



Quality Assurance of insulated cables NZ B1 Webtute

Kewen Kueh – Power Assets Fleet Manager

Powerco

29/03/2022 (Online)



cigre

For power system expertise



Introduction

- Kewen Kueh – Power Assets Fleet Manager, Powerco
- Overall responsibility for maintenance & renewal of Power Assets Fleets
 - HV substations (Transformer, Switchgear, Grounds)
 - HV & LV Underground cables
- NZB1 WG3 - Cable maintenance, testing and condition assessment



Summary

“What does Quality Assurance of insulated cables mean?”

- **The Why - Asset life cycle management**
 - TB787 – ISO Series 55000 standards, implementation and information guidelines for utilities
- **The How - Cable Maintenance strategy development**
 - TB825 Maintenance of HV Cable Systems
- **The What – Case study (application of PDCA cycles) & Tools**
 - TB728 PD assessment Diagnostic tools



The Why



The Why: Asset life cycle management – Guidelines (TB787)

“Asset Management involves the balancing of cost and risk opportunities against the desired performance of assets, to achieve the organizational objectives. The balancing might need to be considered over different timeframes”

- Many are moving to the ISO 55001 system for asset management.
- ISO management standards are industry agnostic
- Provides:
 - an overview of asset management
 - a clause-by clause review of ISO 55001 that offers an interpretation in the context of electrical utilities
 - a survey on the progress and intentions of utilities regarding ISO 55001
 - in-depth case studies listing the processes and IT systems put in place

2019 release - free to members

[e-cigre > Publication > ISO series 55000 standards: Implementation and information guidelines for utilities](#)

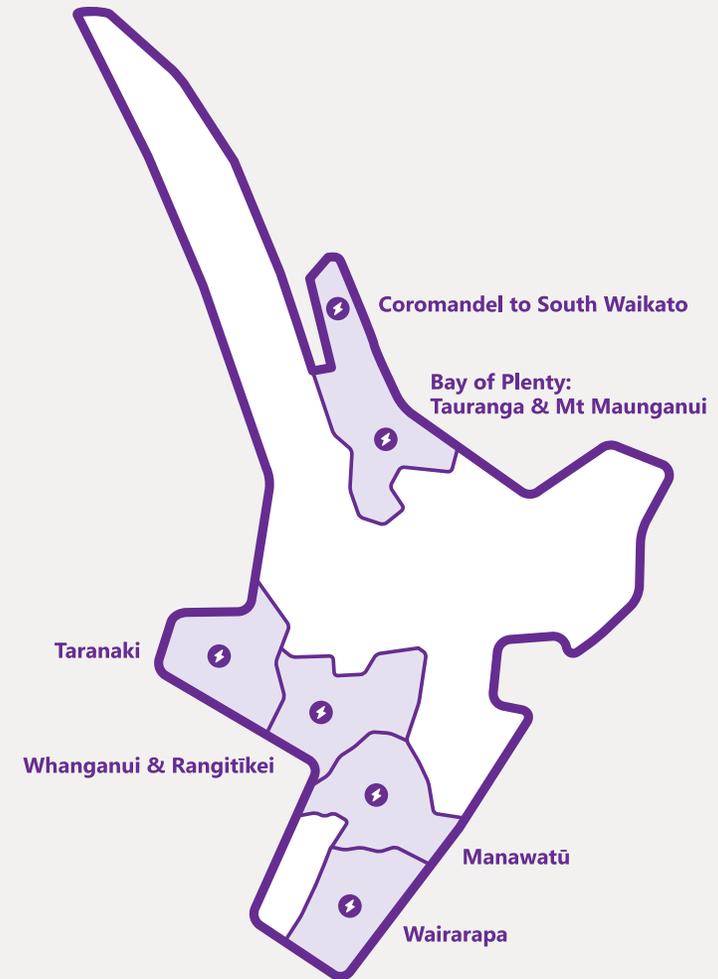
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The Why – Powerco example

- Powerco is a NZ gas & electricity utility, supplying 344,000 residential homes, commercial & industrial businesses
- About 25% of NZ population
- 22,000 km of Overhead Lines up to 110kV
- 7,000 km of cables up to 110kV, primarily urban networks in Tauranga, Palmerston North etc.



MARKETPLACE EUROPE

80 million European households struggle to stay warm. Rising energy costs will make the problem worse

By Walé Azeez, CNN Business

Updated 1406 GMT (2206 HKT) October 1, 2021

Newshub.

