Task Force

Core Ground and Winding Insulation Resistance Performance and Interpretation

IEEE
Advancing Technology for Humanity

Experimental work in factory

New OIP distribution transformers

Tubos Trans Electric

IEEE

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

IEEE

Tabulated average values

Tubos Trans Electric

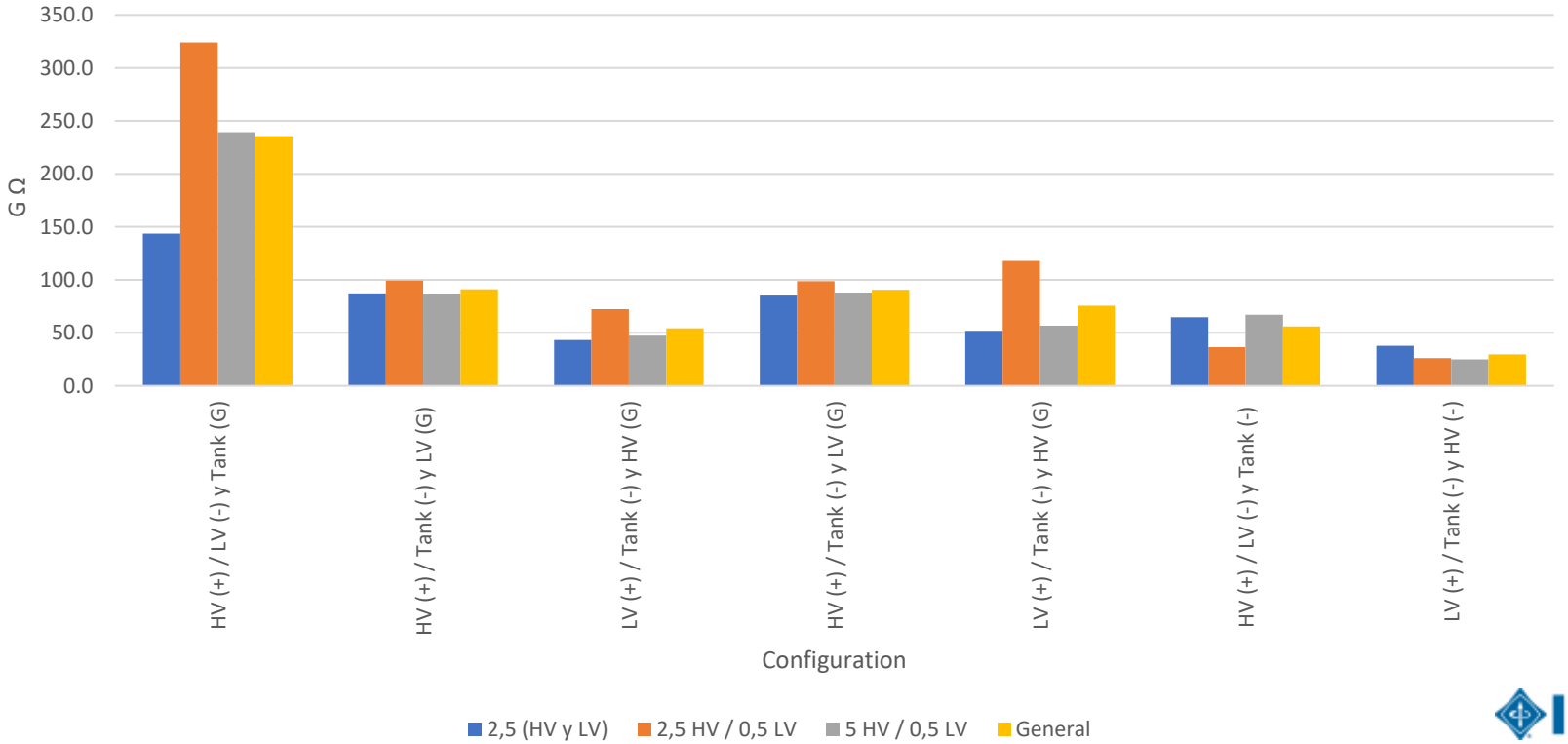
Values - GΩ *Test time : 1 minute*

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

IEEE

Results by Configuration



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

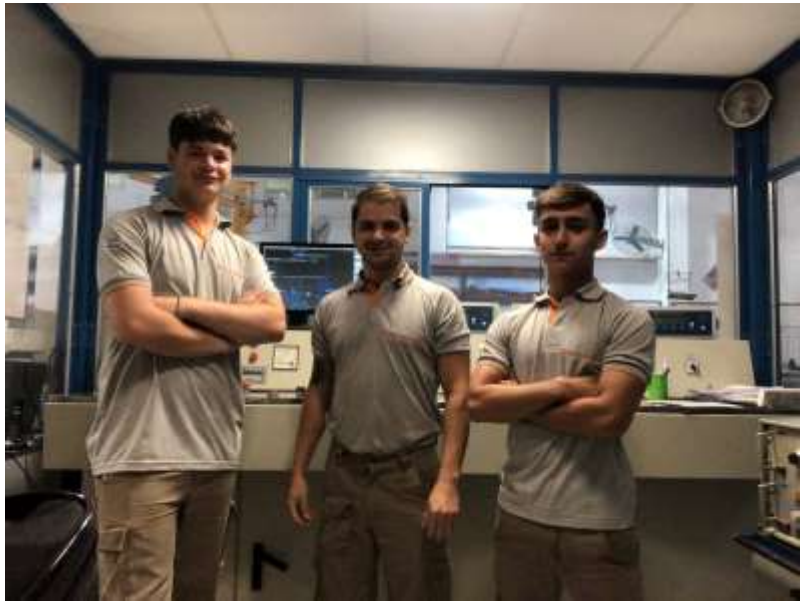
❖ Constructive type ????

IEEE

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 ???

