



Independent Review of Aurora Network – summary of findings

Michael Van Doornik, Manager Advisory (VIC)

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Agenda

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2. Limitations of the review
3. Our approach to undertaking the review
4. Overview of Aurora's network
5. Approach to calculating risk
6. High level view:
 - Safety
 - Resilience
 - Security
 - Performance
7. Key risks by asset class
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Terms of Reference

- WSP has been engaged to determine the current state and condition of the Aurora electricity distribution network in Dunedin and Central Otago.
- Independent review in tri-partite agreement with Aurora and the Commerce Commission.
- Key driver – need for the network to provide acceptable performance with respect to public safety, reliability, resilience, environmental risk and post-fault restoration times.
- The full terms of reference can be found on Aurora's website:

<http://www.auroraenergy.co.nz/about/independent-review/>

Terms of Reference (cont.)

- Outcome of the review:
 - risk assessment of the current state of the network assets.
 - prioritised list of key risks.
- The review only considers the current condition and risk of the network.
- The scope does not include recommendations for mitigation of risks.
- The assessment is based on data held by Aurora, data gathered by WSP using a sampling approach and site inspection to validate existing data.
- There has been no benchmarking against other electricity distribution businesses.

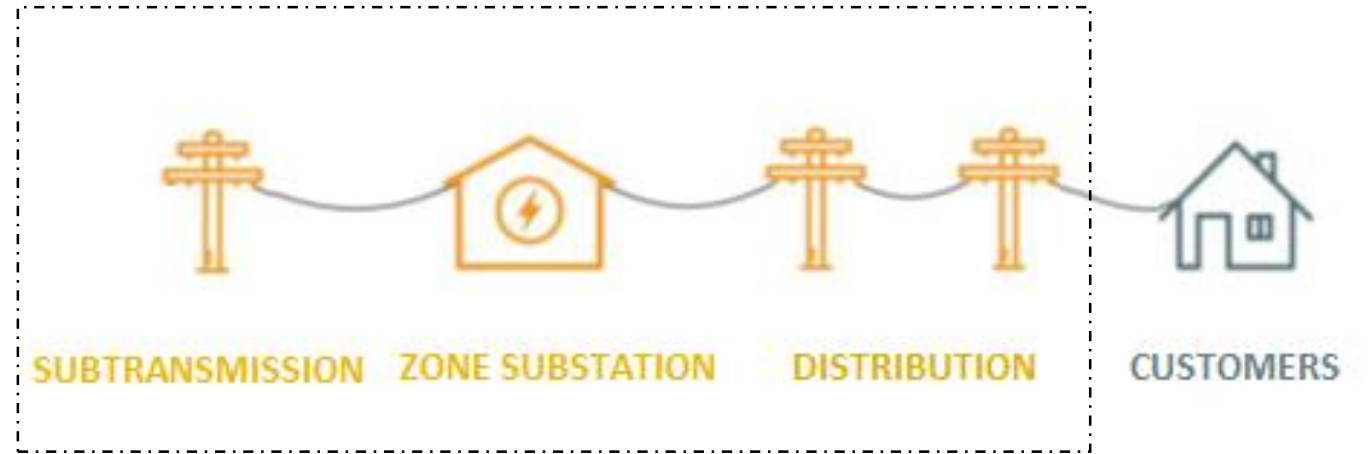
Aurora's electricity distribution networks



Dunedin: predominantly urban, higher population density

Central: predominantly rural, lower population density

Aurora's assets included in the review



- | | | |
|------------------------|----------------------|------------------------|
| • Poles and cross arms | • Transformers | • Poles and cross arms |
| • OH Lines | • Circuit breakers | • OH Lines |
| • UG Cables | • Protection systems | • UG Cables |
| | | • Transformers |
| | | • Switches |

WSP's approach to calculating risk – two approaches

Quantified Risk = Prob. of failure x Prob. of failure mode x Consequence of failure

Qualitative Risk = Asset health (Prob. of failure) versus Criticality

- Context: electricity networks inherently have an element of risk.
- Objective to prioritise risk across and within fleets
- Assessing probability:
 - Modelling approach to calculate probability where quantification possible.
 - Engineering and industry experience to determine probability where modelling not possible.
 - Asset health based on inspection and test data


WSP's approach to calculating risk (cont.)

