How the introduction of MV & LV ABC improved reliability, safety, and the resilience of the Tonga Power overhead network

Overhead Lines Designers Forum - North Island – 6 May 2020

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1

Tonga Power

Tonga Power Limited (TPL) provides electricity to Tongatapu, Vavaú, Haápai, and Éua island:

- approx. 21,000 domestic customers, and
- 3,963 commercial customers

TPL's electricity generation relies on diesel and solar.

TPL's distribution network is made of 11kV, 6.6kV, and low voltage lines

The TPL's biggest challenge:

- Adverse environmental conditions e.g. sea spray and vegetation, and
- Seasonal storms that adversely affect the reliability of the already stressed, aging distribution network

2

Benefits of LV and MV ABC systems for distribution lines

Distribution Network

- Reduced risk of feeder faults due to tree contact, line clashing in high winds, wildlife contact (e.g. birds, possums)
- Improved network reliability and resilience
- Improved SAIDI and SAIFI
- More compact design (reduced clearance between phases/ground and shorter poles for the new lines)

3

Benefits of LV and HV ABC systems for distribution lines

Safety and Environment

- Improved public and personnel safety (e.g. no direct contact with live conductors, reduced risk of leakage currents and dangerous touch & step potentials)
- Reduced risk of damage to property or the environment (e.g. bush fires due to sparks or arcing, insulator breakdown, contact with trees or other conductive material)
- Reduced harm to wildlife (e.g. birds, small animals, etc.)
- Reduced visual intrusion of wires and poles

4

LV and MV ABC Design

Everything starts with a good design

However,

"Design is not just what it looks like and feels like. Design is how it works."

Steve Jobs, co-founder of Apple

5

Forces of Nature vs Design

6

7

Principles of Good Design

- Good design makes a power line reliable and long-lasting:
  - Simple and clear e.g. easy to understand and apply
  - Based on the best-known industry practices, experience, and standards
  - Takes into account the local environment and weather conditions
  - It is thorough down to the last detail (e.g. do not leave a room for different interpretations and improvisations)
  - It spells out DO's and DON'Ts
- Good designers learn from the experience of others – good or bad
- Good design is innovative e.g. if there is no standard or best industry practice, a good design should solve any specific problem in an innovative way
- Good design is environmentally friendly, aesthetic, and unobtrusive
- A good design is always the simplest possible working solution

8

Technical considerations

- Physical compatibility (hardware) between LV/ HV ABC and accessories e.g. insulators, clamps, etc.
- Dielectric compatibility between LV/ HV ABC and accessories e.g. insulators, attachment points, etc.
- The transition between LV/ MV ABC and traditional OH lines
- Connection to Transformers and other OH equipment
- Temporary working-earths
- Protection against lightning strikes and transient over-voltages (e.g. NZ ECP 35 & AS/NZS 1768:2007)
- Technical standards and drawings for LV/ MV ABC

