely to be required at peak load times.

Demand Allocations:	**Total**	**Notes**

Consequences if insufficient responses by participants:

For more information contact the Security Coordinator on 0800 488 500

This notice is issued in accordance with Technical Code B - Emergencies, Schedule 8.3, Part 8

A revision of this notice will be issued if there is any change to the situation above.

Transpower New Zealand Ltd The National Grid

Figure 9: GEN 22 Jun 2024 19:12

TRANSPOWER

Grid Emergency Notice — Revision

To:	GEN NZ Participants	**From:**	The System Operator
Sent:	23-jun-2024 15:58	**Telephone:**	0800 488 500
Ref:	5462633550	**Email:**	NMData@transpower.co.nz

Revision of: **GEN, 5460538633, 22-jun-2024 19:12, Unplanned outage**

Cause:	Unplanned outage Top of North Island	
Region or GXP affected:	Top of North Island	
Starting:	~~20-jun-2024 11:17~~	20-jun-2024 11:17
Ending:	~~21-jun-2024 18:00~~	23-jun-2024 16:00

Tripping of Huapai Marsden circuit 1, concurrent with other Northland circuit outages.

Consequences on the power system:

Risk of exceeding grid assets offered capability.

Risk of exceeding AOPO n-1 voltage limits.

The system operator advises:	**At:**
Managed restoration of supply has occurred	North Auckland / Northland
Grid reconfiguration has occurred	North Auckland / Northland

Load restrictions are likely to be required at peak load times.

Demand Allocations:	**Total**	**Notes**

Consequences if insufficient responses by participants:

For more information contact the Security Coordinator on 0800 488 500

This notice is issued in accordance with Technical Code B - Emergencies, Schedule 8.3, Part 8

A revision of this notice will be issued if there is any change to the situation above.

Transpower New Zealand Ltd The National Grid

Figure 10: GEN 23 Jun 2024 15:58

TRANSPOWER GEN REPORT

Grid Emergency Report

To:	GEN NZ Participants	**From:**	The System Operator
Sent:	23-jun-2024 16:16	**Telephone:**	0800 488 500
Ref:	5462453197	**Email:**	NMData@transpower.co.nz

Revision of:
Grid Emergency Notice ref: 5462633550

Cause:	Unplanned outage Top of North Island
At:	Top of North Island
Starting:	20-jun-2024 11:17
Ending:	23-jun-2024 16:00
Action Taken:	Northland area load was managed for the duration of the outage.

This notice is issued in accordance with Clause 13.101, Part 13

A revision of this notice will be issued if there is any change to the situation above.

