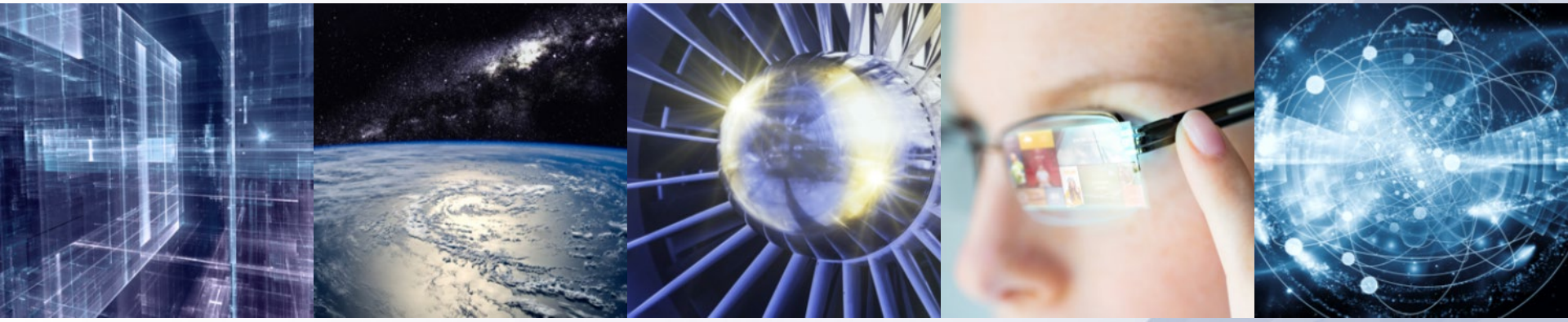

Task Force

Core Ground and Winding Insulation Resistance Performance and Interpretation

IEEE
Advancing Technology for Humanity

TF CG & IR – Performance & Interpretation

Spring 2023 Meeting – Milwaukee WI – Monday March 20, 2023 (4:45 – 6:00 PM)

- TF Chair: Diego Robalino (MEGGER)
- TF Secretary: Aniruddha Narawane (EATON)
- F22 meeting – Total 72 attendees – 16 requested membership
- Main Activities:
  - Scope of work for this TF
  - Purpose definition
  - Assign Volunteers

Patent Claim

Participants have a duty to inform the IEEE

- Participants shall inform the IEEE (or cause the IEEE to be informed) of the identity of each holder of any potential Essential Patent Claims of which they are personally aware if the claims are owned or controlled by the participant or the entity the participant is from, employed by, or otherwise represents

- Participants should inform the IEEE (or cause the IEEE to be informed) of the identity of any other holders of potential Essential Patent Claims

Early identification of holders of potential Essential Patent Claims is encouraged

IEEE SA Copyright Policy

https://standards.ieee.org/wp-content/uploads/2022/02/ieee-sa-copyright-policy.pdf

IEEE SA CR

IEEE SA COPYRIGHT POLICY

- The IEEE SA Copyright Policy is described in the IEEE SA Standards Board Bylaws and IEEE SA Standards Board Operations Manual
  - IEEE SA Copyright Policy, see
    Clause 7 of the IEEE SA Standards Board Bylaws
    https://standards.ieee.org/about/policies/bylaws/sect6-7.html#7
    Clause 6.1 of the IEEE SA Standards Board Operations Manual
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- IEEE SA Copyright FAQs
  - https://standards.ieee.org/faqs/copyrights/

- IEEE SA Best Practices for IEEE Standards Development

http://standards.ieee.org/content/dam/ieee-standards/standards/web/documents/other/best_practices_for_ieee_standards_development_051215.pdf

- Distribution of Draft Standards (see 6.1.3 of the SASB Operations Manual)
  - https://standards.ieee.org/about/policies/opman/sect6.html

Members TF (48)