9

Learning from the mistakes of others

10

11

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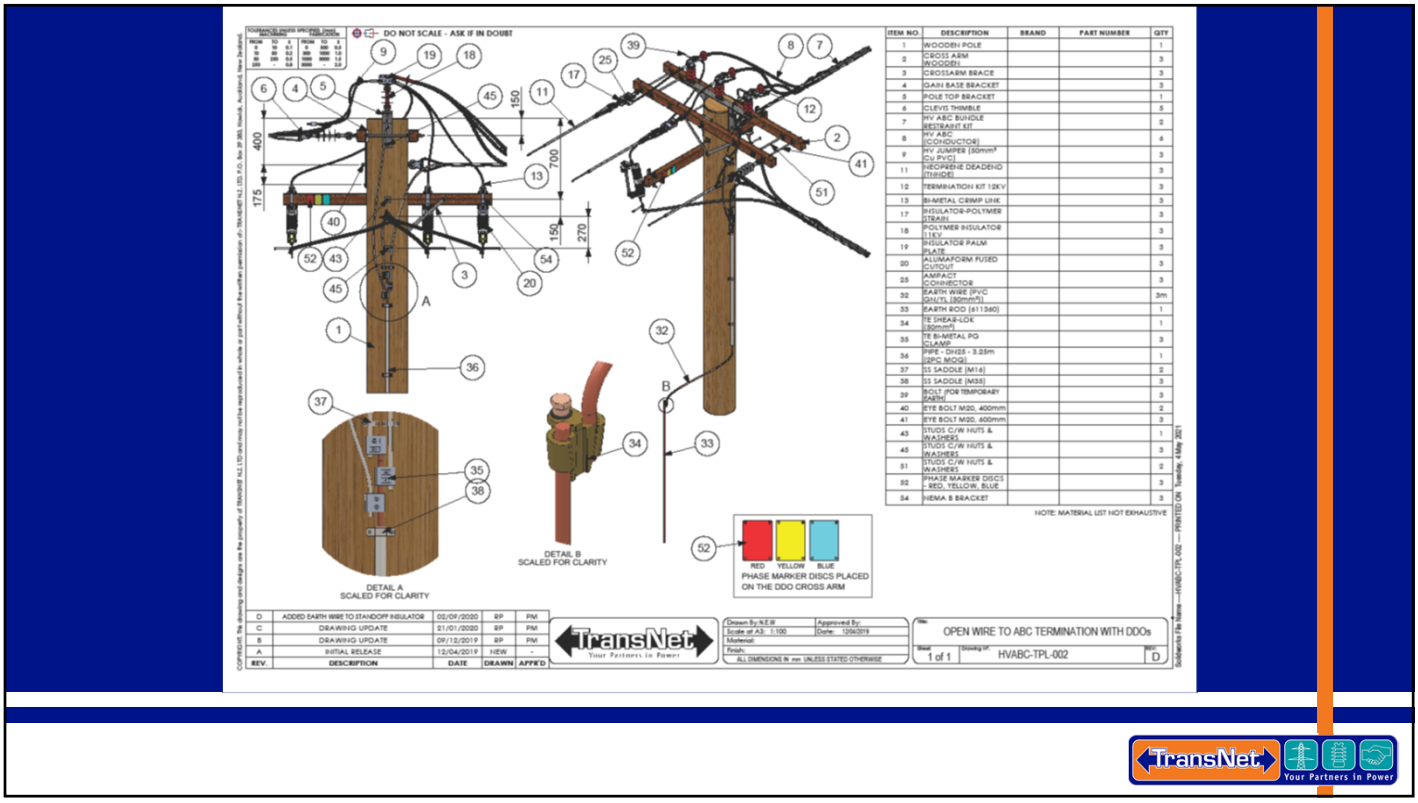
13

TransNet's experience with LV/MV ABC for Tonga Power

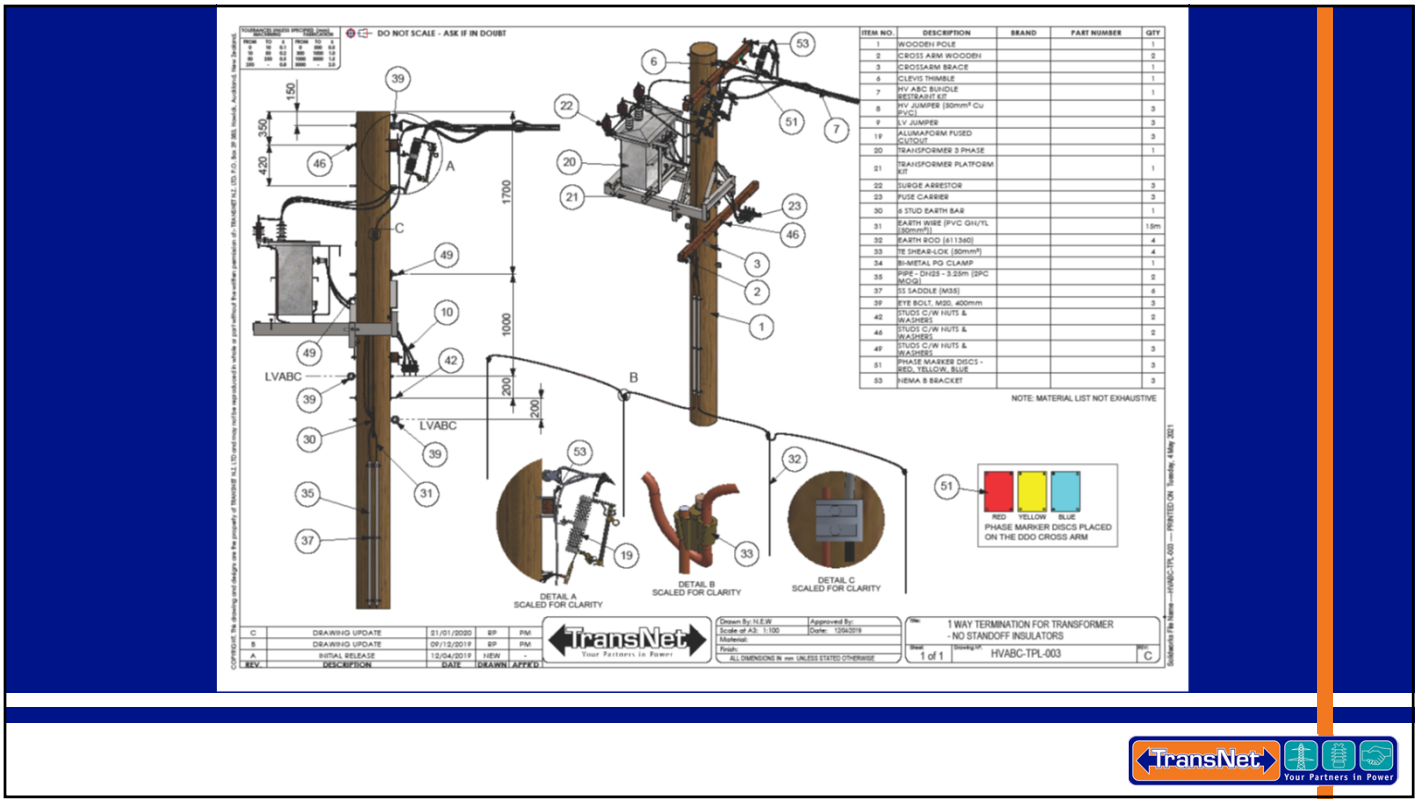
LV/MV ABC network design, construction, and installation:

- Technical standards/drawings which do not leave any room for different interpretations and improvisations
- Training of field staff with no or limited previous experience
- Supply chain e.g. sourcing the best quality hardware; delivery, consistency, compliance etc
- Project implementation plan
- Workmanship e.g. empowering linemen to take pride in their work, monitoring, feedback

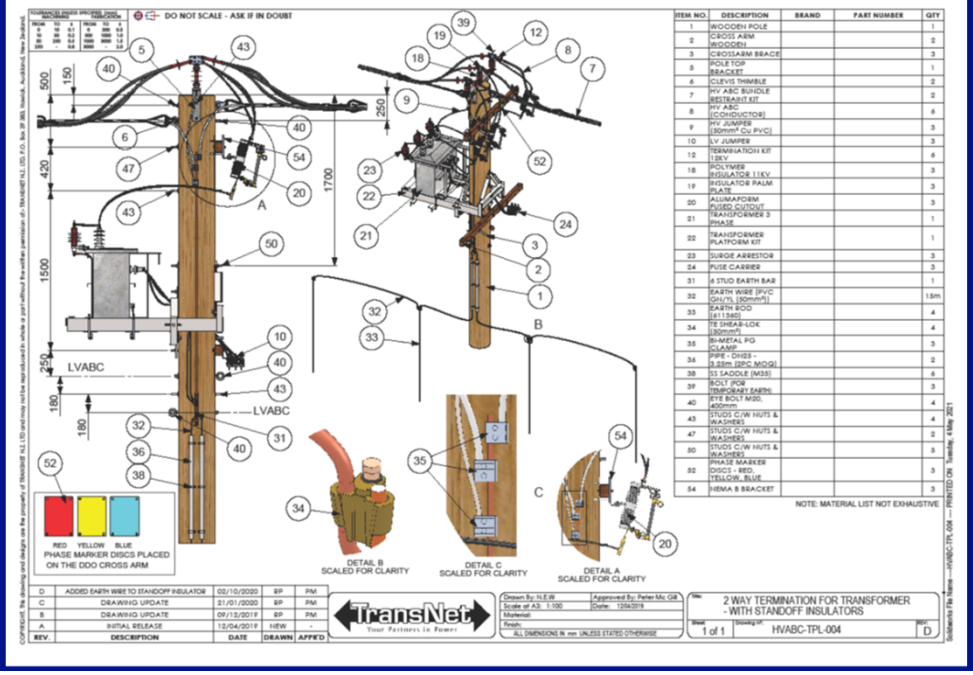
14


DO NOT SCALE - ASK IF IN DOUBT
DETAIL A
SCALED FOR CLARITY
DETAIL B
SCALED FOR CLARITY
RED YELLOW BLUE
PHASE MARKER DISCS PLACED
ON THE DDO CROSS ARM
NOTE: MATERIAL LIST NOT EXHAUSTIVE
OPEN WIRE TO ABC TERMINATION WITH DDOs
HVABC-TPL-002
TransNet
Your Partners in Power