Transpower New Zealand Ltd The National Grid

Figure 11: GEN report 23 Jun 2024 16:16

Appendix E: Northland substation load charts

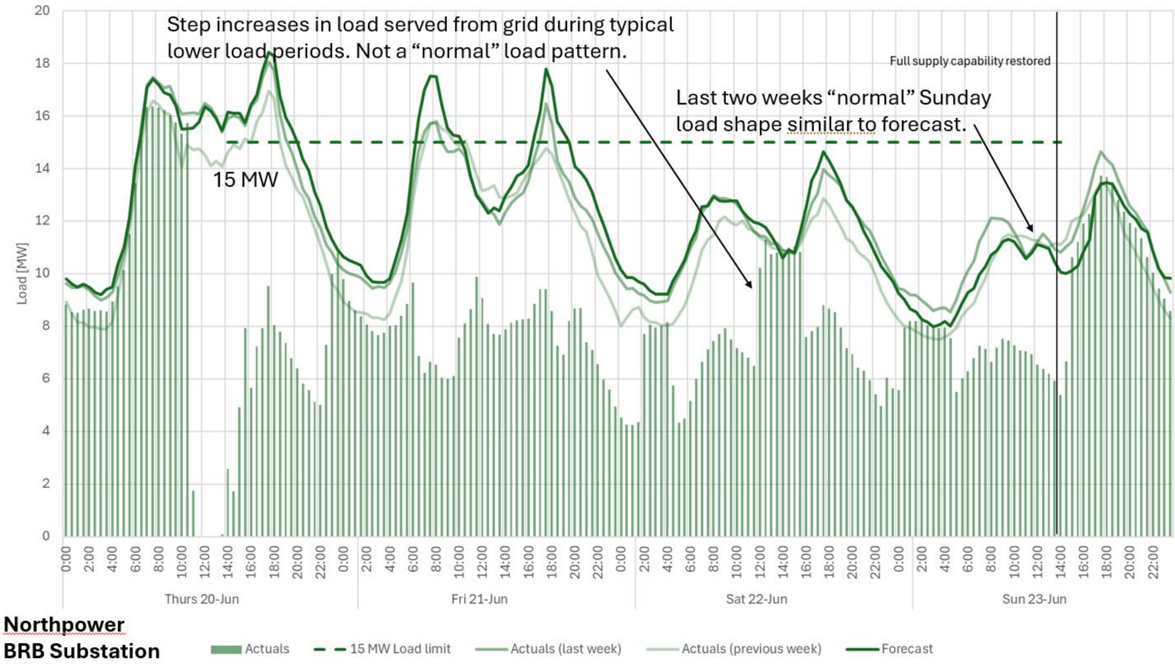

Figure 12: BRB substation load chart

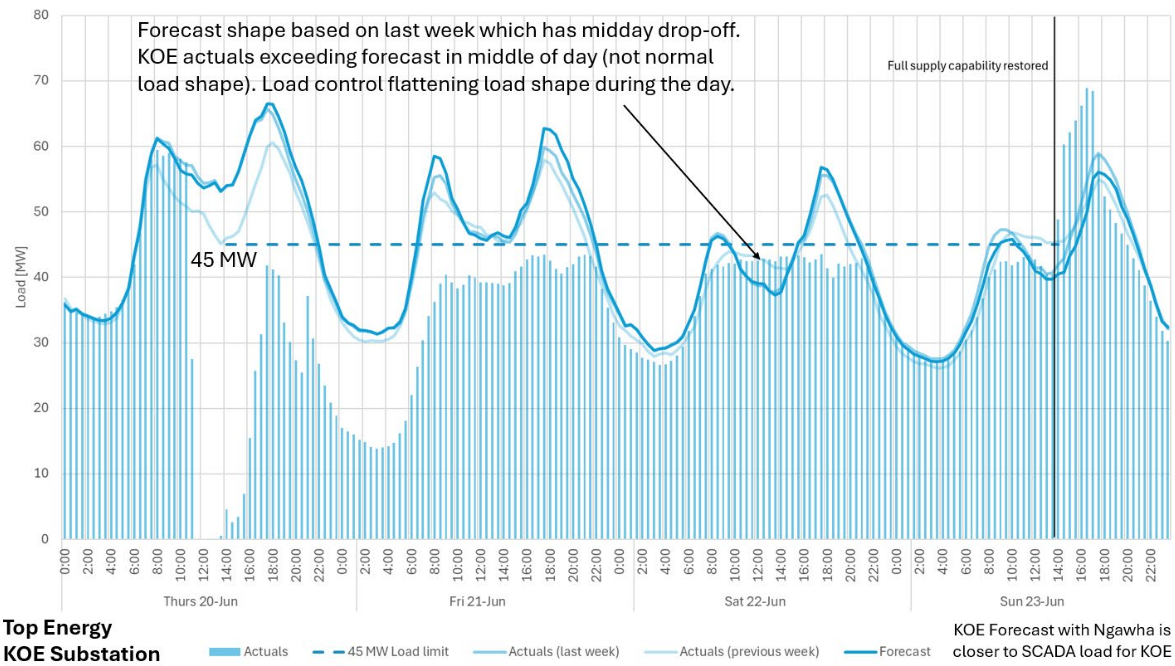

Figure 13: KOE substation load chart

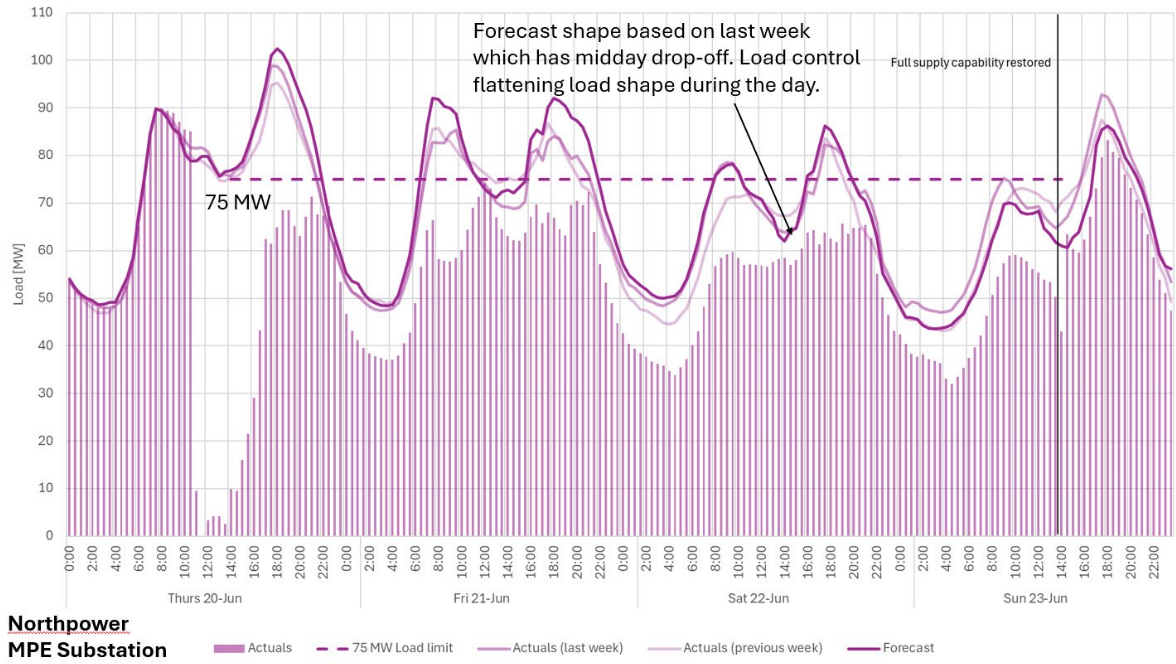