Last Name	First Name	Last Name2	First Name3	Last Name4	First Name5
Adams	Kayland	Gyore	Attila	Sen	Cihangir
Almeida	Nabi	Herron	John	Shalabi	Jaber
Ansari	Tauhid	Hollrah	Derek	Shosanya	Adetokunbo
Antosz	Stephen	Kiparizoski	Zan	Singh	Kushal
Artega	Javier	Leal	Fernando	Som	Sanjib
Avanoma	Onome	Mahajan	Kushal	Taylor	Marc
Ayers	Don	Mani	Balkrishanan	Tendulkar	Vijay
Boettger	William	Mbouombouo	Mama	Tolcachir	Eduardo
Britton	Jeffrey	Narawane	Aniruddha	Varghese	Ajith
Calitz	David	Panesar	Parminder	Vijayan	Krish
Castellanos	Juan	Patel	Poorvi	Wallach	David
Debass	Samson	Patel	Rakesh	Wazir	Areeb
Dutta Rey	Samragui	Robalino	Diego	Weiseusee	Matt
Ferreira	Marcos	Rodriguez	Leopoldo	Weiss	Zachery
Flores	Hugo	Sauer	Dan	Yang	Baitun
Gara	Loren	Scott	Dennis	Zhang	Shibao

Agenda

- Call for Patents
- Copyright Policy
- Suggested Agenda
- Minutes from F22
- Attendees Introduction
- Presentation of Tests carried out by Tubos Trans Electric S.A. (Argentina)
  - Distribution specimens
  - Average results at 2.5 and 5kV
- Presentation of IR testing on a 2-winding transformer (D. Robalino)
  - Oil-impregnated
  - Dry-type
- Task Assignments – revision
- Meeting Adjourn

Experimental work in factory

New OIP distribution transformers

Tubos Trans Electric

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Scope of work

Considerations

Tubos Trans Electric

- Test on distribution Transformers 63 kVA up to 1000 kVA (13,8 kV)
- 43 units were tested in the 3 possible configurations.
- 2 different construction types.
  - Up to 250 KVA
    - LV (Helical - paper wrapped conductor) / HV (Helical – magnet wire)
  - 315 KVA and larger
    - LV (Foil) / HV (Helical – magnet wire)
- No Core / Ground IR test was performed (construction characteristics)
- Test was carried on 3 different voltages – 0.5 kV (LV); 2.5kV; 5 kV

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Tabulated average values

Tubos Trans Electric

Values - GΩ *Test time : 1 minute*

Test Voltage (kV)	Configuration						
	Recommended			Typical		Alternative	
	HV (+) / LV (-) y Tank (G)	HV (+) / Tank (-) y LV (G)	LV (+) / Tank (-) y HV (G)	HV (+) / Tank (-) y LV (G)	LV (+) / Tank (-) y HV (G)	HV (+) / LV (-) y Tank (-)	LV (+) / Tank (-) y HV (-)
2,5 (HV - LV) - 9 units	143,7	87,2	43,1	85,2	51,9	64,6	37,7
2,5 HV / 0,5 LV – 7 units	324,0	99,2	72,4	98,7	117,8	36,3	26,1
5 HV / 0,5 LV - 27 Units	239,4	86,4	47,3	87,9	56,8	67,1	24,9
General	235,7	91,0	54,2	90,6	75,5	56,0	29,6

