

APPENDIX 23

EFFECTS ON POWER INFRASTRUCTURE

LYTTELTON PORT OF CHRISTCHURCH

RECOVERY PLAN

ASSESSMENT OF ELECTRICAL POWER SUPPLY INFRASTRUCTURE:

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1. Introduction

This report has been prepared by Pedersen Read Limited in response to the Canterbury Earthquake Recovery Act 2011 New Zealand Gazette, No. 65 “Direction to Develop a Lyttelton Port Recovery Plan” for an assessment of “supporting infrastructure” (the power supply). This includes the damage sustained from recent seismic activity, the resultant resilience of the power system and what upgrade work is necessary to facilitate the long term vision of the Port of Lyttelton as set out in the Port Lyttelton Plan.

The Port Lyttelton Plan sets out Lyttelton Port of Christchurch’s (LPC) 30 year vision for the repair, rebuild, enhancement and reconfiguration of the port. A large number of construction projects are required as part of the vision, and these are expected to occur over a period of approximately 12-15 years. These construction projects will enable the port to continue to reconfigure to meet the growing freight demands for the next 30 years as well as providing community access to the waterfront.

2. Description of the Power Supply Infrastructure

External Orion Network

The Orion supply to all of Lyttelton is via dual circuit 11,000 volt (11kV) aerial cables on a single line of poles over the Port Hills from the Orion Heathcote substation. These cables each have a maximum rated capacity of 7MVA (megavolt ampere). However, Orion’s policy is to provide ‘N-1’ redundancy and this limits the maximum rated capacity for Lyttelton to 7MVA with one backup circuit available if a fault occurs in the primary circuit.

The aerial cables transition to underground 300mm² aluminium cables; one supplying the Orion Brittan Terrace substation and one the Orion Simeon Quay substation.

The Orion Heathcote Zone substation supplying Lyttelton is able to be connected to two Transpower grid exit points at the Bromley and Islington (via Halswell substation). This dual supply option provides an ‘n-1’ level of redundancy.

The Port complex receives 11kV power supply from Orion’s Simeon Quay substation via two underground cables with demarcation at the Port’s main substation in Sutton Quay. Beyond that demarcation, LPC own and operate an independent internal 11kV distribution network. That power supply is also supplemented with limited capacity 400 volt standby diesel generators for essential loads, at the Lyttelton container terminal (LCT) substation.

Internal LPC Network

The LPC power network comprises 11kV and 400 volt power distribution.

Prior to the earthquakes, the Port’s 11kV network was configured to provide two 11kV cable routes (more commonly referred to as ring mains) to all main substations. These ring mains provided an alternative power supply option if one supply cable, or its associated 11kV switchgear, is damaged or out of service for maintenance purposes.

3. Earthquake Damage to the LPC Power Infrastructure

The Port suffered major damage in the September 2010 earthquake. The earthquake on the 22nd February 2011, centred less than three kilometres to the north-west of the Port, caused more damage to buildings, above and below ground services and equipment forming the reticulation and infrastructure of the power network. The earthquake on the 23rd December 2011 and the on-going aftershocks have caused further damage.

The following is a brief summary of the damage to the power infrastructure:

- Z Berth Substation: This building substation suffered major structural damage and land subsidence in the surrounding area. As a result, the substation was decommissioned and removed along with the alternative 11kV cable forming the ring main between No.2 Jetty and Cashin Quay substations.
- Cashin Quay Substation: This building suffered structural damage and was decommissioned, removed and subsequently replaced by SW Substation.
- Oil Wharf Substation: This land on which this kiosk was located subsided and the kiosk dropped to a position causing the kiosk to be partially submerged at high tide.
- Other substations: Minor structural damage occurred in other substations.
- 11kV underground cables: The lateral spread and ground movement in the Port has resulted in damage to a number of 11kV cables including:
 - The cable to Z berth.
 - The cable that was used for the ring main to Cashin Quay Substation.
 - The cables to the junction boxes for connection to the trailing cables of the container cranes.
 - Cables entering substations shifting and causing physical strain to switchgear terminations within substations.
- Some underground cables and ducts have been damaged by ground movement causing crush damage. This caused duct collapse and damage to cable sheaths and water ingress to cables.