Figure 14: MPE substation load chart

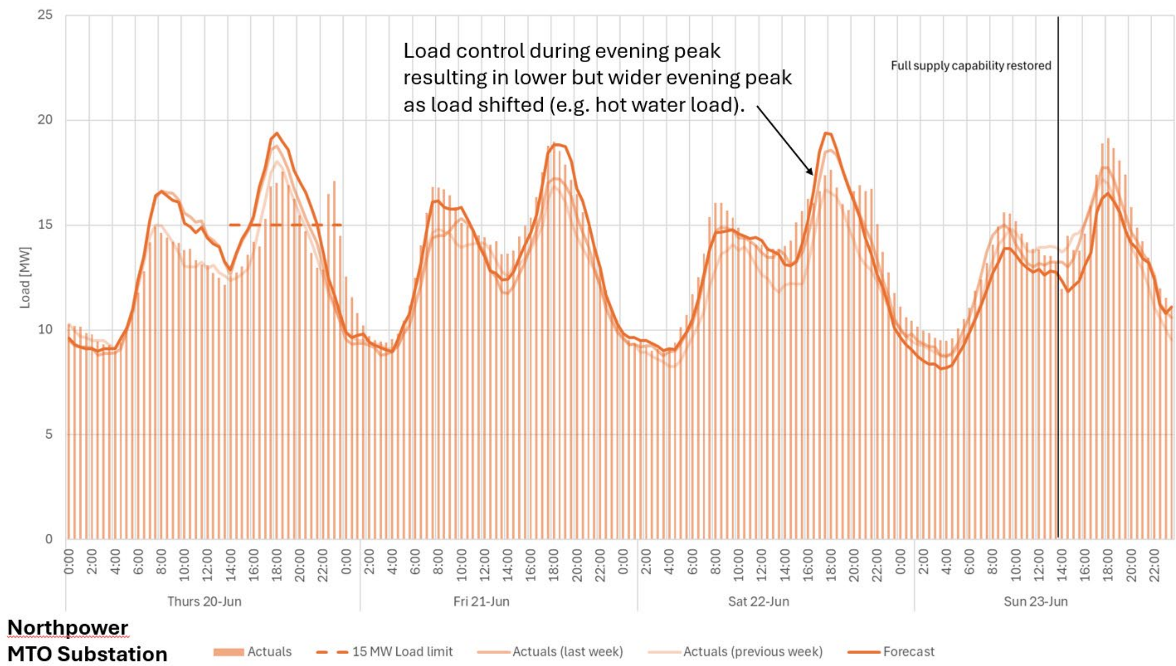

Figure 15: MTO substation load chart

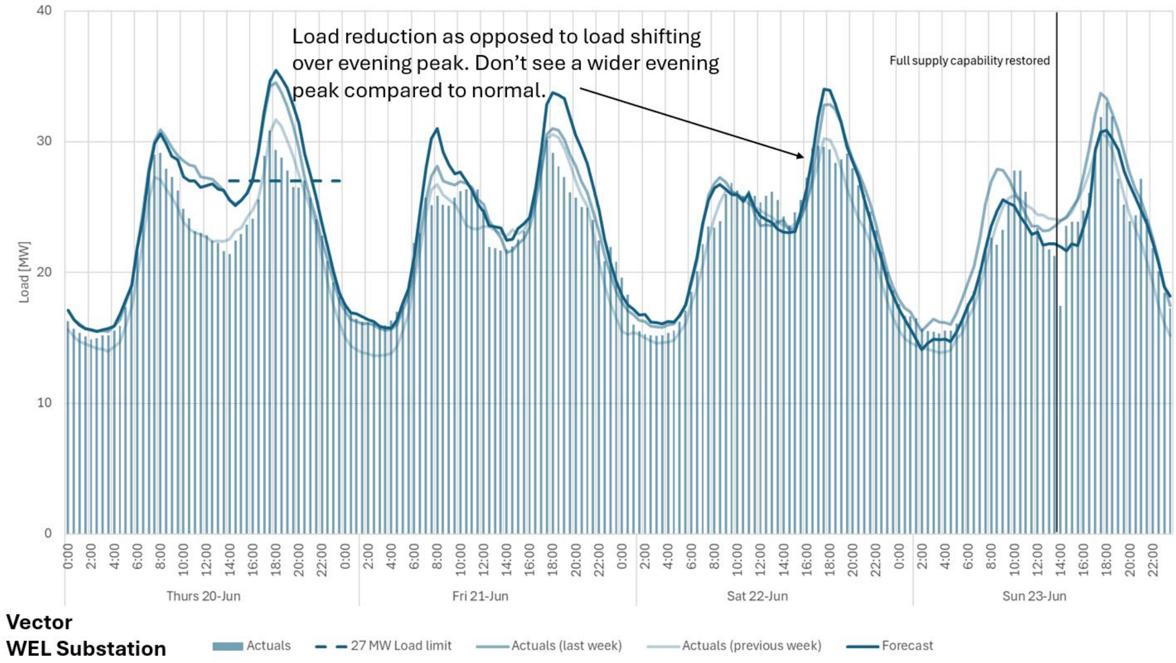

Figure 16: WEL substation load chart

Appendix F: Northland loss, market analysis

The following screen shots are from PI Vision.

At time of tripping, MPE (purple), KOE (teal) and BRB (red) loads