Some units was tested 2 times with different voltages

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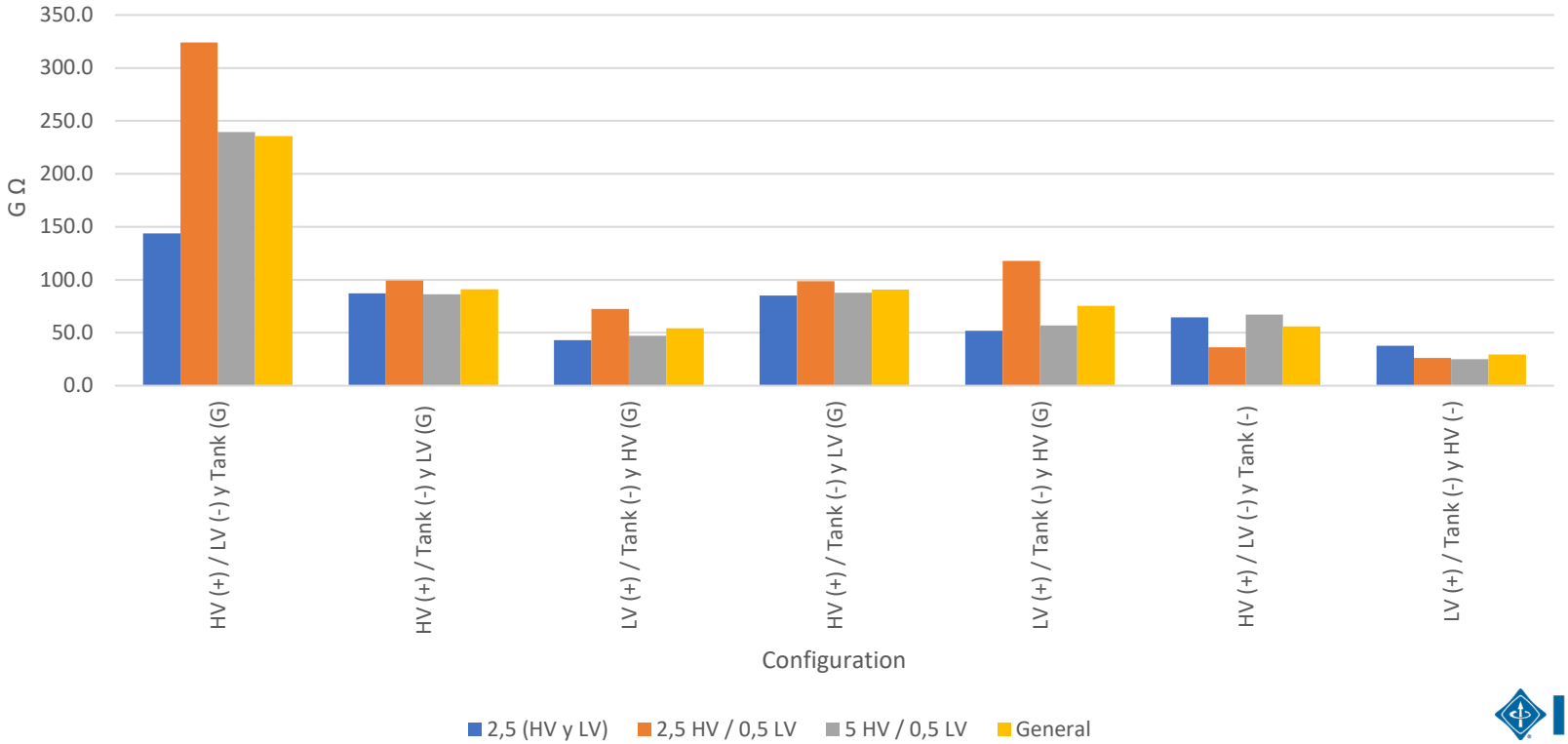
Results by Configuration

Tubos Trans Electric



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Summary of Results

Tubos Trans Electric

		Recomended			Typical		Alternative	
		HV (+) / LV (-) y Tank (G)	HV (+) / Tank (-) y LV (G)	LV (+) / Tank (-) y HV (G)	HV (+) / Tank (-) y LV (G)	LV (+) / Tank (-) y HV (G)	HV (+) / LV (-) y Tank (-)	LV (+) / Tank (-) y HV (-)
Rated power < 315 kVA (16 units)	Average GΩ	**266**	**86**	**66**	**88**	**96**	**50**	**26**
Rated power ≥ 315 kVA (27 units)	Average GΩ	222	93	44	93	50	70	30

❖ Constructive type ????

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Future Work

- Continue measurements in distribution transformers.
- Incorporate measurements on power transformers (up to 230 kV, mostly 145 KV class)
- Incorporate data from field test (difficult the boys are not very organized)

Credits: distribution transformer test field staff, TTE S.A

Questions ???