4. Remediation Works Completed due to Earthquake Damage

A significant amount of remediation has occurred, some under emergency to reinstate power supplies, some in response to ground and wharf repairs, and some as part of planned infrastructure upgrades.

The following is a brief summary of the remediation works carried out due to damage to the 11kV power infrastructure:

- A new Gladstone Pier substation kiosk was established to provide a 400 volt power source to Gladstone Pier area as result of the loss of the Z Berth Substation. This required a new temporary 11 kV cable run across the damaged Gladstone pier to replace the damaged underground cable. This new substation is connected on a single “spur” cable.
- A new straddle workshop, SW substation was established to replace Cashin Quay substation. This new substation is connected on a single “spur” cable.
- The Oil Wharf Substation has had minor civil works to raise it above the high tide level.
- Some minor structural repairs have been undertaken in substations.
- New 11kV underground cables and cable ducts have been installed to replace damaged items for the connection of two of the container cranes.
- Cable terminations have been eased or extended to remove the physical strain on switchgear terminations.

5. Resilience of the Power Infrastructure

There a number of elements of both the internal and external power infrastructure that could be improved to increase the reliability of the power supply to the Port of Lyttelton and reduce the risk of power loss. This loss of power could be for a period from hours to multiple days or weeks in duration, depending on the nature of the causative event and the resultant damage.

The following is a brief summary of the vulnerable elements of the power infrastructure:

External Elements

- The power supply to the suburb of Lyttelton is via a dual circuit, single aerial transmission line over the Port Hills from the Orion Heathcote substation. This transmission line is vulnerable to damage due to natural events such as rock fall, snow or wind damage, for example, if a rockfall knocked over a transmission line pole then power supply to the whole of Lyttelton would be lost.
- The power supply to the Port of Lyttelton is from the Simeon Quay substation owned by Orion. This substation is located at the base of a clay cliff which has experienced land slips in the past. If this substation was damaged and taken out of service, there is no simple or quick alternative for power restoration to the Port.
- The existing power supply to Lyttelton has a rated capacity of 7MVA. The Port's peak power consumption prior to the addition of the new Liebherr crane was approximately 3.4MVA. The new crane is rated at approximately 1.6MVA. The proposed expansion will significantly increase the power requirements of the Port. It is estimated that the peak demand of the Port could be around 10MVA with the expansion into Te Awaparahi Bay and the anticipated growth in freight volumes. **Without an upgrade of the power supply to Lyttelton, enhancement plans will be constrained.**

Internal Elements

- The power supply to the Port of Lyttelton is via two 11kV cables from the Orion Simeon Quay substation to the Port's Sutton Quay Main Substation. This is a single point of supply to the port with no alternative feeder option.
- The 11kV ring main to the coal facility and eastern end of the container terminal was lost due to earthquake damage to Z Berth Substation and its associated 11kV cables. No alternative backup (or ring feed) is available if this cable fails or if there is a fault in the 11kV switchgear at either end of this cable.
- The earthquakes have caused significant lateral spread and ground movement. In addition to the damage to 11kV cables identified in Section 3 of this report, there is a risk that any underground 11kV cable could fail without warning as a result of damage due to earthquakes.
- The 11kV reticulation system has limited capacity for load growth within the Port, particularly at the eastern end of the container terminal and coal facility. The existing single cable to Officers Point Substation is running at full capacity with the recent connection of the new (fourth) container crane.

6. Upgrade Work to Address Improve Resilience and Capacity of the Power Infrastructure

External Elements

Orion Network

In response to the vulnerabilities identified in the previous section, and following discussions with the Port on their longer term strategic growth, Orion has proposed the following modifications to their network and its connection to the Lyttelton and Lyttelton Port of Christchurch:

- The installation of a new cable through Lyttelton road tunnel (subject to NZTA approval) which will increase the capacity available to 14MVA, provide an alternative path and backup for the aerial transmission line over the Port Hills.
- The reconfiguration of the existing Orion 11kV supply cables to enable the removal of the Simeon Quay building substation. In the short term they propose that the new supply to the Port would be sourced from a modified Dublin Street substation.
- The creation of a new substation on LPC land in the vicinity of Norwich and Gladstone Quays (Norwich Quay Substation), along with the reconfiguration of the Orion cabling in the area, to create a new point of supply to the Port's network.

