

#### 67th AMEU Convention SUSTAINABLE CUSTOMER CENTRIC ELECTRICITY UTILITIES IN THE 4TH AND 5TH INDUSTRIAL REVOLUTION

#### Power Transformer Diagnosis and Maintenance: To Test OR NOT to Test?

Presented by Alexander Dierks Managing Director Alectrix (Pty) Ltd



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### To Test OR NOT to Test?





Lost power transformer hardware Damage to secondary equipment in substation Extended periods of loss of supply to customers Personal safety risk





### **Transformer Failure Statistics**

Cigre WB A2.37: Survey of 22,000 grid transformers with 150,000 service years



Source: DEVELOPMENT AND RESULTS OF A WORLDWIDE TRANSFORMER RELIABILITY SURVEY" CIGRE SC A2 COLLOQUIUM 2015, Shanghai





#### **A Real Case**



What Revenue is lost for a 20MVA transformer not supplying customers?

> 100% load during day (16h) 50% load during night (8h) 2.50 R/kWh

> R1 Million per day

= 20MVA \* (16h\*100% + 8h\*50%) \* 2.50R/kWh





#### **Maimonides Principle:**

"Give a man a fish, and you feed him for a day. Teach a man to fish, and you feed him for a lifetime."

#### **Alectrix' Principle:**

"Give a utility a finished test report, they can supply power for a year. Teach a utility to test themselves, they can supply power for a lifetime."





#### 1) Visual Inspection

- Oil leaks, silicon breathers, noise
- 2) Dissolved Gas Analysis
  - Duval triangle
- 3) Insulation Resistance Measurement
  - Megger at 5kV





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- 1) <u>Short Circuit Impedance Test</u>
  - Leakage Reactance measurement
- 2) Static Winding Resistance Test
  - Three phase DC test
  - Charging / Discharging of winding
- 3) <u>Excitation current measurement</u>- after demagnetization
- 4) Transformer Turns Ratio Test (TTR)
  - Three phase AC test
  - Voltage ratio measurement
  - Vector group measurement





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- Dynamic Winding Resistance Tests

   DC continuity test for OLTC
- 2) Winding Tan-Delta Measurement
  - Dissipation factor: HV & LV
  - Frequency response
- 3) Bushing Tan-Delta Measurement
  - Capacitance & DF for HV bushings
- 4) <u>Sweep Frequency Response Analysis</u> - SFRA
- 5) <u>Partial Discharge Measurements</u> - Early failure detection
- 6) <u>Di-electric Response Analysis</u> - Moisture in solid insulation (paper)





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DF frequency sweep





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#### **Teaching to Fish...**

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#### **Summary & Conclusions:**

- 1) Power transformers are the most valuable asset in a power system
- 2) Huge revenue is lost when power transformer is not supplying power
- 3) Testing and diagnosis of power transformers can prevent failures!
- 4) Basic Diagnostics: Visual inspection, DGA, IR
- 5) Standard Electrical Tests: Short circuit impedance, winding resistance, excitation current, TTR
- 6) Advanced Electrical Tests: Dynamic winding resistance, winding TD, bushing TD, SFRA, PD, DRA
- 7) 'Teaching to fish' is crucial 'to feed for a lifetime'!







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# Thank you!



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