Consequence: the outcome of a failure that could have a safety impact to the public or staff, reduction of reliability by loss of supply or the environment (quantitative).

Criticality: the importance of the asset to continued reliable and safe function of the electricity network (qualitative).

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	Increasing consequence (criticality) -->				
Prob of Failure -->					



Aligned to Aurora's matrix to display risk

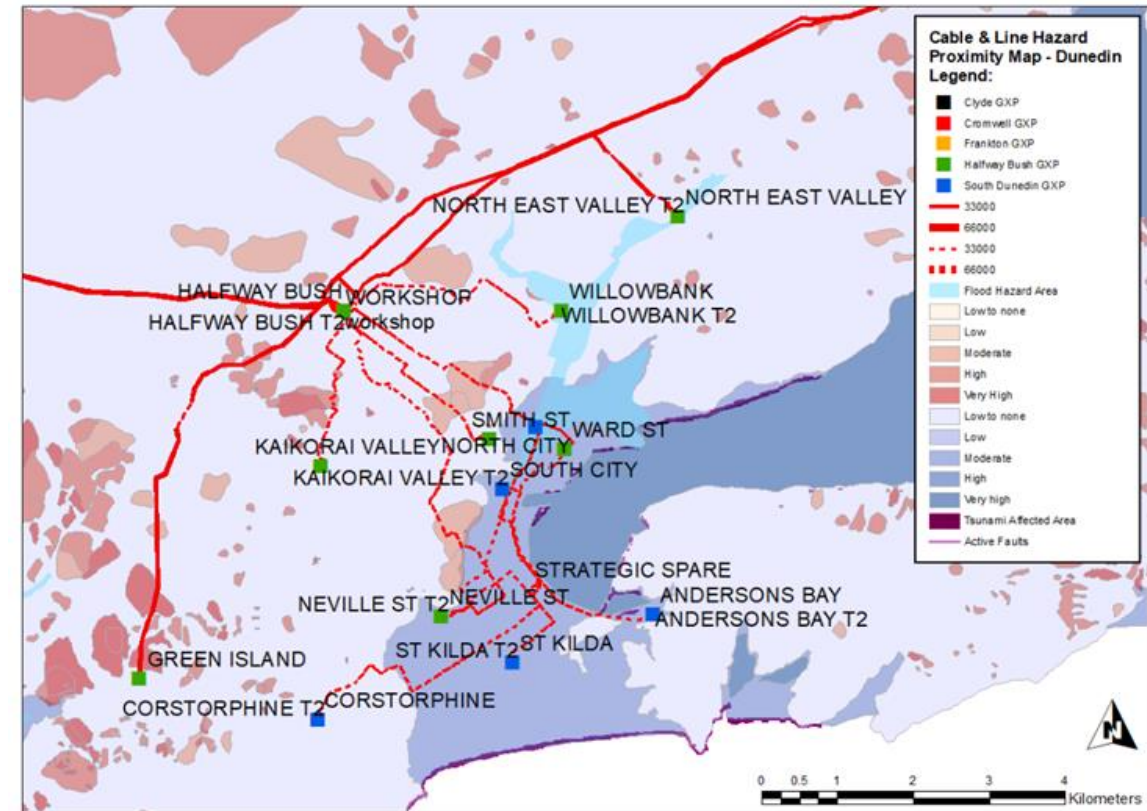
Output: prioritised list of assets/risks to be addressed by Aurora

Our key findings – Safety

- Most assets pose low risk to public safety, reliability or the environment. Some exceptions will be discussed later.
- The review found that some safety risks were not managed to be as low as reasonably practicable:
 - Public risk – identified with protection systems that did not always isolate faulty equipment, and
 - Worker risk – zone substation asset.

Our key findings – Resilience

- The key resilience issues were related to liquefaction (earthquake) affecting the subtransmission cables in central Dunedin.
- Both subtransmission cables are in the same trench
- Other assets are not significantly impacted.