16 March 2022

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COST OF LIVING ●

Cost of living: New Zealanders struggling to get by say Government tax cut not enough

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Business ► Economics Banking Money Markets Project Syndicate B2B Retail

Cost of living crisis

Rising cost of living is having a devastating impact

Letters

Tue 15 Mar 2022 17.27 GMT

Feeding Britain's **Andrew Forsey** on the alarming number of people on the edge of crisis, **Pam Walker** on sinking into fuel poverty, and **Peter Carter** on poor people being ripped off by energy firms

Price vs. Quality tradeoff



The Why – Powerco Example

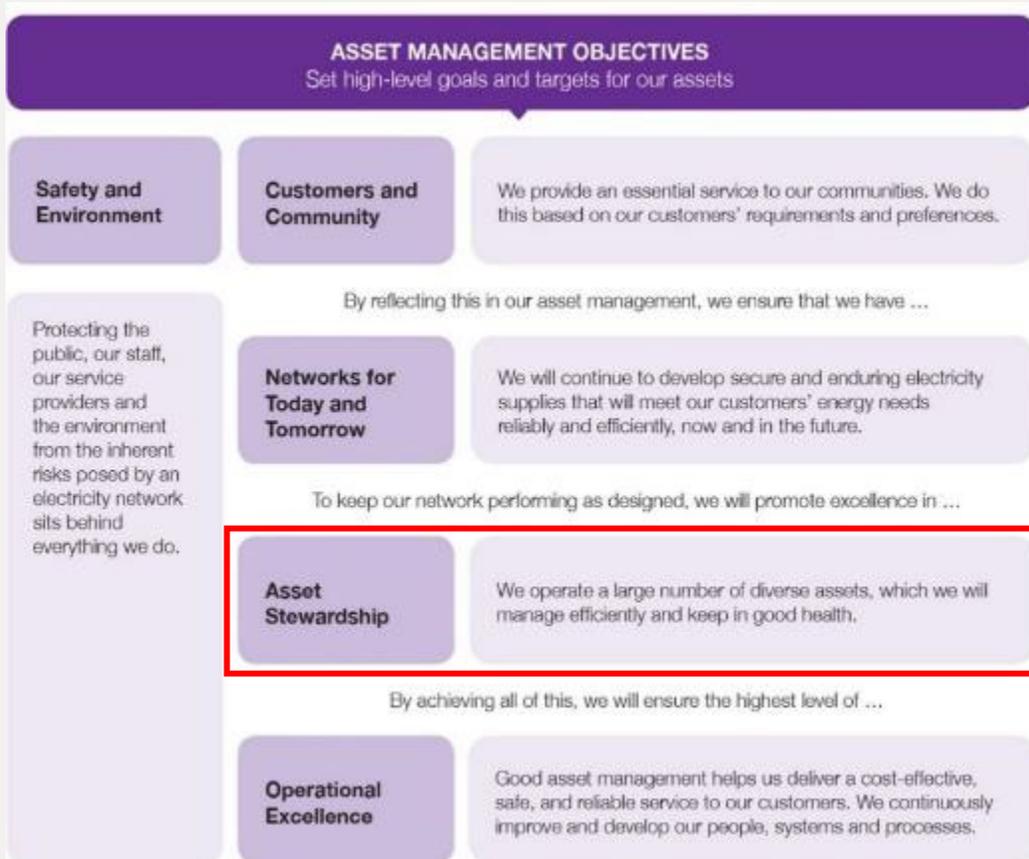


Table 20.1: Cables portfolio objectives

ASSET MANAGEMENT OBJECTIVE	PORTFOLIO OBJECTIVE
Safety and Environment	No public safety incidents from contact with our cable network.
	Minimise oil leaks from pressurised oil-filled cables.
Customers and Community	Minimise traffic interruptions when managing cable assets in road reserves NZUAG.
Networks for Today and Tomorrow	Investigate the use of real-time cable ratings using distributed temperature sensing.
	New cable sized to meet future demand
Asset Stewardship	Maintain the failure rate of cable assets at or below target levels.
	Proactive testing and renewal work on critical circuits
Operational Excellence	Improve our knowledge of the LV cable fleet.

