

CIGRE A2 – Transformer Reliability Webinar

Improving Reliability through Specification, Design & Construction

**Lagath Ganepola, Principal Engineer – Major Plant & Diagnostics
Powerlink Queensland**

May 2021



cigre

For power system expertise



■ RELIABLE TRANSFORMER



BALANCING ACT

- Absolute Minimum vs Comprehensive
 - **AS/NZS 60076.1 – Annex A (5 pages) vs 255 pages**
- What you **NEED** vs What you **WANT**
- Specify **SHALL & SHALL NOT**
- Receive Design Data
- Intellectual Property Assurance
- Verification
 - ✓ **Design Review CIGRE Technical Brochure 529**
 - ✓ **Clamp Down Witness**
 - ✓ **Factory Acceptance Test Witness**



Annex A (informative)

Check list of information to be provided with enquiry and order

A.1 Rating and general data

A.1.1 Normal information

The following information shall be given in all cases:

- Particulars of the specifications to which the transformer shall comply.
- Kind of transformer, for example, separate winding transformer, auto-transformer or series transformer.
- Single or three-phase unit.
- Number of phases in system.
- Frequency.
- Dry-type or liquid-immersed type. If liquid-immersed type, whether mineral oil, natural insulating liquid or synthetic insulating liquid. If dry-type, degree of protection (see IEC 60529).
- Indoor or outdoor type.
- Type of cooling.
If the transformer is specified with alternative methods of cooling, the respective lower power values are to be stated together with the rated power (which refers to the most efficient cooling).
- Rated power for each winding and, for tapping range exceeding $\pm 5\%$, the specified maximum current tapping, if applicable.
- Rated voltage for each winding.
- For a transformer with tapplings (see 6.4):
 - whether 'de-energized' or 'on-load' tap-changing is required;
 - any requirements for fixing the ratio of turns between two particular windings on a more than two winding transformer;
 - whether any tapping or range of tapplings can be reduced power tapplings;
 - the number of tapping steps and the size of the tapping step or the tapping range;and either:
 - which winding is tapped;
 - if the tapping range is more than $\pm 5\%$, the type of voltage variation, and the location of the maximum current tapping, if applicable;or:
.....

CORE

- Core Temp Rise, Frames + Tank — 75° C

No of Core Ducts, Tie Plate Slots, SS Turrets

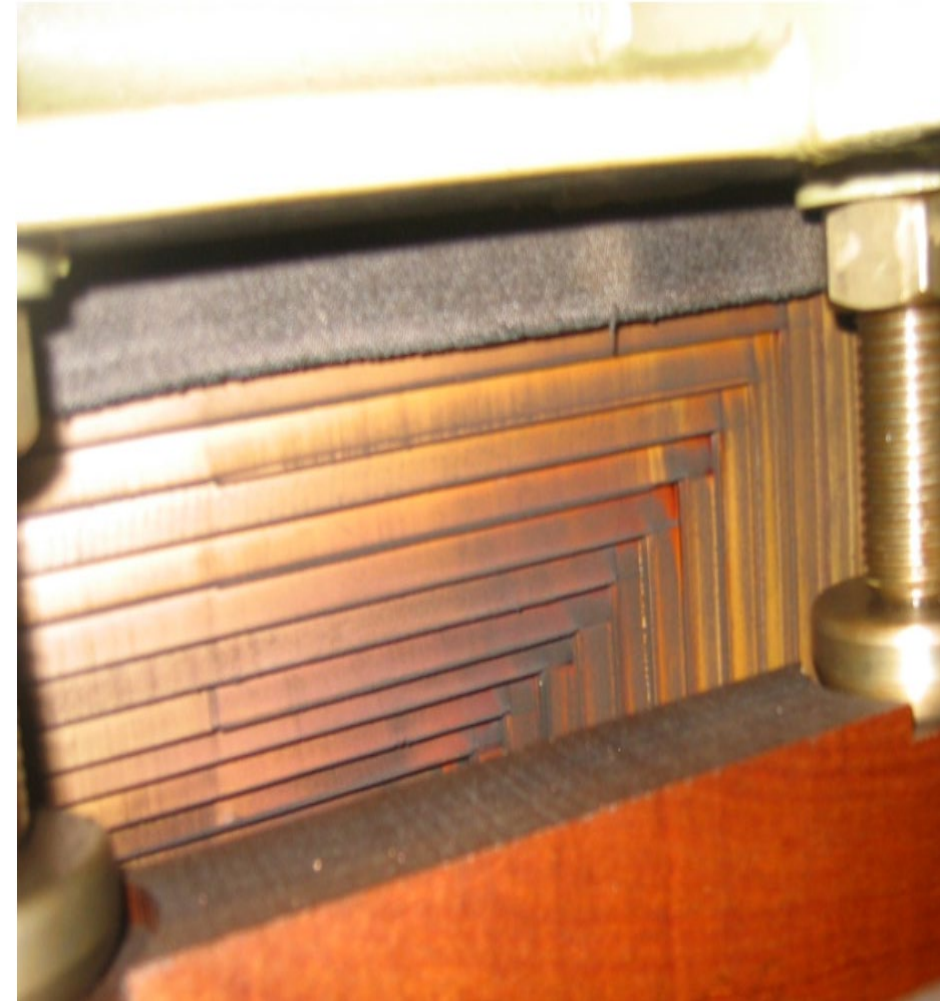
- Flux Density

- Over Voltage/ Over Excitation - Overheating
 - Generator Step-up – Performance Criteria

