Lifting the Performance of the Grid

Improving the Performance of Transpower's Assets by Maintaining Intellectual Property in the Procurement of Power transformers

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Poor Performance of Aged Transformers

- Transpower suffers poor performance from its aged power transformers.
- The major failure rate is around 1 winding failure every 12 months (approximately 1.0% per annum).
- The forced and fault outage rate is 6 times the average of benchmarks, and 10 times that of good performance.
- Historical records show that many of these aged and poorly performing transformers were bad designs or poorly manufactured or accepted with questionable final factory test results from the outset.

The Risks are Built-In

Worldwide experience clearly demonstrates:

- The overwhelming majority of lifetime risks in power transformers are built in by the time they are shipped.
- The only reliable way to manage these risks is during the procurement process.

Timeline of transformer procurement

	Current practice – from 1992
Specification	Focussed on mitigating critical risks
Tendering	2-4 pre-qualified factories only
Vendor engagement	Design reviews, factory inspections and witness tests by qualified experts
Major failures	Only 2 since 1992 out of 300 purchased (2008 and 2014)

	Historic practice
Specification	Basic
Tendering	Open – lowest compliant
Vendor engagement	No factory inspections and factory witness tests by remote appointed agents lacking suitable qualifications
Major failures	45 since 1978
Estimated cost of failures	> $60 million

Intellectual Property is Key

- Good lifetime performance of power transformers depends upon best practice in procurement.
- Best practice requires skilled interventions in the procurement process to provide assurance of outcomes.
- Intellectual property is key to long term sustainable good performance.

Capability must be Maintained

- Transformer design practice and manufacturing techniques continue to evolve due to competitive pressures.
- Transpower's intellectual property and capability must be maintained.

The minimum requirements for Transpower are:

- Maintain the technical procurement specification in accordance with good practice and continuous improvement.
- Understand the design concepts, skills and capability required to undertake an effective design review.
- Understand the skills and capability required to inspect internal build quality of the transformer at critical manufacturing points and the final external build quality.
- Understand the skills and capability required to ensure the factory acceptance tests have complied with the specification and the corrective actions required in the event of test failures or problems.
- Understand how to effectively maintain and repair transformers to ensure full asset life is attained with minimal whole of life expenditure.

The Need

- Transpower has an on-going business plan to reduce expenditure and whole of life costs (particularly maintenance expenditure).
- Transpower is extending the life of its remaining aged single phase and three phase transformer fleet by refurbishment involving workshop/site based detanking and bushing replacements.
- The expertise to extend the life of existing transformers (particularly for winding repair and bushing replacements) primarily comes from Transpower engineers gaining knowledge and experience in the design, manufacturing and testing of new power transformers. Transpower has many issues with transformer corrosion and high maintenance costs due to its severe marine environment. Performance improvement in this area is driven at the procurement phase to ensure the transformer is correctly manufactured to perform in our severe marine environment.
- Transpower has many issues with oil leaks due to premature gasket deterioration. Correct gasket selection at the procurement phase improves long term performance and reduces maintenance costs.

The Plan

- Transpower engineering staff actively participate in each transformer design review, key factory manufacturing inspections and all final factory acceptance tests.
- Experienced ex transformer design consultants provide expertise for design reviews and for factory manufacturing inspections and final acceptance tests.
- Selected specialist contractors from New Zealand participate in factory manufacturing inspections and final acceptance tests to provide backup and a succession path for when the ex transformer design consultants retire.
- Transpower staff participating in factory visits provide feedback to the procurement technical author and the procurement commercial manager to continuously improve the procurement specification and manage risk.
- Transpower engineering staff with experience from factory visits provide the on-going expertise to address issues arising at site over the 5 year warranty period.
- Transpower engineering staff with experience from factory visits provide the on-going expertise to provide maintenance and repair advice over the 50 year life cycle of the transformer.

