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TEST ON INSTRUMENT TRANSFORMERS

TRAINING BOOKLET: 4

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1. INTRODUCTION

1.1. OBJECTIVES

The tests on instrument transformers are made with the objectives of:

- Quality control of the product and reliability guarantee.
- Compliance with national or international standards and different specifications from customers.

According to its purpose, we can classify the test:

- **Dielectric**: Instrument transformers insulating properties.
- **Accuracy** of the instrument transformer which is a fundamental characteristic for this type of transformers.
- **Uniformity** of production.
- Not pushing the limits of permissible **heating**.
- Ability of conductors to withstand **high currents** of limited duration, which appears during faults or incorrect connections.

1.2. STANDARDS

In this paper we focus on the most widespread international standard, IEC (International Electrotechnical Commission).

The different IEC standards currently enforced on the conventional instrument transformers are:

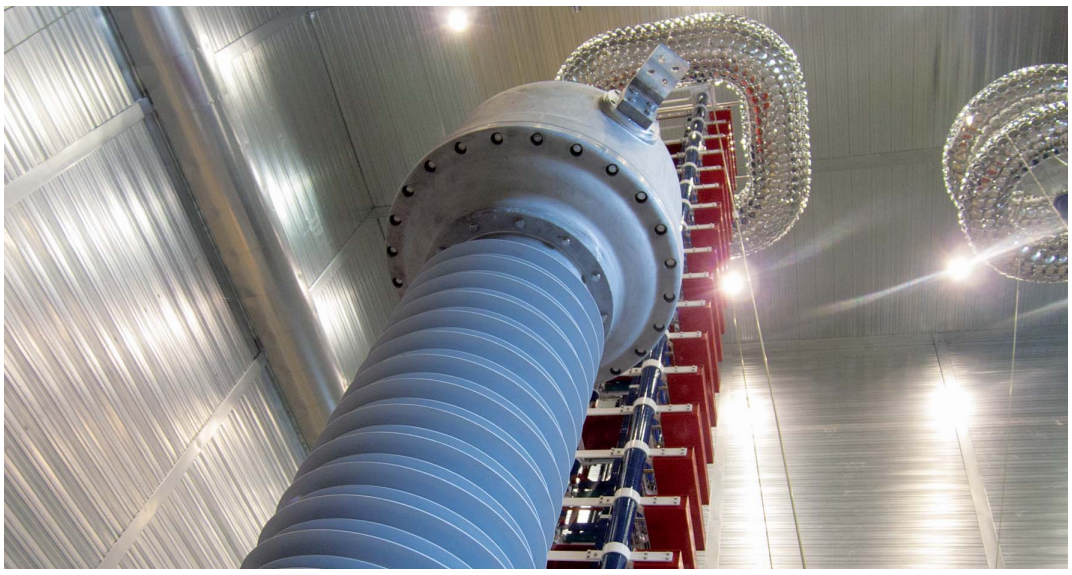
REFERENCE	TITLE	PUBLICATION DATE
IEC 61869-1	General requirements	2007
IEC 61869-2	Additional requirements for current transformers	2012
IEC 61869-3	Additional requirements for inductive voltage transformers	2011
IEC 61869-4	Additional requirements for combined transformers	2013
IEC 61869-5	Additional requirements for capacitor voltage transformers	2011

There are other international standards such as IEEE / ANSI, originally from USA, that are commonly applied in some countries in America and Asia, and the GOST standard with application in Russia and other countries of Eastern Europe and Central Asia.

There are also national standards such as NBR (Brazil) or GB (China), and several countries adapt IEC as their local standard with slight modifications, such as AS (Australia), UNE (Spain) or CSA / CAN (Canada).

1.3. SPECIFICATIONS

Each client may have their own particular specification which in general does not differ much from the above standards.



› Type test performed on a CG 245 kV.

2. TEST CLASSIFICATION AS PER IEC

2.1. TYPE TESTS

These are tests to prove that the **design** meets the mandatory requirements of the standards. They apply to a type or model.

They are only to be performed on a single sample of each different model of transformer. After the tests, it can be justified that other equipment made to the same design are also valid.