- DC Injection – SVC/ STATCOM .
– 1.5 Tesla @ Ur

NER S5.2.5.4
Generating
system response
to voltage
disturbances
Automatic access
standard

CIGRE Working Group
WG33.10 'Electra
No.179' -1998



CORE

- Core Plates Edges/ Dogs Ears \$ 10.00 FIX



WINDINGS – ELEMINATION OF P_{ARTIAL} D_{ISCHARGE}

- Electro-Static Analysis of Complete Insulation Structure FEM Modelling
 - SAFETY MARGIN –
Corona Inception Field Stress / Corona Inception Field Strength

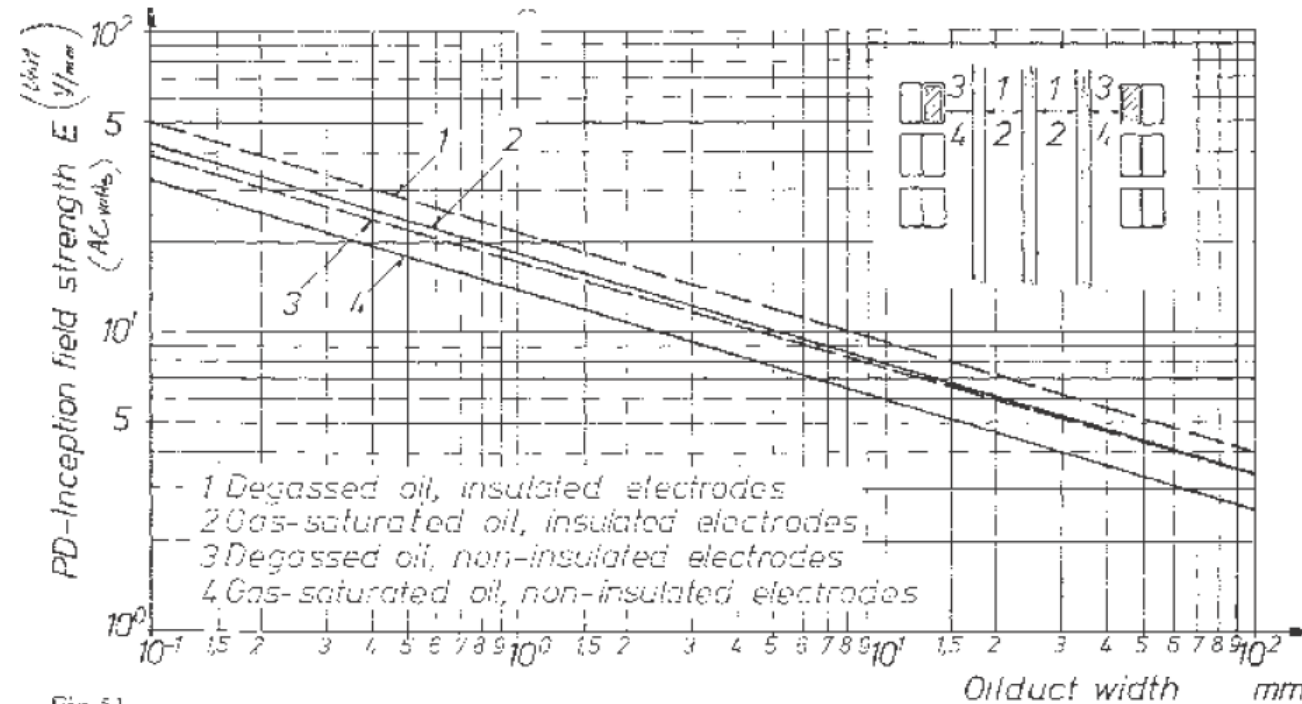
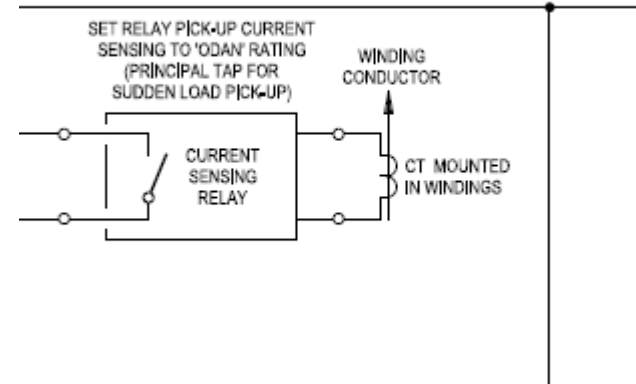