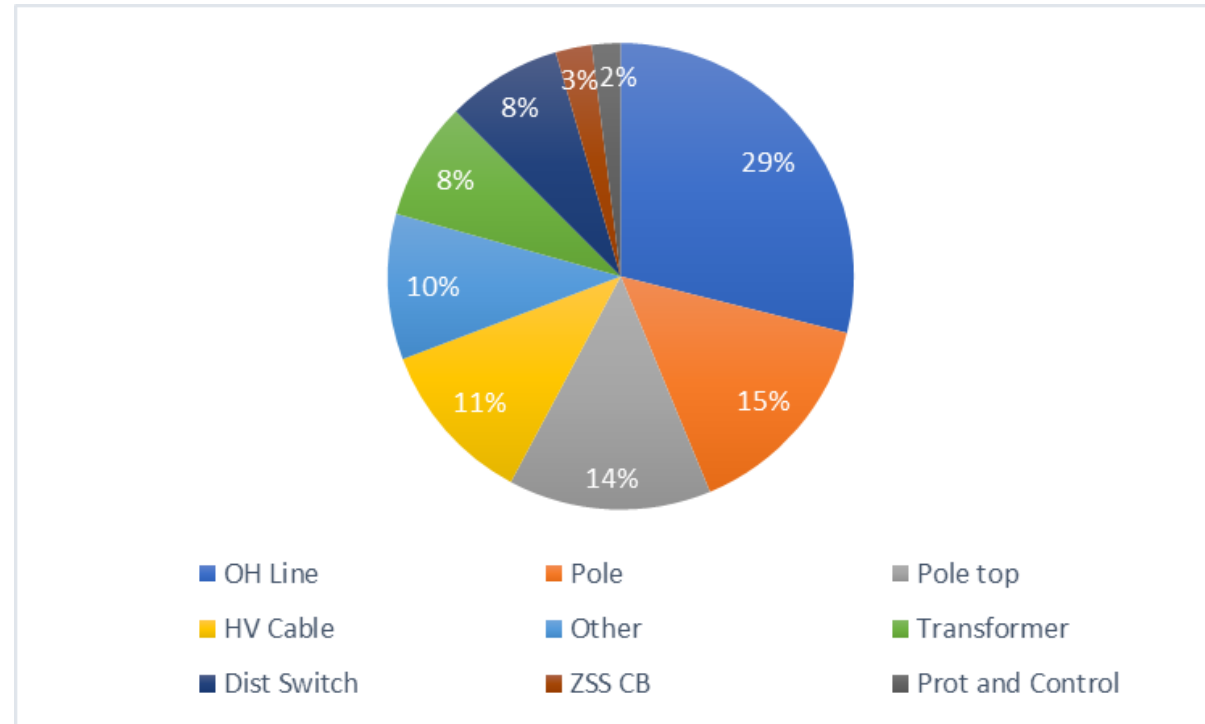
Our key findings – Security

Network security is the ability to maintain supply following equipment failures.

- The network has an appropriate topology for the geographic obstacles and distribution of the customers.
- No high risk issues were identified.

Our key findings – Performance

- Network performance, measured as SAIDI and SAIFI, has declined over the past 5 years with a slight improvement recently.
- OH lines, poles and cross arms cause 58% of unplanned outages from deteriorated assets.



Our key findings – Assets

Electricity assets have long lives (40 to 60 years is common). A large portion of the network was established during the 1950s to 1970s. Aurora is now managing assets in their end of life phase.

Asset data was found to be adequate for this review, but improvements can be made.

Overall, we found most assets pose low risk to public safety, reliability or the environment. Exceptions were found within the following fleets:

- Protection systems
- ZSS circuit breakers
- ZSS transformers
- Support structures (poles, cross-arms)
- Specific distribution switchgear types

Findings by asset class

Protection systems



Increasing consequence (criticality) -->

Prob of Failure -->	0	110	76	384	0
	0	1	32	86	0
	0	7	63	17	0
	0	17	41	58	0
	0	41	54	79	0

563 assets in RED risk zone



- A significant proportion of relays are approaching end of life
- Approx. 50% of relays pose a risk of not operating as intended
 - Loss of calibration of settings
 - Some instances where relays failed to operate (15 HV out of 278)
 - 30% of the CTs at Green Island ZSS failed testing
- Red Zone: elevated risk of faults not being isolated, possible:
 - Damage to equipment
 - Live lines on ground