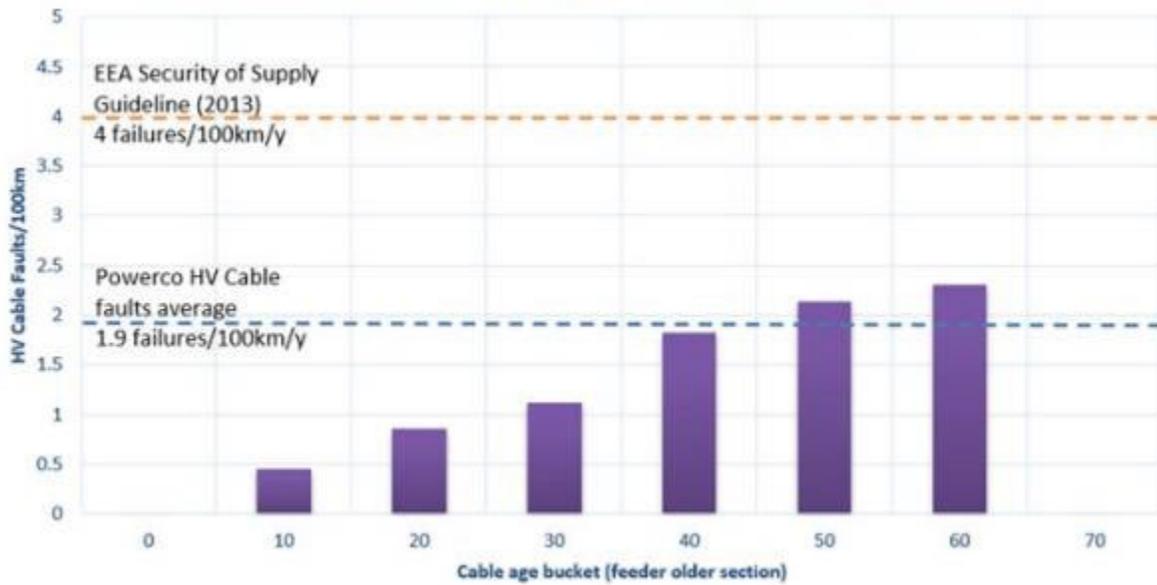
Powerco 2021 Asset Management Plan

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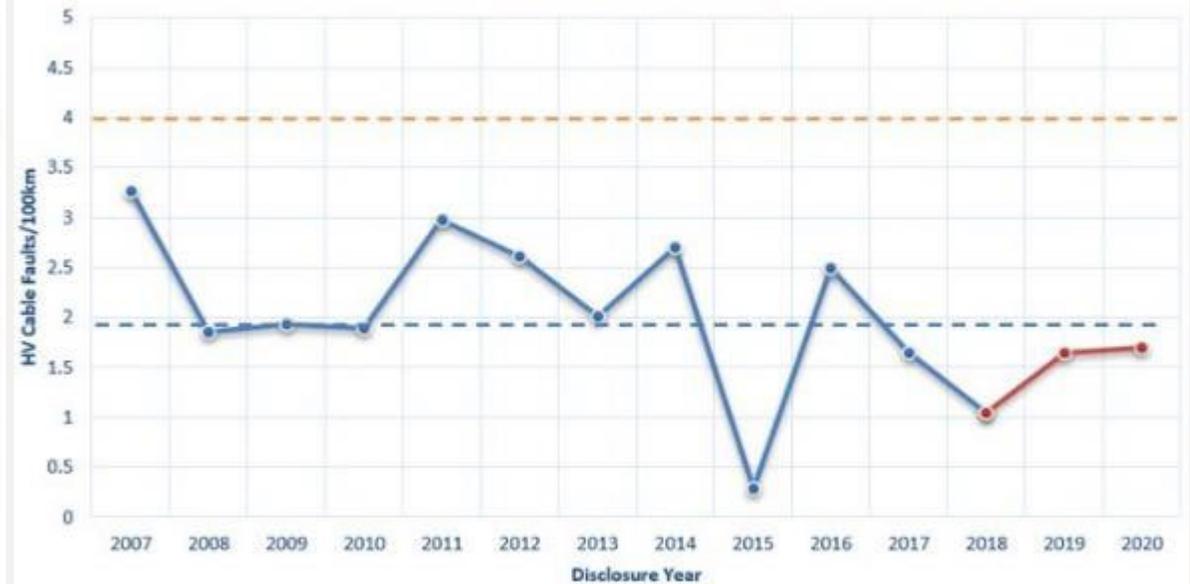


The Why – Powerco Example

11 year HV Cable faults by age (2007-2018) excl. third party



11kV HV cable faults by year (2008-2020) excl. third party



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The How



The How - Cable maintenance strategy development

Table 3-1: Breakdown of direct maintenance cost by % for different transmission equipment

Transmission equipment	G	S	Tr	L	T	Ca	P	Co
Predictive Maintenance	54	57	50	36	35	24	57	40
Corrective Maintenance	18	17	23	29	26	45	18	32
Refurbishment	20	17	18	29	35	24	13	12
Others	9	9	8	6	4	7	11	19

G = general, S = switchgear, Tr = transformer, L = line, T = tower, Ca = cable, P = protection, Co = control

CIGRE Report 2000 "Questionnaire on Maintenance Policies and Trends" (JWG 23/39)

- Cable assets have a disproportionate cost of reactive repairs vs. proactive maintenance
- Improvements in diagnostic/testing technologies provide an opportunity to move towards predictive
- Increases in PM costs should leave to lower CM costs, and lower costs to customers overall