drop to 0. WEL (blue) and MTO (orange) loads appear almost unaffected:

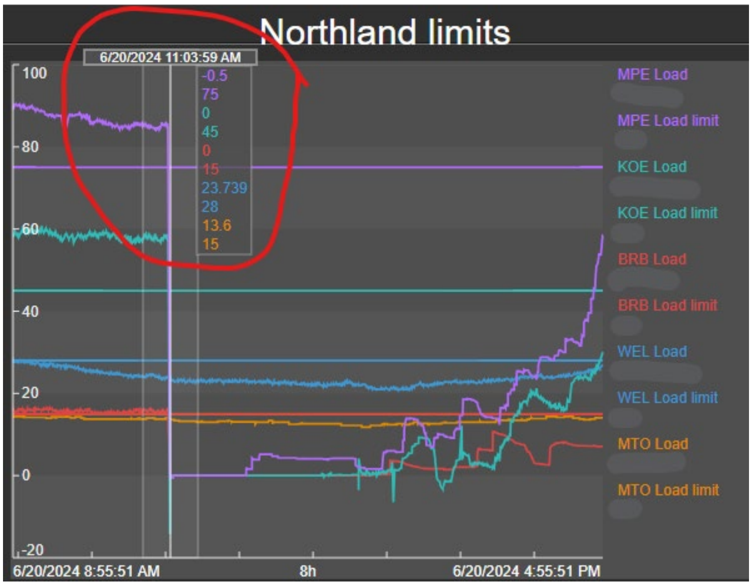

Figure 17: PI Vision plot - 20 June 2024 11:03:59

Load starts returning gradually around 12, first at MPE:

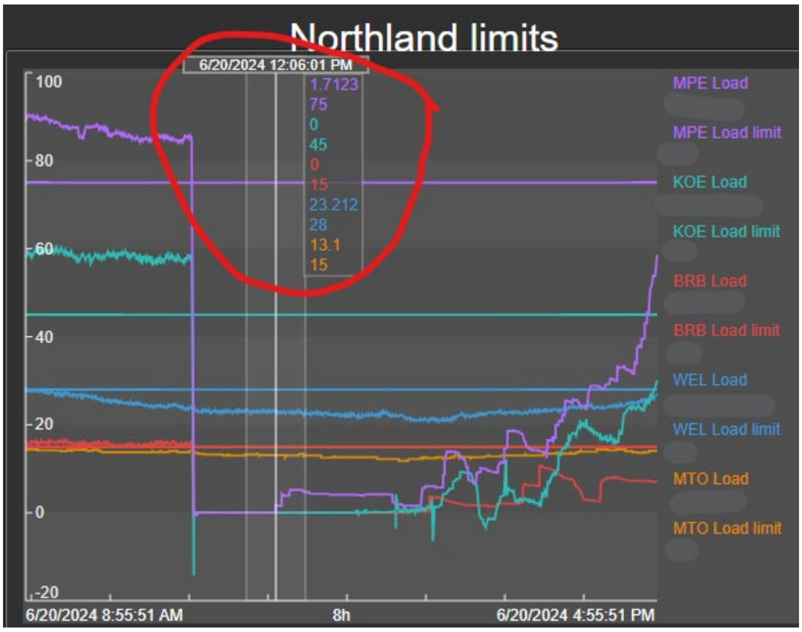

Figure 18: PI Vision plot - 20 June 2024 12:06:01

Prices over the day:

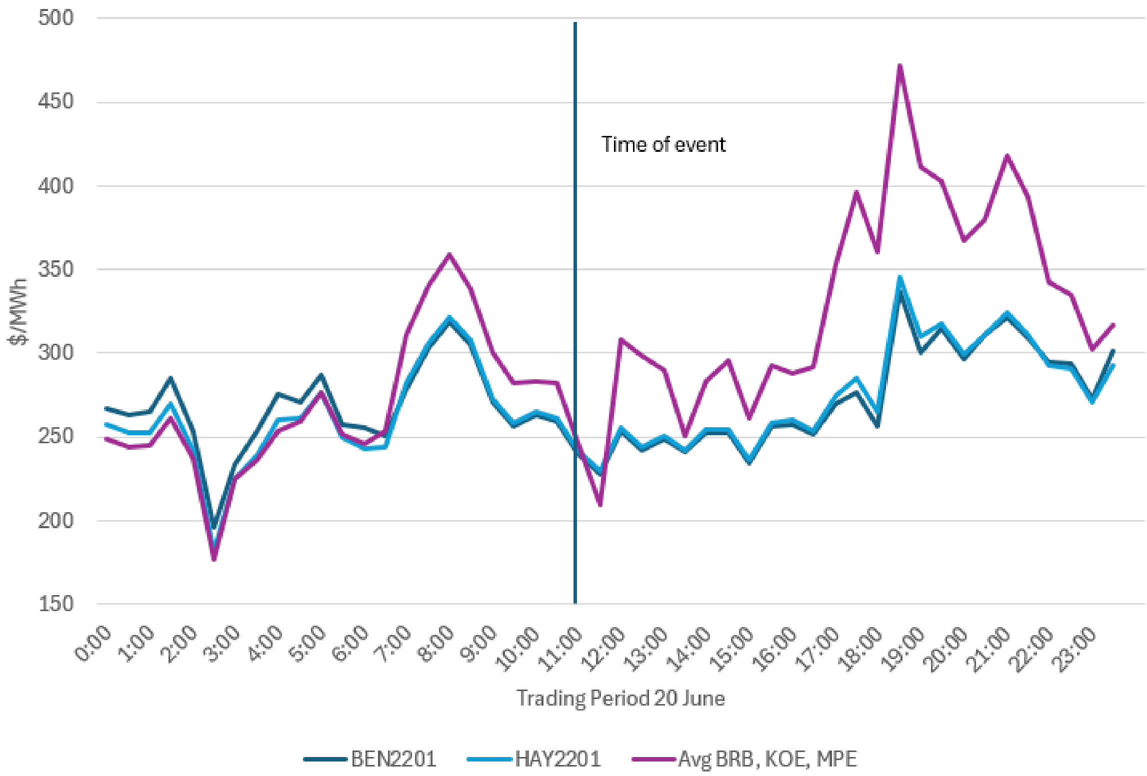

Figure 19: Prices on 20 June 2024

Final price vs forecast prices in latest PRSS before event.