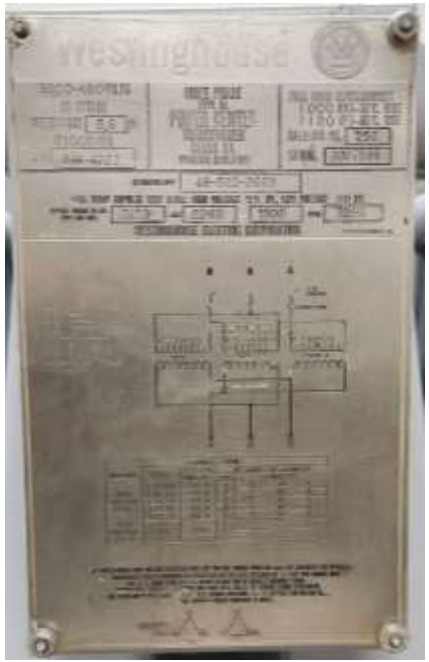
Thanks

Experimental Work – I

IR test repeatability in oil-impregnated distribution transforme

The specimen

Mineral oil immersed Transformer



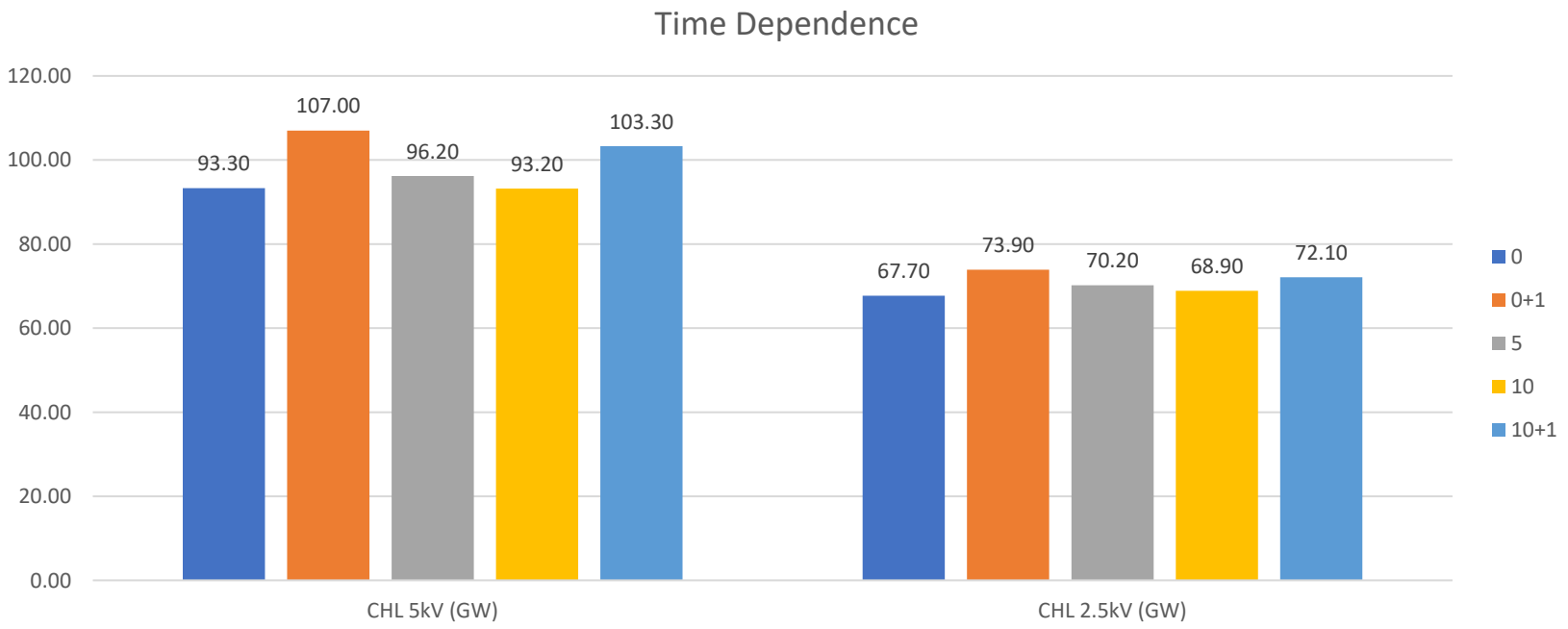
The unit is available at the AVO Training Institute in Dallas, TX