The How: TB825 - Maintenance of HV Cable Systems

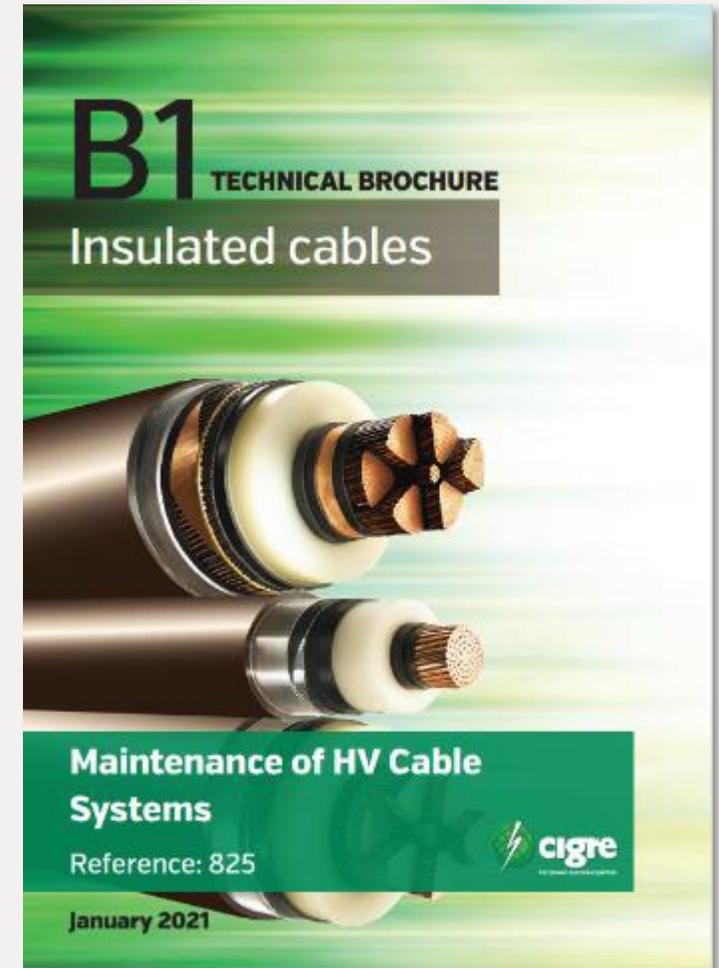
- Update of the TB 279 which includes more updated technologies and practices for Maintenance.
- Covers all cable types, incl. submarine and land cables*
- Existing Maintenance practices and Strategies
- Monitoring and diagnostics
- Spare part management, emergency preparedness and training
- Cost of Maintenance
- Remaining life
- Future developments / big data
- Case studies

*Note – focused on >36kV

2021 - free to members

[e-cigre > Publication > Maintenance of HV Cable Systems](#)

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The How: TB825 (2021) Webinar

Maintenance types

- **Time-based maintenance (TBM)**, based on a specified predetermined schedule
- **Condition based maintenance (CBM)**, based on the present condition (continuous monitoring) of the component (e.g. dial before you dig)
 - **Predictive Maintenance**, carried out to determine when maintenance should be carried out to avoid failures in service
- **Probabilistic approach**, this method takes into account several parameters, such as asset condition, maintenance costs, importance of the asset, risks
- **Corrective maintenance (CM)**, to repair or replace broken items

Underground Cable Systems: Avoiding Third Party Damage

Providing proper information (e.g. dial before you dig)

Periodic Patrolling

Underground Cable Systems: General

Inspections

- Cable and accessories
- Earthing and bonding
- Mainly visual
- Damage/wear/defects
- Cable movement
- Hotspots/Corrosion

Maintenance D

- Periodic check
- Sheath/Service
- SVL testing
- Screen current measurement
- DTS, PD, Tan

- All types require competent, trained personnel
- Transition from periodic intervals towards on-demand
- Transition from time based maintenance to condition based

Maintenance on Submarine Cable Systems

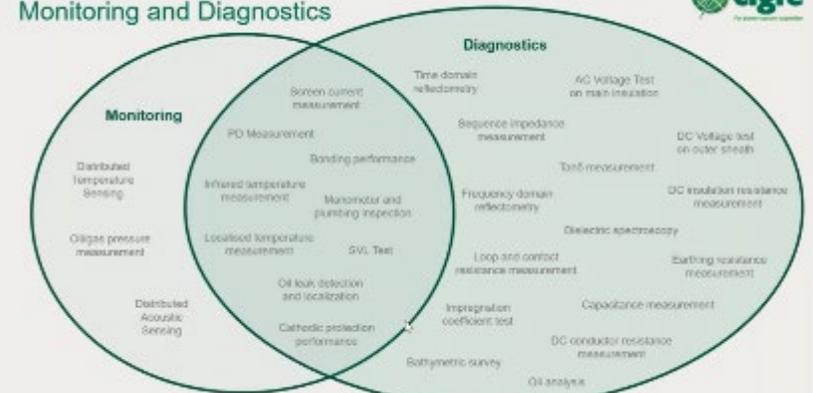
The cable system is also subject to natural threats such as hydrodynamics, change of seabed morphology, corrosion, earthquake, etc...

✓ Overview of activities to control cable protection and health, such as:

- Offshore geophysical surveys
- Inspections at landfalls & offshore platforms
- Monitoring
- Additional or remedial protection works



Monitoring and Diagnostics



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The How: TB825 Monitoring/Diagnostic approaches – maintenance costs

Table 7-3: Overview of diagnostic techniques

Diagnostic Technique	Monitoring /Diagnostic	Cost Level (Chapter 9.3)	AC						DC					
			Land			Submarine/Subsea			Land			Submarine/Subsea		
			XLPE	PILC	SCFF/HPFF	GP	XLPE	SCFF/HPFF	XLPE	MIND	SCFF/HPFF	XLPE	MIND	SCFF/HPFF
AC Voltage Test on Main Insulation	D	L1-L6	X	X	X	X	X	X	-	-	X	-	-	-
PD Measurement (online, offline, monitoring)	M/D	L1-L6	X	X	X	X	X	X	-	-	-	-	-	-
DC Voltage Test on Main Insulation	D	L1-L4	-	X	X	X	-	X	X	X	X	X	X	X
DC insulation resistance measurement	D	L1	X	X	X	X	X	X	X	X	X	X	X	X
Dissipation Factor Measurement (Tan Delta)	D	L1-L3	-	X	X	X	-	X	-	X	X	-	X	X