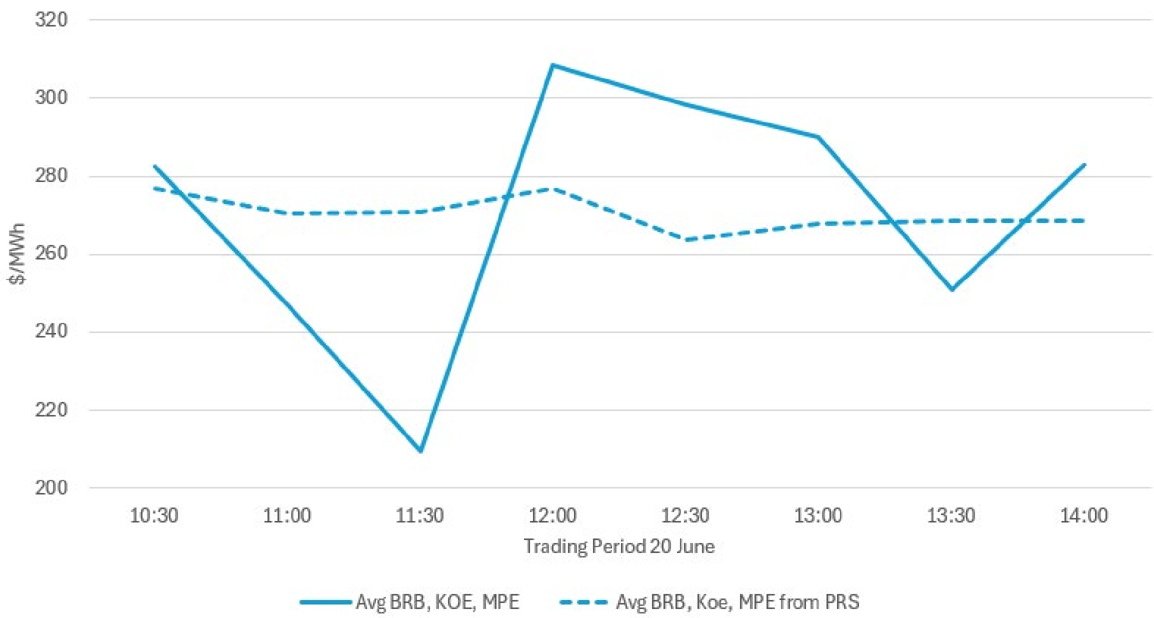

Figure 20: Final prices v forecast prices on 20 June 2024

Appendix G: Weather conditions

Heavy Rain Warning - Orange

Area: *Northland north of Whangarei*

Period: *16hrs from 8:00pm Wednesday to 12:00pm Thursday*

Forecast: *Expect 80 to 120 mm of rain. This rain comes in addition to the 60 to 80 mm of rain which has already accumulated in the east of Northland north of Whangarei. Peaks rates generally 10 to 20 mm/h but 25 to 40 mm/h possible in localised downpours, with thunderstorms also possible. Note that the largest accumulations are likely from about the Bay of Islands northwards.*
Low chance of upgrading to a Red Warning.

Impact: *Streams and rivers may rise rapidly. Surface flooding, slips, and difficult driving conditions possible.*

Action: *Clear your drains and gutters to prepare for heavy rain. Avoid low-lying areas and drive cautiously.*

Issued: 7:27pm Wednesday, 19th June 2024
Next Update: 10:00am Thursday, 20th June 2024

Thursday 20 Jun 2024:
A slow moving trough is expected to bring frequent showers or rain to Northland. Thunderstorms are also possible. There is a low confidence that accumulations will reach warning amounts.

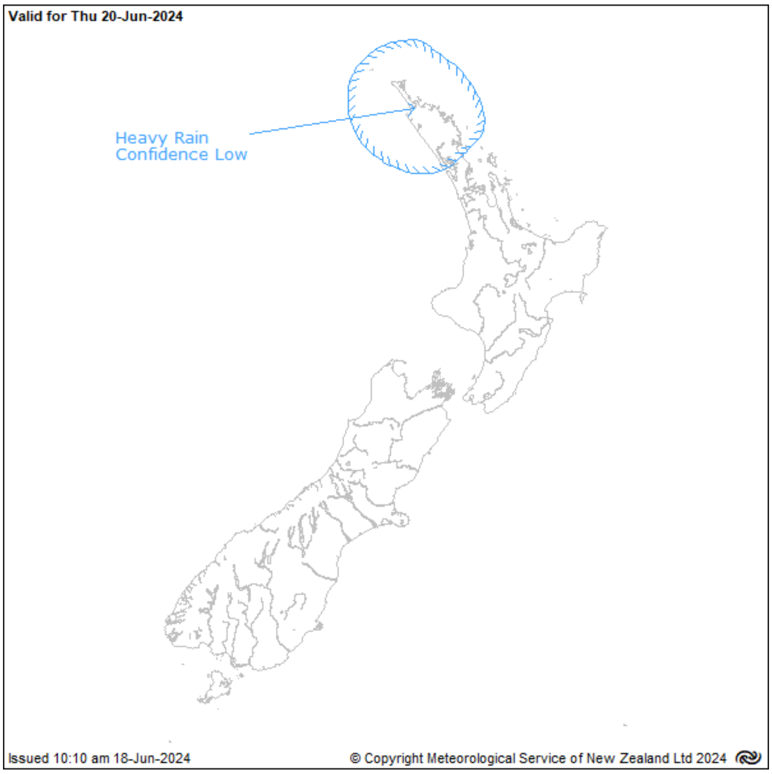

Figure 21: Expected weather conditions for Thursday 20 Jun 2024 (MetService)

NGOC risk assessment for between 20 June 2024

Outage Date	C/D	Outage Block(s)	Sites at Risk	Comments	Next 3 days	W>40	W>80	LIT	R	SN
NNI										
19 - 30/06/24	C	KPU_T4 KPU_WKO_1 KPU_357_VT367	KPU	N-Security to PCO	20	M				
					21	L				
					22					
17 - 21/06/24	C	LFD_DIS_76	LFD	N Security to VLD	20	M				
					21					
17 - 20/06/24	C	MDN_LST_6B MDN_T6	MDN, MPE, KOE	N Security to NPW & TOP	20	H		M	M	
18 - 21/06/24	C	BRB_HPI_1 HEN_HPI_1	BRB, MDN, MPE, KOE	N-Security to NPW & TOP	20	H		M	M	
					21	L		L	L	
19 - 21/06/24	C C C D D D	ARI_HTI_1 HTI_T1 HTI_87_97_127 HTI_T2 HTI_CB_122 HTI_124_134_127	HTI	N-Security to TLP, Waipa Power Supply	20	M				
					21	L				
20/06/24	D	PAO_CB_212	PAO	N-security to PCO.	20	M				

Key:- W=Wind, LIT=Lightning, SN=Snow, R=Rain,
L=Low, M=Moderate, H=High and leave empty for Minimal
C= Continuous, D = Daily

The NGOC risk assessment for 20 June 2024 identified high wind risk for some parts of Northland on 20 June 2024 and 21 June 2024.