15


DO NOT SCALE - ASK IF IN DOUBT
LVABC
LVABC
DETAIL A
SCALED FOR CLARITY
DETAIL B
SCALED FOR CLARITY
DETAIL C
SCALED FOR CLARITY
RED YELLOW BLUE
PHASE MARKER DISCS PLACED
ON THE DDO CROSS ARM
NOTE: MATERIAL LIST NOT EXHAUSTIVE
1 WAY TERMINATION FOR TRANSFORMER
- NO STANDOFF INSULATORS
HVABC-TPL-003
TransNet
Your Partners in Power

16


DO NOT SCALE - ASK IF IN DOUBT
LVABC
LVABC
RED YELLOW BLUE
PHASE MARKER DISCS PLACED ON THE DDO CROSS ARM
DETAIL B
SCALED FOR CLARITY
DETAIL C
SCALED FOR CLARITY
DETAIL A
SCALED FOR CLARITY
NOTE: MATERIAL LIST NOT EXHAUSTIVE
TransNet
Your Partners in Power
2 WAY TERMINATION FOR TRANSFORMER - WITH STANDOFF INSULATORS
HVABC-TPL-004
D

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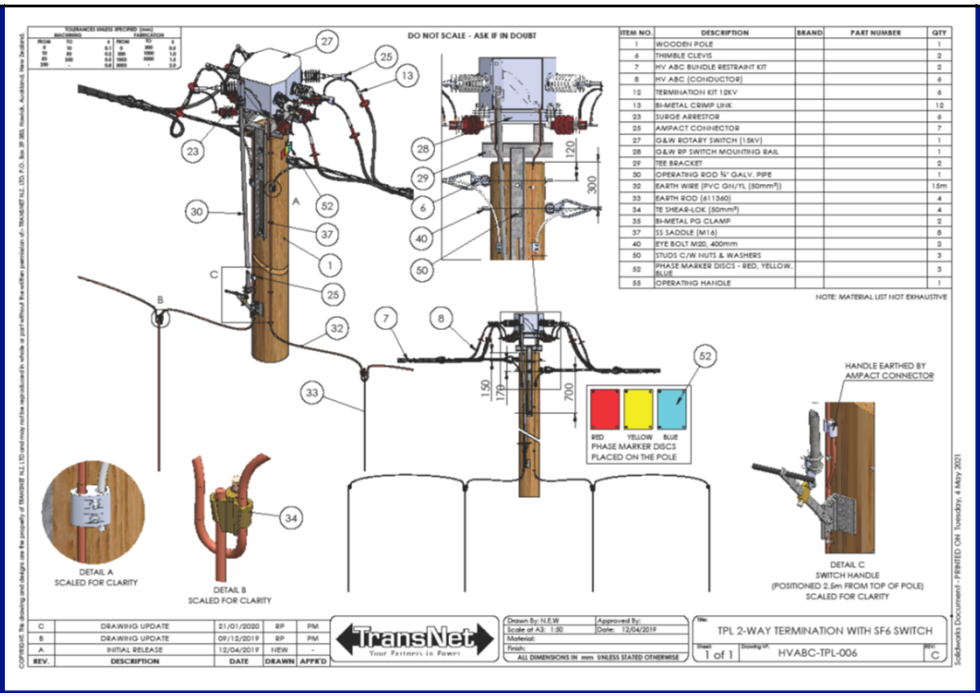
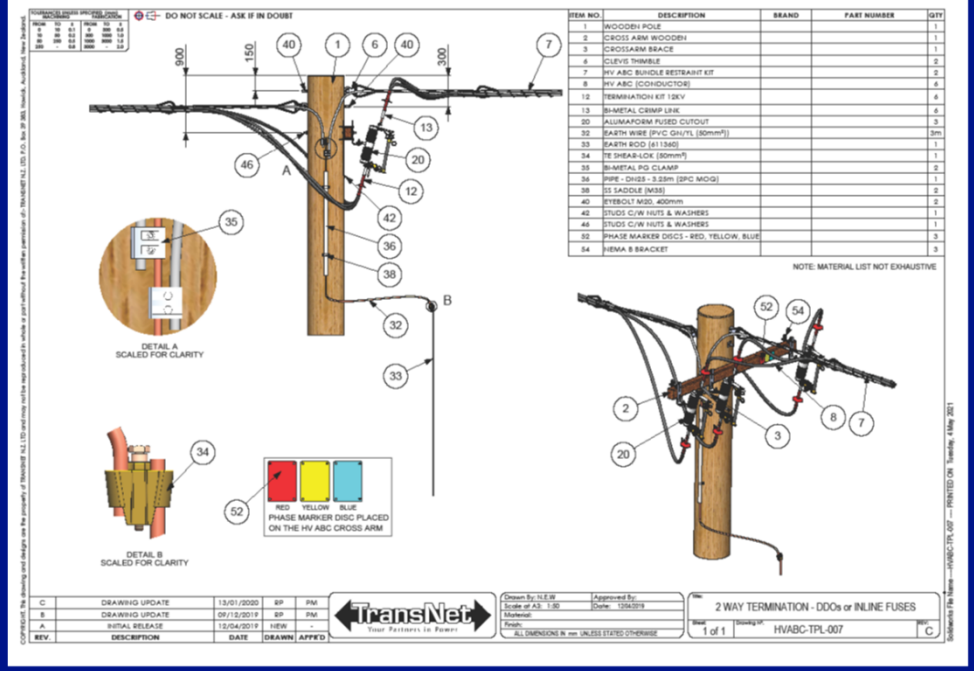