The How – Understanding failure modes & effects (Example)

From TB279 - Chapter 5:



Item	Event/cause	Consequence	Probability of occurrence
(9)	Assembly error causing local increase of electrical stresses	Electrical treeing through partial discharge	Medium
(10)	Assembly error of joint connector	Local overheating and insulation damage	Low
(11)	Assembly error leading to imperfect sealing	Water penetration causing reduced material properties	Low

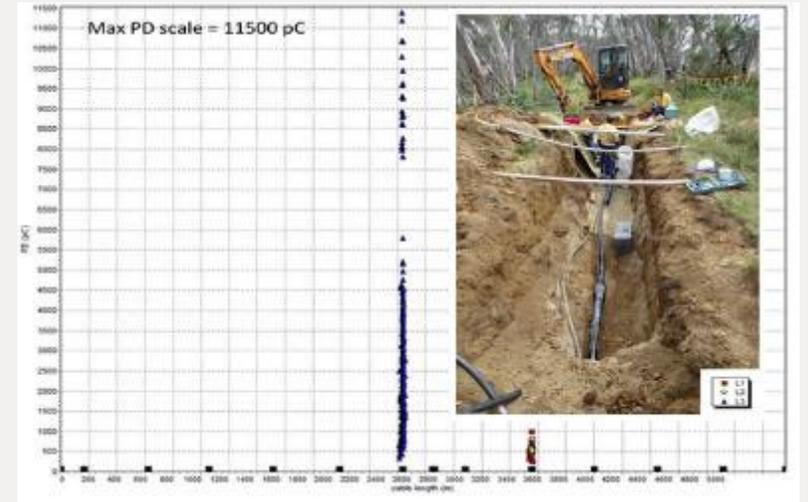
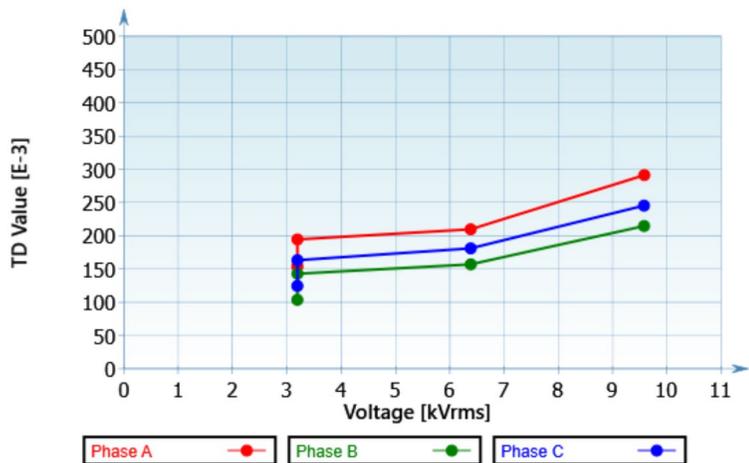
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The How - Understanding detection methods (Example)

Applicable TB 279 Chapter 6 Diagnostic Tools: UNL Example

Tool	Events/cause detected
(3) Tan delta measurement	Ingress of water in insulation area Tracking in joints
(5) Partial discharge measurement	Defects and deterioration of insulation Assembly errors in accessories