These proposed upgrades will enhance the security of supply to the wider Lyttelton area. An alternative cable route installed via the road tunnel will greatly reduce the risk of an extended power outage to Lyttelton due to adverse weather events or possible damage to the aerial transmission line from rock fall.

The increased available capacity will also mitigate potential power disturbances (extend low voltage events or sudden changes or 'spikes') that could occur on the Lyttelton power network with a large changeable loads, such as the operation of the container cranes.

The proposed amendments will remove the constraints to future growth that the present network provides.

Internal Elements

LPC are in the process of preparing a plan to prioritise the work necessary to increase the resilience of the Port's power infrastructure. At present there are multiple single points of failure that could result in extended power outages that would significantly affect productivity at the Port.

A process is in place to formulate this work plan. The following proposed modifications are a broad outline of the works required (not necessarily in the correct order of priority):

- A new second point of supply is required from the Orion network to the LPC network. This can be obtained from the proposed new Orion Norwich Quay Substation.
- This second point of supply will need a connection point into the LPC 11kV network. This connection point could be either at:
 - A new/modified No.2 Jetty Substation, or
 - A new/modified LCT Substation, or

- A new Central Substation (possible replacement for SW Substation), or
- A new/modified Officers Point Substation

This new supply will also provide the increased capacity required for the expansion of the Port in the Te Awaparahi Bay reclamation.

- The LPC 11kV network of substations and cabling, that form the basis for the Port's primary reticulation, should be configured to provide a ring main system where there are two alternative paths of supply to all major substations, i.e. there would be no single points of failure
- A new central substation would be established in the vicinity of the SW Substation or Te Awaparahi Bay / MCC2 Substations for the connection of the new ring main supply beyond LCT Substation. This new central substation could replace the existing SW Substation (and in doing so, remove a possible restricting fixed point in an expanded container terminal), or combine and relocate MCC2 and Te Awaparahi Bay Substations. This new substation would form the key point for the expansion of the 11kV network for new loads in the reclaimed land in Te Awaparahi Bay.
- Consideration needs to be given to the resilience of the power supply in the event of a significant tsunami. This would include consideration of:
 - Location of new substations
 - Building construction
 - Switchgear type and configuration
 - Spare parts held in stock (and the location of these)
- Consideration needs to be given to the resilience of the power supply in the event of a significant seismic event. This would include consideration of:
 - Location of new substations (avoidance of rock fall / land slide)
 - Building construction (construction standards)
 - Seismic restraint of equipment
 - Cable entries into building provided with spare cable to permit ground movement to avoid applying strain to cable terminations.

7. Conclusion

The Port Lyttelton Plan shows the long term vision of the Lyttelton Port of Christchurch for the rebuilding and enhancement of the Port.

This plan show changes to Dampier Bay, the inner harbour and expansion on reclaimed land in Te Awaparahi Bay to the east of the port.

The power supply to Lyttelton is currently provided by an 11kV aerial transmission line over the Port Hills from the Orion Heathcote substation. This line has a maximum rated capacity of 7MVA with 'N-1' redundancy.

To provide improved security of supply and a maximum rated capacity of 14MVA for the whole of Lyttelton, with 'N-1' redundancy, Orion are proposing to install a new 11kV cable via the Lyttelton road tunnel to a new Orion Norwich Quay substation.

Lyttelton Port of Christchurch operates its own internal 11kV power network. At present the network demarcation is at the Port's Sutton Quay substation.

It is proposed that this new Orion Norwich Quay substation provides a new second supply to the port and increase the available capacity to meet the future estimated maximum demand of 10MVA for the port.

A number of upgrade options are outlined for the internal power network. Included is the requirement to provide a ring main to all major substations.

The internal 11kV electrical infrastructure suffered significant damage due to the earthquakes. A considerable amount of work has already been undertaken to address the damage and provide resilience to the power network, however further works are required.

8. Appendices

Appendix A 11kV Main Reticulation Network Overview Plan- Existing

Appendix B 11kV Main Reticulation Network Overview Plan- Upgrade Options

8.1 Appendix A 11kV Main Reticulation Network Overview Plan- Existing



8.2 Appendix B 11kV Main Reticulation Network Overview Plan- Upgrade Options