ZSS circuit breakers

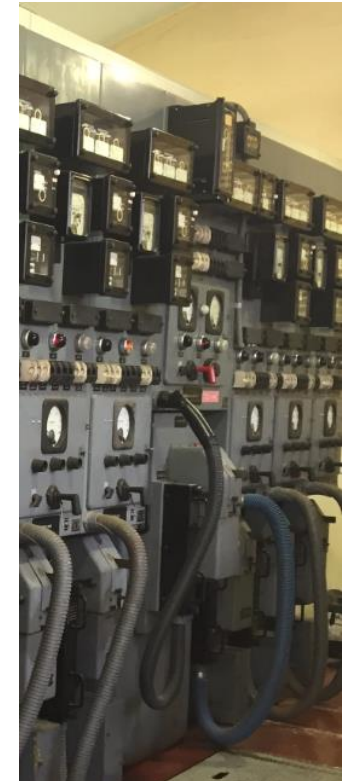


Increasing consequence (criticality) -->

Prob of Failure -->	5	1	1	15	0
	10	1	31	60	15
	4	20	64	0	11
	17	39	13	0	0
	11	25	48	17	0

148 assets in RED risk zone

- 148 circuit breakers (36% of the fleet) have elevated risk of failure:
 - A large proportion of circuit breakers have passed their nominal life (decom of Neville St will remove 34 old CBs)
 - Certain types have had failures in other electricity businesses
 - Maintenance of some CBs is not up to date
 - Some CBs not fully maintained internally
- Oil insulated circuit breakers have an elevated consequence of failure:
 - Risk of fire propagating through switchboard due to oil insulation
 - Predominately reliability risk, but a safety risk of work crew present.



ZSS Transformers



Increasing consequence (criticality) -->

Prob of Failure -->	1	0	0	0	0
	7	0	4	1	0
	6	0	2	4	2
	7	2	4	2	1
	6	3	3	3	5

8 assets in RED risk zone

- Risk assessment is driven by reliability, calculated as expected energy at risk. 8 transformers (out of 63) considered to have elevated risk, driven by:
 - Internal condition
 - Other components (tap changer)
- Two of the transformers with elevated reliability risk (at Neville St) are currently being replaced.
- East Taieri had a moderate level of safety risk – located adjacent to a petrol station. All others have a low safety risk.



Support structures



Increasing consequence (criticality) -->

Prob of Failure -->	0	0	1	0	0
0	1568	691	396	157	0
1	17456	6623	2965	1210	0
2	6587	2380	975	300	0
3	8114	2686	1246	694	0

1,368 assets in RED risk zone

- Public safety is the key risk driver for this asset class.
- 1,264 poles (4% of the Dunedin fleet) in Red risk zone in Dunedin (higher population density) and 104 poles (0.4% of the Central fleet) in Central.
- Poles appear to be showing a steady or slightly reducing level of failure – reflective of the recent focus on pole inspections and remediation.
- There is an emerging risk with cross arms – mostly due to increasing asset deterioration and defects.



Distribution switchgear



Increasing consequence (criticality) -->

Prob of Failure -->	49	1698	5	0	0
	72	3045	6	0	0
	69	2341	3	4	0
	10	404	0	0	0
	9	249	0	0	0

9 assets in RED risk zone

- 9 distribution switches (0.1% of the fleet) have an elevated risk with respect to safety. The majority of distribution switchgear has low to moderate safety risk.
- The Long and Crawford (L&C) type of switchgear has resulted in recent failures in New Zealand and Australia and has a number of industry safety advice notices and an Order from EnergySafety (Western Australia) against it.
- Minor consequence score due to most of the L&C switchgear type being housed within a shelter and therefore reducing impact on public.

Key assets with Minor risks



- Sub transmission cables:
 - Oil and gas leaks evident and failed tests.
 - Due to redundancy currently not a big risk to network reliability, but expected to increase over time as all the cable is the same age and likely to have similar rates of deterioration.
- Sub transmission lines:
 - Marginally insufficient clearance between 66kV and 11kV circuits (1.8m compared to 2m in code) on the UC66-1 and UC66-2 lines (Cromwell to Wanaka). Construction issues have resulted in post insulators on a lean.
- Zone substations:
 - Alexandra 33 kV bus non compliance clearances to ground (can touch live bus from ground level). Field crew risk only.
 - Contractors not following latest Aurora inspection procedures (observation from Green Island, Alexandra ZSS visits).
 - Fire detection does not cover all rooms within substation buildings.

Overall summary of risks



End