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The What

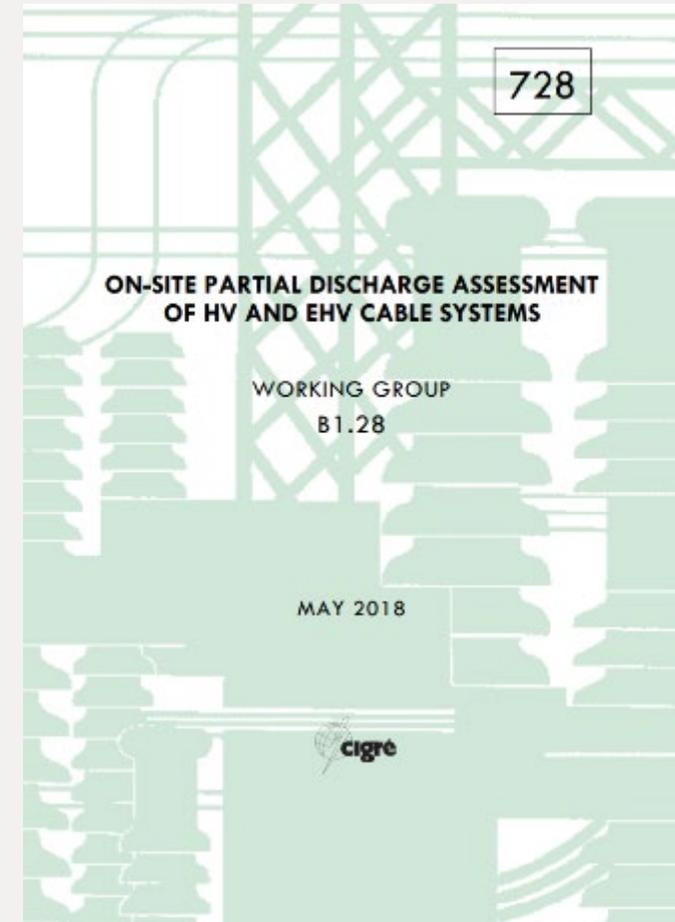


The What: On-site Partial Discharge assessment of HV and EHV cable systems

- Partial Discharge (PD) measurement is a proven diagnostic method for insulated cables and accessories.
- PD detection sensitivity has improved for use in noisy environments
- Many more new cable system installations are viable
- Good experience in identifying defects in new installations
- Outlines the findings and associated recommendations and allows to consider the most suitable testing parameters in site conditions

2018 release – Free to members

[e-cigre > Publication > On-site Partial Discharge Assessment of HV and EHV Cable Systems](#)