DESIGNATION	IEC CLAUSE	PURPOSE	APPLICATION	REMARKS
Temperature-rise test	7.2.2	Verify that temperatures that can damage the insulation will not be reached with the specified service conditions	General	
Impulse voltage test on primary terminals	7.2.3	Check that the internal insulation can withstand the possible overvoltages that could occur from: - Lightning over the line (lightning impulse) - Circuit breakers and disconnectors maneuver (switching impulse)	General	Impulses as per IEC 60060-1 Lightning (1.2/50 μs) Switching (250/2500 μs) Switching Um≥ 300 kV
Wet test for outdoor type transformers	7.2.4	Check that the external insulation withstands a much higher voltage than usual service even in the most unfavorable conditions (rain)	General (only for outdoor use)	For Um<300 kV same as 7.3.1 in rain. For Um≥ 300 kV same as 7.2.3. Artificial rain of certain specific characteristics (IEC 60060-1)
Electromagnetic Compatibility tests (RIV)	7.2.5	Check that the radio interference level introduced by the transformer is within the limits, not reaching values that can disrupt radio communications	General	Um ≥ 123 kV
Test for accuracy	7.2.6	Verify that the transformer complies with the limits of error of the assigned accuracy class	General	
Verification of the degree of protection by enclosures	7.2.7	Check the degree of protection provided by enclosures to the entrance of particles or water and to mechanical impacts	General	
Enclosure tightness test at ambient temperature	7.2.8	Check the leakage rate of the insulating gas	SF_6 insulated transformers	Also a routine test
Pressure test for the enclosure	7.2.9	Checking the resistance of metal enclosures and insulators to pressure	SF_6 insulated transformers	
Short-time current tests	7.2.201	Verify that the transformer withstands the thermal and dynamic forces arising from a short-circuit in the line	CT Combined	
Short-circuit withstand capability test	7.2.301 7.2.502	Verify that the transformer withstands the mechanical, electrical and thermal forces arising from an external short-circuit in the secondary windings	IVT CVT Combined	Short-circuit time: 1s
Ferro-resonance test	7.2.503	Check that the ferro-resonace suppressing device works properly, preventing ferro-resonance from being permanent when it occurs	CVT	For type test more measuring points are taken than for routine test
Transient response test	7.2.504	Check that the secondary voltage closely follows the abrupt changes in the primary	CVT	Only applicable to protective secondaries
Type test for carrier frequency accessories	7.2.505	Tests for drain coil and voltage limitation device	CVT with carrier frequency accessories	Impulse voltage test on drain coil and voltage limitation device. Voltage withstand test for drain coil

2.2. ROUTINE TESTS

These are tests to assure that the **equipment manufactured** meets the requirements of the standard.

They must be performed on each and every one of the transformers manufactured. They must comply with the minimum requirements which ensure the above objectives. (To do this type tests performed on identical model must have been previously done).

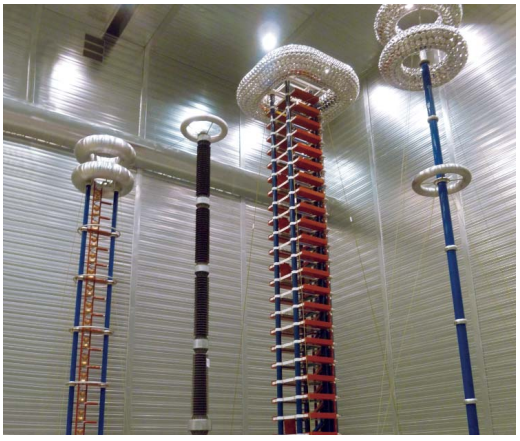
DESIGNATION	IEC CLAUSE	PURPOSE	APPLICATION	REMARKS
Power-frequency voltage withstand tests on primary terminals	7.3.1	Check that the internal insulation quality to ensure the estimated life of the transformer. Test voltages are much higher than those present in normal operating conditions (future ageing)	General	
Partial discharge measurement	7.3.2	Checking the internal insulation condition (no cavities, porosity or gas) that could lead to premature failure	General	Um ≥ 7.2 kV
Power-frequency voltage withstand tests between sections	7.3.3	Check the internal insulation between different sections of the transformer	General	Only applicable to transformers with more than one section
Power-frequency voltage withstand test on secondary terminals	7.3.4	Check the internal insulation between windings and to ground subjecting them to a power frequency voltage much higher than the service one	General	
Test for accuracy	7.3.5	Verify that the transformer complies with the limits of error of the assigned accuracy class	General	
Verification of markings	7.3.6	Avoid possible connection errors that could lead to a malfunction	General	
Enclosure tightness test at ambient temperature	7.3.7	For oil-insulated transformers, verify that there are no leaks that could result in a future malfunction. For gas-insulated transformers ensure that leakage rate is below the limit.	General	CVT: Required for EMU and capacitor divider. CT and IVT: Not mentioned in standards. Done during manufacturing process.
Pressure test for the enclosure	7.3.8	Checking the resistance of metal enclosures and insulators to pressure	SF_6 insulated transformers	
Determination of the secondary winding resistance	7.3.201	Measure the resistance, corrected to 75°C,to demonstrate compliance with the specification	CT Combined	For accuracy class: PR, PX, PXR, TPX, TPY, TPZ
Determination of the secondary loop time constant	7.3.202	Prove compliance with the specification	CT Combined	For accuracy class: PR and TPY
Test for rated knee point e.m.f. and exciting current at rated knee point e.m.f.	7.3.203	Prove compliance with the specification	CT Combined	For accuracy class: PX and PXR
Inter-turn overvoltage test	7.3.204	Check the insulation between turns and layers of the same winding	CT Combined	
Ferro-resonance check	7.3.501	Check that the ferro-resonace suppressing device works properly, preventing ferro-resonance from being permanent when it occurs	CVT	
Routine tests for carrier-frequency accessories	7.3.502	Tests for drain coil and voltage limitation device	CVT with carrier frequency accessories	