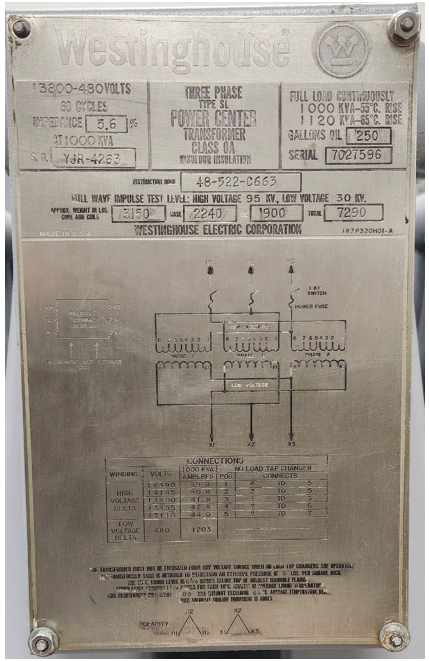
Thanks

Experimental Work – I

IR test repeatability in oil-impregnated distribution transforme

The specimen

Mineral oil immersed Transformer



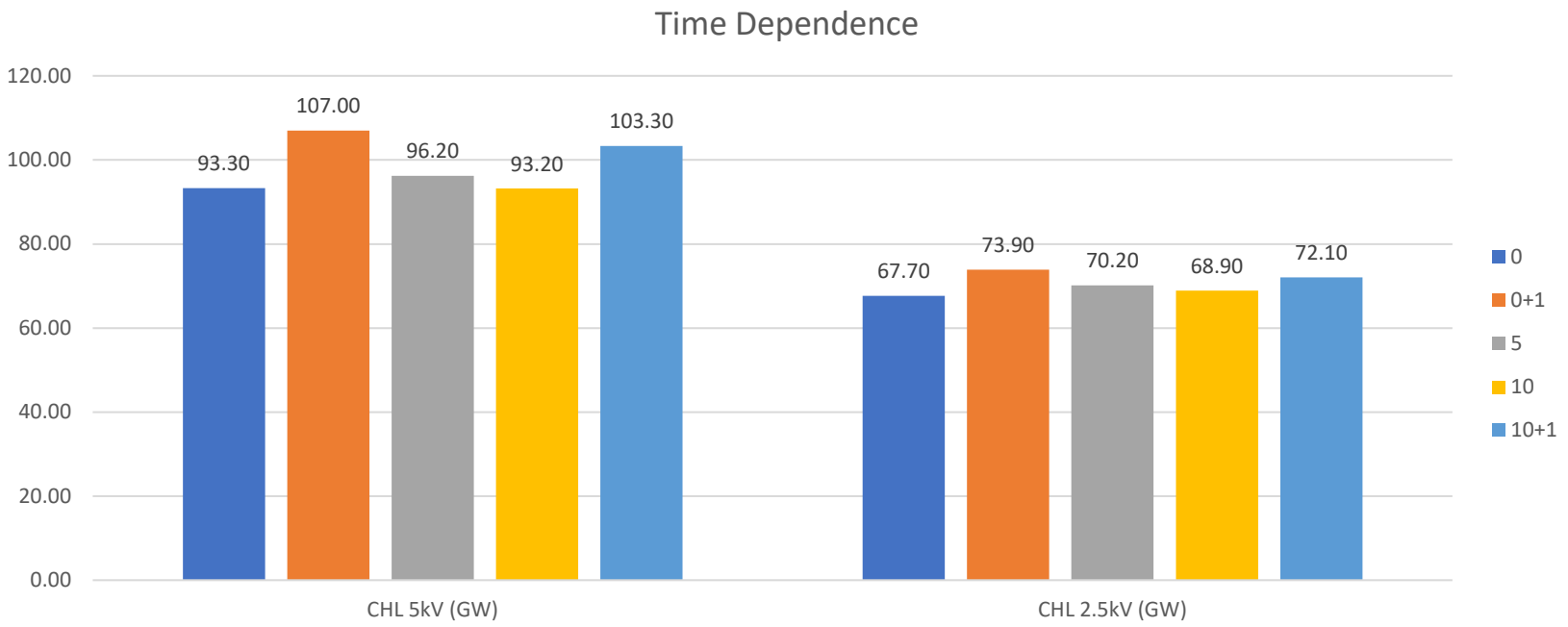
The unit is available at the AVO Training Institute in Dallas, TX

- Y.O.M : 1970
- Dd0
- Temperature: ~ 21C
- In-doors testing

Results of IR test on OIP unit as a function of time

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS	TEST 2 (IMMEDIATE)	UNITS	TEST 3 (5 min)	UNITS	TEST 4 (10 min)	UNITS	TEST 5 (1 min)	UNITS
CHG	5000	RED (+)	BLUE (GUARD)	BLACK (-)	13.97	GigaOhms	14	GigaOhms						
CHL	5000	RED (+)	BLACK (-)	BLUE (GUARD)	93.3	GigaOhms	107	GigaOhms	96.2	GigaOhms	93.2	GigaOhms	103.3	GigaOhms
CLG	500	BLUE (GUARD)	RED (+)	BLACK (-)	19.76	GigaOhms								
CHG	2500	RED (+)	BLUE (GUARD)	BLACK (-)	12.75	GigaOhms	13.4	GigaOhms						
CHL	2500	RED (+)	BLACK (-)	BLUE (GUARD)	67.7	GigaOhms	73.9	GigaOhms	70.2	GigaOhms	68.9	GigaOhms	72.1	GigaOhms