The What: Testing parameters

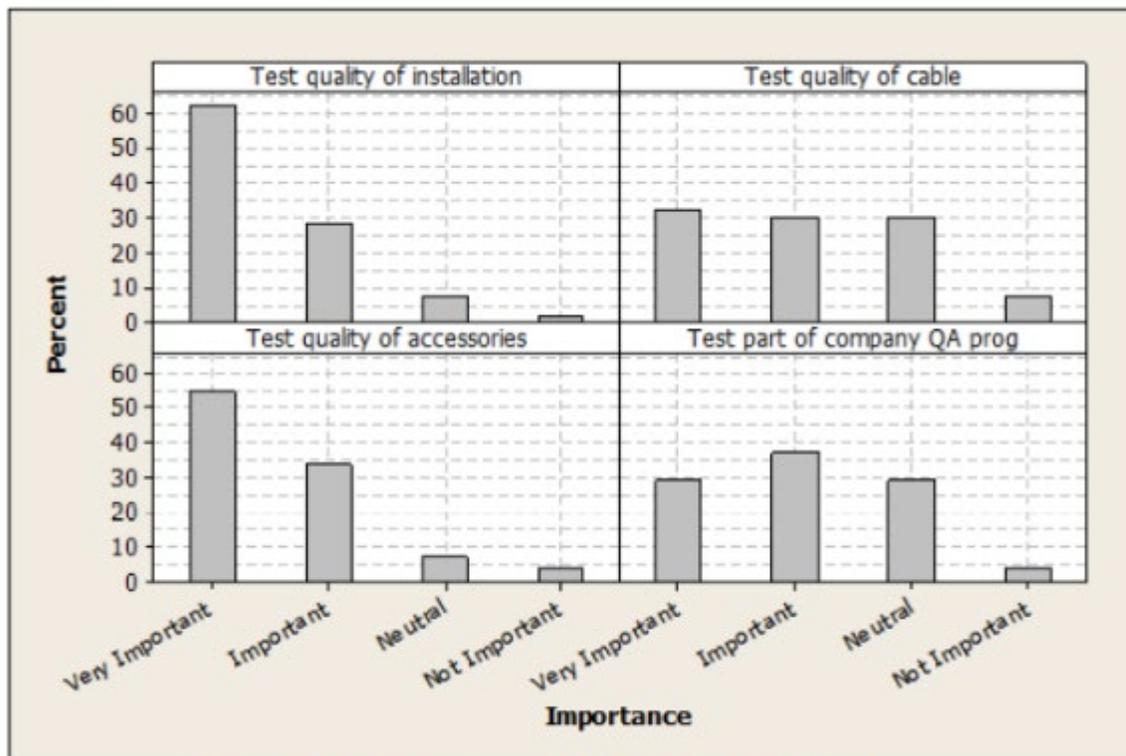


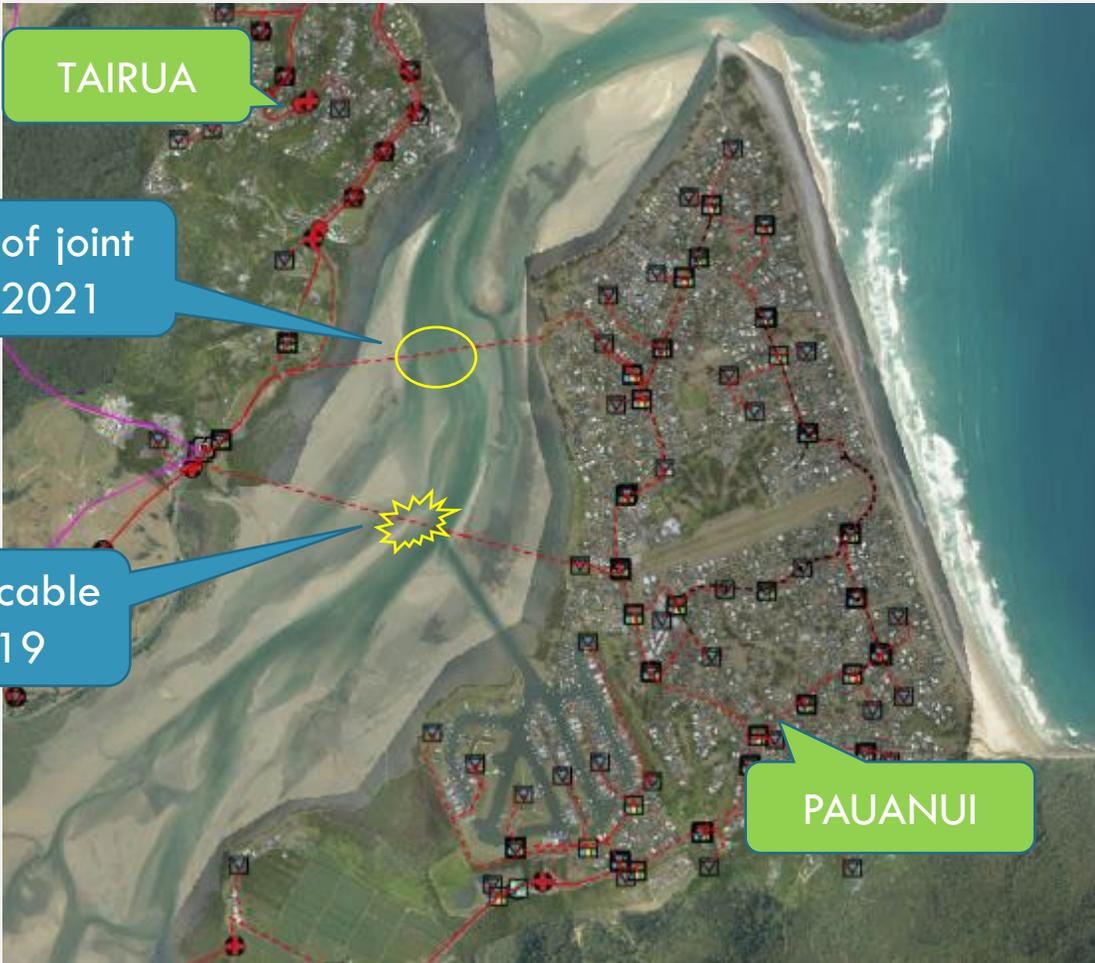
Figure 2.3: Relative importance of PD testing - Significant Reasons

Decreasing order of importance:



- Quality of installation
- Quality of accessories
- Quality of cable
- Testing part of company QA Prog

Case Study – Submarine cable failures



Location of joint failure 2021

Location of cable strike 2019

TAIRUA

PAUANUI

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Parameter	2019 Failure	2021 Failure
Repair Cost (\$)	\$150k (Temp) \$600k (Final)	\$300k
Repair Time (weeks)	6 weeks (Temp) 27 weeks (final)	6 weeks
Details	No spares/materials	Spares & service provider arrangements



Case Study – Application of TB825 reference

Finding #1: Cable strike was possible due to exposure



Finding #2: Plans for spares & repair approach are essential



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Section 5.1.2.1 Offshore surveys

- *“it is advisable that cable system owners maintain up-to-date cable system records, charts etc, to a reasonable level of accuracy taking into account the dynamics and properties of the seabed”*