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Tower Structure: Foundation Repairs

Base Plate Repairs(Transpower Specification)

Associated Work Modules

- GLP-PO401 – Plant Operation – Sand Blaster

Operational Limitations/ Previous Actions

- Resource consent must be obtained from the Territorial Authority prior to start of sand blasting work. Any special conditions in the resource consent shall be implemented in addition to the requirements of this procedure (for example possible use of sand-blasting tent or screens).

Special Safety Precautions

- All repair plant and associated equipment shall be operated and maintained as specified by the manufacturer.
- Steel preparation and concrete removal has significant noise and eye hazards. Appropriate PPE –hearing and eye protection shall be worn at all times during exposure to these hazards.
- Hammering, abrasive blasting, grinding and mixing of grout and concrete creates a dust hazard. Silica in the dust can result in severe long term health problems.
    - Always wear a respirator during these operations (P1 respirator or as per material data sheets).
    - Use non silica sand products for abrasive blasting .
    - Wherever possible wet down the area to be worked to minimise the dust hazard.
- The paint used to undercoat and topcoat the steel is considered a hazardous substance and contains elements that can result in severe long term health problems.
    - Always wear a respirator during these operations (half mask respirator with organic filter or as per material data sheets)

Method

1. Prepare Base Plate

a. Completely remove all existing mortar. Drill into the centre of the base plate using an impact drill with masonry bit from each side. Remove mortar by breaking out with jack hammer.

b. Check that there is enough room between the base plate and pile cap to sufficiently blast the underside of the baseplate. A minimum of 30mm is required for the blasting nozzles to fit. Lower the pile cap as required using a jack hammer to break out the concrete to create sufficient space.

c. Check for any areas on the pile cap surface that may require repairs. Remove loose or damaged material back to sound concrete.

Safety Note: Use eye, ear and respirator PPE while operating the jack hammer and driving bars.

d. Inspect anchor bolts and base plates. Record the degree of rusting of the base plates and anchor bolts on QA. Use mirror to inspect the underside of the base plate.

e. Blast clean the anchor bolts and base plate. Sweep blast 300mm up tower leg. Record any reduction in the cross sectional area of the anchor bolts and base plate on QA.

Note: Ensure the levelling nuts under the base plate are done up flush with the underside of the base plate before blasting and/or sealing bolt voids

f. Remove hold down nuts and washers. Sand blast anchor bolt voids, bolt threads, nuts and washers if corrosion is present. Sweep blast only if no corrosion.

g. Apply Sika Aktivator – 205 to clean the bolt voids after blasting. Note: Allow 15mins between application of Activator and Sealant.

h. 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. The application temperature range is 5°C to 40°C.

2. Paint Steel

a. Apply undercoat (Carboguard 635 or other approved product) to the base plate top and bottom, anchor bolts and 300mm up the tower leg. Apply undercoat slightly onto the pile cap around the anchor bolts. The minimum application temperature is -7°C, this will vary drying times refer material data sheet.

b. Apply topcoat (Carboguard 635 or other approved product) to the base plate top and bottom, anchor bolts and 300mm up the tower leg. Apply topcoat slightly onto the pile cap around the anchor bolts. The minimum application temperature is -7°C, this will vary drying times refer material data sheet.

Safety Note: Use half mask respirator with organic filter PPE while applying this paint product.

3. Install new Grout Under Base Plate

Note: If badly damaged pile cap the repair may need done prior to grout installation to provide a level platform for the formwork otherwise it can be done after (refer sections 4 and 5)

a. Apply masking tape around the steel edges of the base plate.

b. Install polystyrene or styrofoam strips (20x15mm) along edge of the base plate to form sealant chase, using steel spike plates to hold in place.

c. Set up formwork to required dimensions.

d. Place dry sand around the formwork to prevent grout flowing out under the formwork where the pile cap surface is not level.

e. Measure required quantities of grout (Sika Grout 215 or similar approved product) and water and mix in bucket using mixer attachment in an electric drill at less than 500rpm. Sika Grout 215 (25kg bag) mixed with 6 litres of water makes 15 litres of pourable grout.

Safety Note: Wear P1 respirator during the product bag opening and mixing operation where there is poor ventilation or significant dust hazard.

f. Pour new grout (Sika Grout 215 or other approved product) using a watering can or square mouthed bucket to fill the area under the base plate enclosed by the formwork. The application temperature range is 5°C to 25°C.

g. Protect newly poured grout from fluctuations in temperature by covering with sacking as required.

Note: In hot conditions sacks should be wetted and placed over the footing and new grout to prevent grout drying too fast.

Note: If frost is possible dry sacks should be placed over the footing and new grout.

h. Check that the grout has hardened (usually the next day) . Remove the formwork when the grout is sufficiently hardened.

i. Remove the polystyrene or styrofoam strips from the recess in the new grout.