Results of IR test on OIP unit as a function of time

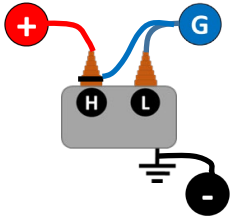


Influence of connections

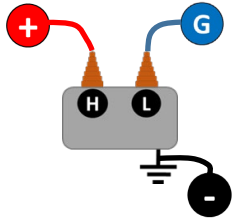
Comparative Analysis CHG

- Test performed at same voltage
- Test performed on unit “as-found”
- IR test is 1min duration

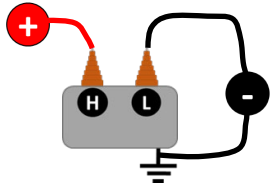
Measurement connections required



Recommended



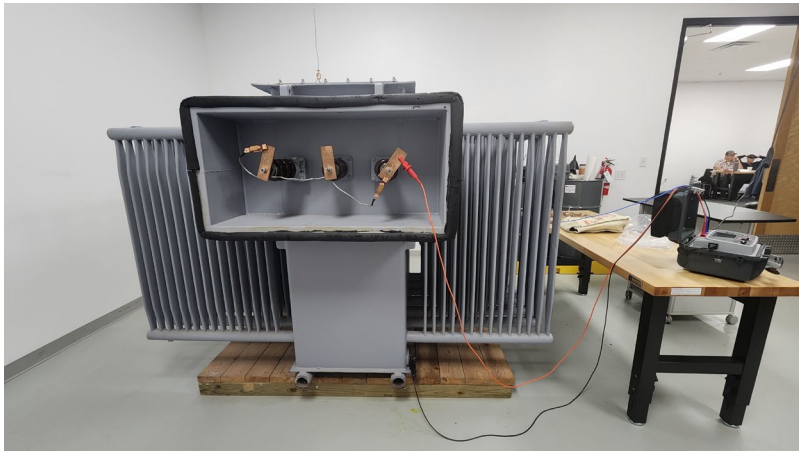
Typical



Alternative

Influence of connections

Typical Connections on OIP unit



Typical vs. Alternative

The effect of guard

- Both test carried out using 5kV test voltage from HV side and 500V from LV side

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS
CHG	5000	RED (+)	BLUE (GUARD)	BLACK (-)	13.97	GigaOhms
CHL	5000	RED (+)	BLACK (-)	BLUE (GUARD)	93.3	GigaOhms
CLG	500	BLUE (GUARD)	RED (+)	BLACK (-)	19.76	GigaOhms

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS
CH(L+gnd)	5000	RED (+)	BLACK (-)	BLACK (-)	12.46	GigaOhms
CL(H+gnd)	500	BLACK (-)	RED (+)	BLACK (-)	10.77	GigaOhms

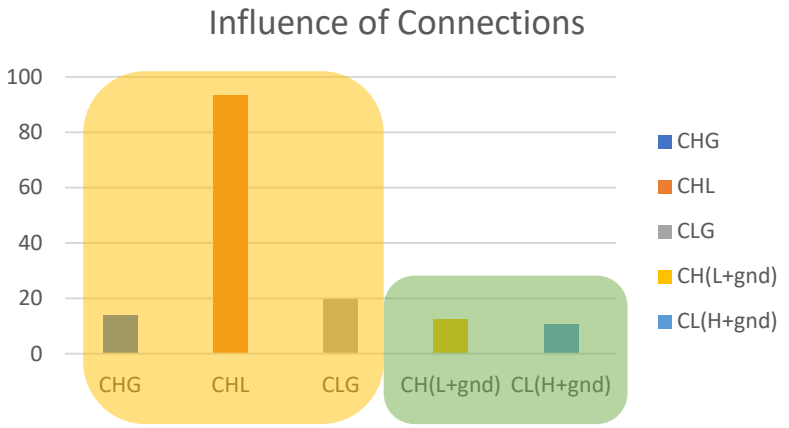
Typical vs. Alternative

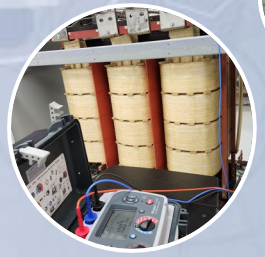
The effect of guard

- Results of TYPICAL INTERWINDING test are higher than other TYPICAL and ALTERNATIVE tests.
- Results of CHL several times higher
- Alternative connection gives similar results

Where to set limits?