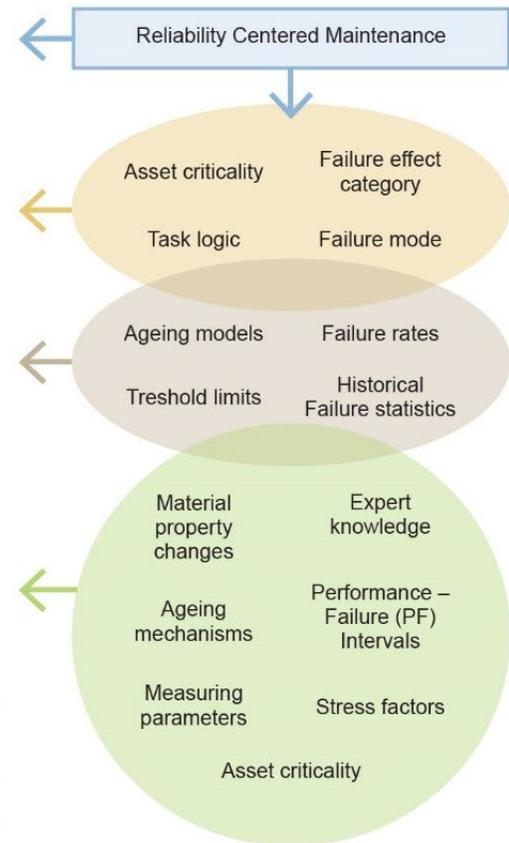
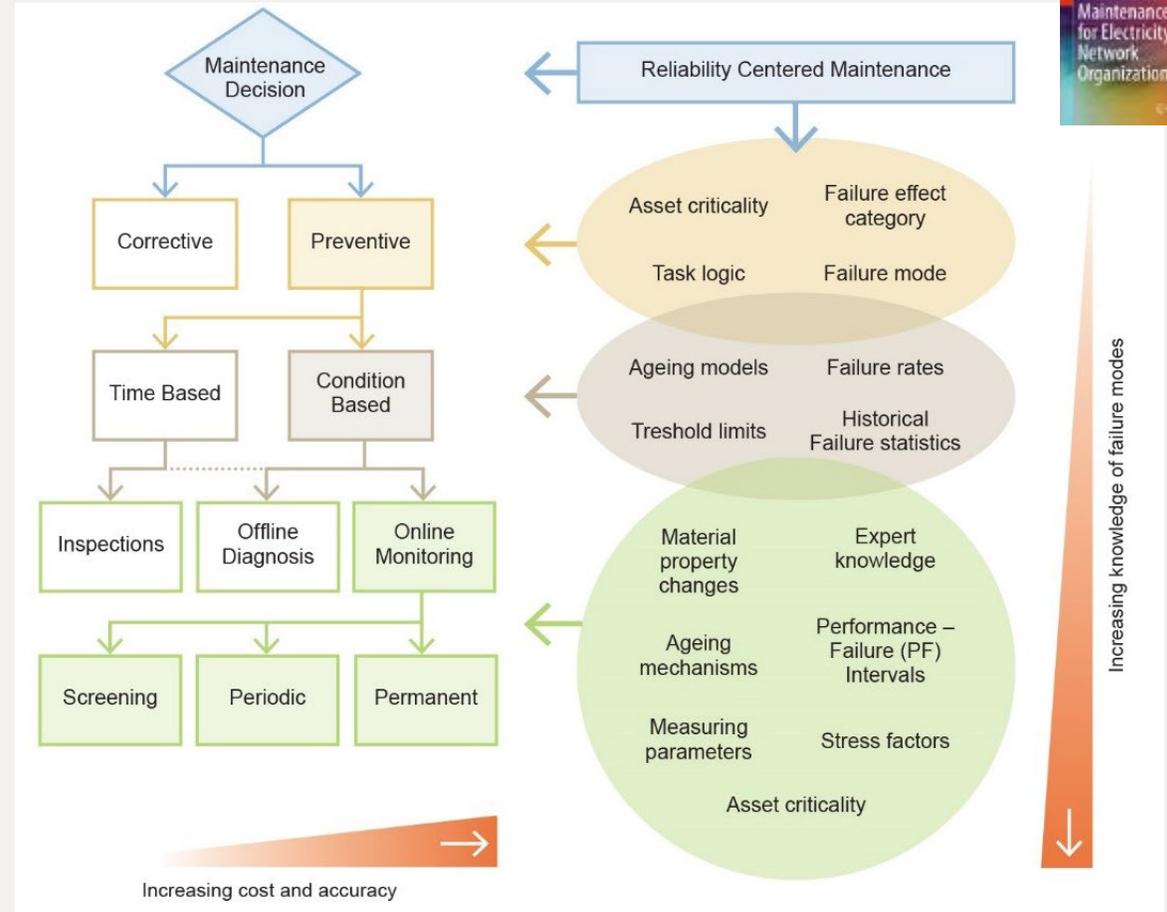
> We are now undertaking underwater surveying to identify when cables may be exposed
> We are also looking at physical protection methods where large seabed movements are likely/expected

5.2 Corrective maintenance on submarine cable systems (Page 44)

“Further to pinpointing of the fault, availability of jointing personnel and equipment shall be assessed, followed by commence preparation of spare cable transport logistics as well as stored equipment and materials”

> We now hold appropriate spares and have trained service providers to carry repairs out

Case Study – Submarine cable failures



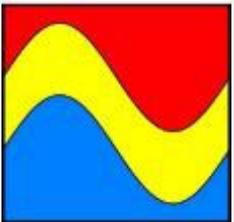
Increasing cost and accuracy (indicated by a rightward arrow)

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Conclusions

- **The Why** – Strategic alignment/”Line of sight” - organisations need an asset management system that links business objectives to the “doing”, with a systematic Plan-Do-Check-Act cycle for continuous improvement.
 - TB787 can provide some guidance here
- **The How** – For cable systems, considered application of diagnostic tools can improve the whole of lifecycle costs to customers while moving to more planned vs. unplanned outages
 - TB825 (2021) provides guidance has a good overview of tools and cost/treatment aspects to consider, when forming a strategy
- **The What** – It is important to establish clear rules/criteria on actions to take as a result of the maintenance strategy, so the benefits can be realised, and likewise this is checked and reviewed over time



Northpower



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NZ B1 WG3 Plug...online survey



CIGRE NZ B1 - Survey of cable testing in New Zealand

CIGRE NZ B1 WG3 is a New Zealand-based working group of utilities and test providers. Its purpose is to understand and identify gaps or shortcomings in the area of maintenance and condition assessment testing in the New Zealand context, and collaborate on solutions.

This survey will be used to help orient our activities to best support information sharing of best-practice maintenance and condition assessment of MV cables. The deadline for completing this survey is the **15 April**. It is estimated to take 5-10 minutes to complete.

This survey is **anonymous**, however there is an opportunity to provide your contact details at the end if you would like to become more involved.

Thanks

Questions or contact me at
kewen.kueh@powerco.co.nz