DO NOT SCALE - ASK IF IN DOUBT
RED YELLOW BLUE
PHASE MARKER DISCS
PLACED ON THE POLE
HANDLE EARTHED BY AMPACT CONNECTOR
DETAIL A
SCALED FOR CLARITY
DETAIL B
SCALED FOR CLARITY
DETAIL C
SWITCH HANDLE
(POSITIONED 2.5m FROM TOP OF POLE)
SCALED FOR CLARITY
NOTE: MATERIAL LIST NOT EXHAUSTIVE
TransNet
Your Partners in Power
TPL 2-WAY TERMINATION WITH SF6 SWITCH
HVABC-TPL-006
C

18



19

Building the TPL's LV/MV ABC network

Tonga ABC installations so far:

- MV ABC – 78 km
- LV ABC – 551 km

Important steps:

- Evaluate the benefits and risks associated with technology
- Review and re-adjust the network standards, drawings, and installation practice based on information received from the field
- Ongoing consultations, feedback from the field, and learning

20

21

22

23

24

The outcome

In the areas where Tonga Power installed MV and LV ABC, they have achieved:

Significant improvements in network reliability and resilience:
- Reduction of network faults caused by storms and vegetation
- Quick recovery after storms – reduced time for repair/reinstatement
- No faults due to line clashing
- Reduced stress on feeders previously caused by frequent faults
- Easy and quick to do minor fixes, repairs, and hardware replacements (e.g. fully insulated aerial cable, no need for the extreme G&B measures)

Safety:
- Improved public and personnel safety
- Improved power supply to critical customers
- More compact design (reduced clearances)
- Reduced risk of damage to property and environment

Environment:
- No harm to wildlife
- Visual effect

25

Key points

- Technical expertise and knowledge
- Practical experience
- Understanding the failure modes of OH hardware
- Good technical drawings, standards, equipment testing & proper customization (if needed)
- Training and pride in workmanship
- Get the right and proven hardware
- Project delivery, consistency, and compliance
- Spell out DO's and DON'Ts
- Do it right - Do not improvise
- Never compromise on quality and safety

26

The results speak for themselves
Cyclone Tino in Tonga (18 Jan 2020, est. 180km/h)

27

NZ and the international perspective

- Australia (22kV)
- South Korea (LV and 22.9kV)
- Pacific (LV and 11kV)
- New Zealand (LV and 11kV)

Practical considerations vs theory - LV ABC vs 11kV ABC vs 22kV ABC

In any case:
LV/MV ABC can be your best friend or your worst enemy – the choice is yours

28

"Have no fear of perfection - you'll never reach it."

Salvador Dali

Any questions?

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29