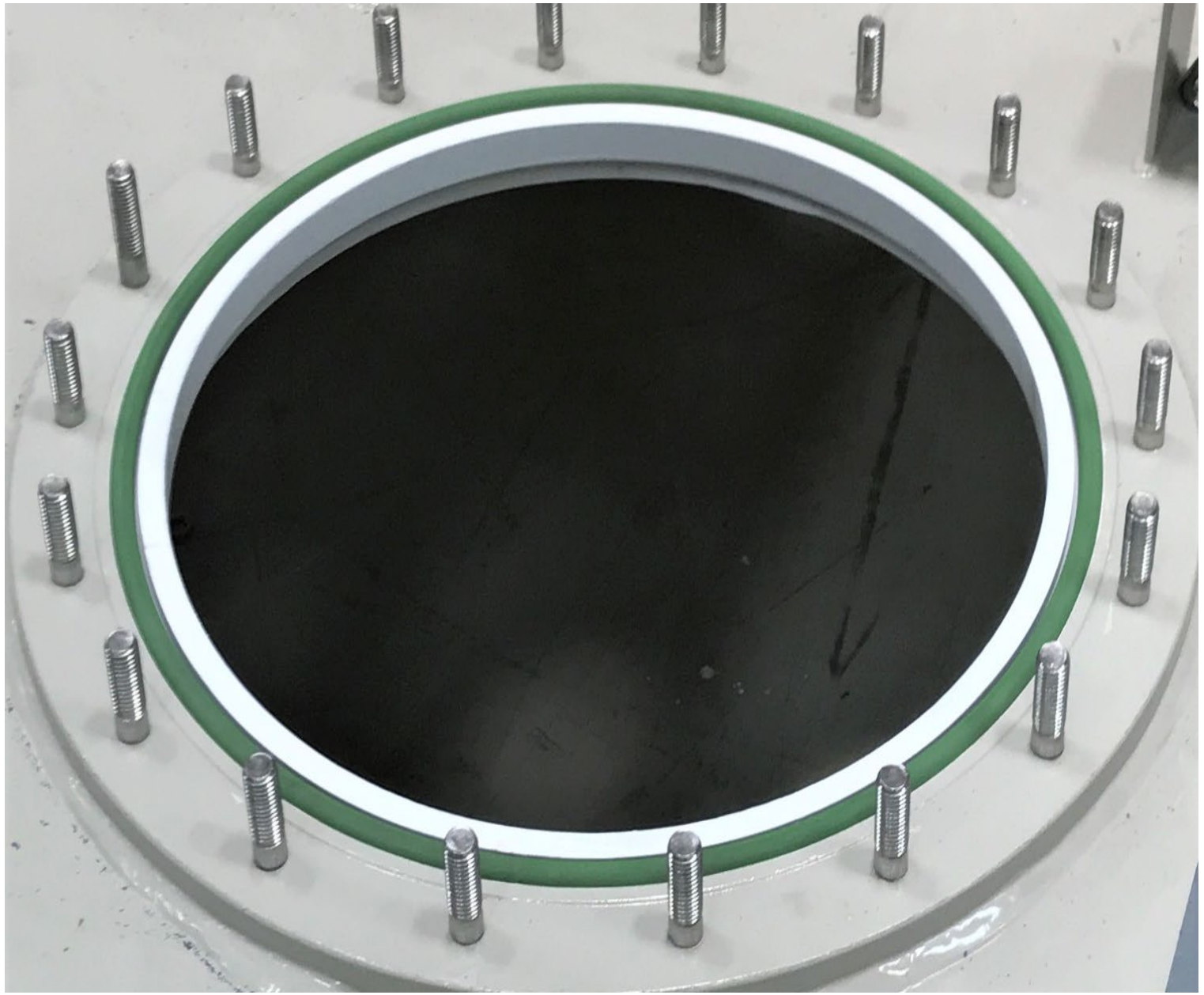
Key Performance Review Stages

- Pre-qualification of the factory (technical and commercial) with a cross checking technical questionnaire followed up by a factory audit.
- Design review at the factory including electrical and magnetic field plot analysis of windings, leads, core, tank, cooling, noise and losses. Verification of low partial discharge design requirements.
- Comparison of the manufacturer’s proposed design with their current manufacturing practices to assess their ability to meet the specification requirements including statistical analysis of previous tested designs.
- Review of mechanical and seismic design (high seismic performance to IEEE 693).
- Review of the manufacturers proposed measures to meet the specified severe marine corrosion protection and gasket sealing requirements.
- Manufacturing inspection of key stages: tank fabrication, core assembly, individual windings, complete phase assembly, dryout, corrosion protection, final performance testing and permission to ship.
- Site assembly, pre-commissioning tests and acceptance handover.
- Site warranty inspection at 1 year intervals over 5 year warranty period.