Note: Allow new grout to harden for 3-4 days before removing the formwork and polystyrene, to stop chipping the edge of the mortar chase

j. Grind all sharp edges and projections off the new grout using handheld angle grinder leaving bevelled edges in preparation for application of seal coat and sealant.

Safety Note: Use eye, ear and respirator PPE while operating the grinder.

4. Minor Pile Cap Damage (if required)

a. Ensure all loose material is removed back to sound concrete.

Safety Note: Use eye, ear and respirator PPE while operating the jack hammer.

b. Clean area with sand blaster, grinder or compressor as required.

c. Apply bonding primer coat (Sika MonoTop-910N or similar approved product) to ‘pre-wetted concrete’ is required. Sika MonoTop-910N can be mixed with a drill at less than 500rpm or by hand. The application temperature range is 5°C to 30°C.

d. Apply repair mortar (Sika Monotop-352N or similar approved product) to the repair area and smooth with a trowel.

Note: Repair mortar should be applied while the bonding coat is still wet

5. Major Pile Cap Damage (if required)

a. Ensure all loose material is removed back to sound concrete.

Safety Note: Use eye, ear and respirator PPE while operating the jack hammer.

b. Clean area with sand blaster, grinder or compressor as required.

c. Install formwork to concrete pile cap as required.

d. Apply bonding primer coat (Sika MonoTop-910N or similar approved product) to the repair area.

e. Apply repair mortar (Sika Monotop-352N or similar approved product) for repairs up to 75mm thickness or if > 75mm then appropriate concrete grade to repair area (refer to foundation design for concrete grade). Trowel to a smooth finish.

6. Apply 1st Protection Coating to Pile Cap

a. Once the pile cap repair has hardened, clean area with sand blaster, grinder or compressed air as required.

b. Apply 1st protection coat (SikaTop Seal-107 Dryseal or similar approved product) to the pile cap. Ensure that it is applied 50mm down the outside edge of the pile cap and into the sealant chase.

Note: Wrap pile cap with polythene or cover with sacking to protect the coating from wind and direct sun light.

7. Apply 2nd Protection Coating to Pile Cap

a. Ensure the areas are clean and dry.

b. Inspect paint for any damage or chipping and if required apply another topcoat (Carboguard 635 or other approved product) to the side and top of the base plate and 300mm up the tower leg. The minimum application temperature is -7°C, this will vary drying times, refer material data sheet.

c. Apply 2nd protection coat (SikaTop Seal-107 Dryseal or similar approved product) to the pile cap. Ensure that it is applied 50mm down the outside edge of the pile cap and into the sealant chase.

Note: Wrap pile cap with polythene or cover with sacking to protect the coating from wind and direct sun light.

8. Apply Sealant to Chase

a. Ensure the chase is clean and dry, dry with heat gun or gas torch if required. The pile cap protection coat and paint top coat should both be applied into the chase so the sealant is bonding the 2 coatings together.

b. Install bond breaker tape in the bottom of the recess.

c. Apply primer (Sika Primer-3N for porous substrates (concrete) and Sika Activator-205 for non-porous surfaces (metal) or similar approved products) to either side of the sealant chase. Note: Allow 30 minutes between Primer and Sealant application

d. Install and form sealant (Sikaflex AT facade or similar approved product) into the formed recess so that water will run away from the base plate.

e. Remove your gloves and wet finger to smooth Sika Flex along the chase.

Note: **If the recess is wet, dry the recess using an electric heat gun or gas torch. There should be no grout residue on the edge of the base plate steel.**

9. Clean and reinstate the site.

a. Remove all construction debris and reinstate site.

10. Minimum Crew Size: 1

a. The exception is minimum crew size of 2 when breaking out, hammering, abrasive blasting or grinding.

Minimum Equipment List (as required)	
Hearing protection, face shield, eye protection and respirator P1 and half mask respirator with organic filter	Material technical data sheets and safety data sheets
Hammer drill, masonry bits and chisels	Generator and fuel
Compressor and fuel	Jack hammer and chisels
Driving bars and hammer	Mats and pads for kneeling on
Inspection mirrors	Calipers
Blasting tent or screens	Sand blaster and blasting sand
Impact/Rattle gun	Spanners, sockets or slogging wrenches
Thermometer, hydrometer	Heat gun, gas torch
Sealant applicator gun	Paint brushes
Rags	Paint thickness gauge
Form Work and clamps	Sand
Polystyrene strips	Steel spike plates (to hold poly)
Measuring jug	Mixing bucket
Electric drill and paddle	Water containers
Sacks	Trowels
Angle grinder	Wire brush
Small tool (sealant finisher)	Security fencing

Revision Log (changes identified with two lines in the margin - one each side)

Rev	Description	Date
05	Paint product used, process order & updated photos	13/06/2022