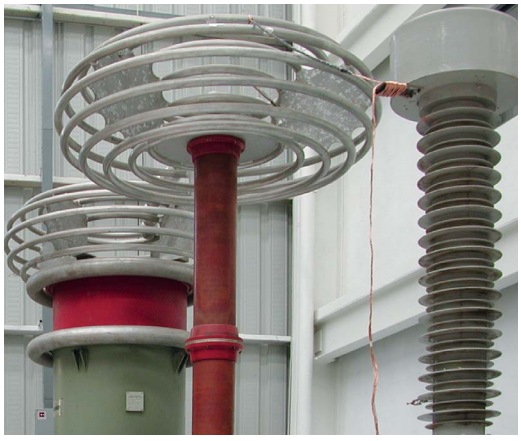
2.3. SPECIAL TESTS

These are tests to ensure compliance with **special requirements** of the standard (optional), and they are performed under manufacturer-buyer agreement.

They are usually required as a result of service conditions different from the usual.

DESIGNATION	IEC CLAUSE	PURPOSE	APPLICATION	REMARKS
Chopped impulse voltage withstand test on primary terminals	7.4.1	Check the behavior of the transformer against transitory electrical stress produced by chopped waves that can appear in the line as a result of impulse wave rebound effect	General	Type test for CVT Not applicable to VT for GIS
Multi chopped impulse test on primary terminals	7.4.2	Check the behavior of the transformers against transitory electrical stress (high frequencies), which may appear during the service as a result of the opening and closing of the disconnectors. Special attention is given to the design, location of the internal screens and connections through which the transitory currents circulate	CT, IVT, Combined	Um ≥ 300 kV
Measurement of capacitance and dielectric dissipation factor	7.4.3	a) Check the homogeneity of production b) Before and after other tests (dielectric), indicates whether they have been correct c) In CVT verifies that the real capacitance of the transformer is within the tolerance limits around the rated capacitance	Dry and oil-paper insulated transformers	Routine test for CVT. ARTECHE performs as a routine test to all the transformers
Transmitted overvoltage test	7.4.4	Check the ability against very high frequency overvoltages that can penetrate the insulation, reaching the equipment connected to the secondary, with the corresponding threat to equipment and people	General	
Mechanical tests	7.4.5	Check that the transformer support the mechanical efforts that can occur in a line due to the weight of cables, wind, earthquake, etc.	General	
Internal arc fault test	7.4.6	Check transformer behavior to an internal arc fault causing an explosion	CT, IVT, Combined	Um ≥ 72.5 kV
Enclosure tightness test at low and high temperatures	7.4.7	Check the leakage rate of the insulating gas at the operation temperature limits	SF_6 insulated transformers	
Gas dew point test	7.4.8	Checking the quality of the gas by its maximum moisture content	SF_6 insulated transformers	
Corrosion test	7.4.9	Check the resistance to corrosion of the metal parts of the transformer	General	
Determination of the temperature coefficient	7.4.501	Associated with the temperature type test	CVT	
Tightness design test of capacitor units	7.4.502	Prove the quality of the tightness design of the capacitor units	CVT	





› Impulse type test to a 1,200 kV capacitive voltage transformer.

› Routine test to a 145 kV inductive voltage transformer.

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