Cost Comparisons

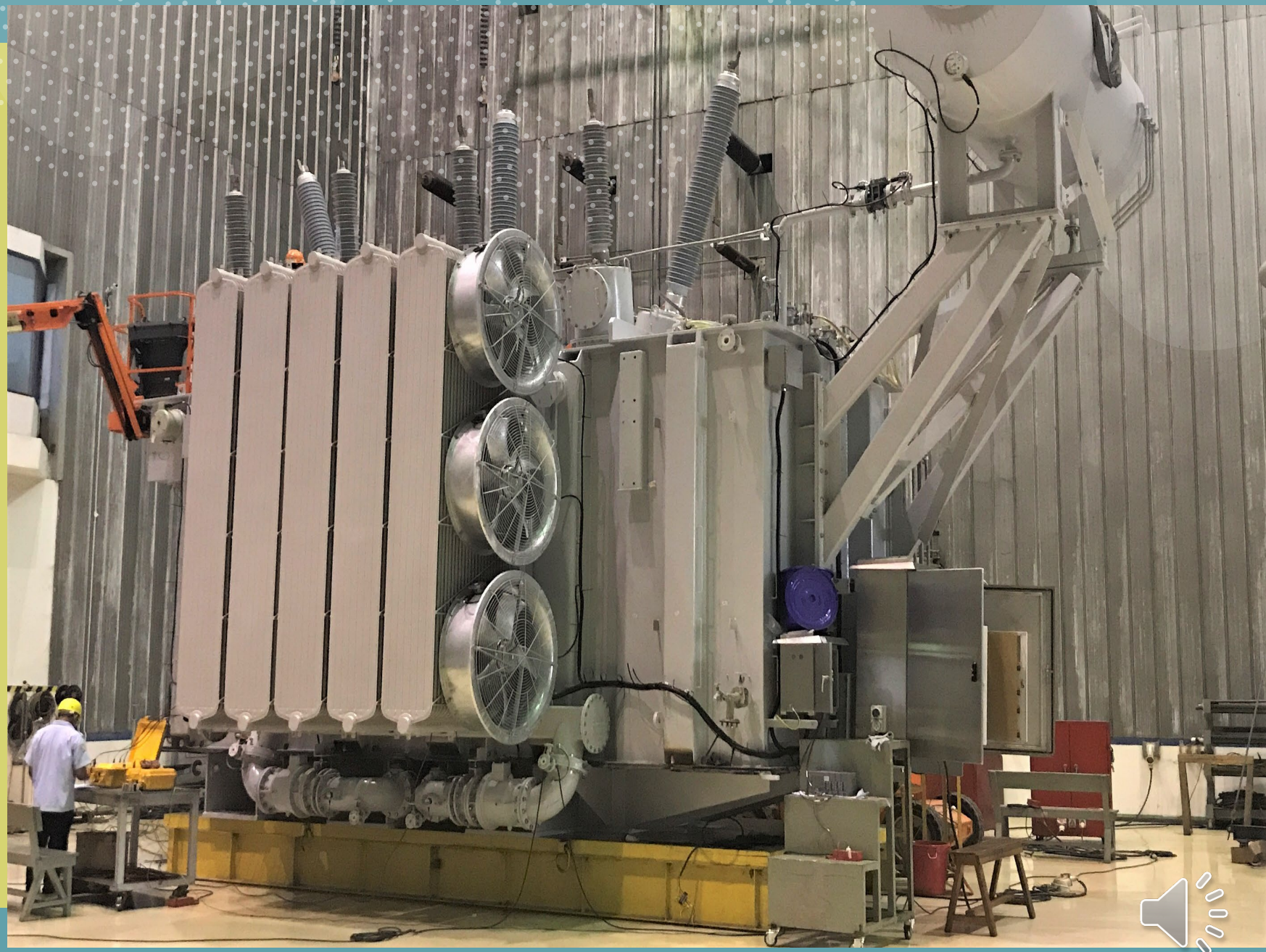
- 1 x 220/33 kV 120 MVA new power transformer (delivery, oil filling and assembly at site) NZ $2.8 million.
- Total project installation cost NZ $4.5 million.
- Total lifetime maintenance and mid-life refurbishment cost NZ $1.5 million.
- Total transformer lifetime cost NZ $6 million.
- Total design review and factory inspection cost NZ $87,000.
- Equivalent to 2 spare 220 kV bushings.
- Equivalent to 1.5% of total transformer lifetime cost.
- 1 x premature transformer major failure or repair or replacement cost (including strategic spare mobilisation) NZ $2.5 to $3.5 million.

Stainless Steel Flanges (304L or 316L)



Stainless Steel Pipework, Sloping Lid, Zinc Spray Main Tank

Seismic Supports, Stainless Steel Control Panel, Low Noise Fans, Attached Radiators



Questions