Need for good feedback from the group





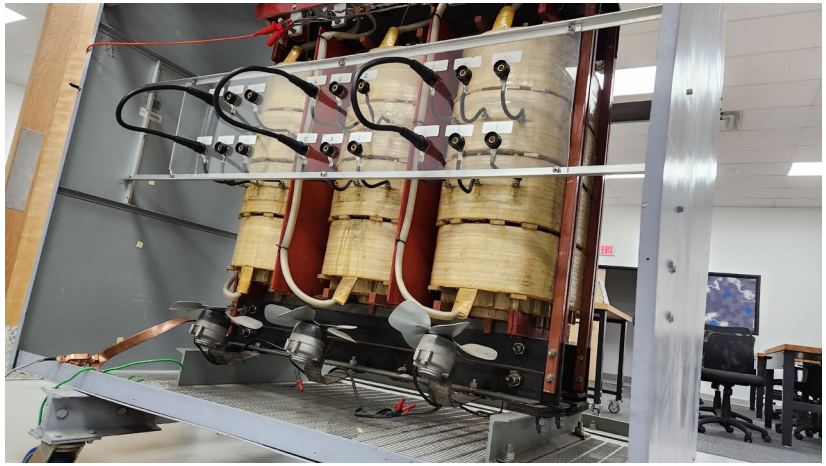
Experimental Work – II

IR test repeatability on dry-type distribution transformer

The Specimen

Dry-type distribution transformer

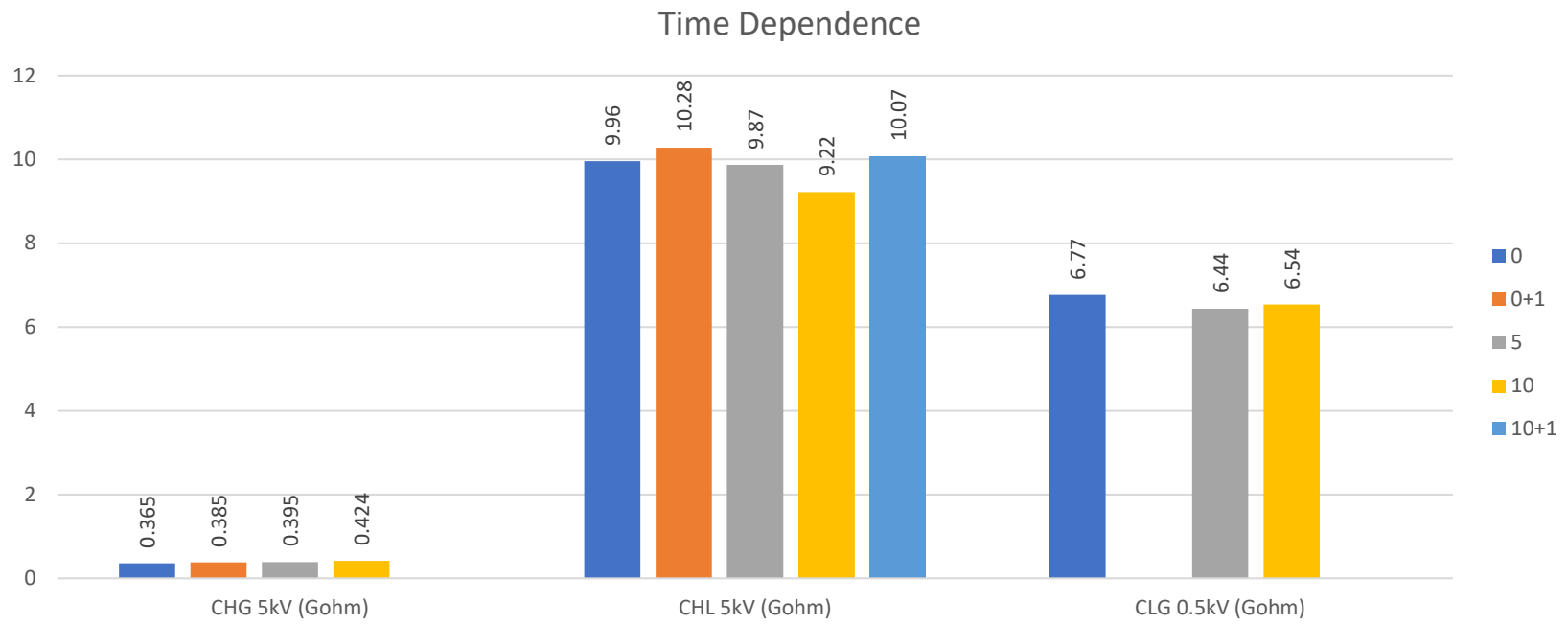
- The unit is available at the AVO Training Institute in Dallas, TX
- 1 MVA ; 13.2 / 0.208
- Dyn7