- 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

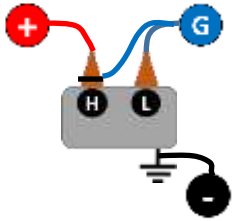


Influence of connections

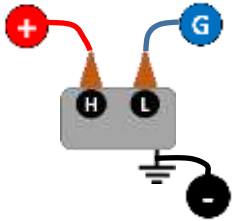
Comparative Analysis CHG

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

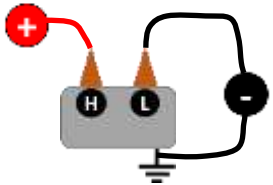
Measurement connections required



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

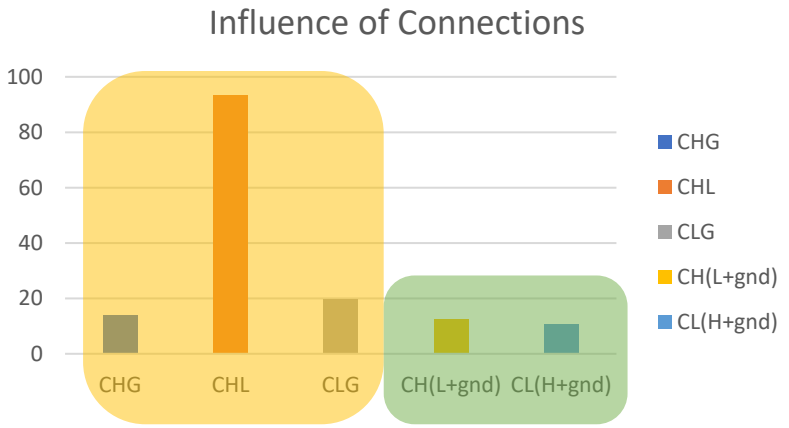
Typical vs. Alternative

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

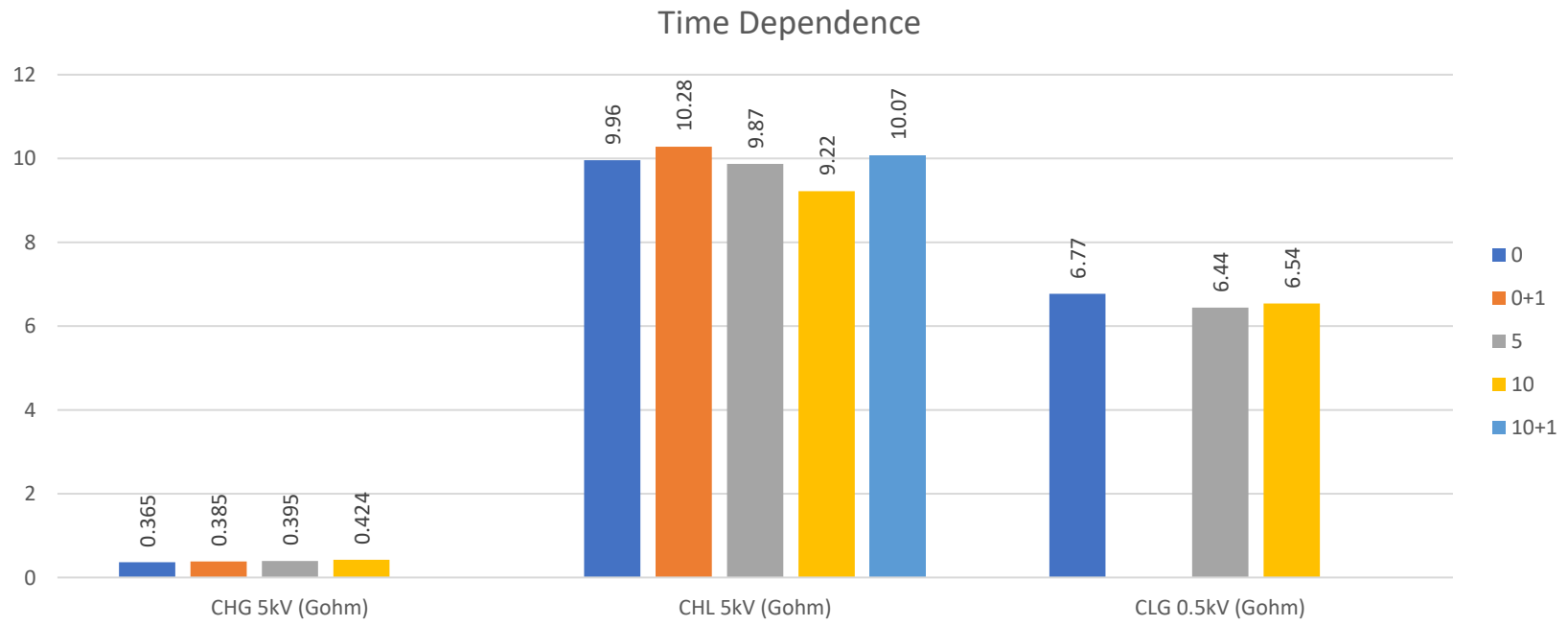
Dry-type distribution transformer

- 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

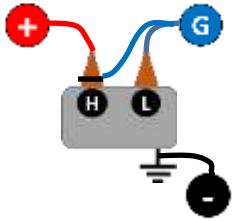


Influence of connections

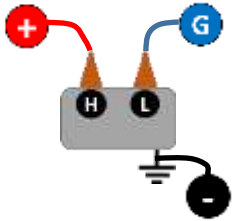
Comparative Analysis CHG

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

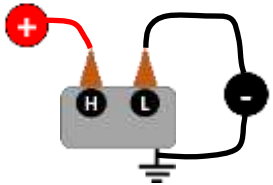
Measurement connections required



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