Fig. 51
Electric strength of transformer oil

COOLING

- Pump first or Fan First
 - ONAN/ODAN/ODAF
 - ONAN/ONAF/ODAF
- Redundancy – Standby Pump
- Sudden load Pick-up



OVERLOADING

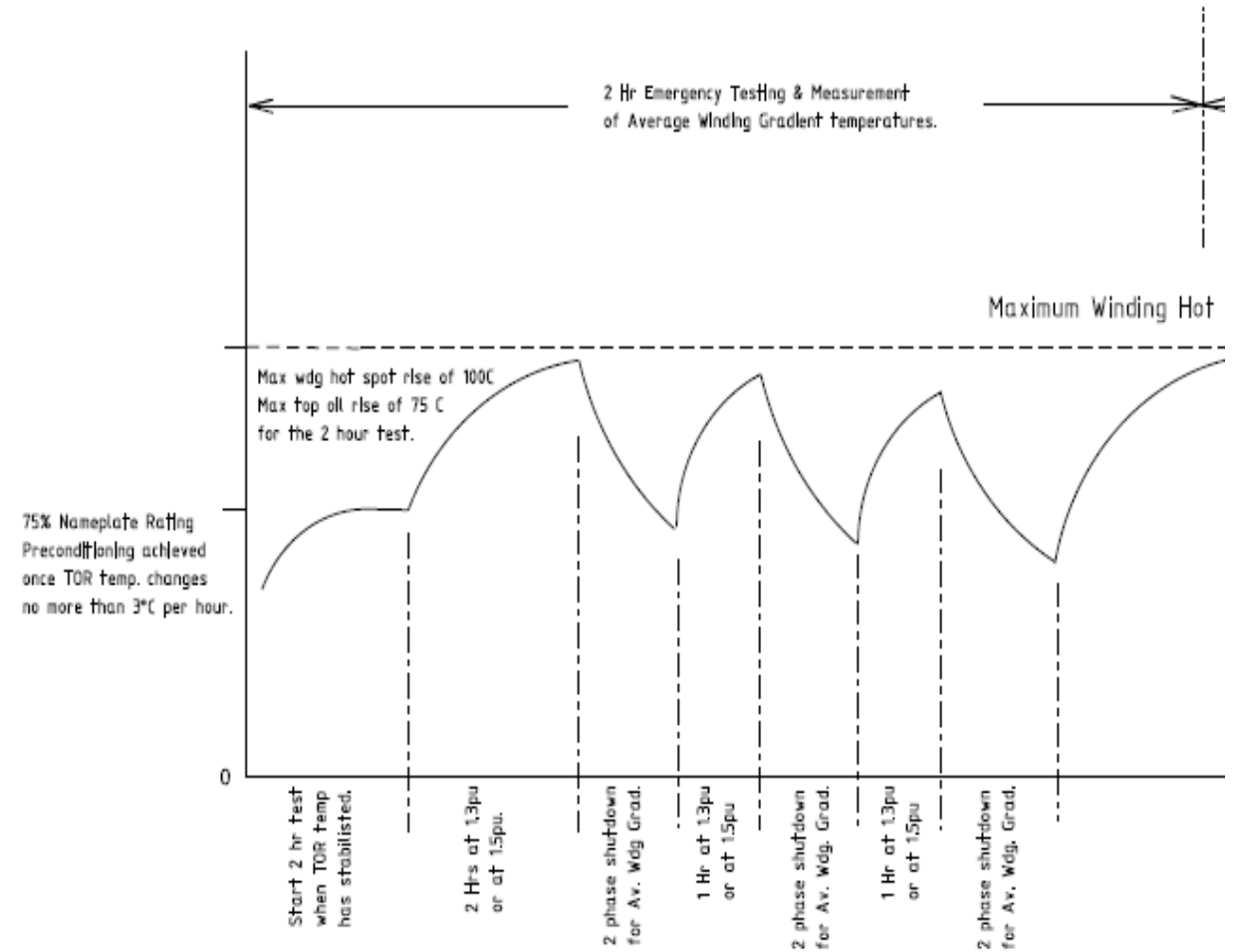
Not only PU Rating

- Duration
- Starting Condition
- Stabilisation Criteria
- Limiting Criteria

Winding Hot Spot Temperature Rise 100°C

Top oil Temperature Rise 75°C

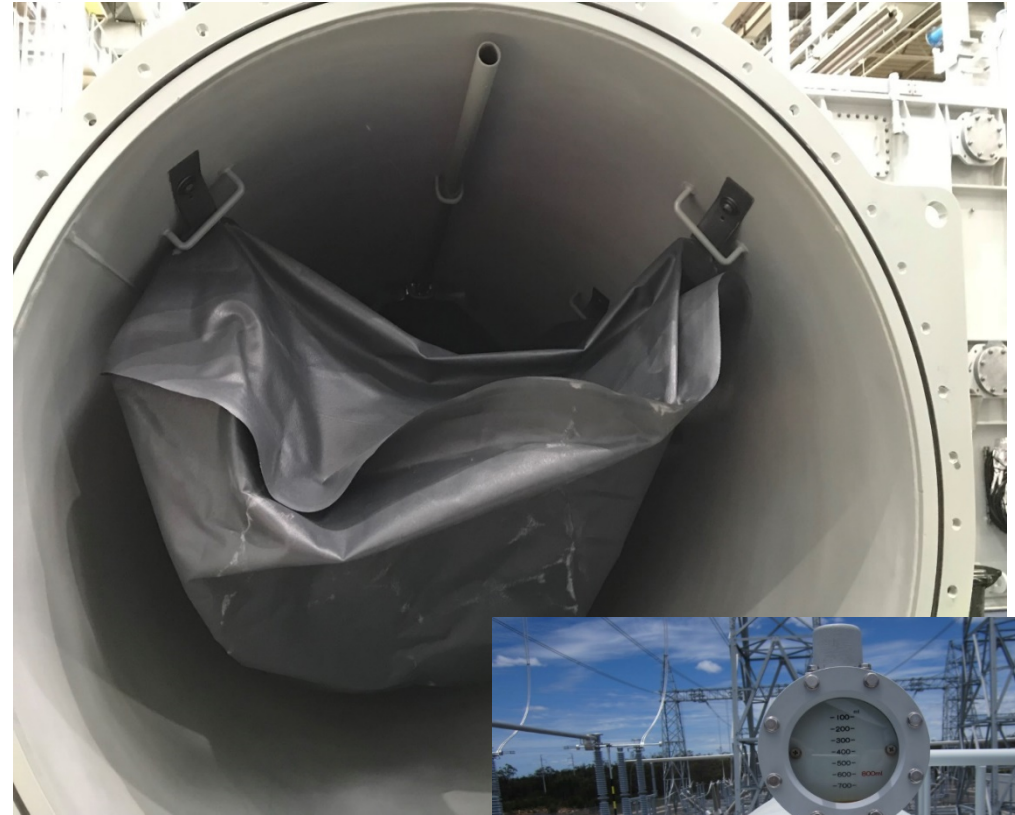
- Use Fibre optic probes @ Test



AGING



- Sealed Oil / Insulation System-
Conservator Bag
- Conductor Insulation –
Degree of Polymerisation
(DPv)



SHORT CIRCUIT WITHSTAND CAPABILITY

- System Fault Levels for ALL Systems
- Pre-fault Operating Voltage – U_m
Asymmetry Factor 'K' – 1.9
- Z_0/Z_1 Ratio
- Self Supporting Inner most winding or Packed
- Tertiary Winding Design/Physical Size



SHORT CIRCUIT WITHSTAND CAPABILITY

- Single Piece Top Clamping Ring with Uniform Thickness
- 3 Phase Simultaneous Clamping
- Allowance for Residual Clamping for Tie (Fitch) Plate designs





CORROSION PREVENTION 6 Years in Wet Tropics