Results of IR test on dry-type unit as a function of time

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS	TEST 2 (IMMEDIATE)	UNITS	TEST 3 (5 min)	UNITS	TEST 4 (10 min)	UNITS	TEST 5 (1 min)	UNITS
CHG	5000	RED (+)	BLUE (GUARD)	BLACK (-)	365	MegaOhms	385	MegaOhms	395	MegaOhms	424	MegaOhms		
CHL	5000	RED (+)	BLACK (-)	BLUE (GUARD)	9.96	GigaOhms	10.28	GigaOhms	9.87	GigaOhms	9.22	GigaOhms	10.07	GigaOhms
CLG	500	BLUE (GUARD)	RED (+)	BLACK (-)	6.77	GigaOhms			6.44	GigaOhms	6.54	GigaOhms		

Results of IR test on dry-type unit as a function of time

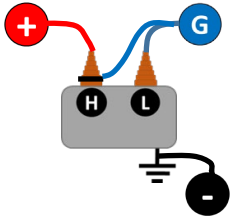


Influence of connections

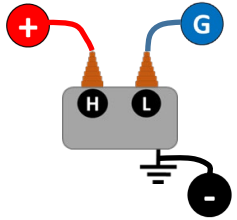
Comparative Analysis CHG

- Test performed at same voltage
- Test performed on unit “as-found”
- IR test is 1min duration

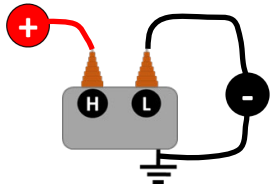
Measurement connections required



Recommended



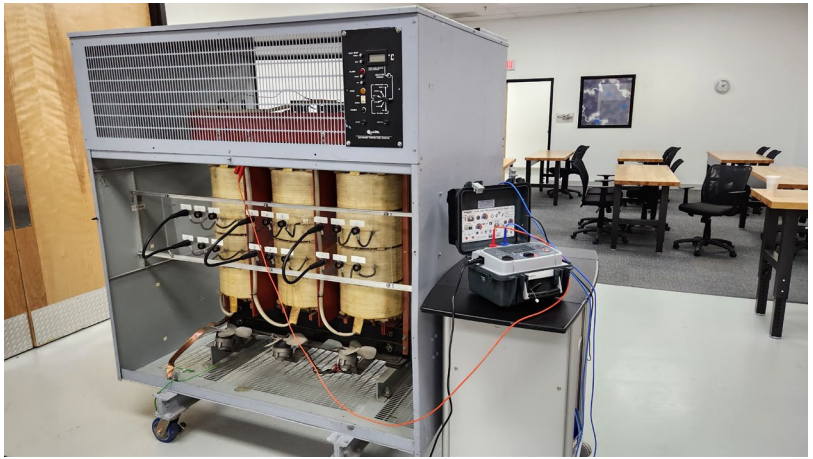
Typical



Alternative

Influence of connections

Alternative Connections on Dry-type unit



Typical vs. Alternative

The effect of guard

- Both test carried out using 5kV test voltage from HV side and 500V from LV side

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS
CHG	5000	RED (+)	BLUE (GUARD)	BLACK (-)	365	MegaOhms
CHL	5000	RED (+)	BLACK (-)	BLUE (GUARD)	9.96	GigaOhms
CLG	500	BLUE (GUARD)	RED (+)	BLACK (-)	6.77	GigaOhms

CAPACITANCE	TEST VOLTAGE	HIGH	LOW	GROUND	TEST 1	UNITS
CH(L+gnd)	5000	RED (+)	BLACK (-)	BLACK (-)	396	MegaOhms
CL(H+gnd)	500	BLACK (-)	RED (+)	BLACK (-)	1.3	GigaOhms

Typical vs. Alternative

The effect of guard

- Results of TYPICAL INTERWINDING test are higher than other TYPICAL and ALTERNATIVE tests.
- Results of CHL several times higher
- Alternative connection gives similar results

Where to set limits?

Need for good feedback from the group