CORROSION PREVENTION

Equipment Type	Exposure Area	Surface Treatment
Transformers tank, pipes, conservator	Outdoor, in contact with transformer oil on one side	<p><u>Option 1</u></p> <p>Sa 3 Blast Clean > Organic Zinc 1 (75 microns) > Polyurethane 1A (50 microns + 150 microns) - total dry film thickness 275 microns</p> <p><u>Option 2</u></p> <p>Sa 3 Blast Clean > Organic Zinc 1 (75 microns) > Epoxy 3A (50 microns + 100 microns) - total dry film thickness 225 microns</p>
Transformers tank, pipes, conservator	Internal, in contact with transformer oil	<p>Epoxy 4 dry film thickness 150 micron</p> <p>Alternatively Tenderers standard if approved by Purchaser</p>
Transformers	Outdoor Tank Base	Sa 3 Blast Clean > Epoxy 4 - total dry film thickness 400 micron
Transformer and cooler bank structural steel	Outdoor, not exposed to transformer oil	Hot dip Galvanised to AS 4680
Cubicles & Marshalling boxes, distribution boards	Outdoor	<p>Minimum 3.0 mm Aluminium Alloy grade 5251-H34 to AS 1734</p> <p>Alternatively minimum 2.5 mm brushed Stainless Steel Grade 316</p>



